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ECORYS Nederland BV
P.O. Box 4175
3006 AD Rotterdam
Watermanweg 44
3067 GG Rotterdam
The Netherlands

T +31 (0)10 453 88 00
F +31 (0)10 453 07 68
E netherlands@ecorys.com
W www.ecorys.com
Registration no. 24316726

ECORYS Macro & Sector Policies
T +31 (0)10 453 87 53
F +31 (0)10 452 36 60

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1 Introduction

The European air transport system consists of a fleet of about 5 000 aircraft, and moves 1 billion people per year. The sector contributes about EUR 500 billion to the EU GNP and employs 3.1 million people, which represents 1.9% of all EU jobs. Exports amount to 60% of the aeronautics industry's turnover, generating a trade surplus of EUR 2.2 billion.[1]

The aerospace industry must operate in a long-term perspective of 20 to 30 years. Accordingly, the policy framework which is established today and the respective allocated resources determine the perspectives and performance of the industry for decades to come.

This study's aim is to give an overview of the current state of the European aerospace industry (AI), its relevance and competitive position in the global aerospace market. It provides a data analysis with a quantitative assessment of the competitive situation in Chapter 2. The subsequent Chapter 3 offers a qualitative assessment of the large European AI countries, the behaviour and strategies of the major companies, an overview on the main AI subsectors and finally current trends in product and technology development. Chapter 4 analyzes the general framework conditions for this industry within Europe followed by an analysis of the major competing countries in Chapter 5. The subsequent Chapter 6 then provides a synthetical summary on the competitiveness of the European AI, which is followed by a strategic outlook consisting of a SWOT analysis and policy recommendations in Chapter 7.

The focus of the study is on civil aviation, which explicitly excludes space activities. Military aviation is only included in the analysis when interdependencies to civil aviation are significant and important or when the available data allow no differentiation. The analysis will cover the manufacturing of large jet airplanes, regional and business jets, helicopters, engines, intermediary input (equipment, avionics/electronics, aerostructures/components) as well as maintenance, repair and overhaul (MRO).

The following introduction provides a short review on the previous DG Enterprise study "Star 21", an overview on the basic industry characteristics, the historic evolution, and general patterns in the business cycle of the (European) AI.

1.1 Previous Work

The Strategic Aerospace Review for the 21st century (European Commission, 2002) is a report drafted on the basis of analyses and recommendations given by the European Advisory Group on Aerospace, which was set up for this purpose in 2001study. It was supported by the European

[1] See: European Commission, 2006.

Commission and aims at "creating a coherent market and policy framework for a vital European industry". The report highlighted the strategic role of the industry as a generator of wealth, maintainer of global competition and as a driver of innovation. Furthermore it gave a view on the industry profile, covering the civil and military links and stating the cyclical nature of this capital-intensive industry, which underwent several waves of consolidation and privatisation.

The report concluded that for an improved governance of civil aviation a strong European organisation is needed in order to drive the overall policy of the sector. This comprehends a Civil Aviation Authority as well as a harmonized Air Traffic Management (and a master plan for the Single European Sky initiative). Furthermore recommendations have been given in the fields of "competing on world markets" (ensure improved access to world markets / fair reciprocal market access, wider international agreements to simplify export controls on products with US components, international cooperation programmes) and the operating environment (consider specific aerospace features in competition policy, analyse impact of taxation schemes on innovation, coordinate and apply tax and other incentives to promote innovation, consider education and training needs of a long term skilled work force, facilitate cross-border mobility of staff - also with respect to social security schemes, accelerate development of practical training schemes in accession countries, let key stakeholders define long-term research priorities and improve the coordination and joint planning of research programmes – at European, national, regional and industry levels, allocate sufficient public resources to sustain a long-term civil aeronautics research strategy with a total investment of EUR 100 billion for the next 20 years from public and private sources).

Additionally the report offers recommendations on how to safeguard Europe's security and defence capabilities as well as its role in space.

The European Commission replied to the STAR 21 report with a Communication[2], in which most of the recommendations are taken on board.

1.2 Particularities of the Industry

To understand the competitiveness of the aerospace industry one needs to know the particularities of this very special industry. The following six points depict the peculiarities of the aerospace industry. These strongly influence the structure and evolution of the production organisation, the localisation of activities and – last but not least – the relation between the governments and the industry[3]

High technological level

The high technological level of current aircraft configurations and its underlying technology imply that a slight improvement in the technology is obtained through great efforts and a steep increase in the final costs of the vehicle. This does also explain the significant homogeneity of technological solutions: a little erroneous variation of the technology and price involve massive financial losses. There is a very high risk for a wrong positioning in the technology matrix. Firms

[2] COM(2003) 600 final, 13.10.2003, A coherent framework for aerospace – a response to the STAR 21 report.
[3] The following paragraphs are based on Esposito and Raffa, 2006.

try to reduce these risks through various collaboration and cooperation agreements with other firms including those that could be potential competitors.

Technological complexity

The complex nature of an aircraft is a barrier to innovation, as it implies limited possibilities to control all technologies and interdependencies. Again, huge efforts translate into small technological improvements. Firms therefore concentrate their know-how in particular areas to push the technological frontier. To manufacture an aircraft therefore implies the need to develop a system of relationships between specialised firms.

High and increasing development costs

At the end of the eighties, some authors estimated that development costs for a new generation aircraft would reach USD 10 billion. The estimates for the A380 reached USD 15 billion in 2004. To reduce high development and management costs and to reduce financial risks, firms go to an intensive pre-project period to single out those partners best suited for the work.

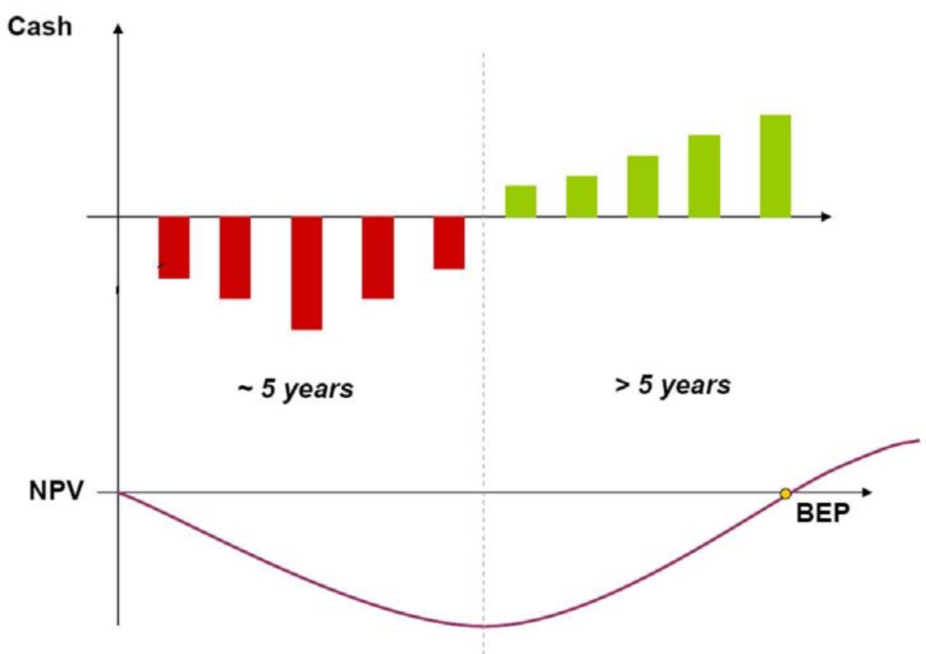
Long break even periods and small markets

There is no single country in the world able to absorb in its internal market the numbers of aircraft necessary to reach the break even threshold, which assures the profitability of a single manufacturer. Furthermore, many governments impose direct and indirect barriers on the acquisition of aircraft not manufactured with the contribution of local firms. Large manufacturers get around these market barriers by making agreements involving firms from different countries in the production process.

Problematic cash flow

The aerospace industry is characterised by heavy upfront investments and exceptionally long programme lives, which lead to a very problematic cash flow profile, as indicated in Figure 1.1.

Figure 1.1 Life Cycle Costs in the Aerospace Industry



Source: Airbus & EADS Global Sourcing Strategy, BDLI, May 2009.

Funding of the development process is therefore a very critical factor for a company's success. It is also increasingly important for smaller companies, as prime contractors move to a further sharing of risks and development costs.

Markets operating under such cash flows patterns tend to become a monopoly, as second movers have hardly any chance to enter the market by themselves. Airbus was only able to enter the market of large civil aircraft after massive state intervention, leading to the oligopoly we currently see in the market of aircraft with more than 100 seats.

High interdependencies between civil and defence markets

Military markets follow their own logic, as the states are usually covering the development costs of the new products, which leads to a much lower risk for the involved companies. Even if applications at system level are not very common, the respective companies usually strongly benefit in the civil markets from these newly developed technologies. The US department of Defence explicitly funds dual-use technology development in order to support the strategic goal of economic leadership for the US industry. Examples can be found at systems level with the B707, the CASA CN 235 or the BellBoeing Ospray Tilt Rotor Aircraft (V22 in military, and BA 609 in civil markets). It is currently unclear however, if the synergies to be used are increasing or not. They will probably also depend on the military budgets of States. System level dual use developments however become more and more seldom, as the requirements of the respective markets diverge.

Due to growing budget constraints public authorities ask the AI to use civil R&D results for military project. A400M was the first military project that was funded by a scheme up to now only applied for civil projects. As a consequence not only technical problems but financial issues hampered a smooth product development.

Strategic industry

Since its early days the aerospace industry has been seen as a strategically important sector of the economy. Governmental support and market protection have always been instruments for the internal organisation and the financing of the industry.

Arguments for this support are traditionally (i.) military autarky, (ii.) spill-over and external effects of this high tech industry and (iii.) the need to prevent monopoly power of other countries in this field. Nowadays the efforts to keep this high-tech and high-wage sector in the countries have become increasingly important in the light of the ongoing globalisation and its accompanying new division of labour within the world. A new (practical) argument is the need for an own industrial policy as the necessary strategic answer to other nations industrial policy. This argument does hold, even if there would be no economic benefit of supporting an industry in the first place.

This last two arguments become more and more important especially as countries like China, Russia, Brazil and India are now more and more entering this market with own products and services and a strong governmental support.

1.3 Historical Evolution of the Industry

The factors described above have, in the past, imposed various barriers for the firms operating in aviation, resulting in a (vertical) production organisation on an international scale with an intense collaboration of firms. They have also led to an ongoing (horizontal) consolidation of the industry, within Europe and Northern America as well.

1.3.1 Horizontal Evolution of the Industry[4]

In-house production phase – The 1950s

In the 50s, as the technology was dominated by the piston engines, there was practically no co-operation agreement among aircraft production firms. An aircraft was wholly designed and produced by one company, as at that time they were still able to overcome the technological and financial barriers of such a project.

First collaboration phase – The 1960s

Mainly due to the introduction of the jet engine, the first collaborations in the industry began. One of the main drivers of this was the engine manufacturer Rolls-Royce (RR), which made an agreement with an American and a European company. The Concorde programme also gave birth to a co-operation between British Bristol Siddeley (later taken over by RR) and the French Snecma to develop the Olympus engine, and between the British Aerospace Corporation (later BAE) and the French Sud Aviation – Société Nationale de Construcions Aéronautique to develop the Concorde. A lot of different programmes were launched and carried out simultaneously. Most of the German aerospace industry's activities were restricted to manufacturing in licence.

European consortia phase – The 1970s

The 70 saw the evolution of the first European programmes and consortia. As an answer to the American competitors, Airbus was created. The Airbus A300 was the result of an alliance between Aerospatiale, DASA, BAE and CASA. In the engine sector the former agreements were consolidated and two more were added: The first consortium between RR, TU and Fiat Avio to develop the Turbo-Union (RB -199 for the Tornado), the second between the French Snecma and the American General Electric to create the CFM family. The Tornado development gave also rise to an aircraft consortium called Panavia, a tri-national consortium consisting of British Aerospace, MBB of West Germany, and Alenia Aeronautica of Italy. The driving factor for the growing international co-operations was the increasing project volumes and the shrinking abilities to execute them within national borders. Only the US and to a certain extend France – that pursued an explicit national aerospace industrial policy – focused on national projects further on.

Worldwide cooperation phase – The 1980s

In the 80s, there was an increasing tendency to internationalise the production cycle of the aircraft industry. Especially the need to develop a new generation of engines - with low fuel consumption and the ability to propel large aircraft - pushed the development of big international cooperations (RR, Pratt & Whitney, Fiat Avio and Japanese JACE formed the first cooperation involving three different continents: the International Aero Engines, IAE). This consortium built the V2500 in order to provide an alternative engine for the newly developed Airbus A320 aircraft family compared to the existing CFM56, which powered the Boeing 737. Also the strategies of

[4] This characterization follows Esposito, 2004.

Airbus, Aerospatiale and British Aerospace changed as they aimed at becoming the number one in the air transport sector.

Crisis phase – Early 1990s

In the early 90s, the aviation industry underwent a period of crisis due to a sharp drop in world demand and a heavy reduction in the turnover and stall in all firms. The tendency to form international relationships however did not slow down. Especially the breakdown of the former communist block and the increasing costs of developing new programmes pushed the tendency to form worldwide co-operations. The high level of technology achieved now required a global market to remain profitable. At the same time, the strategy of the Airbus consortium changed again, aiming at conquering the world leadership (instead of only competing with US companies in specific market segments). In 1992 the German MBB and the French Aerospatiale joint their helicopter divisions and created Eurocopter, to strengthen its position in global markets.

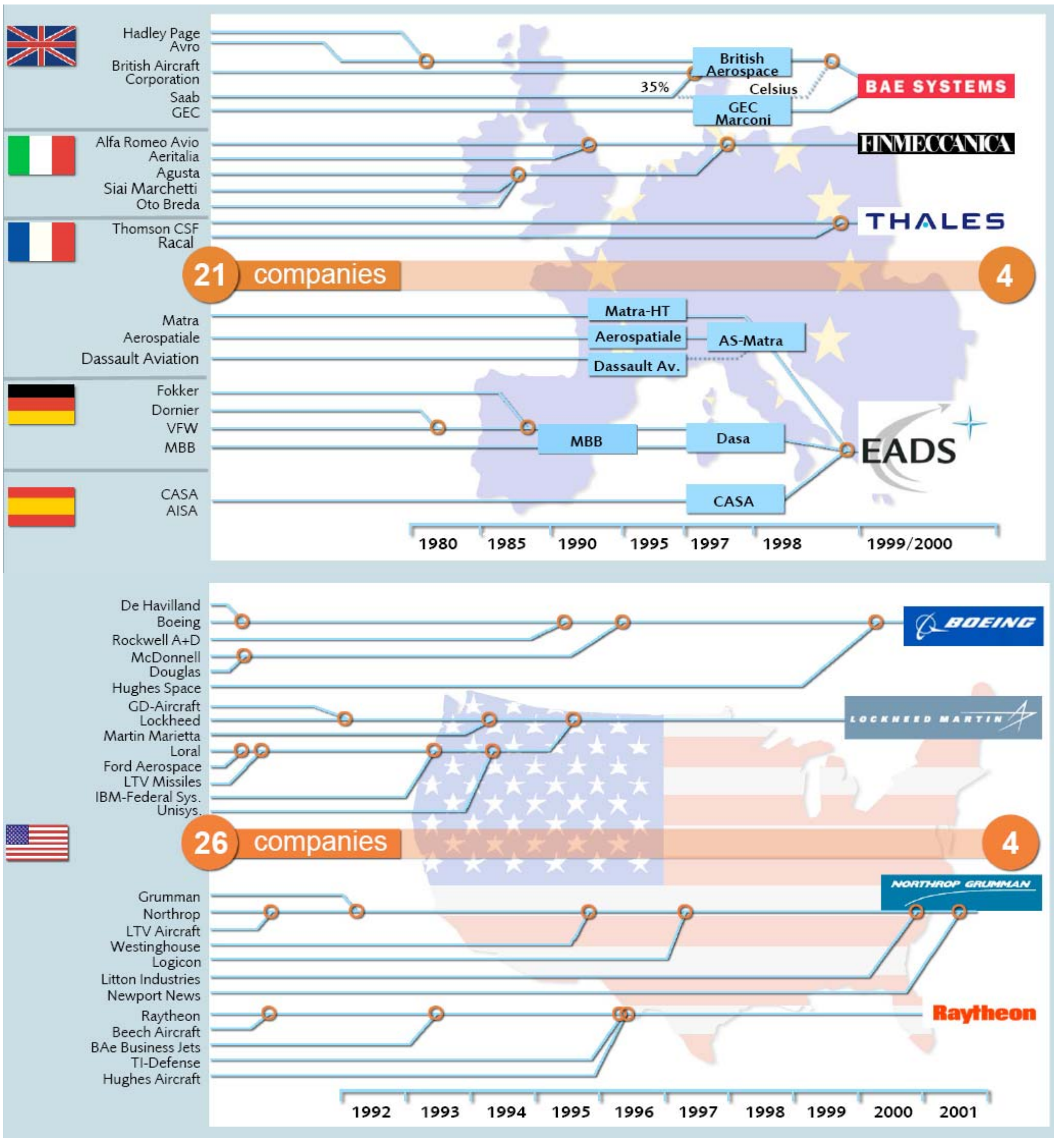
Industrial integration phase– Late 1990s

From 1995 onwards, the aerospace sector came out of the slump and with the recovery in world demand new programmes were launches (civil A380, and the Joint Strike Fighter in the military realm).The extremely high technological and financial efforts helped to move the industry into the integration phase. In Europe, the European Aeronautic, Defence and Space Company (EADS) and BAE Systems group emerged as the remaining systems integrator (and Thales and Finmeccanica as system suppliers). In the US, Boeing, Lockheed Martin, Northrop Grumman and Raytheon emerged out of this consolidation process. (Figure 1.2)

Worldwide reorganization phase –2000s onward

The emergence of the six worldwide groups has changed the competitive landscape at the local and international level. The market for large civil aircraft is now characterised by the rivalry between Boeing and Airbus. The A380 broke the monopoly in the large long-range aircraft, and both companies are now competing with the B787 and A350 XWB in the long range, medium size wide body market.

Figure 1.2 Consolidation in the European and American Aerospace Industry



Source: EADS.

1.3.2 Vertical Evolution

The reorganisation of the industry on a world scale has brought about a profound reorganisation of the production cycle in global terms and the reorganisation of the supply chain. A first step to understand and to analyse the recent developments within the supply chain is to see the trend in an historical perspective. In the last forty years, the four main evolutionary phases can be pointed out in line with Esposito and Raffa, 2006.

Creation of a supply relations system

The first phase, characterized by a strong growth of the sector lasted until the end of the seventies. One customer, typically the integrator had various suppliers. The key ability of the suppliers was a technical one. The Original Equipment Manufacturers (OEMs) used job orders to select the more dynamic suppliers and started to establish a hierarchy within the supply system.

Steadying of the supply system

The second phase lasted all the eighties and was also characterized by a period of strong growth. Within this time period, the supply relationships emerged as pyramids, with only a few developed suppliers at the top (first tier) with which tight collaborative relations were established. The integrator developed a non homogeneous distribution of job orders in order to operate on a long term perspective. The suppliers were thus able to grow in size and could increase their technical capabilities with only moderate pressure to reduce prices. This was especially helpful for the small and medium-size companies which were especially found in Europe (due to the traditionally national markets). This created a great level of trust within the industry especially for these small companies.

Fluctuating supply

As discussed before, the aircraft industry underwent a period of crisis in the early nineties with a sharp drop in world demand. The big integrators reacted by integrating previously outsourced activities, which implied a sharp reduction in job orders for the suppliers. In the second half of the 90s demand rose again, which allowed integrators to outsource again as much as possible of the production process. The result was fluctuating supply relations, where the integrators increased and reduced the amount of activities according to the economic cycle. This caused dissolution of mutual trust that is perceived as a necessary prerequisite for an efficient and well developed supply system.

Creation of a cooperative supply system

This phase began when the industry came out of the slump after the shocks at the beginning of the decade and is a consequence of the horizontal transformation of the sector at national and international level. The OEMs move their core competencies and re-organize their system of alliances in a changing context. At the same time new players from emerging countries such as China and Russia appear on the aircraft market. In the 90s these countries were mainly seen as suppliers of low-labour cost and satisfying technological know-how. In some segments the emerging competitors strongly increased their know-how and put additional competitive pressure on the established suppliers in Europe and the US.

1.4 Business Cycles in the Aerospace Industry

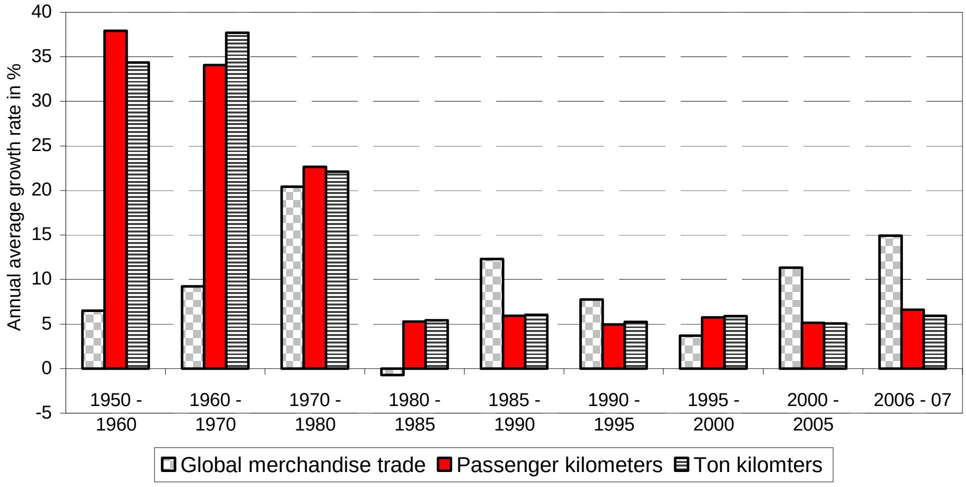
Globalization is a phenomenon based on growing regional and international linkages. Transport operators have always benefitted from this development. Most transport sectors have grown stronger than the global economy. After the breakdown of the New Economy's bubble the world experienced high growth rates that have not been seen for decades. The global gross domestic product (GDP) expanded between 4% and 5% for a couple of years. Numerous economists had expected that the world will follow a higher growth trend than during past trends. Here we follow the standpoint of Goldman Sachs that the high growth momentum of past years was the result of certain exaggerations, among others in the financial markets. The current recession and the following slow recovery will only lead to a trend rate of around 3%. For an understanding of the global economic development the aggregated international merchandise trade is used.[5]

[5] There are some statistical problems linked with the calculation of the global GDP, therefore here we use the global merchandise trade as an indicator for the global development. Air transport counts for about 35% of the global merchandise trade. See: IATA (Ed.), Value Chain Profitability, IATA Economics Briefing No. 4, June 2006, p. 5.

Figure 1.3 gives a clear picture for the globalization, an expression only created in the mid-1990s. Obviously the international trade expanded during the 1970s much stronger than these days. Even more dynamic grew the airline operators' business. This development can be contributed to the small size of this sector and a broad range of opportunities for new applications.

The uptake of the global economic development is remarkable if one compares it with the 1980s and the 1990s. However, it must be taken into account that the size of the global economy is much bigger than during the 1970s. The airline operators' business also gained momentum, but it was more moderate as compared with to global merchandise trade. As compared to the global GDP the operators enjoyed a stronger expansion, a well-know pattern since long.

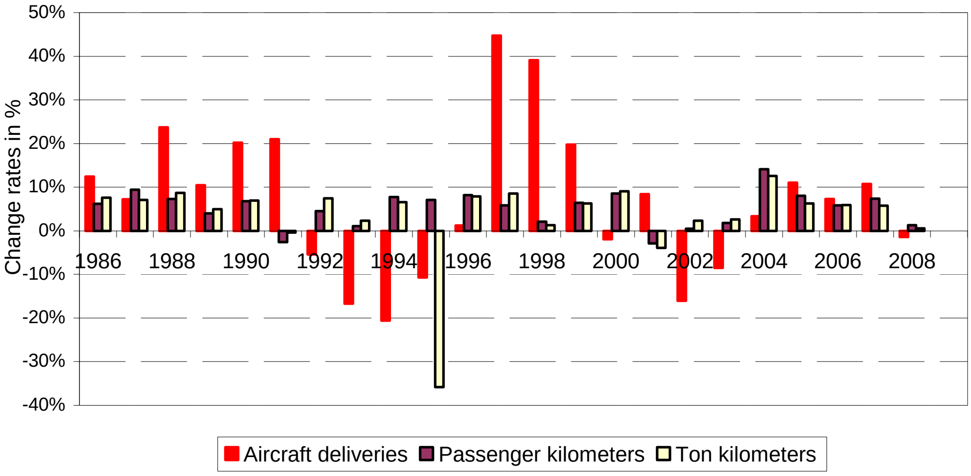
Figure 1.3 Global Economic Development and the Business of Airline Operators



Source: UNCTAD, ICAO/ATI, own calculations.

Figure 1.4 discloses the business cycle of the aerospace manufacturers and its linkages to the airline operators. The boom at the end of the 1980s led to an above average growth of the number of delivered aircraft. The global slowdown 1991 to 1993 reduced the growth of the airline operators; only in 1991 their global business shrank slightly. The years after until 1995, for four subsequent years the delivery of aircraft shrank at about one half. The second half of the 1990s was marked by a soaring demand, but it took more than two years to reach former heights. The slowdown after the breakdown of the New Economy Bubble was moderate as compared with the preceding cycle. The time-lag between the airline operators' recession and the manufacturers' was one to two years only.

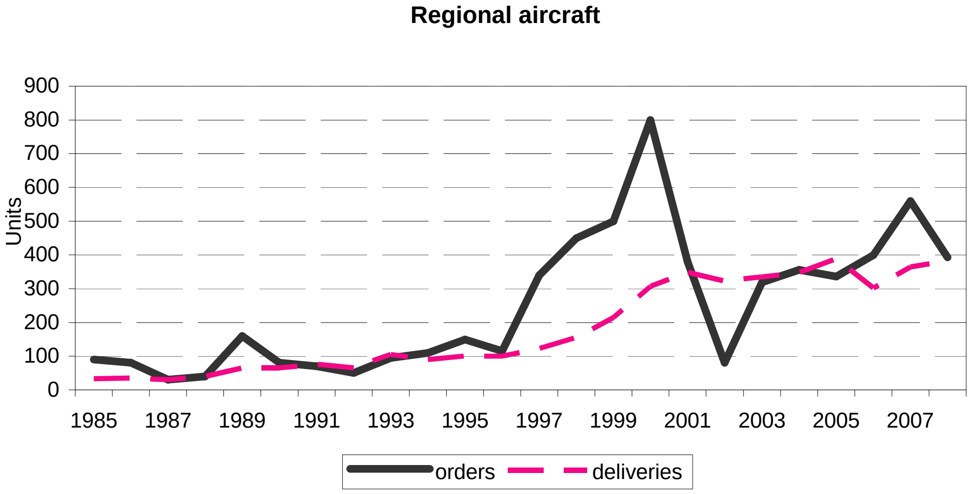
Figure 1.4 The Business of Airline Operators and the Aerospace Manufacturers (Deliveries in Numbers)

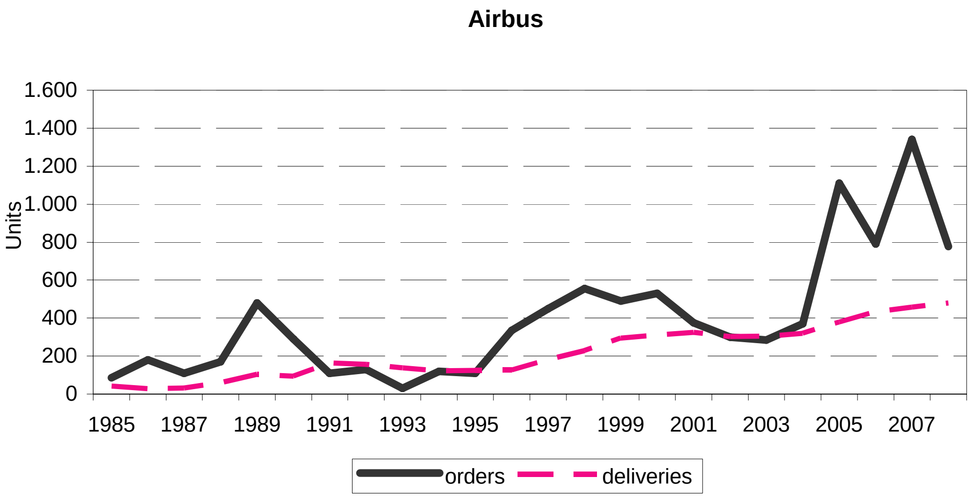


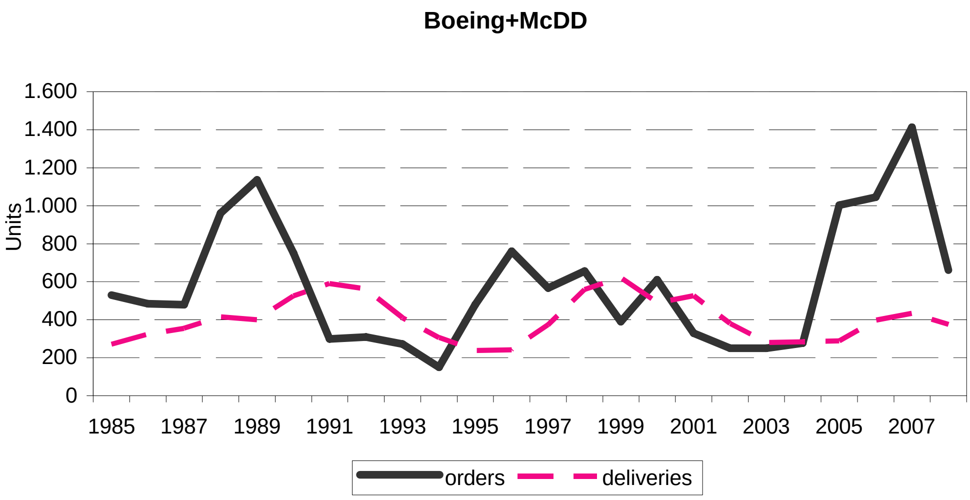
Source: ICAO/ATI, Decision, own calculations.

An investigation in the subgroups of the aerospace industry disclosed that the boom during the second half of the 1990s was driven above all by regional aircraft. They benefitted not only from the cyclical recovery after a severe slump the preceding years but from a shift in the demand to short- and medium-range airplanes dedicated as commuter planes to serve air traffic hubs. The long-term development discloses a remarkable upward trend, although they did not benefit that much from the latest upswing as Boeing and Airbus with their supply of long-range airplanes. A comparison of the performance of both of these big suppliers reveals the upward trend of Airbus from 1985 up to 2008. Only recently Airbus took over the lead in the global market by the number of delivered airplanes (Figure 1.5).

Figure 1.5 Business Cycles in the Civil Aircraft Industry







Source: Decision, own calculations.

The airline operators and the manufacturers are part of a wider sector that comprises other industries which supply complementary services. These industries altogether are necessary for the provision of air transport services to customers. Quite different industries are compared with each others such as freight forwarders, lessors etc. (Figure 1.6) IATA (2006) has investigated the profitability of these industries. An expected result was the loss in profitability during the slowdown after the breakdown of the New Economy Bubble and the terrorist attack 9/11. More interesting is the fact that profitability differs strongly between the industries under consideration. Computer reservation systems proved to be most profitable. Aerospace manufacturer were in the medium range, although very volatile.[6]

The study carried out by IATA and McKinsey evaluated airport operators as most problematic. They command a natural monopoly and are often run by public authorities. In particular in the US airports charge airlines high for their service and are very inefficient. In Europe the situation is different. Private operators are successful and exploit all opportunities to gain additional reve-

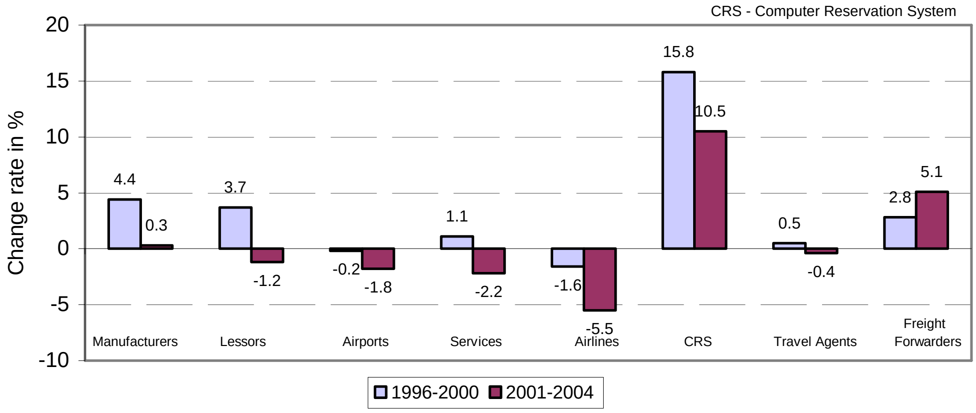
6 See: IATA (Ed.), Value Chain Profitability, IATA Economics Briefing No. 4, June 2006.

nues, but charges are likewise high. The adjustment of airports to changing requirements in customer services and growth are perceived as poor.

Although this view might be biased to a certain extent by IATA the study provides some insight in bottlenecks in the supply system that incorporates potential limitations to further growth. On average the airlines profitability is not satisfying from an investor's standpoint. The return on investment is – with regard to the investor's risk taking – insufficient. Other industries with similar risks pay higher premiums. This poor financial performance could become a stumbling bloc for the progress of the sector, because the business of airline operators is capital intensive. In 2004 the airline operators invested USD 380 billion, at around 55% of total investment expenditure of the sector. In a more risk avers environment the availability of funds has been already reduced.

The study highlights that in general "no-frills" low-cost carriers (LCC) delivered higher Returns on Invested Capital (ROIC) than network airlines. This is a reflection of both their higher operating margins and of the lower capital base. However, even the LCCs have not created positive returns during the more severe years 2001 to 2004. The growth of these carriers has been remarkable during the past years, but to a certain extent this was a substitution of network airlines supply. The growing competition in the air transport market will induce a reduction of margins and a structural change in the years to come. Shrinking profitability from a level - not satisfying to investors seeking a risk premium – in an environment of more risk averse players in the financial markets can lead to a financial crunch.[7]

Figure 1.6 The Economic Framework for the Aerospace Industry



Source: IATA 2006, own calculations.

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7 Handelsblatt, 9 July 2009.

2 The Quantitative Analysis of the European Aerospace Industry

The analysis of the EU27 aerospace industry data is done within the current data limitations. In principle all the different sub-sectors are studied, including: aircraft (also military), helicopters, engine manufacturing, aircraft parts production and flight simulation services. Overhaul, repair and training services are covered through a more qualitative approach due to a lack of data. While the analysis covers also military aircraft production (as it is heavily related to the civil aircraft production), it does not cover other defence related land and naval activities. The production and employment analysis is based on Eurostat Structural Business Statistics (SBS) data at NACE 35.3 level, which is rather aggregated and covers also space production[8], and the trade analysis is done based on the UN Comtrade HS 1996 data on 6 digit-level, which again gives a more detailed picture of all sub-sectors.[9] In addition, other data sources from entrepreneurs associations, such as Aerospace and Defence Industries Association of Europe (ASD), have also been used. It must be taken in mind that the official Eurostat figures comprise only information from enterprises of which the main activity is the manufacture of products, classified as aerospace products. The figures of the entrepreneurs' associations also comprise figures from companies that are part of the aerospace value chain but whose products are classified otherwise. The advantage of the first statistics lies in the fact that international comparisons can be carried out by the use of officially available figures that are collected and aggregated similarly.

The first section tackles the quantitative analysis from a sectoral standpoint, primarily by the use of Eurostat figures. The evolution of the industry over time, efficiency indicators and the regional distribution are disclosed. The relative performance of the European AI with all of the European manufacturing indicates changes in the comparative advantage. An analysis of foreign trade by the use of shares in global trade as well as the RCA indicators provides insight in the performance in international markets.

The second part of the Chapter tackles the quantitative analysis from a microeconomic standpoint. The major objective of this procedure is to analyse the profitability and the financial performance of the sector. Within the EU27 the key players are compared with the average of all AI companies under investigation to disclose discrepancies in the economic performance of smaller and big European firms. A comparison of key European and non European players has been carried out to investigate in changes in the economic performance and its impact on international competitiveness.

8 The spacecraft data cannot be separated from the overall "Aircraft and spacecraft" grouping. The European nomenclature for production has been revised. The latest version NACE (2008) does not yet contain any figures, but in future the aerospace industry will be presented under NACE 30.3.

9 In this report global trade has been analysed from the standpoint of each of the economies under investigation. This means trade relations between non European countries have been investigated. UN Comtrade is the most adequate source for this purpose.

2.1 The Sectoral Analysis of the European Aerospace Industry

The European aerospace industry – based on Eurostat figures[10] - employed 375,300 people in 2008. The output amounted to EUR 127.8 billion. The value-added came up to EUR 34.5 and declined by an average 1.5% per annum during the period from 2001 to 2008, calculated in constant 2008 prices (Table 2.1).[11] Behind this European development are quite different trends in the Member States that are disclosed in Chapter 3.

The key figures provided from ASD for the European aerospace industry differ from official sources. The turnover of aeronautics and space activities in 2008 came up to EUR 104.7 billion and the number of employees reached 500,240[12]. This equals a turnover per capita of EUR 209 thousand. The differences between official statistics and those of the associations are enormous and needed clarification. The major differences have been clarified. They are based on a different scope of the statistics. In brief: The official statistics refer to aerospace products as classified in the nomenclature, whereas the associations' surveys try to catch all companies with a major stake in the aerospace value chain. As a consequence in most cases the figures are higher than that of official statistics. For international comparisons it was necessary to use official statistics that pursue the same approach.

[10] For a comparison with the European aerospace association's (ASD) figures see: Figure 2.12

[11] Over the period under investigation the output showed a cyclical pattern. 2001 was on the upside of a cycle, but 2008 was also on the upside of a cycle. Therefore the business cycle does not bias the development much, but technical problems and delays in new project have had a noteworthy impact on the development and the performance of the sector, as will be shown in the next chapter. France and Germany have been above all affected.

[12] ASD fact and figures 2008

Table 2.1 Key figures for the European Aerospace Industry

EU 27		2001	2008	2001 - 2008 Change rate in %	Share of total EU-27	
					2001	2008
Output	Production (2008 prices, EUR billion)	115.8	127.8	1.4%		
	Value-added (2008 prices, EUR billion)	38.2	34.5	-1.5%		
Labour force	Employees (thousands)	373.0	375.3	0.1%		
Productivity	Value-added per employee and year (thousands, constant prices)	102.5	91.9	-1.6%		
FR, UK, DE, IT, ES, PL						
Output	Production (2008 prices, EUR billion)	83.5	93.5	1.6%	72.1%	73.2%
	Value-added (2008 prices, EUR billion)	32.4	30.6	-0.8%	84.6%	89.4%
Labour force	Employees (thousands)	327.8	330.2	0.1%	87.8%	88.1%
Productivity	Value-added per employee and year (2008 prices)	98.7	92.6	-0.9%	n.a	n.a
	Wage adjusted productivity	192%	167%	-2.0%	n.a	n.a
Labour costs	Per employee and year (thousands, constant prices)	51.3	55.5	1.1%	n.a	n.a

Source data: Eurostat, National association statistics (for growth rates between 2006-2008), Own calculations

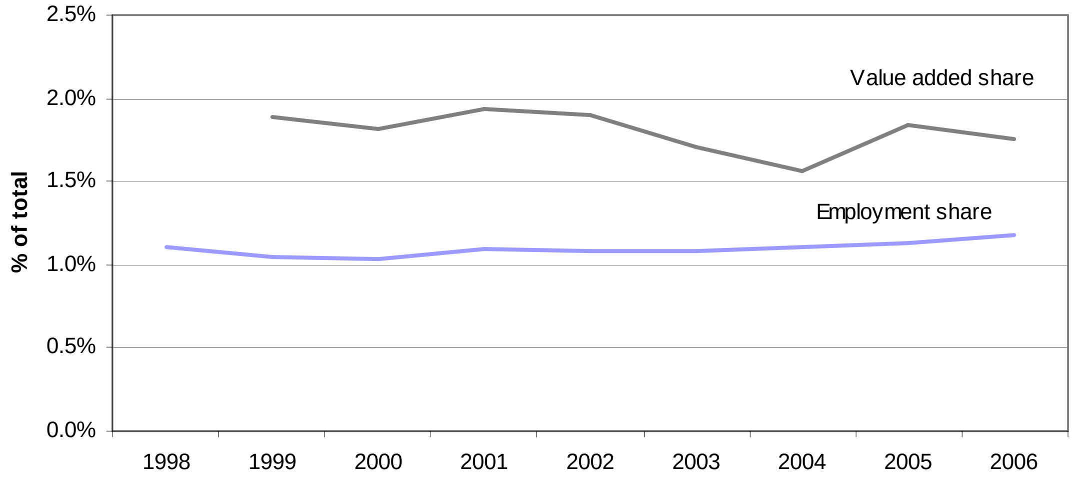
The focus of the study is civil aerospace. Its share on the European output of final products is around 60%. However, only in few cases the statistics are available that allow a differentiation within the aerospace industry (AI).

The bigger European countries France, the United Kingdom, Germany, Italy and Spain are considered in detail. Poland was also selected as a country for a more in depth analysis as an example from within the new Member States. These 6 countries together comprise over three quarter of the production and even 89% of value-added. This group of countries covers the large European OEMs. The differences in the pace of growth between production and value-added indicates a reduction of the manufacturing depth that has been induced by OEMs strategies to focus more on system integration. (Table 2.1)

2.1.1 The Development and Performance of the Aerospace Industry

In general, the aerospace industry in the EU is in political terms an important sector, in economic terms its relative importance is less outstanding. However, it creates spillover effects for other high-tech-sectors in terms of innovations. During the last decade, the EU27 aerospace industry has experienced a breakdown between the events of 9 September 2001 and the year 2004, which resulted in an explicit decline in the value-added share of the sector during that time. However, at the same time the share of aerospace employment out of the total manufacturing employment has stayed relatively constant at around 1.2%. Figure 2.1, provides the share of aerospace industry's value-added and employment out of total manufacturing value-added and employment from 1998 to 2006, as newer data are currently not available in Eurostat.

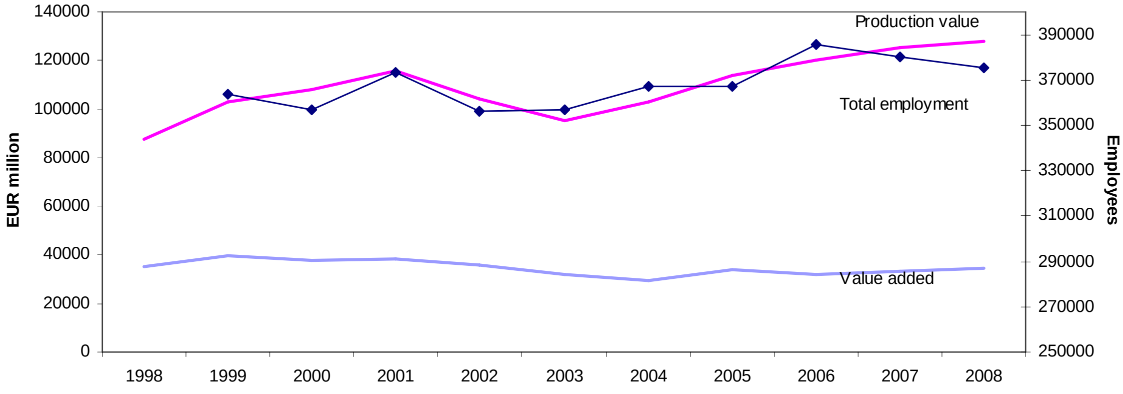
Figure 2.1 Share of Aerospace Value-added and Employment in the EU27 in Total Manufacturing



Source: Eurostat.

Figure 2.2 shows the latest trends in the value of production, value-added (which represents the difference between production value and intermediate input) and in employment. The value of production and value-added have been calculated with 2008 constant prices. At 2006 the total production value was at around EUR 127 billion, the value-added at around EUR 34 billion and the sector employed around 375 000 persons. The growth of the production value has not been accompanied by an analogous growth in value-added during the last ten years, which already indicates an outsourcing tendency (strongly increasing the intercompany deliveries within the aerospace industry, or outsourcing to other industries or to non-European countries), while employment has increased slightly. The production has experienced a large volatility during this period. After a small growth period that lasted till 2001, declines took place from 2001 to 2003, caused by the events of September 11, while the production grew again after that.

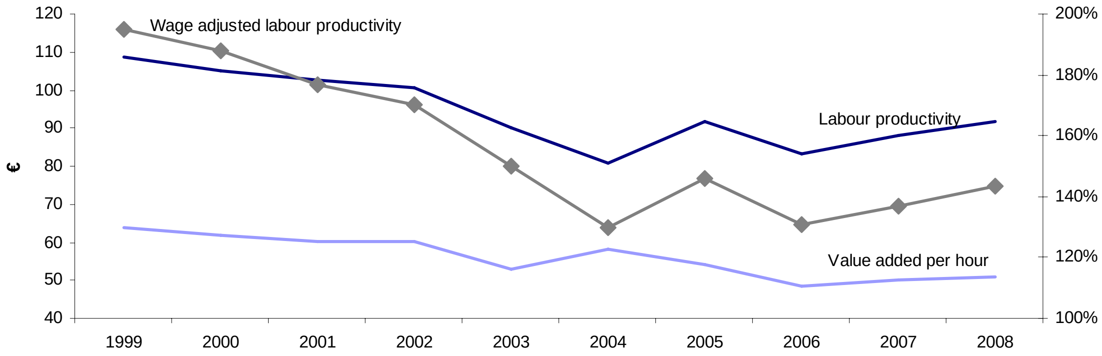
Figure 2.2 Total EU27 Production Value, Value-added and Employment Trends in the Aerospace Sector in Constant 2008 Prices[13]



Source: Eurostat, National association statistics (for growth rates between 2006 - 2008)

In real (i.e. inflation-adjusted) terms the productivity of the industry has shown a small downwards trend. Figure 2.3 shows the productivity trends measures for labour productivity (i.e. value-added per employee, measured in thousand EUR per head), for wage adjusted labour productivity (measured as labour productivity by average personnel costs, in %, i.e. the ratio of value-added per employees divided by the average personnel costs[14]) and for value-added per hour (measured as EUR per hour). The labour productivity has faced a decline according to each of the indicators as the employment (and wages) of the sector have been growing faster than the value-added. In depth analysis of the following chapters has disclosed that this development has been induced by investment in human capital (more and better educated personnel) and new products, which has a delayed effect on production and value-added – particularly in this industry with extremely long product-life-cycles and development periods.

Figure 2.3 Productivity of EU27 Total Aerospace Industry in Average by 3 Indicators (Based on Constant 2008 Prices)



Source: Eurostat, own calculations (2007 and 2008 estimations).

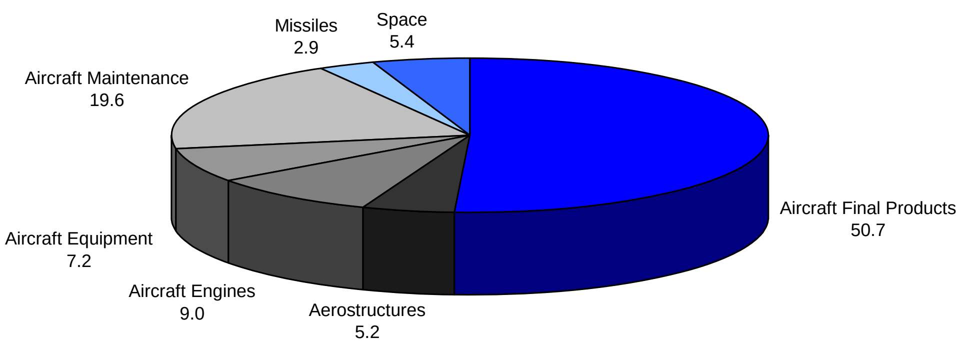
[13] The current production and value-added values have been corrected to constant 2008 values by the Eurostat Producer price index data for overall manufacturing industries. Further, the values for 2007 and 2008 are estimations based on the ASD sector growth rates between 2006-2008, as the Eurostat data covers only the period 1998-2006.

[14] Consistent ratio values of wage adjusted labour productivity that are under 100% indicate a serious threat to the competitiveness of the industry, as the labour costs are higher than the average value-added per employee.

2.1.2 The Structure of the Industry

Together the production of aircraft and helicopters (i.e. aircraft final products) accounted for over 50% of total aerospace production at 2006 in the EU27 according to the Aerospace and Defence Industries Association of Europe (ASD). In addition, maintenance and repair services accounted for some 20%. Figure 2.4 shows the breakdown in detail.

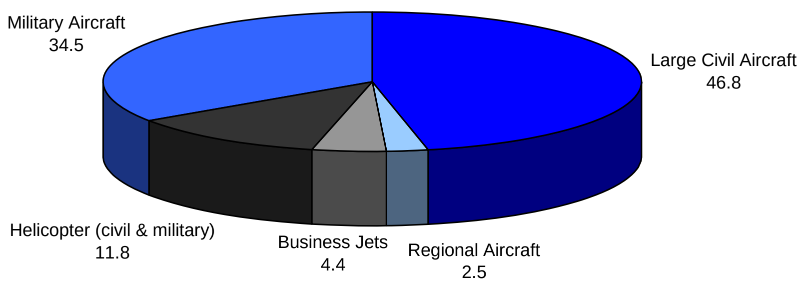
Figure 2.4 Breakdown of EU Aerospace Industry Turnover by Product Segment in 2006 in per cent



Source: ASD, Annual Report 2006.

Figure 2.5 provides further the breakdown of aircraft final products according to the ASD. Large civil aircraft and military aircraft account by far for the largest share of aircraft final productions, while e.g. helicopters account only for some 11% and regional aircraft and business jets for few percentages.

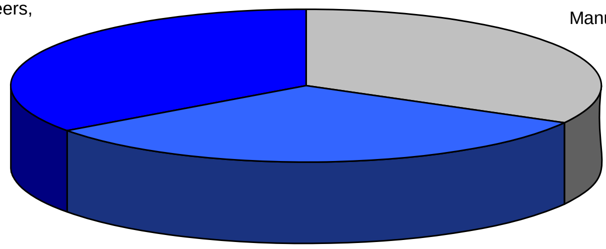
Figure 2.5 Distribution of Aircraft Final Products in 2006 in per cent



Source: ASD, Annual Report 2006.

Figure 2.6 presents again the breakdown of the employees in the European Aerospace industry by their skills levels according to the ASD. Around 1/3 of the employees are highly educated (university graduates), 1/3 manual workers and 1/3 others (including technicians, draughtsmen, craftsmen, secretaries, etc.).

Figure 2.6 Skills Levels of the Employees in the EU Aerospace industry in 2007 in per cent



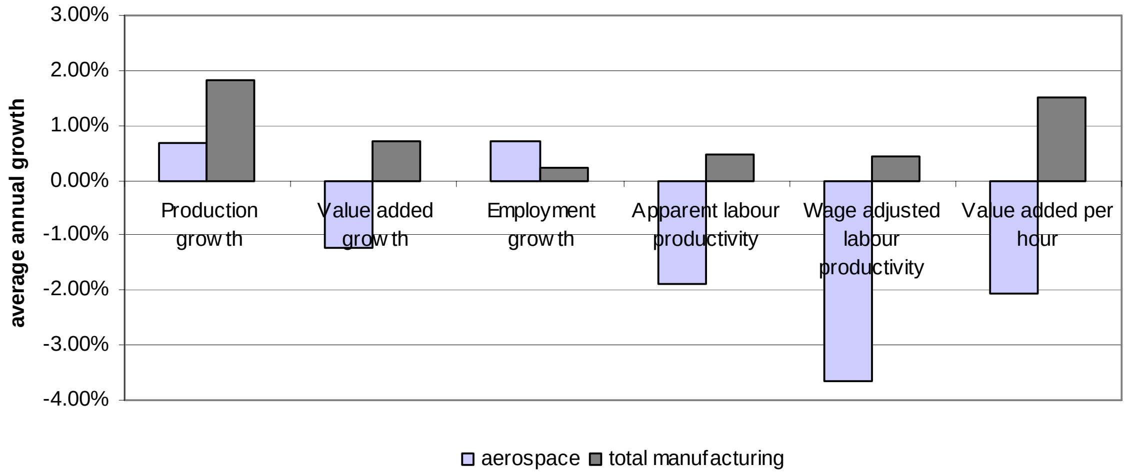
Source: ASD, Annual Report 2007.

2.1.3 Performance Comparison to the Total European Economy

Compared to the other manufacturing industries, the European aerospace sector has shown lower production growth and lower value-added growth during the period from 2001[15] to 2006. Figure 2.7 provides the average annual growth rates of various performance indicators from 2001 to 2006 inconstant prices for aerospace and for the total manufacturing industry[16]. As employment (and wages) in the aerospace industry has increased more than in other industries and the related employment growth has been faster than the real growth of value-added, the apparent labour productivity and wage adjusted labour productivity have decreased while in overall manufacturing industries in general the opposite has been true. Similarly, the value-added per hour has decreased. The increase in the real wages compared to other manufacturing industries is reflected especially in the decrease in wage adjusted labour productivity in the aerospace industry, while the same indicator for all manufacturing industries has increased (as the wages in other industries have even decreased somewhat in real terms).

[15] The growth rates have been calculated from 1999 due to lack of reliable data for the employment level at 1998.
[16] Both industries values have been deflated with the earlier mentioned Producer Price index for manufacturing industries.

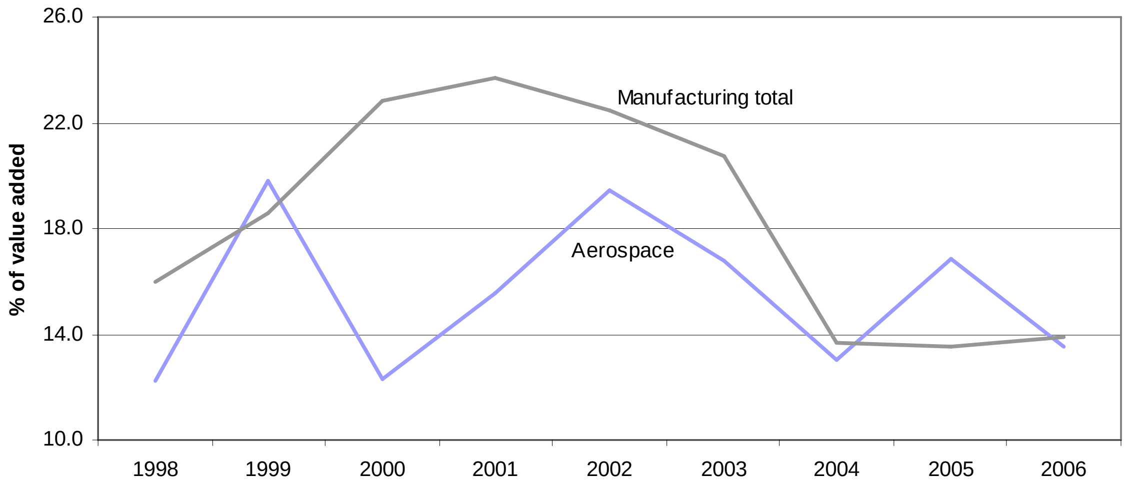
Figure 2.7 Comparison of EU27 Average Annual Growth Rates from 2001 to 2006, Aerospace Industry vs. Manufacturing in Total[17] in constant prices[18]



Source: Eurostat, authors' calculations.

The investment in aerospace (as % of value-added) has been slightly lower and more volatile than in other manufacturing industries during the period from 1998 to 2006. While the investment experienced a rise in general manufacturing from 1998 to 2001 and has been decreasing since till 2006, the investment in the aerospace sector have stayed in general in a more stable range and varied in about two year intervals as Figure 2.8 illustrates.

Figure 2.8 Investment Rate (as % of Value-added) at Aerospace Sector vs. All Manufacturing



Source: Eurostat.

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17 The growth rates have been calculated from the constant 2006 value indicators. Explanation of the indicators can be found from sub-section 2.1.1 and the technical annex.

18 The growth rates have been calculated from the constant 2006 value indicators. Explanation of the indicators can be found from sub-section 2.1.1 and the technical annex.

2.1.4 The Regional Distribution of the European Aerospace Industry

The aerospace industry in the EU27 was still highly concentrated in 2006, while decentralisation has been going on. France, UK and Germany accounted for nearly 80% of the total EU27 aerospace production and value-added and around 70% of the total employment. However, while France had by far the highest production value, it lies behind the UK (the second largest aerospace producer in the EU) in terms of value-added and employment share. A major reason for this statistical discrepancy can be seen in the final assembly line of Airbus in Toulouse, where the major part of Airbus aircraft is finalized and delivered.[19] Table 2.2 provides detailed information on the share of each EU27 country's aerospace production, value-added and employment in 2006. In addition, the average annual growth rates in constant prices from 2001 to 2006 have been reported for each country. The average annual growth rates of the aerospace production during the last decade shows that many smaller producer countries are catching up. For example, Austria, Slovenia, Spain, Czech Republic and Denmark have been growing significantly during the last decade, given the low initial position. At the same time, value-added has declined in countries like the UK, Germany and Sweden.

[19] The final assembly lines of Airbus are in Toulouse (two assembly lines for the Airbus types A320, A330, A340, and A380), Hamburg (Germany) (one assembly line, for types A318, A319, A321 and A380 interior furnishing), Seville (Spain) for the Airbus A400M and Tianjin, China for the A320 series.

Table 2.2 Regional Distribution of the EU27 Aerospace Industry and the Growth from 2001 to 2006 of the Sector in each Member State in Constant Prices

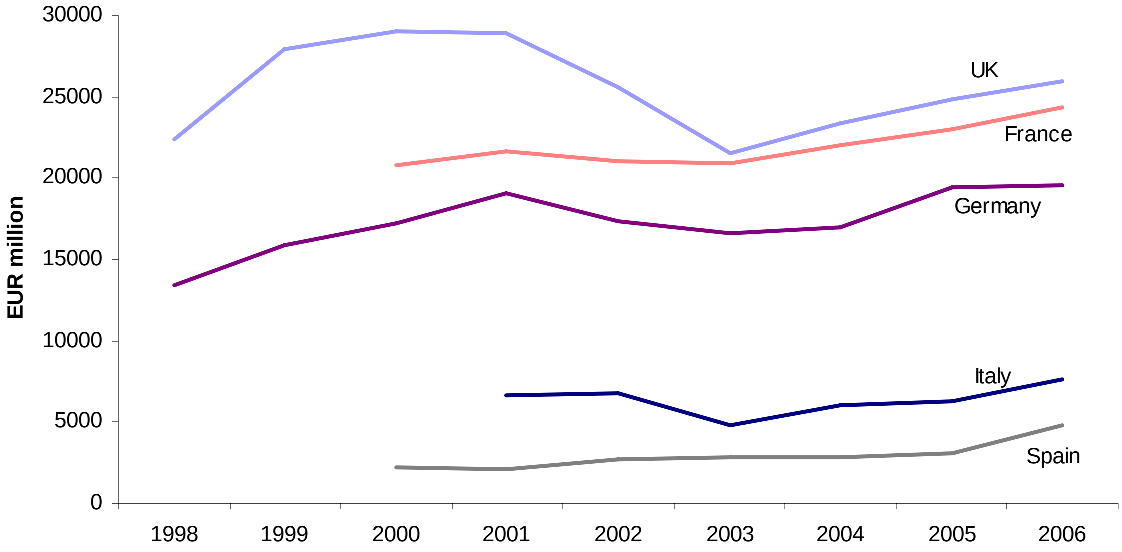
	Production value		Value-added		Employment	
Country	Share of total EU27, 2006	Average annual growth	Share of total EU27, 2006	Average annual growth	Share of total EU27, 2006	Average annual growth
EU27	100%	0.7%	100%	-1.2%	100%	0.7%
FR	42.8%	2.4%	29.3%	4.0%	25.6%	2.1%
UK	23.1%	-2.2%	31.3%	-4.3%	25.7%	-2.4%
DE	17.4%	0.4%	20.4%	-1.3%	19.9%	0.7%
IT	6.8%	2.6%	7.8%	1.4%	8.7%	0.9%
ES	4.2%	17.8%	3.5%	11.1%	4.1%	8.2%
SE	1.8%	4.3%	2.0%	-1.4%	2.7%	1.3%
BE	1.1%	-5.0%	1.5%	-7.3%	1.6%	-3.9%
NL	0.9%	4.1%	1.1%	2.0%	1.3%	1.3%
PL	0.4%	8.9%	0.7%	1.0%	3.8%	-0.5%
IE[20]	0.4%	n.a	0.5%	n.a	0.9%	n.a
GR	0.3%	n.a	0.6%	n.a	1.0%	n.a
CZ	0.3%	4.9%	0.3%	-5.0%	2.0%	-1.2%
RO	0.2%	0.8%	0.3%	-5.6%	1.6%	-8.0%
DK	0.2%	8.6%	0.3%	12.8%	0.3%	12.9%
AT	0.1%	31.6%	0.2%	27.7%	0.2%	12.7%
HU	0.1%	15.8%	0.1%	18.9%	0.3%	-2.3%
FI	0.1%	4.8%	0.1%	2.6%	0.2%	-0.9%
LT	0.0%	12.2%	0.0%	2.5%	0.1%	7.2%
SI	0.0%	10.2%	0.0%	24.4%	0.0%	n.a

Source: Eurostat, values in constant 2006 prices with PPI deflator.

Figure 2.9 and Figure 2.10 show the development of the aerospace production value in the largest producer countries in the EU and for some of the smaller ones. Most countries in both groupings have experienced in general an upward trend in the production until September 11, 2001. In the following two years the whole industry experienced a decline, but after 2003 started a new growth period. The production in Spain, France, Germany and Italy has performed better than in the UK.

[20] No time series available.

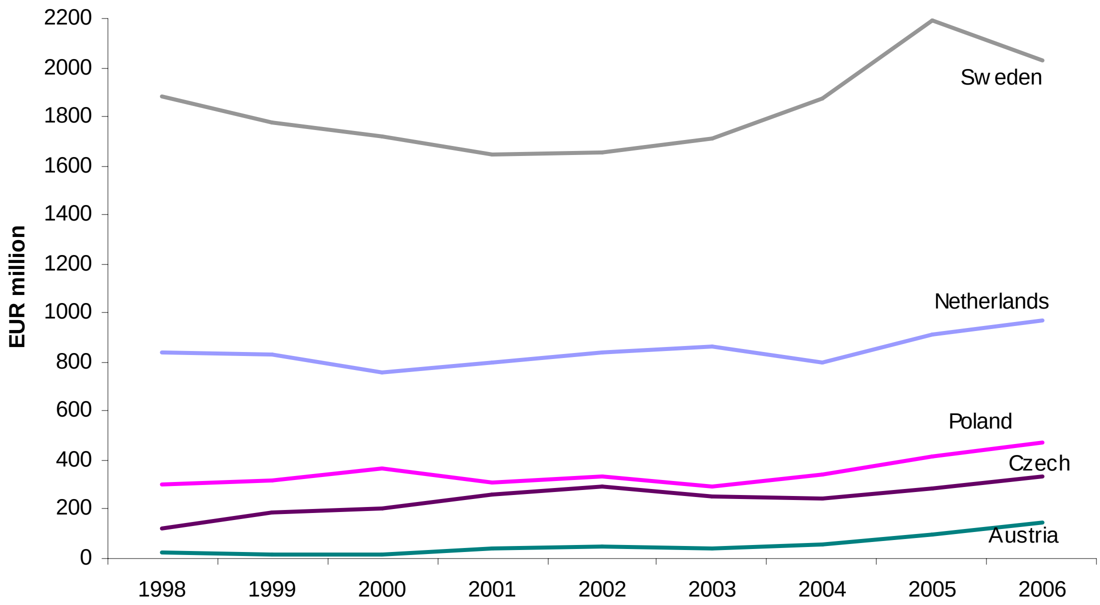
Figure 2.9 Production Trends of Main EU Aerospace Producers, Constant 2006 Prices



Source: Eurostat.

Similarly, many other smaller producer countries have experienced a general upwards trend during the whole period, but with some yearly variation visible. For example, while Sweden and Poland faced a small decline between 2001 and 2003 in their real production, the other listed countries were growing during the same time.

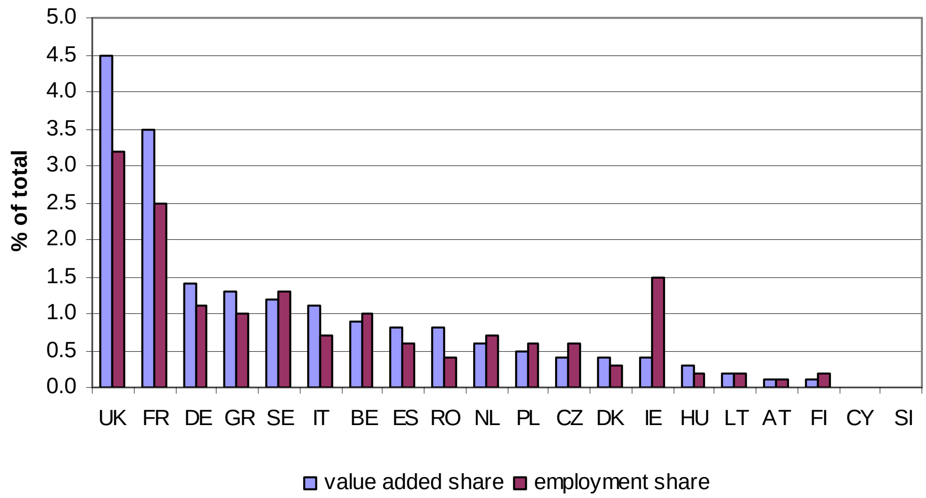
Figure 2.10 Production Trends of Smaller Aerospace Producer Countries, constant 2006 prices



Source: Eurostat.

The size of the aerospace production in the largest EU producer countries is not only caused by the total size of the respective economy; the aerospace industry plays in these countries traditionally an important role, which can be seen in a significantly higher share of aerospace in total manufacturing value-added and employment, as Figure 2.11 illustrates. This is most obvious in the UK (with 4.5% of total value-added and 3.2% of employment), followed by France (3.5% of value-added and 2.5% of employment), Germany and Italy. Also in some smaller producer countries, like Sweden, Greece[21], Belgium and Romania the industry accounts also for a relatively high share of value-added and employment[22].

Figure 2.11 Share of Aerospace Value-added and Employment of National Manufacturing total at 2006



Source: Eurostat.

In terms of total employment, the UK, France, Germany and Italy have also the largest numbers of people employed in the sector as Figure 2.12 presents. The focus of the analysis within this Chapter is on the use of statistics provided by public statistical bureaus. These data are collected in each European country from all companies by the public statistical bureaus. It is a 100% survey of all manufacturing companies that products that fall under the NACE 35.3 of the European harmonized nomenclature. However, there are companies who are strongly involved in the production of intermediary products for the aerospace industry and they also have to be covered within this study. Therefore we additionally use statistics of the associations of the AI, the European and the nationals (for a detailed discussion of the differences of scope of the public statistics and the statistics of the associations see: Annex 9.3).

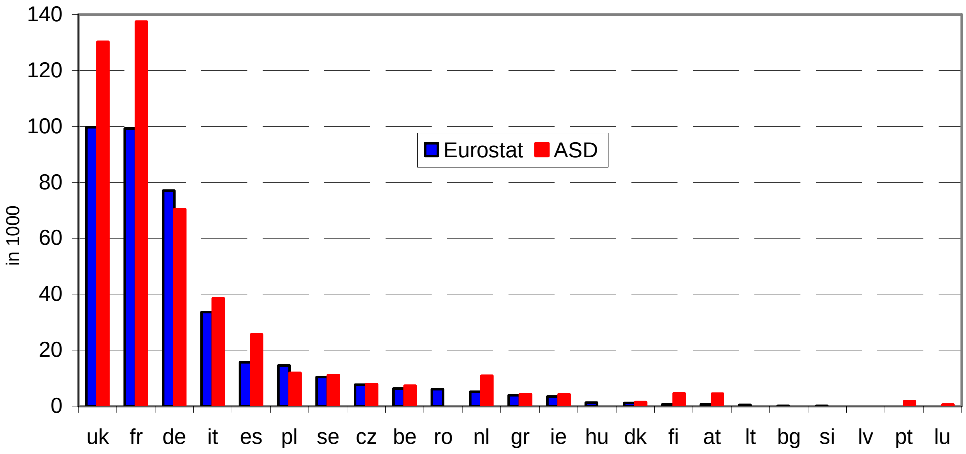
The comparison depicts that for most of the countries the European association ASD reports much higher figures than Eurostat. The discrepancies are remarkable for the bigger countries with the exception of Germany. But the German association, BDLI, reports a much higher figure of 85,500 employees. This means that also for Germany the number of employees is much higher. There are some countries for which only Eurostat figures are available, Hungary and Romania, and some countries only ASD employment figures are available (e.g. Portugal and Luxembourg). As a consequence for the European study on the AI it is of importance to have in mind the discrepancies of the different sources. Higher figures of the associations can primarily be explained

[21] In Greece the importance of the sector relates mostly to the small size of manufacturing activities (while services account for a significantly larger share of GDP than in many other countries).

[22] The employment figure for Ireland is an outlier that is not taken into consideration here.

by the integration of upstream companies in their surveys that are not in the scope of NACE 35.3. However, it is disputable if the enormous discrepancies in some countries can be explained by this fact. The different scopes of both statistical sources can be justified and can contribute to the results of the competitiveness study. In particular the country reports make explicit use of both sources.

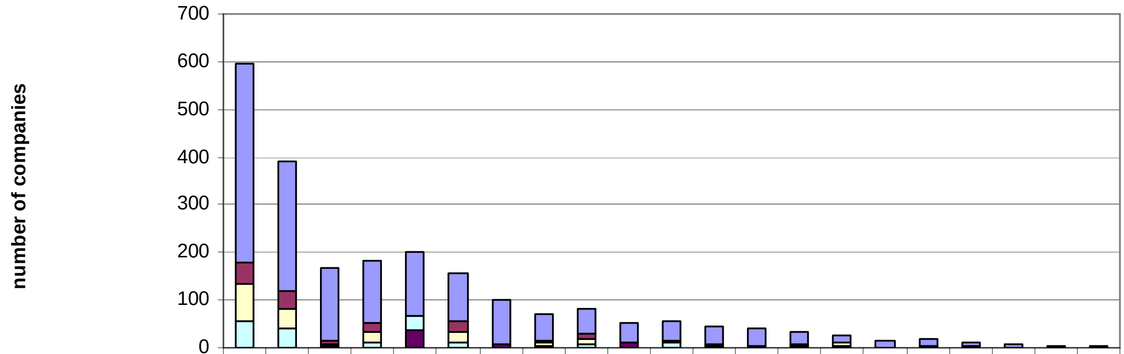
Figure 2.12 Breakdown of Aerospace Employment between the EU Countries at 2006



Source: ASD, Eurostat SBS.

On the one hand, with respect to the size of the companies in the sector, the majority of them are smaller enterprises when measured by number of companies. However, large companies play dominant roles in the sector especially in the UK and France. (Figure 2.13) On the other hand, in terms of value-added, the largest companies account also for the largest share.

Figure 2.13 Number of Companies per Size Classes (Employment) at 2006



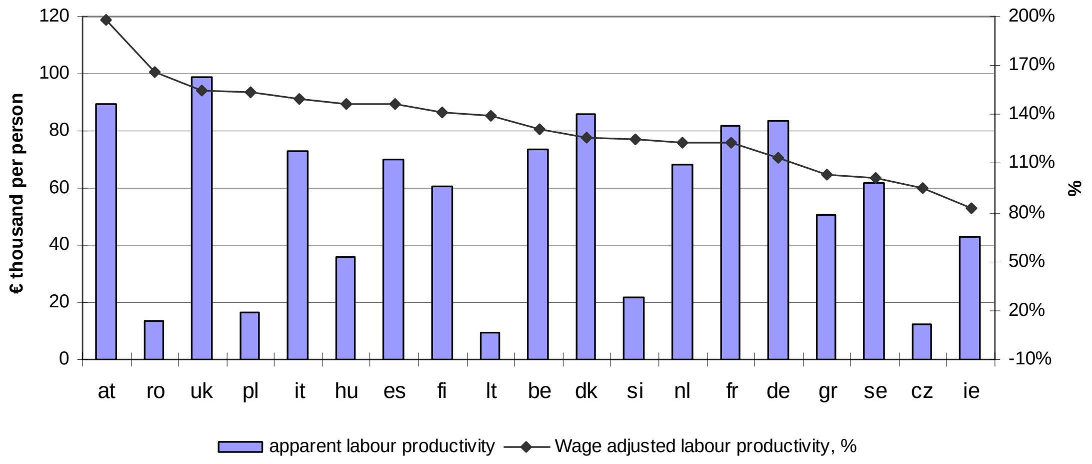
	UK	FR	SE	IT	DE	ES	HU	NL	CZ	BE	PL	PT	AT	DK	RO	SI	LT	FI	LV	EE	LU
1-19	416	271	153	133	133	103	96	55	53	43	40	38	36	27	15	14	14	10	6	4	2
20-49	43	38	6	16		23		5	10		4	2	2	4	0	1	2	1	1		1
50-249	80	43	5	22		22		5	11		1	3	2	2	7		3			1	
over 250	55	40	4	13	29	10		5	7		11	1	1	1	5			1			
size not specified	0	0	0	0	39	0	6	0	0	10	0	0	0	0	0	0	0	0	0	0	0

Source: Eurostat.

Note: Companies which size is not specified might belong to any of the other categories or are not made explicit because of confidentiality (e.g. for Germany the 39 companies whose size is not specified might belong to both of the smallest categories, because Germany no longer collects data for companies with less than 50 employees).

Figure 2.14 shows the productivity levels measured by the apparent labour productivity (value-added per person employed) and wage adjusted labour productivity (apparent labour productivity per average personnel costs, %) in each EU member state at 2006 prices. Austria and UK are among the top countries in productivity according to both indicators, but e.g. Denmark, France and Germany perform relatively low when measured by the wage adjusted indicator – even though the direct value-added per person employed is relatively high. Ireland and the Czech Republic received relatively low scores for both indicators. France and Germany are relatively close to each other in terms of value-added per employee, while a lower wage level gives France a competitive advantage. The UK is far ahead in value-added per employee, which gives it a leading position in both competitiveness indicators. The underlying reason is a successful although painful process of consolidation (see Chapter 3.2.4). Romania compensates a low value-added per person by extremely low wages, which makes it to an outstanding candidate for low cost production, see section 3.2.4.

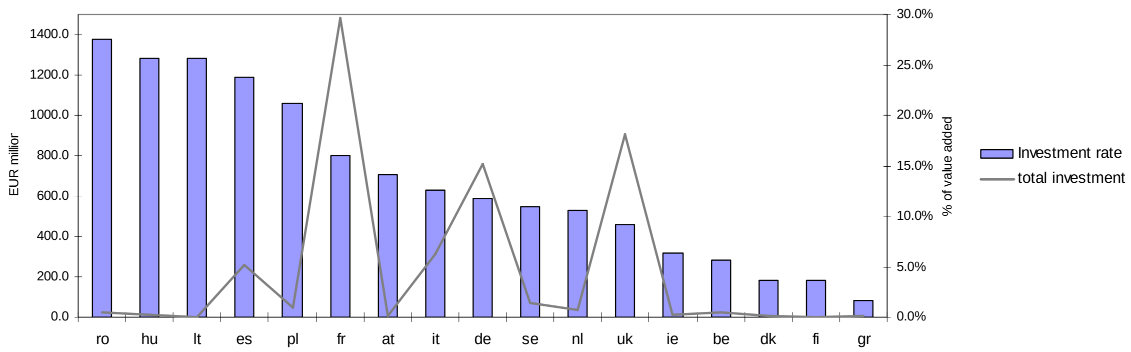
Figure 2.14 Productivity Levels in Different EU Member States at 2006



Source: Eurostat SBS.

The country specific investment rates (i.e. investments as percent of value-added) presented in Figure 2.15 illustrate also that especially some of the new Member States (such as Romania, Latvia and Hungary) have relatively high levels of investments compared to the majority of the more "traditional aerospace industry locations" in the EU (such as Germany, Sweden and UK). This suggests that the aerospace industries are expanding in many of the lower production cost countries in the EU and support hence the assumptions of a regional restructuring of the industry within the EU to the benefit of the European AI's competitiveness in global markets. However, as the total investment levels show, in value terms the most investments are still made in the top 3 aerospace countries, namely France, Germany and the UK.

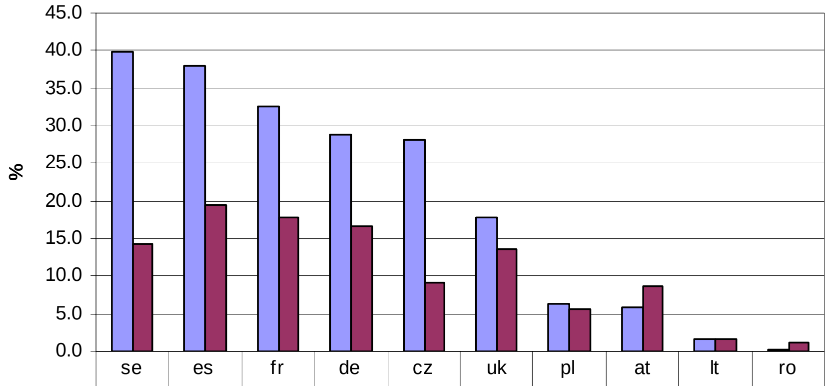
Figure 2.15 Investment Rates at 2006 (% of Value-added) and Total Investments, EUR million



Source: Eurostat SBS.

The regional distribution of R&D expenditure (civil and defence) among the EU Member States at 2006 is presented in Figure 2.16, though only for the few countries, that have reported data. With regards to the R&D expenditure share in value-added terms and the share of R&D in employment, Sweden, Spain, France, Germany, Czech Republic and UK have a relatively high focus on R&D in their countries. On the other end, e.g. Romania, Latvia and Austria reported significantly lower shares in both categories. These countries are primarily production sites and less involved in concept design and research activities.[23] In general, these figures document the concentration of R&D functions in the largest aerospace producer countries in the EU.

Figure 2.16 Aerospace R&D (civil and defence) Functions Importance in some Member States at 2006



	se	es	fr	de	cz	uk	pl	at	lt	ro
Share of R&D expenditure in value added	39.9	37.9	32.5	28.8	28.1	17.7	6.3	5.9	1.6	0.3
Share of R&D employment in the number of persons employed (%)	14.2	19.5	17.8	16.6	9.2	13.6	5.6	8.6	1.6	1.1

Source: Eurostat SBS.

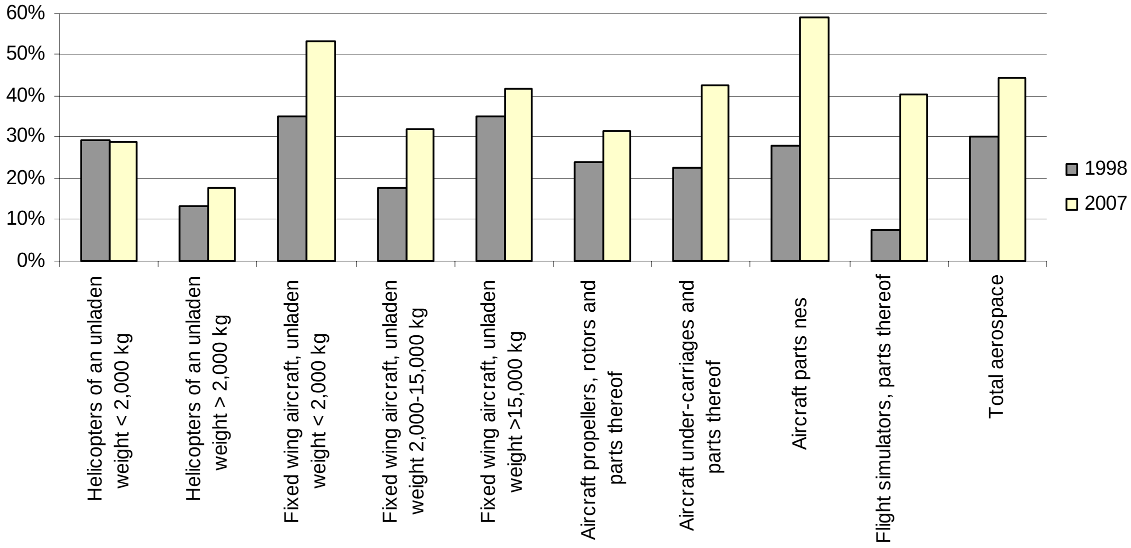
2.1.5 The Intra-European Trade Relations of the European Aerospace Industry

During the last decade the increasing importance of the EU and rise of new Member States has raised the intra-EU27 trade flows significantly. While the average annual growth rate of total extra-EU27 exports was around 4% during the last decade (as mentioned in the previous subsection), the intra-EU27 exports rose by over 16%. As a result, the share of intra-EU27 exports out of total (intra- and extra-EU27) trade flows in nearly all aerospace sub-categories increased as well. See Figure 2.17 for the share of intra-EU27 exports out of total at 1998 and at 2007. Especially aircraft parts, the product group that nearly exclusively contains intermediary products - parts and components – manufactured and traded within the value chain, have grown much above the average and gained shares in the intra-trade. This development indicates a rise in the intra-European division of labour. Flight simulators have shown likewise a significant increase in the share of intra-EU27 exports.

In total, intra-EU trade accounted at 2007 for over 40% of the total EU27 trade flows of around EUR 57.3 bn (see next section for more information on the extra-EU trade and the total EU27 trade).

[23] For Austria it is of importance to mention that there is a noteworthy activity of relevance for the AI outside the scope of NACE 35.3. This concerns material sciences, electronics and software. In these areas Austria is strong in R&D.

Figure 2.17 Shares of Intra-EU27 Exports out of Total EU27 Exports at 2007 and 1998

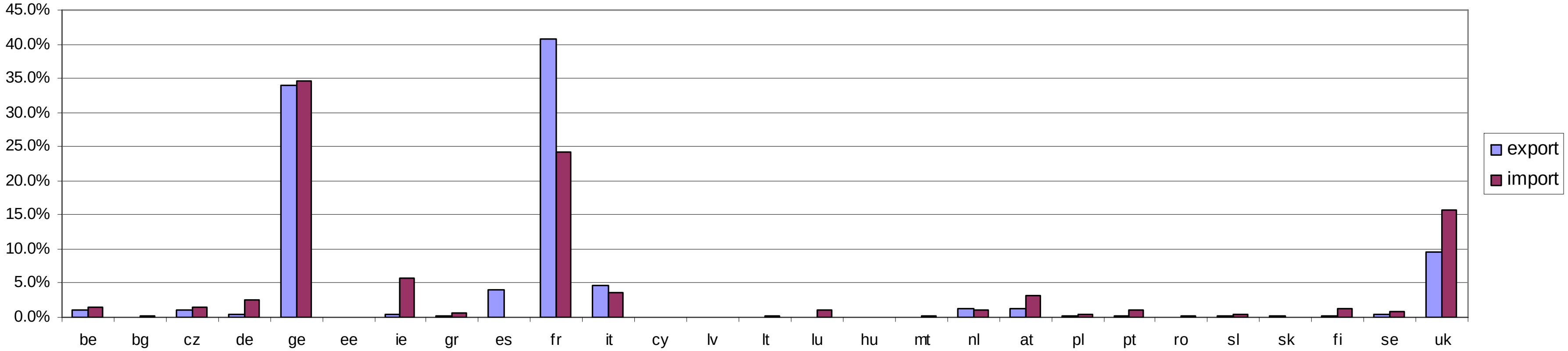


Source: UN Comtrade, own calculations.

With respect to the overall trading (both intra- and extra-EU27) Figure 2.18 shows that both the export and import trade flows are dominated by few players in the EU; France, Germany, UK and Italy.

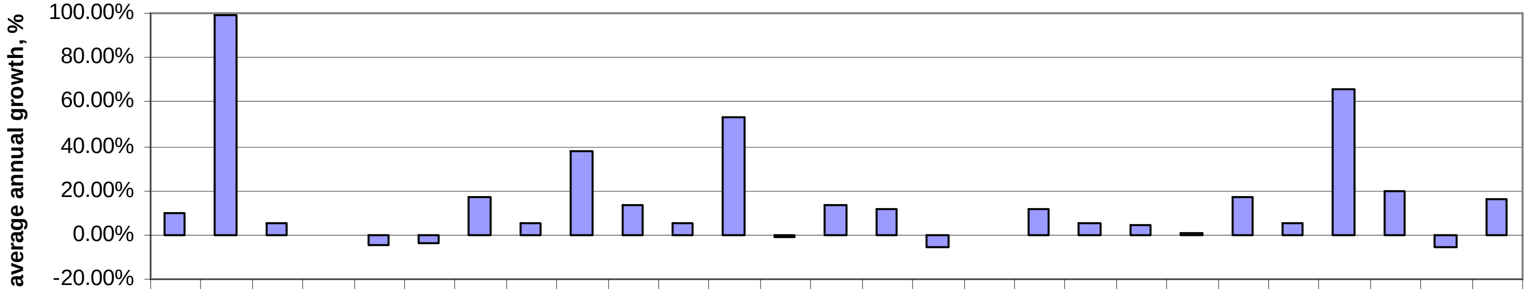
Figure 2.19 provides the country specific average annual growth rates in intra-EU27 exports. Especially Belgium, Slovenia and Hungary experienced high growth rates during the last decade. In addition, Luxemburg and Cyprus experienced extremely high growth rates from marginal levels (up to 600% and 325% respectively), but these have not been included in the below table due to their overshooting effects. At the same time, e.g. the intra-EU27 exports from Sweden, Latvia, Denmark and Czech Republic have been declining.

Figure 2.18 Share of EU Member States on the Total Aerospace Trade at 2007 (Intra and Extra-EU27 Trade)



Source: UN Comtrade. Note: UK data from Eurostat due to lack of data in Comtrade.

Figure 2.19 Average Annual Growth Rates per Country of Intra-EU27 Exports on Aerospace Products from 1998 to 2007



	at	be	bg	cy	cz	dk	ee	fi	fr	de	gr	hu	ie	it	lv	lt	lu	mt	nl	pl	pt	ro	sk	si	es	se	total EU
Growth	9.40	99.0	5.38		-4.51	-3.71	17.2	5.04	38.1	13.4	5.01	53.3	-1.03	13.6	11.4	-5.50		11.6	5.38	4.53	0.84	17.3	5.15	65.3	19.8	-5.75	16.0

Source: UN Comtrade, own calculations.

Of special importance is the aspect of the integration of the old and new Member States in the European AI. One important indication is given by changes in the trade between both of these country groups. The trade balance in aircraft parts has shifted from a deficit in 2008 to a clearly positive trade balance for the new Member States. The share of this product group of total exports has increased from roughly 10% in 2001 up to more than 50% in 2008. Some growth has also taken place in OEM products, such as smaller aircrafts, a market where the Czech Republic has a stake and strategic interest, and large helicopters above all manufactured in Poland. (Table 2.3)

Table 2.3 Trade between Old and New Member States (Accession 2004 and later on)

	Old Member States' exports (i.e. new member states imports)			New Member States' exports (old member states imports)		
	2001	2008	Total change rate	2001	2008	Total change rate
	EUR million	EUR million	in %	EUR million	EUR million	in %
Total	552	727	31.8%	496	284	-42.7%
Fixed-wing aircraft >15 to	344	433	25.8%	393	6	-98.4%
Fixed-wing aircraft 2-15 to	111	120	7.9%	46	106	129.2%
Fixed-wing aircraft <2 to	7	9	30.1%	7	8	16.0%
Helicopters >2°to	3	32	808.7%	1	2	54.5%
Helicopters <2°to	16	24	44.9%	2	0	-97.7%
Aircraft parts nes	57	103	78.5%	40	150	277.9%
Aircraft propellers etc.	5	2	-61.9%	4	3	-22.8%
Aircraft under-carriages etc.	7	5	-26.2%	3	10	229.9%
Flight simulators	0	0	n.a	0	0	n.a

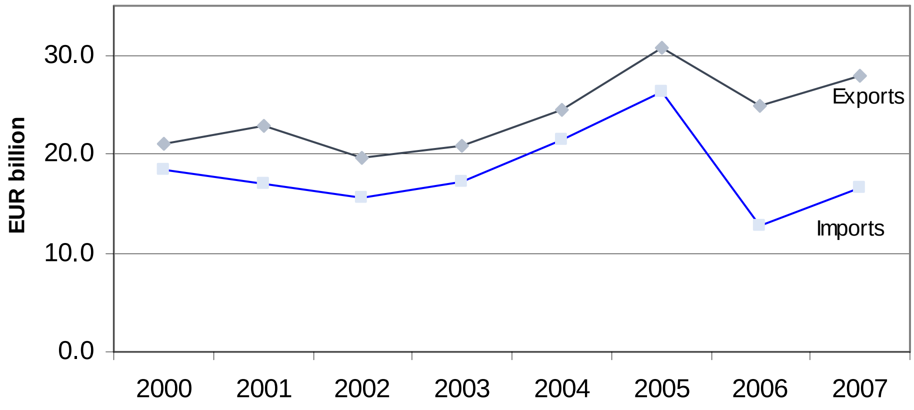
Source: UN Comtrade, Eurostat, own calculations.

2.1.6 The Extra-European Trade of the Aerospace Industry

The EU27 Aerospace[24] trade accounted for some 2% of the total EU27 trade in 2007 and 2.5% of the total exports in manufactures. In value terms, the exports have been growing whereas the imports shrank during the period from 2000[25] to 2007 enhancing therefore the trade surplus. Figure 2.20 provides the values of extra-EU27 aerospace trade from 2000 to 2007.

[24] Excluding space products, balloons, gliders, kites and parachutes.
[25] The comparison was done from 2000 to 2007 due to lack of data for years 1998 and 1999.

Figure 2.20 Total Extra-EU27 Aeronautics Trade from 2000 to 2007



Source: UN Comtrade, HS 1996. Space products are not included.

With regards to the trade data, it should be noticed that there are some differences between the trade data in the official, public sources (UN Comtrade and Eurostat) vs. the data of the industry associations. For compatibility reasons, Table 2.4 provides a comparison between these figures for the most important trade figures of EU27 and US for the year 2007.

The following analysis of the extra-EU trade is based on the official UN Comtrade figures of extra-EU trade only (so the intra-EU trade has been excluded).

Table 2.4 Comparison of the 2007 Aeronautics Trade Data of Official Sources and Industry Associations, EU27 and US

Source	Extra-EU27 trade	Total EU27 trade (intra and extra-EU trade)	US external trade
UN Comtrade, Eurostat	EUR 28 bn ($36.4 bn)	EUR 57.3 bn ($74.6 bn)	EUR 56.9 bn (USD 74 bn)
Statistics of the Industry associations	**ASD:** EUR 53 bn of exports outside Europe (56% of total turnover of EUR 94,5 bn)		**AIA:** EUR 75.6 bn (USD 98.3 bn)

Sources: UN Comtrade[26], Eurostat, ASD Facts and Figures 2007

Compared to the domestic production, the aerospace product exports have accounted for some 20-30% of the total production value between 2000 and 2007. (See Table 2.5) Looking from the domestic market point of view, around 20% of the total domestic as well as foreign supply in the EU27 market was imported.

[26] NACE DM 35.5 code of UN Comtrade HS 1996 data on 6 digit-level, excluding space equipment trade. Eurostat data for the same NACE codes. For the total EU27 trade calculation the Comtrade data has been supplemented by the UK trade figure of Eurostat due to the lack of this data in Comtrade. Exchange rate of $1.3/EUR 1 has been used (as in other parts of the study).

Table 2.5 The EU27 Aerospace Industry's Exports- and Imports Ratios

Indicator	2000	2001	2002	2003	2004	2005	2006
Exports ratio = (X / Q) %	22.7 %	5.0 %	21.8 %	25.2 %	26.9 %	29.6 %	27.3 %
Imports ratio =M / (Q – X + M)	21%	4%	18%	22%	24%	26%	16%
[1] No production data available for 2007.							

Source: UN Comtrade, HS 1996 (trade data), Eurostat (production data).

Table 2.6 presents the value of EU27 total aerospace exports and imports for 2007 and 2000, the share of each subsector of the total (export or import) value and growth of exports and imports per subsector (and in total). As can be seen, by far the largest share of the aerospace trade takes place in the exports (67% of total aerospace exports) and imports (50% of imports) of large aircraft.[27] This is followed by trade in aircraft parts (15% of exports and 30% of imports), trade in small aircraft (9% and 13%) and in helicopters (6% of exports). In percentage terms, the exports of helicopters (heavy and particular light) have been increasing the most between 2000 and 2007. [28] For comparison, the imports of helicopters, small aircraft and aircraft parts grew the most during the same period.

Table 2.6 Share of Extra-EU27 Exports and Imports per Subsector at 2007 and 2000

Sector	Exports			Imports		
	billion EUR share		Annual average change rate 2000-2007	billion EUR share		Annual average change rate 2000-2007
	2007	2000		2007	2000	
Total aerospace	28.0	21.0	4 %	16.5	18.4	-1 %
Fixed wing aircraft, unladen weight > 15,000 kg	67.00 %	54.40 %	8%	50.00 %	51.70 %	-2%
Fixed wing aircraft, unladen weight 2,000-15,000 kg	9.00 %	31.60 %	-8%	13.00 %	33.10 %	-8%
Fixed wing aircraft, unladen weight < 2,000 kg	0.50 %	0.40 %	7%	1.00 %	0.20 %	36%
Helicopters of an unladen weight > 2,000 kg	4.00 %	0.60 %	32%	2.00 %	0.50 %	20%
Helicopters of an unladen weight < 2,000 kg	2.00 %	0.90 %	97%	1.00 %	0.20 %	23%
Aircraft parts nes	15.00 %	9.80 %	12%	30.00 %	12.00 %	15%
Aircraft propellers, rotors and parts thereof	1.00 %	0.50 %	13%	1.00 %	0.30 %	8%
Aircraft under-carriages and parts thereof	1.00 %	1.60 %	1%	3.00 %	1.50 %	10%
Flight simulators, parts thereof	0.20 %	0.20 %	7%	0.40 %	0.50 %	-3%

Source: UN Comtrade, HS 1996.

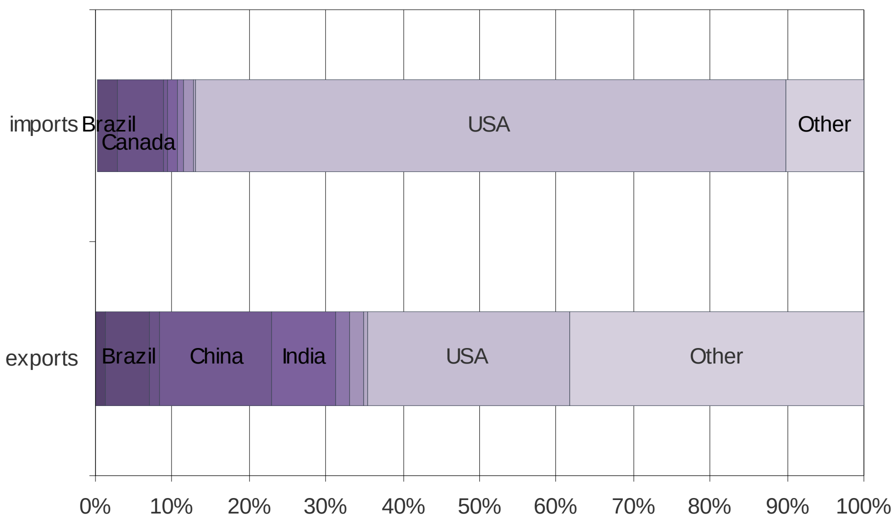
[27] This comprises not only large aircraft as often defined by more than 100 seats, but most of regional aircraft with less than 100 seats.

[28] This development may have been promoted by the decision that Eurocopter became main contractor for the US armed forces with 332 orders of its Light Utility Helicopter UH145, which became generally known in 2006.

With respect to the trade balance in the sub-sector level, EU27 had a surplus at 2007 in all other sub-sectors except for aircraft under-carriages and parts thereof, aircraft parts and in flight simulators and parts thereof.

Figure 2.21 shows the share of exports and imports by the main partner countries. The share of imports coming from the USA has been increasing from 2000 by some 17 percentage points, making it by far the largest source of import to EU27. In addition, some 6% of the imports came from Canada and 2.6% from Brazil. The imports from China and India were still relatively small (around 1%). The share of 40% of exports to "other" countries includes among other the relatively high value of exports to: United Arab Emirates, Switzerland, Qatar, Malaysia, Turkey, Mexico, Singapore and Philippines. The exports of EU27 to these countries accounts for some over 20%. The rest of the 40% of exports to other countries is divided between various partners with relatively small shares to all of them (out of the total extra-EU27 exports).

Figure 2.21 Extra-EU27 Aerospace Products Import and Export shares and values of by Main Trade Partners 2007, EUR billion



	exports	imports
Other	11	2
USA	7	13
South Africa	0.1	0.1
Russian Federation	0.5	0.2
Japan	0.5	0.1
India	2.3	0.2
China	4.1	0.1
Canada	0.4	1.0
Brazil	1.5	0.4
Australia	0.4	0.0

Source: UN Comtrade.

The exports of EU27 were more evenly distributed at 2007. While the largest share was still going to the USA, China, Brazil and India accounted for some significant shares as well (15%, 6% and 8% respectively). Since 2000 the exports of EU27 have been also growing the most to these three aforementioned countries in addition to Australia and Russia. This has balanced and disaggregated the EU27 export structure in aerospace products compared to year 2000.

Table 2.7 clarifies further the share of imports coming from each partner country per each subsector and in total and shows the share of all imports coming from these partner countries out of total imports and the average annual growth rate of imports from 2000 to 2007 by partner. While it is evident from the table that in most subsectors the USA is the most important import source, some exceptions can be found as well. For example, the imports of flight simulators originate mostly from Canada. Russia is exporting even larger share of large helicopters to the EU27 than the USA.[29]

The average annual growth rates of imports show as well that new competitors have emerged. Especially the imports from India (91% growth) and China (59% growth) have substantially increased, but the total shares remain relatively low. However, the dominant imports from USA is and remains unchallenged (with import shares of up to 88%) and due to the high absolute trade values, even the relatively low growth rates in the imports from the US have had larger absolute effects than many of the higher growth rates that relate to significantly smaller trade values.

Table 2.7 Share of EU Imports at 2007 from each Partner Country out of the Subsector total and Growth of Imports per Partner 2000-2007

Partner	Fixed wing aircraft > 15,000 kg	Fixed wing aircraft 2,000-15,000 kg	Fixed wing aircraft < 2,000 kg	Helicopters of an unladen weight > 2,000 kg.	Helicopters of an unladen weight < 2,000 kg	Air-craft parts	Aircraft propellers, rotors and parts thereof	Aircraft under-carriages and parts thereof	Flight simu-lators	Total aerospace	Growth of imports per partner
Australia	0%	0%	1%	0%	0%	1%	0%	1%	0%	0%	7%
Brazil	2%	0%	0%	3%	4%	0%	1%	0%	0%	3%	-6%
Canada	2%	10%	1%	4%	7%	5%	7%	4%	74%	6%	3%
China	1%	0%	0%	0%	0%	2%	2%	1%	0%	1%	59%
India	0%	0%	0%	0%	2%	1%	9%	1%	1%	1%	91%
Japan	1%	0%	0%	0%	0%	1%	2%	2%	0%	1%	13%
Russia	0%	37%	0%	0%	1%	7%	3%	1%	0%	1%	17%
South Africa	4%	0%	0%	0%	0%	1%	0%	1%	0%	0%	15%
USA	69%	32%	88%	72%	81%	54%	68%	76%	15%	77%	2%
Total share from these partners	80%	78%	90%	79%	95%	72%	92%	87%	90%	90%	2%

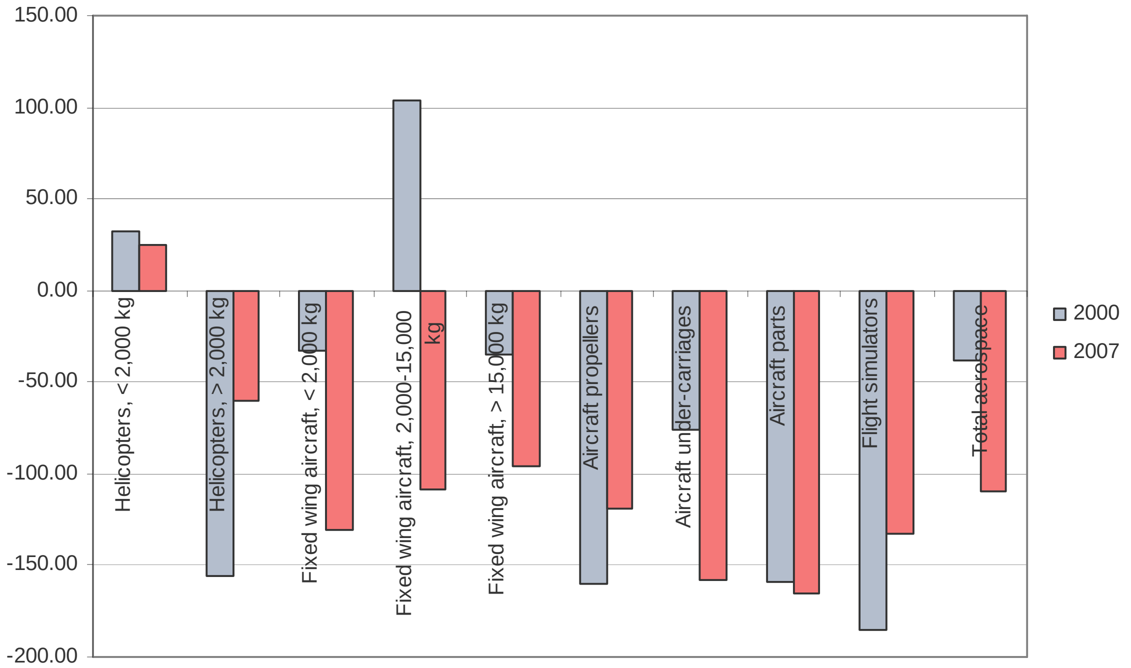
Source: UN Comtrade.

[29] The US American helicopter manufacturers are specialized on military applications, which are generally not traded as freely as civil products.

An important measure for competitiveness which relates to foreign trade is the "revealed comparative advantage", which is calculated via the traditional Balassa Index[30] (BI). In the below figures an index value above 0 means that in the EU the share of aerospace exports (out of total exports of manufactured goods) is higher than in the comparison group, and, hence, the EU is considered to have a relative advantage in the exports of that product.

Figure 2.22 shows that the competitiveness of the European aerospace industry is below the one of the US industry in most of the sub-sector (all but small helicopters) according to this measure. In addition, the competitiveness of the EU27 industry has been worsened compared to the USA e.g. in the production of fixed wing aircraft since 2000. However, the reduction of the RCA indexes of 2000 to 2007 has been affected by a decrease in the European exports of aerospace products that is not plausible with regard to the development in global markets. Airbus has gained shares during the period under consideration. But official statistics from different sources do not provide the same development. Because the associations of the AI do not collect trade figures it is not possible to make corrections to this indicator. As a consequence it will not be used for the assessment of the competitiveness of the European AI if we do not succeed in identifying more plausible sources.

Figure 2.22 EU27 Revealed Comparative Advance (RCA) EU against USA at 2007 and 2000



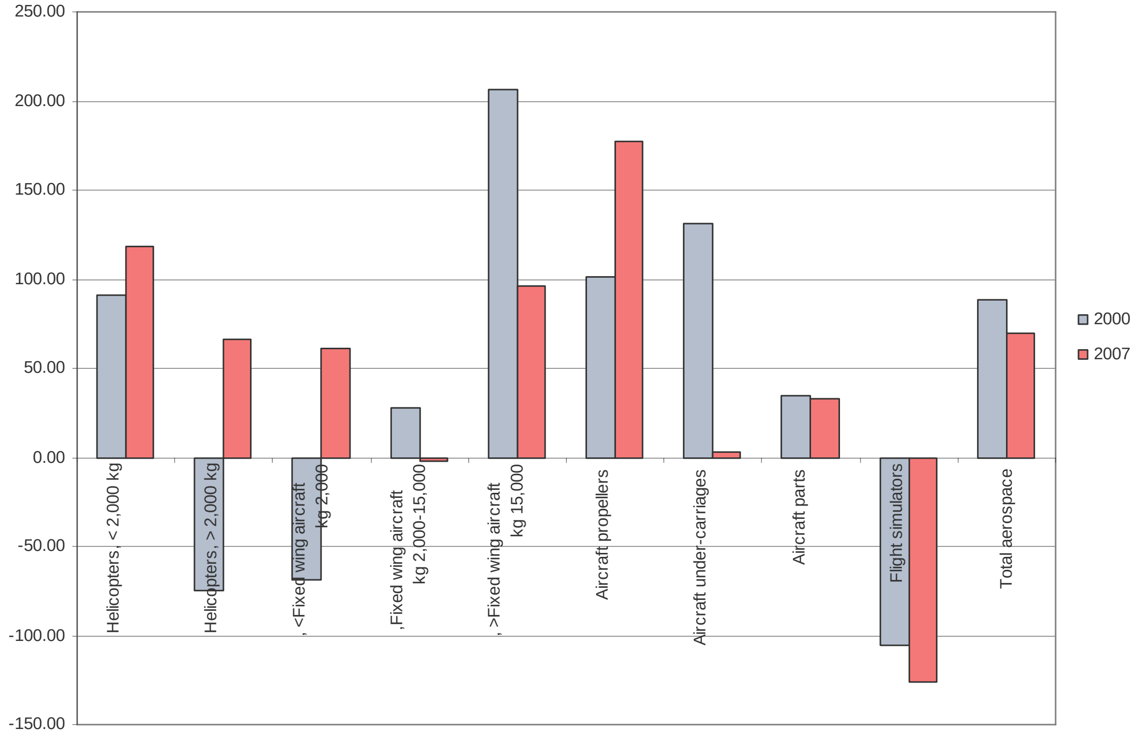
Source: UN Comtrade, own calculations.

However, when the EU27 exports are compared to the exports of all other countries except for the USA (the rest of the world or RoW exc. USA), they are found to have a strong competitiveness advantage in all subsectors except for flight simulators. See Figure 2.23. The competitive-

[30] The BI is based on the share of the exports out of total exports compared to the share of the exports in a competing country or in the world. The simple version of the exact formula for the above calculations is BI= ln ((Xij/Xtj) / (Xir/Xtr)) * 100, where i is the subsector, j is the main country, t refers to all products and r refers to the reference country or country group.

ness of EU27 has been also increasing e.g. in the production of small and large helicopters and in small aircraft. At the same time, small decreases in the competitiveness of large aircraft and aircraft undercarriages seem to have taken place. However, again the changes in the competitiveness should be studied with caution.

Figure 2.23 EU27 Revealed Comparative Advance (RCA) against the RoW (exc. USA) at 2007 and 2000



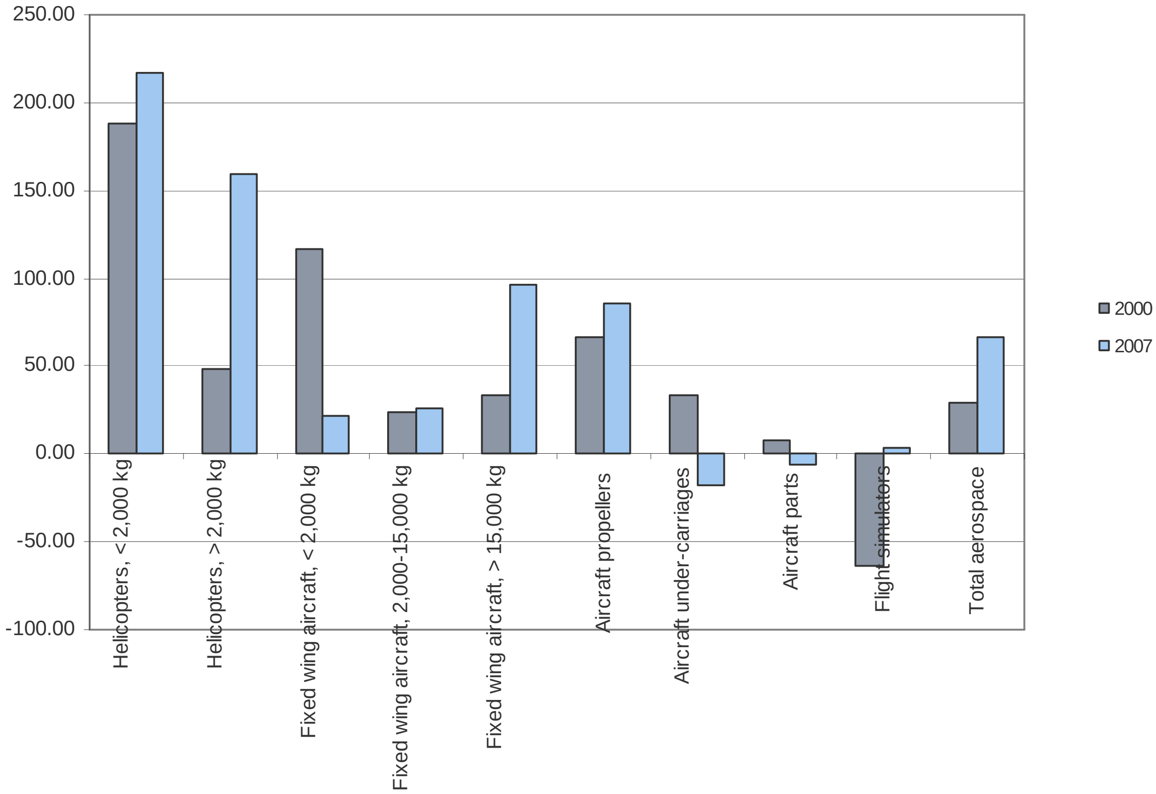
Source: UN Comtrade, own calculations.

Modifications of the original Balassa index have been also made to measure the revealed comparative advantage in other ways. We use for comparison a modification, which compares the export-import ratios of the subsector to the export-import ratio of the whole (and same) country (for all products).[31] In other words, the alternative index is measuring the competitiveness of EU27 against the other industries competitiveness in the EU27 itself (and not specifically against any particular country or country group) and takes into consideration the net balance in trade. It is based on the assumption that if the exports/imports ratio of a subsector is higher than of the country in total, the subsector is considered to have a comparative advantage compared to other industries. An index value above 0 means again that the subsector has a comparative advantage (or a strong position) in the respective country or region compared to the average of all other industries within the same region. In addition, as above mentioned as well, this index is also equally sensitive to yearly changes in the trade flows of not only the aerospace subsectors, but all industries. Hence, the change from 2000 to 2007 should be again considered with caution.

Similar to the other measures (and in high correlation with the subsector trade balances), the EU has a comparative advantage in all aerospace sectors except aircraft parts and flight simulators.

[31] The Alternative RCA index is calculated as Index = ln ((Xij/ Mij) / (Xtj/ Mtj)) * 100, where X is exports, M imports, i is the subsector, j is the country, t refers to all products.

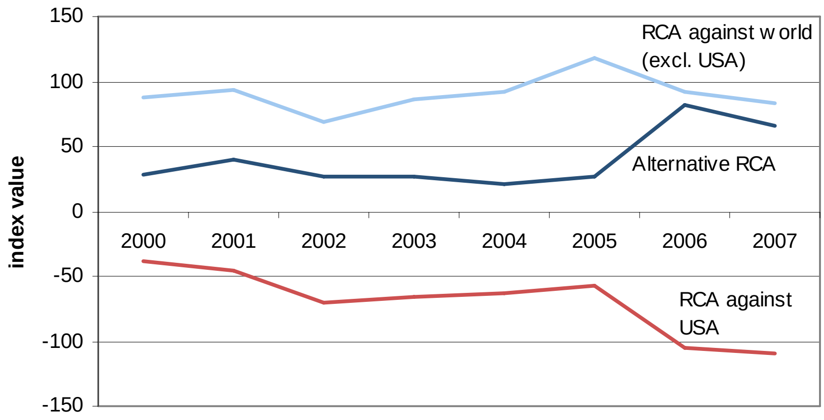
Figure 2.24 EU27 Alternative (Domestic) RCA Index for each Subsector at 2000 and 2007



Source: UN Comtrade, own calculations.

In order to assess the yearly fluctuations in the RCA, time series for the RCA index for the total EU27 aerospace industry are presented in Figure 2.25. It shows that the EU27 aerospace industry's revealed comparative advantage has been staying relatively stable against the world (with a small positive trend) when the USA is excluded, and has been rising internally (alternative RCA index). However, against the USA their competitiveness has been indeed decreasing over the period.

Figure 2.25 Yearly RCA Indexes for total EU27 Aerospace Industry from 2000 to 2007



Source: UN Comtrade, own calculations.

2.1.7 The Performance of the EU Aerospace Industry in Global Trade by Subsectors

Behind the US the EU27 is the leading player in the global aerospace market. The trade balance shows a surplus that in 2008 is much higher than in 2001. However during the period under investigation some market shares were lost. The underlying reason for that development is disclosed by an investigation of the subsectors. All countries that have a major stake as OEM enjoy a trade surplus, but only that of the EU and the US increased.

Table 2.8 The Performance of EU27 in Total Global Trade

Total aerospace	2001			2008		
	Share in global trade	RCA	Trade surplus	Share in global trade	RCA	Trade surplus
	in %	0 = neutral	in % trade volume	in %	0 = neutral	in % trade volume
EU27	28.25%	73	14.67%	23.77%	50	30.23%
USA	41.24%	119	35.20%	38.56%	138	53.43%
Japan	1.60%	-147	-6.02%	1.26%	-153	-42.04%
Canada	8.08%	59	25.60%	5.17%	42	15.15%
Brazil	3.34%	120	61.98%	3.22%	78	34.61%
Russia	0.31%	-172	47.24%	n.a.	n.a.	n.a.
India	0.07%	-233	-52.92%	0.66%	-71	-81.61%
China	0.37%	-251	-84.21%	0.87%	-251	-72.81%
South Africa	0.20%	-82	-67.25%	0.29%	-65	-50.09%
Australia	0.37%	-107	-51.88%	0.46%	-110	-60.98%

Source: UN Comtrade.

The nomenclature of Comtrade does not allow to discriminating between large and regional aircraft. The statistical category of aircraft with a weight of more than 15,000 kg contains both groups. The EU and the US are manufacturers of large aircraft (LA), most of the other economies under investigation in Table 2.9 are manufacturers of regional aircraft or are about to become it in the future. Europe has maintained its position and expanded its trade surplus. In contrast the US has suffered some losses in global market shares, but the trade balance has improved. The major players in the regional aircraft market have shown a quite different development. While Brazil strongly expanded its global share Canada lost some of its former importance in this market segment.

Table 2.9 The Performance of EU27 in Global Trade with Commercial Aircraft

Aircraft >15000kg	2001			2008		
	Share in global trade	RCA	Trade surplus	Share in global trade	RCA	Trade surplus
	in %	0 = neutral	in % trade volume	in %	0 = neutral	in % trade volume
EU27	30.77%	82	24.10%	30.17%	74	48.13%
USA	42.25%	121	51.79%	39.49%	141	69.46%
Japan	0.01%	-631	-97.30%	0.00%	n.a.	-100.00%
Canada	3.70%	-19	3.85%	3.61%	6	15.99%
Brazil	0.89%	-12	99.54%	4.47%	111	77.13%
Russia	0.10%	-283	-6.27%	n.a.	n.a.	n.a.
India	0.00%	n.a.	-100.00%	0.03%	-384	-63.43%
China	0.03%	-509	-98.65%	0.36%	-339	-91.98%
South Africa	0.12%	-128	-72.61%	0.13%	-147	-32.91%
Australia	0.12%	-222	-49.17%	0.05%	-325	-94.49%

Source: UN Comtrade.

The development in the global market for smaller aircraft is depicted in Table 2.10. This category comprises above all business jets, a market segment that has always been dominated with a strong US presence.

Table 2.10 The Performance of EU27 in Global Trade with Smaller Aircraft

Aircraft 2000kg - 15000kg	2001			2008		
	Share in global trade	RCA	Trade surplus	Share in global trade	RCA	Trade surplus
	in %	0 = neutral	in % trade volume	in %	0 = neutral	in % trade volume
EU27	21.95%	155	4.38%	19.39%	30	-6.63%
USA	19.43%	44	-44.78%	40.39%	143	27.18%
Japan	0.09%	-434	-90.05%	0.00%	n.a.	-100.00%
Canada	30.90%	193	78.99%	12.30%	129	55.58%
Brazil	21.75%	308	97.70%	6.30%	145	43.55%
Russia	0.01%	-492	-92.02%	n.a.	n.a.	n.a.
India	0.00%	n.a.	n.a.	0.32%	-145	-98.88%
China	0.27%	-281	-94.29%	0.50%	-306	-32.98%
South Africa	0.40%	-12	-79.02%	0.84%	43	-70.81%
Australia	0.08%	-267	-89.79%	0.19%	-198	-80.77%
	94.89%			80.23%		
Aircraft <2000kg						
EU27	34.59%	93	63.19%	42.93%	109	72.82%
USA	19.23%	43	-32.42%	20.02%	73	-8.16%
Japan	0.22%	-344	-92.79%	0.27%	-307	-71.89%
Canada	17.57%	137	59.20%	12.65%	132	38.86%
Brazil	1.01%	1	-62.09%	0.14%	-234	-93.80%
Russia	0.00%	-1152	-99.99%	n.a.	n.a.	n.a.
India	0.00%	n.a.	-100.00%	0.09%	-274	-98.34%
China	0.00%	n.a.	-100.00%	0.00%	n.a.	-100.00%
South Africa	0.28%	-46	-80.27%	1.00%	60	-52.18%
Australia	1.05%	-3	-40.84%	0.43%	-117	-82.65%
Note: The market segment for business aircraft is within the range of 2000 and 15000 kg						

Source: UN Comtrade.

The global market for helicopters is dominated by Europe and the US. While the US is far in the lead in the military segment European companies command a strong position in the civil market. Over the period under investigation the European players were able to expand the global market share remarkably. In both of the size categories Europe gained importance and enjoys a trade surplus. Simultaneously the US lost market shares, in the segment of smaller helicopters it is a net exporter (Table 2.11).

Table 2.11 The Performance of EU27 in Global Trade with Helicopters

Helicopters >2000kg	2001			2008		
	Share in global trade[1)]	RCA	Trade surplus	Share in global trade[1)]	RCA	Trade surplus
	in %	0 = neutral	in % trade volume	in %	0 = neutral	in % trade volume
EU27	10.77%	-23	29.34%	44.29%	113	76.91%
USA	59.34%	155	68.48%	28.29%	107	31.76%
Japan	0.04%	-506	-96.65%	0.06%	-457	-96.46%
Canada	10.54%	85	56.00%	9.66%	105	69.86%
Brazil	0.04%	-315	-92.80%	0.00%	n.a.	-100.00%
Russia	10.78%	184	96.65%	n.a.	n.a.	n.a.
India	0.00%	n.a.	-100.00%	0.00%	-608	-99.70%
China	0.00%	n.a.	-100.00%	0.00%	-1013	-99.95%
South Africa	0.41%	-10	-60.93%	1.55%	103	14.52%
Australia	0.35%	-114	-82.07%	1.82%	27	-40.82%
Helicopters <2000kg						
EU27	34.59%	93	63.19%	42.93%	109	72.82%
USA	19.23%	43	-32.42%	20.02%	73	-8.16%
Japan	0.22%	-344	-92.79%	0.27%	-307	-71.89%
Canada	17.57%	137	59.20%	12.65%	132	38.86%
Brazil	1.01%	1	-62.09%	0.14%	-234	-93.80%
Russia	0.00%	-1152	-99.99%	n.a.	n.a.	n.a.
India	0.00%	n.a.	-100.00%	0.09%	-274	-98.34%
China	0.00%	n.a.	-100.00%	0.00%	n.a.	-100.00%
South Africa	0.28%	-46	-80.27%	1.00%	60	-52.18%
Australia	1.05%	-3	-40.84%	0.43%	-117	-82.65%
1) In this market segment large military contracts had a noteworthy impact on global trade shares.						

Source: UN Comtrade.

2.2 The Microeconomic Performance of the European Aerospace Industry

2.2.1 The Intra-European Comparison of the Performance of Aerospace Companies

The micro economic analysis of the European aerospace industry (AI) is based on data from the AMADEUS database, which has been supplemented and cross-checked with experts and stakeholders. A list of 234 large civil aerospace companies has been identified (see: Annex 9.4) with a strong focus on civil aerospace. The distribution of the companies in the sample over the EU-countries is as follows in Table 2.12.

Table 2.12 Country Distribution of Aerospace Companies in Analysed Sample

Country	Number of civil aerospace companies in sample
France	100
United Kingdom	50
Spain	24
Germany	21
Italy	15
Czech Republic	6
Belgium	5
Poland	4
Austria	3
Romania	2
Portugal	2
Denmark	1
Switzerland	1
Total	**234**

Source: Own calculations on the base of Amadeus data.

For these companies in our sample several indicators and ratios[32,33] between 2001 and 2007[34] were analyzed (all values in nominal terms and averages are weighted). Please note that conclusions can only be drawn for the sample of companies and not for the (civil) aerospace industry as a whole!

32 For each indicator or ratio calculated in Amadeus a short formula is given in footnote. A detailed formula is given in a technical annex (see Annexes Part 5).

33 Annual values of indicators and ratios based on the Amadeus data are calculated using the filled in variables for the set of companies for that specific year. If for one year the variable is not filled in for a particular company, that company will not be included in the calculation of the ratio or indicator for that year. However the ratio or indicator will be calculated for the next year if the value is filled in for the next year. The consequence is that the calculation of a time series of an indicator or ratio might be based on a different set of companies for each year (within the same sample). Especially if samples are small (e.g. in our analysis per country) the resulting time series should be interpreted with caution.

34 Before 2001 the number of companies with filled in variables is too low to get reliable analyses. 2008 figures are only available for a very limited number of companies, so we decided not to include them.

Box 2.1: Creation of the sample

The microeconomic sample consists of 234 large civil aerospace companies in the EU27. In this box the sample set-up will be explained.

In the Amadeus database there are in EU27 more than 2400 companies which have as main activity code NACE 35.3. Unfortunately some major aerospace companies don't have NACE 35.3 as main activity code because they are for example listed as holding company with activity code NACE 74.15. Therefore the Amadeus list has been enriched in three ways: by searching in national and European association member lists, by using a suppliers list of EADS and by incorporating an existing list of French companies active in aerospace industry.

Because of the fact that this enriched list of 2600 companies still contains companies that are defence or space focussed or that provide airline services (like catering, handling, airline carriers, …), and that this study is focussing on civil aerospace companies, a one-by-one screening of the companies had to be done. We focussed on the major players as they are responsible for a large part of sector output and performance.

In order to have a validated list of at least 200 major EU27 players, aerospace experts from Bauhaus Luftfahrt and Decision classified the top 400 players (based on both the number of employees and the operating revenue in 2006) based on the following criteria:

- percentage of turnover in aerospace related activities;
- percentage of aerospace turnover in civil activities;
- manufacturing or service oriented.

In order to get a list of aerospace companies that are focussed on civil 'manufacturing' aerospace (where we suppose that these activities are the 'driver' of their accounts), the following companies were retained:

- more than 50% of their turnover in aerospace related activities;
- more than 50% of aerospace turnover in civil activities;
- manufacturing oriented.

By using these criteria we got a final list of 234 large civil aerospace companies (in the following figures 'Aerospace sample EU27' is used to indicate this sample).

Per employee ratios

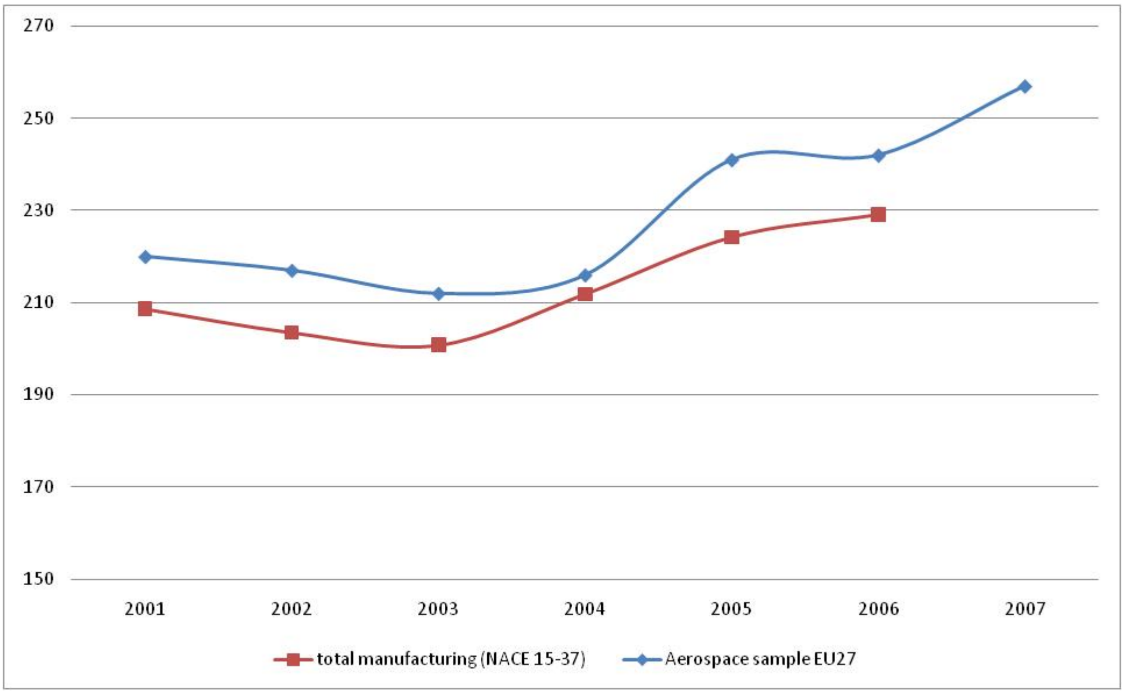
In this section two indicators expressed per employee will be discussed: operating revenue per employee and value-added per employee

Operating revenue per employee

*Overall operating revenue per e*mployee[35] for the sample of identified companies in the civil aerospace industry, decreased after 2001, but recovered from 2004 on. Over the whole period the average annual increase in productivity was 2.7%, whereas operating revenue in total manufacturing industry rose by a modest 2% on average. (Figure 2.26)

35 Formula = operating revenue / number of employees (calculated only for companies where both variables are known).

Figure 2.26 Operating Revenue per Employee (in thousands EUR)[36]

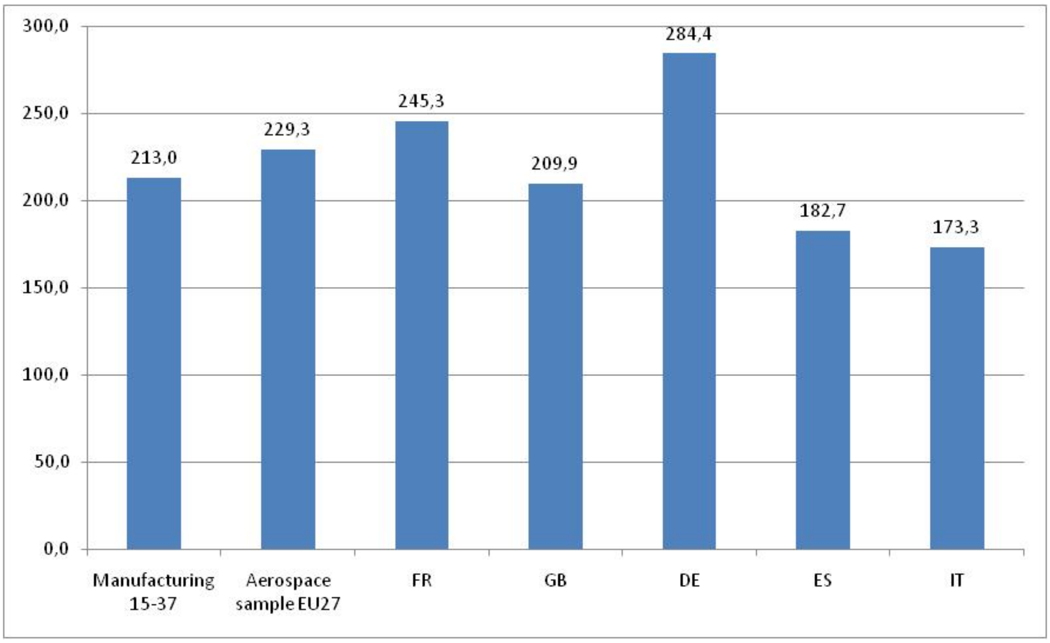


Source: Own calculations on the base of Amadeus data.

The average operating revenue per employee (in absolute values between 2001 and 2007) was above average in France and especially Germany, but German operating revenue per employee was continually decreasing for the companies in the sample. Aerospace companies in United Kingdom, Spain and Italy are performing below average, but their operating revenue per employee increased on average, especially for the Italian companies. (Figure 2.27, Figure 2.28)

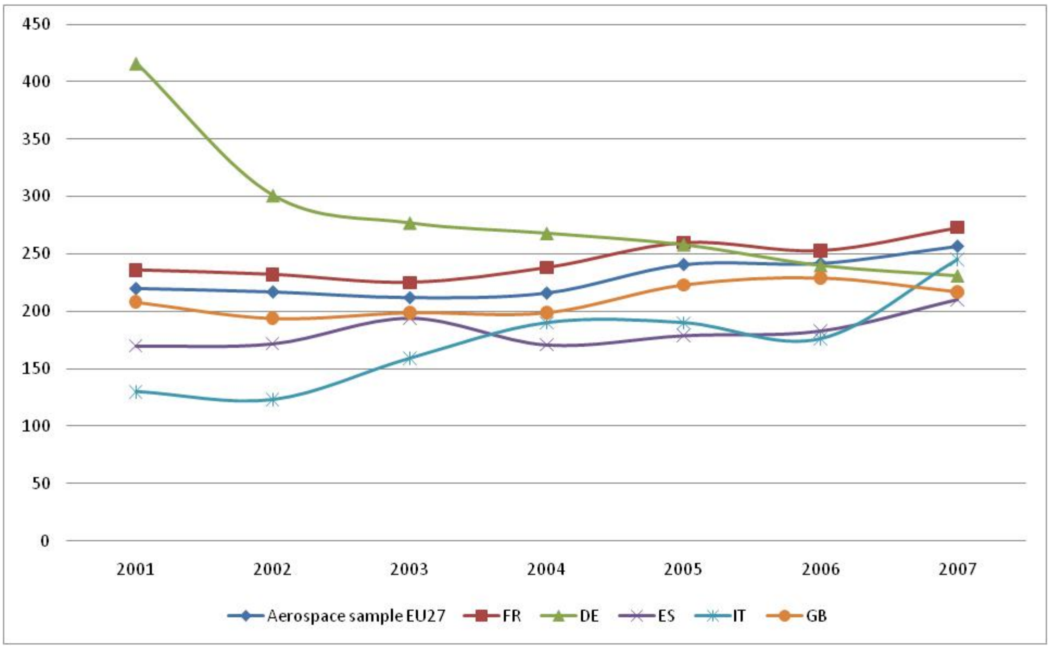
[36] Operating revenue per employee for total manufacturing industry for 2007 could not be calculated in the online dbase due to the large number of records (more than 1 million records).

Figure 2.27 Average Operating Revenue per Employee (in thousands EUR - 2001-2007).



Source: Own calculations on the base of Amadeus data.

Figure 2.28 Operating Revenue per Employee Major Countries (in thousands EUR)



Source: Own calculations on the base of Amadeus data (note that the 'aerospace sample EU 27' comprises all the companies from Table 2.12, so not only the companies from the 5 major countries).

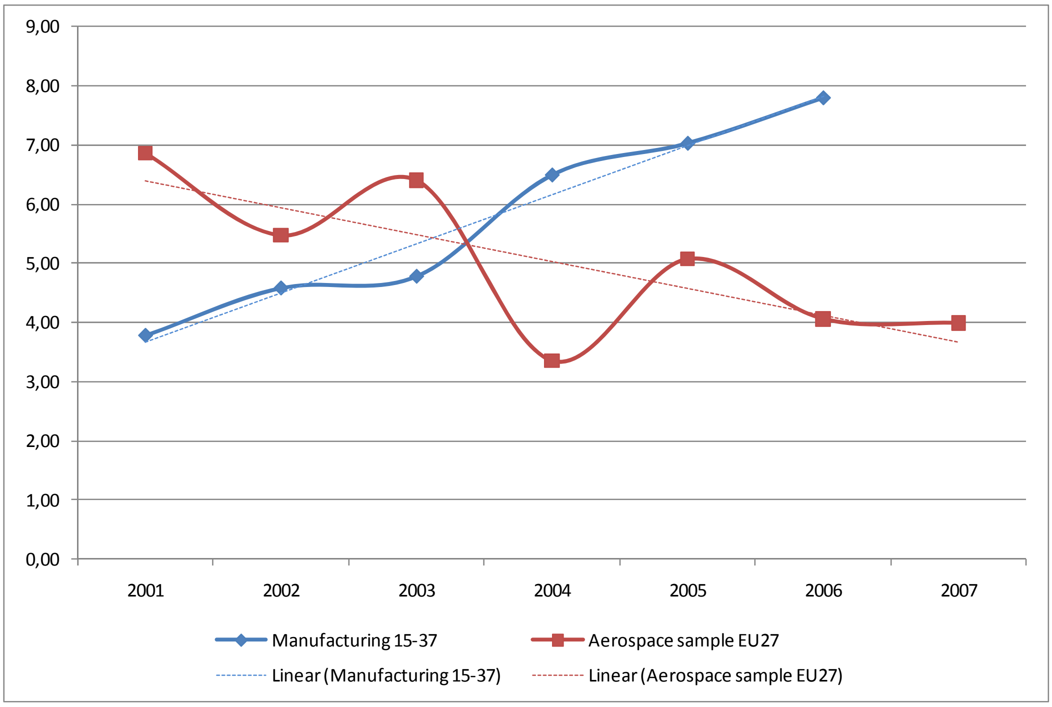
Profitability indicators

In this section we discuss six profitability indicators, each one viewed from a slightly different angle (company's view or investors view): profit margin, EBITDA, EBIT, return on shareholders' funds, return on capital employed and finally cash flow to turnover. They all are following the same downward trend for the sample of companies.

Profit margin

The average profit margin[37] for the sample of major European companies in the aerospace industry, was 5% in the period 2001-2007, but crumbled away from more than 7% in 2001 to 4% in 2007. Compared to the manufacturing industry where average profit margin was continuously growing and was 5.7% in the period 2001-2006, aerospace industry performed relatively weak. (Figure 2.29).

Figure 2.29 Profit Margin (in %)

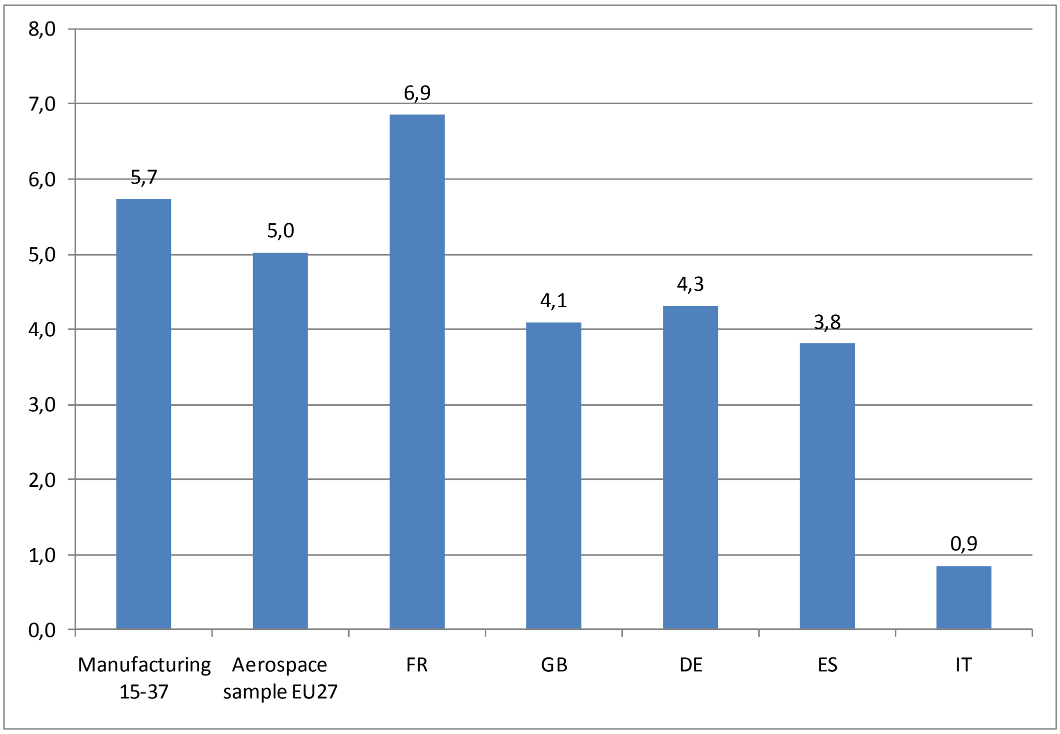


Source: Own calculations on the base of Amadeus data.

France is the only country which has an above average profit margin, but in all countries profit margins dropped significantly from 2004 on, with a slight revival in 2005 but again a decline in 2006. Since 2003 the Italian companies in our sample have a constantly negative profit margin, with only a slight revival in 2007. British companies were performing below average until 2004, but profit margin recovered in last years. The sharp fall of profit margin in Germany in 2006 is remarkable, given the good performance between 2001 and 2005. (Figure 2.30, Figure 2.31)

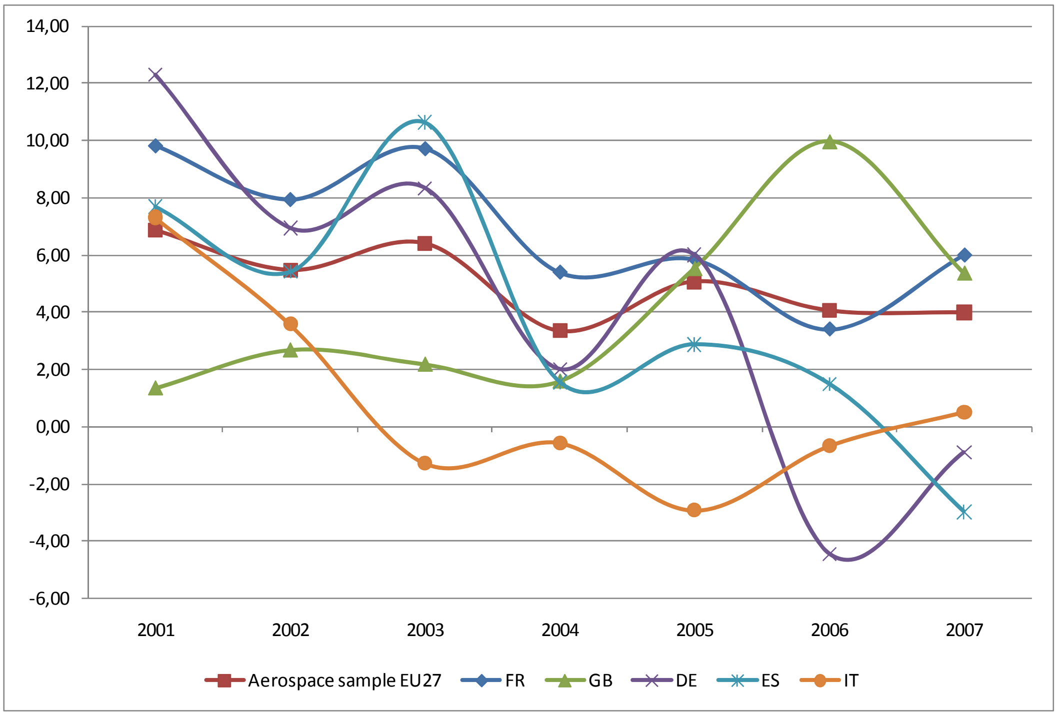
[37] Formula = ((operating profit/loss + financial profit/loss) / operating revenue) * 100.

Figure 2.30 Average Profit Margin (in %) per Country



Source: Own calculations on the base of Amadeus data.

Figure 2.31 Profit Ratio Major Countries (in %)

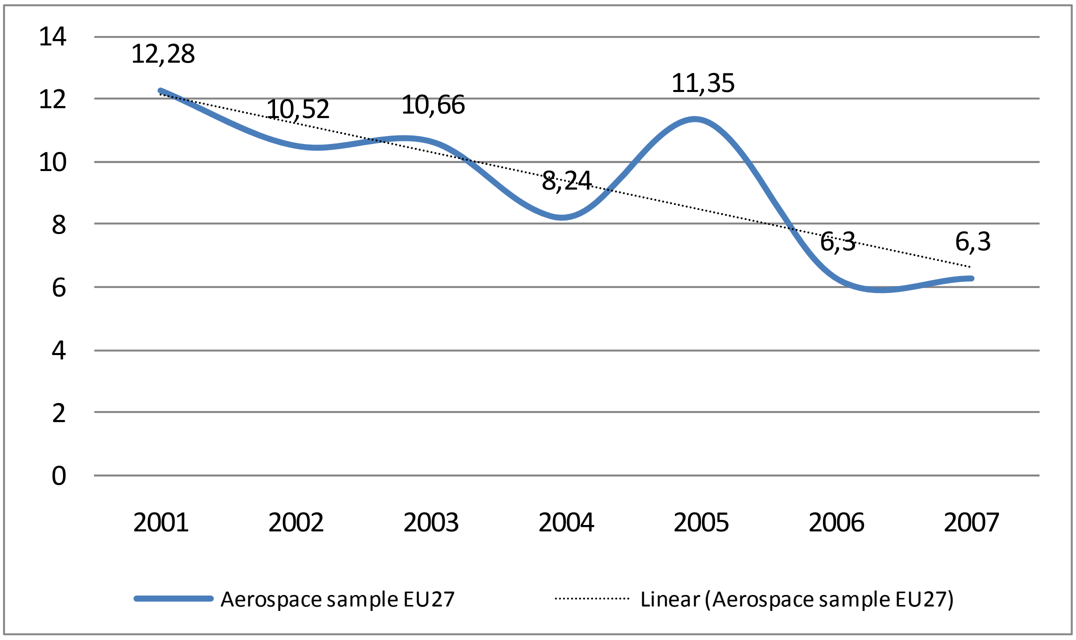


Source: Own calculations on the base of Amadeus data.

EBITDA margin

EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization) margin[38] measures the extent to which cash operating expenses use up revenue. It is used, mostly by investors, to assess a company's profitability by comparing its revenue with earnings. Generally, a higher value is appreciated for this ratio as that would indicate that the company is able to keep its earnings at a good level via efficient processes that have kept certain expenses low. In the aerospace sample EBITDA follows a downward trend during the last years, except for 2005. (Figure 2.32, Figure 2.33)

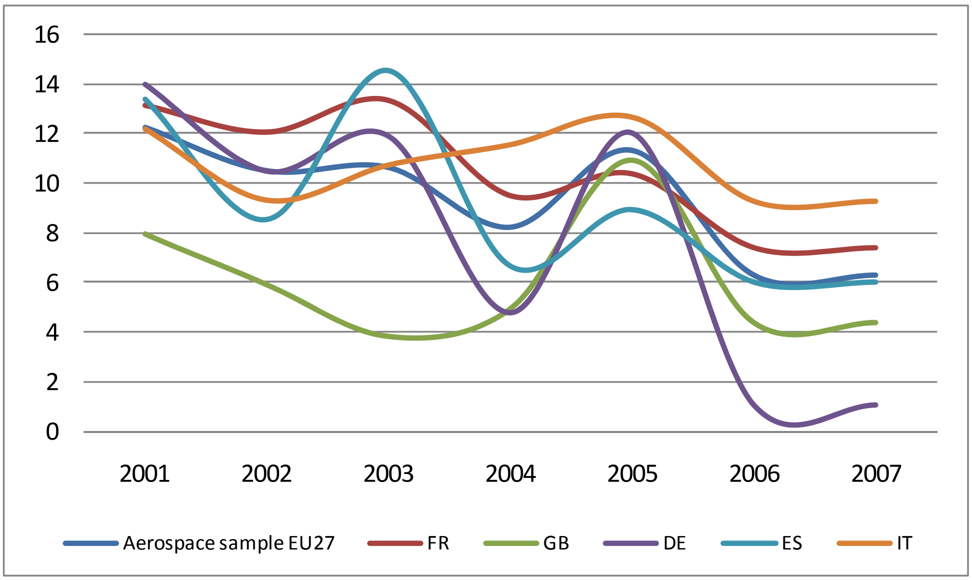
Figure 2.32 EBITDA Margin (in %)



Source: Own calculations on the base of Amadeus data.

38 Formula = (Operating P/L + Depreciation) / Operating Revenue) *100.

Figure 2.33 EBITDA Margin Major Countries (in %)



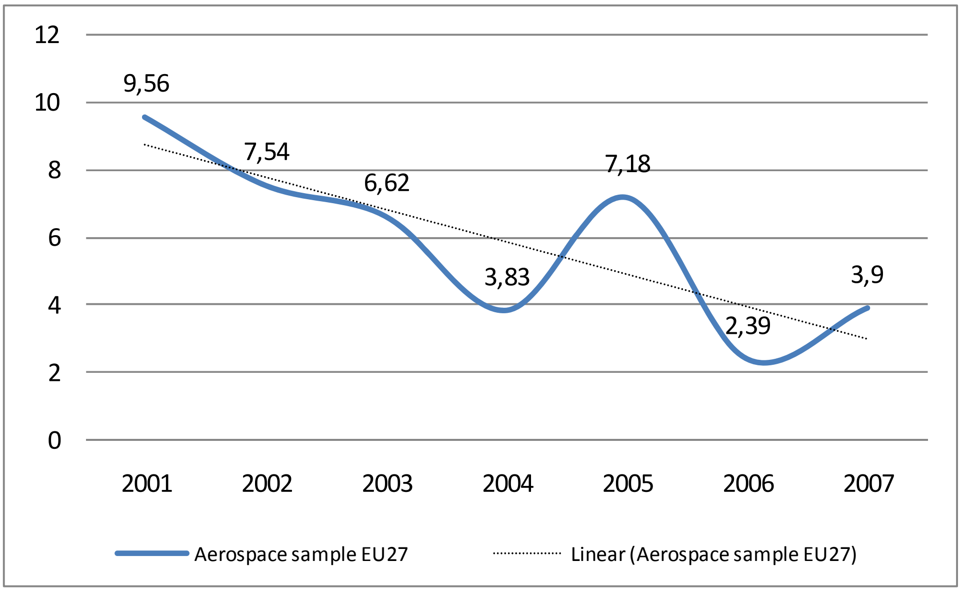
Source: Own calculations on the base of Amadeus data.

EBIT margin

EBIT margin[39] is a profitability measure that is useful when comparing multiple companies, especially within a given industry, and also helps evaluate how a company has grown over time. The EBIT margin is another measure investors can use to assess a company's financial health. The EBIT margin shows you the percentage of each euro of sales revenue that is left after all expenses have been removed, excluding net interest and income tax expenses.

The EBIT margin for the companies in the aerospace sample is following the same downward pattern as the EBITDA margin. (Figure 2.34, Figure 2.35)

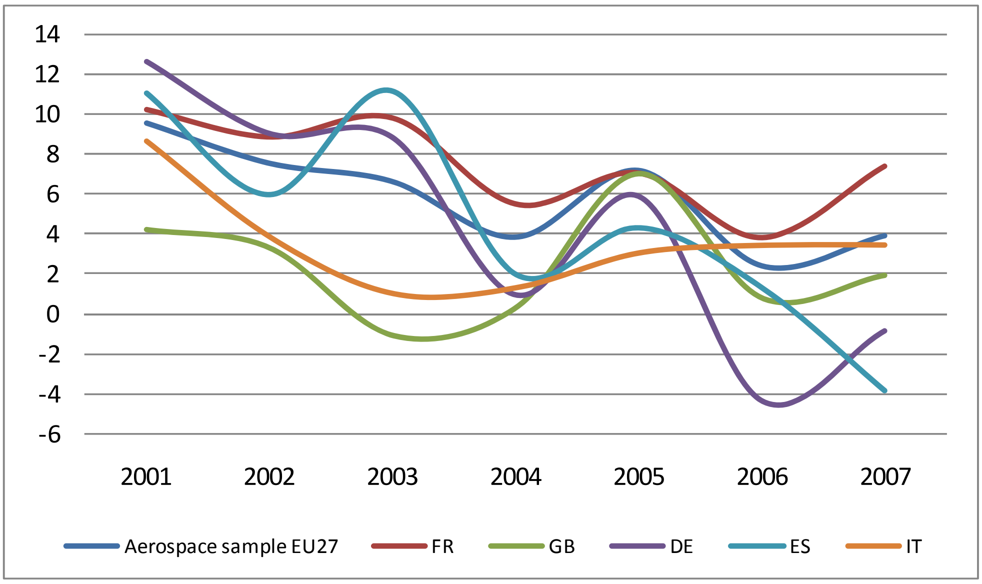
Figure 2.34 EBIT Margin (in %)



39 Formula = (Operating P/L / Operating Revenue) * 100.

Source: Own calculations on the base of Amadeus data.

Figure 2.35 EBIT Major Countries (in %)



Source: Own calculations on the base of Amadeus data.

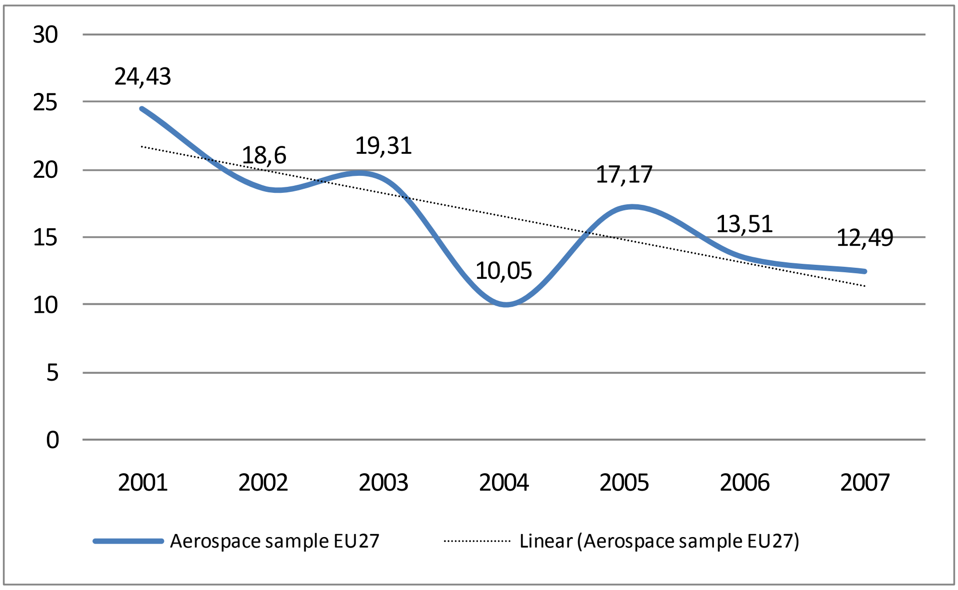
Return on shareholders funds

The Return On Shareholders Funds (ROSF) ratio[40] has historically been used by industry investors as a measure of the profit for the period which is available to the owner's stake in a business. The Return On Shareholders Funds ratio is therefore a measure of profitability from the standpoint of the shareholder. It indicates whether or not a company is generating adequate profits in relation to the resources invested in it by shareholders.

For the sample of aerospace companies ROSF ratio decreased over the past years. The pattern is consistent with the other profitability indicators. (Figure 2.36, Figure 2.37)

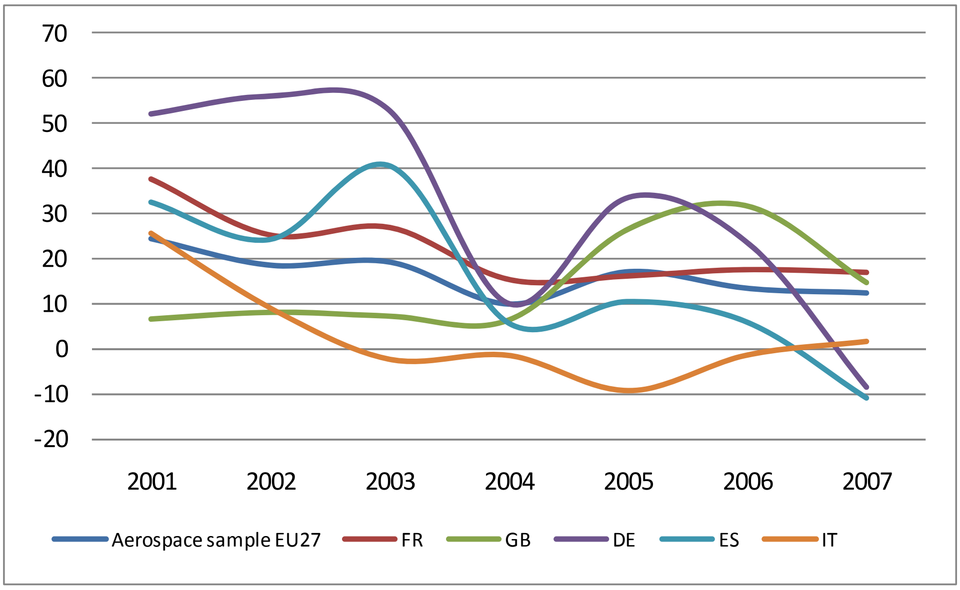
[40] Formula = (P/L before Tax & Extr. Items / shareholder funds) * 100.

Figure 2.36 Return on Shareholders Funds (in %)



Source: Own calculations on the base of Amadeus data.

Figure 2.37 Return on Shareholders Funds Major Countries



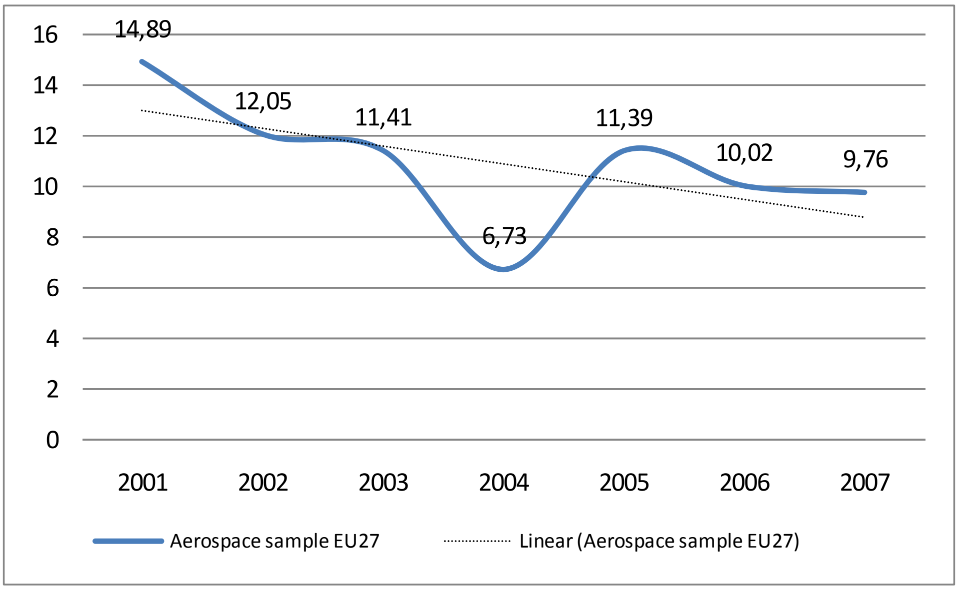
Source: Own calculations on the base of Amadeus data.

Return on capital employed

The Return on capital employed (ROCE) ratio[41] indicates the efficiency and profitability of a company's capital investment. ROCE should always be higher than the rate at which the company borrows; otherwise any increase in borrowing will reduce shareholders' earnings. For the sample of aerospace companies ROSF ratio decreased over the past years. (Figure 2.38, Figure 2.39)

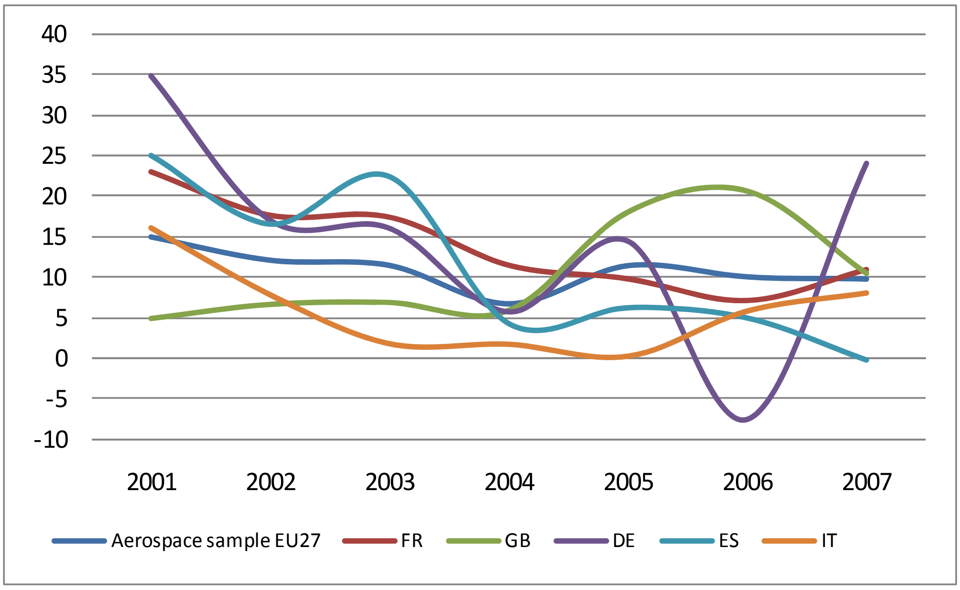
41 Formula= ((P/L before Tax & Extr. Items + Interest Paid) / (Shareholders Funds + Non-Current Liabilities)) * 100.

Figure 2.38 Return on Capital Employed (in %)



Source: Own calculations on the base of Amadeus data.

Figure 2.39 Return on Capital Employed Major Countries



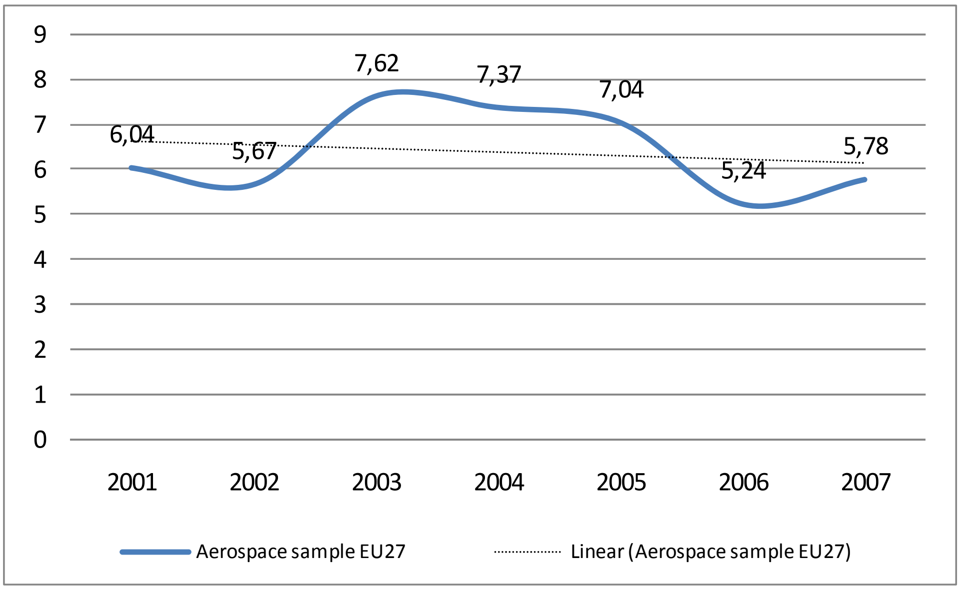
Source: Own calculations on the base of Amadeus data.

Cash flow to turnover

Cash flow to turnover ratio[42] was only slightly decreasing between 2001 and 2007. However from 2003 to 2005 this ratio performed markedly better. (Figure 2.40, Figure 2.41)

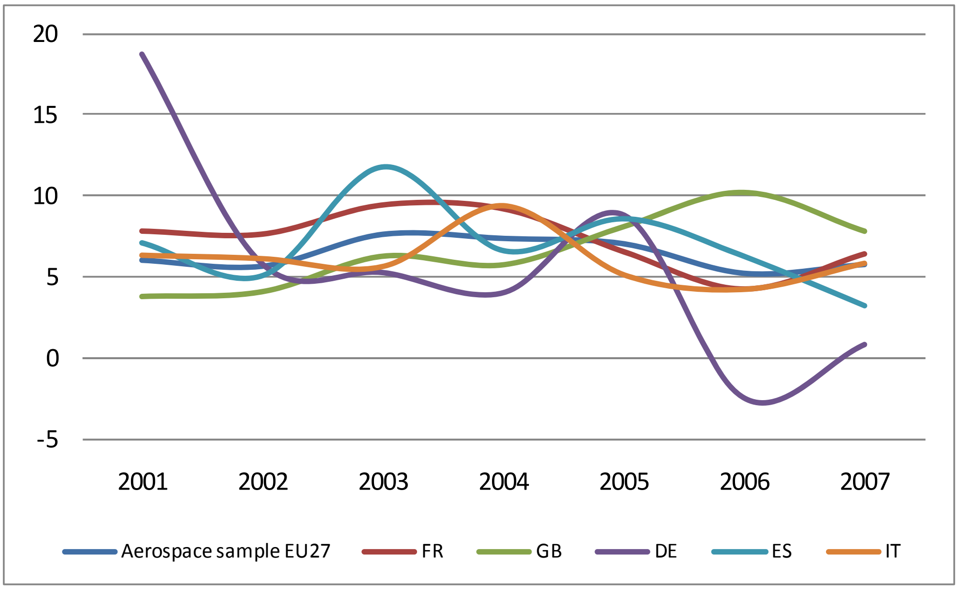
42 Formula= (cash flow / operating revenue) * 100.

Figure 2.40 Cash Flow to Turnover (in %)



Source: Own calculations on the base of Amadeus data.

Figure 2.41 Cash Flow to Turnover Major Countries (in %)



Source: Own calculations on the base of Amadeus data.

Financial and structural indicators

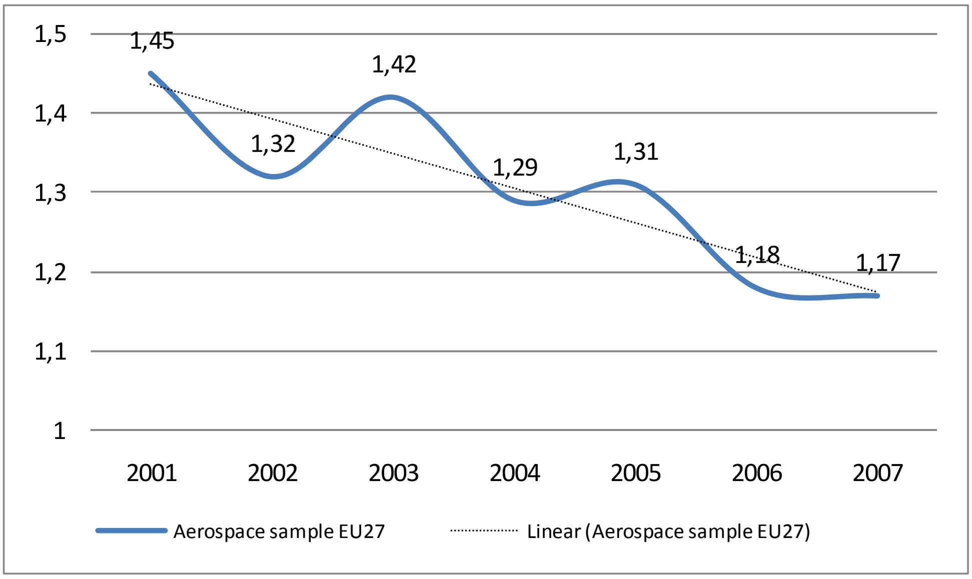
In this section we discuss three indicators to evaluate financial viability of companies both from a short term perspective (current ratio and liquidity ratio) and from a long term perspective (solvency ratio). The companies in the sample are viable in the long term, but short term viability is under pressure and needs to be improved.

Current ratio

Current ratio[43] or working capital ratio measures whether or not a firm has enough resources to pay its debts over the next 12 months. It compares a firm's current assets to its current liabilities. Low values for the current or quick ratios (values less than 1) indicate that a firm may have difficulty meeting current obligations; values between 1.5 and 2 are considered as being in healthy conditions.

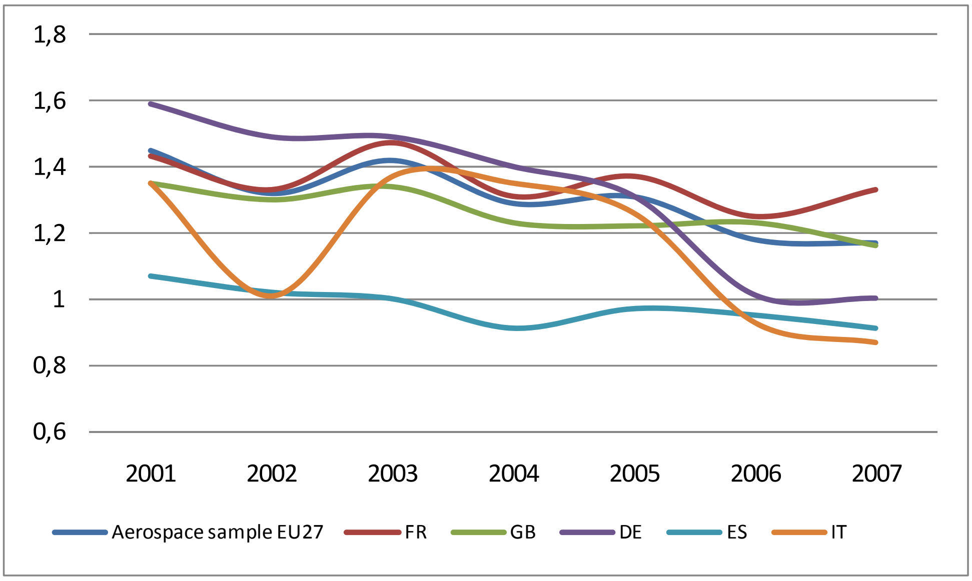
In the sample of aerospace companies current ratio crumbled away over the past years and is becoming a point of attention. The current ratio of the Spanish companies in the sample is since 2004 structurally below 1. (Figure 2.42, Figure 2.43)

Figure 2.42 Current Ratio



Source: Own calculations on the base of Amadeus data.

Figure 2.43 Current Ratio Major Countries



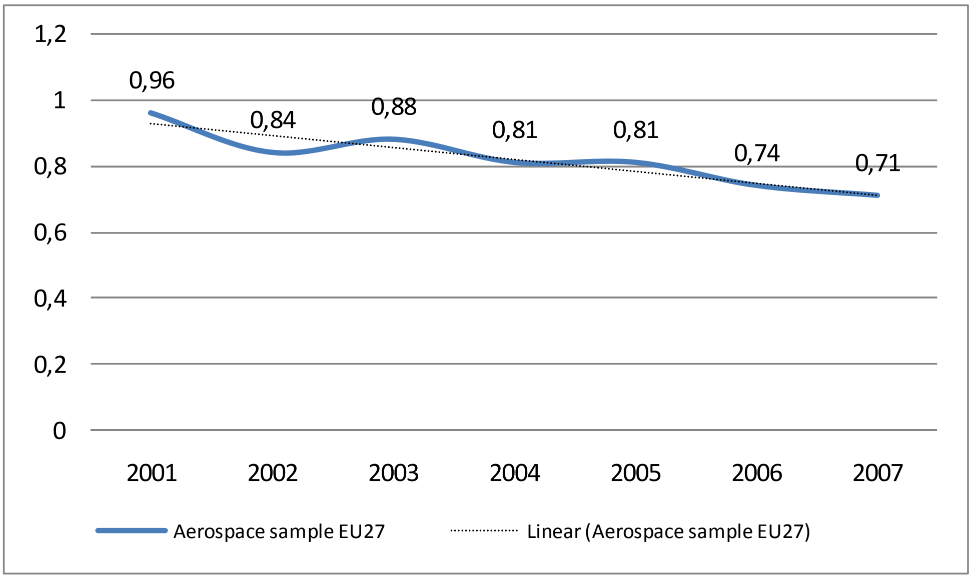
[43] Formula= current assets / current liabilities.

Source: Own calculations on the base of Amadeus data.

Liquidity ratio
The liquidity ratio[44] (the Acid-test or quick ratio) measures the ability of a company to use its near cash or quick assets to immediately extinguish or retire its current liabilities. The difference with the current ratio is that stocks are not taken into account. Quick assets include those current assets that presumably can be quickly converted to cash at close to their book values. Generally, the liquidity ratio should be 1 or better, but 0.5 is considered as a minimum value. (Figure 2.44)

As with the current ratio, the liquidity ratio is crumbling away over the past years. Liquidity ratios in Spain, Italy and Germany are the worst. (Figure 2.45)

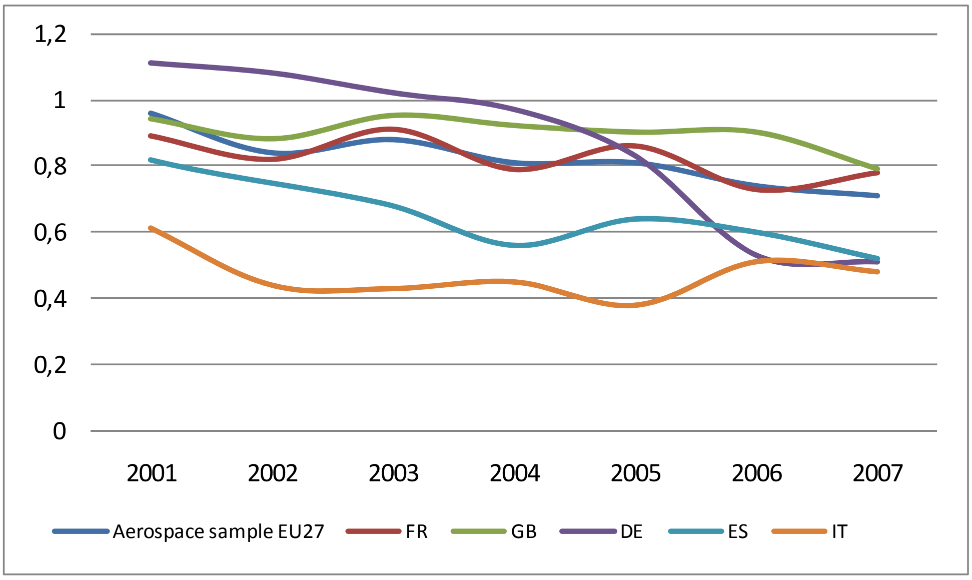
Figure 2.44 Liquidity Ratio



Source: Own calculations on the base of Amadeus data.

[44] Formula = (current assets – stocks) / current liabilities.

Figure 2.45 Liquidity Ratio Major Countries



Source: Own calculations on the base of Amadeus data.

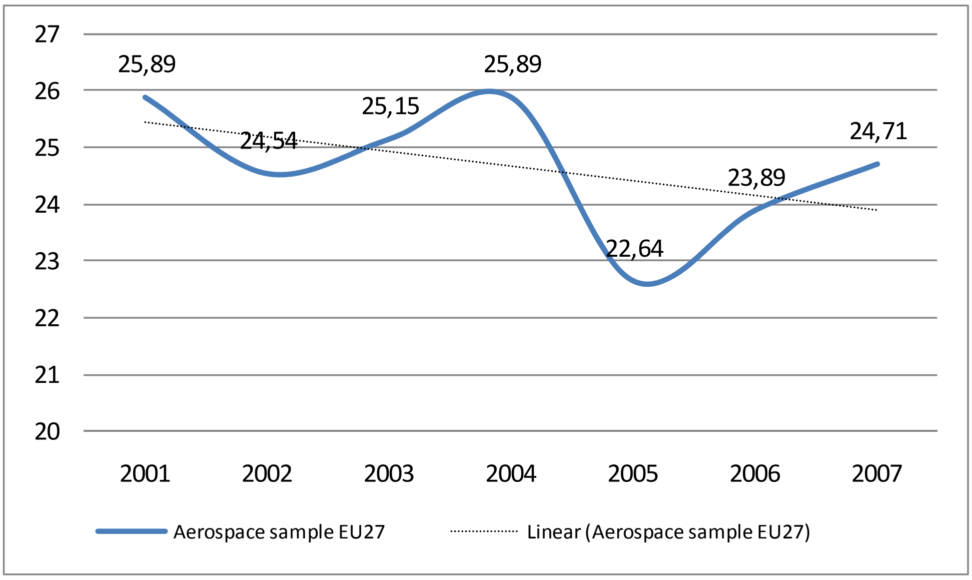
Solvency ratio

The solvency ratio[45] assesses a company's ability to meet its long-term obligations and thereby remain solvent and avoid bankruptcy. It provides a measurement of how likely a company will be to continue meeting its debt obligations. Acceptable solvency ratios will vary from industry to industry, but as a general rule of thumb, a solvency ratio of greater than 20% is considered financially healthy. Generally speaking, the lower a company's solvency ratio, the greater the probability that the company will default on its debt obligations. (Figure 2.46)

For the sample of aerospace companies solvency ratio was constantly above 20 over the past years, however with a slightly downward trend. Again German, Italian and Spanish companies are performing below average. (Figure 2.47)

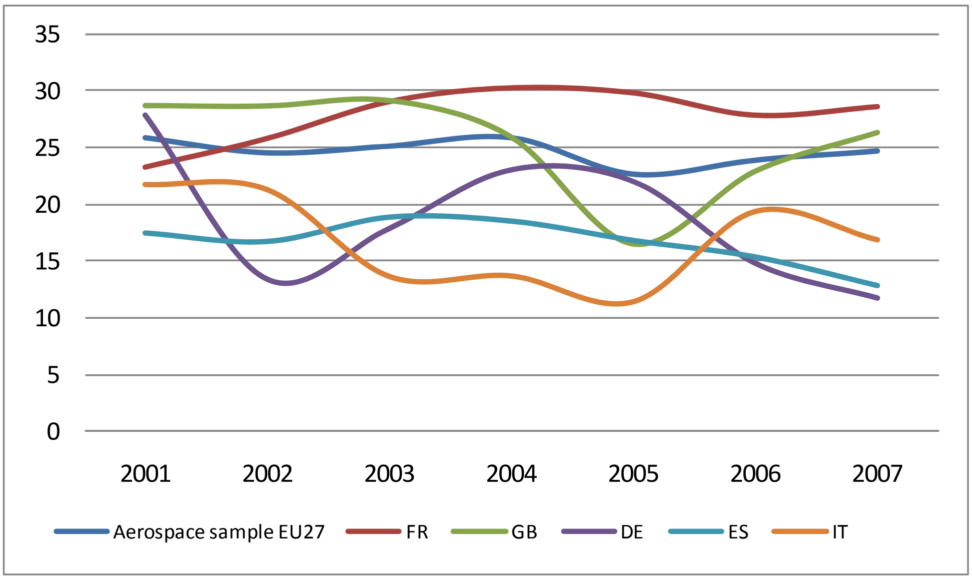
[45] Formula = (shareholders funds / total assets) * 100.

Figure 2.46 Solvency Ratio



Source: Own calculations on the base of Amadeus data.

Figure 2.47 Solvency Ratio Major Countries



Source: Own calculations on the base of Amadeus data.

Conclusion

For the period under consideration the European AI experienced a contrasting business environment. There was a major slowdown after 9/11 in 2001. The following upswing cycle gained strong growth momentum for a couple of years and provided good business opportunities. During that time large projects have been launched, such as the A380 and A400M. Noteworthy resources have been allocated to these projects. Long-term investments have been made and – as usual for the launch of new aircraft – related revenues are expected for the years to come. This put a burden on the economic performance of the European AI. Moreover the situation grew even worse with delays and technical problems that emerged within these projects. Additionally the latest project A350 has started and employees have been allocated without immediate revenues.

As a consequence the economic situation of the European AI did not improve as one had expected in such a bright market environment.[46] Although the operating revenue has been growing in recent years, the economic performance worsened, as highlighted by the Profit Margin, the Return on the Capital Employed etc. As compared to the overall manufacturing it becomes quite clear that manufacturing firms were able to improve their economic performance, as indicated by the Profit Margin. The European AI suffered a shrinking Profit Margin.

The development of the economic performance within the European AI has not evolved homogenously for all companies. Although all companies in the value chain have been hit by the delays and technical problems, it is the large firms that have suffered bigger setbacks than their smaller counterparts (see Table 2.13). Because of the delays and the technical problems the big firms were compelled to set aside reserves for payments caused by default on contracts etc. They had heavily invested in new staff for the development of new products, whereby the recruiting activities of smaller companies was moderate. The effect is mirrored in the operating revenues per employee that increased less for key companies than for smaller companies.

With regard to profitability the smaller European companies do not perform worse than the key players. The indicators Return on Shareholders Funds and on Capital Employed disclose they even had performed better. But one has to take in mind that the profitability of the key players has been directly hit by the problems with the big projects. Otherwise performance would have been better.

[46] A warning of the economic performance has already been disclosed in Chapter 2.1, where sectoral statistics have been analysed. (Chapter 2.1)

Table 2.13 The Microeconomic Performance within the European Aerospace Industry

Indicator		EU companies		EU key players[1)]	
		Average 2001 - 2008	Change rate 2006-2008 versus 2001-2003 in percentage points	Average 2001 - 2008	Change rate 2006-2008 versus 2001-2003 in percentage points
number of companies in sample		*234*		*13*	
per employee ratios					
	Operating revenue / employee (th. EUR)	232,25		261,38	
	value-added per employee (th. EUR)	77,90		na	
profitability ratios					
	Profit margin (in %)	5,41	-0,87	3,67	-1,11
	EBITDA (in %)	10,20	-1,65	11,58	-1,37
	EBIT (in %)	6,61	-1,85	6,73	0,52
	Return on shareholders funds (in %)	16,49	-6,66	9,99	-3,64
	Return on capital employed (in %)	11,15	-1,87	7,88	3,20
	Cash flow to turnover (in %)	6,69	0,16	7,01	-1,42
financial/structure ratios					
	Current ratio	1,29	-0,23	1,17	-0,15
	Liquidity ratio	0,80	-0,19	0,81	-0,24
	Solvency ratio (in %)	25,77	2,17	22,88	1,61

1) Europe's largest companies (see: Table 2.14)

Source: Own calculations on the base of Amadeus/Orbis (numbers for 2008 are preliminary because only 40% of companies submitted their accounts. That is the reason why we compared the period 2001 till 2003 with the period 2006 to 2008).

2.2.2 The Microeconomic Analysis of the Aerospace Industry: comparison of the EU with main competitors

Creation of the sample

The microeconomic sample for worldwide comparison of EU27 aerospace industry with its global competitors (United States, Canada, Brazil, Russia and China) consists of 36 key civil aerospace companies. The list of key players is based on the Aviation Week 'Top Performing Companies', but as with the microeconomic analysis of the EU27, there is a focus on civil 'manufacturing' aerospace companies, however, this does not exclude that also defence business is covered by this analysis.[47] The list contains both manufacturers (large civil aircraft, regional jet, business jet, and helicopter as OEM or Tier-1) and suppliers (avionics and electronics, aero structures and components, MRO) In total 13 EU27 aerospace companies are included in the sample and 23 non-EU27 companies, of which 15 are American. (Table 2.14)

47 If companies also have defence oriented activities, these activities will of course also be reflected in the overall company accounts. That's the reason why we focussed as much on companies with a focus on civil manufacturing aerospace.

Table 2.14 Analysed Sample of 36 Worldwide Key Players in Civil Aerospace Industry

Rank	Company	Country
1	GENERAL ELECTRIC COMPANY	United States of America
2	BOEING CO	United States of America
3	UNITED TECHNOLOGIES CORPORATION (Pratt & Whitney)	United States of America
4	EUROPEAN AERONAUTIC DEFENCE AND SPACE COMPANY EADS N.V.	Netherlands
5	HONEYWELL INTERNATIONAL INC	United States of America
6	BOMBARDIER INC	Canada
7	THALES SA	France
8	SAFRAN	France
9	ROLLS-ROYCE GROUP PLC	United Kingdom
10	GOODRICH CORPORATION	United States of America
11	DASSAULT AVIATION SA	France
12	EMBRAER - EMPRESA BRASILEIRA DE AERONAUTICA S.A.	Brazil
13	ROCKWELL COLLINS INC	United States of America
14	EUROCOPTER	France
15	MTU AERO ENGINES HOLDING AG	Germany
16	SPIRIT AEROSYSTEMS HOLDINGS, INC.	United States of America
17	LUFTHANSA TECHNIK AG	Germany
18	EUROCOPTER DEUTSCHLAND GmbH	Germany
19	JAPANESE AERO ENGINES CORPORATION	Japan
20	AAR CORP	United States of America
21	SUKHOI AVIATSIONNAYA KHOLDINGOVAYA KOMPANIYA	Russian Federation
22	SINGAPORE TECHNOLOGIES AEROSPACE LTD	Singapore
23	WOODWARD GOVERNOR CO	United States of America
24	TRIUMPH GROUP INC	United States of America
25	OAO SCIENTIFIC PRODUCTION CORPORATION IRKUT	Russian Federation
26	VOLVO AERO AB	Sweden
27	FINMECCANICA S.P.A.	Italy
28	PZL - SWIDNIK SA WYTWORNIA SPRZETU KOMUNIKACYJNEGO	Poland
29	CHINA AVIATION INDUSTRY CORPORATION FIRST 5716 FACTORY	China
30	CESSNA AIRCRAFT COMPANY	United States of America
31	HEXEL CORP	United States of America
32	BELL HELICOPTER TEXTRON INC.	United States of America
33	TEXTRON SYSTEMS CORPORATION	United States of America
34	GULFSTREAM AEROSPACE CORPORATION	United States of America
35	MITSUBISHI AIRCRAFT CORPORATION	Japan
36	FIAT AVIO - SPAZIO SPA	Italy

Source: Consortium's Desk Research.

For these companies in our sample several indicators between 2001 and 2007[48] were analyzed (all values in nominal terms and averages are weighted). Please note that conclusions can only be drawn for the sample of companies and not for the (civil) aerospace industry as a whole.

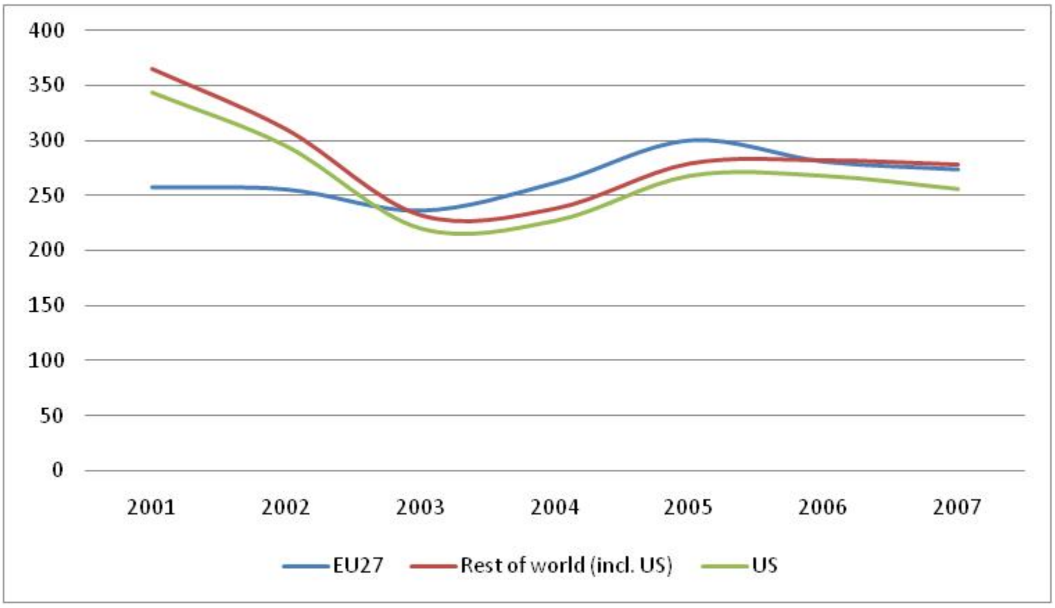
48 The number of companies with filled in data for the years before 2001 is too low to get reliable results, data for 2008 are very preliminary for EU27 companies (only 40% of 2008 accounts already included in Amadeus/Orbis). We decided not to include them in the graphs.

Per employee ratio

Operating revenue per employee

Overall operating revenue per employee for the sample of identified companies in Europe increased on average 1.3% annually[49], while it decreased for non-European companies by 3.5% annually for the period 2001-2007. However, European operating revenue per employee remained on average over the period 2001-2007 6.2% lower (EUR 267 thousands vs. EUR 287 thousands), but from 2004 to 2006 operating revenue per employee was higher for the EU27-companies. (Figure 2.48)

Figure 2.48 Average Operating Revenue per Employee (in thousands EUR).



Source: Own calculations on the base of Amadeus/Orbis data.

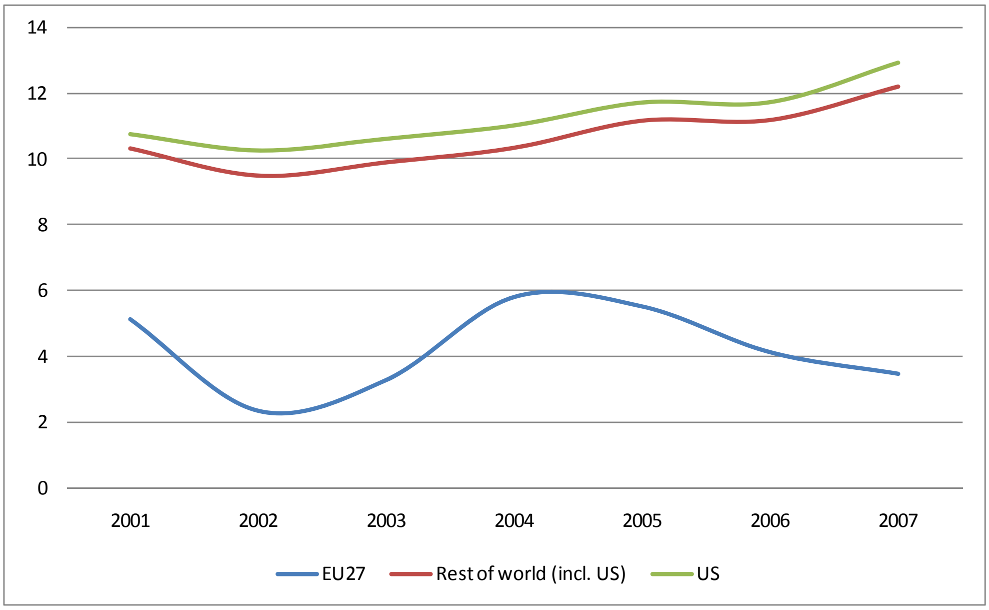
Profitability indicators

Profit margin

The average profit margin for the sample of non-European companies in the aerospace industry was considerably higher compared to the European companies (10.65% vs. 4.22% or 1.5 times higher). The average annual growth rate between 2001 and 2007 for European companies and its competitors was about the same (3%), but with large upward and downward fluctuations in the EU27-sample, whereas the non-European companies had a linear growth of their profit margin. (Figure 2.49)

[49] The broader European sample used for the intra-European comparison disclosed a worse development of performance (stagnation).

Figure 2.49 Average Profit Margin (in %)

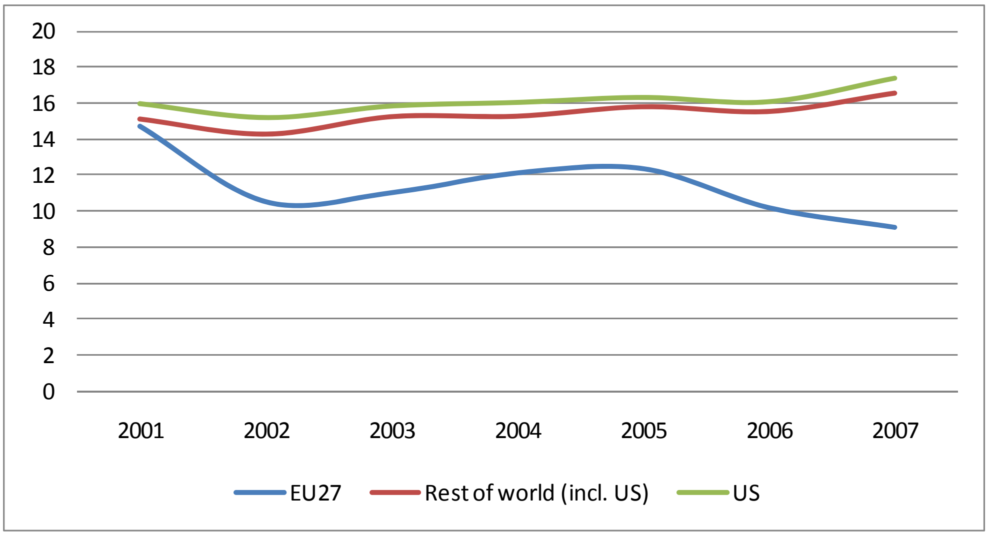


Source: Own calculations on the base of Amadeus/Orbis data.

EBITDA margin

While the average EBITDA margin for the sample of non-European companies in the aerospace industry was slightly improving (+1.6% annually between 2001 and 2007), EBITDA margin for the European companies decreased by on average 6.7% annually between 2001 and 2007. (Figure 2.50)

Figure 2.50 EBITDA Margin (in %)

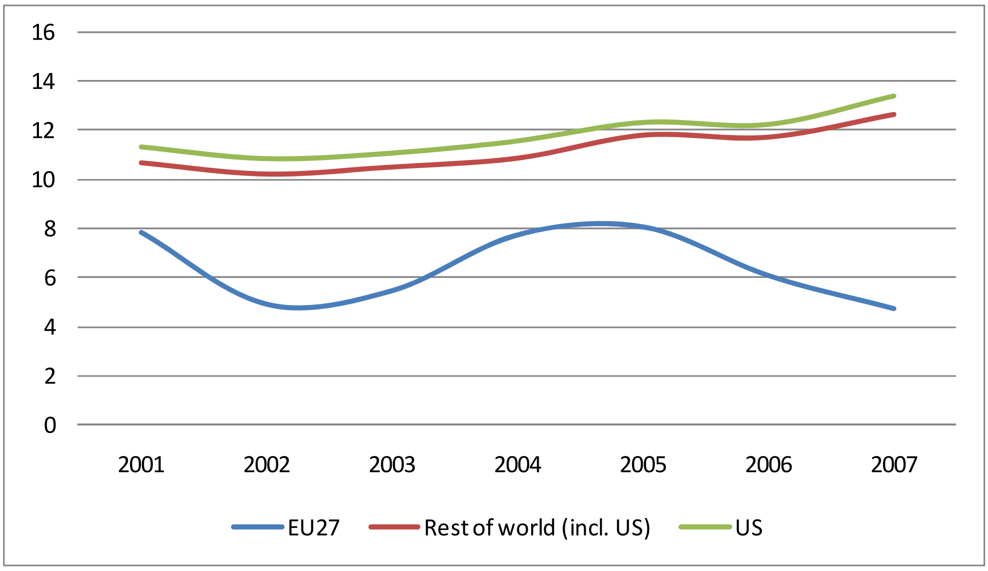


Source: Own calculations on the base of Amadeus/Orbis data.

EBIT margin

The average EBIT margin for the sample of non-European companies in the aerospace industry was modestly improving (+3% annually between 2001 and 2007). The EBIT margin for the European companies decreased on average 4.5% annually between 2001 and 2007. (Figure 2.51)

Figure 2.51 EBIT Margin (in %)

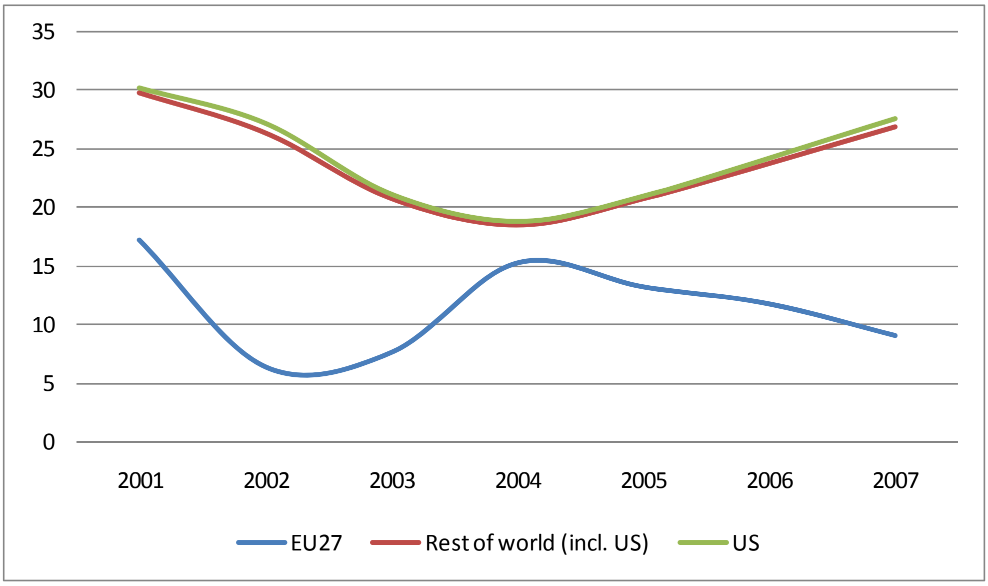


Source: Own calculations on the base of Amadeus/Orbis data.

Return on shareholders funds (ROSF)

The curves of the ROSF ratio follow the opposite direction in EU27 and in competing countries. The EU27 ROSF was on average less than half of the %-level of the non EU27' ROSF (11.50% vs. 23.81%) during the period 2001-2007. (Figure 2.52)

Figure 2.52 Return on Shareholders Funds (in %)



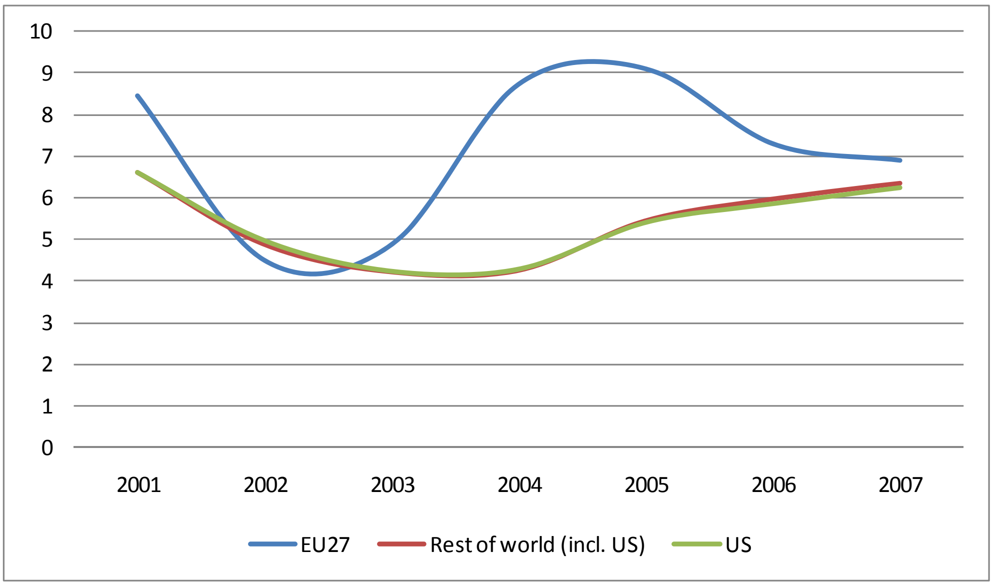
Source: Own calculations on the base of Amadeus/Orbis data.

Return on capital employed

Return on capital employed was for the period 2001-2007 on average 1.7 percentage points higher for the EU27 aerospace companies than for the companies in competing countries (7.1% vs. 5.4%), but is more capricious (Figure 2.53). When comparing return on capital employed with return on shareholders funds, European companies have the highest return on capital employed but the lowest return on shareholders funds. A plausible scenario for a lower ROCE for non-

European companies can be that non-European companies have more non-current liabilities than their European competitors combined with a lower interest paid (because of a lower interest rate)[50].

Figure 2.53 Return on Capital Employed (in %)



Source: Own calculations on the base of Amadeus/Orbis data.

Cash flow to turnover

Another profitability indicator, the cash flow to turnover ratio has a similar pattern as the other profitability ratios. Furthermore in % terms the EU sample has a significantly lower ratio than the companies in the sample for the rest of the world. (Figure 2.54)

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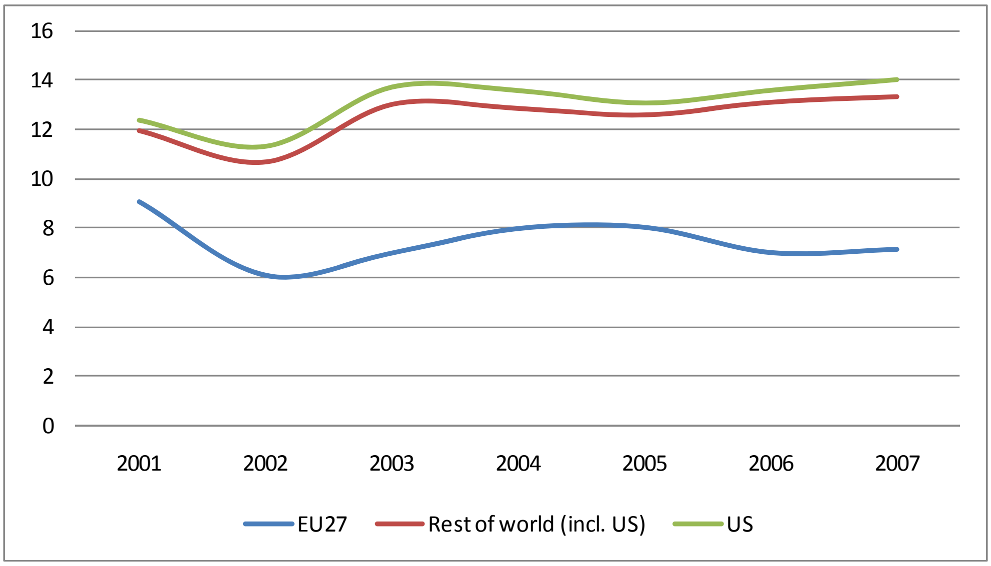
50 Formula ROSF = (P/L before Tax & Extr. Items / shareholder funds)*100 and formula ROCE = ((P/L before Tax & Extr. Items + ***Interest Paid***) / (Shareholders Funds + **Non-Current Liabilities**)) * 100. In this scenario the non-European ROCE numerator will increase less than the denominator so that a smaller ROCE will be the result.

Figure 2.54 Cashflow to Turnover (in %)



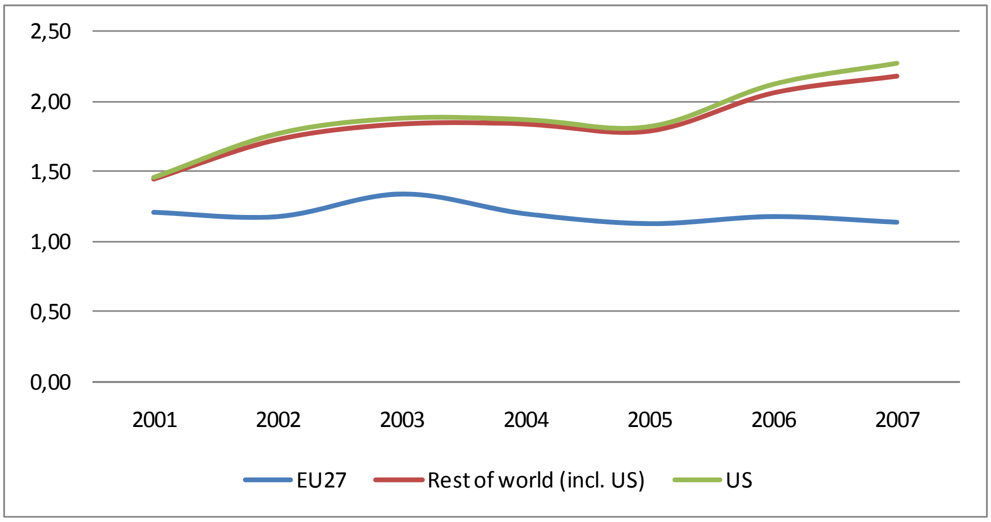
Source: Own calculations on the base of Amadeus/Orbis data.

Financial and structural indicators

Current ratio

The EU27-key players in aerospace industry had an average current ratio of 1.20 in the period 2001-2007 (annual decrease of 0.7% on average), whereas non EU27-companies had an average current ratio of 1.84 (annual increase of 7.3% on average). (Figure 2.55)

Figure 2.55 Current Ratio

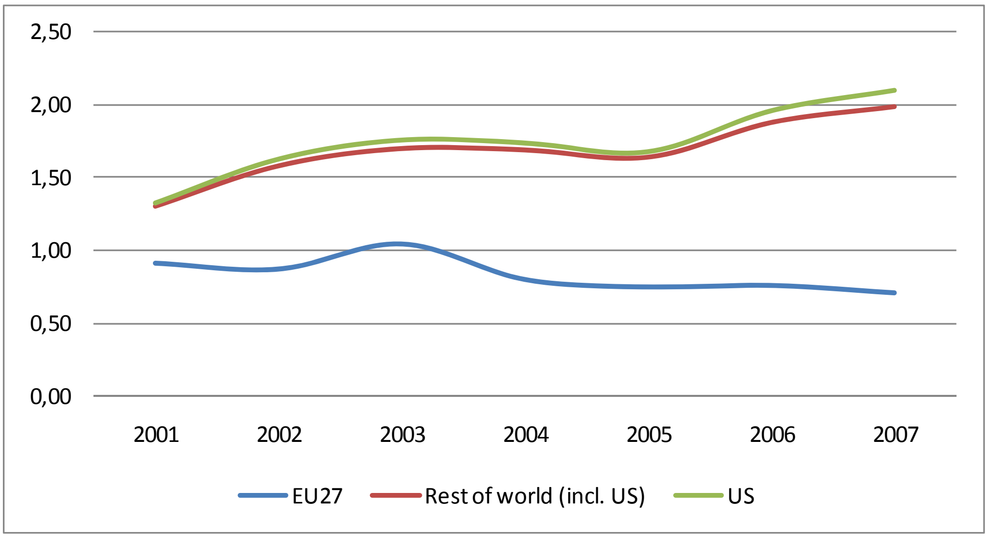


Source: Own calculations on the base of Amadeus/Orbis data.

Liquidity ratio

The worsening liquidity ratio for the EU27-key players in aerospace industry (0.83% on average over the period 2001-2007 but on average decreasing by 3.2% annually), is a point of attention as the gap with its competitors has been widening rapidly over the last 2 years.(Figure 2.56)

Figure 2.56 Liquidity Ratio

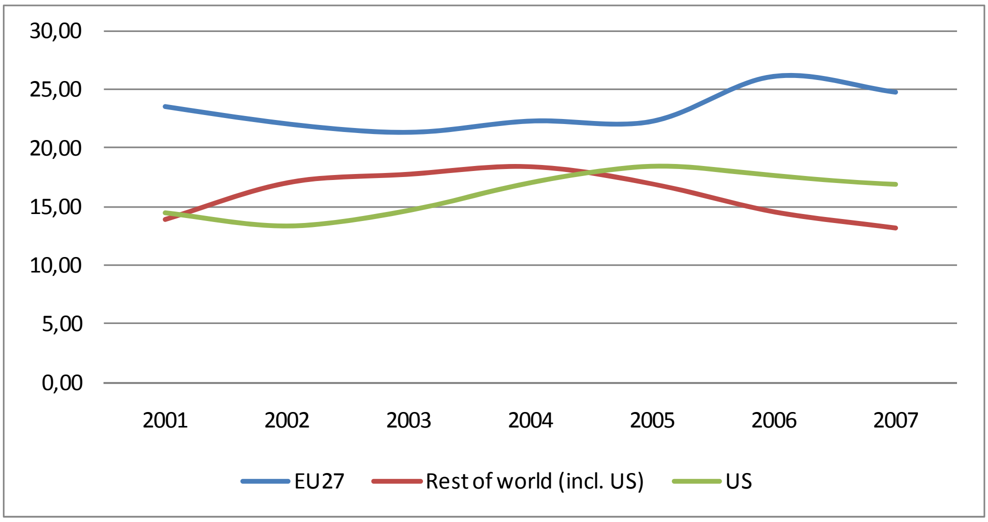


Source: Own calculations on the base of Amadeus/Orbis data.

Solvency ratio

In contrast with the short term financial structure indicators, the EU27-aerospace companies perform well when meeting its long-term obligations (average solvency ratio of 23 which is considered as being healthy). In the non-EU27-countries solvency ratio decreased by only 0.2% annually with an average value of 16. (Figure 2.57)

Figure 2.57 Solvency Ratio



Source: Own calculations on the base of Amadeus/Orbis data.

Conclusion

In comparison with the companies in the non-EU sample, nearly all indicators of profitability of the European key players show a weaker performance, not only in terms of lower profit indicators over the years, but also in terms of its trend over the period under consideration. For the non-EU companies the profitability trend has been slightly upwards. For the EU companies in the sample it has been rather downward.

The only exception within the group of performance indicators is provided by the Return on Capital Employed, where the values are higher for the EU group, yet more volatile. It contrasts with the Return on Shareholders Funds (ROSF) where non-European companies perform better. The ROCE is more comprehensive by definition and indicates that on average all financial means provided by owners or creditors with a long-term involvement in the AI get a higher return in Europe than in non-European countries and in particular in the US. In the US shareholders are refunded higher, while outside creditors get a much lower rate.

In terms of financial health of the AI companies the picture is different. The liquidity ratio follows in general the main profitability patterns that have been observed, yet the solvency ratio for the EU companies in the sample is clearly better. This indicates among others that in terms of meeting their long-term obligations the EU companies in the sample do relatively well, while for shorter term obligations the position is more challenging.

Given the observation that the productivity levels are on average relatively similar – as indicated by the operating revenue per employee - these figures suggest that financial viability of the EU aerospace is getting under strain in the short run. Note that the sample consists of the major companies in the World. Unless there are good reasons to believe that in upstream activities or in certain major niche markets the performance of the AI is substantially different, the overall picture of the EU aerospace industry is getting critical. However, Table 2.15 indicates that the smaller European AI companies are not in a situation that is worse than that of the key players. The liquidity position is even a bit better than that of their bigger counterparts.

Following the sample of the key US and key European players are compared with each other. The non-US competitors comprise only 8 firms and the results are too volatile to be interpreted in detail.

The above figures give an impression for the development over microeconomic performance of the aerospace industry for the period under investigation. Table 2.15 does compare the big European players with its big US competitors. All the big players gain operating revenue per employee – of similar size. It is only around 3% higher for the US competitors.

The economic performance of the European key players has worsened over the period under investigation. Nearly all profitability ratios have been affected, except for the EBIT and return on capital employed. For the US all profitability indicators were on a higher level and showed a positive development. Only the Return on Capital Employed is on a lower level for the US, but has improved somewhat.

The analysis of this subchapter has disclosed that the big European players as compared with their US competitors lack on profitability. A comparison over the whole period has revealed that this has been the case even before troubles with new projects emerged.

The indicators on the ability to meet financial obligations disclose that European firms are definitely more on strain than their US competitors in the short-term. While liquidity can turn out to become a challenge in the current situation their long-term solvency is however secured.

Table 2.15 The Microeconomic Performance of the Aerospace Industry

Indicator		EU key players		US key players	
		Average 2001 - 2008	Change rate 2006-2008 versus 2001-2003 in percentage points	Average 2001 - 2008	Change rate 2006-2008 versus 2001-2003 in percentage points
number of companies in sample		*13*		*15*	
per employee ratios					
	Operating revenue / employee (thousands EUR)	261,38		270,00	
	value-added per employee (thousands EUR)	n.a.		n.a.	
profitability ratios					
	Profit margin (in %)	3,67	-1,11	11,15	1,10
	EBITDA (in %)	11,58	-1,37	15,99	0,48
	EBIT (in %)	6,73	0,52	11,68	1,03
	return on shareholders funds (in %)	9,99	-3,64	24,71	0,24
	return on capital employed (in %)	7,88	3,20	5,33	0,43
	cash flow to turnover (in %)	7,01	-1,42	13,00	0,90
financial/structure ratios					
	current ratio	1,17	-0,15	1,96	0,59
	liquidity ratio	0,81	-0,24	1,81	0,54
	solvency ratio (in %)	22,88	1,61	15,77	2,03

[1] The growth rate is strongly biased by outliers in the period 2001 – 2003 and therefore skipped.

Source: Own calculations on the base of Amadeus/Orbis (exchange rates calculated on daily basis, indicative annual average exchange rates EUR/USD were 1,492 (for 2008), 1,368 (for 2007), 1,258 (for 2006), 1,244 (for 2005), 1,249 (for 2004), 1,138 (for 2003), 0,947 (for 2002, 0,896 (for 2001)).

3 The Qualitative Analysis of the European Aerospace Industry

This chapter is dedicated to a more qualitative in-depth analysis taking into account the results of the fieldwork. It links the desk research, statistical analysis and literature analysis, with empirical results gained from interviews with experts of the industry.

The first section differentiates the EU AI by the bigger Member States and takes Poland into account as an example for the situation in the accession countries. The historical background of the national AIs is provided. An in-depth analysis of economic situation, the structure, the supply programme strengths and weaknesses is carried out. Special attention is paid to the framework conditions and public policies dedicated for the AI. This section is concluded with an overview and an assessment of public initiatives in the countries under consideration.

The second section is dedicated to companies' behaviour. It starts with an overview on the changing market environment they have to take into account in their strategies. In the first place OEMs are adapting to these requirements and try to distribute part of the growing competitive pressure to their suppliers. The procurement strategies and risk sharing concepts of OEMs are analysed in view of the interaction between suppliers and their clients. This has an impact on the value chain its configuration and regional sourcing strategies. These factors altogether alter the framework conditions for smaller enterprises that are urged to meet the challenges. This point is discussed at the end of this section.

The third section is dedicated to the subsectors of the AI. It provides a detailed investigation in the global market, framework conditions and driving factors. The performance of the most prominent suppliers is highlighted and an assessment of the European AI in international market and future perspectives is carried out.

The fourth section analyses areas of technology that are of importance for the manufacture of aircraft. Latest trends and the state of the art of Europe in the global race on innovation are disclosed.

3.1 The Country Reports

3.1.1 France

Overview

The mass production of military aircraft started during World War I and has brought the French aerospace sector from a craftsmanship production to industrial manufacturing processes. Between the two World Wars the aeronautics industry developed itself on two markets: the military and commercial applications (postal and passenger). This was the time of aircraft manufacturers as Latécoère, Breguet and Potez. From 1936 on a great part of the French aviation industry was nationalized by the Popular Front.

After the Second World War the French aviation industry had to be rebuilt. Just like in other countries the know-how of German engineers was used to contribute to this reconstruction[51]. The engineers were redundant in Germany, because it was not allowed to build any aircraft. Successive waves of mergers and nationalizations led to the creation of SNECMA in 1945. In 1957 the SNIAS became Aérospatiale (now part of EADS). ONERA, the national research institute for aeronautical technologies was created in 1946.

From the 1960s on many programs have been launched in cooperation with European countries (Breguet Atlantic, Concorde, Jaguar, C160, Alpha Jet). The creation of Airbus, Eurocopter and EADS followed the logic of such cooperations. It resulted in more sustainable structures by aiming at the rationalization in the European production network. Today, with the exception of Dassault Aviation, at the level of OEMs most French companies are integrated in a wider European aerospace industry.

The French State is more or less directly involved in some large companies:

- For EADS an intermediate structure was created, in order not to have a direct State control. Sogepa Company owned entirely by the State holds 50% of SOGEADE, which holds the 22.5% share of the State and the share of Lagardère in the equity capital of EADS[52];
- A slightly higher than 30% share of the equity capital of Safran is held by the State.

The Dassault family still controls Dassault Aviation, while EADS is holding a 46.32% share of the French manufacturer.

Performance

At the beginning of the decade, the world civil aircraft market peaked in 2000 for aircraft orders and 2001 for deliveries; then 2002 to 2004 period was flat period with a new cycle of growth starting in 2005. The situation of the French industry reflects typically that global situation. The year 2008 is currently the next peak after 2000-2001; since the end of the year 2008, following the financial and economic downturn, the aerospace industry is about to decline. Over the 1998 to 2008 period the annual growth rate of French civil aerospace industry (annual turnover) was 5.4% per year; when comparing on a shorter scale with the 2000-2006 the growth level was below at 4.7%, showing the impact of the 2002-2004 flat period.

With a total turnover of EUR 28.9 billion in 2008, France is one of the leading aerospace industries worldwide. The comparable figures for the USA are EUR 58.4 billion and the United Kingdom EUR 26.4 billion. For the years under consideration the French AI's production soared and grew at an average change rate of 4.2% between 2001 and 2008, at constant prices. However this development was strongly driven by structural changes in the value chain. Outsourcing and relocation to lower levels reduced the manufacturing depth. As a consequence the value-added did not follow this development, it even declined by an average rate of 1.3%. This shrinkage cannot be blamed on a specific poor evolution of the French value-added, it also declined in Germany

51 The Technical Aerospace Workshop Rickenbach and the competences of BMW in Germany will be the starting point of the skills in SNECMA's jet manufacturing (military engine ATAR).

52 In order to have State representatives only at the board of SOGEADE and therefore not directly involved in the management of EADS.

and in the United Kingdom. However the decline of value-added in constant prices in combination with a growing number of employees and specific labour costs is a burden for the economic performance in the current situation. (Table 3.1)

Table 3.1 France: Operating Figures for the Aerospace Industry

France		Units	2008	2001 - 2008	Share of total EU27	
				Change rate in %	2001	2008
Output	Production (constant prices)	EUR billion	28.9	4.2%	19.3%	28.3%
	Value-added (constant prices)	EUR billion	8.1	-1.3%	26.4%	24.5%
Labour force	Employees	1,000	96.4	2.7%	22.4%	25.8%
Productivity	Value-added per employee and year (constant prices)	1,000 EUR	84.0	-3.8%	n.a	n.a
	Wage adjusted productivity	%	128%	-4.7%	n.a	n.a
Labour costs	Per employee and year (constant prices)	1,000 EUR	65.6	0.9%	n.a	n.a
Labour costs	Per employee and year (current prices)	1,000 EUR	68.8	3.1%	n.a	n.a

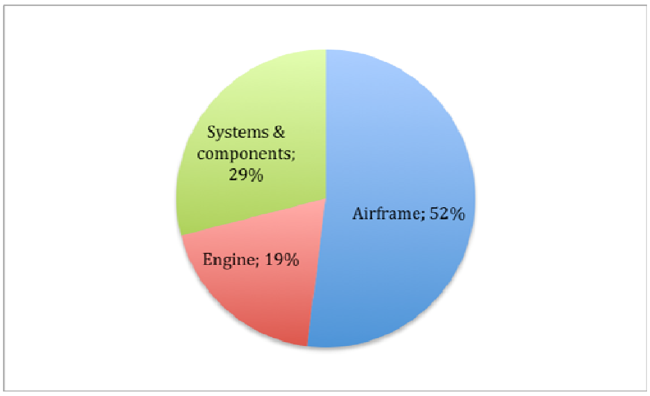
Source: Eurostat, SESSI/INSEE, GIFAS, CUSTOMS.

In spite of the shrinking value-added the employment in the French AI strongly expanded. As a consequence productivity declined and worsened the economic performance. Once more this has not been induced by a loss of efficiency in production processes, but by technical problems and delays in big projects the A380 and A400M and set-up activities for the A350. Highly qualified staff was expanded in Nantes and St. Nazaire.

Supply structure

The breakdown of the non-consolidated aerospace turnover by major categories indicates that around one tenth is in the space industry, whereas around 90% is in civil and defence aeronautics. The turnover attained with the French Government is EUR 4.351 million or about 13%, it includes military sales and financing for R&D. A differentiation by major component groups discloses that more than 50% of output is airframes (Figure 3.1).

Figure 3.1 France: Industry Structure



Source: GIFAS.

France is an important Member State for the final assembly of aircraft. Dassault and ATR are important OEM manufacturers and France is also of major importance for the delivery of Airbus aircraft to clients. France is not only a major manufacturer of fixed-wing aircraft but helicopters. (Table 3.2)

Table 3.2 France OEM Deliveries (2008)

Segments	Quantities of Deliveries
Passenger aircraft (Airbus)	
A 320 family	199
A 330 / 340 family	85
A 380 family	8
Regional aircraft (ATR)	55
Business jets (Dassault Aviation)	72
Helicopters	341
CFM Engines (Snecma)	1268
Turbomeca	1189

Source: GIFAS.

Public policies

This reconstruction of the AI after World War II was done with the support of important state investments. It was dedicated to remain independent as an OEM manufacturer. Without losing track of this objective the French AI has strengthened its European linkages and cooperations. The result of these activities is reflected in the industry's structure. At present, this policy takes part in the frame of a European context characterized by a restructured industry (EADS, Thales, etc) and the intervention of European funding schemes (PCRD). The French policy (funding, programs) falls within this framework and in compliance with European targets (e.g. reducing pollution) and in compliance with its partnerships.

Several ministerial departments are involved in various areas with regard to this industry. The concerned cabinets are:

- The Ministry of Finance has a representative on the board of directors of companies in which the State holds stakes and is involved in all decisions concerning funding of R&D programs;
- The Department of Defence is involved:

- as technical supervisory institution which results in a representation on the board of directors of companies where the state is a stakeholder.
- as a customer and as such can send a representative to the Board of Directors of the concerned companies;
- in funding and supervising ONERA;
- in the implementation of various test centres;
- the control of national security aspects that concern the defence of the State and has rights to decide on certain activities or even may control foreign investment with an impact on defence;
- The Department of Transport, where the funds are set up for financing the R&D and the civil aviation programs, including the refundable advances[53];

In 2008 a national Council for Civil Aeronautics Research (CORAC) was created to link to European initiatives and to bring together private and public authorities (Ministry of Research, Ministry of Industry and Department of Defence). The main role is to set up objectives for civil aeronautics research in relation with:

- European research frameworks and objectives validated through the ACARE
- European and national policies requirement regarding the field of aeronautics

In a more technical way, the objective of the Green policy set out in the Grenelle Environment Round Table is to address environmental challenges that may also reveal themselves as being strategic and economic challenges:

- To reduce fuel consumption and gas emissions (CO_2, NO_x);
- To reduce noise near airports;

Some of the strategic objectives are common to civilian and military applications such as propulsion where maintaining engine manufacturers' skills could not be sustained only on one market (civil or military).

The above mentioned general objectives of public policy can be converted into:

- Maintaining a strategic defence industry that possesses the ability to supply key military aircraft independently from other countries;
- Maintaining the competitiveness of an industry whose contribution to the national economy and employment is important;
- Stay important as a centre of reference for the global aerospace industry.

These goals have been converted into areas of key-technologies that have to be in the focus of the national policy:

- Architecture and project management;
- Controlling technologies (materials, aerodynamics, piloting ...);
- Control of strategic elements (propulsion, key structural elements (Table 3.3).

Efforts have been taken in R&D on the cockpit and its intersection of all functions of relevance for flight.

53 This department no longer certifies aircraft since that responsibility was assigned to EASA that was established in 2002.

Table 3.3 Know–how and Key Structural Element

Key structural element	The nose	The central section	The wings
Main associated element & know-how	Nose gear Cockpit Electronic systems	Convergence of all structural efforts (wings – fuselage junction) Hydraulic Main landing gear	Engine Brake Flying performance (lift force, etc.)
	Interaction in between & with other structural elements and systems		
	For those 3 zones development and production facilities are located in France and the UK		

Source: DECISION.

The R&D expenditure of the French civil and military aerospace industry has not been expanded with the same pace as production or turnover, it only reacted 10% between 2003 and 2008. But it is of note this moderate development has been caused above all by a stagnation of public funds. Self-funded R&D of the French AI grew by an average rate of 7.8% between 2003 and 2007. (Table 3.4) In 2007 R&D self-financed by the industry represents 54% of the global R&D, the remaining 46% originated mainly from public funding and / or customers:

- Clients: Department of Defence, CNES, ESA etc.
- Financing from non-customers: Ministry of Transports, Ministry of Research, European funding, etc.

The effort of self-financing of industrial accounts represents 8% of the turnover.

Table 3.4 France: R&D Expenditure

EUR million	2003	2004	2005	2006	2007
Turnover (*)	24 911	25 943	28 313	30 569	33 491
Total R&D	4 367	4 703	4 709	5 049	4 999
- of which self financed	1 960	1 778	2 000	2 102	2 650
- in % of turnover	17,5%	18,1%	16,6%	16,5%	14,9%
(*) Gifas scope					

Source: GIFAS.

Funding from the Directorate of Civil Aviation programs (French Ministry of Environment, Transport etc.) support the European objectives of the ACARE for 2020: reduction of fuel consumption and emissions of CO2, NOx and perceived noise. In order to achieve these ambitious goals, the financing budget of civil aeronautics research (CAPD) was increased to EUR 257 million in 2008.

ONERA, the main research organization of the public sector has a budget of around EUR 190 million of which 40% comes from the government.

In addition, the state initiative of security clusters led to the creation of three specific aviation poles which are discussed under "Regional cluster". These clusters play an important role in the emergence of cooperation on R&D projects.

An important funding initiative was launched by Airbus in cooperation with Caisse des Dépôts et Consignations and the Safran Group. Under the label AEROFUND II, an equity fund worth EUR

75 million dedicated for the French aeronautical sector was made available. The objective is to support the development of subcontracting small- and medium-sized companies of the aeronautic sector. Very important is the following aspect made explicit in a press release: Additionally it (AEROFUND II) aims to accompany the growth and emergence of companies capable of becoming essential partners of the industry.[54] The wording implies that there is a preference to support companies with specific abilities indispensable for the strengthening of the value chain. For instance companies with management and system integration abilities can become preferred partners to access this fund.[55]

Clusters of the aerospace industry

The locations of the French AI reflect its historical regionalization with:

- Ile-de-France[56] and Midi-Pyrenees. In Ile-de-France the most important aviation industrial activities are the ones of the Safran group, the relative importance of this region also reflects the presence of head offices, of research and of non-aeronautical activities (space, weapons).
- Region of Toulouse is in turn strongly imbued with Airbus activities.

There are also two other regions to be mentioned:

- The Aquitaine with the industrial activities of Dassault Aviation and activities of solid propulsion for the aerospace industry (EADS Space Transportation, Snecma Propulsion Solide and SNPE);
- The Provence-Alpes-Cote d'Azur with the French location of Eurocopter and Thales Alenia Space.

Three specific clusters of aeronautics and space have been labelled in the frame of the program of the competitiveness clusters. Both regions Midi-Pyrénées and Aquitaine are gathered in a cluster named "Aerospace Valley" labelled world competitiveness cluster by the Government. This centre covers aeronautics, space and embedded systems for nine strategic fields:

- Energy, propulsion, engines and environment;
- Aeromechanics, materials and structure;
- Safety and security of air transport
- Living Earth and Space
- Navigation, positioning, telecommunications
- Embedded Systems
- Architecture and integration, industrial organization
- Maintenance, service, training
- Access to space and orbital infrastructure

The competitiveness cluster ASTech in Ile-de-France covers space transport, business aviation, propulsion and equipment, it addresses the following topics:

- Vehicle Architecture
- Energy on board
- Training
- Aviation Maintenance
- Materials and processes

[54] EADS press release: AEROFUND II: EUR 75 million fund for the aeronautical sector, 22 July 2008, http://www.eads.com/1024/de/investor/News_and_Events/news_ir/2008/20080722_airbus_aerofund_ii.html

[55] One of the supportive factors of the framework conditions for the aerospace industry is provided by the financial markets. Beyond publicly incited initiatives the globally leading bank in aircraft funding, CALYON, subsidiary of Crédit Agricole, is French. Other important players in this market are from China and Qatar.

[56] Paris region.

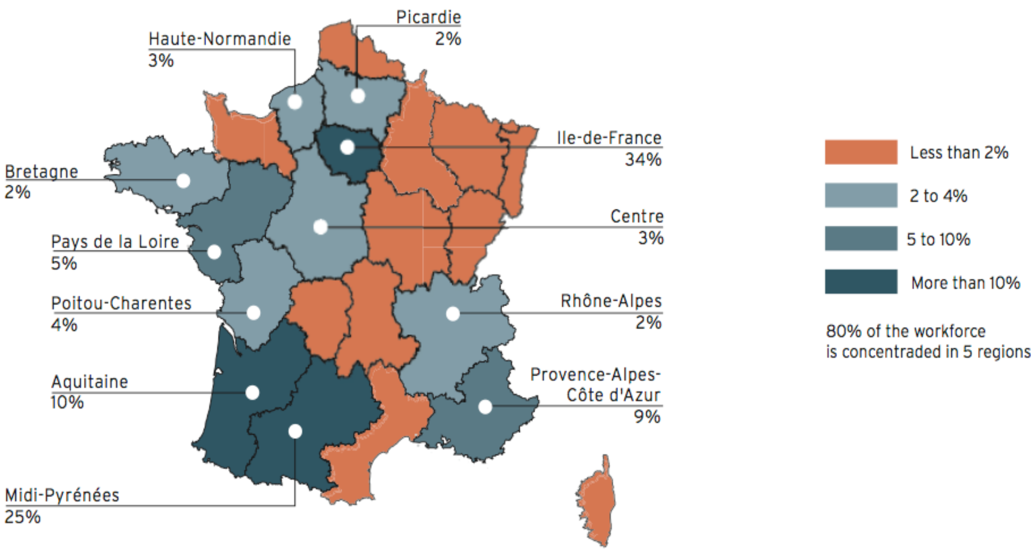
- Testing means
- Propulsion equipment

In Provence, Alpes, Côte d'Azur the cluster PEGASE gathers players focused on aeronautics, space and three axes of development (monitoring, transportation, intervention missions). This cluster focuses essentially on light aircraft, unmanned aerial/airborne vehicles (UAVs), helicopters, airships and other new concepts.

At national level, the Aerospace Industry accounts for 3.6% of the total industrial employment. With its concentration in 3 major regional clusters, the Aerospace Industry has there a larger, when not dominant, share of the industrial employment (Figure 3.2):

- In Ile de France the Aerospace industry is important (5% of the total industrial employment in the region) but its relative size is low compared with the 2 other clusters;
- in Aquitaine the Aerospace industry is the second largest industry with 12% of the employment in all of the manufacturing industries in the region;
- In Midi-Pyrénées the Aerospace industry is the dominating industrial activity with 25% of the local employment in manufacturing industry [it also account for 25% of total aerospace employment][57].

Figure 3.2 French Aerospace Employment by Region



Source: GIFAS.

Industry structure

One of the challenges for French and European industry is to retain full control of complex programs in a new context of shared sovereignty and industrial skills with foreign partners (certification, testing, technology etc.).

The development of French industry relies on two bases:

- An industrial base, which consists mainly of the 260 member companies of the GIFAS:
  - comprising private companies: Dassault Aviation, Potez, Latécoère, Daher and a large number of smaller enterprises;

[57] The share is relative to main activities as covered in official statistics systems. The indirect importance of the AI for the local economy is much higher, in particular for Midi-Pyrénées.

    - comprising companies with shares held by the State: Safran, EADS (via SOGEADE).
- A state-owned platform with public administrations (DPAC, DGA), research centers (ONERA) and test facilities (mainly military like CEAT or CEV).

This structure reflects the history of the French industry and the strong synergies that exist today between civil and military aviation. Indeed in addition to these technical synergies, manufacturers are seeking to balance their civil activities with military activities, which are often countercyclical.

Regarding some key issues like industrial organisation, commitment in European or international cooperation, linkage between civil and military business, etc. the three main French manufacturers are showing an interesting panel of diverse strategy.

Airbus

Airbus employs in France around 40% of its overall staff. (Table 3.5) Regarding technological development, industrial organisation or cooperation issues Airbus could benefit from its more cautious strategic approach than Boeing. Examples for this stance are initiatives dedicated to the restructuring of the value chain in combination with a leap forward in the application of composites. However, latest developments in the A400M programme clearly indicate that benefits from a diversification in military business need not be profitable in the short and medium term. In the military sector Boeing proved to be more successful with its projects.

Table 3.5 French Airbus Main Figures

2008 in million EUR	Total Airbus
Turnover	5 727
Employees	21 500

Source: Airbus.

Aerolia

This division of EADS became operational in January 2009. The origin of this creation is the unsuccessful attempt to sell the aero-structure activities as planed in the Airbus *Power 8 programme* of costs saving. Over 2,000 former employees of Airbus based in St-Nazaire, Méaulte and Toulouse were progressively transferred from Airbus to Aerolia which also plans to start operations in its new centre to be open in Tunisia in 2010. The *low cost* centre will also receive subcontractors' activities, it is now planned to reach the size of 1,500 people by 2014.

According to SESSI/INSEE[58] and industrial activity classification code, there are above 70 smaller enterprises[59] located in France and are directly linked to the AI. This count is a narrow view, it does not include companies of the same size group with 15% to 50% of their turnover made with aerospace customers but not classified into that industry, as well as companies smaller than 20 employees. Together they are and totalling over 6,000 employees (6% of total) with a turnover of EUR 840 million in 2007 (3% of total). With an average of 84 employees, they size is below 100, for an average sales of EUR 11.5 million. As compared to the overall French aerospace industry their export ratio is lower (30% compared to the above mentioned big players 60%), their valued added share as a percentage of turnover is higher (36%). The investment ac-

[58] Enquête Annuelle d'Entreprise, 2007, figure for company & legal entities larger than 20 employees.
[59] Below 250 employees.

tivity is of similar magnitude as of the big players, the investment ratio (investment expenditure as a percentage of turnover) reached 11% in 2007.

Thales

The aerospace and defence electronic is one of the leading world actors in competition with U.S. Raytheon or Lockheed-Martin, Italian Finmeccanica or British BAE Systems. During the last 10 years, and following the acquisition of the UK company Racal[60] the group clearly has strengthened on this core business (aerospace and defence) and withdraw from various other civil areas in the field of professional IT. Its main products include radar, avionics, communication systems, missiles, satellites and naval defence systems.

During the 90s the French Government kept its strategic stake in the group[61]. It decided to have an industrial partner, Alcatel. A major change took place in October 2008: the Alcatel-Lucent group sold its stake to Dassault Aviation which became the new *prime* industrial stakeholder with a 26% stake. Another solution under discussion was a merger with Safran.

Table 3.6 Thales main figures

2008 in million Euro	Total group
Turnover	12 665
- of which in France	3 165
- of which civil aerospace	1 270
- of which defence & government	7 600
EBIT	877
Order backlog	22 938
R&D	2 400
Employees	63 248
- of which in France	32 233

Source: Thales.

Safran

The engine manufacturer is covering the whole scope of aircraft (civil/military, helicopter, small/large aircraft) and is also engaged since 30 years in a successful international engine partnership. 1974 its affiliated company SNECMA launched a 50/50% joint venture with GE to develop and supply engines for civil market, CFM International. This joint venture has become a global leader in engines for civil aircraft and is an important supplier to Boeing as well as Airbus.

The Safran group has diversified aeronautical business in key subsystems; SNECMA and then Safran successfully consolidated it and is a world leading provider, with unit such as:

- Messier-Dowty: Landing gear
- Aircelle: engine nacelles
- Hispano-Suiza: electrical power

For engine business the civil sales share reached 87% in 2008;

60 In 1998 the defence departments of Alcatel, Dassault Electronic and Thomson CSF were merged under the trade name Thomson CSF. In 2000, after the acquisition of Racal, the group was renamed as Thales

61 Including a 27% share plus a golden share. This decision was made after intense discussions on the sale of public shares to foreign industrial investors such as the Britisth GEC or South Korean Samsung.

Table 3.7 Safran Main Figures

2008 in million EUR	Total group
Turnover	8 659 (*)
- of which engine	5 803
- of which aero equipment	2 856
EBIT	644 (*)
- of which engine	584
- of which aero equipment	60
Order backlog	20 087
- of which engine	15 755
- of which aero equipment	4 332
Employees	54 500 (**) 43 020 (*)
- of which engine	21 350
- of which aero equipment	21 670
- of which in France	35 600 (**)
- of which in Europe	41 600 (**)
(*) Aerospace (engine & equipment) (**) Total group	

Source: Safran.

Dassault

Despite a narrow market Dassault successfully maintains state of the art know-how for aircraft technologies: advanced Computer Aided Design (CAD) solutions, virtual production, carbon structures, etc. all used for the latest model of the Falcon business jet family which arrived on time on market and benefitted from soaring demand in the last 4 years.

In order to maintain both industrial independence and know how, Dassault participates in a major European programme for future combat aircraft concept, Neuron. But for the moment the next short-term issue is to go across the crisis that will be more severe in business jets and with no compensation from defence programs. So far, the Rafale found no foreign customer.

Table 3.8 Dassault Main Figures

2008 in million EUR	Total group
Turnover	3 748
- of which in France	1 166
- of which civil	2 116
EBIT	434
Order backlog	8 500
Employees	12 438
- of which in France	8 500

Source: Dassault.

Latécoère

The parts and aerostructure supplier – a former seaplane manufacturer - is a specialist of doors, fuselage section and electrical harnesses. The company runs plants France as well as in Brazil, the Czech Republic, Germany, Spain and Tunisia. Its main customer is Airbus (A320, A340, A380, A400M), but also manufactures fuselage sections, doors of harnesses batch for Dassault Falcon, Embraer ERJ 170/175/190/195 and Boeing B-737, B-777 and B-787 plus harnesses for satellites. It is a joint stock company with 12% shares held by the employees.

Table 3.9 Latécoère main figures

2008 in million euro	Total group
Turnover	684
- of which in France	455
- of which civil aerospace	675
- of which defence & government	9
EBIT	-6
Order backlog	2 012
R&D	28
Employees	3 985
- of which in France	2 204

Source: Latécoère

The development of the 1st generation of Airbus aircraft also created a network of very small industrial company between 10 and 50 employees within the Toulouse area. Today they continue to operate as direct suppliers to Airbus (at least for replacement and parts).

Table 3.10 Clusters & Share of Local Companies

Cluster	Companies of legal entities	Of which local[62]
Ile de France	61	22
Aquitaine	29	13
Midi-Pyrénées	37	19
Others	99	-
Total	226	-

Source: SESSI.

Conclusion

The French industry and government has always shared a common vision on the necessity to maintain and develop the R&D funding, the industrial capacity or the know-how to keep an operational and independent AI that commands all relevant key-technologies. This effort is reflected in the structure of the AI with OEM manufacturers and groups that by their size and access to financial markets have the ability to handle big contracts for OEMs. The AI has gained continued support and costs have partly taken over by the French government that is involved in corporate governance of important players in the market. National policies contributed to the consolidation and the development of the aircraft industry without reducing the influence of the government.

France is an important manufacturer of engines for civil and military aircraft, fixed-wing aircraft and helicopters. CFM, a 50/50% joint venture of SNECMA and GE has an excellent access to the US and the EU, the by far biggest markets for engines.

[62] 75% of employees are based in the same region

The French clusters seem to benefit from a sectoral division of R&D, with points of gravity in different regions. This is different from cluster initiatives in other Member States. Notably based in *Midi-Pyrénées*, *Gironde* and *Ile-de-France*, a comprehensive design and system integration competence is available that is of relevance for the design of aircraft platforms.

The historical French model faces several challenges and the need for structural change:

- A shift is necessary in the relation between the French AI and its national customers, such as defence and the national airline operator. Until the early 1990s these clients run own R&D and design departments and were involved in know-how generation and innovation. OEMs did not fully own competency in these areas.[63].
- The globalization in the civil aeronautics is driven by various factors (cost of production, exchange rate variations, access to markets, need of additional external financing, risk sharing). As a consequence the French industry tries to access partners and locations outside of Europe.
- A more difficult market environment, in particular in the defence markets since the end of the Cold War. Growing competition from Russia and the United States and the emerging countries (BRIC).

Growing competitive pressure and funding constraints put a question mark on the strategic orientation of the French AI policy, which has so far prioritized a comprehensive funding and support of all relevant key-technologies. It will become more important for France to exploit synergies within the European AI, specialize in certain subsectors and technology niches and to use the respective comparative advantages. The decrease of the value-added in contrast to the soaring output indicates difficulties for France as a location for production. However, the French AI with its big groups in the area of Tier-1 and Tier-2 is about to internationalize its production networks. The preferred region is North-Africa, in particular Tunisia and Morocco.

3.1.2 United Kingdom

Overview

Consolidation in the early 1960s reduced the number of companies in the UK AI to a large extent. In a series of mergers 12 companies were combined into two: the British Aircraft Corporation and Hawker Siddeley Aviation. In 1977 these two companies and Scottish Aviation were nationalised and merged into the statutory corporation, British Aerospace (BAe), as a result of the Aircraft and Shipbuilders Industries Act. Privatization came stepwise: The Government sold 51.6% of the shares in British Aerospace in 1981 and the remaining shares in 1985. In 1999 BAe merged with the defence electronics subsidiary of General Electric Company, Marconi Electronic Systems, to form BAE Systems. Thus the biggest European and the worlds third biggest defence company was created. BAe (British Aerospace, the parent of BAE Systems) became a member of Airbus in 1979 but when EADS was formed in 2000 as a merger of the partners of Airbus, BAE Systems was the only company to remain independent. BAE withdrew from the Airbus group by selling its share to EADS but it is still participates in military programmes.

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[63] To become an independent OEM some companies needed to acquire know-how from customer that was done progressively with the restructuration and concentration process. A similar situation can be found in the rail industry; the first prototype of the TGV was built by the SNCF, which is the rail operator and not Alstom the train manufacturer; now with the fourth generation AGV Alstom developed its own platform independently.

In the course of the two to three decades the UK AI passed through an ongoing restructuring. An indicator for this process is the change of the number of jobs. Employment has been halved from 1980, when there were 242.000 jobs in the sector to 2008 with 100,740 jobs (Table 3.11). Parallel to the employment reduction an internationalisation of the British AI took place. The industry shows a pronounced global standard today. British enterprises achieve a turnover of GBP 8.12 billion and employed 51,936 persons in foreign countries. Especially the big British companies like BAE Systems, Rolls Royce and GKN have established capacities abroad. Simultaneously to the globalisation of British enterprises foreign investors were attracted by the UK.

Together with France the UK is the biggest European aerospace industry (AI) in Europe and the second biggest in the world.[64]. In 2008 100,740 employees – a decline of 11% against 2007 - worked for the AI. The turnover of GBP 20.57 billion (EUR 26.37 billion) was 1% higher than a year before. The UK AI has an outstanding track-record for international collaborations and the world's leading aircraft manufacturers have selected UK-built Rolls-Royce engines for top aircraft programmes (e.g. A380 and Boeing 787 "Dreamliner"). An important market for the British AI is the service for maintenance, repair and overhaul. Around 40.000 employees work for this business sector. This is mainly due to the strong market position of the engine manufacturer Rolls Royce.

Table 3.11 The Global British Aerospace Industry 2008

Location of UK companies:	Turnover	Orders	Employment
	£ billion		Persons
UK	20.57	35.04	100.740
In rest of Europe	0.97	3.71	4.560
USA	6.44	6.72	40.091
In rest of the world	0.71	0.71	7.285

Source: SBAC, 2009.

Performance

Table 3.12 gives an overview in the recent development of the UK aerospace industry. The figures show a noteworthy decline over the period under consideration. Production shrank by an average annual change rate of 1.6% between 2001 and 2008. This development was worse than for other big European Member States. It was induced by a steep decline at the beginning of the decade. Even more pronounced was the reduction of staff by 5.1% on average per year.

However the value-added per employee improved against the trend in other big European Member States and contributed to an increased labour productivity. This tendency might be partly induced by higher efficiency in course of a consolidation in the British AI. But the UK is to a lesser extent exposed to the troubles of Airbus with technical problems and delays in big projects, such as A380 and A400M. (Table 3.12)

[64] All figures are from the Society of British Aerospace Companies (SBAC figures; otherwise mentioned). Figures correspond to SBAC member enterprises and additional enterprises covered by the SBAC survey.

Table 3.12 Operating Figures for the UK Aerospace Industry

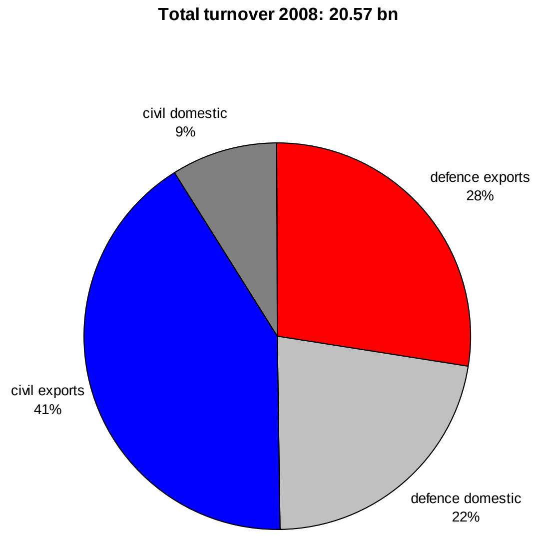
UK		Units	2008	2001 - 2008	Share of total EU27	
				Change rate in %	2001	2008
Output	Production (constant prices)	EUR billion	26.37	-1.6%	26.3%	27.1%
	Value-added (constant prices)	EUR billion	10.06	-3.2%	38.1%	29.6%
Labour force	employees	1,000	100.74	-5.1%	30.2%	22.3%
Productivity	Value-added per employee and year (constant prices)	1,000 EUR	99.89	2.0%	n.a	n.a
	Wage adjusted productivity	%	163%	1.4%	n.a	n.a
Labour costs	Per employee and year (constant prices)	1,000 EUR	61.21	0.6%	n.a	n.a
Labour costs	Per employee and year (current prices)	1,000 EUR	64.92	2.6%	n.a	n.a

Source: Eurostat, SBAC 2009, own calculations.

Supply structure

Total sales are divided equally between military and civil markets. In 2008 the gap between civil and military sales was less than 1%, down from 27% for the civil market in 1980 (SBAC, 2009). 69% of total sales were destined for export markets. The largest export market was Europe with a turnover of GBP 5.82 billion followed by the US where the UK achieved a turnover of GBP 3.41billion. A more detailed look at the AI reveals that in particular civil sales are destined to markets abroad (Figure 3.3).

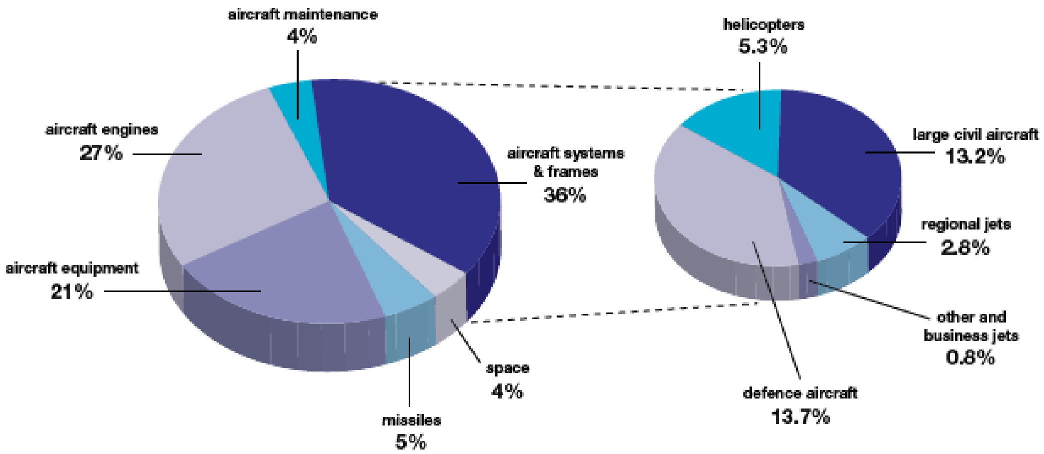
Figure 3.3 UK Aerospace Industry Sales by Type



Source: SBAC.

Industry sales by product groups show that aircraft systems and frames was the largest generator of turnover in 2008 followed by aircraft engines, which reflects the importance of Rolls Royce in the British AI (Figure 3.4). The segment large civil aircraft performed extremely well in 2008, with sales increasing by 36%. To a large extent this development was the result of the depreciation of the British Pound Sterling from a very high level (SBAC, 2009).

Figure 3.4 UK Aerospace Industry Sales by Product Group



Source: SBAC.

The United Kingdom is a leading provider of services for airlines. British companies command at around 17% of the global market that has an annual market value of around USD 40 billion.

The United Kingdom is a leading supplier of Air Traffic Management Systems (ATM) that takes hold on leading technologies. Strong interest in the introduction of the latest available technology has been highlighted by the industry's association, SBAC.

Public policies

Similar to other countries' initiatives of the government is central to understand AI in the UK. Governments influence the aircraft market as they are buyers of aerospace equipment for their armed forces and through the provision of financial support for civil aircraft development programmes and exports. In UK the AI has received funding through the Civil Aircraft and Aeroengine budget at least since the early seventies. In 1990 the Civil Aeronautics Research and Technology Demonstration (CARAD) programme was initiated by the Department of Trade and Industry (DTI) to provide support for long-term development projects of civil aircraft equipment that incorporated big financial and technical risks. Even though the CARAD research projects met the stated objectives of the programme, CARAD only ran until 2006. From 1990 to 2006 CARAD spent over GBP 270 million on grants for research projects helping key sectors in the UK AI to maintain its technological basis to remain competitive in the global market (BERR, 2008).

In 2002 the Aerospace Innovation and Growth Team (AeGT) was established by the Secretary of State for Trade and Industry. It brings together people from the industry, the government, academia and the UK Aerospace Unions. The mandate was to map a 20-year vision for the AI and propose how to realise the vision. The vision stated by the AeGT is that by 2022 'the UK will offer a global Aerospace Industry the world's most innovative and productive location, leading to sustainable growth for all its stakeholders'. Since 2005 AeGIT work is overseen by the Aerospace Innovation and Growth Leadership Council which is jointly chaired by the Minister for Industry and Regions and the Chief Executive of BAE Systems. The AeGIT identified areas where improvements are required to achieve the vision and formulated the National Aerospace Technology Strategy (NATS) in 2004. To co-ordinate funding for the NATS the National Aerospace Strategy Group has been set up. It is chaired by the Minister for Science and Innovation (dti, 2007).

Currently a Technology Strategy Board provides government support to the AI through the Technology Programme. The Technology Strategy Board is a business led non-departmental public body established in 2007 to promote research into, and development of technology and innovation of UK businesses. It is funded by the Department of Innovation, Universities and Skills[65].

Whereas the CARAD programme was drafted for sectoral support, governmental support now is directed to bringing sectors and technologies together to gain from synergies and knowledge transfer. The Technology Programme includes Collaborative Research and Development (CR&D) grants and Knowledge Transfer Networks (KTN). KTN are established and funded by the government, industry and academia. These national networks bring together people from different organisations to encourage innovation through knowledge transfer[66]. CR&R grants reduce development risk of companies by covering 25-75% of R&D costs[67]. KTN and CR&R are

65 http://www.innovateuk.org/_assets/pdf/Press%20Release%20Technology%20Strategy%20Board%20re%20Budget%2022%20April%2009.pdf
66 http://www.innovateuk.org
67 House of Commons Trade and Industry Committee, The UK Aerospace Industry, Fifteenth Report on Session 2004-05.

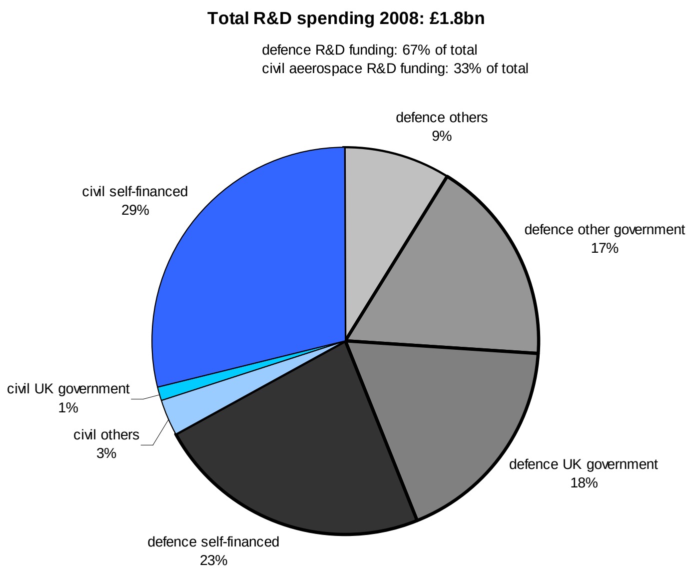
non-sector specific. From an overall budget for the CR&R programme of EUR 1.4 billion, aerospace related projects on average secure 60 million per year (AirTN 2009).

The new public schemes initiated after the phasing out of CARAD are perceived as less adequate and the horizontal approach does not meet the needs of the AI in a proper way. The advantages of the horizontal approach – the exploitation of synergies and spill over – do not sufficiently contribute to the competitiveness of the British AI in an industry that is strongly dependent on public initiatives. This drawback is aggravated by the fact that public infrastructure in R&D, universities, test facilities etc. is deficient if compared internationally. In particular companies located in Germany and France have access to a more elaborated network than in the UK.

AI companies are also eligible for tax breaks (also non-sector specific) and launch aid (AI specific). In 2008 R&D tax credits of GBP 70 million were claimed in the aerospace industry. Repayable launch aid depends on projects but committed funding for the next three years is approximately at GBP 50 million per year (SBAC, 2009).

From total investments in R&D of GBP 1.83 billion in 2008 government funding was only a small part. UK government spent GBP 340 million on aerospace R&D and other governments spent GBP 300 million (all of foreign funding was destined to defence R&D). Only 1% of total R&D spending was UK government funding to civil aeronautics (SBAC, 2009) (Figure 3.5).

Figure 3.5 UK Aerospace R&D Funding Sources 2008



Source: SBAC.

Financial support for the industrial sector is rising, as the government feels that a healthy industrial sector is vital for the UK economy. In July 2009 GBP 150 million worth of government aid for manufacturing were announced with most going to Rolls Royce. Rolls Royce will receive GBP 45 million in government support for four Rolls Royce factories in deprived UK areas, with Rolls Royce planning to invest over GBP 300 million in the four factories. Another GBP 45 million from the Technology Strategy Board is intended to help Rolls Royce to develop greener aeroplane engines. GBP 40 million is directed to the research programme SAMULET – 'Strategic Affordable Manufacturing in the UK with Leading Environmental Technology' – in which Rolls Royce plays a leading role. Much of the GBP 40 million funding comes from the Technology Strategy Board[68].

In an attempt to secure and create jobs at Bombardier's Northern Ireland plant the UK government supports the C-series programme with a repayable loan of GBP 113 million (for the development of composite wings), which has been approved by the European Commission. Bombardier is the largest manufacturing company in Northern Ireland with over 5,000 employees[69].

Clusters of aerospace industry

In an attempt to spread economic prosperity and wealth the Regional Development Agencies have been launched in 1999. Among other activities they provide support to regional companies and attract investors. They have taken initiatives to support the development and competitiveness of companies from the aerospace sectors. Special attention is paid to smaller enterprises and the creation of clusters is understood as a tool for improving the framework conditions for the smaller players in the AI. They perceive the proximity to companies and the public administration as an advantage.

The AI is located in various regions across the UK. The Northwest is the heartland of the UK AI. Over 800 companies, including BAE Systems, Airbus and Rolls-Royce, are located in the region. 54% of the high technology jobs in this region are in the AI[70]. Total turnover is GBP 7 billion representing, one third of the UK's entire gross value-added in the aerospace sector[71]. The area is strong in the production of military aircraft and the production of Airbus civil aircraft wings is located there. Wings for civil aircraft are speciality of the United Kingdom and provide around one half of the global demand for LCAs.

2000 people are employed in the aerospace sector in Wales, where in particular MRO related activities are carried out. At the Airbus site in Broughton the wings for the A380 are manufactured. The Welsh Assembly government awarded Airbus a grant of GBP 28 million to create a centre to develop composite wing production at the Broughton site in June 2009[72]. The Next Generation Composite Wing research programme is located in Wales.

The Midlands cluster is represented by the Midlands Aerospace Alliance. The are four areas of specialization,

- the production of gas turbine and other aircraft propulsion systems,
- electrical, mechanical, hydraulic systems dedicated for the control of moving parts of aircraft and engines,
- the manufacture and machining of special metals and composite materials,
- special engineering and design services, as well as factory equipment and tooling.

68 http://www.guardian.co.uk/business/2009/jul/28/mandelson-manufacturing-aid
69 http://www.northernireland.gov.uk/news/news-deti-300609-foster-reinforces-northern
70 House of Commons Trade and Industry Committee, The UK Aerospace Industry, Fifteenth Report on Session 2004-05.
71 http://www.aerospace.co.uk/about-nwaa/the-north-west.php
72 http://www.aerospacewalesforum.com

The areas of specialization comprise a big number of smaller enterprises that are on low levels in the value chain. They provide parts and components to the big players' subsidiaries in the region, such as Rolls Royce, Goodrich Actuation Systems and Meggit.

In South-East England are at around 1,200 companies located with linkages to the AI. The Farnborough Aerospace Consortium is dedicated to support the regional players and provide support to smaller enterprises. Explicitly the FAC perceives itself as a facilitator for smaller enterprises to get access to the global primes in the market.

Other clusters are located in Scotland, West England and in the North-East of England there is a strong defence industry cluster.

The regional development by the British government is supported by funds provided to the Regional Development Agencies (RDA). These institutions have a close contact to companies and knowledge of the regional strengths and weaknesses and by that are well-suited for specific measures to exploit the comparative advantages. In fact smaller enterprises perceive these activities as helpful. However, from a more general standpoint criticism is expressed. The RDA's initiatives are not coordinated and a duplication of activities takes place. This is a dissipation of means that could be used for more far-reaching projects.

Industry structure

BAE Systems is the largest aerospace company in the UK with revenues of GBP 18,843 million and employment of 106,000 – at around half of them abroad - in 2008 and dominates the UK aerospace industry[73]. The company operates in a wide range of military projects. BAE has a 33% stake in the Eurofighter Typhoon which it develops together with EADS-Deutschland (Germany), Alenia Aerospazio of Italy and EADS-CASA (Spain).[74] MBDA, a world leading missile systems company, is a joint venture of BAE Systems (37.5%), EADS (37.5%) and Finmeccanica (25%). BAE has also a 20% interest in Saab AB and is shareholder at Gripen International.

Rolls Royce is the world's second largest provider of jet engines and the second largest UK company in the AI. In 2008 the civil aerospace department at Rolls Royce generated revenues of GBP 4.5 billion (the defence department generated an addition GBP 1.7 billion). Rolls Royce, originally a car manufacturer, turned towards the production of aero engines during the First World War. After the Second World War, Rolls Royce moved into the civil aircraft market. Financial miscalculations resulted in the nationalization of the company in 1971. The aero engines department stayed under state ownership until 1987.

The appreciation of the British Pound against the U.S. Dollar had been one of the greatest challenges for UK producers in recent years (Flight Plan, 2009). A significant proportion of revenue for globally operating UK aerospace companies like Rolls Royce is denominated in dollars while costs are calculated in GBP. The 8 cent deterioration of the GBP/US exchange rate in 2008 cost the Rolls Royce Group GBP 104 million[75]. Even though the pound has fallen from the historic heights, Rolls Royce is attempting to diversify the currency risk by moving production and other activities to dollar invoiced and low-cost countries. With a record order book in 2008 the rebal-

[73] Figures for BAE Systems go beyond aerospace and include the full range of products for air, land and naval forces, electronics, security information technology solutions and customer support services.

[74] http://www.baesystems.com/AboutUs/InternationalPartnerships/index.htm

[75] http://www.rolls-royce.com/Images/2008%20PLC%20Annual%20Report_tcm92-11543.pdf

ancing to foreign markets will be mainly through the opening of new plants than through the closure of existing plants in the UK[76].

However, if the British Pound will strengthen once more, the off shoring of activities by UK aerospace companies will accelerate. In 2008, due to the depreciation of the Pound, the exports increased in both the civil and the defence markets, and attributed to the overall increase of sales in the aerospace market, which otherwise would have fallen (SBAC, 2009).

GKN Plc (Guest, Keen and Nettlefolds) is a leading UK company in engineering with around 40,000 employees and a focus on automotive industry has a big stake in the aerospace industry as one of its main activities. In 2008 GKN Aerospace generated sales of GBP 1,002 million. It is a Tier-1 supplier operating in three areas: aerostructures, propulsion systems and special products. Its top three customers (Boeing, Airbus and United Technologies Corporation) represent 50% of its divisional sales. Aerostructures account for 50%, propulsion systems supply 30% and special products 20% of the GKN aerospace turnover (each including service business). GKN aerospace has extended its presence by acquisitions in all relevant markets (65% of the aerospace turnover was achieved in the USA). In 2006 GKN acquired Stella Aerostructures to stabilise the market position in the civil sector (Boeing 777 and 787) and to improve the access to military programmes. Since 1998, when it acquired a former Dornier production site, GKN has a plant in Munich (Germany) and supplies Airbus with aerostructures.

Cobham Group is an aerospace and defence company with a turnover of GBP 1,467 million. As a global Tier-2 company it supplies prime contractors, OEMs and governments. Nearly half of its revenue is generated through military contracts. The business unit Avionics and Surveillance made up 29% of total revenues and Aviation Services 15%.

Meggitt Plc specialises in aerospace equipment, high performance sensors, defence training and combat systems. 2008 sales were GBP 1,163 million with 46% of turnover accruing in the civil aerospace market (68% of this turnover was created in aftermarket activities).

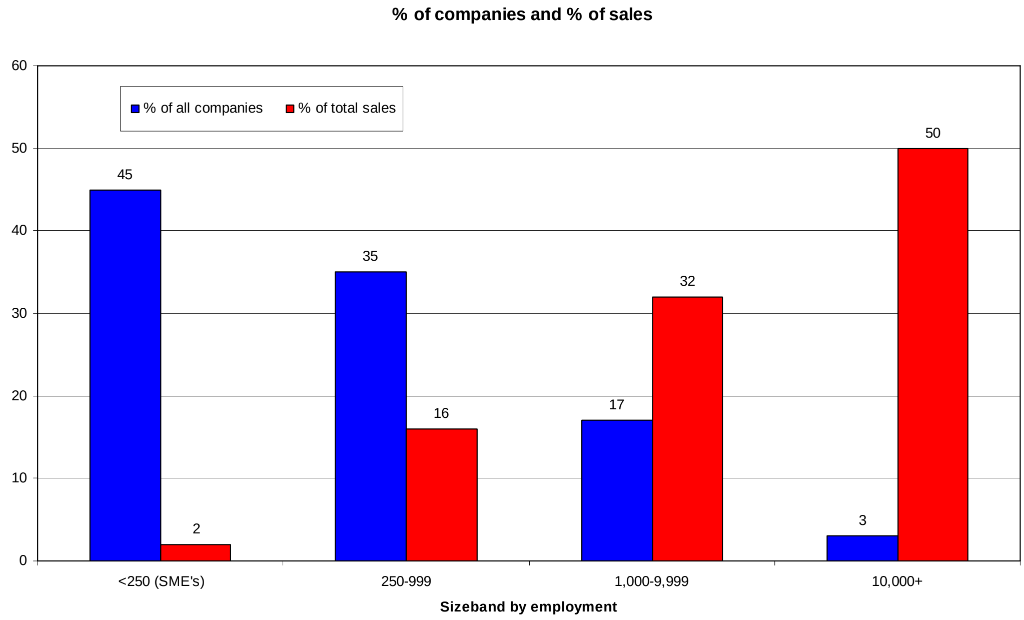
Putting all information together 50% of the total British AI turnover is generated by a few big companies which employ 10,000 people and more.[77] 45% of the companies in the sector are smaller enterprises (having fewer than 250 employees) but their share in total turnover is below 5% (Figure 3.6). Different from the big companies, smaller enterprises are geared to the supply chain if the British Tier-1, Tier-2 enterprises. This is apparent from the distribution of the turnover by direction. In 2008 smaller enterprises achieved 72% of their turnover in the UK, 14% with other European countries and only 6% with the US.

The smaller enterprises perceive a growing competitive pressure from abroad. The recent depreciation of the British Pound has suspended the situation, but this is not a stable situation. Much of the pressure comes from competitors located in the new Member States. With regard to differences in the wage levels British smaller enterprises see above all perspectives in specific market segments, such as short lead time deliveries, difficult to machine materials etc.

76 http://www.independent.co.uk/news/business/news/rollsroyce-to-shift-production-away-from-britain-779833.html

77 The most recent figures from SBAC industry surveys relate to 2006.

Figure 3.6 UK Aerospace Industry by Company Size 2006



Source: SBAC, 2007.

Some important changes in the British AI took place in recent years. In 2006 BAE sold its stake in Airbus. By this exit direct British influence on Airbus' corporate governance got lost. BAE also spun of its plant in Prestwick to the US Spirit Aerostructures and Airbus sold its plant in Filton to GKN. These developments have loosened the integration of the British AI in the European LCA activities. There is some anxiety that the traditional role of the United Kingdom in manufacturing Airbus is eroding. In particular in areas where the UK has always been strong, in wings for LCAs the contracts were given to Germany for the A400M and Spain and Germany got additional contracts for the A350XWB.

Conclusion

Like in many other Member States the AI of the United Kingdom underwent a phase of consolidation, but in the UK this had large consequences for its productivity. An enormous shake-out of staff took place and the economic performance improved significantly. Compared to French or German indicators for labour productivity and labour costs the UK shows a better performance, but one has to take in mind that for both other countries these indicators are distorted by technical problems and delays in Airbus projects. They should improve as soon as these problems are resolved.

The UK has been a global leader in the AI. It is a leading supplier of aircraft propulsion, CFK applications for wings, MRO, and it is technologically on the leading edge of ATM. However, the investigation in the sector disclosed less supportive framework conditions for R&D than for the German and French AI. The reduced linkages to Airbus Industries are perceived as a disadvantage. There is some likelihood that the United Kingdom will lose its preferred position of in the area of wings for LCA within Airbus and therefore also some of its excellence.

Smaller enterprises on lower levels of the value chain experience growing competition from the new member states. They try to overcome the related challenges via specialization and niche strategies. Some support is provided by Regional Development Agencies (RDAs). However, it is reported that the activities of the RDAs are not coordinated and some duplication of work, in particular in the area of R&D takes place.

3.1.3 Germany

Overview

The German aeronautics industry (AI) has been a global leader in the development of airplanes since the first decades of the 20th century. The first international aerospace exhibition (Internationale Luftfahrtausstellung (ILA)) was carried out in Berlin in 1909. However the exhibition lost much of its former importance after World War II when it was prohibited to manufacture aircraft in Germany. At that time an enormous brain drain took place. In the 1960s most of the production was parts manufacturing in licence with limited capacities. Only during the 1970s – after most of the restrictions had been abolished - the aerospace industry gained momentum and indigenous R&D activities became important again. Today the AI belongs to the smaller manufacturing industries in Germany, although the German companies have made much progress in recent decades. This is still a consequence of the restricted opportunities after World War II.

In course of large restructuring activities in the 1970s and early 1980s MBB emerged as an internationally renowned industry group.[78] In course of these developments the German aerospace industry capacities have been embedded in European programme- and cooperation-structures, such as the Airbus consortium, the military project Panavia (building of the tactical aircraft “Tornado”), and the merger of the respective helicopter-capacities of Aerospatiale (France) and MBB to “Eurocopter”. At that time the inflation-adjusted value-added of aeronautics grew much faster than the rest of the industry.[79] At the end of the 1980s MBB (which was partially state-owned) was acquired by Daimler-Benz and merged in 1989 with Dornier GmbH (the second remaining domestic OEM) as well as the engine manufacturer MTU (also owned by Daimler Benz) to “Deutsche Aerospace AG” (DASA). This process led to a full privatization of the German aeronautics industry.

In the early 1990s a simultaneous decrease in civil and state demand led to a worldwide recession in aeronautics, which was primarily due to a change in the international security-political framework conditions[80]. This development was aggravated for the European industry due to a USD weakness. The related budget cutbacks and planning uncertainties hit all aerospace producing countries, but the effect was particularly severe for Germany, which suffered a real decrease in turnover of 25.3% from 1990 to 1991. However, the wage costs per employee continued to rise significantly during this recession (+23.9%), which negated the intended rationalisation effect. One underlying reason is that rationalization measures have only been pursued for blue-collar work, where moderate wage increases were accompanied by substantial layoffs. Simultaneously white collar work experienced significant wage increases and suffered few layoffs. The underlying rationale was to preserve key competencies during the crisis, but a side effect was an enduring loss in profitability. This corresponded to an industry loss of EUR 1.43 billion in 1995 (or 18.6% of gross production value).

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78 On 6 June 1968, Messerschmitt AG merged with the small civil engineering and civil aviation firm Bölkow, becoming Messerschmitt-Bölkow. The following May, the firm acquired Hamburger Flugzeugbau (HFB), the aviation division of Blohm + Voss. The company then changed its name to Messerschmitt-Bölkow-Blohm (MBB).

79 From 1980 to 1990 the growth rate was (with 4.5%) more than three times as high as the rest of the industry (with 1.3%).

80 The first gulf war had a large negative effect on civil aviation, while the fall of the iron curtain triggered an interruption of many military procurement programs.

A revival of civil aviation in the second half of the 1990s initiated a recovery of the industry. The reorganisation programme Dolores (Dollar Low Rescue) succeeded finally to reduce the wage rate from 36.3% in 1995 to 20.5% in 2000. However, the problems of the preceding crisis finally led to further concentration and to the foundation of the European Aeronautic Defence and Space Company (EADS) on 10 July 2000. This fundamental reorganization has strengthened the international competitiveness of the German – or meanwhile rather the European – aerospace industry.

In 2008 the German AI reached with a turnover of EUR 21.7 billion only 1.5% of the whole industrial value-added. However, as an advanced technology industry with a high innovation potential it holds a special position with regard to global competition for the most attractive industrial locations.

Performance

Table 3.13 gives an overview on the recent development of the German aerospace industry based on Eurostat figures. During the years after the terrorist attacks of 9/11, 2001 the downturn in air transport had some spillover effects into the AI. But when the downturn came to an end strong growth started. On average for the years 2001 to 2008 production grew at an average rate of 3.1%, in constant prices. However the value-added shrank simultaneously, on average at a rate of 0.8%, but not that strong as in France and the UK.

During the period under investigation employment in the AI grew. This had a negative effect on productivity as measured by value-added per employees: value-added stagnated in the investigated period whereas the number of employees grew steadily with an average rate of 1.7%. A similar and even stronger development has been observed for France. This loss in productivity is attributed to the technical problems and delays in currently running big Airbus programmes like the A380 and the A400M and the simultaneous launch of the A350. Therefore this development cannot be interpreted as a loss in the efficiency of internal procedures. It must be understood as an investment into the future, as it relates to the expansion of high-skilled staff and the development of new aircraft with the potential of growing revenues in future years. However the decline of value-added in constant prices in combination with a growing number of employees and specific labour costs is a burden for the economic performance in the current situation. (Table 3.13)

Table 3.13 Operating Figures for the German Aerospace Industry

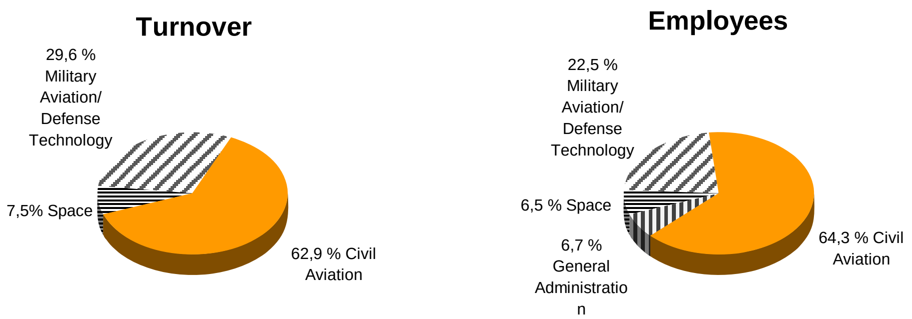
Germany		Units	2008	2001 - 2008	Share of total EU27	
				Change rate in %	2001	2008
Output	Production (constant prices)	EUR billion	21.7	3.1%	17.4%	22.3%
	Value-added (constant prices)	EUR billion	6.7	-0.8%	21.2%	19.6%
Labour force	Employees	1,000	83.8	1.7%	20.0%	22.3%
Productivity	Value-added per employee and year (constant prices)	1,000 EUR	79.4	-2.4%	n.a	n.a
	Wage adjusted productivity	%	105%	-4.5%	n.a	n.a
Labour costs	Per employee and year (constant prices)	1,000 EUR	75.8	2.2%	n.a	n.a
Labour costs	Per employee and year (current prices)	1,000 EUR	79.7	4.0%	n.a	n.a

Source: Eurostat, BDLI, own calculations.

Supply structure

For the investigation in the structure of the AI the statistics of the German association, BDLI are used. Two thirds of the turnover is destined for civil aerospace, around a quarter for defence and the remainder for space. The distribution of employees by demand categories differs slightly. A fourth group of employees is mentioned that cannot be categorized adequately, this concerns the general administration. (Figure 3.7)

Figure 3.7 The Structure of the German Aerospace Industry by Demand Category 2006



Source: BDLI, own calculations.

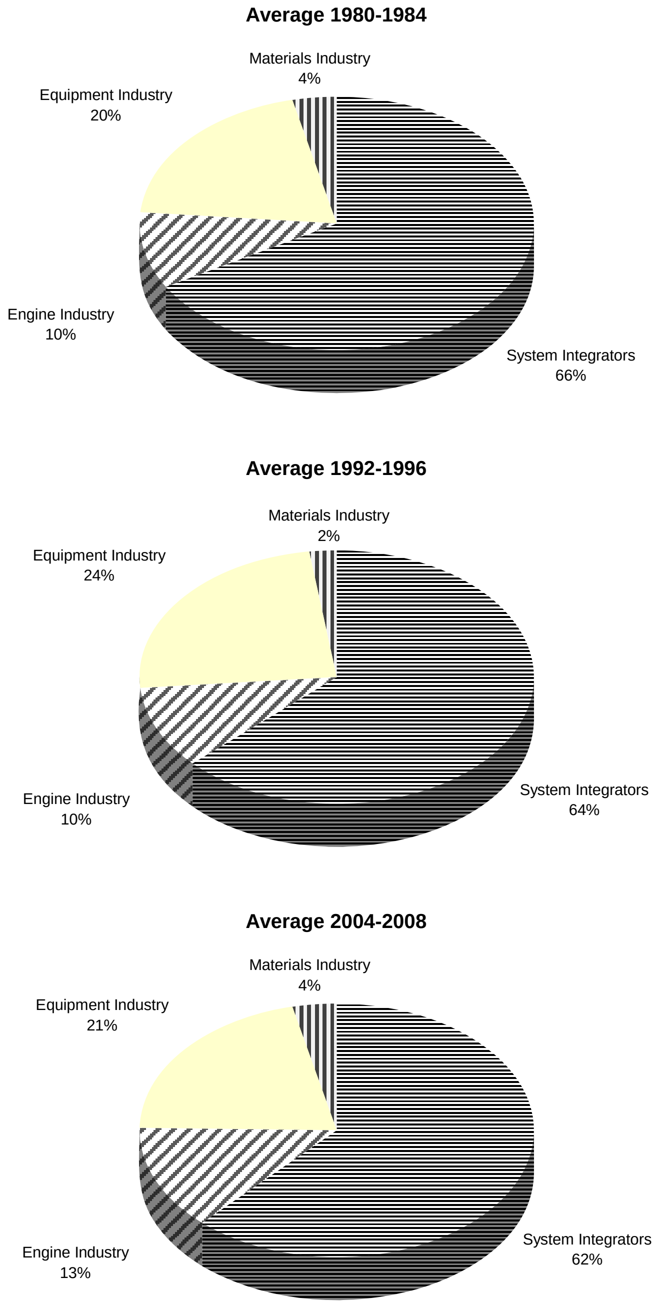
The position of the German AI within the value chain of the industry can also be depicted according to the following different groups or categories:

- The first group contains system integrators, such as the OEM-suppliers Airbus and Eurocopter that supply final products (large civil aircraft and helicopter).
- The second group contains engine manufacturers for jets and helicopters, RollsRoyce Germany, MTU Aero Engines, Turbomeca.
- The third group contains equipment manufacturers that supply a broad range of products, among them landing gears, avionics, measurement equipment, safety devices cabins, interior equipment etc.
- The fourth group contains a group of companies who primarily provides basic parts and components to the aerospace industry. Specific know-how in material technologies, machining, hardening etc. is a key competency.[81]

Figure 3.8 depicts the structure of the German AI by the kind of major product areas over time. The largest area is system integration with a share of total turnover of about two thirds, with a slight decrease in recent years. The structure is quite stable over the investigated period, but it becomes obvious that the importance of the system integrators has been slightly reduced in favour of the engine manufacturers. However, until 2002 the share of engine manufacturers was above 15% and it came back down to around 13% in recent years. The equipment manufacturers come up to around one fifth of the industry's output. The remainder is provided by the materials industry.

[81] The companies subsumed under this category are often branches of technology groups that have a stake in different industries, such as automotive, or engineering. This group contains above all companies that do not fall in the scope of the aerospace industry as defined by the NACE 35.3 (see: Annex9.3).

Figure 3.8 The Structure of the German Aerospace Turnover by Major Product Areas



Source: BDLI, own calculations.

Final assemblage and OEM activities are of outstanding importance for the German AI. Its output comprised 40% of total Airbus fixed-wing aircraft and 42% of total Eurocopter rotorcraft deliveries. (Table 3.14)

Table 3.14 Germany: OEM Deliveries (2008)

Segments	Quantities of Deliveries
Passenger aircraft (Airbus)	
A 320 family	187
A 380 family	4
Helicopters	245

Source: BDLI.

Public policies

The German politics regards the aerospace industry as a sector of pivotal importance for the technological competitiveness of the German economy.[82] Two federal ministries pursue policies with an impact on the AI. The Federal Ministry of Economics and Technology (BMWi) follows a more vertical approach compared to the Federal Ministry of Education and Research (BMBF) which follows a more horizontal approach. The BMBF defines programmes on basic technologies, such as micro-systems, optics, nano-technology, new-materials etc. that are of relevance for the AI. Within the areas of technologies companies can suggest and apply for projects.

Since long the BMWi offers support via a specific research program for the aerospace industry (Luftfahrtforschungsprogramm (LuFo)). This is the most important scheme for the German AI. The latest version of the updated program, the LuFo IV covers the period 2009 to 2013.[83] The scope is not limited to the AI, but comprises all areas of relevance to improve the efficiency of air transport, in particular the infrastructure.

Of major importance for the participation of smaller technology driven companies in these schemes is the well-developed infrastructure consisting of universities and research bodies. They possess or have access to the sometimes very expensive equipment for research and testing, as for instance wind tunnels. This infrastructure is attractive not only for German firms but incite foreign companies to launch activities in Germany.

The LuFo pursues an integrated approach. It provides support not only on R&D and the development of new products, but to production technologies, necessary for an efficient manufacturing process. Special attention is paid to so-called Integrated Technology Projects (IP) that are dedicated to bring together technologies that have been developed separately so far. This system approach is perceived as of major importance for progress in the AI. The focus is on next generation large airplanes for short- and medium-range distances.

Of high importance for German policies targeted at the AI is the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt, DLR) which is also responsible for project management organization for the LuFo programmes of the BMWi. It is a non-profit organization with around 6000 employees that runs 13 locations in Germany. The organization refers in its Strategic Research Agenda (SRA) explicitly to European initiatives as guidance for its own long-term orientation. The DLR is linked with Europe's leading aeronautical research institutes through EREA (Association of European Research Establishments in Aeronautics). Besides project man-

[82] http://www.bmwi.de/English/Navigation/Economy/industrial-policy,did=76808.html

[83] Funding of R&T as well as "integrated technology projects" within the framework of the national aerospace research programme (LuFo) – third call 2010 – 2013, in: Bundesanzeiger, Nr. 17, 3 February 2009, p. 419.

agement the DLR is directly involved in research projects and runs the expensive research facilities that are indispensable for advanced R&D activities.

The program has been linked to European initiatives, in particular ACARE. Several R&D efforts have been undertaken so far in the area of active and passive technologies for the improvement of flight physics in order to achieve the ACARE goals. Moreover it is possible to use funds of LuFo in joint international research projects. There are important cross-border initiatives in the AI that are part of the long-term franco-allemand co-operation in high-tech areas. The agreement was signed in 1992 and the operative activities are carried out by the French aerospace lab ONERA (Office National d'Études et de Recherches Aérospatiale) and by the German DLR.

Since then the cooperation has been expanded continuously. In 1998 an agreement on a partnership in the area of rotorcraft research was concluded. Even more important has been the signature of the framework agreement of ONERA and DLR for the cooperation in fixed-wing aircraft technologies in 2001. Then the initiative was linked to the emergence of a European AI around the French-German core company the European Aeronautic Defence and Space Company (EADS).[84]

As a consequence of this bilateral cooperation cross-border initiatives have been stimulated. In 1994 the Association of European Research Establishments in Aeronautics (EREA) was founded. It brings together research bodies from 12 Member States, whereof 8 are full members and 4 associated.[85] Another activity in this context is the European Transonic Windtunnel (ETW) that has been founded by France, Germany, Great Britain and the Netherlands.

Clusters of the aerospace industry

There are numerous regional centres of the AI in Germany. Most of them are closely linked to the governments of German States. Generally speaking, the public activities show the typical pattern of the German economic policy that is directed towards the creation of supportive framework conditions for smaller enterprises. Not only the co-operation with research bodies and universities is high on the agenda, but support is provided to companies that want to gain access to potential development partners and clients in Germany and abroad.

Hamburg is a cluster of outstanding importance for Germany with the production facility of and the delivery centre for the Airbus A320 family (A380 to certain regions). The region combines several initiatives under the umbrella of "Hamburg – The Place for Innovation". Public authorities, universities and companies of the industry co-operate. Special effort is made in R&D on interior equipment and related manufacturing technologies. Of importance is a qualification initiative that aims at the development of infrastructure as well as the qualification of personnel on all levels. Hanse Aerospace and Hanseatic Engineering & Consulting Association are non-profit organizations that have been founded to co-ordinate the interests and activities of smaller enterprises and service companies in the Hamburg region. The umbrella organization pursues an explicit cross-border approach and manages the European Aerospace Cluster Partnership (EACP). Most important are cooperations with French clusters of the AI.

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84 Bundesministerium für Bildung und Forschung (BMBF), Ministère de l'Éducation Nationale, de l'Enseignement Supérieure et de la Recherche, Ministère délégué à la Recherche (ed.); 40 Jahre Deutsch-Französiche Zusammenarbeit in Forschung und Technologie: Bilanz und Perspektiven 1963 – 2003, Bonn – Berlin – Paris 2005, p. 22ff.

85 http://www.erea.org/index.php?option=com_content&task=section&id=7&Itemid=29, (A more detailed analysis of area will be provided in the chapter on the European framework condition.

The Aviabelt initiative of the nearby Bremen region has a focus on manufacturing technologies, engineering, R&D, as well as education and training. The "Niedersachsen Aviation Cluster" of Lower Saxony with locations in Bremen and Stade is strong in carbon fibre constructions. Strong expertise for applications in the aerospace industry and in windmills is available and synergies from both areas of applications can be exploited.

The Berlin Brandenburg Aerospace Alliance (BBAA) bundles the activities of smaller enterprises in the region. For the AI projects above all two topics are of importance, engine technology and light weight construction. In the areas efficient networks of subcontractors shall be created. Members of the engine project are RollsRoyce Germany and MTU. The project on light weight construction has a focus on general aviation and light aircraft.

The Aerospace Initiative Saxony coordinates activities of local firms and supports their integration into international markets. There are noteworthy activities to get access to companies in Eastern Europe and China. One of the key-projects is a cooperation with the Austrian FACC, a company specialized in composites for the aerospace industry and GWT, a company specializing in the manufacture of tools for the production of components.

The Bavarian "bavAIRia" is an initiative focused on a broad range of technologies of relevance for the civil, military and space activities. The Bavarian cluster comprises big firms, such as Liebherr, Eurocopter, Diehl, and MTU that are major players in the global market. The development of this cluster is strongly related to the Bavarian government that since long has pursued a strategy to create an internationally competitive cluster. Satellite navigation and Global Monitoring of the Environment (GMES), as well as the development of unmanned airborne vehicles (UAV) are technologies that do not directly affect the civil aeronautics sector, but spill-over and spin-off effects can have an impact on techniques applied in airplanes of the future. Initiatives on engineering are dedicated to better link smaller enterprises service companies into AI's networks. Initiatives in engines take into account the ACARE objectives for the development of more efficient airplanes but also that Bavaria has become an important location for production in turbines.

The „Forum Luft- und Raumfahrt Baden-Württemberg" is an initiative of the state government that co-ordinates the strengths of the manufacturing sector in the south-western part of Germany. Strengths of the region lie in areas such as micro-systems, opto-electronics, flight control and avionic.

Table 3.15 summarizes the German cluster initiatives and their respective core area.

Table 3.15 German Aerospace Clusters

Cluster initiative	Core Area	Established
Aerospace Initiative Saxony (ASIS) Dresden www.aerospace-saxony.de	Modern Materials (especially Composites), Material and Structural Testing, Electrical, electronical and optical equipment, Processing of metal parts * R&D – and engineering science services	2008
Aviabelt Bremen www.Aviabelt.de	Manufacturing, Engineering, R&D, Education and Training	2005
bavAIRia Oberpfaffen-hofen www.bavairia.net	aero engines, aerostructures, weapons systems, "more electric aircraft" components, avionics components, aircraft interiors, cargo compartment solutions, simulation & training systems, avionics, satellites, launcher components, GMES	2007
Berlin Brandenburg Aerospace Alliance(BBAA) Berlin www.bbaa.de	Service, MRO	1998
Forum Luft- und Raumfahrt Baden-Württemberg e.V. (LRBW) Ostfildern www.lrbw.de	Supply Industry: equipment, cable, sensors, electronics, components, engines	2005
Hamburg - The Place for Aviation(HH) Hamburg www.luftfahrtstandort-hamburg.de Hanse Aerospace Hamburg www.hanse-aerospace.net Hanseatic Engineering & Consulting Association (HECAS) Hamburg www.hecas-ev.de	Alround (construction of entire aircraft, fuselage assembly, cabin systems and cabin interior equipment, MRO, application of new materials and compounds) innovative integrated solutions for air transportation	2001 2001 2001
Niedersachsen Aviation Hannover www.niedersachsen-aviation.de	MRO, Materials (CFK)	2008

Source: Desk Research.

Industry structure

The merger of French and German aerospace activities by the creation of EADS N.V. was a leap forward to a more integrated European industry that was strengthened by Spain that also became a shareholder of the firm. This was a far reaching decision in particular for Germany. Its entire system competency has been transferred to EADS, whereas other European countries maintained some of their system competency, such as France with Dassault, Italy with Finmeccanica, the United Kingdom with BAe and Sweden with SAAB.

The most important EADS companies in Germany are Airbus Deutschland GmbH with its locations in Hamburg, Bremen, Buxtehude, Nordenham and Varel and Eurocopter Deutschland with locations in Donauwörth and Ottobrunn. Airbus Germany has a stake in large civil aircraft (LCA) and is specialized in short to medium-range aircraft. 187 airplanes of the A320 family (A318, A319, A320, and A321) and four A380 have been delivered to clients in 2008. Eurocopter Deutschland delivered 245 helicopters.

Premium Aerotec with its 6,000 to 7,000 employees has become the biggest European manufacturer in the market segment "aerostructures" and in this segment one of the leading manufacturers worldwide. The sale of this company failed primarily because of the opaque order situation (A380). Heavy investment has been carried out to strengthen its capabilities and increase the efficiency of production.[86] Premium Aerotec has the potential to become an important Tier-1 supplier in Germany, and attract clients from all over the world. But competition is strong in the market. The global leader in this market segment, Spirit Aerosystems from the US, has already invested in Europe with production sites in England and Scotland.

Germany is a stronghold in Avionics. There are big players, such as Diehl and Liebherr and numerous smaller enterprises.

In 2008 The Airbus production site, Laupheim was sold to the French-German consortium of the German Diehl (51%) and the French Thales (49%). It has been affiliated to the already existing Diehl/Thales joint venture, Diehl Aerospace and strengthens the competence in system integration in the field of cabins.

The market for landing gears has been dominated by two major players, Goodrich and Messier-Dowty. In recent years the Swiss Liebherr with its German based facilities has also proved to be very successful in this market segment and won important contracts. The company has strengthened its Tier-1 abilities. This success is assessed as an important contribution to the German AI's adjustment to changes in the value chains envisaged by the big OEMs.

The activities of the Power 8 Programme are also directed towards a more efficient and transnational organizational structure. Four central areas for production, product programme, procurement and engineering and four Centers of Excellence (CoE) around complete aircraft components have been created. Simultaneously many of the responsibilities for R&D have been centralized in Toulouse. This restructuring is a prerequisite for a more efficient transnational organization. The autonomy of national companies has been reduced and they got the status of "national representatives". The centralization in France poses a risk for the balance of interests in the decision making process.

Furthermore, regarding EADS' focus on core activities, divestments in non-core areas and the transfer of bigger work packages to suppliers will accelerate, which imposes an increasing pressure to consolidate the suppliers landscape in order to serve the tightened requirements for program participation.

The restructuring of the supply chain is an important issue in relation to the Vision 2020 of EADS, which involves several challenges for the German small and medium-sized businesses. An important one relates to globalization and the goal to divert 40% of its sourcing and 20% of the employees outside Europe, which sets an increased competitive pressure on German suppliers. In several interviews it was mentioned that OEMs and first tier suppliers (like Diehl) try to convince smaller suppliers to go jointly with them abroad to build a new production cluster, jointly profit from low cost conditions and gain easier access to the relevant market and local resources.[87] But if this approach fails, several small suppliers are at risk to be replaced by foreign manufactures. Affected are in particular activities, which can be easily made elsewhere. Examples are metal injection moulding, engineering, or documentation.

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86 The design and manufacture of aerostructures is more suited to globalisation than other parts of the value chain. This means that higher efforts are needed to maintain comparative advantages and to stay on the leading edge of technology. See: BMWi (Ed.), Bericht des Koordinators für die deutsche Luft-und Raumfahrt, Berlin August 2009 (Vorabversion), S. 22. http://www.bmwi.de/BMWi/Navigation/Ministerium/Minister-und-Staatssekretaere/Visitenkarten/visitenkarte-hintze,did=309210.html?view=renderPrint

87 The necessity to build industrial parks has also been stressed by Recaro, a major German seat-manufacturer.

Many German smaller enterprises are technology-driven – often market leaders in specific niches, but too small for substantial system-management-competencies or large financial resources. This is a major problem and hindrance for a necessary restructuring process in context with the changed market conditions (explicitly formulated by EADS in its Vision 2020 and mainly driven by the competitive forces of globalisation). Many of these companies do not posses management capabilities necessary for becoming a subsystem supplier that has to co-ordinate and organize work for companies on lower levels of the value chain. These companies would not only have to change their strategic orientation but also their management philosophy and perhaps hire executives experienced in this field of business. These companies face the challenge to maintain their technological excellence in a globalized world or to try to step into a different business area.

Access to short and long term credits has turned out not yet to be a severe problem – at least for OEMs and first tier suppliers. Airbus offered to support suppliers in financial distress with equity financing, but the reaction was primarily a refusal. Nevertheless, it was mentioned that state aid in terms of loan guarantees or loans at preferential terms would be highly appreciated by the industry. Small suppliers stress that currently it has become more difficult to prefinance investments via bank-loans, given that in the aviation business non-recurring costs have to be financed by the long-term revenues (15-20 years) of an aircraft program.

The global market for aircraft propulsion is dominated by three players with the ability to manufacture complete engines, the US companies GE, P&W and the British RR and the French-US joint venture CFM of SNECMA and GE. However, Germany has a noteworthy stake in the market with MTU Aero Engines AG and Rolls Royce Germany Limited & Co. Rolls Royce Deutschland, a subsidiary of the British engine manufacturer. RR Germany offers complete services from development through reduction to in-service support for aircraft engines. The company takes advantage of the excellent research infrastructure and is involved in the initiatives of the Berlin-Brandurg cluster to create a network of strong subcontractors in the engine value chain. In 2005 the German subsidiary received the RR share of the V2500, the engine for the A320 family. The enterprise offers a complete service for aircraft engines from development through production to in-service-support.[88]

MTU is one of the leading aircraft engine manufacturers in the world market and has become a specialized supplier within the engine value chain. The company is a Tier-1 supplier to most engine manufacturers or consortia in Europe or in the US.

Germany is involved in the development of both propulsion systems dedicated for the aircraft of the future. MTU Aero Engines is working on the design of the Geared Turbofan (GTF) and RollsRoyce Germany on the Open-Rotor concept. These activities are not only supported by public funds but by the R&D infrastructure and available test facilities in Germany.

Typically the manufacturers of engines are strong in services that contribute a noteworthy share to their total sales. Maintenance, Repair and Overhaul (MRO) are not only offered by the manu-

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[88] Rolls Royce Deutschland, which was founded as Motorenfabrik Oberursel in 1913, acquired by Klöckner-Humboldt-Deutz and newly formed in 1990 as BMW Rolls-Royce, received its current name in 1999 and has a workforce of 3,000 employees.

facturers but by joint ventures and independent companies. German players in the market of independent MRO suppliers with global importance are Lufthansa Technik und MTU Maintenance.

The competence for MRO in Germany has been strengthened by the concentration of activities in the Military Air System (MAS) in Manching run by EADS. The Competence Centre of Excellence comprises beyond traditional MRO upgrading, retrofitting and basic revamping. Although this is only a military service facility a lot of experience in the organization and execution of comprehensive and complex MRO will be gained and thus incorporates the potential for spin-offs and spill-overs to the civil sector, including the qualification of personnel.

Conclusion

There are several big players in the German AI. Airbus Germany and Eurocopter are two examples for important and successful OEM manufacturers located in Germany. There are only some potential Tier-1 suppliers, such as Premium Aerotech, Diehl and Liebherr Aerospace (in aircraft production), or MTU Aero Engines (in the engine market). It is of note that in recent years the strength of German companies in this area has increased. However the German AI is characterized further on – as well as the indigenous manufacturing industry in general – by many smaller enterprises, often family owned. These companies are driven by their technological competence in a particular market niche and busy working on maintaining their excellence.

Germany owns an excellent R&D infrastructure by international standards. The co-operation of universities, public and semi-public research bodies as well as test facilities provides a stimulating environment for innovation in the aerospace industry. The available infrastructure does not only provide advantages for German companies but also attracts foreign players to exploit the opportunities of the supportive R&D environment. This R&D environment is a prerequisite to meet the challenges of the growing global competition and contributes to the strengthening of German smaller enterprises in global competition.

German core competencies in manufacturing are primarily in the domains of fuselage, fuselage-structures, and complex cabin equipment. It is of note that by M&A companies have improved their competency as system integrators. Furthermore it is strong in high-lift-systems, vertical tail manufacturing, and final assembly, A specific strength of technological driven German companies is identified in the areas of avionics and engines. For smaller engines Germany has become the competence centre for RR. Cross-cutting activities such as flight-physics and aerodynamics are R&D intense and benefit much from the excellent German infrastructure.

The stance of the German authorities is directed to support medium-sized enterprises in their efforts to stay on the leading edge in global competition. Moreover, the German authorities have a strong focus on the AI and know of their stimuli on other industries to maintain or even accelerate the pace of technological progress. As a consequence many initiatives are taken by the Federal and the States' governments to create adequate framework conditions. There are numerous cluster initiatives that try to develop regional strengths and these can easily be accessed by local smaller enterprises. To increase their efficiency the German AI association, BDLI, plays a noteworthy role with its fora, Regional Forum and Forum Equipment and Material, in the process of the consolidation and mutual adjustment of the disperse activities.

One of the biggest challenges German firms face is the change in the procurement strategies of Airbus that require bigger companies with strong risk taking abilities, good access to the financial markets and specific management capacities to handle system integration at least on a subsystem level. Smaller enterprises have partially tried to overcome this detriment by cooperations, but for many family-owned niche-suppliers the related share of sensitive information with possible competitors is rarely acceptable. Smaller enterprises highlight that such cooperation must be like a one-stop-shop with regard to communication, reliability and contractual obligations. Such a requirement cannot easily be reached by a simple cooperation treaty. Specific funding resources and entrepreneurial abilities are necessary. The structural changes to meet the challenges of the EADS Vision 2020 have not yet gained sufficient momentum.

3.1.4 Italy

Overview
The Italian aerospace industry is the fourth largest in Europe generating annual revenue of EUR 8.7 billion and employing 36,300 people. Approximately 10% were employed in the space sector. With an estimated investment in R&D of EUR 1.3 billion[89] the aerospace sector is a cornerstone for innovation and modernisation in the Italian economy.

Finmeccanica is Italy's main group operating in the aerospace, defence and security sectors. Unlike many of its international competitors Finmeccanica does not have its origins in the sector. It was set up in 1948 by the "Istituto per la Ricostruzione Industriale" (IRI – an Italian state-owned holding company, closed in 2000) to manage State participation in the mechanical and ship-building industries. Over the years, with the acquisition of several companies, Finmeccanica began to focus in the electro-mechanical and the aerospace sectors. At the beginning of the century, Finmeccanica further strengthened its role in the aerospace and defence sectors by acquiring Aermacchi and a 30% share in Fiat Avio (now the Avio Group). In 2004, Finmeccanica acquired GKN's 50% share in Agusta Westland, the world's second biggest producer of civil helicopters after Eurocopter. Finmeccanica has remained a company with strong public influence and a share of 60% owned by the government.

Alenia Aeronautica resulted from the fusion of Aeritalia and Selenia in the early 1990s. Until then Aeritalia was Italy's most important manufacturer of airplanes and acted as a subcontractor of McDonnell Douglas over many years. In this affiliation it produced fuselage components and systems for the MD-80 series. This relationship was reflected in the client customer relationship of Alitalia and McDonnell Douglas and – after the takeover by Boeing – found some continuation in the production of the Boeing 767 and later in the participation in Boeing 787. Although a Finmeccanica company, Alenia Aeronautics operates fairly independent from Finmeccanica since 2002 when it was spun off from its parent company.

Performance
The Italian AI enjoyed strong growth over the period under consideration. Between 2001 and 2008 production grew by an average annual rate of 4.1%. In contrast to the other big Member States the value-added grew, but with 2.3% per annum at a somewhat lower pace. Employment grew at roughly the same pace. As a consequence productivity indicated by the value-added per employee and year grew slightly. In contrast to the bigger Member States Italy's contribution to the EU27's gross value-added increased over the years. (Table 3.16)

[89] http://www.californiaspaceauthority.org/images/international-opps-images/Torino-Piemonte-Aerospace.pdf

Table 3.16 Operating Figures for the Italian Aerospace Industry

Italy		Units	2008	2001 - 2008 Change rate in %	Share of total EU27 2001	Share of total EU27 2008
Output	Production (constant prices)	EUR billion	8.7	4.1%	5.9%	9.0%
	Value-added (constant prices)	EUR billion	2.7	2.3%	6.8%	7.8%
Labour force	Employees	1,000	36.3	2.2%	8.6%	9.6%
Productivity	Value-added per employee and year (constant prices)	1,000 EUR	73.1	0.5%	n.a	n.a
	Wage adjusted productivity	%	147%	0.0%	n.a	n.a
Labour costs	Per employee and year (constant prices)	1,000 EUR	49.8	0.4%	n.a	n.a
Labour costs	Per employee and year (current prices)	1,000 EUR	52.7	3.0%	n.a	n.a

Source: For 2008 estimations Eurostat (STB), ASD; Employment figures from 2007.

Supply structure

The Italian AI is a manufacturer of the turboprop aircraft ATR and of Agusta Westland helicopters. With Finmeccanica Italy is of outstanding importance for the European AI with its production of electronics. The company is perceived to be on the leading edge of technology and provides high-tech components to all areas of the AI, the civil, the defence and the space sector.

Italian manufacturers play an important role in the production of aerostructures. All big OEM, such as Boeing, Airbus, Bombardier and Embraer are clients. Moreover Italy has a noteworthy stake in the manufacturing of parts and subassemblies in the AI. The concerned companies in the value chain face strong competition from foreign manufacturers. In particular North Africa is mentioned as an upcoming region on the lower end of the value chain.

Public policies

Public R&D initiatives are coordinated and public infrastructure is made available by the Italian Research Centre (CIRA). The body was created already in 1984 and the majority of share capital is held by governmental organizations, the Italian Space Agency (ASI) and the National Research Council (CNR)

The Ministry of Education, University and Research has a major role in government funding of R&D projects. The main instrument is the National Research Plan (PNR), which is renewed every three years. The targets of the present PNR are strived for by eleven strategic programmes, one of which relates to ‘Ships, Aeronautics, and Helicopters’. During the 2005 to 2007 period the budget of the PNR was EUR 1,100 million. Additional to the PNR, an Aerospace Research Programme was defined, with respect to the industrial and research needs (Air TN, 2009). Italy also takes part in SESAR and the CleanSky Programme, two themes within the 7th Framework Programme.

Regional policy has always played a major role for the Italian government. As a result many of the locations for the AI are in the south, above all in Puglia and in Campania. In this region there are many smaller enterprises that are subcontractors on lower levels of the value chain.

Public policy has perceived a decline in the competitiveness of Italy as a production location for simple products, machined parts and labour intensive assemblage. The Italian government incites bigger firms to become system and subsystem integrators and give a hand to Italian smaller enterprises and keep them in the value chain.

Clusters of the Aerospace Industry

The Italian aerospace industry is concentrated in the more industrialized northern regions Piedmont, Lombardy, Latium, as well as in the south, in Puglia and Campania. Clusters have been formed and are supported by regional policies. In some areas the decline in the automotive industry has incited the regional public administration to support investment in the AI.

The formation of clusters benefits also from the proximity of manufacturing sites of Alenia Aeronautics and its subsidiaries. Alenia Aeronautics maintains a strong manufacturing presence in all regions. One exception is Lombardy where, instead of Alenia, Agusta owns a large production base and serves as a crystal nucleus for smaller suppliers. Dozens of smaller enterprises are clustered around the large manufacturers to supply components. However, smaller enterprises are highly dependent on their large local customers and few suppliers have been able to become autonomous (ITHK, 2009).

Currently, there is the tendency to create inter-regional clusters and cooperations. In October 2008, Campania and Puglia decided to form an inter-regional cluster. Piedmont and Latium are thinking of a similar strategy. In September 2008, Campania, Puglia and Piedmont have signed an agreement of cooperation in the aerospace market. The efforts were made to streamline the supply chain of smaller enterprises which are resident in those areas and to match their activities with the expertise of Italy's research centres and universities in those regions. Moreover a better coordination of the regional bodies initiatives is necessary to reduce the risk of duplication of work. Clusters and cooperations benefit their members through synergies (especially in R&D) and risk-sharing.

Industry structure

Finmeccanica is one of the world's leading groups in the fields of helicopters (through its subsidiary Agusta Westland) and defence electronics and is the European leader for satellite and space services. It is the second largest industrial group in Italy (behind Fiat) and the largest of the hitech industrial groups. Through its subsidiary, Alenia Aeronautia, Finmeccanica is Italy's leader in aeronautical production. Finmeccanica worldwide employment comprises 73,000 people, generates revenues of EUR 15,037 million (2008 figures) and operates facilities in Europe and the US. To maintain a competitive edge, 14% of its annual turnover is invested in R&D. In absolute figures this is the highest R&D ratio of an Italian company.

As the Italian leader in the aeronautics industry Alenia Aeronautics manufactures products for military and commercial aircraft, aerostructures, advanced mission systems, unmanned aerial systems and aircraft maintenance and modification. The company has generated revenues of EUR 2.530 million in 2008, an EBIT of EUR 232 million and employs 13,907 workers. Alenia Aeronautics has a wide international network of subsidiaries and joint ventures. This includes

Alenia Aermacchi, the world leader in the production of training aircraft, Alenia Aeronavali, an overhaul and modification company, Alenia Composite and Alenia North America which represents its interests in the United States. In an equal-share joint venture with EADS, Alenia Aeronautica owns ATR, which dominates the regional turboprop market. Alenia has recently started a partnership with the Russian company Sukhoi to develop and market the Superjet 100, an advanced and environmentally friendly regional jet.

This joint venture serves to achieve the objective to reduce dependency from the defence industry and the growing financial tightness of public budgets. However, this is a challenge for corporate governance: R&D and manufacturing processes must be adapted to changing requirements. In civil aerospace design-to-cost and an efficient production with bigger lots are essential features for a competitive supply. Such a transition is a learning process and needs some time. The cooperation with Sukhoi is dedicated to gain experience and to reduce the dependency on public defence budgets that become more and more stressed.

Alenia Aeronautics maintains the traditional strong cooperation with Boeing. It is a manufacturer for production of the composite fuselage barrel section and the horizontal stabilizers for the B787. To support the 787 Dreamliner programme, Alenia North America and the Boeing Company set up the joint venture “Global Aeronautica”. It integrates fuselage parts prior to shipment to the final assembly at the Boeing assembly facility in Everett. But Alenia Aeronautics also cooperates with Airbus and manufactures aerostructures for the A321 and A340–500/600 and fuselage parts for the A380.

Encouraged by the increasing utilisation of composites, both companies have decided to establish Italy's first composite recycling facility. Mainly intended to precede composite scrap from the nearby Alenia manufacturing centre, the facility will also advance knowledge surrounding the recycling of composite airplane parts into reusable materials for manufacturing and created 75 jobs in the region of Puglia (Southern Italy).

Another important player in the Italian AI is Avio. Avio is one of the oldest companies operating in the aerospace industry worldwide. Founded in 1908 by Fiat as Fiat Avio in an attempt to diversify its business, it now is the leading Italian manufacturer of aircraft and naval engines and a leader in space propulsion. Since 2003 Avio is owned by Finmeccanica and The Carlyle Group. The most recent programs for which Avio is partnered are the GEnx for the Boeing 787 Dreamliner, the Trent 900 for the Airbus A380 and the SaM146 engine for the Russian aircraft Superjet 100.

DEMA, founded in 1993, started with designs airplane components. Some years later on the company went beyond engineering services and launched own production facilities. After a rapid expansion and the acquisition of smaller manufacturers, turnover in 2008 reached EUR 33 million and employment is at 600 workers. DEMA succeeded in lowering its dependence on a single customer and signed a contract with Bombardier in 2008. In this value chain DEMA is a Tier-1. This position is assessed by the company as an advantage as compared to it Tier-2 position in most other value chains. The company has acknowledged the importance to integrate regional companies into its value chain. However the price pressure and growing competitiveness has induced DEMA to invest in Tunisia and use the advantages of the low wage supply.

Conclusion

While many of their European counterparts have been integrated into EADS, Italian aerospace companies have largely stayed independent and continue to operate in specific market segments. Some have become important suppliers in their niche markets, such as Aermacchi, Agusta Westland or Piaggo Aero (producer of turboprop executive aircraft). The participation of Alenia (and therefore Finmeccanica) in the Sukhoi Superjet 100 project is driven by a strategy to become less dependent from the defence industry. A learning process has started to reduce the cost burden by introducing the principle of design to costs in engineering services and streamline manufacturing processes to better meet the requirements of the civil side of the AI.

Italy is famous for its ingenious companies that trust in a good access to cheap labour. But during the last decade the competitiveness eroded. Companies have erected new plants abroad, in particular in North Africa and expanded capacities. Increasingly client companies ask suppliers to internationalize production. Sometimes this is an indispensable prerequisite for winning a contract. It has been reported that suppliers submit two tenders, one based on domestic cost calculation and one based on foreign factor costs. This behaviour underscores the growing competitive pressure indigenous companies are exposed, although labour costs are much lower than in the other big Member States.

3.1.5 Spain

Overview

Construcciones Aeronáuticas S.A. (CASA) is Spain's leading company in the aeronautics' sector. Since its emergence in 1923, CASA has maintained a dominant role in the Spanish AI. After the Second World War, CASA established itself as an important producer of transport aircraft[90]. The C-212 was sold over 470 times throughout the world. In 1972, CASA became a member of the Airbus Industry Economic Interest Group and in 1999 joined the EADS. Today EADS - CASA employs 10,000 people and concentrates its activity in the production of aircraft (both military and civil), maintenance and space. EADS-CASA and Airbus are an integral part of the Spanish AI. Their strong presence in Spain is a driving force behind the emergence of smaller suppliers. The landing gear for many Airbus planes, such as the A380, is produced in Spain and the final assembly line for the A400M is located in Seville, Andalusia. 27% of EADS-CASA employment belongs to the Airbus business, 44% to the Military Transport Aircraft and 16% to the Defence division of group. The remainder is dedicated to work for Astrium (7) and Eurocopter (5%). This allocation of employment to business areas comprises the staff of the headquarter that comes up to 2% of the overall employment. The distribution of the EADS-CASA workforce underlines the importance of the integration of the Spanish aeronautic industry in the European joint military transport programme.

Performance

The Spanish AI proved to be extraordinarily dynamic. Over the period between 2001 and 2008 production grew at an average annual growth rate of 12.5% and value-added by 7.9% at constant prices. It gained much importance during that time and it share of total EU27 value-added grew from 2.0% up to 3.3%. Eurostat statistics show a figure for employment of 15,200 in 2008[91]. This

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90 http://www.technologyreview.com/microsites/spain/aero/

91 According to ATECMA data, the Spanish aerospace industry employed 36,160. This figure is much higher than that of Eurostat because of a much wider definition of the sector. The data have been obtained from the Aerospace Statistical Survey 2008. The statistical data represent the entire sector in Spain, with, in addition to information on the companies forming part of ATECMA, data on Space

equals a share of total European employment of already 4.7%. The expansion of employment did not keep pace with output and value-added per capita increased by 2.3% per annum. The growth of productivity has been affected by capacity utilization and economies-of-scale that can easily be exploited during phases of strong growth. In spite of this advantageous development the cost pressure increased. Nominal wages grew by 4.3% on average of the period under consideration and took much from the advantageous development. (Table 3.17) This is a pattern that has also put pressure on other industries' international competitiveness in Spain.

Table 3.17 Operating Figures for the Spanish Aerospace Industry

Spain		Units	2008	2001 - 2008	Share of total EU27	
				Change rate in %	2001	2008
Output	Production (constant prices)	EUR billion	4.9	12.5%	1.9%	5.1%
	Value-added (constant prices)	EUR billion	1.1	7.9%	2.0%	3.3%
Labour force	employees	1,000	15.2	5.4%	3.2%	4.7%
Productivity	Value-added per employee and year (constant prices)	1,000 EUR	74.6	2.3%	n.a	n.a
	Wage adjusted productivity	%	150%	1.4%	n.a	n.a
Labour costs	Per employee and year (constant prices)	1,000 EUR	49.7	0.9%	n.a	n.a
Labour costs	Per employee and year (current prices)	1,000 EUR	53.3	4.3%	n.a	n.a

Source: For 2008 estimations Eurostat (STB).

Supply structure

According to ATECMA data, the Spanish aerospace industry employed 36,160 persons in 2008. Taking indirect and related employment into account this figure could be four or five times higher. The share of aircraft-related employment (civil and military) was 91%, 9% worked for the space sector. Aircraft and system companies accounted to 71% of the total workforce employed in the sector (Table 3.18). The high-tech character of the industry is reflected in the structure of employees. 42% of them are university graduates or similar diploma. Many of the manual workers who represent 48% of total employment have received training in sophisticated aerospace technology tasks.[92]

Companies and over 1000 subcontractors. Albeit following the ASD model, results deviate from published ASD figures. The idea is that ASD figures cover less of the Spanish AI sector than ACTEMA figures. The ATECMA figures are much higher than those of Eurostat because they comprise all employees in the value chain. Such a discrepancy exists between figures of the national associations and official statistics in most other Member States too. For a detailed discussion see: Annex 3.

92 Data are from ATECMA Statistics 2008.

In 2008 consolidated turnover based on ATECMA statistics had reached EUR 5,577 billion in the AI.[93] The greatest share of the turnover was allotted to systems and frames (Table 3.18). 54.7 % of the total consolidated turnover was generated in the civil sector, with the remaining 45.3 % generated in the military sector mainly in activities related to the Eurofighter Tycoon and the Airbus 400M projects (ATECMA, 2008). In 2008 the first two helicopters of Eurocopter have been delivered.

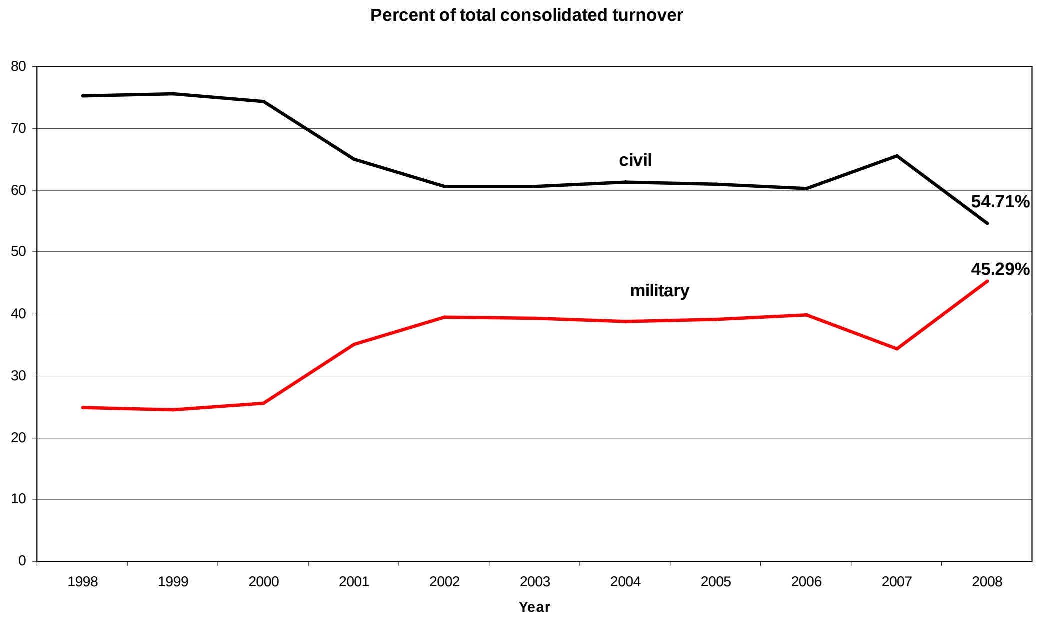
Table 3.18 The Spanish Aerospace Industry by Sector 2008

	Employment	Consolidated Turnover	R&D Expenditure
	Persons	Million EUR	
Total	36,160	5,577	540
	In percent of total		
Systems and Frames	71.0	69.6	76
Engines	6.5	11.4	9
Equipment	14.0	9.6	15*
Space	8.5	9.4	-
*** Equipment + Space**			

Source: ATECMA Statistical Information 2008.

The civil sector has remained the most important sector in Spain with 54.7% of turnover generated in this area. However, over the last one and a half decades the civil sector has lost much weight: in 1998 the share of the civil sector was three quarters of turnover (Figure 3.9).

Figure 3.9 Turnover of the Spanish AI by Civil and Military



Source: ATECMA Statistical Information 2008.

93 This figure differs from Eurostat and has been based on a survey of ATECMA among members.

Public policies

Since 2006, the Centre for the Development of Industrial Technology (CDTI), a Spanish public organisation under the Ministry of Industry, Tourism and Trade (MITT), is responsible for managing all R&D aeronautic programs under the responsibility of the MITT. In 2006 the CDTI prepared an Aeronautics Strategic Plan to optimise the government's policies for the next eight years. The main objectives are:

- To support integration capabilities in both aircraft and systems
- To strengthen the auxiliary and sub-systems industrial base
- To strengthen the Spanish traditional technological capabilities and diversify towards new promising areas
- To encourage the different Spanish regions to participate in aeronautics R&D funding[94]

Through the Strategic Plan the Spanish government attempts to raise turnover to over EUR 11,700 million by the year 2016, more than twice the 2008 value. The MITT is responsible for promoting and developing new opportunities within the aeronautics sector. The Ministry of Science and Innovation is in charge of developing and implementing the government policies in academia, scientific research, technological development and innovation in all sectors including public research centres (AERNET; Air TN, 2009).

The Aeronautics Strategic Plan intends to reinforce traditional technological strengths and to diversify towards new promising areas like UAVs, very light jets (VLJs) and alternative propulsion systems[95]. To meet the targets the budget for R&D schemes will be expanded from EUR 246 million in 2008 to EUR 550 million in 2016.

Beyond aeronautic industry-specific R&D schemes, that provide companies with loans and grants, companies can benefit from horizontal support mechanisms. This includes the CENIT programme, a financing instrument aimed at large-scale strategic projects subject to high technological risk, favouring collaboration between public and private institutions or venture capital for early stage technology companies.

Clusters of the AI

Aerospace activities in Spain are concentrated in the Madrid Region, Andalusia and the Basque Country. 94% of AI turnover is generated in these three regions, with 63% of aggregate turnover Madrid has by far the largest AI industry (Figure 3.10). Regional government policies were an important factor for the development of the AI in the Basque region. After the industrial crises in the region in the 1970s and '80s that mainly affected the steel and shipbuilding industries, the Basque government assisted companies to create an AI in the region. Before the 1990s the AI was virtually non-existent. SENER Ingeniera, an engineering, consultancy and systems integration company, founded in 1956 was for a long time the only company operating in the sector. SENER is the leading multidiscipline engineering company in Spain with a workforce of over 2000.

In the early nineties, the Industry Department of the Basque government had carried out a study to assess the competitiveness of the aeronautics industry in the Basque Autonomous Community and then invited companies to become part of an aeronautics cluster. In 1997, Hegan, the Aero-

[94] http://www.nlr.nl/eCache/AIR/12/129.pdf

[95] Data used by Ministerio de Industria, Turismo y Comercio, Invest in Spain.

nautics Cluster of the Basque Country, was officially formed. Beside major companies and numerous smaller manufacturers INASMET (representing the Basque Technology Centres) and the Engineering School of the University of the Basque Country (UPV-EHU) participated in the setup meeting. As a result cooperation within the cluster has been initiated with the creation of CTA (Aeronautics Technology Centre). Its main objective has been to carry out structural and fire tests.

In 2000 the region of Catalonia created a similar platform by launching BAIE (Barcelona Aeronautics and Space Association) to strengthen the regional AI. The organisation has been established to further cooperations. Currently BAIE counts more than 90 members. However, Catalonia has not caught up with the other, more important clusters.

With 21% of total Spanish aerospace turnover the AI in Andalusia is the second largest in Spain. The aeronautics cluster in Andalusia is made up of a few large facilities, among them factories of EADS-CASA, Airbus and Gamesa and a network of smaller enterprises. Most companies are located in the provinces of Seville and Cadiz. The importance of the region stems from participation in the design and production of the A380, final assembly of the Eurofighter Typhoon assembly of the Tiger helicopters and the final assembly of the A400M.[96]

To further strengthen the aeronautics sector the Regional Development Agency launched the Helice foundation in 2002, an initiative to improve collaboration of companies within the region. With the goal to promote the development of the regional AI, the Andalusian Foundation of Aerospace technology (FADA) was created in 2007. FADA manages the Centre for Advanced Aerospace Technologies (CATEC), which has boosted knowledge, intellectual property management and technological innovation. In an attempt to provide a physical infrastructure to cluster members close to EADS-CASA facilities in Seville the regional government created the technology park, Aeropolis.

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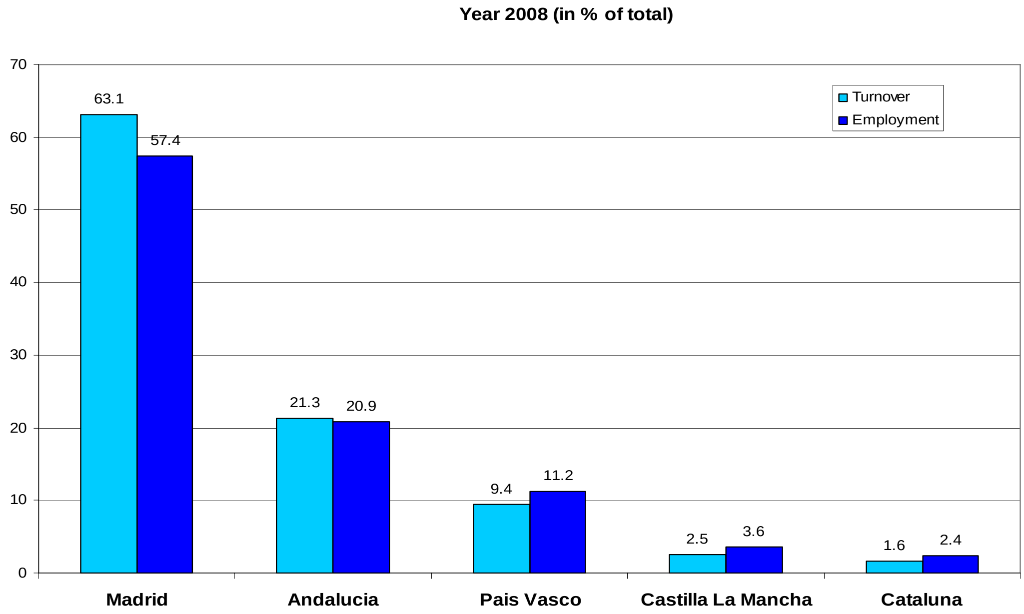
[96] Aguilera, C. M.. Castanedo, A.. Guerrero, F., 2006, in IFIP International Federation for Information Processing, Volume 224, Network-Centric Collaboration and Supporting Fireworks, eds. Camarinlia-Matos, L., Afsarmanesh, H., Ouus, M., (Boston: Springer), pp, 583-590 EADS-CASA was also responsible for project management, but due to the technical problems and the delays the responsibility has been assigned to Airbus.

Figure 3.10 Turnover and Employment by Region



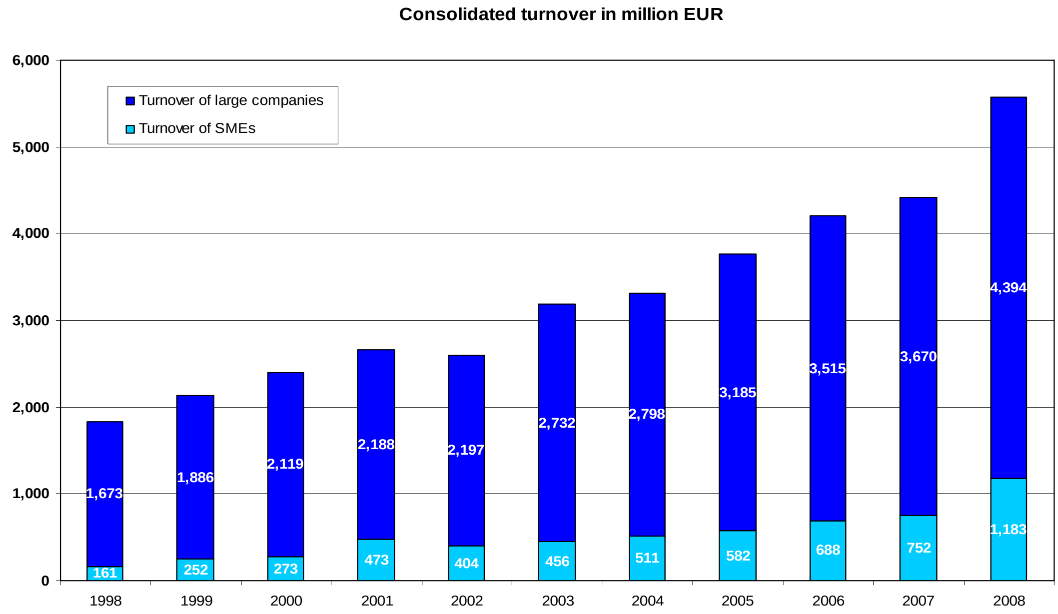
Source: ATECMA Statistical Information 2008.

Industry structure

Similar to other European countries smaller companies[97] have contributed to the development of the Spanish aerospace industry. In 2008 the Spanish aerospace industry consisted of 6 large companies with 1,000 employees and more, 11 companies in the range of 250 to 1,000 employees and 318 small and medium sized companies with less than 250 employees according to ATECMA statistical data[98]. In total 95% of the companies were smaller companies. The contribution of smaller companies[99] to the industry turnover (and employment) is growing. In 1998 around 10% of the total turnover came from the smaller or medium sized companies, but in 2008 this share has doubled (Figure 3.11).

97 Atecma, 2008.
98 Atecma, 2008.
99 Companies with less than 250 employees.

Figure 3.11 Turnover of Spanish Smaller Enterprises and Large Companies



Source: ATECMA Statistical Information 2008.

An overview on the structure of the Spanish aeronautic sector by its role in the value chain is provided in Figure 3.12.

Since the mid-nineties the aeronautic industry has followed a restructuring and consolidation process through mergers and the creation of new groups. The objective of these processes was to create leading firms with sufficient capacity and potential for the competition on the ever more competitive global market (Alfonso-Gill 2007, p. 144). In 2008 a considerable number of commercial alliances and integration between companies occurred. Companies tried to achieve the right size in order to remain competitive in a highly globalised sector (ATECMA, 2009).

In 1989, together with CASA and Rolls-Royce, SENER created ITP (Industria de Turbo Propulsores). ITP was dedicated to establish a Spanish manufacturer of aircraft engines and ITP has evolved to become Spain’s leading company in the field of aeronautical engines and gas turbines. Today, ITP is owned by Sener Aeronáutica (53,125%) and Rolls-Royce (46,875%). It has a turnover of EUR 447 million. Subsidiaries include ITR, a provider of maintenance and overhaul services and ITP Engines UK, a company dedicated to engineering services and the design and manufacture of turbo-machinery and aeronautical software.

In 1993 Gamesa Aeronautica was founded, the company’s name was changed to Aernnova. It is one of the most important Spanish firms in the aeronautics sector. The company won its first risk-sharing partnership contract with Embraer, already when it was established. Big OEMs, such as Sikorsky, Bombardier, Boeing (for the 747LCF and the 747-8) and Airbus (for the A-400M) have been clients. Since 2002 Aernova is risk-sharing partner for Airbus A380. The company designs, develops and manufactures subassembly structures for large civil aircraft. In 2007 Aernova had a turnover of EUR 396 million and employed 3140 people.

Figure 3.12 Structure of the Spanish Aerospace Industry

PRIME CONTRACTORS	**Complete integration capability**	**EADS-CASA** **Eurocopter**
OEMs – Original Equipment Manu-facturers	**Taking part in FAL.** **Intermediate added value products**	**AIRBUS, Indra, SENER, ITP, AERNNOVA, THALES**
SUBCONTRACTORS	**Systems or sub-systems manufacturers**	**Hexel, SACESA, CESA, ac (aries complex, s.a.), TECNOBIT**
AUXILIARY INDUSTRY	**Product manufacturers**	**Ca. 170 companies**

Source: Ministerio de Industria, Turismo y Comercio, Invest in Spain.

The Spanish AI is well positioned to respond to the increasing demand for composite materials in aircraft. Several research facilities specialised in carbon fibres are located in Spain. The Airbus Advanced Composites Centre in Toledo has been focused on the design and manufacture of curvature panels, and developed techniques to make possible carbon fibre fuselage sections for large commercial aircraft. In 2006, to concentrate the composite-related know-how in Spain a cooperation of the Spanish Ministry of Industry, Tourism and Trade, the Regional Government of Madrid and EADS created FIDAMC, the Spanish Composites Research, Development and Application Centre. The financing of the project was divided between EADS (50%), State and Regional governments (50%). FIDAMC explores emerging technologies to test their feasibility and their performance.

Hexcel, a world leading advanced structural materials company of the US, operates a facility in Parla. To meet the growing demand in prepreg (pre-impregnated materials: carbon-fibre reinforced resin materials used to produce aerospace components such as A320/A330 horizontal empennage and A380 rear fuselage section) it has added a new prepreg line at the plant in 2006. In 2008 Hexcel opened Spain's first plant to manufacture carbon fibre in Illescas, near Toledo (it was the first carbon fibre plant for Hexcel in Europe, the biggest manufacturer of CFK worldwide)[100]. The plant is close to the facility in Parla, where the carbon fibre from the Illescas plant will be converted into prepregs.

Conclusion

Spain is the third major shareholder of EADS and strongly involved in several large-scale projects. The Spanish aerospace industry has performed well over the period under consideration. Output grew by a double digit rate in constant prices between 2001 and 2008. A noteworthy restructuring of the industry has been taken place and the strategic positioning of companies has improved. This development is in contrast to other manufacturing industries, for instance the

[100] http://www.hexcel.com/News/Market+News/Hexcel+opens+first+carbon+fiber+plant+in+Spain.htm

automotive industry that has to struggle to maintain competitiveness in comparison with locations in the new Member States.

Although the Spanish AI has reported growing foreign activities and imports of intermediary parts and components, even from China, the Spanish smaller enterprises are perceived as better integrated in the international AI. The Spanish output share has increased significantly. This is partially due to heavy investments in the local AI. Hexel, the world biggest manufacturer of composites, has for example erected plants and participates actively in Spanish R&D projects. The investment conditions are not least thus favourable as the government heavily invests in R&D funding (budget doubling between 2008 and 2016) and provides financing instruments like the CENIT programme. However the labour cost increase counters this positive development and reduces Spain's currently still favourable local conditions.

3.1.6 Poland

Overview

Poland has a long history in aeronautics. In 1928 "Warszawa-Okecie" was founded, the first Polish manufacturer of airplanes.[101] Other companies followed suit, such as the Polish Aviation factory. During the World War II production sites were occupied and run by German manufacturers (Messerschmitt). After the war the Polish aerospace industry became part of the Warsaw Pact defence industry. The focus was on the production of jet fighters (MIG 15 and follow-up models), helicopters jet trainers and special purpose planes. Poland became a stronghold for the manufacture of engines, piston engines, turboprop, jet engines. The first jet engine was a replica of RollsRoyce dedicated to propel the initial MIGs.

The Polish aerospace industry has undergone a structural change after the breakdown of the communist regime. In former times most of the output was related to the defence industry and around half of these products were exported to the Soviet Union. The Polish aerospace industry lost its markets and the division of labour within the Eastern Bloc was dissolved. A conversion to general aviation and the opening up of new markets became necessary.

The first linkages of the Polish aerospace industry with Western companies have already been created during the Soviet era. In 1976 Pratt&Whitney started a cooperation with WSK"PZL-Rzeszow" S.A. for the production of jet engines. Today this company is 100% owned by the United Technology Corporation (UTC) via the Pratt&Whitney Corporation (PWC). Goodrich invested in the Krosno plant and produces landing gears for the US-Fighter F-16. It is envisaged that the landing gear for the successor will also be manufactured in Krosno. The largest Polish aircraft manufacturer, Polskie Zaklady Lotnicze PZL in Mielec, has been taken over by the Sikorsky Aircraft Corporation in 2007. The company supplies airplanes for special applications in fire fighting, agriculture etc. The company manufactures helicopters and in 2011 start with the production of the Black Hawk helicopter.

After the breakdown of the Iron Wall US companies were the first to heavily invest in the Polish aerospace industry. Today they command 40 to 50% of the foreign direct investment. In particular UTC has a big stake via its companies, PWC, PWC-Canada and Sikorski. From a Polish standpoint industrial investors from Europe were hesitating in the beginning.

101 2001 this company was acquired by EADS CASA and is run under the firm name EADS PZL "Warszawa-Okecie".

In recent years players from the old Member States have expanded their activities. Among them are most of the big manufacturers of France, Spain and Italy. German firms have increased investment in Poland. MTU does not only erect a plant but sets up a R&D-facility and wants to benefit from the know-how available in the region. Also smaller companies are investing in Poland, such as the family-owned and medium-sized German firm Remog. These investments are not mere relocations but are carried out to exploit growing regional demand induced by an emerging aerospace cluster. The French Safran Group is involved in Poland via its affiliate Hispanio-Suiza. It manufactures engine control systems, power electronics and actuators in Poland.

Performance

Up to now the Polish AI contributes only a small portion of 0.4% to the European industry's production. As compared to all of the Polish manufacturing industries its share does not exceed 0.5% of value-added. This means that the AI is not of outstanding importance for the Polish economy.

However it has been strongly growing, well above the EU27 average at an annual average rate of 7.9% between 2001 and 2008 in constant prices. Although, the transformation of the industry to a market economy has not yet been concluded and further structural change is necessary, the number of employees has grown in recent years caused by booming production. On average for the period under consideration the employment has stabilized between 2001 and 2008, because of a reduction during the early years under consideration. (Table 3.19)

Table 3.19 Operating Figures for the Polish Aerospace Industry

Poland		Units	2008	2001 - 2008 Change rate in %	Share of total EU27 2001	Share of total EU27 2008
Output	Production (constant prices)		0.5	7.9%	0.3%	0.5%
	Value-added (constant prices)	EUR billion	0.3	2.2%	0.7%	0.8%
Labour force	employees	1,000	14.7	0.0%	3.9%	3.9%
Productivity	Value-added per employee and year (constant prices)	1,000 EUR	18.0	2.2%	n.a	n.a
	Wage adjusted productivity	%	142%	-1.8%	n.a	n.a
Labour costs	Per employee and year (constant prices)	1,000 EUR	12.6	4.2%	n.a	n.a
Labour costs	Per employee and year (current prices)	1,000 EUR	13.5	6.6%	n.a	n.a

Source: UN Comtrade, HS 1996 (trade data), Eurostat (production data), own calculations.

However the Polish AI is extremely price competitive as compared with other countries' industries (Figure 2.14).

Supply structure

The AI manufactures a number of different products. There are some OEM products that were developed and designed in Poland and have been built and marketed, such as helicopters from Swidnik, fixed-wing aircraft for specific applications in agriculture, fire fighting, trainers etc. These aircraft are sold for civil and military applications.

The Polish AI holds a strong position in engine manufacturing, jet engines, piston engines and turboprop. There is a noteworthy foreign involvement in the production of jet engines. Strong knowledge in manufacturing and in material sciences provides a supportive environment. Recently facilities have been expanded.

The majority of output is intermediary products manufactured for big clients, such as landing gears. There is a common view of experts of the industry that the Polish AI should focus on intermediary products and take a cautious stance against the manufacture of OEM products.

Public policy

The Polish Aerospace Technology Platform (PATP) coordinates R&D activities in Poland. Moreover it is integrated in European networks, such as ACARE and brings Polish companies and other organisations into the European research networks schemes. The Polish AI has been involved in the 7th Framework Programme. The focus has been on flight physics, aerostructures, propulsion and avionics.

Poland has no explicit political aerospace strategy. However the importance of the industry is well-accepted and the Ministry for Science and Higher Education, with a focus on R&D, and the Ministry for Structural development, with a focus on regional- and infrastructure-development, provide support.

There is one high-tech R&D project to be mentioned that gets public support and links universities domestic and foreign companies, the research for the production single-crystal turbine blades. In this context industry's stakeholders pointed to one advantage of national funds, compared to European ones, based on more safety in intellectual property rights.

Clusters of the aerospace industry

Most of the aerospace companies mushroom in the south-east region of Poland, a European aerospace cluster east of Krakow, the only one in Poland. The bureaus of the Aviation Valley Association are located in Rzeszow (www.dolinalotnicza.pl) that is member of EACP European cluster network. Today it is a cluster of around 75 companies that are closely linked into the global value chain of the aviation industry. Its know-how bases are metallurgy, propulsion technology and metalworking. Parts and components for engines, gears, bearings with specific requirements on rigidity are manufactured above all for the big OEM in the US and Europe. Special purpose airplanes and helicopters are built and marketed globally. The transformation of the aerospace industry to a sector in a market economy environment had to meet several challenges:

- Privatization of the state-owned facilities,
- Create viable companies,
- Opening up of new markets,
- Shift most of the production to civil aerospace

The restructuring has not yet been concluded, although around 80% of the Polish aerospace production is already dedicated for civil markets. However, the remainder of 20% of the production utilizes less than half the capacities available for military purposes. This is remarkable because in recent years the booming demand for airplanes led to some bottlenecks in the civil sector, but the conversion of the military side did not make sufficient progress, caused by influential interest groups.

The socialist economy was not built on western style companies, but on production sites, research facilities and trade organisation. Therefore the transformation to a market economy did not only require the privatization of units, but to create viable companies with R&D departments and sales organisations. This has led to an innovation network that is not that strongly based on individual companies' in-house technological development than in Western countries. Universities and partly publicly funded research bodies play a more important role and are connected via the Aeronet Aviation Valley initiative.

Industry structure

The Polish aerospace industry strongly trusted on its technological competency and strived for integration into the global industry via cooperations and affiliations with big foreign groups and inward investment. The transformation has been successfully pursued with companies that have become suppliers in the value chain. However with Polish OEM manufacturers the transformation process turned out to be more difficult, although there have been competitive products available. The major problem was the marketing after the breakdown of the communist system. The companies have not been able to outbalance the loss of sales by gaining access to new markets because of the non-existence of an international sale- and service network.

Two OEM-manufacturers have not yet been privatized and the majority stakes are held by the government. There is PZL Swidnik, an OEM manufacturer of helicopters with around 3,000 employees and a track record of more than five decades international experience in this business. A tendering procedure has been opened. Several industrial and financial investors are interested in Swidnik. But it turned out to be a strategic decision with far reaching effects on the Polish aviation industry. In August 2009 the majority (87.6%) of PZL Swidnik have been bought by Agusta Westland (Finmeccanica Group). [102]

Many of the companies have remained small as compared to international standards. They do not possess a broad portfolio of technologies, but are strong in certain areas where they are specializing on. A typical company is ULTRATECH Ltd. that started production in 2000 and manufactures parts for the Boeing 737 landing gear that are delivered to the Goodrich plant in Krosno. Some companies are on the leading edge. As a consequence those firms are not able to become players on the higher levels in the supply chain pyramid. New forms of cooperations must be developed to strengthen the position of the Polish aerospace industry in the global market by the creation of sub-system suppliers. Mutual benefit is also expected from the growing interrelationships between the subsidiaries of the big European manufacturers that possess the means for a system or subsystem supplier and the smaller Polish manufacturer that do not own a broad portfolio of technologies.

The WSK"PZL-Rzeszow" S.A. uses a single crystal technology for the production of turbine blades. It is a licence based on US technology and licence fees are paid by the mother company PWC. WSK"PZL-Rzeszow" S.A. is involved in a Polish scheme together with universities and research bodies for the development of an own technology for the manufacturing of single crystal

[102] See: "Les Echos" (F), 19 August 2009, p.16.

parts. This activity is dedicated to catch up with most advanced producers of engines in the world who are also busy in the technology area. Poland is about to strengthen the position in the aerospace value chain by the use of own know-how. Within the broad range of activities in aerospace technologies the initiative in the area of composite materials are to be highlighted.

Outsourcing has become an important strategies for the bigger manufacturers in Poland who – during the times of socialism – had trusted above all on own production to be independent from insecure deliveries. More and more non-core activities and low value-added parts are procured from specialized shops from within Poland, but also from the Czech-, Slovak Republic and the Ukraine. More sophisticated and high-tech components are procured also from west European countries and the US. This concerns above all electronic and optical equipment.

The major deficit of Poland, in particular of the Aviation Valley region, is the poor infrastructure. It hampers above all outsourcing to neighbouring countries. Railways and roads are not up to European standards. In particular poor quality of north-south-linkages is perceived as a disadvantage for the integration in neighbouring AIs.

Conclusion

The Polish AI had early links to Western companies and already started to manufacture for P&W Canada decades ago. There are strong linkages to the US AI. Although in recent years the Polish companies have intensified their contractual relations to the European AI programs, the share of US FDI comes up to more than 40%.

The industry's privatization is not fully concluded, yet. It has turned out to be a difficult procedure, for instance with the helicopter manufacturing. However, even if the government is still involved in the management of several aerospace companies, there is no obvious political aerospace strategy in Poland.

As a legacy of the socialistic economy Polish firms are used to trust in external R&D. This is reflected in a well-elaborated infrastructure and cooperations with universities and independent research bodies.

There is a general tendency among companies to leave the OEM markets and become as a subcontractor an integrated part of the value chain.[103] This strategy requires an upgrade of the manufacturing processes and internal procedures for quality management.

Many Polish companies try to establish themselves in the manufacturing of more complex components instead of parts that only competes by low costs.

The Polish AI is strong in material sciences, mechanics and metal working. The current trend to upgrade production and supply has induced them to outsource some of their production to other countries with an even lower cost structure, in particular the Ukraine. Other outsourcing activities, e.g. in engineering services as has been reported for the Czech Republic have not been identified for Poland.

[103] An opposite strategic orientation has been reported for the Czech Republic where OEM-manufacturers increase their efforts to improve their position in this market.

The remote location of the Polish AI (in the south-east of the country) with respect to the European industrialized centres is perceived as a structural disadvantage. An improvement of the traffic infrastructure is perceived as necessary to strengthen the integration into the European AI. There are industrial linkages to Romania and to Finland.

The development of the Polish industry towards subcontracting activities in the value chain is not a general development within the new Member States. In the Czech Republic some companies pursue the opposite strategy and try to strategically develop their OEM business areas. Behind these companies are some investment funds, at least one with close linkages to Russia. This strategy turned out to be successful only with very light airplanes. Already in the size category of business jets more effort has to be spent.

3.1.7 Assessment of National Policies dedicated to the Aerospace Industry

All European Member States with a noteworthy stake in the AI assess this sector as crucial for the overall competitiveness of their economy. This view is driven by the knowledge of high-tech products and by the expectation of spill-over and spin-off effects to other industries. The AI is subject to public policies in these Member States and initiatives to be taken are directed towards an improvement of the competitiveness of the AI from the standpoint of the situation in this individual country and the needs of its important players.

However, Member States are aware that the efforts to be taken to play a major role in the global market cannot be provided by an individual Member State. This fact has also been acknowledged by stakeholders of the industry in France, the one country that has pursued a clear strategy to control all of the key-technologies for aircraft for decades independently. Only in recent years a rethinking of this strategic orientation has taken place. In spite of this objective France – as other countries too - has always been involved in cross-border activities, one of the most long-standing cooperations is of the German DLR and the French Onera.

The Member States have been busy in the creation of clusters or growth poles (a not that familiar expression these days). The investigation in public policies of the Member States under consideration in this section disclosed that there are numerous clusters in each of the bigger countries. In many cases the national clusters have evolved in parallel and measures to co-ordinate have been taken later on. As a consequence in most of the Member States there were some complaints on non-coordinated initiatives and the risk of double work. In France there exists a noteworthy division of labour between clusters and funds are provided for specific tasks. One might assume that this is an effect of the centralized structure of the public administration as compared for instance with Germany. In the United Kingdom the RDAs get funds for the development of their regional economy. This is evaluated as a potential risk for double work and the launch of projects with non-far reaching objectives. The Member States have perceived these problems and activities for the coordination have begun. In Germany the association of the industry, BDLI, has taken over the task that is not an easy one because of the federal structure of Germany.

The conclusion drawn from the investigation in public policies in the six Member States under investigation is that the governments pursue quite different strategies that to a certain extent suit to their institutional structure, in particular with regard to the regional orientation, but also to general guidelines of the economic policy. The advantage of Germany is its well elaborated R&D infrastructure with universities, private and partly private research bodies and testing facilities. Due to the federal structure smaller companies enjoy the advantage of the closeness to these establishments. The advantage of France lies in the coordination of public initiatives that is presumably best in Europe.

The United Kingdom has changed its policy directed towards the AI. The former vertical approach to support the AI was given up and since a couple of years a horizontal approach is pursued. From an economist' standpoint such a regulatory policy is welcomed. The British companies of the AI perceive this approach as a detriment for their longterm competitiveness in a global environment where vertical policies are the common for initiatives dedicated towards the AI. The situation is aggravated by the fact that the British R&D is compared to France and Germany poor.

Italy with its industrial backbone of smaller enterprises has lost much of its competitiveness in recent years. This is a challenge for the AI in an era of growing competitive pressure. Moreover the Italian AI is strongly dependent on the defence market that has come under pressure because of public budget constraints. This is mentioned as an important issue in the cooperation with Sukhoi that is dedicated to strengthen Italy's stake in the civil market. A second direction of development is pursued by support to companies that have the potential to become subsystem integrators. They shall provide opportunities to small firms to stay in the value chain.

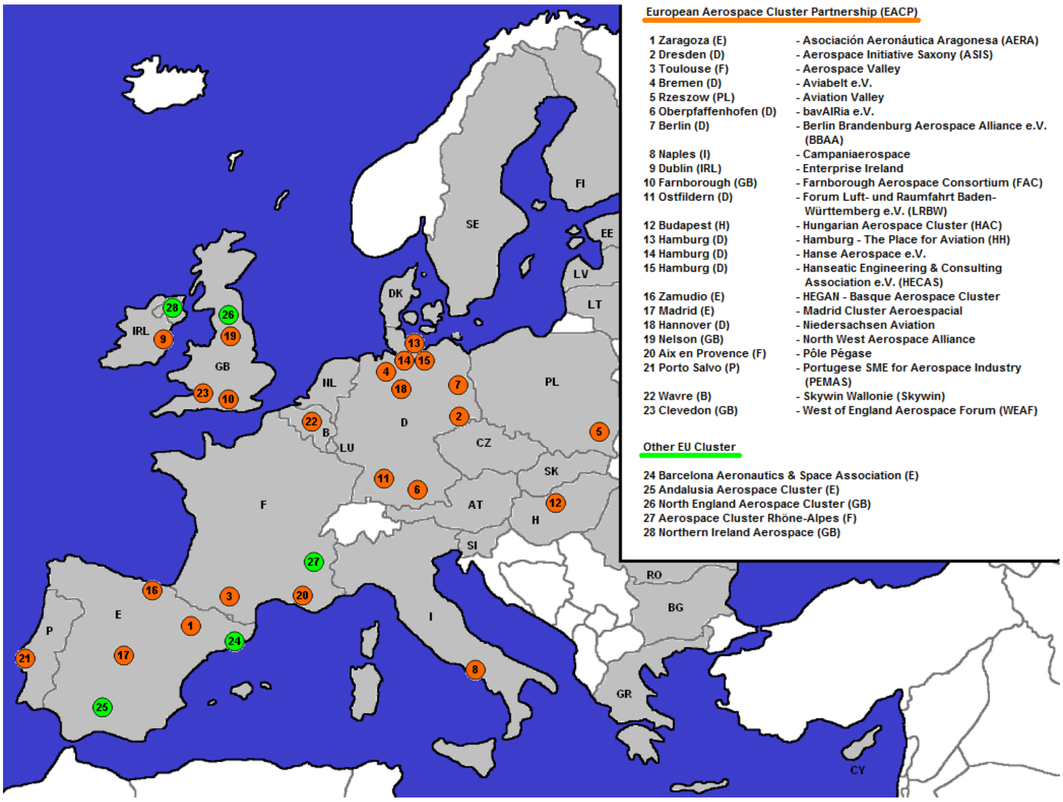
Spain has been extremely successful in recent years. Its stake in EADS and an industrial policy dedicated to grow an indigenous aerospace industry have become drivers of the development. However, as with other industries in Spain wage increases can turn out to become a detriment to the competitiveness of Spain as a production location. Because of the high growth in the recent past, problems have not yet emerged.

The European Aerospace Cluster Partnership (EACP) is one initiative that has been launched to better communicate among the Member States and has turned out to be viable in particular with topics related to employees of the AI (see: Chapter 4.1). There are 23 regional clusters linked together that are coordinated by the "Place for Aviation" Hamburg. Five additional clusters do not participate in the network (Figure 3.13)

Another European platform available for the coordination of regional activities is the European Research Area (ERA).[104] It is dedicated for researchers to interact seamlessly cross-border. The platform follows a horizontal approach and is open to R&D personnel of all sectors.

104 http://ec.europa.eu/research/era/index_en.html

Figure 3.13 Cluster of the European Aerospace industry



Source: EACP; own recherché.

3.2 Companies Behaviour

The structural change of the AI and the pattern in companies' behaviour can only be properly understood if one takes into account the environment in which the AI is working. Following the most important areas are mentioned that are perceived as drivers for companies to take decision on market and procurement strategies.

3.2.1 Changing Market Environment

Since around two decades the competitive pressure in the AI's markets has been permanently increased, although the sales markets have shown a strong trend growth.[105] In the market for large civil aircraft (LCA) a duopoly is caught in a tough competition, each player is eager to stay on the leading edge. Both companies are backed by strong public support. Other players are eager to tap into this market and expand their product programmes to bigger types of aircraft and add to the competition in the lower end of the market segment. Moreover, emerging economies, in particular the BRICs, recognise the key importance of the aerospace industry as a driver of high-tech innovations and their relevance for many other industries. They have put into effect strategic programmes for their national AIs. They strive for cooperations with the advanced industrialized manufacturers and for this purpose they exploit their advantages of cheap resources, not only in blue-collar labour but also in engineering and design capacities.

105 Average annual growth rate for passenger jet deliveries between 1996 and 2005 is 7.88% (calculation based on data from Rolls-Royce Market Outlook 2006 – 2025).

The cyclicality of the demand for aircraft and the long-cycles, with long-lasting upswings and respective phases of stagnation or even a reduction is a challenge for the AI. These fluctuations are contrary to the fact that the industry needs a highly qualified staff on all levels. As a consequence long-term employment policies are necessary for a sustainable level of competitiveness.

The OEM manufacturers have tried to meet this challenge by risk sharing along the value chain. However, Boeing was the first to pursue an extreme approach to focus its own activities on system integration only and to shift much of the production, design, R&D as well as the integration of subsystems to companies in the value chain. The structural change is an evolving and ongoing process towards high specialisation like in the automotive industry during the preceding decades (see A.T. Kearney, 2003). The Boeing initiative was intended to exploit unused efficiency potentials, but contained also a lot of risks.

The results as far as they have become public in connection with Boeings Dreamliner project are sobering. Massive delays have been reported and the coordination along the value chain has turned to be extremely difficult[106]. In spite of all these problems the Boeing concept is perceived as a necessary development by competitors of the industry. It has become the predominant strategic option that will change the value chain more than other concepts in the years to come.

The European OEM-manufacturers have observed the US initiative and – in spite of the ambiguous result – become convinced that they have to pursue a similar restructuring of the supply chain. They have increased their efforts to exploit the opportunities and put additional pressures on the suppliers. The supply chain managers of the OEMs are convinced that they have learned from Boeing's experiences and will be able to introduce a new supply chain management and structure of deliveries with less friction. However, in course of the current and ongoing problems with the final assembly of the "Dreamliner" B787, which are among other things caused by coordination problems with suppliers, Airbus should become aware of the associated risks of such a model. It remains to be seen, whether the European competitor can learn from the American example and avoid similar pitfalls.

3.2.2 Procurement Strategies of OEMs

EADS with Airbus is by far the most dominant European player of the AI. Its procurement policy is of outstanding importance for companies in the value chain and the majority of them will have to adapt to the related requirements. The EADS/Airbus sourcing strategy focuses on four major goals: improve market access (meet offset obligations), value to cost (low cost production), access to resources (raw materials and human capital), and the risk management (e.g. currency volatility). In consequence the share of non-EU procurement has to rise and risk sharing partners have to assume the responsibility for larger subsystems and equipment workpackages.

Manufacturers in other market segments, such as business and regional jets, helicopters and engine manufacturing, do not necessarily follow the EADS/Airbus example. In fact it was reported that some of these companies rely on in-house production and their know-how in key compo-

[106] As a consequence of the ongoing delays in the launch of the Dreamliner 787 Boeing reintegrated a Vought Aircraft Plant to accelerate productive and efficiency improvements to ramp up production. Additionally it was reported that Vought was overcharged with the financial burden based on the risk sharing agreement arranged with Boeing. See: Joseph Weber, Boeing Buys a Vought Aircraft Plant, in: Business Week, 7 July 2009.

nents and manufacturing technologies. However, even these companies are changing the structure of the supply chain to raise efficiency potentials. The measures they take are not contrary to those taken by EADS/Airbus. However the Airbus/EADS approach is more stringent with to focus its business on system integration and to reduce its dependency from the Euro. Therefore the outline of what EADS/Airbus envisages provides insights in the changes other companies have to expect.

One important topic lies in the reduction of the threat by exchange rate variations. The market of aircraft is like many other globalized markets based on the USD as the majority of aerospace products are paid in USD. However, a large fraction of the occurring production costs of European firms (including the wages) are paid in Euro, which exposes the respective firms to significant currency risks. It can be expected that this will not change in the foreseeable future. Most of the big clients, the airline operators, are also calculating in USD, not only the fuel but also tickets in international trade. Two options are used to reduce the risk. The first alternative is risk sharing with suppliers. The second is the increase of global sourcing (see section 3.2.4).

The risk sharing with suppliers is based on contractual agreements on USD invoicing. 1st tier suppliers distribute their risk further on to 2nd tier suppliers. Currently a distribution to higher levels is not widespread and strongly depends on the financial performance and the kind of integration of a company in the value chain. In the near future it is envisaged to increase the procurement volume for propulsion up to around 75%. Other procurement areas, such as equipment and aerostructures follow suit but it will take some time until a similar portion of the procurement volume will be invoiced in USD. However it is already envisaged to shift the USD exchange rate risk for the A350 procurement to 0% by USD invoicing with suppliers up to 100% in most of the procurement groups, propulsion, equipment and aerostructures. This means that 100% of the “flying parts packages” will be subcontracted in USD. Only in other areas of procurement, such as engineering a noteworthy share will remain subcontracted in USD.

3.2.3 Patterns of Interaction in Different Segments of the Supply Chain

OEMs such as Airbus pursue general strategies for the procurement and organization of the supply chain. However, the patterns of interaction are distinct between the different segments of the supply chain.[107]

Aerostructures and final assemblage
The production of aerostructures is characterized by high manufacturing costs reflecting the labour intensity of the manufacturing processes. With high labour costs in the West, the location of final assembly plants in the USA (Boeing), France and Germany (Airbus) is difficult to justify on efficiency grounds alone. Companies in this market segment are not only expanding assembly lines abroad to attain market access, but to reduce dependency of the euro and to take advantage of lower labour costs. Airbus has recently opened an assembly line in Tianjin, China, which has been accompanied with a sales contract of the A320 for the Chinese market. The assemblage in China is an important step and provides experience in the set up of a production line in a low wage country. Although the productivity there is low yet, scale and learning curve effects will improve the performance in the coming years. However, the increasing use of composite material

[107] See: IATA, 2006.

may change the current trend in production relocation, as the processing and use of new materials cannot rely on well proven and experienced processes and requires high engineering potential.

Engines

A particularity of the segment is the high share of MRO as a percentage of total sales. The largest part of revenue and profit margin for the large manufacturers of propulsion systems comes from the sale of spare parts, the rent of engines and maintenance, and thus the after-sales market. The after-sales services generate two to three times the value of an engine sold to a client during its lifetime. The activities of the engine manufacturers are strongly linked to the activities of airlines, in particular since the appearance of maintenance contracts based on flight hours instead of maintenance hours.

Big consortia characterise the supply chain. Cooperations allow the engine manufacturers to share risks and development costs. The importance of the after-sales services has an impact on the interaction between the companies in the engine value chain. It is characterized by more stable and long-term cooperations than in other segments of aerospace value chains. This characteristic is perceived as a factor that contributes to the assessment of experts of the AI that the value chain in the manufacturing of engines is exemplary efficient.

Landing gear

The supply of landing gear for LCA is in the hands of a duopoly between Messier-Dowty (a subsidiary of Safran) and Goodrich. They offer the complete range of landing gears and are the principal suppliers to Airbus and Boeing. Liebherr, the third player in the sector, is producing landing gear for regional and business aircraft. In the medium term Liebherr may be pushing for a market share in the market for LCA, thus destabilising the duopoly. This is suggested by the successful acquisition of important contracts in this segment.

The segment's cooperation with OEMs is strong since the landing gear needs to integrate in the structure of the aircraft. The landing gear may even be designed by the OEM. Like the propulsion system, the landing gear needs maintenance. The plane is immobilised 3-5 days in 10 years for repairs and replacements of landing gear equipment. Services make a noteworthy share of total sales. For instance services make up 48% of landing gear activity for the Safran Group.

Steering

Avionics represent 30-35% of the development costs of a commercial aircraft and only 10-15% of production cost (because of the complexity of the design and testing of new concepts, whereas the automation of the production process is higher than in other segments of the AI supply chain, close to the level of automation in the electronics industry). The steering represents an important part of avionics, making up 2% of the price of an aircraft and 20% of the price of avionics. Like other avionics systems, the steering is characterised by small production costs relative to development costs.

Nacelle

The nacelles are the interface between various parts of an aircraft. Producers need to adapt the nacelles to different engines and types of aircraft. As a result cooperation between the producers of nacelles, engine manufacturers and OEMs are close. Before delivery to the final assembly, the engine is integrated to the nacelle. Similar to the landing gear supply chain, the supply chain for large nacelles is characterised by a duopoly of Safran/Aircelle and Goodrich. Like for other aeronautic components, there is a development towards increased use of composites for the nacelles.

However, due to the proximity to the engine the nacelles bear some particularities and require specific expertise.

3.2.4 Supply Chain Evolution and Sourcing Activities

The factors that explained the evolution of the horizontal and mainly the vertical relations in the past (see: Chapter 1.3) will also be the relevant drivers for the future: The technological level is so high, that there is no single technology that will drive future developments. In contrast, new aircraft will probably be more influenced by innovations between the various systems and by manufacturing technologies. The substantial costs associated with new developments will therefore lead to a further widening of the collaboration network already found in the sector.

In addition, the manufacturers face more financial pressure from the airlines, who themselves have been put under more competition following the ongoing liberalisation of the markets since the 1990s. The new competitors from China and Russia will also force the industry to focus on core competencies to preserve technological leadership. The ability to manage the complex supply chain will become increasingly crucial for this.

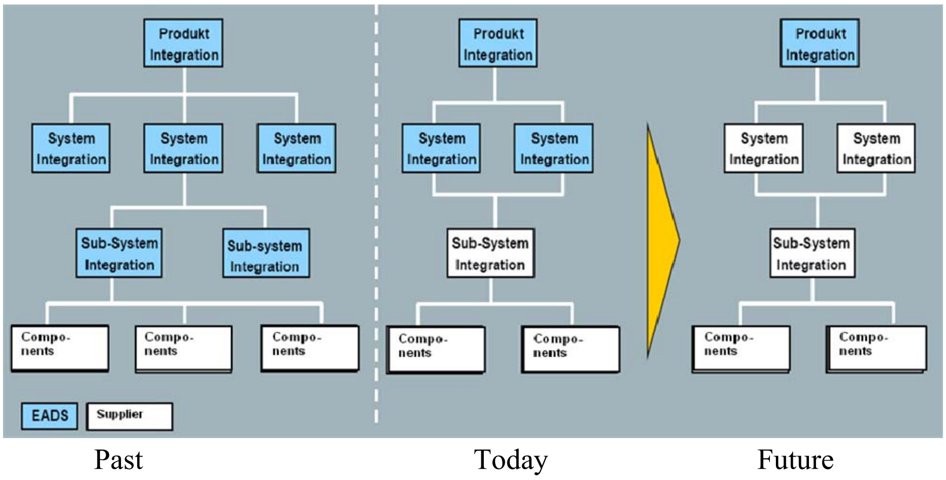
Reorganisation of the supply chain
As described above, the industry is still in the phase of the creation of a cooperative supply chain. However, whereas in the 1990s the industry has mainly been driven by cost reductions considerations within the supply chain. It now becomes more and more important to secure quality and grab various strategic chances offered by specialised firms all over the world and the potential market access offered by these firms.

The new organisation will be characterized by the following aspects (See: Figure 3.14):

- An increasing **focus on product integration** for leader firms like Boeing and Airbus (moving closer to a "total" system integrator and lifecycle value provider role). They will move their core technology towards programme coordination, final assembly and interaction with the market (airlines, governments, etc.).
- A **reduction of suppliers** to cut transaction costs and to consolidate suppliers for a stronger financial backbone to finance necessary investments.
- Further **shift of responsibilities and risks** to first tier suppliers. Suppliers moving from short term service providers to long term partners. The result is that the suppliers have a serious possibility to move up in the production pyramid. They will no longer be only engaged in technical problems, but also in the management of the significant technological and production process. Their supply activities are therefore evolving from a mere production of parts and components to the offer of a service (from production to the service phase, comprising maintenance, repair and operations for airlines).
- Suppliers must **provide detailed product information** (deeper than today). Selling black boxes is impossible.
- **Establishment of supplier networks** through adoption of information technologies enabling network wide connectivity for coordinating complex interdependencies. To exchange data with a common tool will be mandatory at a worldwide level.
- **Further internationalization** to take advantage of international diversity and expertise.

As a consequence of the OEMs' increasing focus on product integration they try to spin off business units and production sites. Airbus sold locations in France, Germany and the UK to manufacturers in the supply chain. This has turned out to be difficult in some cases. Airbus spun off Aerolia (F) and Premium Aerotech (D) into independent companies for sale, but no investor was found. Currently Airbus is busy to strengthen the strategic position of both of these companies and to prepare them for trade sale. (Figure 3.14)

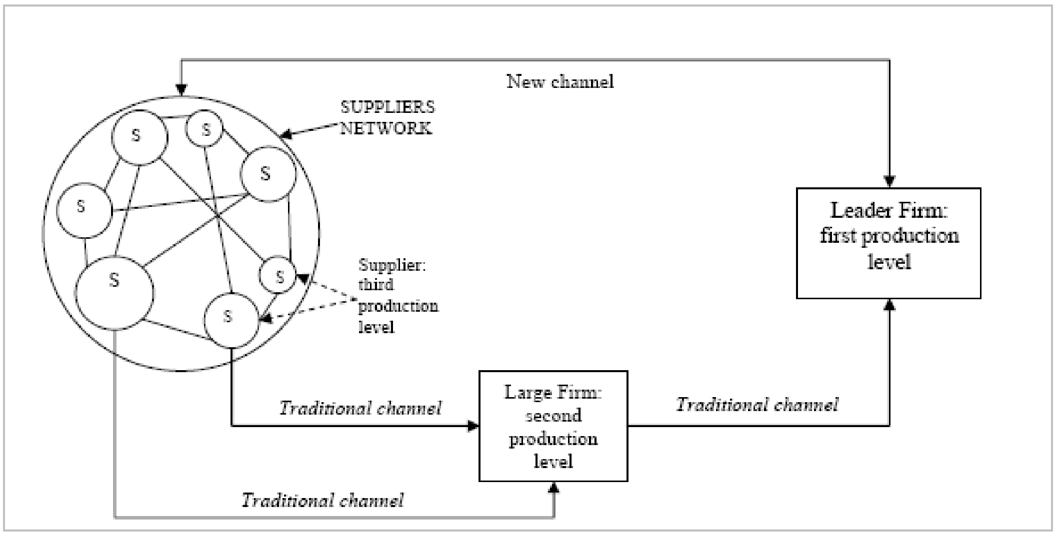
Figure 3.14 Changes in the Structure of the Supply Chain



Source: Presentation by EADS/AERVICO 2007.

In this context, the suppliers need to reduce costs, improve the technological level and guarantee a higher quality and service level to the customer. These changes are particularly challenging for small and medium western firms, which have been operating in the sector for quite some time. These factors are pushing the suppliers towards the creation of supply networks, which incorporate various skills and competencies to meet customers' requirements. Within these networks the leader firm will directly communicate with lower tier suppliers, creating a new channel of interaction. The model will change from a linear one to a more "unstructured", network like model. (Figure 3.15)

Figure 3.15 Network Like Model of the Supply Chain



Source: Esposito and Raffa, 2006.

It is essential for these new supplier networks to be efficient, robust and competitive. The management of the supply chain needs to be build on simple processes, monitored by Key Process

Indicators (KPIs) and must be suited to the relevant business models (civil, military). It must be robust in the sense that it must resist to a failure of one of its elements, which implies careful anticipation and risk management. In addition the networks need to be competitive, which means that there is an industrial maturity reached from the first item produced. The management must be devoted to continuous improvement of productivity and needs to react and adapt fast to changing environments.

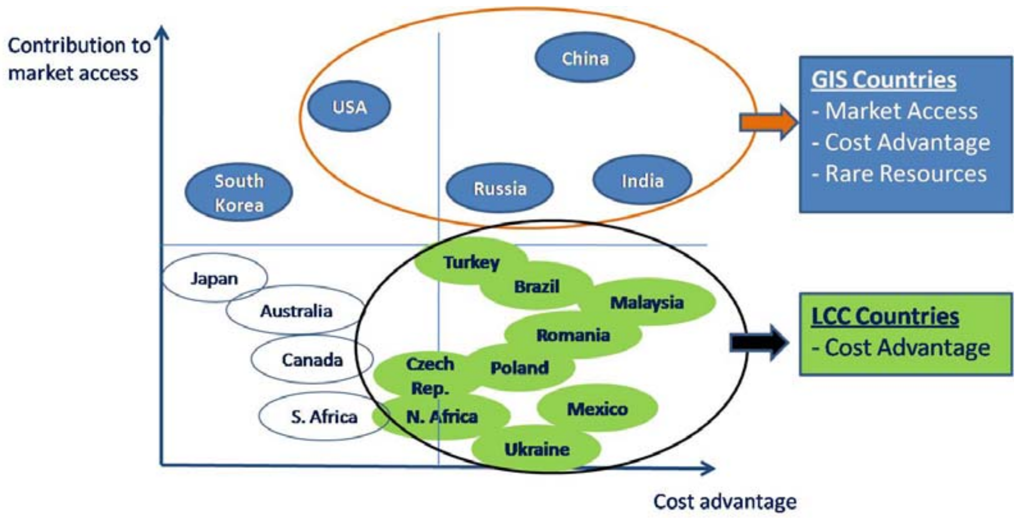
Sourcing activities

Sourcing describes all parts of value-added from outside the respective company, in particular procurement of single parts or whole sub-systems to be integrated in an airplane. In the past decade the vertical range of manufacture has decreased substantially. Within the EADS, for example, the value-added-share was at 60% in 1990 and has shrunk to merely 20% today. A major reason for this development is the tendency to concentrate investment in core competence areas and to source other activities out to other companies. As the complexity (of subsystems and their interaction) constantly rises, the integration is regarded as such a core competence of the major aircraft manufacturers.

More than half of outsourced activities are in the areas of complex systems, equipment and structures. Production material and product related services account for about 10% respectively and the final quarter consists of indirect, non product related activities.

The EADS has set up a Vision 2020, which gives a target for global (non-European) sourcing of 40%. Major reasons are primarily market access (sales support and offset) and risk management (currency, wages, supply chain) and to a fewer extend the access to rare resources (raw material, engineering) and production in low cost countries (high value for cost). Currently more than three quarters of its purchasing volume comes from within Europe while European sales represent only 40% of sales volume (whith a decreasing tendency).

Figure 3.16 Regional Distribution of Global Procurement and Objectives

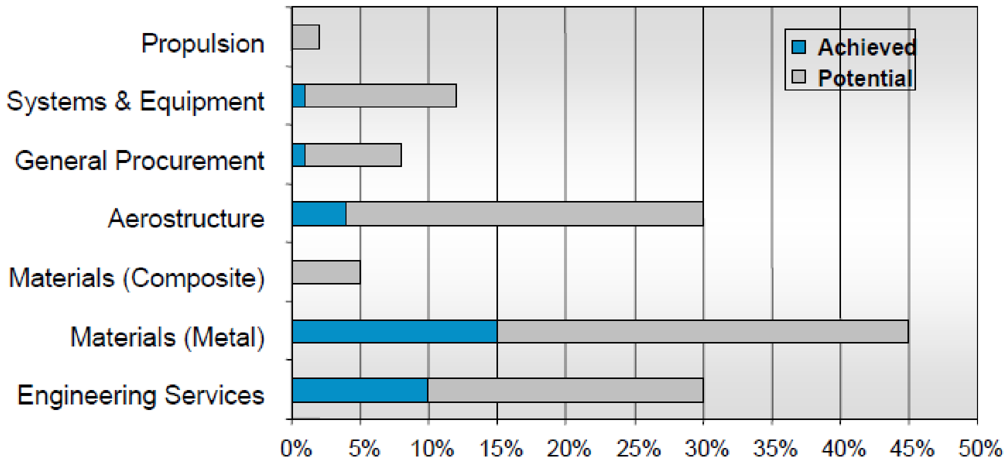


Source: EADS.

Priority sourcing countries following a “Global Industrial Strategy” (GIS) are USA, China, Russia and India. Sourcing candidates mainly for low cost reasons are Turkey, Brazil, Malaysia and Romania (See: Figure 3.16).

Major potential for sourcing activities can be seen in aerostructure, materials and engineering services (see Figure 3.17).

Figure 3.17 Global Sourcing Potential by 2020 – Tier 1+



Source: EADS.

3.2.5 Extent and Role of Smaller Enterprises in the EU Aerospace Sector

Smaller enterprises play an important role in the European aerospace industry. Figure 2.12 shows the European aerospace companies per size class and country, which gives an impression of the relative importance of smaller enterprises (SMEs): 80% of all aerospace companies have fewer than 50 employees and are therefore categorized as small, 9% are between 50 and 250 employees, which attributes them the size category medium[108]. This large share of smaller enterprises gives an idea on how many niches and special, complex tasks can be found in this industry. However, the mere amount of smaller companies is not enough to describe their role and importance. In terms of input or purchasing volume share for the large OEMs the smaller companies play an important supporting role, but they are not the key players.

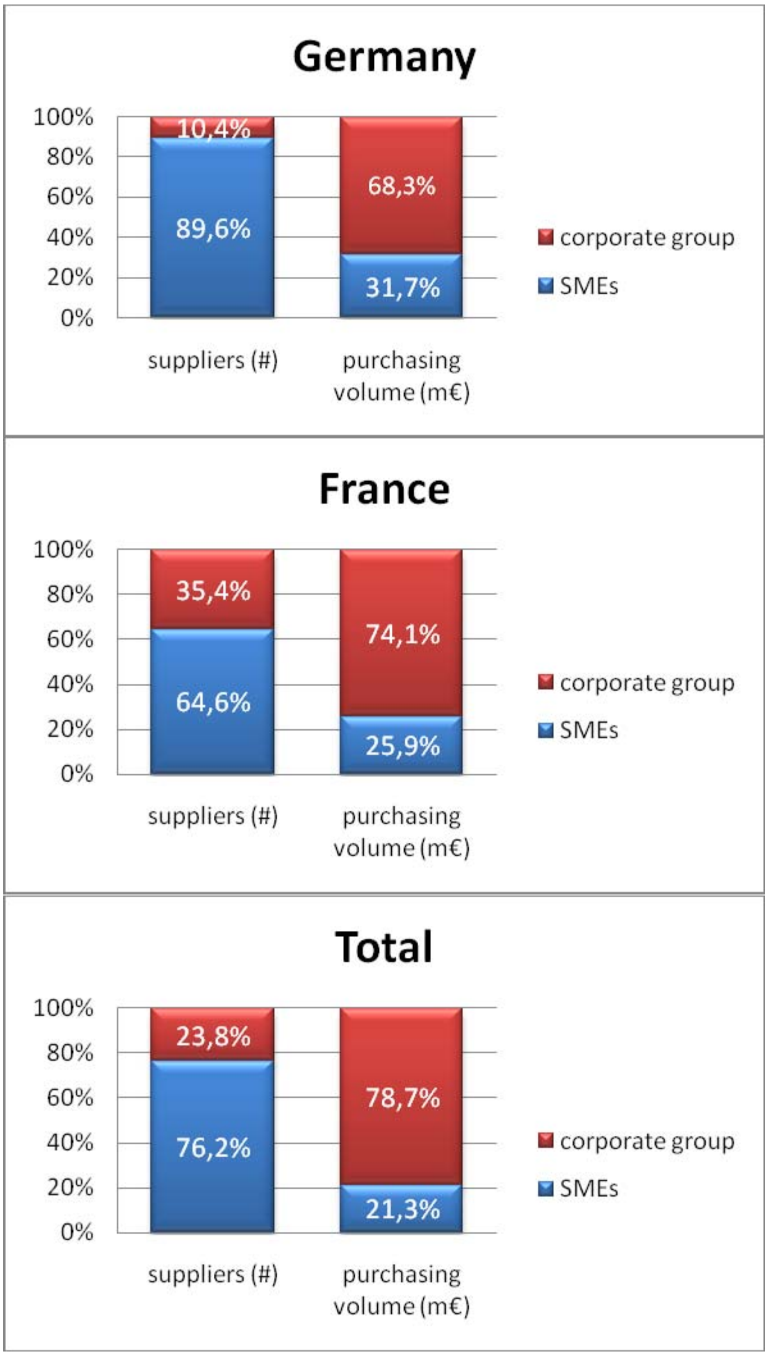
There are numerous smaller companies that are driven by high-tech activities and supply parts and components that contribute much to the manufacture of advanced aircraft. Although many of these companies do not fall under the definition of smaller enterprises used by the European Commission or national authorities they are small by international standards and as compared to other companies in the aerospace value chain. Such firms play a more prominent role in the European AI than in the US, where the consolidation process of the AI has been pressed ahead much further. This European particularity can turn out to become a risk if such medium-sized drivers of technology are taken over by foreign players. The access to know-how and corporate strategies from the standpoint of the non-European owner can weaken the position of the European AI. The most recent example for such a threat is the acquisition of the Austrian FACC, a know-how driven company in composites that has been taken over by the Chinese Xi’an Aircraft Industry Company Ltd.[109]

108 EU Member States traditionally have their own definition of what constitutes an smaller enterprise, for example the traditional definition in Germany had a limit of 250 employees, while, for example, in Belgium it could have been 100. In 2003 the EU has standardized the concept (in Recommendation 2003/361/EC) and categorizes companies with fewer than 10 employees as “micro”, those with fewer than 50 as "small", and those with fewer than 250 as "medium".

109 FACC wird “chinesisch”, in: Der Standard, 3 October 2009, http://derstandard.at/fs/1254310502021/Flugzeugzulieferer-FACC-wird-chinesisch?sap=2&_pid=14299530.

For the major European aircraft manufacturer, EADS, the share of smaller enterprises in the total amount of suppliers varies from 65% in France to 90% in Germany (with an average of 76% on the worldwide purchasing structure of EADS). However, the purchasing volume is clearly dominated by large corporate groups (68% in Germany, 74% in France and 79% globally) (See Figure 3.18).

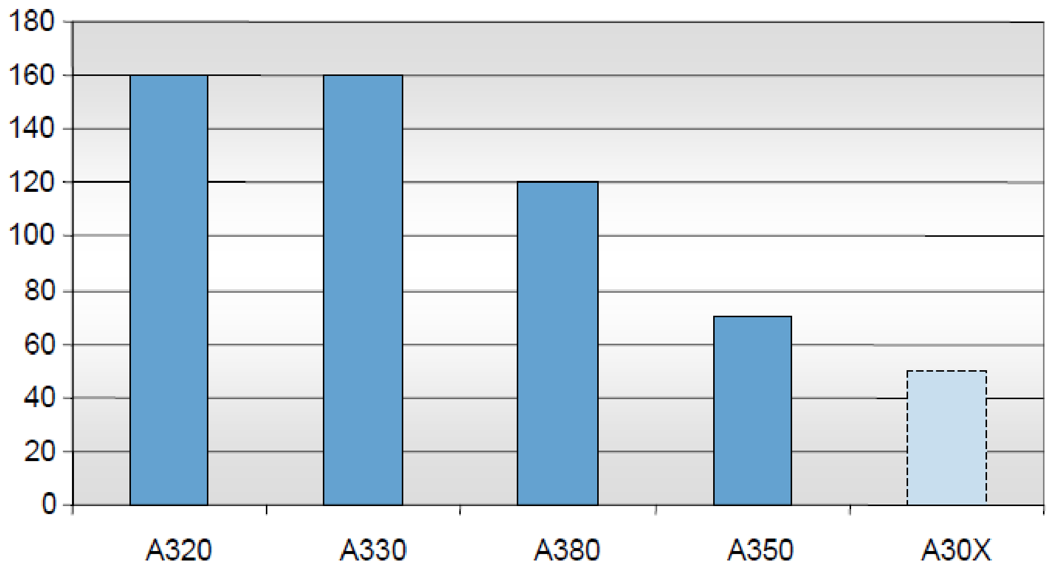
Figure 3.18 EADS Supplier Structure in Germany



Source: Based on EADS Presentation “AerViCo”, 2007.

The increased outsourcing activities (of Boeing and Airbus alike, which are on the one hand intended to reduce the amount of complex tasks for the OEM and to allow a focusing on core competencies, but which increase on the other hand the coordination complexity) induced a consolidation pressure for small suppliers. Small companies with specialized (niche) products but small production volumes are now in a situation where they have to provide complete subsystems in order to stay inside of the relevant aircraft programs, because Airbus intends to reduce the average equipment work-packages within its programs and intends to increase their respective size (see: Figure 3.19).

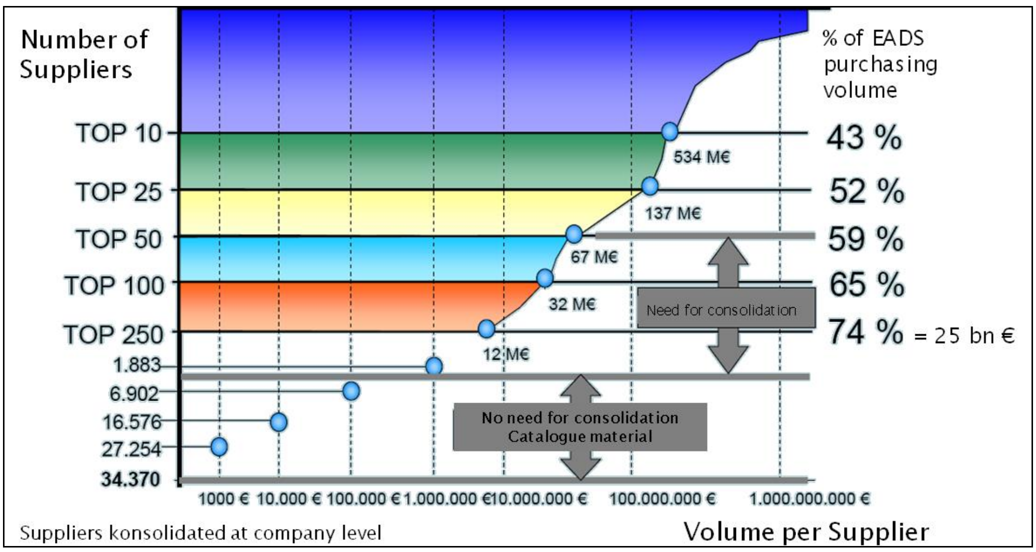
Figure 3.19 Average Number of Equipment Work Packages on Airbus Programs



Source: EADS.

Figure 3.19 illustrates the profile of all EADS suppliers by purchasing volume in 2006, where the segment with "need for consolidation" is explicitly marked.

Figure 3.20 Profile of EADS Suppliers in 2006



Source: Based on EADS Presentation "AerViCo", 2007.

3.3 Subsectors of the Aerospace Industry

3.3.1 Large Civil Aircraft

Traditionally the market for civil, commercial aircraft is split between manufacturers of large jet aircraft above 100 seats, serving primarily international air carriers, and manufacturers of smaller turboprop and jet aircraft below 100 seats, whose customers are primarily regional air carriers and business aviation. Large civil aircraft (LCA) can also be differentiated between narrowbody or single-aisles aircraft (100-230 seats)[110] and widebody or twin-aisles aircraft (>230 seats)[111]

While the market for smaller air carriers features about a dozen manufacturers, the market for large civil aircraft is highly concentrated. Since 1997, when Boeing bought McDonnell Douglas, the market is dominated by the duopoly between Airbus Industries (Toulouse, France) and Boeing Commercial Airplane Company (Seattle, Washington, USA). The aircraft manufacturers of the former Soviet Union, in particular Tupolev and Ilyushin, have lost their previous impact as their former customers now prefer western made aircraft. In 2006 they have been merged to the state owned United Aircraft Corporation (UAC, or OAK in Russian language), see Chapter 5.2 on Russia. The next two paragraphs give a short outline of the two (currently remaining) dominant players in this market.

Key players
Boeing (founded in 1916 as Pacific Aero Products Company by William E. Boeing in Seattle, Washington) has expanded over the years, became the largest global aircraft manufacturer by revenue, orders and deliveries and is the largest exporter by value in the United States. It has a broad product portfolio of commercial aircraft with a transport capacity of 90 seats (B717) to 450 seats (B747).

Airbus, in the meantime Boeing's main competitor, began as a consortium of European aviation manufacturers in 1970 in order to establish a counterbalance to American companies like Boeing, McDonnell Douglas, and Lockheed. A consolidation of European defence and aerospace companies and the formation of EADS[112] around the turn of the century allowed establishing a simplified joint stock company in 2001, owned by EADS (80%) and BAE Systems (20%). After a long sales process BAE sold its shareholding to EADS in 2006, which makes Airbus a 100% subsidiary of EADS. Its product portfolio ranges from aircraft with a transport capacity of 107 seats (A318) to the largest passenger airliner in the world, the A380, with 555-853 seats.

Market shares: status and outlook
In recent years Airbus has successfully challenged Boeings role as the largest manufacturer of commercial aircraft, as Figure 3.21 illustrates.

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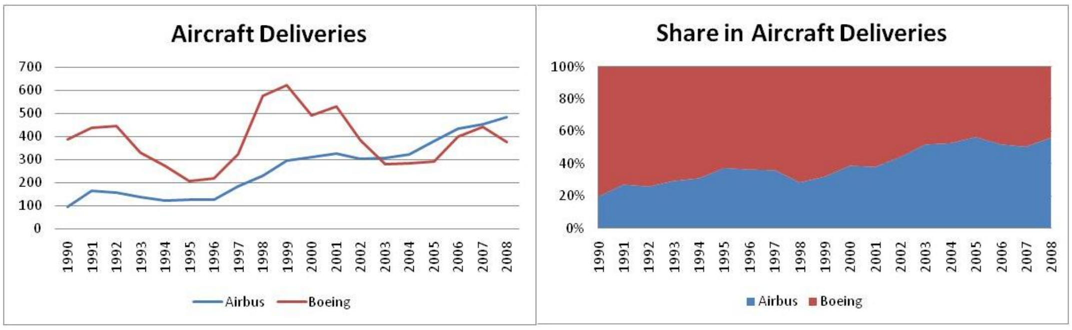
[110] The most common narrowbody aircraft are: the Airbus A320 family, Boeing 707, 717, B727, B737, and B757.

[111] Typical widebody aircraft are: Airbus A300, A310, A330, A340, A350, A380, Boeing 747, 767, 777, 787, Ilyushin Il-86, Il-96, Lockheed L1011 Tristar, McDonnell Douglas DC-10, MD-11.

[112] The European Aeronautic Defence and Space Company N.V. (EADS) is the largest European aerospace corporation, formed by a merger on 10 July 2000 of DaimlerChrysler Aerospace AG (DASA) of Germany, Aérospatiale-Matra of France, and Construcciones Aeronáuticas SA (CASA) of Spain. The company develops and markets civil and military aircraft, as well as communication systems, missiles, space rockets, satellites, and related systems. The company is headquartered in the Netherlands in Schiphol-Rijk and operates under Dutch law.

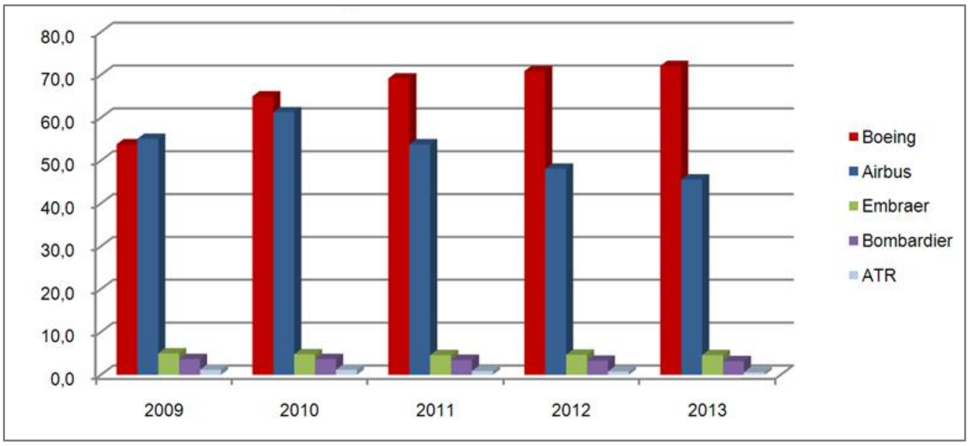
Figure 3.21 Large Civil Aircraft Deliveries: Airbus and Boeing



Source: Data from Airbus and Boeing Websites.

However, Boeing is expected to come back in the coming years. Despite the current delay problems of the Dreamliner (B787), this aircraft not only exhibits a huge order stock, it also arrives several years in advance compared to its Airbus counterpart, the A350. This is a major reason for many forecasters to see Boeing regain a dominant position in terms of market share (see Figure 3.23).

Figure 3.22 Structure and Value of the Business Aviation Market

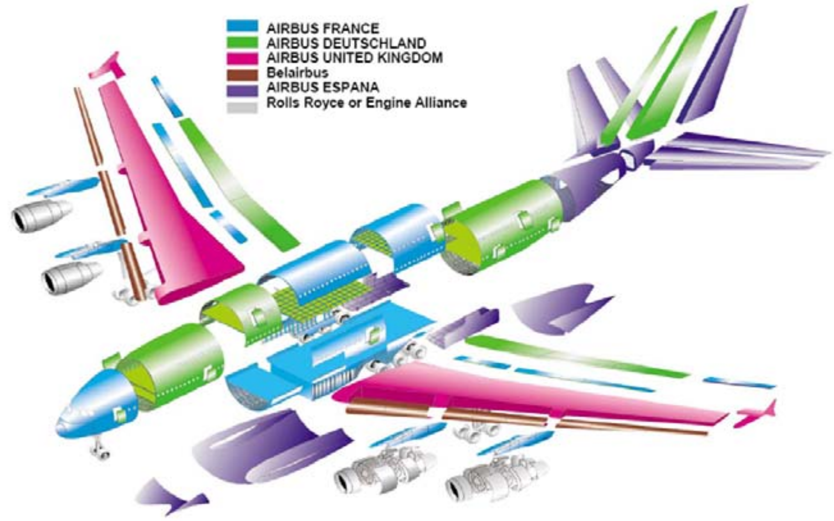


Source: Aerospace Source Book 2009, Aviation Week, 26 January 2009.

Supply chain management

The production of the new Airbus A380 will serve as an example to illustrate the linkages and complex dependencies between European manufacturing sites. As in case of the A380 (see Figure 3.23) one can generally observe a similar pattern in the work share of European Airbus manufacturing sites: France and Germany share the fuselage construction, the United Kingdom is specialized in wing manufacturing, and Spain primarily focuses on tail, fin and pitch elevator.

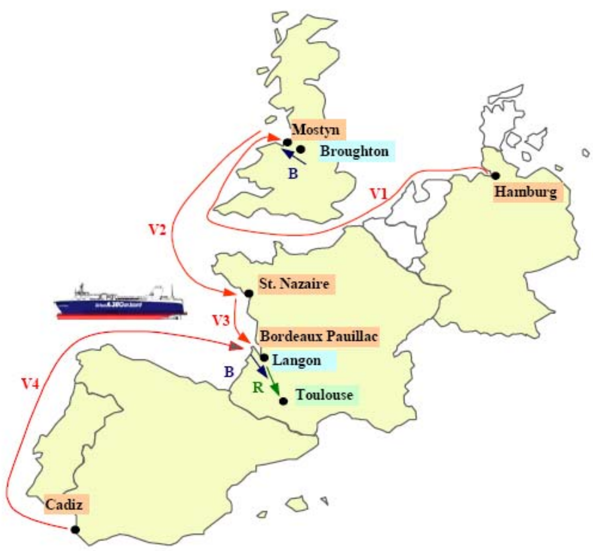
Figure 3.23 A380 Components and Respective Manufacturing Country



Source: Airbus.

After being constructed at several European manufacturing sites, the single components of the A380 are shipped to Bordeau Pauillac in France, where they continue their journey on a barge along the river Garonne until the village of Langon, and further on a lorry in four stages to the final assembly line in Toulouse (see Figure 3.24).

Figure 3.24 Transport of A380 Components to the Final Assembly Line



Source: Airbus.

This process illustrates how far-reaching the consequences of delays or even manufacturing errors on one of the production sites can become.

Boeing, which has, compared to Europe, traditionally less experience in managing the coordination and assemblage of several prefabricated subsystems, has made a risky step towards a new, global supplier base, which goes far beyond the traditional European model. The wings are for example produced in Japan (by Kawasaki Heavy Industries and Mitsubishi Heavy Industries) as well as single fuselage parts (the centre wing box by Fuji Heavy Industries, the forward fuselage and main landing gear wheel well by Kawasaki Heavy Industries). Other components stem from Italy (the centre and aft fuselage as well as empennages are made by Alenia Aeronautica SpA), as well as Australia (wing flaps), China (rudder), Israel (flooring), Sweden (doors) and several other countries. This strategy, which was intended to shift risk and costs towards the suppliers, turned out to be a high risk strategy, as it increases the related imponderabilities, reduces the direct control over the whole production process and aggravated the delays of the 787 programme, which is described in the following subsection.

The new programs

The B787 "Dreamliner"

The currently dominant project, which is now under development at Boeing Commercial Airplanes, is the 787 Dreamliner, a mid-sized, wide-body, twin-engine jet airliner. In terms of pre-launch orders it is the most successful civil airplane ever, with a total of 850 orders by 56 customers as of June 2009. It will be the first major airliner to use composite materials for most of its construction.[113] Boeing built and tested the first composite section while examining the Sonic Cruiser concept nearly five years ago. However, it was suggested by many, such as former Boeing senior engineer Vince Weldon that the risks of having a composite fuselage have not been fully assessed and should not be attempted.[114]

Beside the safety concerns, composite materials also induced some problems in the production process, which was one cause for delays in the launch time schedule.[115]

Boeing decided to change its basic assembly approach beginning with the 787. Rather than receive individual parts and assemble them in Everett, Washington, Boeing assigned its subcontractors to do more assembly themselves and deliver completed subsystems. Boeing would then perform the final assembly. The basic idea of this approach was to get a leaner and simpler assembly line, a lower inventory, as well as reduced risks and costs. However, its success depends on the degree to which suppliers can perform the extra work and some subcontractors have had difficulties completing the extra work, which was another cause for the subsequent delays.

Boeing premiered the first 787 at a rollout ceremony on July 8, 2007 (matching the aircraft's designation in the US-style calendar date format: 07/08/07). However, some of the aircraft's major systems had not been installed at that time, and many parts were attached with temporary non-aerospace fasteners requiring their later replacement with flight fasteners. Boeing had originally planned for a first flight by the end of September 2007, but current delay has accumulated to more than two years by now. This has resulted in a windfall for Airbus, which has contributed to a record A330 demand in the last two years. It is likely that some of Boeing's penalty payments related to 787 delays have been going directly to A330 leases, as many of these orders have gone to leasing customers.

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113 Its materials are (by weight): 50% composite, 20% aluminum, 15% titanium, 10% steel, 5% other (see: Hawk 2005), but measured by volume the composite share is at 80%. Composite materials (mostly carbon fiber reinforced plastics) are significantly lighter and stronger than traditional aircraft materials.

114 The concerns comprehended the facts that carbon fibre, unlike metal, does not visibly show cracks and fatigue, it includes a higher risk of lightning strikes, and problems with a crash landing as the composite fuselage could shatter and burn with toxic fumes.

115 E.g. two huge composite sections (the Wing Box, made by Mitsubishi and the Center Wing Box, made by Fuji) sustained damage after they were joined together when the wings were flexed in. This caused some sections of the wing structure to disband, which was a major reason for delaying the first flight. Interviewees reported that Boeing has major problems with the fitting accuracy of segments that needs a redesign of the concept and puts the whole industrial manufacturing process into question.

The A350 Program

The direct competitor of the B787 (as well as of the B777) is the Airbus A350 XWB, a long-range, wide-body airliner, which is supposed to be available in 2013. In this programme Airbus has turned to U.S. rather than European companies for most of the key strategic manufacturing contracts. The value of the work which has been made public (in mid 2009) is slightly more than USD 24 billion. This represents 80% of all awarded contracts. U.S. companies are now the lead strategic partners of Airbus in the fuel, hydraulics, and avionics sector on the A350 XWB program. Many US suppliers of major subsystems provided already much of the equipment on the Airbus A380. Examples are Parker (fuel), Hexcel (carbon fibre structures), Rockwell (communications equipment), and Hamilton Sundstrand (cabin pressurization system).

This decision to rely on many US suppliers is partly a result of the experience these manufacturers have gained in developing lighter systems for the 787. In addition the USD/EUR exchange rate fluctuations, which pose a major problem for Airbus, are effectively hedged by giving work and therefore a higher USD-based cost share to US companies and are in line with Airbus strategies outlined in its Vision 2020. The first flight is scheduled for 2011, while first deliveries are planned for 2013. At the end of August 2009 there were 493 firm orders from 30 customers.[116]

The next Single Aisle programmes

The successors for the most successful aircraft programs of both firms, the A320 family and the B737, have been more and more postponed. Early announcements assured first deliveries for the middle of the coming decade, but more recent statements (from Airbus) deny its availability before 2020. As the A320 enjoys a considerable margin over the next generation 737 in terms of sales, it is widely assumed that Boeing will take the lead for the succession programme. The code for Boeing’s new airliner will be probably “797”, while Airbus still keeps the working titles “A30X”, “Next Generation Single Aisle” (NGSA), or “New Short Range” (NSR).

A major and often cited reason for the postponements is that the current technical progress (primarily in terms of fuel savings) is not high enough to justify a replacement. Airbus has been evaluating new configurations through both internal research and the European Union-funded Nacre (New Aircraft Concepts Research) project.[117] However, the performance improvements of at least 15%, as required from several customers, are not foreseeable. This pessimistic view primarily relates to the airframe as new engine concepts like the Geared Turbofan promise double digit improvements in fuel efficiency and emissions as P&W puts it (see: Chapter 3.4.6).

Another reason for both manufacturers to postpone the development (beside the currently pressing other problems of stabilizing the production of the A380, and bringing forward the programmes of the A400M and the B787) can be seen in the large order backlog for both airliners (> 1,500 for the B737 and >2,400 for the A320). An early announcement of the successor could encourage the clients to (cancel existing orders and) wait for the next generation of the aircraft. However, this strategy may ease the market entry of new competitors from emerging markets (see the next paragraph) as well as from established manufacturers of regional aircraft upcoming with larger airplanes (e.g. Bombardier’s CSeries). Furthermore, it compromises the achievement of the environmental goals set by ACARE.

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116 See: Aerospace America, May 2009, “Airbus looks to U.S. for A350 XWB suppliers”for the US outsourcing strategy, as well as the Airbus website (http://www.airbus.com/en/aircraftfamilies/a350/) for current orders.

117 Through Nacre, Airbus assessed forward-swept wings, rear-mounted turbofan and open-rotor engines, and vertical tailplanes. So far, the company has been reluctant to name the most promising technologies. The EUR 30-million program ended in spring 2009.

The A320 successor is supposed to be assembled in Hamburg, Germany.[118]

Arising competition

The Chinese Commercial Aircraft Company (COMAC, a subsidiary of AVIC, established on May 11, 2008 in Shanghai) announced at the Asian Aerospace trade fair on 8 September 2009 a model of its "C919" airliner. The C919 is a 130-200 seat commercial aircraft currently under development. China hopes to build it in time for entry into service in 2016. According to COMAC assistant general manager Wang Wenbin there will be two variants: a standard model with a range of 4,075km (2,200nm) and a long-range model able to fly 5,555km. It is supposed to need 15% less fuel compared to an Airbus A320. This improvement is primarily due to the associated next generation engines that are competing for the C919: the CFM International Leap-X, and the Pratt & Whitney PW1000G, which both promise a substantial efficiency increase. Airbus has not yet decided which engine type will power its New Short Range.

Europe's competitive position

Europe has been very successful in the past four decades in bundling its efforts and competencies in order to challenge the dominant players in the US. From a technological point of view it has been proved that the US players have lost their former systematic advantage and that Europe is able to produce the most competitive large civil aircraft worldwide, at eye level with their US counterparts, and partially above. In the best selling segment, the single-aisle short range, the A320 is currently perceived as more advanced than the competing B737. But as times go by and a program for a successor (of both competing models) has not been launched, the risk grows that emerging competitors try to counter the success of this "bread-and-butter" aircraft.

However, in the years to come it is expected that Boeing will be able to reconquer the former leading position, primarily with the sale of the "Dreamliner". Despite the current problems with its 787 production, Boeing has gained more experience in handling composite materials than any other player in the market. Furthermore Boeing is perceived to have a better corporate financial structure and certainly a better access to the US defence market.[119]

The decision of Airbus to procure a higher share of its deliveries for the A380 and the A350 from the USA has been driven by different factors. Among them is "natural" currency hedging an explicit strategy, but also the reliance of companies, which are experienced with lightweight (composite) components. However, interviews suggest that it is also a question of production capacity: some European suppliers cannot involve themselves in several aircraft programs at the same time.

Boeing has pursued an aggressive strategy and tried to push forward simultaneously the application of advanced technologies, such as CFK and to increasingly rely on a new, global supply base. This high-risk-strategy has raised a lot of problems and some of the organizational changes in the value chain had to be reversed. As a consequence the more cautious stance of Airbus has paid out in the short-term. However this should not deny the necessity for Europe to increase the

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118 However, on 2 September 2009 the French newspaper "La Tribune" wrote that Airbus considers building two versions of the future A320, a single aisle and a twin aisle. This could challenge the previous decision to assemble the A320 successor exclusively in Hamburg, as Toulouse has more experience with the manufacturing of large fuselages.

119 See: Aerospace America, May 2009, "Airbus and Boeing: Beyond head-to-head" See: also Chapter 2.2: The return on shareholders funds for European companies is lower, but the Return on Capital Employed (ROCE) is higher. This suggests that the financial position of the Big European players is not worse than their US counterparts.

efficiency of the value chain, although that turns out to be difficult in a political environment where Member States have a close look to employment effects.

As a general result for the sector of large civil aircraft (LCA) one can conclude that both players will face several common challenges, which are primarily backlog management, setup and execution of pending programs, and (in the medium to long run) coping with new competitors. Both players will exploit their know-how for design and manufacture of LCAs to gain the lead in the duopoly and to maintain their competitive edge against emerging manufacturers. A question of strategic importance will be – under the assumption of a constantly increasing size of new aircraft programs with simultaneously scarcer resources – whether they decide to stay in all LCA market segments as they are defined today.[120]

3.3.2 Regional Aircraft

A regional aircraft is a smaller airliner designed to fly up to 100 passengers on short-haul flights, usually feeding larger carriers hubs from small markets. This class of airliners is typically used by the regional operators that are either contracted by or subsidiaries of the larger airlines. Feederliner, commuter, and local service are all alternate terms for the same class of flight operations.

The market for smaller turboprop and jet aircraft for 100 seats and below (regional aircraft) is mainly divided by three suppliers: the French-Italian firm “Avions de Transport Régional” (ATR), the Canadian “Bombardier Aerospace”, and the Brazilian “Embraer”. It was only in the past decade that jet-propulsion became economical for smaller aircraft, which was an improvement in passenger comfort, cruise-speed and perceived safety. Other suppliers, which have failed to adapt this technology early enough (Fairchild Dornier and de Havilland) or who failed to differentiate their product in a type-family (BAe British Aerospace, de Havilland, Fokker) have either suffered bankruptcy or have left the market for regional jets. However, in context of rising kerosene prices the adoption of (more economical) turboprop[121] aircraft becomes again a relevant option for many airlines.

Key players
Similar to the fierce duopolistic competition of Airbus and Boeing in the large civil aircraft market is the regional jet manufacturing competition between Bombardier Aerospace and Embraer.[122] The dominant regional aircraft families are the Embraer Regional Jet series ERJ and the newer E-Jets as well as the Bombardier CRJ programs.[123] These aircraft were originally intended to be used for direct airport-to-airport flights, bypassing hubs, and led to industry-wide discussions about the decline of the hub-and-spoke model, which has not taken place so far.

Bombardier Aerospace is a division of Bombardier Inc, a Canadian conglomerate with products in the sectors aerospace, railway technology, and financial services. It is the third largest aircraft

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120 See: for this issue also the paragraph on new programmes in the next section “Regional Aircraft”.

121 Turboprop engines are a type of aircraft powerplant that uses a gas turbine to drive a propeller.

122 There is even an analogy to the current WTO dispute between Airbus and Boeing: both Bombardier and Embraer were engaged in a subsidy dispute in the late 1990s and early 2000s. It was found by the WTO, in a 2000 ruling, that Embraer has received illegal subsidies from the Government of Brazil. Therefore the WTO ordered Brazil to eliminate its Proex export subsidies program, which was found to aid Embraer. On 19 October 2001, the WTO ruled as well against Canada (as before against Brasil and Embraer) over low interest loans from the Canadian government designed to aid Bombardier in gaining market share.

123 Bombardier's twin-engine Canadair Regional Jets (CRJ) and Embraer’s ERJ 145 family both became best-selling programmes due to low operational costs and a longer range, which was enough to fill routes, which were previously only served by larger aircraft.

company in the world in terms of workforce, and the fourth largest in terms of yearly delivery of commercial airplanes (behind Boeing, Airbus and Embraer). The core of Bombardier Aerospace is established by Canadair, a formerly national Canadian aerospace company, which was privatized and sold to Bombardier in 1986. The acquisition of Short Brothers plc, a British aerospace company, in 1989 further extended Bombardier's portfolio.

Embraer, short for Empresa Brasileira de Aeronáutica, S. A. (English: Brazilian Aeronautics Company, Inc.), is a Brazilian aerospace conglomerate. The company produces commercial, military, and corporate aircraft, and provides related aerospace services.

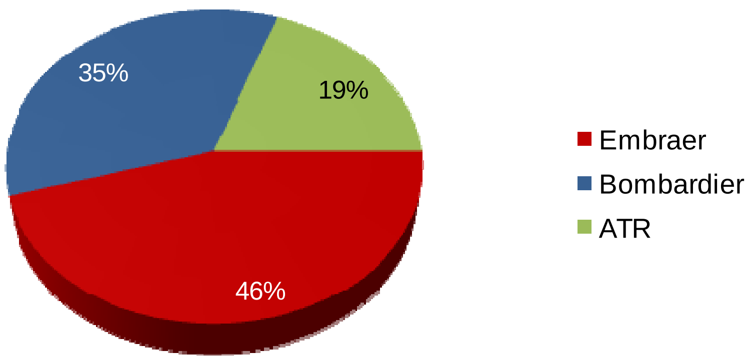
The third relevant player is the European manufacturer Avions de Transport Régional (ATR), a joint-venture of the French Aérospatiale (today EADS) and the Italian Aeritalia (today Alenia). It was formed in 1981 and resides in Toulouse-Blagnac, France. Its primary products are the twin-turboprop, short-haul regional airliners ATR 42 (for 40-50 passengers) and ATR 72 aircraft (for up to 74 passengers in a single-class configuration), which had together 998 orders and 837 deliveries by August 2009.

Market shares: status and outlook

Beside the two dominant American (but non US) players there is also one European competitor, holding about a fifth of the shared market. Figure 3.25 shows the market share between the three dominant players as a percentage of the 2009 market (338 aircraft). The market shares give an even higher concentration when based on the market value of USD 9.9 billion, where Embraer receives 50.5%, Bombardier 37.4%, and ATR 12.1%.

The market for turboprops has experienced resurgence around 2004, due to general air traffic trends, high fuel prices and the need for regional airlines to cut costs and reduce fares - particularly in the face of low-cost carrier competition. This was particularly relevant for ATR, the major European manufacturer in this segment. Looking to take advantage of the increased market interest, ATR has announced improved, -600 versions of its ATR 42 and ATR 72, and is accelerating design studies into a family of 70-98-seat turboprops for service entry in the second half of the next decade.

Figure 3.25 Regional Aircraft Market Share between Largest Three Players in 2009 by Units



Source: Aerospace Source Book 2009, Aviation Week, 26 January 2009.

According to Forecast International[124] the dominance of Embraer is supposed to increase in the following years up to 52.4% (by units and even more by value) in 2013. Bombardier will keep its share and ATR will significantly loose and end up with 13% in 2013 (by units or 7.1% by value).

The new programs

In general the demand for regional jets continues to shift upward to larger-capacity aircraft—from the once-dominant 50-seaters, to 70-seaters and now to aircraft seating 90 passengers and more. Bombardier had been betting that Airbus and Boeing will abandon the lower end of their market segment (e.g. the B717 with 90 seats or the A318 with 107 seats), which would create a market opening for its yet-to-be-launched CSeries. Airbus sales for the smallest single-aisle aircraft, the A318, have been relatively weak, and airlines have been gradually shifting to larger models throughout the narrow-body product range.

With a regional jet product line that extends to 122 seats, Embraer is well-positioned to exploit this trend in the market. The company has displayed no desire to expand seating capacities beyond 122. Meanwhile, its Canadian rival, Bombardier, has launched the 100-145-seat CSeries family. Having reached the design limits of its existing CRJ regional jet series with the 100-seat CRJ1000 model, Bombardier had to launch a new programme if it wanted to compete in the market above 100 seats. It has sized the CSeries not only to take on the largest Embraer jets but also to challenge the Airbus A319 and Boeing 737. The Bombardier CSeries is a family of narrow body, twin-engined, medium range jet airliners with the two models CS100 (110-seats), and the CS300 (130-seats). Bombardier launched (or restarted) the program in 2008 for an entry into service in 2013. The CSeries is designed for the 100- to 149-seat market category, which is estimated by Bombardier at 6,300 aircraft representing more than USD 250 billion revenue over the next 20 years. Bombardier expects to be able to capture up to half of this market with the CSeries. The features of the aircraft include a higher usage of composite materials (46%), a lower cabin altitude and larger windows. The use of advanced materials should allow for a 15% lower seat-mile cost and a significant reduction in maintenance costs. Together with the Mitsubishi Regional Jet it is the first aircraft to use the Pratt & Whitney Geared Turbofan (PW1000G), see Chapter 3.3.5. Furthermore Bombardier has launched the Q400 Next Generation airliner, an improved version of its Q400 70-seat turboprop, and is continuing studies for a 90-passenger version called the Q400X.

Arising competition

The Chinese COMAC (the Commercial Aircraft Corporation of China, a subsidiary of the city of Shanghai and AVIC, the state owned Aviation Industry Corporation of China) is currently building the ARJ21-700, a 90-seat regional aircraft. The first customer delivery will be in late 2010 and so far (Sept. 2009) COMAC has orders for 208 ARJ21-700s.

The Mitsubishi Regional Jet (MRJ) is a passenger jet aircraft seating 70-96 passengers to be manufactured by Mitsubishi Aircraft Corporation, a partnership between majority owner Mitsubishi Heavy Industries and Toyota Motor Corporation. It would be the first airliner Japan has designed and produced domestically since the 1960s. A cabin mock-up and a scale model were presented at the Paris Air Show in June 2007. The first flight is envisaged for 2011, production is planned to begin in 2012 and first deliveries are expected for 2013. Mitsubishi expects a total demand in this size category of 3000 jet aircraft and expects to gain a market share of one third.

[124] See: Jaworowski, 2009 (b).

The Russian Sukhoi Superjet 100 is a modern regional jet in the 75- to 95-seat category. Sukhoi is a subsidiary of the state-run United Aircraft Building Corporation, but 25% of its shares are owned by the Italian company Finmeccanica. The jet is therefore being developed in collaboration with Finmeccanica's subsidiary Alenia Aeronautica. It is designed to compete against the Embraer E-Jets and the Bombardier CRJ programs, while Sukhoi claims that its Superjet 100 will have 10-15% lower operation costs than its Embraer or Bombardier counterparts. The aircraft is currently still in the certification process, but it has received 143 fix orders and 80 options (resulting in 223 total orders) by June 2009. Thirteen planes are currently (June 2009) under construction, and the first four were supposed to be handed over to clients by the end of 2009. However, problems with equipment suppliers will delay the first deliveries until 2010.[125] After 2012, the company expects to build 70 Superjets per year.

Europe's competitive position

The largest European player ATR relies on more conservative technology than its larger competitors. The newest generation of the -600 series (ATR 42-600 and ATR 72-600, announced in Oct.2007) will be introduced during the second half of 2010. Composite materials make up 19% of the total weight of the ATR 72-600 structure, compared to 46% in the Bombardier CSeries. Furthermore the company continues to rely on turboprop propulsion, which has the drawbacks of reduced passenger comfort, cruise-speed and perceived safety, but counts on the advantage of better fuel efficiency. A strong increase in future jet fuel prices may concede a point to this strategy, but in general one has to realize that in the near future Europe will play a minor role in this market segment.

3.3.3 Business and General Aviation

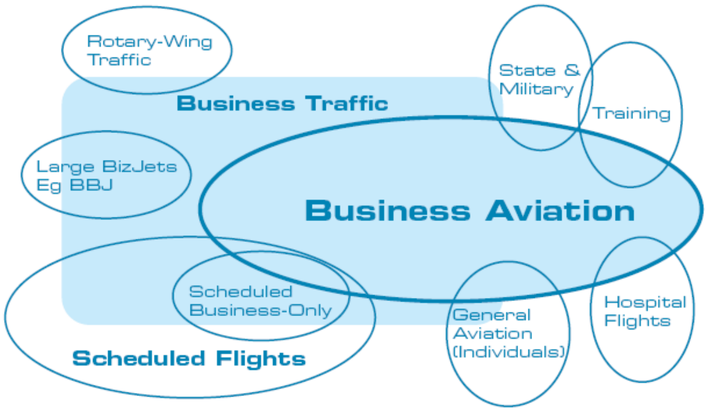
Business aviation is operated under a number of different business models, which have been classified by the International Business Aviation Council (IBAC) in the three categories commercial, corporate and owner operated.

Business class travel on scheduled flights is excluded in this analysis. In particular business class-only flights (operated for the large scheduled full service carriers and for scheduled carriers that solely serve the business market) are excluded.

Figure 3.26 shows the relevant market segment in the classification of Eurocontrol (2007), which shows the overlap with other types of flight.

125 See: dpa (Deutsche Presseagentur), 18 August 2009, "Lieferung von russischem «Superjet» verzögert sich".

Figure 3.26 Structure of the Business Aviation Market



Source: Eurocontrol, 2007.

In 2007, 7.8% of all instrument flight rules (IFR) flights in Europe were business aviation. According to Eurocontrol (2007) this segment has grown more than twice as quickly as the rest of air traffic since 2001. The business aviation network has three times as many airport links (>100,000) as the scheduled flight network, which highlights the relevance of business aviation for point-to-point air travel.

On the operational side the market has a low concentration: only four out of more than 700 European business aviation operators have 1% market share. Since business aviation is ten times smaller than scheduled air traffic, this means that there are many business operators with only one or two aircraft, or more general: 80% of the European operators have fewer than five aircraft in their fleet. These individuals, or small firms, have very limited resources to keep up with changes in equipment requirements or other regulations. According to the Eurocontrol study, business aviation is concentrated in six European countries. France has 16.6% of business aviation departures, the UK 13.8%, Germany 13%, Italy 10.2%, Switzerland 7.4% and Spain 6.1%

General aviation, which includes all flights other than military and scheduled airline flights, builds the majority of the world's air traffic in terms of number of flights. Most of the world's airports serve general aviation exclusively. This segment includes private flying, flight training, air ambulance, police aircraft, aerial firefighting, air charter, bush flying, gliding, and many others. Experimental aircraft, light-sport aircraft and very light jets have emerged in recent years as new trends in general aviation.

Key players

The major business jet manufacturers are the following:

Gulfstream (USA; since 1999 owned by General Dynamics) has produced more than 1,500 aircraft for corporate, government, private, and military customers around the world. The business and private jets are focused on high-end customers.

Cessna (USA; owned by Textron) is most well-known for its small, piston-powered aircraft. However, Cessna also produces business jets, amongst others the world’s fastest one: the Cessna Citation X.

Learjet (USA/CAN) is since 1990 a subsidiary of Bombardier and since then marketed as the "Bombardier Learjet Family" or "Bombardier Business Aircraft".

Dassault Aviation (France) is a French aircraft manufacturer of military, regional and business jets. 46.2% of its shares are held by EADS, while the majority of 50.2% is held by the French Dassault Group.

Other manufacturers are Eclipse Aviation (USA), Hawker Beechcraft Corporation (USA[126]), but also common names as Embraer, Airbus, and Boeing.

In General Aviation there is a variety of manufacturers of turboprop[127] and piston engine aircraft.[128]

Market shares: status and outlook

The market for business aircraft is much less concentrated compared to the market for large and regional aircraft. Figure 3.27 shows the business aviation market shares by value and unit. This illustration gives also an insight into the product portfolio of the respective company. While Cessna seems to be the dominant firm in terms of sold aircraft units, it is more behind in terms of revenue or sold value. This hints to the fact that its main products are smaller general aviation aircraft and that their business jets are in a similar size category. The opposite holds true for Gulfstream, whose private jets have long been considered one of the most prestigious of the larger (heavy) corporate jets.

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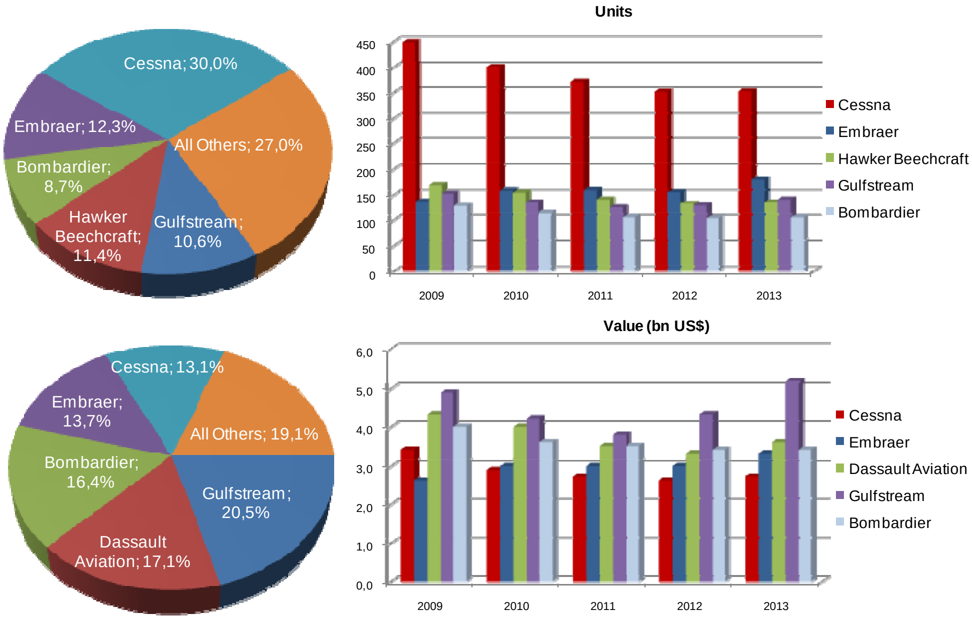
126 Cessna, Hawker Beechcraft, Learjet, Mooney and other manufacturers of small aircraft are all based in Witchia, Kansas (USA), which was formerly known as the "Air Capital of the World".

127 Small turboprop manufacturers are in particular: Britten-Norman, Cessna Aircraft Company, Hawker Beechcraft Corporation, Maule Air Incorporated, Piaggio, Pacific Aerospace Corporation, Pilatus, Piper Aircraft, Inc., Quest Aircraft Company, and SOCATA.

128 Major piston engine aircraft manufacturers are: Adam Aircraft, Alpha Aviation, American Champion, Aviat Aircraft, Bellanca, Britten-Norman, Cessna Aircraft Company, Columbia Aircraft (prev. Lancair), Cirrus Design Corporation, Commander Aircraft, Diamond Aircraft, Embraer, Gippsland Aeronautics, Hawker Beechcraft Corporation, Liberty Aerospace, Maule Air Incorporated, Micco, Mooney, Piper Aircraft, Inc., Quartz Mountain Aerospace, Symphony Aircraft (prev. OMF), Pacific Aerospace Corporation, SOCATA, and Tiger Aircraft.

Figure 3.27 Market Share in Business Aviation by Units and Value



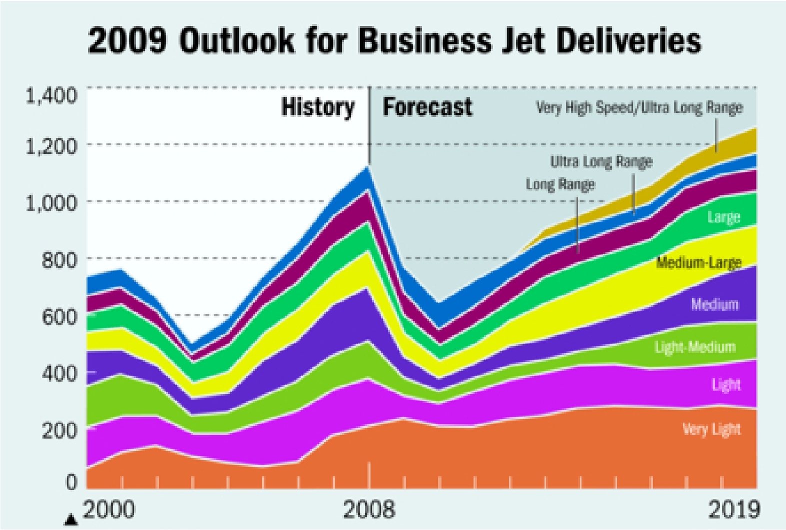
Source: Aerospace Source Book 2009, Aviation Week.

Cessna is indeed the dominant manufacturer in the lower and mid-range part of the market, with a corporate strategy based on ongoing product proliferation and close attention to customer support.

The current financial and economic crisis has stopped the tremendous growth period and currently we are facing a downtown, according to Raymond Jaworowski of Forecast International.[129] Deliveries are supposed to hit the peak of the current growth cycle this year and then begin declining. Eurocontrol (2009) confirms this view for the operational side and predicts a 15% traffic decline for 2009. Honeywell expects the downturn to last until the end of 2009. (Figure 3.28) The crisis affected economic growth and corporate profitability negatively, which in turn reduced the demand for premium business travel. Moreover, the image of corporate business aircraft was seriously tarnished in 2009 when carmakers chose to use private jets to reach Washington DC for discussions about government loans. However, the order books of the business jet manufacturers still ensure a good year 2009, but the subsequent downturn is certain.

[129] See: The "Market Forecast for Business Jet Sector" in Aviation Week & Space Technology 01/26/2009, p. 82.

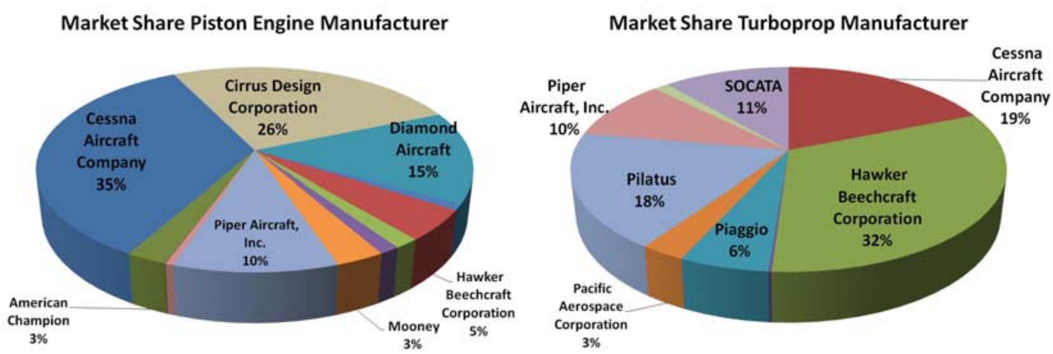
Figure 3.28 Business Aviation IFR Arrivals and Departures in Europe



Source: Honeywell, Aviation Week, 19 October 2009, p.61.

In General Aviation there is a variety of primarily US American manufacturers. Figure 3.29 gives an overview on current market shares.

Figure 3.29 Market Share in General Aviation in 2008 by Units



Source: General Aviation Manufacturers Association, 2008, own illustration.

Europe has a certain importance in the manufacturing of small turboprop aircraft with Piaggio (Italy), Pilatus Aircraft (Switzerland), and SOCATA (France), which make up a third of the market for small turboprops. The new Member States play a minor role in the manufacturing of general aviation aircraft, so far, but some niche manufacturers have stayed in the market after the breakdown of the iron curtain. Aero Vodochody and LET Aircraft Industry are examples from the Czech Republic; PZL-Mielec is one from Poland. These companies are involved in the European Cost-effective Small Aircraft project (CESAR) dedicated to the technological upgrading and know-how transfer. However, the major challenge will be the access to international markets and to provide clients abroad with all MRO in due time.

The new programs

Traditionally, new models were launched during past downturns as a way to stimulate sales and recoveries. With a rash of product launches of new jets targeted for service entry in the 2012-14 timeframe, the manufacturers are anticipating and looking beyond the upcoming downturn.

Some of these new jets represent all-new design such as Bombardier's all-composite Learjet 85 medium jet, Cessna's ambitious Citation Columbus (the largest Cessna aircraft ever built, extending the company's reach into the super mid-size or even large-cabin segments), Embraer's Legacy 450/500 family and Gulfstream's potentially game-changing G650. Others are extensively improved variants of existing designs, such as Hawker Beechcraft's new Premier II or Dassault's winglet-equipped Falcon 900LX and Falcon 2000LX. Besides launching the all-new Learjet 85, Bombardier has introduced improved-performance, XR-labelled versions of its Learjet 40, 45 and 60. Bombardier's next moves might involve stretching the Challenger 300 to counter the Cessna Columbus or developing a top-of-the-line model to battle the G650.[130]

Dassault's all-new Falcon 7X long-range business jet entered service in 2007, and the company is developing a jet to compete in the super mid-size class. Now it's replacing the Falcon 900EX and 2000EX models with longer-range, LX-labelled variants.

Embraer is meanwhile marketing six business jet models, most of which are in various stages of development. The latest models, the Legacy 450 and Legacy 500 are generally aimed at the light-medium and medium segments of the market, respectively.

The Gulfstream product line-up covers the top half of the market, from the medium through long-range segments. In the past year, two new models were announced: the G250 and the G650. The G250 is a super mid-size business jet that presumably will replace the G200. Essentially an evolution of the G200, the G250 boasts several new features, including a new wing, increased cabin size and Honeywell HTF7250G engines. Service entry is set for 2011. Targeted for service entry in 2012, Gulfstream's G650 will have a longer range and larger cabin than any purpose-built business jet on the market. In addition, the aircraft will have a maximum operating speed of Mach 0.925, making it faster than any civil aircraft now in production. With the G650, Gulfstream has significantly upped the ante in the long-range business jet class.

The low end of the business jet market is being transformed by the introduction of new, lightweight, low-cost VLJ[131], which entered the market in 2007, seating eight or fewer people. These new aircraft include the Cessna Mustang, Diamond D-JET and Embraer Phenom 100. One of the more high-profile VLJs has been Eclipse Aviation's Eclipse 500, but the US company has lost its biggest customer (the air taxi operator Dayjet), has been left by its founder Vern Raburn, and is currently restructuring its production efforts. However, despite the problems of Eclipse, VLJs are seen as one of the more dynamic and promising segments of the business jet market in the coming years.

Europe's competitive position

The market for small General Aviation and business aircraft is dominated by US and other American manufacturers. However, Dassault as the relevant European player holds after all about a fifth of the business aviation market in value terms. In General Aviation Europe holds about a third of the relevant market with the three firms Piaggio (Italy), Pilatus Aircraft (Switzerland), and SOCATA (France).

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130 See: Jaworowski, 2009 (b).

131 A very light jet (VLJ), previously known as a microjet, is, by convention, a small jet aircraft approved for single-pilot operation, seating 4-8 people, with a maximum take-off weight of under 10,000 pounds (4,540 kg). They are lighter than what is commonly termed business jets and are frequently used as air taxis.

Several industry stakeholders share the opinion that general aviation has an important role for the general attractiveness of the industry with respect to qualified young academics. In the past, there were more aircraft designers and manufacturers in Europe, so that it was easier for young engineers to get physically in touch with aircraft. The reduced number of OEMs could be one explanation for the decreased interest of engineers in the aerospace sector. General aviation could therefore play a positive role in revitalizing the enthusiasm of young academics.

3.3.4 Helicopters

A helicopter is an aircraft that is lifted and propelled by one or more horizontal rotors, consisting of two or more rotor blades. Helicopters are classified as rotorcraft or rotary-wing aircraft to distinguish them from fixed-wing aircraft, as they achieve lift with rotor blades rotating around a mast. This allows the helicopter to take off and land vertically without a runway, which makes them particularly advantageous in congested or isolated areas where fixed-wing aircraft cannot take off or land. For this reason helicopters play not only an important role in transportation, but also in construction, fire fighting, search and rescue, and military uses.

The current crisis seems to hurt helicopter manufacturers less than other parts of the industry. Eurocopter CEA Lutz Bertling told the daily newspaper “Die Welt” that 2009 could become “a good year”[132] despite some cancellations, because the order backlog is already higher than in 2008. A constantly high demand on the part of security authorities as well as the military sector guarantees a steady order inflow and few cancellations. However, the year 2010 could become more critical in terms of capacity utilization for light helicopters. The following paragraphs, give an overview on major players, the current world market situation including size and shares of it and an outlook into the future.

Key players

The world market for helicopter is currently dominated by a couple of firms, which are specialized either on a civil and public, or on a military operational area. The major players in the market are the following:

The Eurocopter Group is a European helicopter manufacturing and support company formed in 1992 from the merger of German Daimler-Benz Aerospace AG (DASA) and the helicopter divisions of French Aérospatiale. As a consequence of the merger of the Eurocopter Group's former parents, the firm is a wholly owned subsidiary of EADS.

Agusta Westland is a helicopter design and manufacturing company based in Italy and the United Kingdom. It was formed in July 2000 when Finmeccanica S.p.A. and GKN plc agreed to merge their respective helicopter subsidiaries (Agusta and Westland Helicopters) to form Agusta Westland with Finmeccanica and GKN each holding a 50% share.

Bell Helicopter Textron is an American helicopter and tiltrotor manufacturer headquartered in Fort Worth, Texas. A division of Textron, Bell manufactures military helicopter and tiltrotor products in and around Fort Worth, as well as in Amarillo, Texas, and commercial rotorcraft products in Mirabel, Quebec, Canada. In addition, Bell provides training and support services worldwide.

[132] Die Welt, 11 June 2009, „Chefsache – Deutsche Top-Manager im Gespräch, 2009 könnte ein gutes Jahr werden".

Sikorsky was founded in 1925 by aircraft engineer Igor Sikorsky, a Kiev-born American immigrant. The company, named "Sikorsky Manufacturing Company", began aircraft production in Roosevelt, New York that year. In 1929 the company moved to Stratford, Connecticut. It became a part of United Aircraft and Transport (now United Technologies Corporation, UTC) in July of that year.

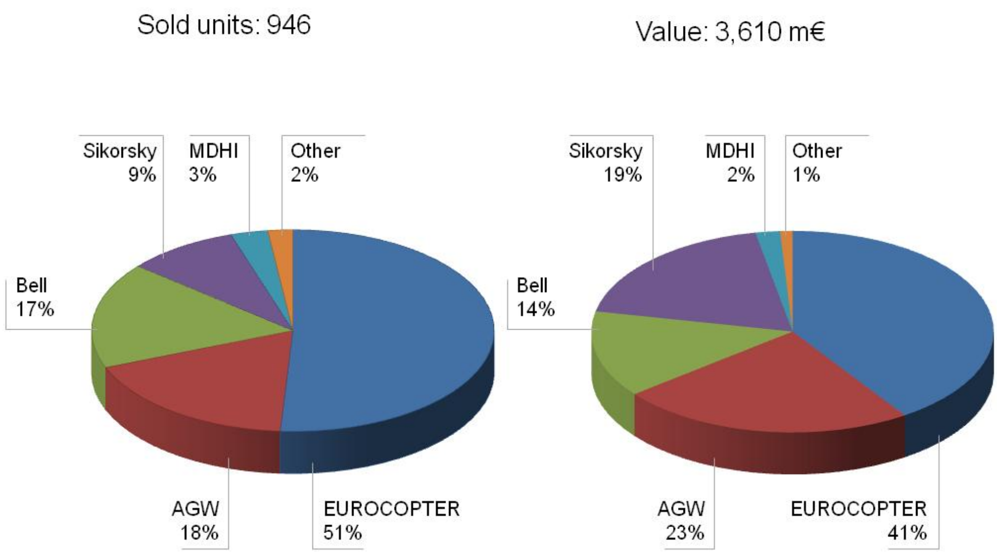
McDonnell Douglas Helicopter Systems (MDHI) is an aerospace company that produces helicopters primarily for commercial use. It is a subsidiary of McDonnell Douglas, which belongs to Boeing.

Boeing Rotorcraft Systems is a US aircraft manufacturer, part of Boeing Integrated Defense Systems. The factories are in Ridley Township, Pennsylvania, a suburb of Philadelphia, and Mesa, Arizona.

Market shares: status and outlook

In the civil market segment (see Figure 3.30) the dominant players are Europeans (Eurocopter and Agusta Westland (AGW) - serving jointly about two thirds of the market) followed by US American firms (Bell, Sikorsky, MDHI).

Figure 3.30 Helicopter World Market, Civil and Public, Deliveries in 2008 (preliminary)



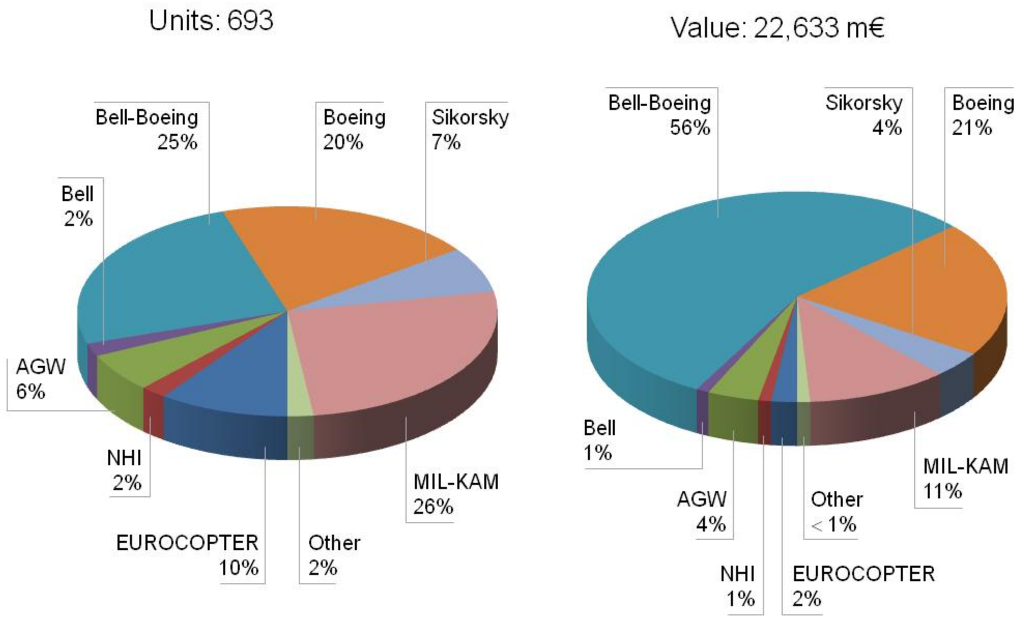
Source: Eurocopter.

The military market looks quite different, as recent orders illustrate in Figure 3.31. Here the US American players are clearly dominant (Bell-Boeing, Boeing, Sikorsky)[133], followed by Russia (Oboronprom or MIL-KAM)[134] and finally Europe (Eurocopter, Agusta Westland).

133 Bell Helicopter Textron built together with Boeing Rotorcraft Systems (which is part of Boeing Integrated Defense Systems or Boeing IDS - a unit of The Boeing Company) amongst others the V-22 Osprey, a multi-mission, military, tiltrotor aircraft with a vertical and a short takeoff and landing (V/STOL) capability.

134 Mil Moscow Helicopter Plant merged with Kamov and Rostvertol to form Oboronprom Corp in 2006. The Mil brand name has been retained. The company participates in the Euromil joint venture with Eurocopter and Kazan Helicopter Plant.

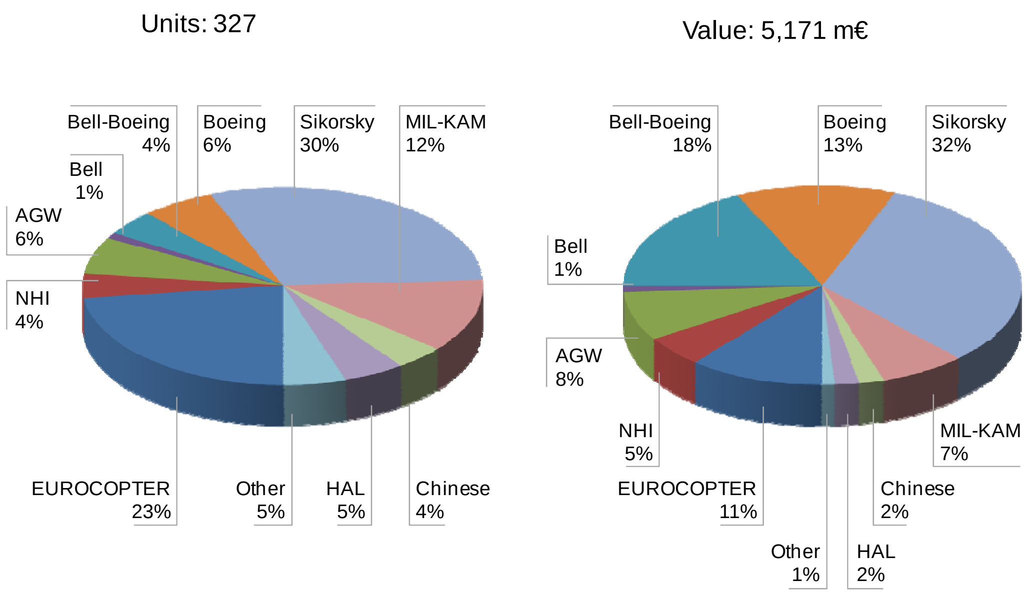
Figure 3.31 Helicopter World Market, Military, Orders in 2008 (preliminary)



Source: Eurocopter.

Bell-Boeing is a partnership, which dominates a large fraction of the market on a value basis, while the number of units is relatively moderate.

Figure 3.32 Helicopter World Market, Military, Deliveries in 2008 (preliminary)

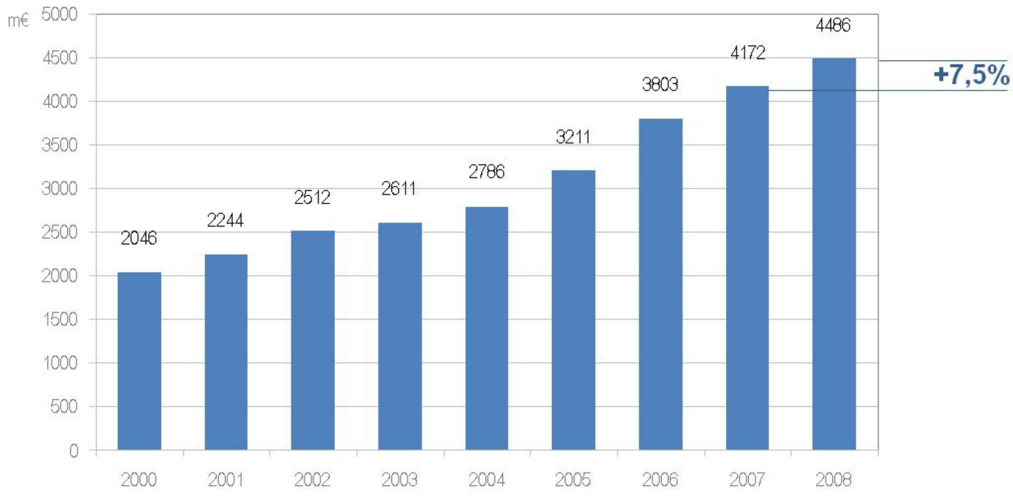


Source: Eurocopter.

Europe's competitive position

In the civil market Europe is in the global lead with Eurocopter and Agusta Westland. Eurocopter is the largest European manufacturer for helicopter and world market leader in the civil part of the sector, providing the largest product portfolio worldwide. There are more than 10,000 Eurocopter-helicopters in operation for about 2,800 customers. In 2008 Eurocopter had 15,492 employees (fulltime equivalents).

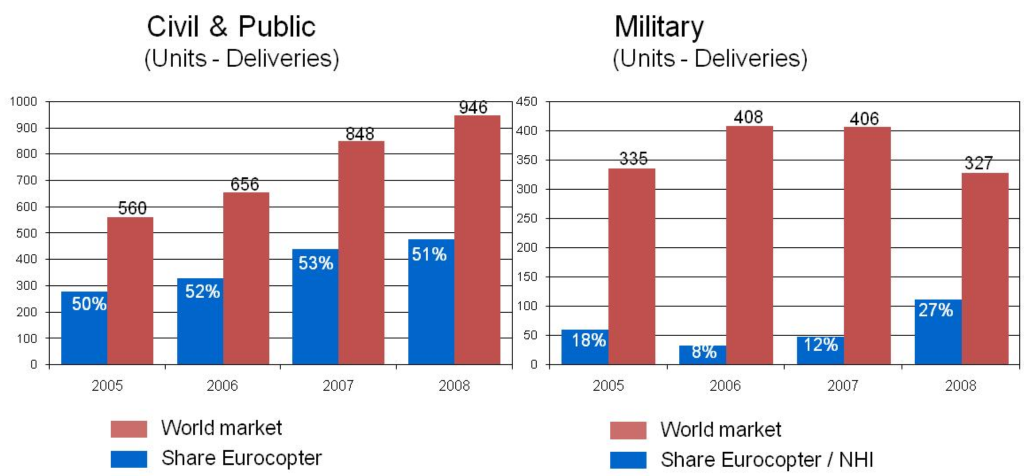
Figure 3.33 Turnover Eurocopter



Source: Eurocopter.

Eurocopter's civil market share is relatively stable since 2005 (slightly above 50%), while its military share is more volatile but has increased recently (see Figure 3.34).

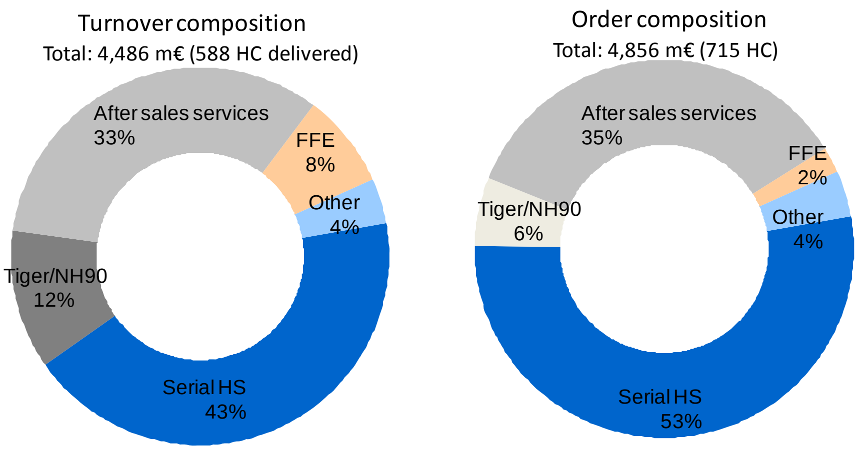
Figure 3.34 Helicopter World Market and Eurocopter Share



Source: Eurocopter.

The largest fraction of Eurocopter's turnover is realized by the sale of serial helicopters, followed by after sales-services (see Figure 3.35).

Figure 3.35 Eurocopter Composition of Orders and Deliveries by Product in 2008



Source: Eurocopter.

Eurocopter has managed to develop local production sites worldwide with own capabilities (local assembly, manufacturing and engineering). This global production network emerged primarily due to the non-tariff trade barrier of "local content" requirements, where several states tied new military orders to the condition of local production. However, this "hindrance" has been turned to an advantage and the foreign offices are increasingly able to support also civil customers. The global deliveries are managed by a central supplier network. The evaluation and further development of local supply potentials has therefore proven to be a success factor, which may also be an example for European manufacturers in other subsectors.

A major success factor is certainly the technological leadership in several domains. Eurocopter was the first company to implement several technologies and new components in civil helicopters. Examples are the 100% glass cockpit, the bearing-free rotor system, a fully synthetic (plastic) cabin, the "Fenestron" (a shrouded tail rotor, which is essentially a ducted fan), and the "fly-by-wire" and "fly-by-light" technology. Interviews suggest that this leading position is (at least partially) due to a higher daringness of the European firms (i.e. the French and German predecessors of Eurocopter), which have based their R&D investment decisions on long term goals. American companies, by contrast, have put more emphasis on short-term return on investment targets.

3.3.5 Engines

Aircraft manufacturers rely for the propulsion of their products on specialized engine[135] manufacturers. This gives airlines in many cases the opportunity to choose between two or more engine types, when they buy an aircraft. This is not only important for the competitive structure of the market, but also for the possible range of missions as well as an optimized MRO infrastructure of the respective airline.

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135 Jet engines can be classed in two broad categories: turbofan and turbojet. In the simpler turbojet, air, taken into the compressor stage, is mixed with fuel and ignited. The compressor is driven via the turbine stage. In the turbofan some of the air, taken in by the fan, enters the compressor stage but the rest bypasses the engine core, creating forward thrust in much the same way as a traditional prop engine.

The major industry players are specialized in different modules and technologies. The market requires high technology expertise and has high barriers to entry, particularly in terms of substantial necessary upfront investments (R&D Concessions) and related certification requirements and regulatory approvals. The contractual relations have traditionally a long term characteristic. Entry into new engine programs generally requires significant upfront investments for R&D. Revenues are received throughout the entire life cycle (>30 yrs.) - according to the program share – for new engine (series) sales and spare parts sales.

Key players

The oligopolistic market is dominated by three major manufacturers: GE Aviation (a subsidiary of General Electric, based in Evendale, Ohio, USA), Pratt & Whitney (P&W, a subsidiary of United Technologies Corporation , UTC, based in Hartford, Connecticut, USA), and Rolls Royce (Derby, UK). Another important engine manufacturer is Snecma[136] (Courcouronnes, France).

For the large single aisle market, these have established two major joint ventures (primarily for risk sharing purpose): the “International Aero Engines” (IAE, Hartford, Connecticut, USA), a subsidiary of P&W (sharing 32.5%), Rolls Royce (32.5%), JAEC (Japanese aero engine cooperation[137], share: 23%) and MTU Aero Engines (Munich, Germany, share: 12%); and the “CFM International” (CFMI, Paris, France), a 50/50 joint venture of GE Aircraft Engines and Snecma. CFMI is the world market leader in narrowbody[138] aircraft propulsion and produces the CFM56, which was for about 25 years the sole engine for the Boeing 737 family and also later for the Airbus A340-200/300. This quasi-monopolistic position gave rise to the formation of IAE in 1983, which powers with its V2500[139] engine the Airbus A320 family and McDonnell Douglas MD-90 aircraft. In 1996 General Electric and Pratt & Whitney formed in a 50/50 joint venture the “Engine Alliance” in order to develop, manufacture, sell and support a family of modern technology engines for new high-capacity, long-range aircraft. The main application for the corresponding engine GP7200 was originally the Boeing 747-500/600X projects, before these were cancelled owing to lack of demand from airlines. Instead, the engine has been re-optimised for use on the Airbus A380 and is therefore competing with the Rolls-Royce Trent 900, the launch engine for this aircraft.

Beside the large OEMs and the corresponding joint ventures (with a regional emphasis on the USA) there are several first and second tier suppliers in the global engine market - primarily in Europe: MTU Aero Engines in Germany, Volvo Aero in Sweden, Avio S.p.A. in Italy, and ITP Engines in the UK, see Figure 3.36. Japan is also strong in this segment with the three parties of JAEC. The USA has only few component suppliers in the engine supply chain.

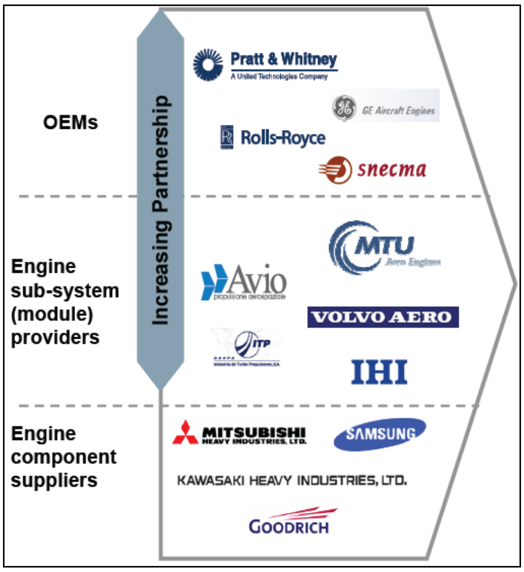
[136] Snecma is a major French manufacturer of engines for commercial and military aircraft, and for space vehicles. The name is an acronym for Société Nationale d'Étude et de Construction de Moteurs d'Aviation (in English, "National Company for the Design and Construction of Aviation Engines"). In 2005, the Snecma group, which included Snecma (called Snecma Moteurs at this time), merged with SAGEM to form SAFRAN. Snecma is now a subsidiary of the SAFRAN Group and previous Snecma group subsidiaries have been reorganised within the wider group.

[137] JAEC consists of Kawasaki Heavy Industries (KHI), Ishikawajima-Harima Heavy Industries (IHI), and Mitsubishi Heavy Industries (MHI).

[138] Size categories: Widebody (>230 seats) engines (60-120 klb take off thrust), Narrowbody (100-230 seats) engines (20-60 klb), Regional & Business Jet (30-100 Seats) engines (<20 klb).

[139] The "V" product nomenclature remains as a legacy of the five original shareholders. FiatAvio withdrew as a shareholder of the program early on but the now-renamed Avio S.p.A. still remains as a supplier.

Figure 3.36 Key Market Participants in Large Engine Business



Source: MTU Company Presentation, August 2009.

Market shares: status and outlook

The global market shares, based on engines currently in service and on order, are listed in Table 3.20 and displayed in Figure 3.37.

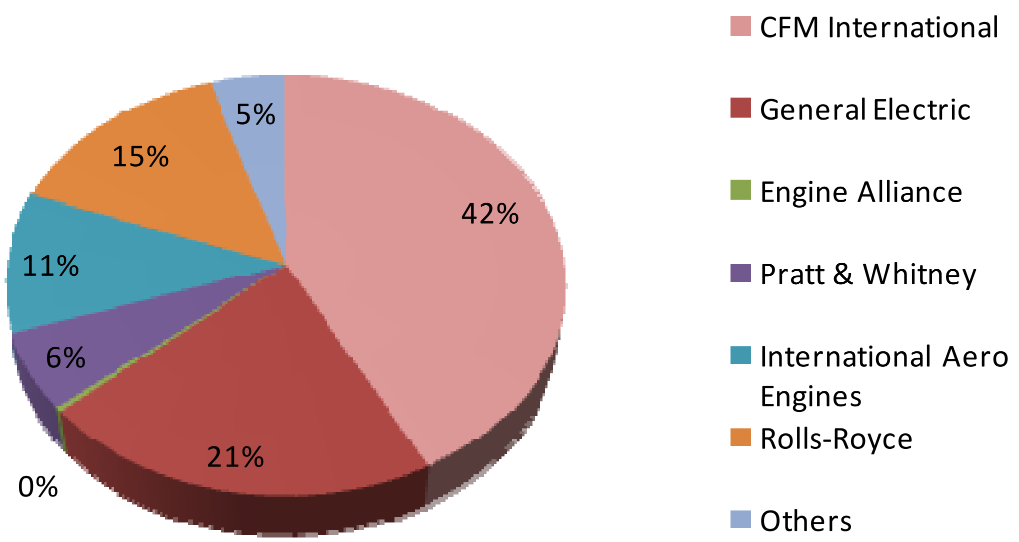
Table 3.20 Engines in Service and on Order, Respective Market Shares

Manufacturer	In service	Orders	Total	Market Share
CFM International	6,732	3,229	9,961	42.2%
General Electric	3,604	1,428	5,032	21.3%
Engine Alliance	4	78	82	0.3%
Pratt & Whitney	1,335	64	1,399	5.9%
IAE	1,530	975	2,505	10.6%
Rolls-Royce	2,416	1,068	3,484	14.8%

Source: Based on Airline Business, April 2009, “Jet Engine Market Statistics”, p. 56.[140]

[140] This source is the only known one, which gives a comprehensive overview on the total sector. However, it is controversial with respect to the absolute numbers. IAE for example celebrated on 28 August 2009 the delivery of its 4,000th V2500, according to their website, while this data source only states less than half of this amount.

Figure 3.37 World Market Shares for Major Engine Manufacturers and Alliances



Source: Own illustration based on Airline Business, April 2009, "Jet Engine Market Statistics", p. 56.

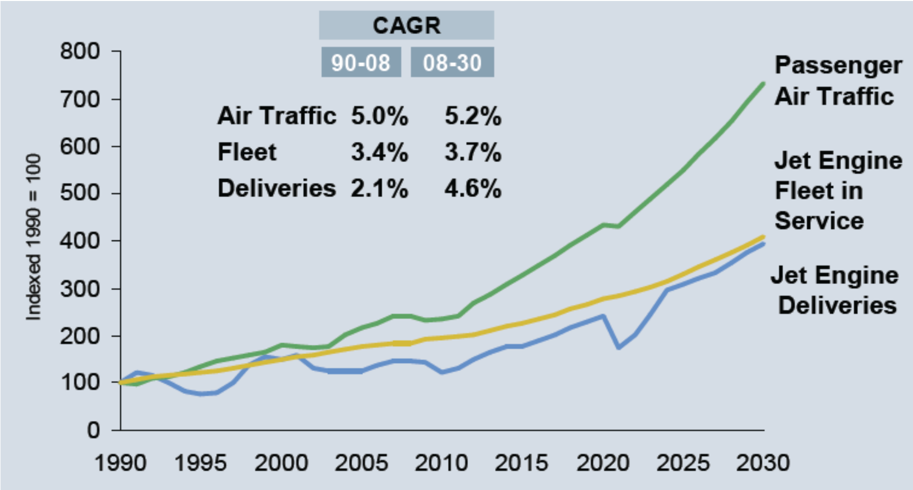
A regional segmentation is not visible at first sight, but when the respective shares of the two major alliances are taken into account one can see a clear picture with two dominant regions: Europe obtains 40.6% of the global engine market[141], while the USA holds the majority with 52.2%.

The world turbine engine market continued to grow in 2008, but with the emergence of the economic crisis the formerly positive projections became more and more cautious. According to the Rolls Royce market outlook of March 2009 the positive news (a reduced jet fuel price and unplaced lease co orders) are heavily outweighed by negative market signals (negative GDP forecasts, current disappointing load factors, aircraft productivity in terms of ASKs per aircraft, cost & revenue per ASM, many new parked passenger aircraft, decreasing lease rates, decreasing net orders, backlog-fleet ratios, and deferrals), meaning that 2009 will be a peak year (or turning point) for industry deliveries. Furthermore Rolls Royce expects load factors to decrease by 1-2%, causing falling aircraft productivity and therefore high levels of retirements.

However, the long term outlook for the coming decades is predominantly positive. MTU sees the expected growth rate for the period 2008-30 at reduced but still comfortable 4.6% (see Figure 3.38).

141 This breakdown is divided as follows: Snecma holds 21.1% (50% share in CFMI), Rolls Royce has 18.2 % (14.8% for specific RR engines and a 32.5% share in IAE), and MTU receives 1.3% (12% share in IAE).

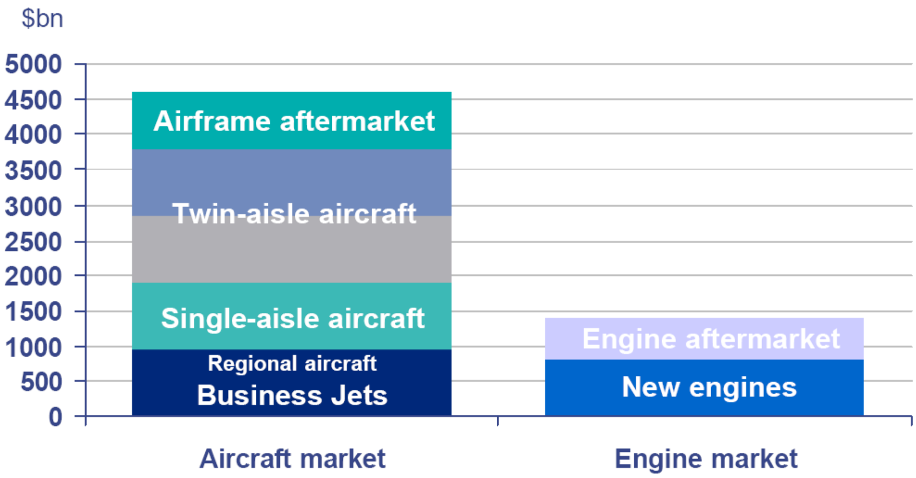
Figure 3.38 Projected Growth for Jet Engines until 2030



Source: MTU, Airline Monitor January/February 2009.

Rolls Royce predicts a market volume for the engine market of almost USD 1,400 billion (including the aftermarket), see Figure 3.39.

Figure 3.39 Projected Aircraft & Engine Delivery Value for 2009-2028



Source: Rolls Royce, Market Outlook 2009.

MTU expects a similar volume (sales of new engines) over the next 20 years with more than USD 600 billion. Broken down into the respective categories this corresponds to widebody engines: USD 300 billion, narrowbody: USD 220 billion and regional jet engines USD 100 billion.

The new programs

The major two new engine concepts are the Geared Turbofan (promoted and developed by P&W) and the Open Rotor (Rolls Royce). For a comprehensive overview on these upcoming propulsion technologies, see section 3.4.6.

Europe's competitive position

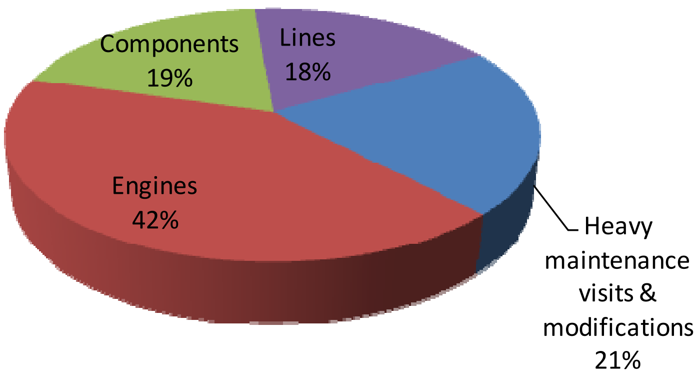
The two main European OEMs, Rolls Royce (UK) and Snecma (F), hold almost 40% of the world market compared to about 52% for US American manufacturers. Furthermore many first tier suppliers in this sector are European companies as the German MTU, the Italian Avio, the

Spanish ITP, and the Swedish Volvo Aero. Due to many alliances the competitive pressure is less intense compared to aircraft manufacturing. However, interviews suggest that R&D velocities have slowed in recent years. Competition authorities have increasingly hindered cooperation and the exchange of experiences between engine manufacturers. As a result the sector experienced costly multiple-funding of similar R&D activities. In contrast to this development there is a demand for more collaborative approaches similar to "open innovation"[142], which are supposed to increase efficiency. The political challenge will be to maintain enough competition in order to avoid pricing agreements without compromising the necessary dynamics in the technology development process, which is so cost- and therefore risk-intensive that single players can and will not perform it alone.

3.3.6 Maintenance, Repair and Overhaul

The worldwide airline maintenance, repair and overhaul business (MRO) consists primarily of airframe maintenance, engine and component work as well as line maintenance[143]. The greatest share in revenues in MRO falls upon engine maintenance (42% of total revenues) followed by heavy maintenance visits and modifications (21%, Figure 3.40).

Figure 3.40 Components of Global MRO in 2008 (Value in %)



Source: Aviation Week Source Book 2009, p. 57, TeamSAI.

The regional distribution of MRO is similar to the global air transport market, with a center of gravity in North America followed by Western Europe and the emerging Asia-Pacific region (see Figure 3.41).

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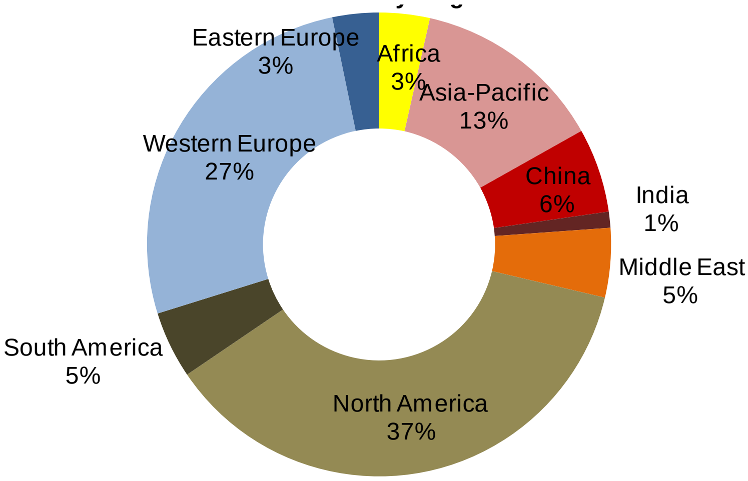
142 Open innovation is a paradigm that assumes that firms can and should use external as well as internal ideas, and also external and internal paths to market (see Chesbrough, 2003, p. xxiv). The central idea behind this concept is that in a world of widely distributed knowledge, companies cannot afford to rely entirely on their own research. Instead they should, on the one hand, buy or license processes or inventions (e.g. patents) from other companies, and take internal inventions, which are not being used in the own business, outside the company (through licensing, joint ventures, spin-offs). On the other hand they should open noncompetitive parts of their business to users and competitors, similar to the open source development in the software industry.

143 Routine-, pre-flight-, transit-, turnaround-, nightstop- and daily-checks as well as scheduled checks and visual checks at flexible locations.

Figure 3.41 MRO Market by Region in 2008 (Total Value USD 45.12 billion)



Source: Aviation Week Source Book 2009, p. 57, TeamSAI.

In line with air traffic, MRO strongly grew in recent years. But in the course of 2008 the upswing came to an end and in the fourth quarter of 2008 the business slowed down. However, in contrast to the airline operators, MRO is expected to enjoy growth in 2009, although a much lower than originally assumed. The expected revenue of MRO will come up to USD 46.8 billion. This is around 3% more than in 2008. This kind of services has always proven to be less sensitive to changes in available and utilized capacities than airline operators' businesses. The latter have to reduce their capacities, as a consequence of the credit crunch and an expected longer-lasting recession. This is primarily a problem in North America, where MROs with contracts to maintain aging jets will experience a significant reduction in business. But the currently generally negative market conditions are ranging from parked aircraft to loss of major customers and shut downs of major facilities. Profit margins for MRO companies, which had been negative from 2001-2006 (following the 9/11 terrorist attacks), turned positive in 2007 and stayed there in 2008, but are now sinking back into the loss area. To repel the negative factors, many airline-affiliated and independent MROs have concentrated their efforts on adding capabilities to service newer generation aircraft, such as the Airbus A380.[144]

Figure 3.42 shows the global market size of MRO for 2008 with EUR 32 billion (or USD 45 billion) and a forecast predicting growth at 4.3% through 2018 to a value of EUR 49 billion (USD 68.6 billion).

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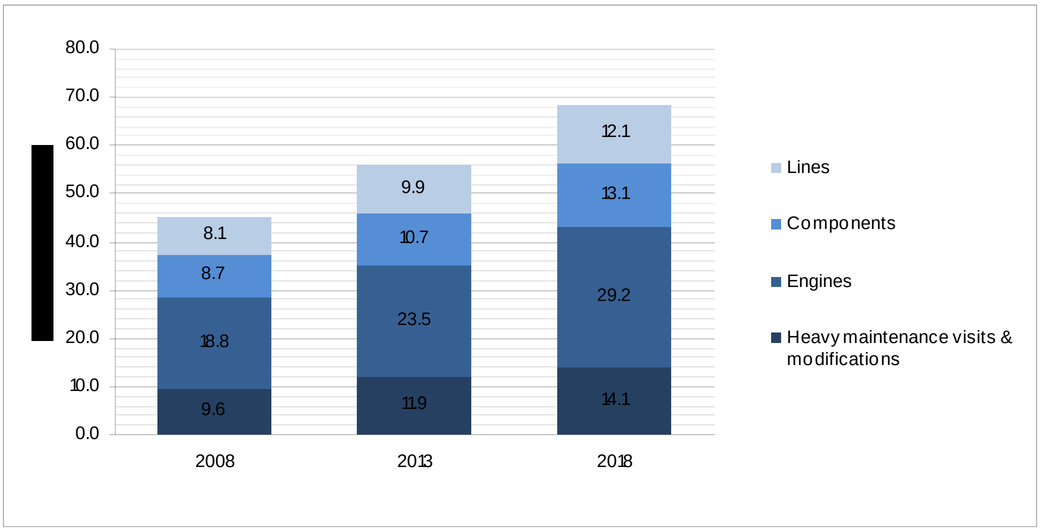
[144] See: *Overhaul & Maintenance*, 8 June 2009, „Top 10 Airframe MRO Providers".

Figure 3.42 Global MRO Market Forecast



Source: Aviation Week Source Book 2009, p. 57, TeamSAI.

The United Kingdom is a leading provider of services for airlines. British companies command at around 17% of the global market that has an annual market value of around USD 40 billion.

Key players

The five major MRO companies are the following:

Singapore Technologies Aerospace (ST Aerospace), a subsidiary of ST Engineering, is based in Singapore, with international offices and facilities located in key aviation hubs in Asia Pacific, Europe, the Middle East and the US. The aerospace company is the world's largest, independent, third party airframe MRO provider with an annual capacity of more than 8 million commercial airframe man-hours, and extensive capabilities in aerospace engineering and development, engines, aircraft components repair and spares

Lufthansa Technik AG (short „LHT“) is the leading manufacturer-independent provider of MRO services for aircraft, engines and components. The Lufthansa Technik Group consists of 28 companies with more than 25.500 employees. It is a 100% subsidiary of Lufthansa German Airlines.

Air France Industries KLM Engineering & Maintenance (AFI KLM E&M) is the MRO service provider of Air France KLM.

Hong Kong Aircraft Engineering Company Limited (HAECO), located in the western part of the Hong Kong International Airport, has, over the years, expanded beyond the boundaries of Hong Kong SAR into Mainland China with Taikoo (Xiamen) Aircraft Engineering Co. Ltd. (TAECO) at Xiamen, Fujian and Shandong TAECO Aircraft Engineering Co. Ltd. (STAECO) at Shandong. It provides "total care" services to its customers.

TIMCO Aviation Services provides fully integrated aviation MRO services for commercial and government aircraft operators. It is based in Greensboro, North Carolina near Piedmont Triad International Airport (GSO) and has also facilities in Macon, Georgia and Lake City, Florida.

Europe's competitive position
The combined market share of the two major European MRO companies (LHT and AFI KLM E&M) among the global top 10 players is with about 25% quite significant. Other manufacturer based MRO services, as for example the ones of Rolls Royce and MTU Aero Engines, complement this strong European position. However, tougher environmental regulation (as the European emission trading scheme or a possible Kyoto follow-up agreement, to be discussed in Copenhagen at the end of 2009) will accelerate the fleet modernization of many airlines. This is good news for the manufacturers, but less so for those who provide maintenance services. New marketing concepts based on flight hours instead of maintenance hours can alleviate the related risk for MRO companies. The British Rolls Royce is a precursor with this model.

3.4 Products and Technology

3.4.1 Technologies and Technological Competitiveness

The air transport system is a complex structure and can be decomposed into individual businesses such as ground handling companies, airports, travel agents, lessors, banks as well as maintenance, repair and operational services companies (MRO) companies, airlines and aircraft manufacturers. All these exemplary businesses are part of a whole, each with different areas of responsibilities, activities and framework conditions that strongly affect the economic performance. (Chapter 1.4) Technology and its steady evolution is one of the major drivers for further efficiency improvements and increasing competitiveness in these sectors. Here, only aircraft development and manufacturing and its technological competitiveness are going to be analyzed.

It has to be noticed, that the aerospace industry is a rather conservative industry. This is partially due to very stringent legislation and certification issues. But there is also constantly the risk of an erroneous variation within that high-tech industry. A false investment can result in massive financial losses for the companies involved. For this study some key-technologies and technologies with high potential have been identified and will briefly be discussed.

3.4.2 Aircraft

The aircraft industry is in a broad sense, the victim of its own success as continuous improvements of conventional configurations can deliver benefits only up to a certain limit. The latest types of aircraft are already very efficient and therefore many experts believe that the limits might be reached by 2030 (which is a short period of time for the aeronautic industry). To speed up (especially fuel-) efficiency the civil aerospace industry is strongly looking for step changing technologies and alternative configurations. Especially the expectations for environmentally friendly aircraft are currently very high on the agenda which cumulated in the call for "Carbon Neutrality by 2050" of IATA Chef Giovanni Bisignani. Irrespective of the question, whether this goal is achievable at all, this target has won importance by the 2008 oil price peaks. New aircraft programs currently under development are mentioned in the respective paragraphs on new programmes in section 3.3.

3.4.3 Aircraft Configuration

Within the aircraft market two important decisions for future types of aircraft have already been made. With the A380 Airbus has tackled Boeing's monopoly in the market for very large aircraft

(>500 seats). As the old B747-400 is due to its age no longer really competitive Boeing has upgraded its flagship. The new B747- 8 (resembling the Dreamliner 787) is scheduled to entry into service in late 2010 (as a freighter) and the passenger module scheduled for 2011.

The second decision has been the launch of the A350 as an answer to Boeing's Dreamliner B787 in the segment of a smaller, long-range aircraft mainly for point-to-point services. After some early problems with lead customers on the use of carbon fibres for the A350 and changes in the design the program is now on track. In spite of the ongoing problems faced within the production of the B787, the orders boosted in mid 2007 with over 80 aircrafts ordered by the key customer Qatar Airways. The A350 family is also well positioned in the market, as it tackles the B787 and the B777.

Whereas these decisions have been taken, the design and technology of the next aircraft programs are currently extremely uncertain. Despite the fact that the airlines of the world are looking for a replacement of the most important aircraft families A320 and B737, Airbus and Boeing are very reluctant to launch new projects in this category of aircraft. They have announced respective projects for times after 2017. Next to the fact that these machines are currently the cash cows and have not yet reached the end of their product life cycle[145], there is a great uncertainty about design concepts for these aircraft to achieve the necessary cost reductions of about 20 to 25 %. There is especially an uncertainty about the engine technology as there are currently two totally different concepts under development (Open Rotors versus Geared Turbofan). These will be discussed in more detail below.

As the maturity level is currently so high, most people in the aerospace industry agree that there is a need for new aircraft configurations and aircraft types. The latter are defined by revolutionary technologies like morphing aircraft, distributed propulsion aircraft as well as more electric or all electric aircraft. According to Farries et. al (2008) all these new aircraft types incorporate the necessary revolutionary leap for a step change. The European Commission has expressed its believe that electric aircraft, currently a pacing technology will have a high impact in the next ten years. However, from a commercial perspective these aircraft technologies are still far from any real production programme.

Another revolutionary step to a more fuel-efficient aircraft might be the development of a Blended Wing Body (BWB). From a technology perspective, an introduction could be possible. However, from a competitive point of view, an introduction of such an aircraft will in all likelihood be done by an American lead company or consortium: The American air force military already operates with the Northrop Grumman B2 Bomber a BWB aircraft. The company has therefore already developed the key-technologies like avionics, engine integration and structures. In this, Europe is desperately lagging behind. Given this, a possible and realistic implementation path for a new BWB passenger aircraft would be through a military BWB freighter development. It would then be transformed into a passenger version for the civil market.

There are a lot of other aircraft configurations discussed in the industry, like a new super- or hypersonic passenger aircraft, a dedicated European freighter for future cargo operations or specialized unmanned aerial vehicles (UAV) or airships. Even if they might be technologically realistic

[145] A lot of American airlines operate quite old machines in this market segment. The need for a replacement will come sooner than Airbus and Boeing would be able to develop a new aircraft. Other competitors' aircraft are not jet acceptable to American and European customers. The reluctance of the two incumbents is therefore well understandable.

in the next 20 to 25 years it is more than questionable whether such radical aircraft concepts will become reality. Especially a supersonic aircraft is a technological dream which is – currently - politically and economically unrealistic.

3.4.4 Aerodynamics

The higher the lift-to-drag ratio of an aircraft, the less energy is needed to keep it aloft. Fuel consumption varies roughly inversely with the lift-to-drag ratio at cruise speeds. Over the long term, increasing this ratio is potentially the most effective means of reducing fuel intensity. Lift-to-drag ratios can be increased with wingspan extensions and other changes to the overall aircraft design.

According to ACARE (2004) hybrid-laminar flow, high-lift engine airframe integration as well as optimized airframe design for high lift-to-drag cruise and low thrust approaches are all pacing technologies which have a big impact potential in the next ten years. Morphing airframes and electro-magnetic technologies for drag reduction in cruise conditions are considered not to have such a strong impact in the upcoming years yet. The specific low noise rotorcraft is an emerging technology with a forecasted high impact factor around 2020. Nevertheless, active flow control is one of the major aspects for further research. With such a technique fuel reduction of up to 15% are thought possible. According to Farries et. al. (2008) 25% laminar flow over the wing can result in 25% less profile drag. Boeing introduces that technology on the engine nacelles of its new B787 commercial airliner.

France and Germany have a noteworthy stake in basic research on flight mechanics and aerodynamics. Europe is on eye level with the US in this key-technology area that needs a good theoretical background and testing facilities to generate new findings.

3.4.5 Structures, Materials and Manufacturing

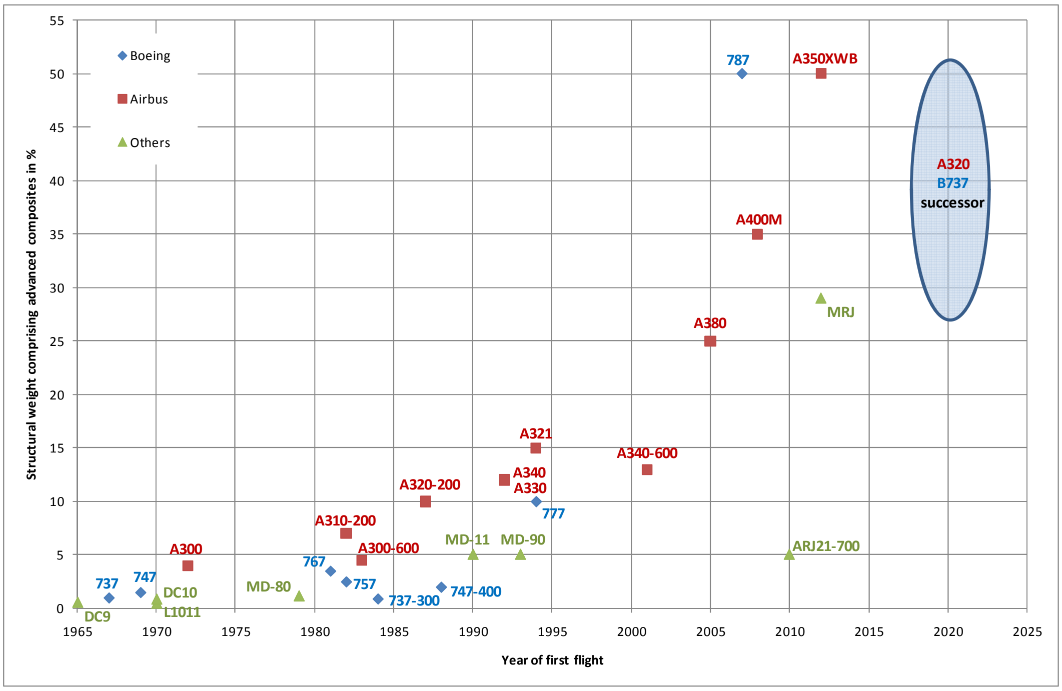
Lightweighting aircraft by using new materials and composites can significantly improve fuel efficiency. Much of the current effort of aeroplane manufacturers and component suppliers to reduce fuel consumption and emissions is concentrated in this area.

Composite materials have induced a major change in aircraft manufacturing. Aircraft companies are increasingly using composites predominately in order to reduce weight and maintenance costs of the airplane. Increasingly more composite materials have been used over the last decades, as illustrated in Figure 3.43. Boeing, as the first commercial aircraft manufacturer decided to design and manufacture 50% (by weight) of the airframe structure including the entire hull of its new B787 Dreamliner from composite materials. The extensive use of composites has been a brave step involving major risks for the project and the company. The superior fatigue performance of composites allowed extending the time between heavy maintenance "D-check" intervals to 10-12 years in contrast to normal six years for planes such as Boeing 767 or Airbus A330. Passenger comfort improvements are offered by increased cabin pressurization corresponding to 6000-ft altitude instead of 7000-8000-ft and higher cabin humidity levels through better fatigue and corrosion resistance of composites.

The Advisory Council for Aeronautics Research in Europe (ACARE) believes that composite materials still have further step change potential in the future. But besides the more extensive use of composite materials for structural applications there is a need for improved affordability and cost effectiveness as well as more functional design to exploit all opportunities provided by the new material, composites. This refers to functions, such as structural health monitoring and repair, noise reduction and shape control.

Micro-Electro-Mechanical Systems (MEMS) offer the potential to actively control and reduce noise. MEMS denominate the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology and allow the development of smart products and can help to expand the space of possible designs and applications (MEMSNET, 2009). Many companies also see the necessity to push forward adaptive structures as well as self repairing structures and coatings. According to ACARE (2004) multifunctional structures (e.g. structures that can carry data) are expected to have a high competitive impact around 2020. Another big competitive advantage has been identified by designing paintless aircraft. That technology could result in overall aircraft weight reduction and is more environmentally friendly. Another big area for improvement can be found in enhanced aircraft health monitoring creating the potential for increased maintenance intervals.

Figure 3.43 Application of Advanced Composites in Aircraft



Source: Bauhaus Luftfahrt.

Despite the current emphasis on composite materials traditional and newly developed aluminium alloys (e.g. Al-Li and Al-Mg-Sc type) are still regarded as competitive materials for continuously evolving (e.g. A380 family) and upcoming aircraft concepts such as the CSeries, Suchoi Super Jet, MRJ, ARJ-21 and A320/B737 successor. Aluminium alloys are still considered because of continuously improved material performance, relatively moderate cost, low risk, possibility for usage of existing production techniques and tooling. Further advantages of metallic concepts are common acceptance and extended experience in appropriate design, ageing characteristics and reparability, availability of standards and potential for further optimization in combination with advanced design principles and new manufacturing technologies accompanying evolution of aircraft families.

3.4.6 Propulsion

Over the past few decades, the fuel efficiency of new jet engines has increased substantially. Engine design has focused on both improving propulsion efficiency and increasing thermal efficiency, as well as on reducing noise levels and NOx emissions. The need to meet stringent safety standards, as well as to reduce noise and other pollutants, often implies a trade-off with fuel efficiency. Thus, the technical challenges of making advances in all areas are substantial.

The need for true alternative energy sources and power-plant solutions is immense. But as of today there has been no real breakthrough. Currently there are two big parties with different views concerning future air breathing aircraft engines. The companies Pratt & Whitney (with the German MTU) are working on Geared Turbofan engines[146]. The PW1000G is due to enter service in 2013 powering two new short-haul aircraft being built by Mitsubishi and the Bombardier CSeries Regional Jet. ACARE (2004) also identifies the ultra-high bypass ratio engine and the contra-rotating fan engine as pacing technologies which are likely to have a high competitive impact in the future.

Rolls Royce and General Electric instead pin their hopes on the development of an open rotor propulsion system. Such unducted fans (UDF) allow to receiving higher bypass ratios than conventional engines, which in turn provide higher efficiency. Open Rotor engines were the subject of considerable research 20 years ago, but oil prices were insufficiently high to make them a commercial prospect. They represent the theoretical limit of propulsive efficiency and could potentially offer significant fuel savings over current engines. However, problems, such as noise and vibration issues, integration difficulties and passenger acceptance, remain to be tackled. Those engine types are considered to be best suited for short to medium range aircraft due to the resulting lower speed. Farries et. al (2008) estimates a high level of maturity for UDFs around 2013-2015, which suggests that both concepts are on a comparable development level.

However, the Geared Turbofan has already been successfully demonstrated at an A340 and B747 aircraft, which indicates a higher maturity than the competing UDF. Performance and fuel efficiency are currently examined. Applications for upgrades of the A320 or B737 are already realistic. The companies that have developed these technologies therefore do currently have a strategic advantage. The competitors with the open rotor now operate under time pressure, as they need to prove fuel efficiency and noise certification capability before the programs for the A320 / B737 successors are launched.[147]

High power density electric motors for the use in commercial aircraft are also examined if they could provide a significant level of competitiveness in the years to come. Fuel cells as an emerging technology might also have a great potential in the future. Another area of research is dedicated to oil-free systems. Moreover, researchers are the opinion that a variable pitch for fan

146 Turbines run most efficiently at high speeds, and fans at low speeds, so turbofan engines have to compromise between the two, because the engine's design requires them to turn at the same speed. Unlike a conventional turbofan, a Geared TurbofanGeared Turbofan uses a gearbox instead of a shaft between the fan and the turbine, which allows the turbine to operate at a high speed while driving the fan at a lower speed. In February 2009 P&W said that in tests, this design had proved capable of "double digit" improvements in fuel efficiency and emissions, and a 50% reduction in noise. See: The Economist, 03.05.2009, "Shifting gears".

147 GE carried out test flights with an open-rotor engine in the 1980s, and reckoned it would use 30% less fuel than similar-sized engines of the time. (See: The Economist, 03.05.2009, "Shifting gears"). However, analyses incorporating aircraft design aspects suggest that relative reduction effects are considerably lower than published in the literature in the past, see Seitz et al. (2009) However, analyses incorporating aircraft design aspects suggest that relative reduction effects are considerably lower than published in the literature in the past, see Seitz et al. (2009)

blades can achieve high thrust at high speeds. This technology as well as achieving high RPM/no thrust conditions can contribute to a better performance in the years to come. However, these technologies are far from any realistic applications in the coming decade.

3.4.7 Fuels

Aviation fuels need to deliver a large amount of energy per unit of mass and volume in order to minimise the weight of fuel carried for a given range, the size of fuel reservoirs, and the drag related to on-board fuel storage. They also need to be thermally stable, to avoid freezing or gelling at low temperatures, and to satisfy other requirements in terms of viscosity, surface tension, ignition properties and compatibility with the materials typically used in aviation.

The fuel crisis in 2008 has shown how sensitive airlines react to rapidly rising fuel costs. The majority of airlines have not yet updated their business models for such high kerosene prices. The industry currently puts a lot of effort exploring the possibilities of alternative fuels to decrease price variability and general dependency from crude oil and especially to reduce emissions, maybe through the use of a fuel based on biomass.

Various types of alternative fuels for future applications are therefore currently being researched. There are three big classes of fuels: fossil based fuels from coal and natural gas, alternative kerosene fuels based on biomass as well as hydrogen fuels. Alternative kerosene fuels can be produced by applying the Fischer-Tropsch processes with coal and natural gas. But also biomass, such as algae and other high energy plants can be used to produce kerosene similar fuels.

Hydrogen is not a viable alternative for the coming decades, due to several problems with infrastructure, storage and energy density. Liquid hydrogen admittedly delivers a large amount of energy per unit of mass, but not per unit of volume. Past attempts, like the “Cryoplane” project, showed that aircraft using hydrogen as propulsive energy source (not just for on-board electric systems) have therefore to be redesigned and need much larger fuel tanks. Other options, such as methane, methanol and ethanol, are characterised by unacceptably low energy density and energy per unit mass, and are therefore not likely to be used in aviation.

To achieve the best benefit out of any new fuel in the short to midterm, a drop-in solution is favoured. This would imply that the new fuel could be used in the existing aircraft fleet. The use of an alternative fuel could well start in the next decade. However, due to production side problems, such as the availability of biomass, large necessary investments, a large scale application of these fuels is unrealistic in the next 5-10 years.

The European Union is currently financing several activities to develop alternative aircraft fuels. The most important initiatives are “Alpha bird” and “SWAFEA”. SWAFEA is dedicated to a comparative assessment of the most promising short-to-medium term options for alternative fuels, including biofuels. The study shall contain an analysis of the environmental sustainability in view of a possible roadmap for policy measures.[148]

[148] The websites for Alpha bird and SWAFEA are: http://www.alfa-bird.eu-vri.eu and http://www.swafea.eu

3.4.8 Flight Mechanics, Navigation, Control and Avionics

Avionics, or aviation electronics, comprise electronic aircraft systems like fly-by-wire (or even fly-by-light) flight controls, system monitoring, anti-collision systems and pilot assistant/interface systems like communication, flight management systems, navigation, or weather forecast. There is a growing need to improve the interconnection of those systems to increase the overall system efficiency, safety and redundancy. Additionally, cross-linking these on-board systems with general air-traffic guidance systems and other ground systems has the potential to increase air-traffic management efficiency and thus reduce emissions. ACARE (2004) identified high precision IFR landings and flight management systems based landings as areas of great importance. Data fusion and signal processing for pattern recognition as well as ground and flight obstacle detection and avoidance systems are important technology drivers to push such approaches. From the standpoint of the aircraft manufacturer advanced avionics to support aircraft operation and maintenance lead to an outstanding impact on the manufacturers' competitiveness. Extended maintenance designs and innovative integrated systems (highly cross-linked avionics) between aircraft and maintenance systems can provide the necessary step change and have an important impact on the costs of aircraft operation.

European competencies in avionics are for example in pilot night-vision systems for helicopters (superimposing a flight trajectory in the pilot screen for the landing approach), Traffic alert and Collision Avoidance System (TCAS) or the fly by wire technology. Airbus and Eurocopter were the first companies worldwide to introduce this technology in civil aircraft or helicopter. Fly-by-wire control systems have replaced manual hydro-mechanical flight control systems to a large extend by electrical and electronic system architectures. The mechanical pilot control input is converted to electric control signals, and flight control computers determine the deflections of the control surfaces powered by actuators. Cockpit and display systems (CDS) and onboard navigation systems (OANS) are important civil aircraft applications, while the helmet-mounted sight display (HMSD) and the operator control panel (OCP) are primarily military helicopter applications. Thales (FR) and Diehl Aerospace (DE, FR) and Liebherr Aerospace (DE, FR) are major European vendors of flight avionics.

3.4.9 Cabin

Current studies imply that the aircraft cabin has a very high improvement potential. According to ACARE (2004) a mission adaptive cabin can be seen as a pacing technology as of today. That particular research area is believed to reach technological maturity within the next ten years. Researchers also propose a removable cabin for passenger aircraft. But this particular technology still is in an early stage of research. Currently aircraft manufactures are testing various new interior environments. New lighting concepts as well as new materials are used to generate a better ambient for the future air traveller (see B787, A350). Especially the airlines hope to be able to gain a competitive edge through a potential product differentiation which has not been seen in the past. In addition, a flexible cabin layout which could be easily adapted to fluctuating demand (throughout the day and the year) would tremendously improved airlines profitability.

3.4.10 Systems Engineering/Processes

As for the product development process some players in the aerospace industry have expressed the need for a multidisciplinary virtual design in the future. Also, it is essential to improve the

European research infrastructure in order to achieve world leading standards. Furthermore, as discussed before, the entire supply chain needs to be more competitive at all levels and suppliers actively have to contribute to the necessary research. As stated at the beginning of this chapter, certification and qualification processes are still very strict. Thus it is of great importance to assist the rapid introduction of new and innovative technologies.

3.4.11 Carbon-Fibre Composites for the Aerospace Industry

Composite materials play an ever increasing role in modern aircraft structures. For the Boeing 787 and the Airbus 350 XWB as much as 50% of the primary structure will be made up of (carbon fibre) composite materials (by weight), compared to only 5% of the original Boeing 737. Europe has always been in the lead with the dissemination of carbon fibre in aircraft (Figure 3.43).

Hexcel, the American based company, is a global leader in advanced structural materials. With sales of over USD 1.3 billion and sales and manufacturing locations in America, Europe (Spain, France, Italy, Belgium, Germany, Austria and the UK), Brazil, China, Japan and Australia the company offers the full spectrum of advanced material solutions and generates 52% of its sales in the commercial aerospace sector and an additional 18% in the defence and space sector. HITCO Composite Materials of the US and the Japanese Toho Tenax company with two plants in Germany and total sales of USD 410.8 million are also leading producer of carbon fibre.

The only European company in the sector of composite materials with revenues over EUR 1 billion is the Dutch TenCate. This company has a noteworthy stake in the US market. However, it has been less successful in benefiting from the increasing use of composites in the AI and could not secure any large contracts. In January 2008 TenCate acquired YLA and CCS Composites.

Another larger European company is Austrian FACC but with EUR 251 million considerably smaller than TenCate. FACC is specializing in the development, design and manufacture of composite components and systems for civil aircraft. The firm offers a wide range of components, for aircraft fairings, fuselages, wings, engines and engine nacelles, components for and complete aircraft cabins. FACC works for many OEM-manufacturers. FACC is involved in the aircraft development programs for the Airbus A380, A350 XWB and Boeing 787 Dreamliner.

The presence of big companies with European headquarters in the AI's value chain is scarce, in spite of the European lead in the application of carbon fibres in the manufacturing of aircraft. Risk sharing partnerships and changing supply chain requirements favour large producers. This is understood as one explanation why Hexcel was awarded the contract to provide primary structural composite materials for the Airbus 350 XWB and expects the 350 program to generate USD 4 billion in revenues through 2025.[149] Hexcel runs to production sites in Spain and have been integrated in the Spanish R&D network on CFK.

The large potential of composite materials in aircraft manufacture is attracting the attention of companies that have until now focused on different sectors. SGL Carbon, one of the world's leading manufacturers in carbon related products - with sales in 2008 of EUR 1.6 billion - an-

[149] The success of Hexcel underscores one of the strengths of the US AI: The existence of large companies in the value chain with high risk sharing potential that attract OEMs. The competitiveness of the big US players is often based on its mere size and not necessarily driven by a lead in technology.

nounced its intention to enhance its turnover in the aeronautics markets. Through its subsidiary HITCO SGL is planning to form a Joint Venture to develop its aerospace business. HITCO is already an important supplier to Boeing. Since more than 50 years HITCO is supplying to Boeing and in recent years has been awarded several supplier awards. HITCO, supported by SGL, has made large capital investments in equipments, plant upgrades and capacity expansion to produce more efficiently and to consolidate its position as a 2nd Tier supplier of composite materials to the AI, such as aero structures to Boeing for the 767 and 787 commercial airplanes and C-17 Transport Aircraft program.

4 The Framework Conditions for the European Aerospace Industry

This chapter addresses general framework conditions for the aerospace industry (AI). The first topics under examination are labour forces and skills. The high-tech engineering industry depends on the availability of a flexible and high-skilled labour force. In the ongoing demographic change the sector is in competition with other sectors and needs a quantitative and qualitative employment planning. The bulk of aeroplanes are manufactured for a global market. For the immense internationality of the business, entry rules and rules for a fair trade and competition are prominent parts of the aircraft business framework. Several European initiatives and studies have dealt with aeronautics and the industry's competitiveness. This includes technological R&D projects as well as more strategical issues. Two of these will be briefly presented: the framework programmes and the Advisory Council for Aeronautics Research in Europe (ACARE). Furthermore the European air traffic management is focused. The "Single European Sky" is a European Commission initiative by which the design, management and regulation of airspace will be harmonised throughout the European Union (European Common Aviation Area, ECAA). Since the world is in the grip of a liquidity driven global crisis access to finance is in the spotlight. This is the fourth part of the chapter on framework conditions. For the aerospace industry, which is a global and capital intense business, the crisis is a big challenge. It hit both the demand side of the aerospace industry with airliners and leasing companies confronted with a credit squeeze and the supply side.

4.1 Labour Force and Skills

4.1.1 Introduction

Labour forces and skills matter very much for the high-technology and high-skilled business of the aerospace industry. Therefore it is essential for the competitiveness of the European aerospace industry that it can resort on a wide reservoir of skilled and qualified labour supply. Generally, the quality of the education and training in Europe shows a high standard, but there is no guarantee that Europe can keep pace with the changing world in a way that it maintains or enhances its technological position. As the demand for professional engineers and technicians probably will grow on all levels of the value chain, the recruitment of qualified personnel could turn out to be difficult.

The importance of the human capital side of aircraft production suggests treating the labour force and skills related issues separately. The preoccupation of the issues can start from two basic points of view. The first and predominant perspective starts from the question what the industry needs. Basic questions are whether there is a workforce who meets the demand of the aerospace industry both in terms of quantity and in quality. The issues may be treated in a static or in a dynamic way but in the focus is always the industry and its labour and skills demand. The second perspective starts from the condition of the special industry labour market and from the point of view of the labour supply and the working conditions. Its basic questions are how save the jobs in this industry are, how continuous the employment histories are and how prevalent temporary employment is.

Both perspectives are not exclusive and without any interrelation but to a certain degree regulate the facets which can be addressed or contrariwise which can be marginalized. Most of the available studies, research results or advisory group reports focused on the industry perspective. Well-known examples are the ACARE reports and the STAR 21 study (Strategic Aerospace Review for the 21st Century).

The Addendum of ACARE, 2008, although concentrated on environment, alternative fuels and security, spends some attention to the skill base of the aerospace industry. It ascertains a continuing lack of transferability of education in aviation related subjects around Europe. The educational coherence is still too low in Europe. The Advisory Council for Aeronautic Research (ACARE) in Europe expects from abolishing deficiencies a substantial increase in the exploitation of Trans-European research synergies. For the AI harmonized education, better and consistent accreditation schemes as well as more soft skills are important objectives to be met. However, ACARE sees a disappointing progress in infrastructure, which is necessary for better research effectiveness.

The European High Level Advisory Group on Aerospace which worked out the STAR 21 study regarded it as a central task to safeguard and further develop a strong European skills base which is a key factor in maintaining global competitiveness and retaining investment in Europe. The overall performance of education and training must be improved and a balance between initial und continuous vocational training has to be established. The advisory group saw signs for increasing difficulties to recruit highly qualified personnel. It was recommended to increase cooperation between a broad range of public and industrial actors and to improve the transparency and recognition of diplomas and certificates. Generally the overall quality of the European vocational training should be advanced.

Compared with the main competitor, the U.S. aerospace industry, most European aircraft production sites are located in countries where relatively high standards of labour legislation are in force. US experts put some emphasis on the statement that this is a disadvantage which concerns all tiers of the aerospace industry because it complicates the expansion or contraction of production workforce size in accordance with production levels (U.S. Trade Commission, 2001, 4-8). But this conjecture has not yet been proved. Quite contrary to the statement, US aeronautic companies use the European production sites too.

In response to restricted (external) flexibility of national labour policies regarding termination of employment in a highly cyclical industry, European aerospace producers manage employment levels, partly by implementing innovative employment schemes. For example, Italian aerospace manufacturers hire workers on 3- to 5-year contracts, providing employment flexibility; in Germany, employees can be borrowed from other aerospace firms and Airbus U.K. employs a significant number of contractors that can be released in periods of slack demand. Airbus itself places an increased number of staff on temporary contracts to provide greater employment flexibility. Moreover, some European aerospace producers have greatly automated their operations to reduce the impact of any labour imbalances and improve productivity.

New business strategies and the structural transformation make an impact on labour quantity and quality. According to the business strategy of the dominant player, Airbus, the company is doing less of the direct manufacturing of its products. The strategy shifts production to tier 1 contract companies which therefore have to accept more of the burden of risk. This forces contractors to increase productivity to save cost. In conjunction with risk sharing tier 1 companies pass cost saving pressure down the supply chain. Standard employment relationship erodes. In Germany until 2001 fixed-term contracts were applied to increase the workforce. After the downturn following 10/11 the prime manufacturers strategy was changed, fixed-term contracts were phased out and temporary workers were phased in. This came along with the dismissal of employees, resp. fixed-term contracts expired. In an attempt to reduce costs aircraft manufacturers and companies of the supply chain offshore work to cheaper locations across the world. Power8 and Vision 2020 (EADS) are globalisation strategies which includes the displacement of production. This globalisation is aimed at market entry but it is also aimed at low-cost-production locations. This kind of offshoring is leading to a loss of medium- and low-skilled employment. Cost-reduction can also be gained by Dollarising manufacturing by shifting work directly to the US companies or to countries whose currency is benched on the Dollar. Exchange rate driven offshoring is potentially leading to a loss of skilled employment in Europe and is therefore diminishing future job opportunities.

4.1.2 Employment Level and Structure

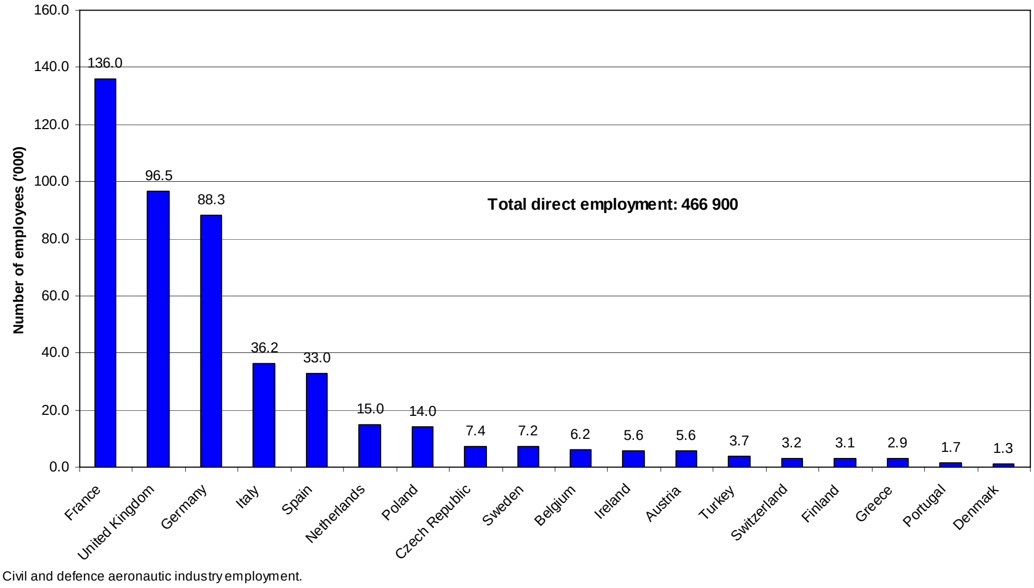
Regional distribution

According to ASD data (2008) 466,900 persons were employed in European Aeronautic Industry. Compared with 2007 this was an increase of 5.6%. The data comprise 18 countries and do not discriminate civil from defence employment (Figure 4.1)[150]. This discrimination is hard to accomplish but isolated information exists. Supposed the share of civil employment in aeronautics is equivalent to the share of turnover on civil products than around 60% of the direct employment in European aeronautics has to be attributed to the civil sector.

Nearly 85% of the direct employment in aeronautics is concentrated in five countries (UK, France, Germany, Italy and Spain). 90% of employment is covered by these countries plus Poland and the Netherlands. Major contributors to the 2008 rise in employment were France, Spain and Germany.

[150] Employment data depend – like other statistical data – highly on survey methods, discriminations and definitions. The differences to Eurostat data are discussed in Chapter 3.

Figure 4.1 Direct Employment in European Aeronautic Industry by Region (2008)



Source: ASD, Facts and Figures 2008.

Skill mix

The quality of the high-tech aerospace business is reflected by the skill mix of industries. ASD data (2007) report 35% of jobs in aeronautics (civil and defence) are highly skilled jobs (engineers, managers) and 32% of employees received an education below university level (technicians, draughtsman, craftsmen, secretaries, etc). According to ASD (2007) data 35% of employees were graduates, engineers, managers etc., 33% manual workers and 32% others. Most manual workers have been trained at the highest level.

An illustration of the particular skill mix of AI (civil and defence aeronautics, space) is provided by the case of EADS (Table 4.1). The competence level of the labour force in this company is rather high. Around 45% of employees have achieved a university education and another 41% are qualified on the vocational training level.

Table 4.1 EADS: Employees per Qualification

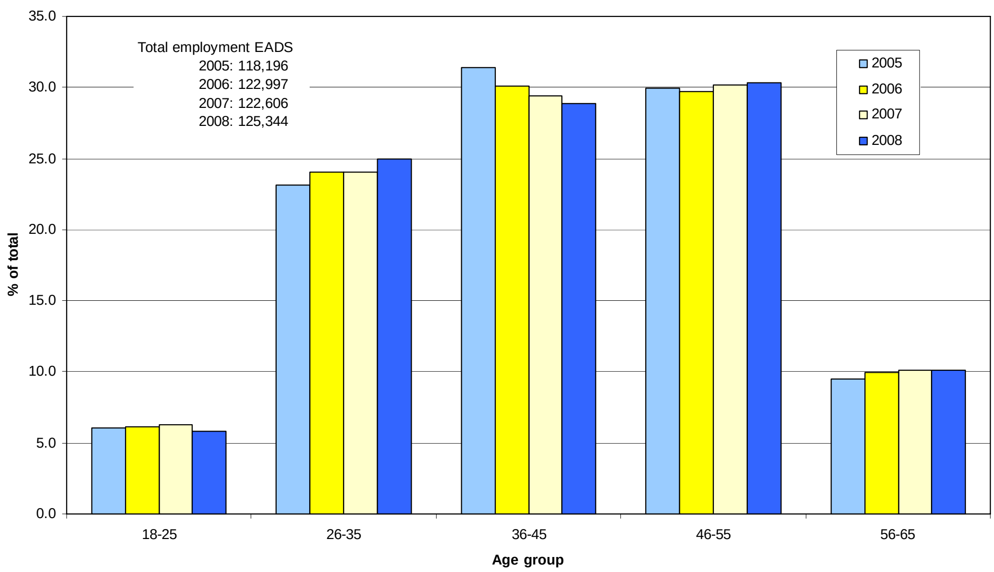
Qualification groups	2005	2008
University (4 years and more	24,0%	25,8%
University (up to 3 years)	18,9%	18,9%
Higher vocational school	11,3%	8,8%
Vocational school	41,5%	41,3%
General school	4,3%	5,2%
Total	100%	100%
Number of employees	118,196	125,344

Source: EADS Report, Corporate Responibility & Sustainability 2007, 2008.

Age and gender distribution

In the course of the last 20-30 years industry employment experienced a concentration of age structures in the middle age range (35-50 years old employees). Lower recruitment rates of young persons – partly due to longer education and training periods – and a broad use of early retirement schemes increased the weight of the age groups which lie in between. When this middle-age-range of employees reaches the age of retirement, replacement rates will increase. There are no detailed and explicitly aeronautical industry figures of the age distribution of the workforce available. Therefore, to approximate the situation, information is taken from EADS, a giant in the sector (civil aeronautics and beyond). Figure 4.2 shows the age pyramid of EADS (civil and defence sectors, space included). The share of older workers (56 to 65 years) increased slowly since 2005 and reached 10.1% in 2008. 30.3% of the workforce is aged 46 to 55 years. This is currently the strongest age group. Despite the shifts of the age distribution the average age of the workforce has not changed. It is 42 years in 2008 as it was in 2005.

Figure 4.2 Age Distribution of Employees at EADS



Source: EADS Report, Corporate Responibility & Sustainability 2007, 2008.

The gender distribution in AI is highly imbalanced. Less than 15% of the workforce is female. In 2008 13.2% of the workforces at the Airbus division of EADS were women. The activities of women in EADS and in total AI companies concentrate in administrative and marketing tasks. The female quota at EADS headquarters was 22.0% in 2008. The traditional rule is: The higher the portion of manufacturing, the lower the quota of women. But in total there was some, but still small progress in the feminisation of the workforce in past years. The development at Airbus illustrates this hesitant progress. The female quota grew from 12.7% in 2005 to 13.2% in 2008.

4.1.3 Skilled Labour Force Demand and Supply

Worries about skill shortages are widespread in aerospace industries. European industry sources indicate that availability of skilled workers and engineers has emerged as an important issue, particularly as the demand for such workers grows with increased European production of civil and military aircraft and requirements for R&D programs. Experts estimated that Europe's aerospace industry faces a shortage of perhaps 25,000 engineers per year (Wall, 2009). Demand for European aerospace workers, who are highly skilled is also growing at the lower tiers of the industry. These producers are increasing their technical staffs to handle work and responsibilities outsourced to them by other firms. At the same time the attractiveness of AI career-paths is still too low. Universities, companies and local authorities have to attach more importance to the building of the workforce of tomorrow. Attractiveness of an industry is a complex concept and includes besides working conditions, wages and other core facts also “soft” elements like identification with the product, projects which can be seen trough from the beginning to the end and a more integrated or holistic approach. Examples for good approaches exist. Different aerospace (and defence) companies operate summer internship programmes and promote the interest of pupils and students. University courses are enriched by a pilot training for prospective engineers at the flight simulator (University of Darmstadt, Germany).

Most of the worries about skill shortages are directed at engineering. In German manufacturing, e.g. engineers were strongly looked for before the impacts of the financial crises hit the export positioned manufacturing sector. According to the calculations of the German Engineers Association (VDI) there was a deficiency of 63,800 Engineers in 2008. Nearly half of this shortage was caused by the professions mechanical engineering and automotive engineering. During the preceding years engineers retired at the average age of 62.1. Because of the demographic process there are concerns that more engineers leave the labour force than young engineers can grow (or want to grow) into the industries.

Partly skills shortages are the result of business policies and of undesirable developments of the production process. If staffing policies and cost saving business programmes are directed to keep capacities lean then short- and medium-termed additional demand is hard to satisfy. Experienced engineers often have to be poached from the sector. Restrictive policies, like the Dolores programme in the 90s damaged the image of aeronautical employment and discouraged students to enter the aeronautic engineering studies. Undesirable developments are another dimension which contributes to skill shortages. As existing programmes like the A380 and the A400M had to cope with problems they absorbed more engineering capacity than originally planned.

But concerns about skill shortages are not a German singularity. E.g. Britain faces also a lack of engineers. Sir John Rose from Britain’s prestigious Rolls Royce Company warned of the skill crisis in his country. He asserted that about a quarter of annual intake of graduates comes from overseas, mainly from Germany and the USA. The skill basis lurks to melt down severely. For instance there seems to be a diminishing interest in professional physics. Since 1990 the number of people taking physics A-level has fallen nearly 40% from 45,334 to 28,119 in the UK.

The US is also concerned by shortages on the engineering level. Top aerospace companies such as Boeing are looking how they can address a potential shortage of aerospace engineers in coming years. There has been a steady decline in the number of engineering graduates in the US since a peak in the mid-1980s. Fewer students at engineering schools are opting for aerospace careers, favouring high-paying high-tech careers in other fields instead. Albeit there are similar concerns in Europe, the situation is different in the USA. The science community in the USA relies on greater inputs from abroad and without foreign-born employees the pace of innovation not only in the AI would slow down. Around half of all engineers with PhDs in the US workforce under the age of 45 are foreigners. This is an overall statement and does not exclusively qualify the situation in the aerospace sector. Boeing is working hard to increase engineering participation of minority groups in the AI. Women are by far under-represented in the AI and could contribute to overcome the shortage in qualified staff. This is also true for the European situation.

Although concerns about a shortage of skilled labour are prevalent in European countries it is not straightforward to verify the situation. Available information does not consistently underpin the concerns. Information from the fieldwork during 2009 gives no clear indication of serious recruiting problems or skill shortages. This depends on the looming downswing of the aircraft production and yet progresses slowly (and slower with an increasing qualification level) but nevertheless currently the competition for workforce experiences a relaxation.

The relaxation with the labour supply should not be taken as a signal to weaken endeavours to promote workforces. The short term cyclical effects of the imbalanced skilled labour demand and supply are embedded in trends which span over at least two business cycles. The predominant demographic development in Europe which is characterised by an aging population and declining younger age cohorts in connection with lower proportions of qualified young people who are opting for mathematics, physics and engineering is a concern for the aerospace industry (and for other industries too). The Organisation for Economic Cooperation and Development (OECD) analysed the graduation by field of education in its member countries and ascertained that the share of graduations by field of education at tertiary-type A level (including advanced research qualifications) has changed slightly over the past six years to the benefit of health, welfare, social sciences, business, law and services. Those areas represented around one-half of graduates in 2006. Rates in natural science-related fields (engineering, manufacturing and construction, life sciences, physical sciences and agriculture, mathematics and computing) have decreased (OECD, 2008, p. 81). Selected results for a sample of countries are given in Table 4.2.

The OECD statistic is a limited indication for a relatively declining interest for natural sciences and engineering. It does not present insight in country specific differences or in motives or incentives for the shift in graduations, but it is an indication to address the qualification issue continuously and to make provisions to meet challenges. To support a better match between demand and supply (quantity and quality), to attract workforce and to strengthen the motivation of young (prospective) academics, industries, associations, unions, labour agencies, chambers, authorities and education and training institutions should co-operate.

The existing aerospace clusters are a natural starting point for this cooperation. The successful example for such cooperation and for a private-public engagement is the Hamburg Qualification Initiative which started in 2000 and developed from a recruitment-oriented initiative to an organization which developed the infrastructure. Additionally this initiative is an activator of transnational cooperation and exchange for training and education and thereby of transnational workforce recruitment. The purpose of the Hamburg Qualification Initiative is to provide the aeronautics industry in the short- middle- and long-term perspective with qualified workforce. The initiative was taken by the Hamburg Public Authority for Economy and Labour (BWA) and a first step was to invite the representatives of aeronautics for a round-table meeting. A first concrete result was an advanced training course in cooperation between Airbus, smaller enterprises and the University of Applied Sciences. This project strengthened the confidence and the motivation for cooperation. Based on this starting point, the Hamburg Qualification Initiative extended activities to other measures and projects:

- Expansion of university courses in cooperation with enterprises
- Creation of new training courses
- Organizational reforms on the public side of vocational training to strengthen efficiency.
- University courses and company demand
- Development of advanced vocational training

- Development of a transnational network
- Development of long-term perspectives to interest children (especially girls) for aeronautics by holding special university courses and summer camps.

Table 4.2 Tertiary-type A and Advanced Research Programmes Graduates, by Field of Education (2000 and 2006)

Countries	Life sciences, physical sciences agriculture		Mathematics, arts and education		Engineering, manufacturing and construction	
	2000	2006	2000	2006	2000	2006
	in %					
Austria	9.2	8.7	3.6	9.1	17.3	14.5
Belgium	11.8	10.2	37.9	36.5	12.5	11.3
Canada	9.3	6.6	39.6	39.0	8.2	8.2
Czech Rep.	8.2	7.5	8.3	4.4	15.5	16.2
Denmark	11.9	4.5	2.8	4.0	9.0	10.2
Finland	6.9	5.7	26.1	29.2	24.0	20.7
France[1]	13.3	8.8	5.5	5.9	11.2	12.6
Germany	m	8.9	m	7.8	m	12.6
Hungary	4.8	4.1	1.1	4.6	9.8	6.3
Ireland	11.8	14.8	9.6	-	9.3	8.0
Italy[2]	6.9	6.6	3.7	2.1	16.0	14.9
Japan	7.8	7.9	-	-	21.3	19.7
Netherlands	6.0	3.3	1.7	4.6	10.6	8.3
Poland	3.7	5.1	1.4	4.8	8.0	8.6
Portugal	5.4	6.6	3.3	5.9	11.2	11.7
Slovak Rep.	6.6	7.7	4.6	4.0	15.4	15.3
Spain	8.7	7.1	4.4	5.4	12.9	14.3
Sweden	5.8	4.8	3.7	3.8	20.5	18.0
Switzerland	9.0	9.5	6.9	4.0	15.7	13.0
UK	12.0	8.5	5.5	6.8	9.9	8.8
USA	7.9	6.2	3.7	3.9	6.5	6.2
OECD (av.)	8.4	6.9	4.2	5.2	12.5	11.9

[1] Year of reference 2005; [2] Advanced research programme graduates refer to 205.

Source: OECD 2008, p. 89.

4.1.4 Labour Mobility

Workforce mobility is an important concern for the European AI. Cultural, linguistic, and legal differences among European nations present challenges for companies desiring to shift work and employees between countries. For example, pension fund requirements and transferability vary among EU countries, which can negatively affect an employee's willingness to move and thus deter worker mobility and limit a firm's employment flexibility.

Aerospace, as a multinational sector, makes it evident that European industries grow together. This means bringing together multiple traditions and institutions and making them work across former borders. This is necessary for training and education where, over many years, every state had developed its own unique education and training system. Internationalisation requires transparent and recognised training courses and graduations. The Pan-Europeanization and internationalisation of production increases the demand for a more internationally focused workforce and a greater focus on language and cultural competences. Several companies have developed their own international modules within existing national training systems (e.g. Airbus apprentices can apply to change temporarily to other production sites)

Multinational companies (e.g. EADS) are keen to establish uniform education and training ideas. The aim is to provide skilled workers from different states with comparable qualifications to enhance mobility between European production sites and to improve international work capability. Intensified European cooperation pushes considerations for a transnational European vocational training system, which does not annul national traditions. An Instrument for this harmonisation is given by the European Qualification Framework (EQF). Especially the AI makes efforts to establish an European education and training framework.

The national cluster initiatives and the new European Aerospace Cluster Partnership (EACP), a network of European aerospace clusters in the framework of CLUNET, constitute opportunities to develop and expand transnational education and training programmes. The Hamburg Qualification Initiatives has demonstrated that transnational cooperation is viable. This Initiative established an exchange in the field of training and advanced training between the aviation clusters of Hamburg and the French aerospace valley of the regions Midi-Pyrénées (Toulouse) and Aquitaine (Bordeaux). In 2004 Hamburg and Toulouse agreed upon a network of aerospace suppliers, schools, universities and training and advanced training institutions. The programme has developed from the exchange of trainees to integrated transnational vocational training courses. In the meantime transnational activities are expanded to Spain (Seville) and Italy (Campania) where, according to the successful experience of the German-French program the network is in the construction phase.

One specific European obstacle to mobility is the language. This does not only refer to the employee himself/herself but the family if it would be necessary to move. In some Member States of the Community language teaching is not widespread and many people only possess basic skills. This aggravates short term cross-border missions.

4.1.5 Labour Force and Qualification in Non-European Countries

United States of America

In 2002 the Commission on the Future of the Aerospace Industry reported that the U.S: aerospace workforce was in jeopardy. It identified basic trends and deficiencies. It pointed to a significant reduction in the number of U.S: workers, partly because of a loss of jobs through outsourcing and off shoring, observed a lack of young workers who are attracted by the aerospace industry and pointed to a need for more mathematics and science education in the United States (US Trade Commission, 2001, 3-7). Later Commission reports confirmed the continuation of the findings (U.S. Trade Commission, 2008, 3-7).

Although various sources report conflicting figures on the number of workers employed in the U.S. aerospace manufacturing industry,[151] the trend is clear: According to the Aerospace Industry

[151] The Aerospace Industries Association's (AIA) figures appear to overstate employment. They include a significant group of employees who manufacture products —"search, detection and navigation instruments" — that may or may not be used in aerospace applications.
The Census Bureau's data is not up to-date. Its most recent data is based on a sampling of a survey originally conducted before 2002.

Association (AIA), the number of U.S. workers employed in the aerospace industry fell by almost half from 1990 (when there were 1.1 million employees) to its low level in 2003 (with 587.1 thousand workers). The workforce in the aircraft sector (civil and defence) shows a similar downwards trend (Table 4.3). In 1990 around 390 thousand were employed with aircraft production, in 2004 this number was nearly halved (207.2 thousand). The employment decline cannot be ascribed to the terrorist attack in September 2001. It was a long-term trend as manufacturers had consolidated their operations and attempted to reduce production costs by eliminating duplicative manufacturing activities. Increases in manufacturing productivity, the elimination of jobs associated with mergers and acquisitions, cutbacks in defence procurement following the end of the Cold War, and an increased offshore sourcing of components diminished the demand for labour force. Since bottoming-out in 2004, U.S. aerospace employment has slowly turned upward. The number of workers for 2008 was 237.0 thousand, 14 percent up from the 2004 figure.

While their numbers have declined over the last 15 years, American aerospace workers are well paid. In early 2007 e.g. the average hourly wage rate for aerospace production workers was USD 27.79, almost 64 percent higher than the wage rate for U.S. manufacturing production worker in general (which was USD 16.99). Labour costs are – among others – reasons for offshoring. Traditionally this was true for manufacturing and low level, standardized work with restricted technology content. But long ago this has changed and engineering has become a field for offshoring to save costs. Boeing has invested more than USD 1 million in a cooperative program with Russia, including the development of the Boeing Moscow Design centre that supports around 1,300 Russian engineers. Costs are important for arrangements of this kind but there are also other reasons for the relocation of qualified work. Market access and the demand for scarce skills are of great importance too. All great players locate engineering activities in countries to get access to aerospace competence and to be present in important markets. Airbus established engineering centres in Wichita (Kansas, USA), Moscow (Russia) and in Bejing (China), in Mobile (Alabama, USA) and Bangalore (India).

The Bureau of Labour Statistics' (BLS) data may be preferable, among these three sources, because it cannot be questioned with having an industry bias (as is the case with AIA) and is not outdated (as is the case with Census data). Moreover, BLS data is based on monthly sampling, as opposed to Census' annual survey.
Here we used the BLS based data published by AIA.

Table 4.3 Employment in US Aerospace Industries

Year	Total aerospace	Total aircraft & parts	Aircraft
	In Thousands		
1990	1,120.8	672.2	389.7
1995	672.6	425.1	249.0
2000	666.1	438.4	242.7
2001	660.7	434.5	241.3
2002	618.4	396.7	220.2
2003	587.1	371.9	209.1
2004	592.0	369.9	207.2
2005	611.7	380.0	211.3
2006	631.8	398.5	221.7
2007	646.8	413.6	230.2
2008	657.1	427.1	237.7
2009[1]	652.0	423.5	239.2

[1] Forecast by AIA.

Source: AIA based on data from the Bureau of Labour Statistics (BLS), 2009.

Some of the jobs in aerospace industry moved from the U.S. to other countries because of an "offset". An "offset" is industrial compensation required of suppliers as a condition for selling to a government-owned or – controlled entity, this is also dubbed as local content. Offsets may involve subcontracting, co-production, and technology transfer. U.S. trade policy opposes offsets because of the adverse effects they may have on the U.S. economy**.** The movement of jobs to overseas occurs when a U.S. manufacturer transfers the acquisition of aircraft parts from a U.S. supplier to a foreign supplier, as mandated by a foreign government.

Unlike defence offsets, the magnitude of which is analyzed annually by the Bureau of Industry and Security, there are no studies that quantify civil offsets. However, from anecdotal evidence it appears that offsets in civil aircraft trade are increasing. Even when no offset is formally required, U.S. civil aerospace manufacturers may feel pressured to source components from overseas in order to win sales. In some cases, governments play Airbus and Boeing against each other to gain the most favourable offsets concessions possible.

Offsets can have cascade effects on the supply chain. Prime manufacturers, such as Boeing, may require that their major component suppliers, such as engine manufacturers, share in the offset requirement. These major component suppliers, in turn, may pass the requirement further down the supply chain to their suppliers.

It was noted by several observers that there are difficulties for the aerospace industry to attract and retain younger workers. According to the Commission on the Future of the U.S. Aerospace Industry, 13 percent of aerospace workers were eligible to retire by 2007 (58 years of age and meeting corporate requirements). This proportion is actually rising in the the years after 2007. The average age of production workers in the civil aerospace sector was 44 and it was even higher at the National Aeronautical and Space Administration (NASA) (51%). According to the BLS, the proportion of workers in the aerospace industry of 34 years old or younger declined from 32 percent in 1992 to 16 percent in 2003.

A major reason for the low interest of young people in the AI was the long-term contraction in the number of workers. Compounding this is the “boom-bust” cyclicality of aerospace manufacturing. Anecdotal evidence points to too many workers who have been hired during good times, fired during lean times, and rehired, by the same company, when business conditions improved. According to the Aerospace Industries Association, in a survey of 500 U.S. aerospace workers, 80 percent said they would not recommend their children pursue an aerospace career due to workplace instability (U.S. International Trade Administration, 2007, p. 52 ff.).

A well-educated workforce grounded in engineering, the physical sciences, and mathematics is critical for the future of aerospace manufacturing in the United States as well as in Europe. There are a number of troubling indications about U.S. preparedness, especially when U.S. educational performance is measured against other countries. U.S. 12th-grade students performed below the average of 21 countries in a recent test of general knowledge of mathematics and science. Of 15 nations, 11 outperformed the United States in an assessment of students’ advanced mathematics skills. A shortage of mathematics and science teachers compounds the problem as do fewer engineering and science students earning degrees – from undergraduate to doctorate – at US colleges and universities. Foreign-owned companies and foreign-born inventors now account for about half of all U.S. patents. According to the National Science Foundation (NSF), the U.S. aerospace industry employed almost 145,000 engineers and scientists in 1986. By 2004, this figure had fallen to just over 40,000. NSF figures indicate that the aerospace industry employed 20 percent of all U.S. R&D scientists in 1979 – and just 3.5 percent in 2004 (U.S. International Trade Administration, 2007, p. 52 ff.).

Canada

Employment in the Canadian aerospace and defence industry was 78,800 in 2002 and fell to 75,000 in 2005. Since 2005 employment numbers have recovered and amount to 83,000 in 2008 (The Aerospace Industries Association of Canada (AIAC) data). Around 20% of the workforce is employed for defence production, 80% is allocated to the civil sector (including space and maintenance, repair and overhaul).

Skilled workforce has been identified as a significant competitive advantage for the Canadian aerospace industry; potential shortages of skilled workers in Canada may undermine this asset. Despite increased employment with some aerospace companies, attributed in part to cyclical employment patterns, shortages have occurred for machinists, tool makers, and software and systems engineers.

Industry officials attributed these shortages to a number of factors, including competition for recent graduates from other high-technology sectors, the attractiveness of the United States due to lower taxes and generally higher wages. Additionally the influx of European engineers and technicians has been reduced because of growing supply vacancies in the AI and other high-tech industries in their home countries.

China

The Chinese aerospace sector ranks among the world’s most dynamic sectors due to the massive investment injected by the government and overall economic growth. China is recognized in the global aerospace industry as an attractive source of labour as it provides an abundant supply of low-wage workers and a stable and practiced aerospace workforce. The enticement of low-cost manufacturing has benefited Chinese firms immensely, with LCA producers, their primes, and even lower-Tier suppliers such as those in Korea and Singapore placing work in China in an effort to alleviate the intense cost pressures they face from their customers by downloading labour-intensive processes. Further, China has a long history of aerospace manufacturing, and the state-owned enterprise system is such that the industry can support and retain experienced workers throughout downturns in the aerospace sector or downtime between contracts.

At the same time, the Chinese industry's inability to fully utilize and modernize its personnel resources may prevent Chinese aerospace firms from moving beyond their current secondary role in the global aerospace industry. For example, despite the low wages earned by Chinese aerospace workers, industry sources note that the amount of training and oversight required to ensure delivery of a quality, usable product means that it is sometimes more expensive to source from Chinese factories than US sources. This is particularly true with respect to more complicated structures — exactly the types of work Chinese industry officials indicate that the country's aerospace firms would like to undertake. Chinese industry sources also report that there is a serious shortage of people with the necessary depth of experience across the industry (Perrett, 2009). Chinese producers still have troubles taking full advantage of the country's engineering talent. In the past the sheer volume of China's aerospace workforce at approximately 281,000 employees, combined with the government's insubstantial efforts to trim aerospace employment, seemed to commit China essentially to a role as a labour-intensive manufacturer of lower technology items rather than a prime systems supplier. But times are changing and China's newly established Avic Aircraft intends to become the third force in making large airplanes. At the moment it is unknown whether this attempt will be successful. On the one hand one should not underestimate the country's determination to establish a first-rank aerospace sector, but on the other it is still a long way to go. The greatest hurdle is the serious shortage of people with the necessary depth of experience across the industry. This experience will not come over night. China also strives to build its own aero engines which are probably the hardest part of the commercial aircraft sector to break into.

Japan

In Japan, the aerospace industries benefit from a greater concentration of skilled workers and engineers, coupled with an employment system conducive to workforce stability. Over many years, Japan has developed its advanced and specialised factors in commercial aerospace through licensed production of US military aircraft and components and through its strengths in manufacturing process technologies.

Direct employment in the aeronautics industry (civil and defence) continued a downward trend for many years and bottomed out in 2006 with 30,967 employees. Since then no clear trend can be recognized. Compared with the 64 million workforces, direct employment in aerospace plays a minor role as compared with other industrialized nations.

Currently the the Japanese aircraft industry is poised to become a serious player in the global market for passenger jets (Pritchard, MacPherson, 2008). Japan's competitive advantages are strong in investments in education and training, endowing Japan with scientific and technological workforce focusing on R&D, along with tapping into global knowledge through direct investment and acquiring leading edge technologies from Western aerospace suppliers (Pritchard, MacPherson, 2008).

4.1.6 Conclusion

A skilled and qualified labour supply is essential for the competitiveness of the European aerospace industry. Generally, the quality of the education and training in Europe shows a high standard, but there is no guarantee that Europe can keep pace with the changing world in a way that it maintains or enhances its technological position. As the demand for professional engineers and technicians probably will grow on all levels of the value chain, the recruitment of qualified personnel could turn out to be difficult.

The predominant demographic development in Europe is characterised by an aging population and declining younger age cohorts. In the course of the last 20-30 years industry employment experienced a concentration of age structures in the middle age range (35-50 years old employees). Lower recruitment rates of young persons – partly due to longer education and training periods – and a broad use of early retirement schemes increased the weight of the age groups which lie in between. When this middle-age-range of employees reaches the age of retirement, replacement rates will increase. The aging of the baby boomer generation means that a growing percentage of the workforce will be eligible to retire in coming years. As women are by far underrepresented in the AI, initiatives to make working in the AI more attractive to female students and trainees contribute to overcome the shortage of qualified staff on the long run.

The demographic trend in connection with lower proportions of qualified young people who are opting for mathematics, physics and engineering is a concern for the aerospace industry (and for other industries too). Statistics indicate a relatively declining interest for natural sciences and engineering. To strengthen the motivation of young (prospective) academics and to attract skilled workforce, industries, associations, unions, labour agencies, chambers, authorities and education and training institutions should co-operate. Existing aerospace clusters are a natural starting point for this cooperation.

Worries about skill shortages are widespread in aerospace industries. European industry sources indicate that availability of skilled workers and engineers has emerged as an important issue. Demand for European aerospace workers, who are highly skilled is also growing at the lower tiers of the industry. Most of the worries about skill shortages are directed at engineering. Experts estimate that Europe’s aerospace industry faces a shortage of perhaps 25,000 engineers per year. The attractiveness of engineering studies is still to low and not enough young people counterbalance the demographic process. Concerns are high that more engineers leave the labour force than young engineers can grow (or want to grow) in. Labour shortages on the engineering level are not alone a European but also a US concern. There has been a steady decline in the number of engineering graduates in the US since a peak in the mid-1980s. But the situation is different in the USA. More than most European countries the science community in the USA can rely on inputs from abroad. Around half of all engineers with PhDs in the US workforce under the age of 45 are foreigners. This is an overall statement and does not exclusively qualify the situation in the aerospace sector. US aerospace industries are working hard to increase engineering participation of minority groups and of women in the AI.

Labour quantity and quality is influenced by business strategies and structural transformations. The prevailing European business strategy of prime manufacturers is to concentrate on core competencies and to do less of the direct manufacturing. The strategy shifts production to tier 1 contract companies which therefore have to accept more of the burden of risk. By this contractors are forced to increase productivity to save cost. In conjunction with risk sharing tier 1 companies pass cost saving pressure down the supply chain. Standard employment relationship erodes. Power8 and Vision 2020 (EADS) are globalisation strategies which include the displacement of production. This globalisation is aimed at market entry but it is also aimed at low-cost-production and at Dollarising manufacturing by shifting work directly to the US companies or to countries whose currency is benched on the Dollar. This brings employment under pressure at both ends. The less qualified labour is challenged by low-cost countries and exchange rate driven offshoring is potentially leading to a loss of skilled employment in Europe.

Workforce mobility is of growing importance for the European AI. Cultural, linguistic, and legal differences among European nations challenge companies desire to shift work and employees between countries. It is necessary for training and education to coordinate multiple traditions and institutions and make them work across former borders. Europeanization and internationalisation of production requires transparent and recognised training courses and graduations. It increases the demand for an internationally focused workforce and a greater focus on language and cultural competencies.

National cluster units and the new European Aerospace Cluster Partnership (EACP) constitute opportunities to develop and expand transnational education and training programmes. The Hamburg Qualification Initiatives can be taken as an example for a successful transnational cooperation. This Initiative established an exchange in the field of training and advanced training between the aviation clusters of Hamburg and the French aerospace valley of the regions Midi-Pyrénées (Toulouse) and Aquitaine (Bordeaux). The programme has developed from the exchange of trainees to integrated transnational vocational training courses. In the meantime transnational activities are expanded to Spain (Seville) and Italy (Campania) where, according to the experience of the German-French programme the network is in the construction phase.

4.2 The Openness of Third Markets

4.2.1 Introduction

The world markets for civil aeroplanes have always been an oligopoly and for large civil aeroplanes (LCA) even a close oligopoly. For several reasons a real competitive market could not develop. High development cost, long amortisation periods and the cost saving effect of static and dynamic economies of scale are basically the reason for high market entry barriers. The technological complexity of an aeroplane forces producers to finance research and development expenditure over extremely long periods. Therefore it is essential for producers to strive for higher market shares than their competitors.

The nature of airplane production and of the airplane market induces governments to intervene. In addition the aerospace industry is regarded as crucial to the national security and to technological leadership. Technologies which have been identified to be a material backbone of security systems are not left to the free market. As there is a strong interlinkage between civil and military aviation, the civil aerospace industry profits from the governmental engagement. The long-lasting US historic dominance in the commercial airplane sector was largely based on the technological knowledge developed for military purposes and programs. Besides the security case, state intervention is frequently justified by positive externalities and spill over effects to other industrial sectors. Moreover a critical role in maintaining a healthy economy is attributed to aerospace industries. It is a knowledge-intensive industry and therefore it employs top scientists, engineers and a vast range of highly skilled workforce. The high skill base and knowledge intensity of aerospace makes the aircraft industry "strategic".

The coordinated European governmental intervention for the Airbus revealed that it is possible to enter a market endowed with a multitude of entry barriers. European companies have received direct aid from the state which was justified as a compensation for the smaller financial base of European manufacturers and to match the indirect help of American defence spending. Both supporters and pundits of state intervention agree that without subsidies Airbus would not exist and Europe had one high-technology sector less in its industrial portfolio. The aerospace industry exhibits characteristics for a successful strategic trade policy.[152]

But strategic trade policy has always caused a provocation. Trade disputes between the main competitors European and the USA were a "natural" consequence. Now, Airbus and Boeing have been competing in the marketplace for decades. There have been GATT (General Agreement on Tariffs and Trade) complains in the past, as well as negotiated agreements. The preliminary last round in this trade disputes was launched by Boeing in 2004. This latest round of complaints lifts the debate on a higher level because of the new, more effective WTO dispute process and the more detailed subsidy rules that now exist. The US commenced a WTO investigation of the European aircraft industry. The EU on its part applied for a reciprocal process at the WTO.

International competition on a market for prestigious products based on security relevant technologies and characterised by considerable state intervention needs international agreements to domesticate unavoidably emerging conflicts and to minimize the distorting role government may play. In principle there are two dimensions of distorting measures: measures which distort trade and measures which distort a fair competition. Both dimensions overlap and are not selective in a strict sense. The first refers to trade barriers and the second to subsidies. Trade barriers are formed by tariffs which restrict imports and non-tariff measures (NTM) like safety and functional standards which complicate the market access. Public support and in particular subsidies deform competition and equal opportunities for all (other) market participants. They are pivotal for the aerospace industry. The trade distorting support or subsidies can be subdivided into direct financial practices and indirect financial support. The types of direct financial funding are (interest benefited) loans, grants, interest free bonds, equity infusions, fiscal incentives, the provision of goods and services, guarantees, payments for exchange rate risks. Indirect support is funding regional business promotion, industrial settlement programs, public procurement and support from government-funded aeronautical research and development.

4.2.2 Safety and Functional Standards[153]

Technical specifications are counted among trade barriers in Europe but also in overseas markets. Numerous technical specifications for aircraft which incorporate the potential of barriers to trade exist. E.g. there are US product standards which differ from international standards, airworthiness standards and aircraft engine standards but technological trade barriers affect US producers too. This applies to functional and safety standards that require additional testing and certification by the European Union's Authorized Economic Operator programme. As long as the US and the EU

152 Strategic trade policy is defined as trade policy that conditions or alters a strategic relationship between firms, implying that strategic trade policy focuses primarily on trade policy in the presence of oligopoly (Brandner, 1995).

153 The following statements are based on a separate study about non-tariff measures for the European Commission. This study is under progress.

have their own regulation the design of product must be adapted to different requirement and double certification is necessary.

Non-tariff measures are costly because most of the aerospace products are manufactured in small series industry. An additional pressure on the harmonization process comes from existing and developing international production fragmentation networks. Furthermore, intensifying transatlantic relations within common development and production projects stimulate initiatives to harmonising standards, testifying and certifying procedures. Bilateral agreements which facilitate the reciprocal airworthiness certification of civil aeronautical products imported/exported between two signatory countries redress the situation. Bilateral Airworthiness Agreements (BAA)[154] or Bilateral Aviation Safety Agreements (BASA) with Implementation Procedures for Airworthiness (IPA) provides for airworthiness technological cooperation between the European Aviation Safety Agency (EASA) and its counterpart civil aviation authorities.

A recent bilateral initiative to strengthen cooperation on aviation and safety and to alleviate technical and administrative procedures for the mutual recognition of certificates was negotiated between the EU and the US. It is meant to replace national agreements of Member States with the US on these subjects. The main purpose of the BASA US-EC is to enable the reciprocal acceptance of findings of compliance and approval issued by the technical agents Federal Aviation Administration (FAA) and EASA and aviation authorities. The purposes of the agreement are to allow the reciprocal acceptance of approvals and findings of compliance issued by the two aviation authorities, to ensure the continuation of high-level regulatory cooperation and to promote a high degree of safety in air transport. The scope of cooperation under this agreement covers

- the airworthiness approvals and monitoring of civil aeronautical products,
- environmental testing and approvals,
- and the monitoring of maintenance facilities.

There are two different kinds of certifications. Some of the certificates are mutually accepted without any request. For other a request on recognition is necessary and technical specifications will be checked. Minor changes do not need any specific approval.

In June 2008 the agreement on cooperation in the regulation of civil aviation safety was signed but a year later it was still not ratified and had not entered into force. The US government did not implement the Bilateral Safety Agreement with the European Union. The sticking point seemed to be the “outsourcing” of maintenance work by US aircraft operators to foreign repair stations.

4.2.3 Distorted Competition by Unconcealed and Concealed Support

The strong interest of governments in the aerospace industry has lead to a broad range of schemes initiated to provide support. Since 1992 direct and indirect government support to the aircraft industry in the United States and the European Union has been regulated by the EU-US Agreement on Trade in Large Civil Aircraft (LCA). The agreement was aimed at minimizing the trade-distorting role which governments in the LCA sector might play (cf. Pritchard, MacPherson, 2004, p. 62). Article 3 of the agreement prohibits governmental funding for the production of LCA, Article 4 established limits on the percent of governmental funds that may be provided for the development of new, LCA (33 percent of a new aircraft program’s total development costs.

[154] BAAs are executive agreements concluded prior to 1996.

Funds must be repaid at rates at least equivalent to the cost of government borrowing). Article 5 limits the benefits that manufacturers of LCA may receive from indirect government support, such as from performing government-funded aeronautical research and development (Identifiable benefits from indirect government support are not to exceed 3 percent of total LCA industry's annual turnover, and 4 percent of annual turnover of any manufacturer of LCA).

In late 2004, the US Trade Representative (USTR) gave notice of withdrawal from the 1992 EU-US LCA agreement, and requested consultations regarding alleged support to Airbus by the EU and some of its Member States. The rationale of the US added up to the allegation that government funding for Airbus (reimbursable launch investments) has to be regarded as interdicted and actionable according to the WTO-Agreement on Subsidies and Countervailing Measures (SCM Agreement). The US complaints refer to a broad range of different schemes, from royalty payments (which switch commercial risks to governments), investment in infrastructure to research and technology support and preferential loans from the European Investment Bank (EIB).

The EU responded immediately and claimed that Airbus has already repaid more than it had borrowed in launch aid and that other loans have been made according to standard policy. This was doubted by Boeing as it was convinced Airbus has not paid back the aid. But a critical point for Boeing was that, even when Airbus had paid back, it paid it at an interest rate that's not commercial what still constitutes a subsidy.

The EU initiated a countermeasure by initiating WTO dispute settlement proceedings regarding a number of US measures, including federal state and local subsidies. For its part, the EU is challenging various US subsidies benefiting Boeing. In addition to the tax breaks (federal and off-shore agreements) the EU is challenging the US system under which:

- Boeing sees its own R&D expenses reimbursed
- Boeing benefits from extensive cooperation with NASA, Department of Defence (DoD) engineers at no cost;
- Boeing is able to use testing facilities and equipment also at no cost; and
- a large number of patents and other technologies are also put at the disposal of Boeing free of charge.

The EU considers that the subsidies are in violation of articles 3, 5 and 6 of SCM Agreement and article III of the WTO 1994. The EU intends to demonstrate before the WTO panel that the subsidies benefiting Boeing have allowed aggressive pricing and put losses on Airbus.[155]

On the 4th of September 2009 the WTO issued the interim report on the US-EU dispute to officals from the United States and the European Union. This preliminary ruling concerns the US complaints about unfair government support for Airbus. The interim report is confidental and unpublished and therefore not available for a discussion of the contents. As long as no details are known it is only possible to refer to very general assessments by US authorities, US news agencies and the press. These sources regard the preliminary WTO ruling as a success for the US point of view. They claim that central themes of the US petition have resonated in the WTO interim report. The assessment of EU circles is different. The EU does not see a great success for the US position. Le Figaro reported that around 70% of the US complaints were diapproved (Le

[155] The status quo of the WTO proceedings can be viewed under: http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds317_e.htm

Figaro 2009). The real extent of acceptance and non-acceptance is still unclear but clear is that the ruling is only the first step and at most half of the story in a process which could take years to produce a final result. The next step is a WTO ruling on the EU counter case against the US which is expected in about half a year in spring 2010.

The current US-EU trade dispute and other preceding conflicts are not singular events. Brazil and Canada had engaged in a bitter and lengthy trade dispute concerning government support for their respective national aerospace industries (Goldstein, McGuire 2004). Brazil's interest rate equalisation programme and Canada's subsidies for regional jets preoccupied the WTO from 1996 on, when Canada requested the establishment of a panel to investigate the consistency of Brazilian export subsidies and grew into an all-out trade war. In the end both parties were justified but the practice of subsidizing did not change. In the future, emerging competitors on the marketplace for regional (China, Japan, Russia) and for large civil aircraft (China) could critically change the international game.

The context of the much broader global development of the aerospace industry from the bipolar supply of large commercial aircrafts and new competitors entering the market for regional aircrafts casts new light on bipolar conflicts. While China, Russia and Japan strengthen their aerospace endeavours with subsidies and are under way to win greater market shares, existing market leaders run the risk to block each other.

4.2.4 System Integration and the Internationalisation of Subsidy Sourcing

The technical and commercial challenge to make a LCA is immense. First, the technical component of the challenge forced aircraft makers to extensive supplier networks and then the commercialization of complex technologies increasingly required operations within networks. Systems integrator can spread commercial risk across the supply chain by sharing revenues on the basis of final sales. It can take advantage from human capital and industrial infrastructure and exploit competences all over the world.

Trade practice rules (WTO) may also be itself a driving force for an international network production. Pritchard and MacPherson (2007) advance the view that the WTO EU/US Large Commercial Aircraft Dispute will change the way all aircraft manufacturers finance the launch of new programs. Boeing had already opted for a system integration mode of production for its new 787 model, whereby manufacturing and design processes were distributed across an international network of risk-sharing partners. Prichard and MacPherson (2007) asserted that by offset programs and by the network of foreign suppliers Boeing learned to find government financing support mechanisms to replace its own self-funding of aircraft launches, while simultaneously negotiating away Airbus' ability to get EU government repayable launch investment for new aircraft programs. Japanese firms were designing and producing important wing components for the Boeing 787 with the help of development funding from government. One has to be careful with exact numbers but Pritchard and MacPherson (2005) dared estimation. According to this the Japanese government support for the 787 development will be USD 1,688 million, which is likely to be split into 30% non-repayable grants and 70% in repayable loans. Such a scheme ultimately lowers manufacturing costs of Japanese suppliers, cost savings which are subsequently passed through to Boeing. McGuire too ascertains that the Japanese government funding for the Boeing 767 and 777 was a royalty-based scheme, a system which Boeing is complaining for being used by its competitor.

This development could also spark new and more complex trade conflicts than before. Pritchard and MacPherson (2008) who take Boeing and Japan as an example, share the opinion that subsidies deployed by the governments of foreign production partners also violate WTO regulations (Pritchard, MacPherson, 2004).

4.2.5 Conclusion

The strengthening of transnational institutions in the field of standards, technical requirements, certification and mutual acknowledgement is cost-saving as it reduces bureaucratic burdens and encourages competition. The establishment of EASA was an essential move and has improved Europe's strategic position. It advanced the European weight and counterbalances the power of the FAA. A strengthening of EASA competences and the transfer of more national responsibilities will increase the international bargaining power.

From 1992 to 2004 the EU-US LCA agreement regulated the tension filled relationship of LCA manufacturers successfully. The latent discontent with the practice how new aircraft projects were launched and the achievement of Airbus triggered the US withdrawal from the agreement. But things have changed since. In the aftermath of the financial crisis a trade conflict which could be carried to the extremes is a danger for the regeneration of the world economy. Another aspect which could alter the US-EU relationship is the emergence of new competitors. China and Russia have ambitious commercial air transport programmes and in 7 to 8 years narrow-body airplanes will roll of the production lines. The (potential) competitors' programmes do not work without massive state aid. An equal market share policy of Airbus and Boeing is challenged by this development. For this reason alone the US and EU should reconcile before the WTO final judgement. The "cost" of the dispute might turn out to be higher than any possible result for both sides.

4.3 Access to Finance

The world is in autumn 2009 despite signals for a recovery still in the grip of a liquidity driven global crisis. It is this character of a simultaneous recession which makes the crisis different from past economic downturns. The US is in a recession, as well as Japan, and the economies of the EU and Non-OECD countries. The crisis emerged from the financial sector but seized industry and services within a more or less short delay. Especially for the US market it is true that the days of cheap and easy credits are over and terms have gone to be more arduous and the requirements for credit quality have grown. But Europe has also to bear the consequences of the crisis in form of close terms of credit.

For the aerospace industry, which is a global and capital intense business, the crisis is a big challenge. The damage was felt in phases with airlines and business jets hit first followed by commercial aircrafts second and by defence programmes last. The menace came (and is coming) from declining passenger numbers, lower freight volumes, decreasing flying activity of corporate personnel and a credit squeeze which threatens both aircraft turnover and the controlled consolidation of the supply chain. Generally the turmoil in the credit market and the weakened state of banks globally could reduce bank participation in aircraft financing over the next years.

Even before the global crisis started airlines underwent a period of attrition and consolidation. Consolidation by way of merger and acquisitions had become a major focus in Europe an in the US. The global economic crisis imposed financial pressure on the air transport sector and forced the majors to dump capacity and consolidate route networks. According to IATA figures the numbers of passenger kilometres flown on international markets were 1.1% down on August last year and freight volumes declined for the same month on year earlier levels by 9.6%. Both passenger and freight capacities have been cut already in 2008 but not so much that a fall of aircraft utilisation could be avoided. Not alone transnational but also regional carriers are suffering. In the past, regional carriers often profited from suffering major network carries but now capacity reductions are extended to regional allies of these carriers, thus forcing them to downsize their fleets. Slowing passenger traffic is making the operating economics of regional jets problematic.

Driven by this difficult operating environment the profitability of airliners was weakened and the prospects are troubled. IATA financial forecasts expect losses from commercial airline operations worldwide in 2009 to reach USD 11 billion.[156] For the next few years it will be difficult for airlines to grow revenue. IATA assumes that losses will continue next, albeit considerably lower. Low profitability of the airline business and the lack of liquidity in the financial sector is a risk to order books of the industry. Some of the backlogs of commercial aircraft manufactures were at risk as airlines and leasing companies began to re-evaluate outstanding orders. This was due to lower travel and freight demand but also to tighter credit markets. Customer financing has become more difficult and emerged as a big challenge for aircraft builders in 2009, 2010 and perhaps beyond.

Leasing companies are an important link between airlines and aircraft manufactures are part of the financial sectors which run into serious trouble. The financial crisis has deeply shaken the leasing sector. ILFC (International Lease Finance Corporation), the biggest aircraft lessor by value, has been hit by the fate of its corporate parent AIG (American International Group), an insurance company that suffered from the storm in the financial markets. The second large group in this market, GECAS, an affiliated company to GE suffered likewise. And these are not the only leasing company which is sidelined by its own problems. CIT Aerospace (owned by CIT Group) and RBS Aviation (owned by RBS) have also parents that face financial challenges. The problem for lessors is access to finance and the cost of that funding. A strong problem as they need constantly to roll over their shorter-term debt. The amounting uncertainty of the leasing sector and the lack of bank financing for their investment has not fully flowered out in 2009 as lessors investments are financed typically at least 12 months in advance. Hence the limitations of access to finance for aircraft lessors bear on the aerospace industry in 2010 and later.

The speed and global scale of the financial crisis hit business aviation first. Flying activity of corporate personnel dropped together with the suffering of wealth of this group. Already in 2008 (US) manufacturers of business planes have moved to scale back production and lay off workers. This concerns mainly US manufacturers like Cessna and Hawker Beechcraft. Business jets are easy targets for corporate cost cutting and the increasing number of second-hand jets on the market makes aircraft assets falling. The situation of banks after the credit crash badly impairs the customers' ability to finance aircraft deliveries. Unlike regional or large commercial aircrafts, business jets are no assets that can generate revenues and be moved to the transport market which promises most profit. Access to finance for customers and for suppliers of business jets has deteriorated under the conditions of a malfunctioning credit market and a depressed market.

But the financial crisis does not only hit the demand side of the aerospace industry with airliners and leasing companies confronted with a credit squeeze but also the supply side.

[156] IATA Economics: http://www.iata.org/economic

On the supply side which refers to the funding of the operative business and big strategic projects, the impact of the financial crisis coincides in a disadvantageous manner with the structural effect of risk sharing. Prime manufacturers of the aerospace industry reduce their manufacturing depth and hand risks over to suppliers. First tier manufacturers of subsystems forward the risk sharing to subcontractors and so on. This process imposes burdens on smaller enterprises which are harder to bear in recession with restricted access to finance. As financial resources for acquisitions and for investments are not provided on the necessary scale the consolidation of the sector which is programme is threatened. Suppliers are having a harder time with banks. Banks reduced credit lines. Due to the financial crisis, it is becoming more difficult for European SMEs to get credit or loans from banks for investment in the business. Therefore investments which are requirements for the participation in major airplane programmes are jeopardised. The situation is aggravated by Airbus and Boeing programme delays. The aerospace sector is suffering from the technically conditioned delays of aircraft deliveries. The pre-financing of programme parts in the value chain is not counterbalanced by anticipated cash-flows. In combination with the recession and the credit squeeze the homemade difficulties complicate the economic situation mainly of smaller enterprises.

A particular worry is that a few of companies in the supply chain are also working for sectors which are very susceptible to risk. Some smaller enterprises are threatened by insolvency, especially if they have a small customer basis or are interlinked with the automotive sector. The collapse of small and medium suppliers is a problem for the enterprises on higher levels in the supply chain as the search for a substitute may be costly. Orders are often placed on the basis of solid medium or long-term relationships. New technologies are developed today and produced in a greater number of pieces or in series in the following three, five or more years. This tends to result in a preference for the bigger and financially strong suppliers as it is important for a contractor to rely on a supplier who exists for a longer period.

Smaller enterprises are in particular affected by the financial crisis. This has been acknowledged by Airbus and set up funds to strengthen the financial viability of these companies in the value chain, such as the AEROFUND II for France.

The tendency of fieldwork results is that mainly system integrators and the big manufacturers in the aerospace sector had mid 2009 not much to suffer from the financial crisis. Aeroplanes are typically financed 4-12 months in advance and the order books of major aircraft manufacturers were full at the beginning of the crisis. By this the impact on the sector is delayed. Long lead times in aerospace mean that it takes many months for the full impact of the recession to be felt down the supply chain. The crisis probably catches the commercial aircraft sector in full extent in 2010 and 2011. The altered and changing situation on the credit market did not put the bulk of aeronautical LCA-projects at risk in 2009.

For prime manufacturers, the big players in the sector costs of the financial crisis are mainly of indirect nature. A shrinking demand by airlines and leasing companies (or a deferred demand) increases the payback period. This process increases the borrowing requirement in a period when a credit squeeze complicates access to finance. Short time financing of smaller enterprises, endowed with less cash flow, which depend on orders within a supply chain of suffering industries, are hit more by worsened conditions which define access to credits. A few suppliers are very hard to replace. Therefore some companies have developed backup sourcing structures in case when single suppliers may drop out. However, certain suppliers are of strategic importance due to unique technological competences. If those are endangered, subcontracting companies consider direct financial support or direct shareholding.

Even if uncertainty is quite high confidence has returned to the aircraft industry in the second half of 2009. The short-term outlook of great players is positive. The bottom of the recession is regarded to be reached in mid-2009 and an upswing can be expected in 2010. But this evaluation of the short-term optimism of the industry has to consider that there is a professional need to be in touch with optimism. There is a firm conviction of the commercial airframers that aviation remains a long-term growth industry. Next-generation aircraft are needed to replace outdated fleets and to cut direct operational. Fleet renewal plans are not cancelled but temporarily shifted.

Conclusion

The current financial crisis and the involved recession have changed sales opportunities and credit terms for the aerospace industry. In the consequence it became harder for aircraft manufacturers to get credit or loans from banks for investment in their business. In combination with the recession and the credit squeeze the homemade difficulties complicate the economic situation. Compared with system integrators small- and medium sized suppliers are hit harder, all the more if they are concerned with the technically conditioned delays of aircraft deliveries and with the ambitious development requirements of new programmes. Smaller enterprises are partly at the limits of their financial strain and rely on a functioning credit market.

The global economic crisis imposed financial pressure on the air transport sector and forced the majors to dump capacity and consolidate route networks. Both passenger and freight capacities have been cut already in 2008 but not so much that a fall of aircraft utilisation could be avoided. Driven by this difficult operating environment the profitability of airliners was weakened and the prospects for the next year revenues are troubled. Low profitability of the airline business and the lack of liquidity in the financial sector is a risk to order books of the industry. Due to lower travel and freight demand but also to tighter credit markets customer financing became more difficult and emerged as a big challenge for aircraft sellers all the more as the financial crisis has deeply shaken the leasing sector.

As far as airlines have lost their ability to pay for aircraft ordered in better times and demand is constrained by the liquidity squeeze air framers can avoid cancellations cutbacks by providing financial aid. Although deliveries for 2009 should benefit from secure financing, some customers need help with financing this year and the financing challenge for aircraft manufacturers probably could worsen in 2010. Both Airbus and Boeing, the great players have announced that they will give customers more credit than in years before. But there remain many forecast uncertainties whether credit begins to flow sufficiently again.

The absence of affordable credit can be softened by a sustained and increased government support in the form of export credit guarantees. As liquidity and financing are at risk industry is asking European governments to increase export credits in 2009 and beyond to support airline orders. In 2009 France pledged to guarantee EUR 5 billion of loans to airlines to buy aircraft and the German government announced to increase HERMES guarantees. Government backed export credit agencies (ECA) have significantly added on their aircraft financing activities. In 2008 around 15% of Airbus deliveries were safeguarded and 2009 this share is projected to rise to around 40%-50%. Export guarantees are regular in the sector and not limited to Europe. Boeing maintains that the support it receives through U.S. government-backed loans and guarantees is essential to its ability to maintain a competitive edge.[157] As financing markets are very volatile

[157] http://subsidyscope.com/transportation/risk-transfers/exim/

and the commercial markets' support for export financing can be unpredictable and inconsistent the Ex-Im Bank, the U.S. export credit agency[158], has expressed its willingness to provide financing. In the current situation such government intervention is regarded as justified because of the malfunctioning of the credit market and as long as guarantees are provided according to market conditions. Governments have to reduce engagement as soon as the credit market rebounds and can take over the business of funding economic activities.

Particularly smaller enterprises are concerned by the financial crisis. It is becoming more difficult for European SMEs to get credit or loans from banks for investment in the business. The situation is aggravated by Airbus and Boeing programme delays. Parts of the aerospace sector are suffering from technically conditioned delays of aircraft deliveries. The pre-financing of programme parts in the value chain is not counterbalanced by anticipated cash-flows. In combination with the recession and the credit squeeze the homemade difficulties complicate the economic situation mainly of smaller enterprises. Therefore prime manufacturers should increase efforts to keep the programme paths.

Suppliers are hard to replace and a few suppliers are even very hard to replace. Prime manufacturers can hardly survive without a vibrant supply chain that is why they need to pay particular attention to the situation of smaller enterprises which are struggling to adjust to the worsened economic conditions. Therefore some companies have developed backup sourcing structures in case when single suppliers may drop out. However, certain suppliers are of strategic importance due to unique technological competences. If those are endangered, subcontracting companies consider and seize direct financial support or direct shareholding to safeguard the supply chain.

4.4 Knowledge: R&D, Innovation and Product Development

In Europe several initiatives and studies have dealt with aeronautics and the industry's competitiveness. They range from technological R&D projects to more strategically issues and initiatives. Two of these will be briefly presented: the framework programmes and the Advisory Council for Aeronautics Research in Europe (ACARE).

4.4.1 European Research Policy

The Group of Personalities[159] set in its January 2001 report "European Aeronautics: A Vision for 2020" the goals for better serving society's needs while becoming a global leader in aeronautics. Shortly after that, the Advisory Council for Aeronautics Research in Europe (ACARE)[160] was launched at the Paris Airshow in June 2001 in order to establish a Strategic Research Agenda (SRA), which should allow to create a competitive leadership, meet society's needs and to accomplish the formulated goals from the "Vision 2020" in the areas of emissions, noise, safety, security and the efficiency of the air transport system.[161] ACARE is a platform dedicated for the provision of guidelines developed by representatives of the Member States' AIs, the European

158 The Ex-Im Bank is not the only entity that subsidises export.

159 This group consists of the following industry representatives: Pedro Argüelles, Manfred Bischoff, Philippe Busquin, B.A.C. Droste, Sir Richard Evans, Walter Kröll, Jean-Luc Lagardère, Alberto Lina, John Lumsden, Denis Ranque, Søren Rasmussen, Paul Reutlinger, Sir Ralph Robins, Helena Terho, and Arne Wittlöv.

160 www.acare4europe.com

161 In detail: 80% cut in NOx emissions, halving the perceived aircraft noise, five-fold reduction in accidents, improvement of air traffic system capability in order to handle 16 million flights a year, 50% cut in CO2 emissions per passenger-km, reduction of delays such that 99% of all flights are within 15 minutes of timetable.

Commission, research establishments, the manufacturing industry, airline associations, as well as regulators, academia, and airports.

The Vision 2020 (ACARE, 2001) was therefore the first step for the subsequent development of the first SRA (ACARE, 2002), which was supposed to be updated periodically. One key development area of the second SRA (ACARE, 2004) has been to examine the sensitivity of the Agenda to alternative views of the future, which resulted in three different world scenarios. It also presented five High Level Target Concepts in the areas of environmental protection, time efficiency, security, passenger choice and cost reduction, which were intended to identify a set of relevant technologies, or creating a technology pool. The Addendum (ACARE, 2008) is intended to bridge the time between the second SRA and a full review, which is expected for 2010. It identified three areas for increased priority: the environment, alternative fuels and security.

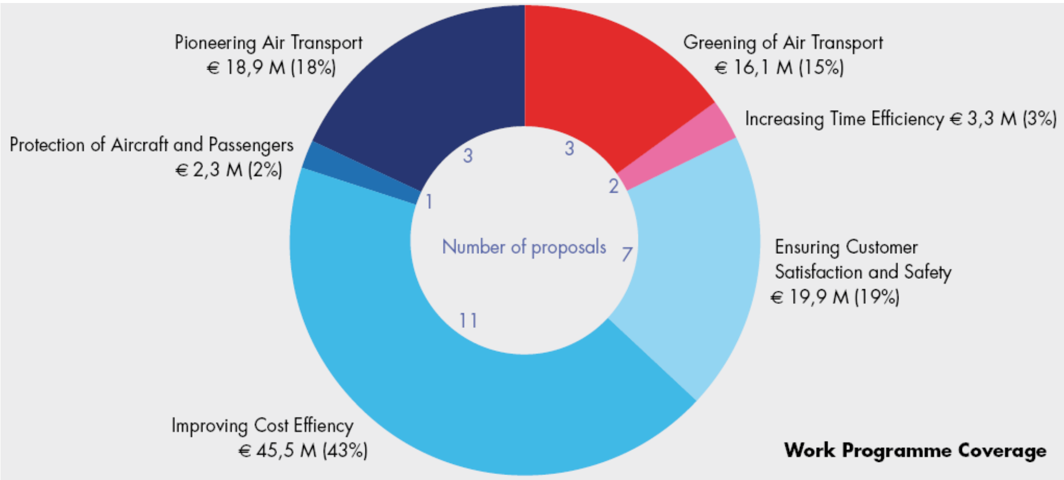
4.4.2 European R&D Funding Schemes

The Framework Programmes for research and technological development (FP) were established in order to support and encourage research in the European Research Area and are the European Union's chief instrument for funding research. The current FP7 covers the period 2007 to 2013.[162]

The sixth framework programme (FP6) has funded several projects in aeronautic research with an overall amount of EUR 903.3 million (European Commission, 2008). Under the topic "Strengthening Competitiveness" 34 projects, primarily with a technological focus, have been funded in FP6.

FP7, which started in 2007, has focused on six major activities in Aeronautics and Air Transport, which are displayed in Figure 4.3 with the respective funding distribution (of EUR 217 million in calls 1 and 2).

Figure 4.3 Activities and Funding in FP7 (calls 1 and 2)

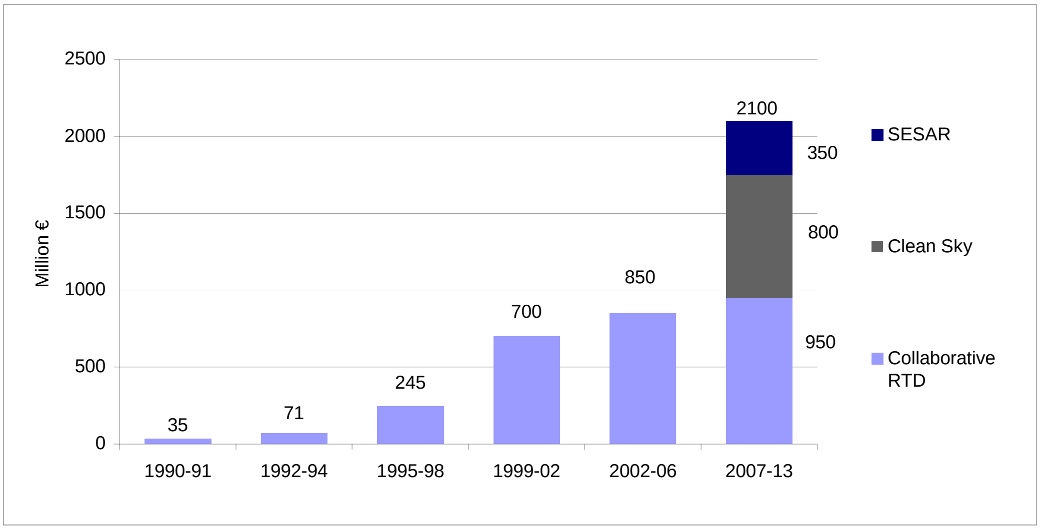


Source: European Commission, CORDIS.

[162] The respective time coverages of the Framework Programmes are as follows: FP1: 1984–1987, FP2: 1987–1991, FP3: 1991–1994, FP4: 1994–1998, FP5: 1998–2002, FP6: 2002–2006, FP7: 2007-2013.

The "CleanSky" Joint Technology Initiative[163] is a Public-Private Partnership (PPP) between the European Commission and industry. It is a 7-year research programme plan for greener generation of European Air Transport that is supposed to reduce the impact of aviation on the environment while strengthening and securing European aeronautics industry's competitiveness. Its purpose is to demonstrate and validate the technological breakthroughs that are necessary to reach the environmental goals set by ACARE. The total funds that have been reserved by the European Commission for technologies of relevance for the aerospace industry are depicted in Figure 4.4.

Figure 4.4 Funds for Research and Development on Technologies of Relevance for Aeronautics



Source: European Commission DG Research.

Interviews suggest that heavy administrative rules for the participation in FP7 research programmes are an increasing barrier for many companies. Given the decreasing success rates in European aeronautics research tendering procedures coupled with growing bureaucratic burdens, small companies increasingly abstain from program participations. Furthermore there is a risk that funds are primarily allocated to large projects and the JTI, which implies an insufficient funding for smaller cooperation projects. IPR protection is an important issue for most aerospace companies, which partly hinders a program participation for mission critical topics, which is aggravated by the need to have at least partners from three different European countries in the research programmes.

Although the amount of money dedicated to the AI by the EU has increased much over time some criticism has been made explicit.[164] A major concern refers to large strategic projects of crucial importance for the industry. The CleanSky Joint Technology Initiative has been mentioned as the most prominent example by experts in interviews. In December 2007 it was formally launched, but even in 2009 it is still not working as intended. The complaints of the industry relate to problems strongly related to the size and importance of JUs. They require specific solutions. The Commission should delegate managerial authority to its representatives involved

[163] A JTI is a new instrument created by the European Commission for FP7 to allow large scale and long term public private research partnerships to implement the ambitious research priorities of the Strategic Research Agenda (SRA) which are of such scale that they will require the mobilisation and management of very substantial public and private investment.

[164] Axel Krein (Airbus), European Public Private Pertnerships with industry – Why they are not working and what can be improved, Speech at the European Parliament, Brussels, 30 September 2009.

in the JU. Moreover a Governing Body is suggested with representatives from all partners. This will be an indispensible prerequisite for a functioning PPP.

4.4.3 National R&D Funding Schemes

According to Weber et al. (2005) the total expenditure of the French government was approximately €818.5 million for civil aeronautics in 2002. This amount is divided by research support to industry (416 m€), research support to academia (26.6 m€) and particular "targeted calls" with clearly defined goals and objectives (375.9 m€), which are primarily destined for activities of ONERA (Office Nationale d'Etudes Aerospatiales), CNRS (Centre National de la Recherche Scientific), CEA (Commisariat de L'Energie Atomique, for materials testing and electronics), CNES (Centre National d'Etudes Spatiales, for materials and atmospheric drag studies), INERIS (Institut National de l'environment industrielle, for studies of environmental impact of aircraft). The funds for civil aeronautics research are channelled through the Ministry of the Economy, Finance and Industry (primary source for industry support), the Ministry of Primary and Higher Education and of Research (coordinating role), the Ministry for Equipment, Transportation and Tourism (primarily air traffic management), and the Defence Ministry (contributions to dual-use programs).

The United Kingdom used to have a Civil Aeronautics Research and Technology Demonstration (CARAD) programme, which expired in 2006. Currently the major funding programmes are financed by the Technology Strategy Board and the Engineering and Physical Sciences Research Council (EPSRC). The EPSRC is primarily funded via the Ministry of Defence and comprehends currently projects in aerospace, defence and marine of an amount of about 200 m£ (stretched over several years). Both funding schemes finance most of the programs in cooperation.

Germany focuses its funding for civil aeronautics primarily on its aviation research program "LuFo" (Luftfahrtforschungsprogramm), which is coordinated and supervised by the German Aerospace Center DLR. The current call of LuFo IV is intended for the time period of 2009-2013 and comprises a total amount of 401 m€. It sets its content-related focus on air traffic control and environmental factors (65%), aircraft safety and air cabin environment (25%), and economic efficiency, value creation and competitiveness (10%). Further public activities include the support for cluster initiatives (like bavAIRia e.V., Berlin Brandenburg Aerospace Alliance e.V., Forum Luft- und Raumfahrt Baden-Württemberg e.V., Hamburg - The Place for Aviation / Hanse Aerospace e.V.).

Spain has an Aeronautics Strategic Plan (with a focus on UAVs, very light jets (VLJs) and alternative propulsion systems), which is funded with 246 m€ in 2008. The CENIT program is aimed at large-scale strategic projects subject to high technological risk, favouring collaboration between public and private institutions or venture capital for early stage technology companies. Finally there are regional programs (CATEC, FADA, Aeropolis), which are supposed to support regional clusters.

Italy has a National Aerospace Research Programme (PRORA), which is carried out by the Italian Aerospace Research Centre (CIRA). The budget of PRORA was 282.9 m€ in 2004. A national research plan (PNR), which is renewed every third year and implemented by the "National Research Council" (CNR), which covers more than 11 programmes, of which three are relevant to aeronautics: the "Aerospace Research Programme" (no. 6), the "Advanced manufacturing Systems" (no. 4), and "Advanced Materials" (no. 7).

There is a large overlap of similar research activities, as most countries are willing to keep and improve their national competencies in key activities of this strategically relevant sector. This may imply the positive effect of some competitive pressure between European countries, but interviews suggest that this effect also implies a waste of funding resources and may prevent fast technological progress. However, a Group for Aeronautical Research and Technology in Europe (GARTEUR) was founded in 1973 in order to foster collaborative research in European aeronautics. Today seven countries are involved in GARTEUR: France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom. The Journal Air & Space Europe Vol. 3, Issues 3-4, pp. 288-320 gave in 2001 with various articles an overview on major European national aeronautics research programmes and the GARTEUR programme.

4.5 The Environmental Framework Conditions

Aviation contributes to climate change in a number of different and in more complex ways than most other sectors. The picture is further complicated by significant uncertainties about the magnitude of the climate impacts that result from various aviation emissions (not only CO_2) in high altitudes.[165] In order to account for these effects, it is more useful to describe the total global warming effect by “radiative forcing” (RF) instead of CO_2, which is supposed to be 2-3 times higher than the CO_2 effect of aviation. However, the levels of scientific understanding of the impacts of each of the contributors to RF from aviation vary.[166] Some measures like improving aircraft engine efficiencies, may result in trade-offs between different pollutants, for example achieving a reduction in CO_2 emissions at the cost of higher NOX emissions.

Several organizations have set (primarily non-binding) emission targets for aviation. The most prominent treaty in this respect is the Kyoto protocol. Under Kyoto, targets for the reduction of Greenhouse Gases (GHGs) were established only for the Annex I Parties (industrialized countries). Even these targets apply only to emissions from domestic aviation and exclude those from international aviation, which was given separate treatment: Annex I Parties are only “committed to pursue” limitation or reduction of GHGs from international aviation, “working through ICAO”. Thus emissions targets for only some 22% of world air transport are covered by Kyoto – further reduced to less than 5% in practice since the protocol was not ratified by the United States.

The UN organization ICAO has agreed in 2009 on a programme of action that included a strategy to achieve fuel efficiency improvements of international aviation at the rate of 2% per annum, in three time period tranches (base year undefined): (i) to 2012 (when the Kyoto Protocol targets expire); (ii) to 2020 (when the post-Kyoto agreement targets are expected to expire); and (iii) from 2021 to 2050.

IATA, the international airline’s association, formulated a set of three sequential goals for all commercial operations by all air carriers as follows:

- an average annual improvement in fuel efficiency of 1.5% from 2009 to 2020;

[165] In addition to CO_2, planes emit NOX which lead to the formation of ozone and methane (CH_4) in the atmosphere. They also emit sulphates and black carbon soot, which have RF impacts. Water emissions lead to contrails and the formation of cirrus clouds that also have an impact on RF. The altitude at which these emissions occur can matter significantly.
[166] See for example Lee et al., 2009.

- carbon-neutral growth from 2020; and
- an absolute reduction of 50% in carbon emissions by 2050, relative to 2005 levels.

The European platform ACARE set in 2001 several goals for safety and ATM efficiency of the air transport system, but also for the environment. The environmental goals include a 50% cut in perceived aircraft noise and CO_2 emissions per RPK, and a 80% cut in NOx emissions. These goals refer to the year 2020.

A binding political measure has been set in Europe: the European emission trading scheme (EU ETS). The EU has introduced a legislation to include aviation in the EU ETS via the Directive 2008/101/EC, published on 13 January 2009. It will start on 1st January 2012 for all flights (for large airplanes with a maximum takeoff weight of more than 5,7t), both within the EU as well as international ones arriving or leaving. Airlines must begin monitoring their emissions from the start of 2010 in order to establish the share of free carbon allowances that each airline will be entitled to when the scheme begins. The total amount of certificates equals 97% (in 2012, and 95% in 2013) of the average emissions of 2004-2006, which corresponds to 210m tonnes of CO_2 emissions. 82% of these certificates will be allocated for free to established airlines according to their RTKs of the year before last. 3% are reserved for new competitors and 15% are auctioned on the market, but this latter share will increase at the expense of free certificates in later years. However, with an expected annual traffic growth of about 5% and an assumed efficiency growth of 1%, the resulting 4% annual growth of CO_2 will result in a demand for certificates of about 280m tonnes. For this reason the system is semi-open, meaning that certificates of other sectors of the EU ETS can be bought for the use in aviation.

A problem of this system for the competitiveness of European companies affects not the industry, but the European airlines and airports. Non-European airlines may bypass European hub airports when connecting North-American and Asian cities while European airlines are bound to their European hub-airports, where they have to pay for their emissions.

4.6 The Operational Environment: Air Traffic Management

The European Airspace is fragmented and will become more and more congested, as traffic forecasts predict a steady growth over the next 15 years despite the current economic downturn. The related air navigation services and their supporting systems are not fully integrated and are based on technologies which are already running at maximum. Contrary to the United States, Europe does not have a single sky, one in which air navigation is managed at the European level. Furthermore, European airspace is among the busiest in the world with over 33,000 flights on busy days and airport density in Europe is very high. This makes air traffic control even more complex. The obvious need to overcome this fragmentation and capacity crunch by structuring airspace and air navigation services at a pan-European level was the background that triggered in 2001 first steps towards the creation of a “Single European Sky”.

Following the Single European Sky initiative of the European Commission, the related EU legislation was adopted in 2004 and updated in 2009, establishing the framework for regulation, interoperability and integration with view to a coherent approach for the design and, management of airspace throughout the European Union and also neighbouring countries (via the European

Common Aviation Area, ECAA). This is expected to benefit all airspace users by ensuring the safe and efficient utilisation of airspace and the air traffic management system[167] within and beyond the EU. Airspace management is planned to move away from the previous domination by national boundaries to the use of 'functional airspace blocks'. The boundaries of these functional blocks will be designed to maximise the efficiency of the airspace. Within the airspace, air traffic management, while continuing to have safety as its primary objective, will also be driven by the requirements of the airspace users, the society and the need to provide for increasing air traffic. The aim is to use air traffic management that is more closely based on desired flight patterns leading to greater safety, efficiency and capacity whilst reducing the environmental impact and costs. The current inefficiencies stem primarily from air traffic control boundaries that follow national borders, and have large areas of airspace reserved for military use when in fact they may not be needed. In the future, this will be addressed by the concept of 'flexible use of airspace'.

An important topic lies in the harmonization and the interoperability of the European and US ATMs, SESAR and, NextGen that have to become part of a global ATM. In 2004 the FAA and Eurocontrol signed a Memorandum of Cooperation in the forefront of the launch of next generation ATMs. In 2008 the International Civil Aviation Organization (ICAO) hosted a seminar dedicated to deepen the exchange of information and to foster the development of the international standards as necessary to come to better interoperable systems. In March 2009, the FAA and the European Commission signed an update to the Memorandum of Understanding established in 2006 to reflect the launch of SESAR development phase. In October 2009, the Council has agreed upon the opening of negotiations towards a Memorandum of Cooperation with the FAA to provide for a formal cooperation framework on R&D for civil aviation matters.[168]

In order to achieve the goals of the Single European Sky initiative, a research program has been initiated. SESAR or Single European Sky ATM Research is the name given to this program, which is set to completely overhaul the European airspace. The SESAR Joint Undertaking was created under European Community law in 2007. The European Community and Eurocontrol are founding members. SESAR is a public private partnership dedicated to system development and validation for air traffic management. Most of the important private companies of the AI have become members, including one US company. The total costs of the program are estimated to amount to EUR 2.1 billion and will be funded by the Community (through the Trans-European transport Network Programme and the Research Framework Programme) by one third, one third of the funds are provided by Eurocontrol and one third will be paid by the industry. SESAR is composed of three phases:

- The definition phase (2004-2008) has been concluded and delivered an ATM master plan defining the content, the development and deployment plans of the next generation of ATM systems. This definition phase has been coordinated by Eurocontrol, co-funded by the Community under the Trans-European Transport Networks programme and Eurocontrol and executed by a large consortium of air transport stakeholders.
- The development phase (2008-2016) will develop and validate technological solutions for the next generation ATM system as described in the definition phase.

[167] Air traffic management in the European Union is largely undertaken by member states, cooperating through EUROCONTROL, an intergovernmental organisation that includes both the EU member states and most other European states as well.

[168] Airbus and Boeing agreed on a cooperation in the development of advanced ATM, in particular related to the European activities (SESAR). The CEOs of both companies that this cooperation is carried out only to exploit advantages provided by advanced ATMs for the environment, but fierce competition between the global leaders in the aircraft market will continue. See: Kieran Daly, Airbus and Boeing sign pact on environmental collaboration, in: Flightglobal, 22 April 2008, http://www.flightglobal.com/articles/2008/04/22/223186/airbus-and-boeing-sign-pact-on-environmental-collaboration.html

- The deployment phase (2013-2020) will consist of a large scale production and implementation of the new air traffic management infrastructure, composed of fully harmonised and interoperable components which will guarantee high performance air transport activities in Europe.

Beyond the introduction of a new European ATM system, it is envisaged to introduce advanced technology for Communication, Navigation and Surveillance (CNS) that is no longer ground based but becomes satellite based.[169] The challenges for Europe to leapfrog to the leading edge are enormous, because there is a threat that national interests counteract to the objectives linked to SESAR and the yet existing conventional CNS systems will hamper the development.[170]

In the field of navigation, Europe has developed and deployed an advanced infrastructure for European Geostationary Navigation Overlay Service (EGNOS). Currently it is under the certification procedure to get the approval for use in safety critical air transport operations. EGNOS certification is scheduled to be completed by mid-2010. In the field of surveillance and communication, Europe is investigating various satellite based technologies to support transfer of Automatic Dependant Surveillance data (for traffic monitoring purposes), pilot-controller voice and data exchanges (for traffic management purposes) throughout the whole European airspace, including remote low density areas. The increasing use of satellite based technologies for CNS purposes is a decisive step towards a significant change from current National to European regional infrastructures with the objective to support safer and more efficient flight trajectories which are of major importance to achieve the ACARE goals to reduce the CO2 emissions.

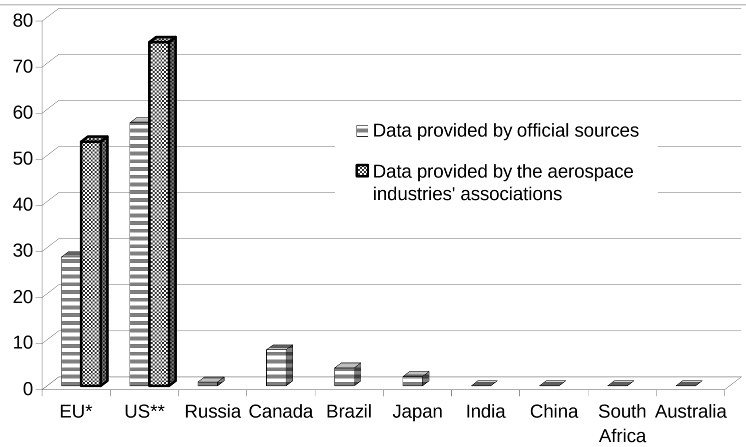
169 http://www.sesarju.eu/public/news/dows40.html

170 Currently The European ATM runs more than 50 ground based beacons, whereas the US runs less than 30. A reduction of beacons is a prerequisite for the reduction of the workload on pilots and to better optimize flight trajectories.

5 The Global Aerospace Industry

This chapter provides insight in the most important economies for the Non-European global aerospace market. Included are the USA, Russia, Canada, Brazilia, Japan and (emerging) competing countries India, China, South Africa and Australia. However, the latter do not play a noteworthy role in global trade yet (Figure 5.1). As the extend of available information and data differs from country to country – especially quantitative information for some countries, here classified as emerging competitors, is missing – there is no standardised subcategorisation exercised. In an optimal way the analysis starts with a historic review, continues with an investigation of the supply structure, collects information on public initiatives dedicated to the AI, provides the regional distribution and the structure of the industry and presents trade data. The minimum is an overview and the presentation of trade data. Major results are highlighted at the end of each subchapter.

Figure 5.1 Key Figures for the most Important Aerospace Industries



* Data from ASD; ASD organisation covers 20 countries (all ‘EU 15’ countries apart from Luxembourg, plus Bulgaria, the Czech Republic, Poland, Norway, Switzerland and Turkey); aeronautics only.
** Data from AIA; exchange rate of USD 1.3 / EUR 1.0.

Source: Eurostat; ASD; AIA; Associations of the industry, National statistical bureaus, Comtrade; own calculations

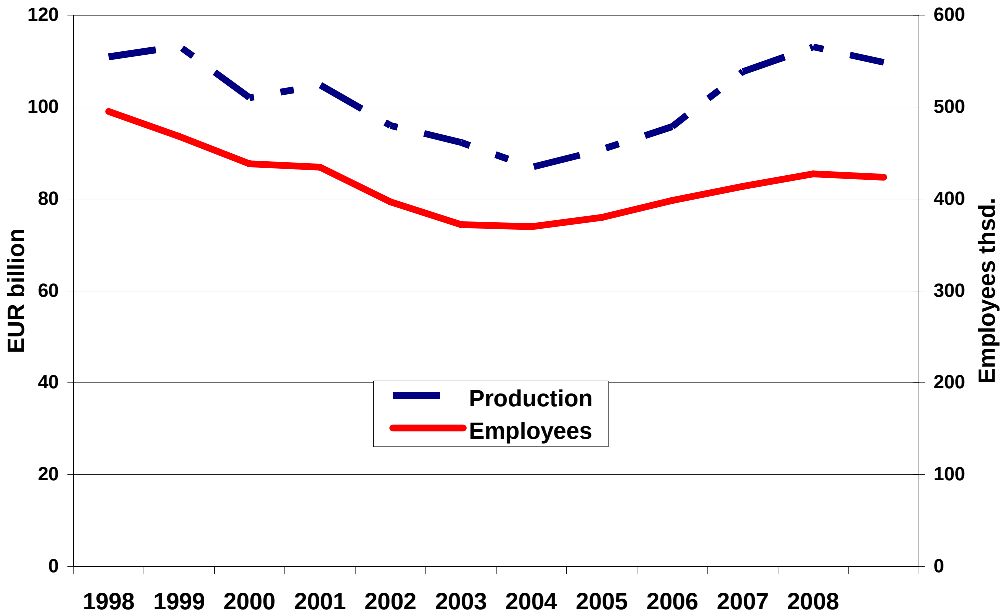
5.1 The US Aerospace Industry

5.1.1 The Size and Development of the Aerospace Industry

Historical review

As one of the historic main developers of the aerospace industry, the US has led the global aerospace production for decades. However, as Figure 2.1 shows, the net sales of the US aerospace industry (the figures exclude space production) have hardly grown during the last ten years and the total employment level has went down. Despite this, the US aerospace industry is still perceived as the world's leading player. But in terms of production the EU has caught up with an average real growth rate of 1.4% between 2001 and 2008. The respective growth rate for the US was 1.1% and total shipments reached 2008 a value of USD 152.3 billion. This equals EUR 113.0 billion in constant prices, price basis 2006 and an exchange rate of USD 1.3 / EUR 1.0, thereof around 36% defence. The respective value – using the same price basis for the EU27 is EUR 120.7 billion. The number of employees shows some differences. The US employed in 2008 427,100 people (AIA statistics) and the EU 374,800.[171]

Figure 5.2 Net Sales of All Aerospace and Space Products of the US Aerospace Industry from 1998 to 2008



Source: US Census Bureau (Net Sales) and AIA (Employment).

Table 5.1 shows the value-added, total employment, apparent labour productivity and total capital expenditure (i.e. estimation of investments) for the total aerospace production and for the sub-sectors of aircraft manufacturing, aircraft engine manufacturing and aircraft parts manufacturing. Aircraft manufacturing (including helicopters) accounted for nearly 60% of the value-added and 55% of the total employment. Aircraft parts manufacturing was the second most important sub-sector with around 24% share of value-added and 23% of employment. Similarly, the aircraft manufacturing accounted for the largest share of total capital expenditure in the aerospace sector, but aircraft parts manufacturing had a higher relative share of the investments compared to their value-added share.

The apparent labour productivity (measured as value-added per employee in EUR thousands) was higher in 2006 for the US with EUR 153.2 than for the EU27 with EUR 87.2. (see: Chapter 2)

[171] It can be assumed that similar to the European statistics for the US a difference exists between the figures on employment of the entrepreneur's association and of official sources. There are no official statistical figures available for 2008, but the number of employees as mentioned in Table 5.1for 2006 is by far much lower and should not be that far away from the figure for 2008, not yet published. This means that in fact the difference in US and EU employment is not that much high.

Table 5.1 US Aerospace Value-added, Employment and Total Capital Expenditure in 2006

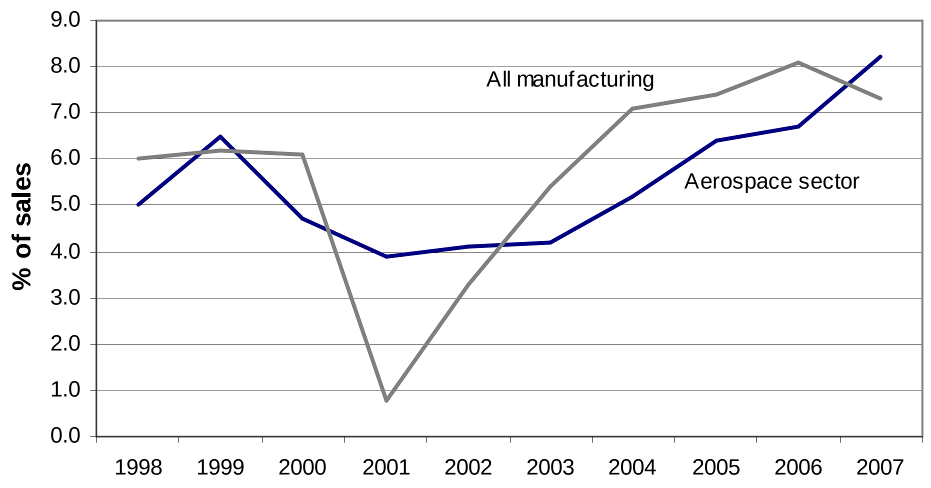
Indicator	Total	Share of total		
	2006	Aircraft manufacturing	Aircraft engine and engine parts manufacturing	Other aircraft parts and auxiliary equipment manufacturing
Value-added[172]	EUR 58.39 billion	59%	18%	24%
Employees	381,110	55%	21%	23%
Labour productivity (value-added per employee), EUR thousand	153.2	163.6	158.9	149.0
Total capital expenditure	EUR 2.22 billion	52%	16%	32%
Exchange rate of USD 1.3 / EUR 1.0 used				

Source: US Census Bureau (Value-added and Capital Expenditure) & AIA (Employees).

Note: The Aircraft manufacturing shares include also not-explained data in the value-added and capital expenditure shares.

Compared to the other manufacturing industries in the US, the aerospace industry has been able to maintain rather stable levels of profits (as percentage of sales). See Figure 5.3. However, during the booming economy from 2003 to 2006, the profits in the aerospace industry were slightly lower than in the other manufacturing industries, in spite of 9/11 and the breakdown of the New Economy Bubble that had a much bigger effect on other manufacturing sectors.

Figure 5.3 Profits as Percentage of Sales in Aerospace Sector vs. All Manufacturing



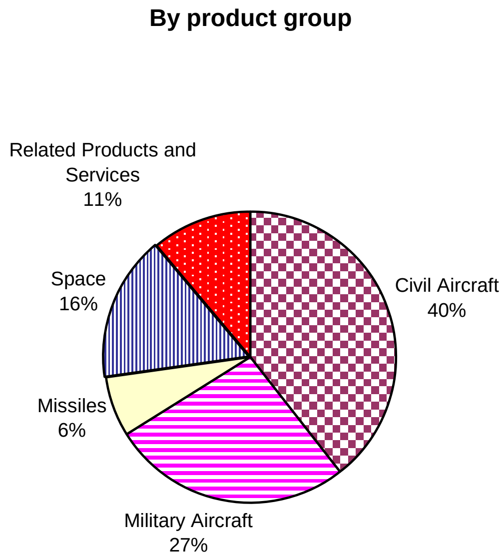
Source: AIA.

172 . Based on US Census Bureau data.

Supply structure

Despite the traditional importance of the military sector in the US, growth rates of civil aircraft sales have outperformed growth of military aircraft sales in recent years and now represent 40% of total sales, the largest share in the aerospace industry by product group. Military aircraft sales in 2008 were a mere quarter of total sales. Missiles made up 6%, Space related sales 16% and Related Products and Services 11% of total sales.

Figure 5.4 Structure of the US Aerospace Industry's Sales



Source: Aerospace Industries Association (AIA), own calculations.

Dividing aerospace industry sales by customers, the largest share are sales to the Department of Defence (44% of total sales). This is more than military aircraft and missiles together. Much of the remainder are maintenance, repair and overhaul (MRO) that reach noteworthy levels caused military actions. The other main group is sales to Other Customers. Sales to NASA and other Agencies only represent 5% of total sales.

Public policies

Public expenditure on R&D for the aerospace industry exceeds other countries' expenditure by a multiple (Aerospace Industries Association, Industry Information). Funding for military projects makes up the largest part. Federal funding for civil projects is mainly carried out through the NASA and the FAA.

In the US there exists no comprehensive national policy directed to the aerospace industry and as a result no single authority managing aerospace policy. Instead, several ministries and agencies, each responsible for a specific sector, follow their own strategies.

The most important national institutions and their relevance to the aerospace industry:

- Federal Aviation Administration (FAA): regulates civil aviation to promote safety and efficiency, develops a system of air traffic control and navigation for both military and

civil aircraft, develops and carries out programs to control aircraft noise and other environmental effects of civil aviation and regulates the US commercial space transportation.
- National Aeronautics and Space Administration (NASA): responsible for space exploration, access into space and the maintenance of the required infrastructure, finances research and development programs of new flight technologies.
- Department of Defence: develops and maintains military aerospace infrastructure and equipment; DoD budget includes financing of basic research.
- National Science Foundation: an independent federal agency, supporting all fields of fundamental science and engineering (except for medical sciences) including some research related to aerospace.

To coordinate science and technology policy the National Science and Technology Council (NSTC) was established in 1993. It is chaired by the President; members include the Vice-President, the Director of the Office of Science and Technology Policy, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities. The Aeronautics Science and Technology Subcommittee (ASTS) is instrumental for the National Aeronautics Research and Development Policy.

The FAA plays a key role in the Next Generation Air Transport System (NGATS or NextGen) program that entails the transformation of the US national airspace system. NGATS represents the evolution from a ground based system of air traffic control to a satellite based system and is the response to the growing volume of air traffic. It is expected that NGATS will not only increase capacity of the air traffic system, but also increase safety, reduce delays and provide beneficial environmental effects. The path of the FAA to NGATS is defined in the NextGen Implementation Plan. The Plan contains fully-funded commitments to near-term operational changes, new airport infrastructure, and improvements to safety, security, and environmental performance.

The corresponding European program is the SESAR project. The European program is currently in its development phase, which will produce a new generation of technological systems and components as defined during the initial phase. The proceeding phase, starting in 2014, is the deployment phase will seek to build the infrastructure. To ensure the coordination of both systems (the American NGATS and the European SESAR), in particular the use of compatible technology, the European Commission and the FAA signed an agreement of cooperation in July 2006.

The FAA provides funding for numerous research projects often in participation with the aeronautics industry. This includes projects on collision warning equipment, equipment for night vision for pilots and navigation- and communication equipment. However, there is no published information on the funding of the FAA directed to the aeronautics industry.

The NASA concentrates its aeronautics research activity in the Aeronautics Research Mission Directorate[173]. The Directorate's New Aeronautics Program is organized in three research programs and one test facility program[174]:
- the Fundamental Aeronautics Program (configured into Subsonic Fixed Wing, Subsonic Rotary Wing, Supersonics and Hypersonics projects),
- the Aviation Safety Program

173 http://www.aeronautics.nasa.gov/about_us.htm

174 Porter, L, NASA's New Aeronautics Research Program, Presentation at the 45th AIAA Aerospace Science Meeting & Exhibit, January 2007.

- the Airspace Systems Program (addresses the Air Traffic Management (ATM) research needs for the NGATS) and
- an Aeronautics Test Program, that runs the wind tunnels and air breathing propulsion test facilities at NASA are available to government, corporations and institutions.

The Aeronautics Research Mission Directorate requested a budget for 2008 of USD 511.4 million. Of this aggregate budget, USD 269.6 million are apportioned to the Fundamental Aeronautics, USD 66.5 million to Aviation Safety, USD 100.1 million to Airspace Systems, and USD 75.1 million to the Aeronautics Test Program. From a peak in 2009 of USD 650 million, the budget is expected to fall and stagnate at a level of around USD 530 million. A stable budget is achieved despite the start of the Integrated Systems Research Program in 2010 which will capture some USD 60 million.[175] The program is an integrated system-level approach to reduce the environmental impact of aviation (in terms of noise, emissions and air quality) in the area of air vehicle technology.

As mentioned earlier there does not exist an overarching national aerospace policy in the US even though the necessity of such an umbrella was pointed out by the Commission on the Future of the United States Aerospace Industry in 2002. Additionally, the Commission observed that the vertical organizational structure of the US government does not allow an integrated view on the national aerospace industry. It therefore recommends the formation of a government-wide management structure that is a prerequisite to implement a national policy more effectively. This should include a White House policy coordinating council, an aerospace managing office in the Office of Management and Budget and a joint committee in the congress. The Commission has also recommended that public funding for long-term research and infrastructure should be increased and national technology demonstration goals be established. These goals should be adopted as a priority. However, many of the recommendations of the Commission have not yet been implemented.

The U.S. National Space Policy has defined clear goals for the space sector and made it a national priority in 2006. But regarding the civil aeronautics sector a national policy is still missing. To date the focus has been to create and maintain an environment favourable for private investments. This is partly the result of the widespread notion in the U.S. that state intervention through support programs without industry feedback acts as a distortion of free markets and does more harm than good. There is the fear that funding will be directed into inefficient uses and consequently lead to painful structural readjustment in the long term. As a result the implementation of support programs is often made conditional on the industry's opinion regarding the profitability of the programs.

R&D is the only area with a unifying Federal policy. After numerous studies and reports pointed towards the problem of the absence of a national policy to guide Federal aeronautics R&D programs, the NSTC established the Aeronautics Science and Technology Subcommittee. On 20 December 2006, the National Aeronautics Research and Development Policy was implemented to better co-ordinate activities. It defines the principles upon which Federal Government aeronautics R&D will be based, the policy objectives and the general guidelines that will drive Federal aeronautics R&D activities until 2020.

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175 This is the complement to the European ACARE scheme.

The general guidelines state that the Federal Government 'should only undertake roles in supporting aeronautics R&D that cannot appropriately be performed by the private sector (companies)'. Specifically, the Federal Government is called upon to play a key role in the following three aspects of aeronautics R&D:

- Investment in aeronautics R&D that supports national defence and homeland security, from basic research through advanced technology development and beyond.
- Long term, fundamental aeronautics research that provides the foundation for future technology development.
- Advanced civil aeronautics research of public interest by improving public safety and security, promoting energy efficiency or protecting the environment but also advanced research in areas where risks or other market factors limit private sector investment.

The Policy also describes the responsibilities of the involved executive departments and agencies in four areas of aeronautics R&D: Stable and long-term foundational research, advanced aircraft systems development, air transport management systems and national research, development, test and evaluation of infrastructure.

It further called for a R&D plan to map research priorities, objectives and timelines. On December 21, 2007, the National Plan for Aeronautics Research and Development and Related Infrastructure was approved by the President. The plan, which will be reviewed on a biennial basis, provides the first integrated plan for Federal activity in aeronautics R&D and related infrastructure. It established high priority national aeronautics R&D activities, challenges and goals for Federal R&D until 2020 in the areas of mobility, national security and homeland defence, aviation safety, energy and the environment.

On a regional level many States have their own programs directed to the aerospace industry. Considerable financial incentives, especially fiscal measures, are used by some States, to support and attract firms and to establish aerospace clusters. Additional to programs available to all firms in the aerospace industry, many States offer support on a case-by-case basis to establish employment in the high-technology aerospace industry and to promote economic development. In this sense companies from other high technology industries are equally enticed with different incentives, such as tax breaks, subsidised real estate, educational schemes. Measures and motives of US regional policy are not much different to those of European Member States to attract companies.

Strong support to the US AI is provided by the Export-Import-Bank of the US. Boeing has been by far the single company that enjoyed support. In 2008 USD 10 billion in loan guarantees were provided for export sales, this was around 65% of the total guarantees provided by the bank.[176]

Clusters of aerospace industry

There are numerous aerospace clusters in the US. This section gives an overview of the states and regions with the largest aerospace industries.

California is the nation's aviation and aerospace leader. The aerospace industry is predominantly located in Southern California. The Commission on the Future of the Aerospace Industry showed that in 2001 aerospace and aviation employment was just under 300,000.

[176] http://subsidyscope.com/transportation/risk-transfers/exim/

On the east coast the Greater Washington Region (including Washington DC, Northern Virginia and Suburban Maryland) has nearly 125,000 employees in aerospace-related occupations. The Region benefits of its proximity to policymakers and government customers and large aerospace companies, like Northrop Grumman, Lockheed Martin and BAE Systems.[177]

On the west coast the Washington State is another stronghold of the US aerospace industry. More than 100,000 skilled workers and more than 600 companies are located in this state. Most prominent is Boeing, but also Goodrich and GE contribute to this cluster. But not only major US players run facilities also European groups, among them Safran and RR have invested in Washington State.

In Texas the aerospace industry employs 48,924 workers (figure Q4, 2008). The major industry employers are Lockheed Martin, Bell Helicopter Textron and Vought Aircraft Industries[178]. Adding employment in the defence industry, employment totals approximately 186,000[179]. To maintain its leadership position in the aerospace industry Texas has created the Governors Office of Aerospace, Aviation and Defence with exclusive focus on growth of the aerospace and defence cluster in Texas.[180]

Colorado ranks high amongst states with a large aerospace industry. Direct employment in the AI was 24,600 in 2005, with military personnel and workers' supporting the aerospace industry total employment (direct plus indirect employment) was 164,500[181]. Although figures on the employment division of the sub-sectors of aerospace are missing, it is safe to say that the largest part of aerospace activity is space related[182]. In fact, Colorado is home to the second largest space sector, behind only California. The dominance of the space industry is also reflected by the presence of six major space contractors in Colorado. Lockheed Martin employs over 10,300 people, with half of them working in the Space Systems Unit that is headquartered in Jefferson County. Other firms are Ball Aerospace and Technologies Corp., Raytheon, Northrop Grumman, Boeing Company and ITT Industries Inc. Systems Division.

Industry structure

Consolidation of the US American aerospace industry is far advanced. After two waves of mergers in the 1960s and the 1990s, the industry is now dominated by large firms offering highly integrated products. Apart from the large firms, specialised small and medium-sized companies play a role as Tier 2 or Tier 3 suppliers, too, but they lack the size and capabilities to supply OEMs with integrated systems and subsystems.

The military sector is an important field of activity of most US aerospace firms. Lockheed Martin, Northrop Grumman and Raytheon, some of the world's largest defence companies generate well above 75% of total revenue in the defence sector. Even Boeing, the world's largest aerospace company and beside Airbus the leading supplier of civil aircraft, generates roughly half its revenue in the defence sector.

177 Greater Washington, Aerospace and Defence Industry Overview, June 2009.
178 http://www.governor.state.tx.us/files/ecodev/profileaerospace.pdf
179 http://www.texasindustryprofiles.com/PDF/twcClusterReports/TexasAerospaceandDefenseCluster.pdf
180 http://governor.state.tx.us/index.php/priorities/economy/industry_cluster_efforts/aerospace_and_aviation_programs
181 http://www.fbla-pbl.cccs.edu/0708Documents/aerospace_100805.pdf
182 http://www.jeffco.org/pdfs/industry-Aerospace.pdf

The principal OEM manufacturers are Boeing and Lockheed Martin. After its merger with McDonnell Douglas in 1997, Boeing is the only manufacturer of large commercial aircraft in the US left. In other segments, there are additional OEMs, like Cessna and Hawker Beechcraft for Executive Jets and General Aviation, Bell and Sikorsky for helicopters. However, there is no US producer of regional aircraft.

The American GE Aviation (Revenues: USD 16.8 billion) and Pratt & Whitney (USD 58.7 billion) are, together with Rolls-Royce (UK), the worlds leading companies for aircraft engines, both for military and large commercial aircraft. The Alliance, a 50/50 joint venture between GE Aviation and Pratt & Whitney, develops, manufactures, sells and supports the GP7200 and engine intended for the A380. GE Aviation also develops the GEnx for the 787 and supplies the Chinese regional jet ARJ21 with an engine. These are the most important projects of the wide range of products of the engine manufacturers.

The American Tier 1 suppliers are predominantly large companies. They are able to offer the integrated systems that OEMs demand and act as risk and revenue sharing partners (RRSP) for large projects in cooperation with OEMs. Honeywell Aerospace (Total Revenue 2008: USD 12.81), Goodrich (USD 7.1 billion), Rockwell Collins (USD 4.77 billion), ATK (4.6 billion), Spirit Aerosystems (USD 3.77 billion), B/E Aerospace (USD 2.11 billion), Hamilton Sundstrand (USD 6.2 billion), Kaman (USD 1.2 billion) and Vought Aircraft Industries are the largest amongst the Tier 1 suppliers to the commercial aircraft market. An integral part of the strategy of these firms has been to grow through acquisitions. An example to this behaviour is B/E: founded in 1987, B/E has evolved from a company with revenues of USD 3 million to one with currently over USD 2 billion in revenues. Over a period of seven years B/E acquired more than 20 companies. Another example is Spirit Aerosystems: Formed from Wichita, Kansas division of Boeing in 2005, it acquired BAE System’s Aerostructures business unit facilities Prestwick, Scotland, and Samlesbury, England only one year later. Through its facilities in Europe, Spirit Aerosystems has been able to reduce its dependency from Boeing and become an important supplier of Airbus. Now Spirit Aerosystems is the world’s largest supplier of commercial airplane assemblies and components.

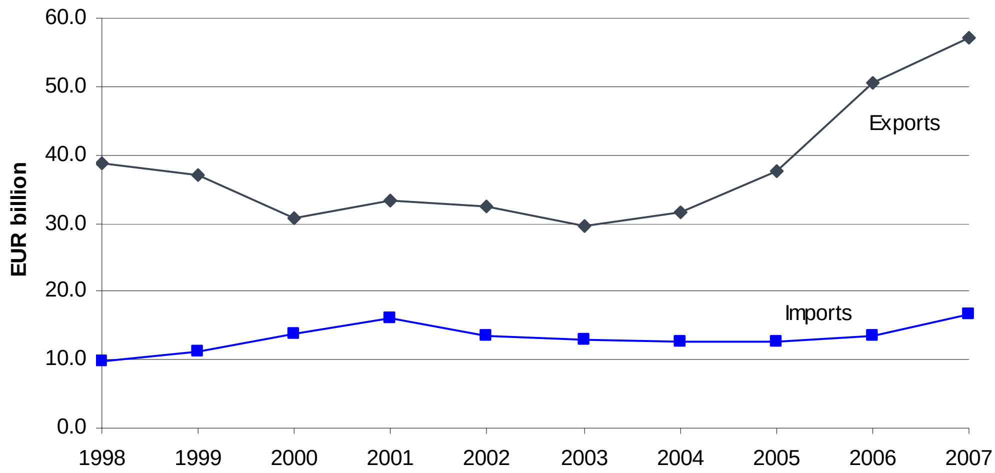
The investment of US companies in the European market has strongly grown during the current decade. In particular companies with a stake in the civil aircraft market have tried to diversify their customer base after the merger of McDonnell Douglas and Boeing. Some of them have successfully been integrated in the Airbus value chain in the recent past. This has also contributed to the Airbus strategy to increase natural hedging. Several other factors have been driving this development, limited capacities in Europe and companies that to a lesser extent have the size and the ability to raise resources necessary to successfully participate in bigger projects such as A380 and to fulfil the requirements of Airbus to carry out bigger working packages. The experience of US firms in the development and production of light parts and components have also been mentioned as reason.

Even within the group of Tier-2 and Tier-3 suppliers, large US companies are present. There are suppliers of metal components, like Alcoa Aerospace (USD 3.1 billion) and Precision Castparts (USD 6.7 billion) or suppliers of composites like Hexcel (USD 1.3 billion). With its European subsidiary Hexcel won the biggest contract for the delivery of composites for the A380. Esterline (USD 1.5 billion) is a specialized manufacturing company serving principally aerospace and defence markets in the avionics and advanced materials market. Another manufacturer of components is the Triumph Group (USD 1.15 billion). Cobham (USD 1.5 billion) until recently a Tier 3 supplier of components has been able to advance to a Tier 2 supplier, through strategic acquisitions and specific R&D.

5.1.2 The External Trade of the US Aerospace Industry

The US has been also by far the leading aerospace exporter until now and during the last decade it has increased further its trade surplus in the global trade with civil and military aircraft. While the EU had total (intra and extra-EU) exports value of around EUR 57 billion, the exports of the US accounted for around EUR 56 billion in 2007[183]. The imports of aerospace products to the US have also increased slightly during the last ten years, but significantly less than the exports. See Figure 5.5.

Figure 5.5 Development of US Total Aerospace Trade from 1998 to 2007



Source: UN Comtrade.

In 2007 large aircraft accounted for the largest share of both US exports and imports in aerospace products. In total the exports and imports of large (> 15,000 kg) and medium (2000 kg to 15,000 kg) sized aircraft and aircraft parts accounted for around 90% of all trade. However, in percentage terms the exports and imports of medium sized aircraft have faced the largest average annual growth rates. While in relative terms the total US aerospace exports have increased less than imports (4.7% against 7.1%), in absolute terms the exports have been growing more.

183 On the other hand, the AIA reported an export value of $96bn for US at 2007, which equals some EUR 73bn.

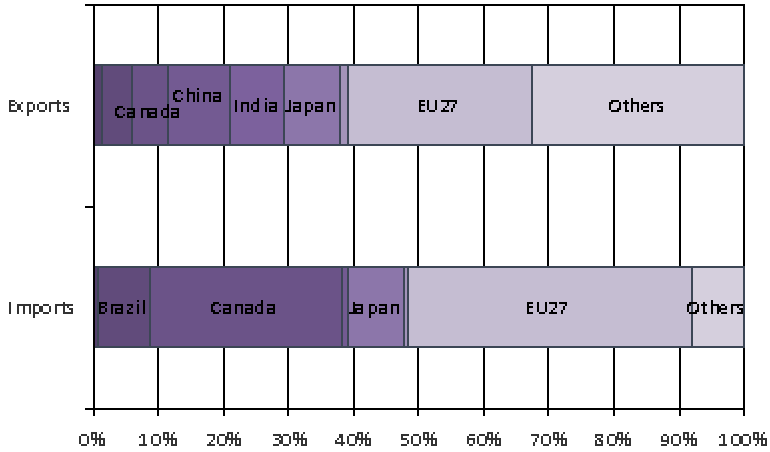
Table 5.2 Share of US Exports and Imports per Subsector in 2007 and 1998

Sector	Exports, share		Growth exports, average annual	Imports, share		Growth imports, average annual
	2007	1998	1998-2007	2007	1998	1998-2007
Total aerospace (EUR value and average annual growth rates 1998-2007)	57,13 billion	38,85 billion	4,7%	16,68 billion	9,76 billion	7,1%
Fixed wing aircraft, unladen weight > 15,000 kg	58,7%	61,0%	18,8%	33,9%	19,8%	8,7%
Aircraft parts nes	25,4%	25,6%	17,9%	33,6%	40,7%	3,6%
Fixed wing aircraft, unladen weight 2,000-15,000 kg	8,8%	7,7%	20,9%	22,0%	30,2%	53,8%
Helicopters of an unladen weight > 2,000 kg	2,5%	1,3%	6,8%	1,8%	2,3%	2,5%
Aircraft under-carriages and parts thereof	2,1%	2,0%	4,1%	3,6%	1,7%	19,3%
Aircraft propellers, rotors and parts thereof	0,8%	1,2%	-0,6%	0,8%	0,4%	26,3%
Fixed wing aircraft, unladen weight < 2,000 kg	0,6%	0,3%	5,9%	1,0%	0,3%	25,0%
Helicopters of an unladen weight < 2,000 kg	0,6%	0,3%	4,6%	2,6%	2,4%	4,1%
Flight simulators, parts thereof	0,3%	0,5%	-2,2%	0,6%	2,1%	-5,4%

Source: UN Comtrade, own calculations.

Figure 5.6 shows the structure of US exports and imports by main trade partners in 2007. While the exports are relatively equally distributed, the imports are more concentrated and originate mostly from the EU, Canada, Japan and Brazil. In percentage terms most of the US exports are bound also towards the EU, China, Japan, India and Canada. Some of the main export partners under the grouping “other partners”, which accounts still for some 33%, includes e.g.: United Arab Emirates, South Korea and Singapore.

Figure 5.6 Total US Aerospace shares and values of Exports and Imports by Partner in 2007, EUR billion



	Imports	Exports
Others	1.36	18.63
EU27	7.28	16.03
South Africa	0.00	0.21
Russian Federation	0.05	0.58
Japan	1.44	4.99
India	0.01	4.66
China	0.15	5.53
Canada	4.93	3.22
Brazil	1.32	2.46
Australia	0.14	0.83

Source: UN Comtrade, own calculations.

With regards to the share of imports in each sub-sector per partner, the EU is the most important source of US imports in total aerospace and specifically in the imports of small helicopter, small and large aircraft and aircraft propellers (where the EU share of imports is over 90%). Canada, again, imports the most large helicopters, medium size aircraft, aircraft under-carriages, aircraft launching gears and flight simulators to the US. See Table 5.3. In relatively terms the US imports from Russia, India and China have increased the most from 2000 to 2007, but in absolute terms these countries accounted still for very small shares of the total imports in 2007 (except for the imports of aircraft under-carriages from Russia, which accounted already for some 5% of the category's total imports).

Table 5.3 Share of US Imports in 2007 from each Partner Country out of the Subsector Total and Growth of Imports per Partner 2000-2007

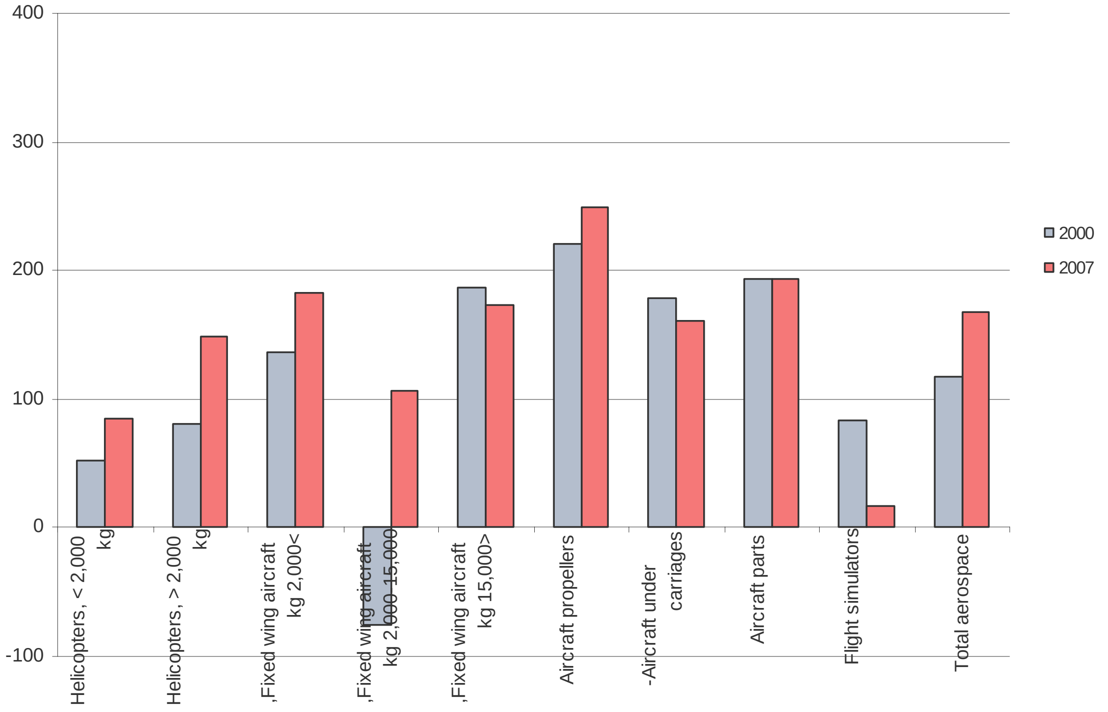
Partner	Fixed wing aircraft, > 15,000kg	Fixed wing aircraft, 2,000-15,000 kg	Fixed wing aircraft, < 2,000 kg	Helicopters, > 2,000 kg	Helicopters, < 2,000 kg	Aircraft parts	Aircraft propellers	Aircraft under-carriages	Flight simulators	Total aerospace	Growth of imports per partner
Australia	0.0%	0.2%	1.0%	0.0%	0.4%	2.3%	0.1%	0.0%	0.0%	0.8%	1.9%
Brazil	18.5%	6.2%	0.2%	0.0%	0.0%	0.7%	0.0%	0.8%	0.3%	7.9%	10.9%
Canada	31.7%	41.7%	38.9%	72.8%	27.8%	13.1%	5.9%	63.4%	77.4%	29.6%	8.7%
China	0.2%	0.0%	0.1%	0.0%	0.0%	2.4%	0.0%	0.2%	0.1%	0.9%	35.7%
India	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.0%	0.0%	0.1%	113.8%
Japan	0.0%	0.0%	0.0%	0.0%	0.0%	25.6%	0.7%	0.7%	0.2%	8.7%	2.9%
Russia	0.0%	0.0%	0.0%	0.7%	0.0%	0.4%	0.1%	4.2%	0.0%	0.3%	126.2%
South Africa	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.7%
EU	49.0%	35.3%	54.7%	25.8%	71.4%	43.0%	90.9%	28.2%	21.1%	43.6%	5.6%

Source: UN Comtrade, own calculations.

The dominance of the US in the aerospace products trade and production can be shown in the relative comparative advantage indexes of each sub-sector. See Figure 5.7, where positive figures mark a comparative advantage's in the sub-sectors and negative values a disadvantage compared to other countries of the world. In 2007 the US had a comparative advantage in the trading of all aerospace sub-sectors, even though their competitiveness in the trading of flight simulators, large aircraft and aircraft under-carriages had decreased mildly from 2000.[184]

[184] The RCA analysis has been done only from 2000 to 2007. E.g. EU27 has no grouped data for earlier than 2000 and the RCA index required data for all countries for the global comparison.

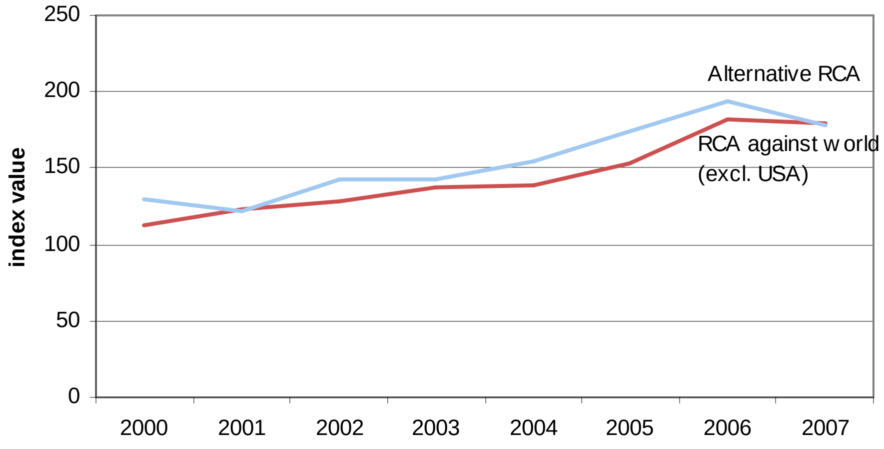
Figure 5.7 US Relative Comparative Advance (RCA) against the RoW in 2007 and 2000



Source: UN Comtrade, own calculations.

The competitiveness of the US against other countries in total aerospace production has been increasing from 2000 to 2007 according to the RCA indicator (and also to the alternative RCA indicator), as Figure 5.8 illustrates.

Figure 5.8 Yearly RCA Indexes for Total US Aerospace Industry from 2000 to 2007



Source: UN Comtrade, own calculations.

Conclusion

The development of the AI of the US shows a similar cyclical pattern as the European sector. However on average over the period the European output grew at a somewhat higher pace and in 2008 it surpassed the US output. By and large both civil industries are of same size. The US industry experienced a growth of labour productivity, on average 1.3%, whereas in Europe labour productivity declined at an average rate of 0.8% between 2001 and 2008, in constant prices. Last year the average employee of the US AI reached a value-added of EUR 153.2 thousand and the European EUR 87.200.

Traditionally the US AI has been closely linked to Canada. Originally wage differentials were a driving factor. Although nowadays labour costs have remained lower wage differentials have become less important for the division of labour. Efficiency gains by specialization in the supply chain and with final products have become more important. As a consequence of the globalisation of the value chain and the industrialization of emerging economies beyond Japan China and India have become noteworthy locations for the production of parts and components.

The restructuring of the AI has led to the creation of big manufacturers, not only Tier-1, but also Tier-2 and Tier-3. This is an asset and contributes to the strength of the US. Such companies own the potential to allocate financial and human resources necessary to meet the requirements of OEMs, to take over the role as system integrators and to become risk sharing partner.[185]

To a large extent the leading position of US firms is based on their longstanding experience to cope with complex tasks. For instance experts of the industry argued that the advantage of the US firm Hexcel in the area of composite as compared to competitors lies in its size and its track record. This view is supported by the argument that US firms have proven to be successful in light weight construction and this has eased their access to the A380 project.

To a large extent the strong technological position of the US originates from the defence industry and R&D in areas with dual use potential. The interviews disclosed that there are spill over effects and economic advantages by the exploitation of available know how. However, with regard to technologies applied in the area of civil aeronautics there may not be a US lead and a noteworthy dependency from US know-how. But simultaneously it was reported that there are small electronics components that usually are imported by the European AI. There is no European supply and US manufacturers try to bar potential competitors from market access by pricing strategies.[186]

The US has always given strong support to the AI. There are numerous programs to foster R&D. The coordination of these initiatives has been evaluated as insufficient. The Obama government envisages to reducing defence projects of importance for the AI.[187] This will induce additional financial stress on companies that are suffering from a slowdown in demand and face stricter funding conditions.

The analysis of international trade disclosed that the US has a strong focus on the AI. As compared with other US industries the aerospace companies have been more successful in global markets and the performance has even improved in course of the past decade. This result is based on a specialization in aircraft exports that has been more pronounced in US trade than in global trade. Not only in exports, but also the trade balance of the US AI has improved during the period under consideration. As compared with the average of other manufacturing industries the US has

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185 Apart from the current problems (e.g. necessary bail out of Vought Industries) in the Boeing value chain - induced by its high-risk value chain strategy – this evaluation is retained.

186 The Dassault fighter Rafale was mentioned as an example that Europe has the capabilities to manufacture high performance aircraft without the use of US supplies.

187 Aviation Week, budget constraints.

always enjoyed a trade surplus and net exports have evolved much better. This means that the US AI has a comparative advantage based on the US manufacturing industry as a benchmark. The evaluation of the global competitiveness needs an additional investigation in the US shares in international trade (see: Chapter 2).

5.2 The Russian Aerospace Industry

5.2.1 The Size and Development of the Aerospace Industry

Overview

The Russian AI was hit hard by the breakdown of the Soviet Union. On the one hand the demand from its former satellite states virtually vanished; on the other hand government funding was reduced. For many years the industry struggled against foreign competition. The mostly state-owned manufacturers and design bureaus (but some had been privatised) maintained few cooperations in R&D, design, production, sales and marketing[188]. As a result the products were not competitive, compared to those of the established producers.

While during the Soviet Area, Russian aerospace industry had produced a quarter of the world's aircraft, annually around 100 commercial aircraft by 2005 the average production of the entire Russian civil aircraft industry was 10 aircraft per year. The decline in the production of civil aircraft in the years immediately following the dissolution of the Soviet Union was 80%[189]. Some manufacturers of commercial aircraft produced as little as one or two planes a year[190].

Current development

Today the Russian aircraft industry comprises 106 enterprises. In 2008 their turnover amounted to Rouble 226.6 billion, of which 29% was exported. The figures comprise the civil and military sector. No indication was made if space activities are covered in these figures. Likewise the portion of defence of total figures is not mentioned. As compared with 2007 turnover shrank due to the financial crisis by 0.9%. However civil aircraft grew by 2.7%.[191]

In an attempt to create an aircraft producer that would be able to meet the growing national demand for aircraft[192] and to compete internationally, the government under President Vladimir Putin, consolidated the public Russian aircraft industry under a state-owned joint stock company, the United Aircraft Corporation (UAC) in 2006[193]. Senior leadership of UAC has set the goal of becoming the world's third largest aircraft manufacturer by 2015. Achieving this high aim will depend on establishing cooperations between UAC member companies and with international competitors.

To assist the development of UAC the Russian government provides financial support to its member companies. However, non-members are reported to have difficulties to access public

188 Flight Plan 2009: Analysis of the U.S. Aerospace Industry; Country Analysis: Russia.

189 The Changing Structure of the Global Large Civil Aircraft Industry and Market: Implications for the Competitiveness of the US Industry, US International Trade Commission, 1998.

190 Arkady Ostrovsky, "Russian Aviation Woos Foreign Investors," Financial Times, 23 August 2006.

191 UAC, Annual Report of Joint Stock Company United Aircraft Corporation 2008, 2009, p. 16.

192 According to the Russian Transport Ministry half of the civil aircraft in operation have passed the legal operational limits and needed to be replaced (Flight Plan).

193 Approximately 20 Russian aerospace companies, including Irkut, MiG, Suchoi, Iljuschin and Tupolev were consolidated into the UAC.

schemes. A three year state budget signed in 2006/2007 provided USD 700 million in direct investment support to UAC[194].

One of the priorities of the UAC, through Sukhoi Civil Aircraft Company, is the development of the SuperJet 100, a regional jet in the 78-98 passenger size. It is designed to compete with regional jets of Bombardier and Embraer and is produced with subcontractor assistance from Western firms. Alenia has become a shareholder with a big stake in the project. Boeing, Goodrich, PowerJet, Messier Dowty are among others.

It was strived for the development of one of the most advanced and environmental friendly regional jets. While equipped with advanced capability in design and manufacture, the Russian AI finds it difficult to compete internationally because of inadequate expertise in marketing, sales and after-sales services. In response to this shortcoming Sukhoi formed a joint venture with the Italian aircraft manufacturer Alenia Aeronautics (51% Alenia Aeronautics, 49% Sukhoi Holding). The joint venture under the brand-name SuperJet International[195] will carry out marketing, sales and after-sales services in Europe, North- and South America. The SuperJet 100 had its first flight in May 2008 and is expected to be delivered from the end of 2009. To date 100 aircraft have been ordered from various airlines, with the largest order placed by Aeroflot (the major Russian carrier) over 30 planes - perhaps under pressure from the government[196]. (Table 5.4)

Table 5.4 Western Partners/Suppliers in the Production of the Sukhoi Superjet 100

Subject	Partner
Strategic Partner	Alenia Aeronautics (Italy), owns stake of 25%
Engine	PowerJet, Joint Venture between Snecma (Safran Group, France) and NPO Saturn (Russia)
Landing Gear	Messier Dowty (Safran Group, France)
Wheels, Brakes	Goodrich (USA)
Hydraulic System	Parker (USA)
Control Systems	Liebherr Aerospace (Germany)
Air conditioning/Ventilation	Liebherr Aerospace (Germany)
Electrical System	Hamilton Sundstrand (USA)
Avionics	Thales (France)
Fuel System	Zodiac (France)
APU	Honeywell (USA)
Cabin Interior	B/E Aerospace (USA)
Fire protection system	Curtiss-Wright (USA)
Consultancy Support	Boeing

Source: Handelsblatt, 17 June 2009.

The engine used for the SuperJet 100 will be the SaM146 produced by PowerJet, a 50/50 engine joint venture of Russian engine maker NPO Saturn and the French Snecma Moteurs. The

194 US Department of Commerce, Russia: Consolidation of the Aerospace Industry.
195 The Sukhoi Company holds 49% shares of the registered capital, while Alenia Aeronautica owns 51%.
196 http://news.bbc.co.uk/2/hi/europe/8234421.stm

SaM146 is not exclusively produced for the SuperJEt 100 but is intended for the regional aircraft carrying 70 to 120 passengers[197]. PowerJet can clearly be seen as the attempt of the Russian AI to compete with established engine manufacturers in the US, Europe and Japan. The development of the engine has been helped by government support. Between 2006 and 2008, the French government provided Snecma with USD 168 million, while Russian authorities supported the programme with USD 116 million from the state budget[198]. This subsidy was motivated by Russia's objective to preserving and enlarging the civil aircraft industry. However, it is unclear whether NPO Saturn remains a private company, as the state owned Oboronprom was asked by former President Vladimir Putin to consolidate the aircraft engine market. So far NPO Saturn and the other major aircraft engine manufacturer, Ufa Engine-Building Industrial Association, were able to resist a state takeover[199].

Despite the efforts of the government to establish a domestic aircraft industry, production in 2008 was as low as in previous years. Only 10 commercial aircraft were produced according to preliminary figures from the Russian Ministry and Trade[200]. Moreover, the produced aircraft are outdated: Tupolev and Ilyushin aircraft consume almost 50% more fuel than their Airbus equivalent and are no longer economical to operate[201]. The 20-30% lower prices of Russian production aircraft do not compensate anymore for the running costs[202]. Even the Russian airline Aeroflot is now buying the vast majority of its planes from Boeing and Airbus. In 2008 the total number of Russian aircraft ordered was only 13. With high and growing demand from national carriers for advanced aircraft and simultaneously domestic production rates of aircraft at low levels the government decided, in 2008, to eliminate import taxes on aircraft with seating capacity of up to 50 passengers and empty weights of up to 15 tons. This was after in December 2007, the government had already zeroed the taxes for large wide-body aircraft with more than 300 seats. This will give Russian carriers a chance to renew their fleets and it recesses the new SuperJet100 (over 50 seats) competitors (more than 50 seats and less than 100) from the import tax reliefs.[203]

Structure of the industry

The structure of the Russian AI shows the pattern of the former socialistic economy that was characterized by the existence of different organizations dedicated for the execution of certain activities. R&D and product development are separated from production units. There are research and testing institutes that are run by the government or governmental institutions. They are involved in the execution of basic research but not the development of new products or they provide the infrastructure necessary to test and optimize design. This infrastructure has remained in operation during the transition phase and provides the indispensable infrastructure for the development of advanced aircraft that meet international standards. The next area comprises design houses that are more or less independent bodies for the development of new aircraft. Traditionally they are not part of a company that manufactures aircraft. Production plants are run independently, although they are specializing on certain products and by that have linkages to special-

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197 http://www.powerjet.aero/?id=191&selt=1
198 http://www.ato.ru/rus/cis/archive/17-2007/aero/aero2/?sess_=76c
199 http://www.defensenews.com/story.php?i=3651408
200 http://www.ato.ru/rus/cis/archive/24-2009/aero/aero1/
201 http://news.bbc.co.uk/2/hi/europe/8234421.stm
202 http://news.bbc.co.uk/2/hi/business/7266853.stm
203 Recent tests indicate that the technical performance, in particular fuel consumption, of the Superjet 100 meets international standards and it can become an important competitor. See: Superjet: Russias Revival or last stand? In: Flightglobal, 6 August 2009. http://www.flightglobal.com/articles/2009/06/08/327497/superjet-russias-revival-or-last-stand.html
This result underscores the assumption that high-tech components provided by the leading specialized manunfacturers in the value chain are of major importance for the design and production of advanced aircraft.

ized design houses. This structure has turned out to be an obstacle for the transition to the market economy.[204]

Around 40 enterprises exist in the Russian propulsion market, which have not yet been restructured in viable groups or companies. It is envisaged to create four holdings that are specializing in the market to improve their performance.[205]

Links to western aerospace companies: Materials, initial processing and human capital

Leading European and American aerospace companies regard Russia principally as a source of raw materials and engineering talent. Boeing, having spent USD 3.5 billion since the collapse of the USSR[206] [207] plans to invest USD 27 billion in the next 30 years in Russia. USD 18 billion are intended to be spent on the purchase of Russian titanium from VSMPO-AVISMA, the world's largest titanium producer[208] (state owned through Rosoboronexport, the government arms exporter monopoly). VSMPO-AVISMA has been a supplier to Boeing since 1993. In recent years VSMPO-AVISMA has strongly grown due to increased demand from Western firms. Boeing entered a 50-50 joint venture with VSMPO-AVISMA to produce titanium parts for the 787 Dreamliner to strengthen the ties. As a result of the deal, titanium machining technology will be transferred to the Russian manufacturer.[209]

As early as 1992, Boeing opened the Boeing Technical Research Centre in Moscow and an engineering design centre as part of the BTRC in 1998. By the end of 2007, the Research Centre employed 1,500 workers[210]. The design of various components for the 787 Dreamliner has been carried out by Russians at these facilities. Russian engineers, while highly educated, only cost a fraction of the American or European counterparts.

Airbus expanded activity in Russia at the beginning of the 1990s[211]. Initially, it was restricted predominantly to the delivery of Airbus aircraft. In 2001, Airbus signed a strategic partnership agreement with the Russian Aviation and Space Agency Rosaviakosmos worth EUR 2.1 billion over the first 10 years[212]. The programme covers a wide range of research and technology projects, manufacture and delivery of parts and components, as well as design work and material procurement[213].

Airbus, together with the Kaskol Group, created an engineering centre of Airbus in Russia (ECAR) in 2003. ECAR is currently involved in the design of fuselage sections for the A380 freighter and design work for the A350. In further cooperations Airbus placed work packages for aircraft of the A320, A330/A340 and A380 families with Russian manufacturers IRKUT Scientific Production Corporation and Voronezh Aircraft Production Association (VASO) worth USD 200 million over ten years.

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204 Aviation Week & Space Technology, Source Book 2009: Russian Federation Prime Contractor Profiles, Fixed-Wing and Rotary Wing Aircraft, 26 January 2009, p. 306.

205 Aviation Week & Space Technology, Source Book 2009: Russian Federation Prime Contractor Profiles, Populsion, 26 January 2009, p. 306.

206 http://www.businessweek.com/print/technology/content/feb2006/tc20060215_694672.htm

207 http://www.investinrussia.info/en/success/00034/

208 http://www.reuters.com/article/rbssIndustryMaterialsUtilitiesNews/idUSL2753317620071227

209 http://www.nytimes.com/2006/08/13/business/worldbusiness/13iht-boeing.2466137.html

210 http://mdb.cast.ru/mdb/4-2007/item_2/article_2/

211 http://www.airbus.com/en/worldwide/airbus_in_russia.html

212 http://www.eads.com/1024/en/pressdb/archiv/2001/en_2001_rosvia.html

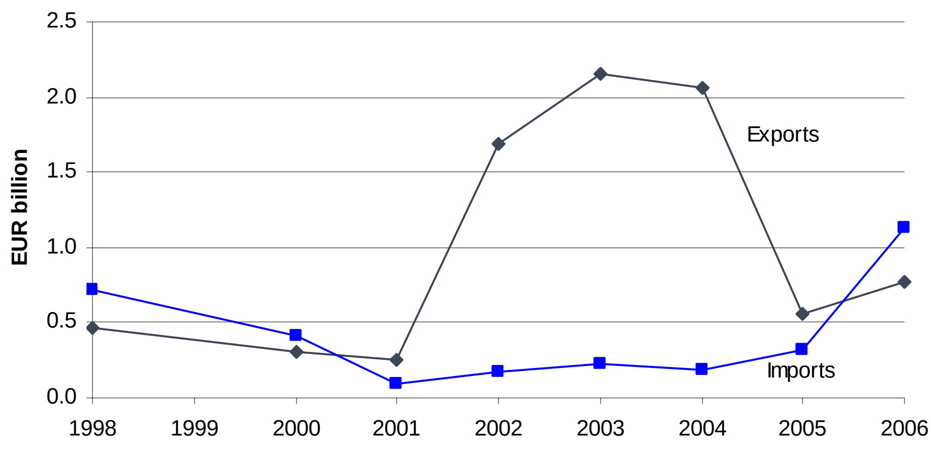
213 http://www.airbus.com/en/worldwide/Russia_backgrounder_en.html

In 2007, EADS and the UAC signed agreements to create a joint venture for the freighter conversion of the A320 family, as well as to offer a five percent airframe participation in the A350XWB programme and making UAC a shareholder of engineering centre of Airbus in Russia[214]. The biggest and longest-term contract in the history of Airbus/EADS co-operation with Russia was signed in April 2009 with VSMPO-AVISMA and covers the supply of titanium to Airbus until 2020. Currently VSMPO-AVISMA meets 50% of titanium demand of Airbus. Additionally EADS is shareholder of the privately held Russian aircraft manufacturer IRKUT. The ownership structure depicts the typical pattern for a privatized company: Management holds 44%, the employees 2%, institutional and other private investors 32% and EADS 10%. These affiliations show the commitment of Airbus to establish strong links with the Russian AI as outlined in the strategic partnership agreement of 2001.

5.2.2 The External Trade of the Russian Aerospace Industry

For a certain time the aerospace product exports of Russia have increased substantially during the last decade, amazingly during the years when the global market declined after 9/11. While from 2001 to 2005 many other countries faced a decrease in their export flows, Russia experienced actually a large increase in exports and in the trade surplus. However, in 2005 the exports dropped again (while many other countries were able to increase their exports) and in 2006[215] the imports were even higher than exports.

Figure 5.9 Development of Russian Total Aerospace Trade from 1998 to 2006



Source: UN Comtrade (no data available for 2007).

For the international trade of the aerospace industry in major product segments see Table 5.5. Final products dominate the imports by far and indicate that the domestic demand has become strongly dependent on foreign supply. Large aircraft accounted still in 2006 for the largest share of and imports, although their portion has dropped from the levels in 1998, but this has been induced by the soaring imports of business jets. At the same time, e.g. the exports of large helicopters, aircraft propellers and small helicopters increased substantially. Additionally the interna-

214 http://www.eads.com/1024/en/investor/News_and_Events/news_ir/2007/2007/20070322_eads_uac_partnerhsip.html

215 The analysis extends only till 2006 due to lack of data for 2007.

tional division of labour has been intensified by strongly growing intermediary exports and imports.

Table 5.5 Share of Russia's Exports and Imports per Subsector in 2006 and 1998

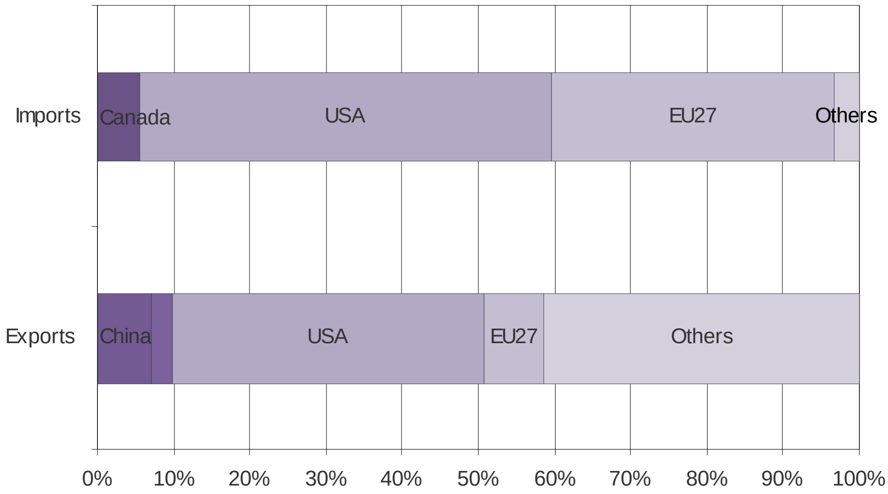
Sector	Exports, share 2006	Exports, share 1998	Growth exports, average annual 1998-2006	Imports, share 2006	Imports, share 1998	Growth imports, average annual 1998-2006
Total aerospace (EUR value and average annual growth rates 1998-2006)	0.77 billion	0.46 billion	7.3%	1.12 billion	0.71 billion	6.4%
Fixed wing aircraft, unladen weight > 15,000 kg	61.0%	85.59%	2.0%	90.6%	98.50%	5.0%
Helicopters of an unladen weight > 2,000 kg	29.0%	9.20%	46.9%	1.6%	0.12%	235.5%
Aircraft propellers, rotors and parts thereof	5.3%	1.71%	46.0%	0.1%	0.12%	9.0%
Aircraft under-carriages and parts thereof	2.1%	1.05%	26.3%	0.5%	0.04%	236.3%
Aircraft parts nes	1.8%	0.96%	22.8%	0.8%	0.19%	59.2%
Fixed wing aircraft, unladen weight 2,000-15,000 kg	0.5%	1.09%	-2.5%	5.5%	0.57%	157.6%
Flight simulators, parts thereof	0.2%	0.07%	29.3%	0.2%	0.00%	-
Helicopters of an unladen weight < 2,000 kg	0.1%	0.00%	5349.9%	0.6%	0.47%	12.7%
Fixed wing aircraft, unladen weight < 2,000 kg	0.0%	0.33%	-11.1%	0.1%	0.00%	261.5%

Source: UN Comtrade, own calculations.

The trade relations of the Russia in aerospace and defence products are rather concentrated. For example imports originate mostly from the US or the EU. The US is also the number one export destination (with around 40% of total Russian exports heading there), while EU and China rank to the second places out of the listed partner countries. Significant share of their exports are also going to other partner countries (not listed separately here) with large majority of them being former Soviet Union countries.

The pattern of exports underscores the difficulties the Russian AI faces to access international markets with products. The underlying reasons are outdated products and missing distribution channels and an MRO network. The extremely high share of exports to the US has been caused by the more aggressive US policy on outsourcing and the creation of international production networks.

Figure 5.10 Total Russian Aerospace shares and values of Exports and Imports by Partner in 2006, EUR million

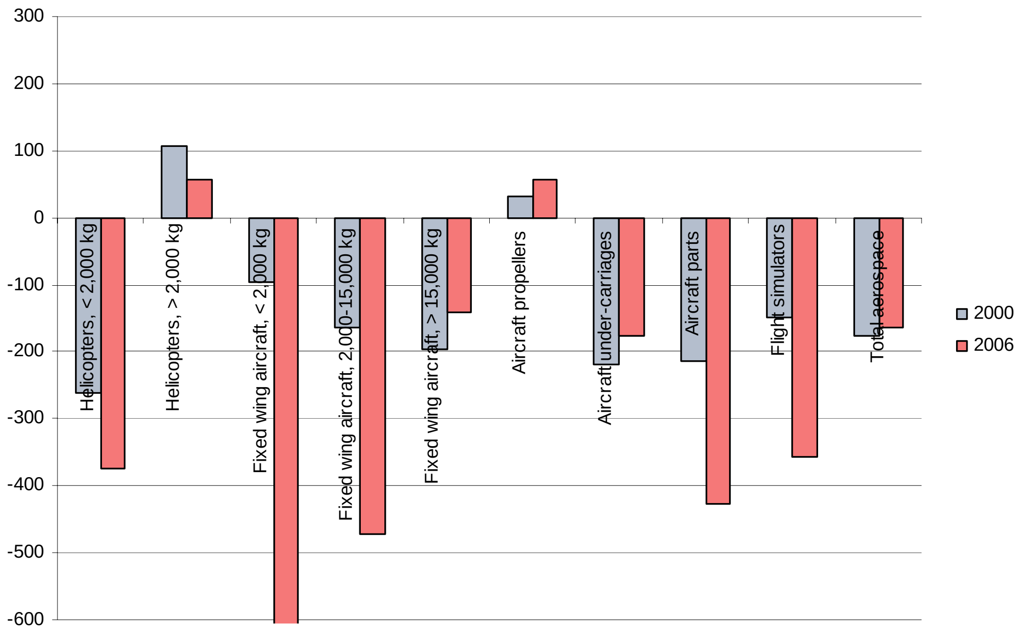


	Exports	Imports
Others	319.2	38.3
EU27	59.2	414.7
USA	314.8	609.9
South Africa	0.1	0.0
Japan	0.0	0.0
India	22.8	0.0
China	53.4	0.3
Canada	0.0	61.1
Brazil	0.0	0.0
Australia	0.0	0.0

Source: UN Comtrade, own calculations.

In the global competition, Russia has not been performing very strongly yet, even though it does have a comparative advantage in the trading of few sub-sectors according to the RCA index – more specifically in large helicopters and in aircraft propellers. In addition, many of the sub-sectors have been losing competitiveness since 2000 (e.g. small helicopters, small aircraft and aircraft parts).

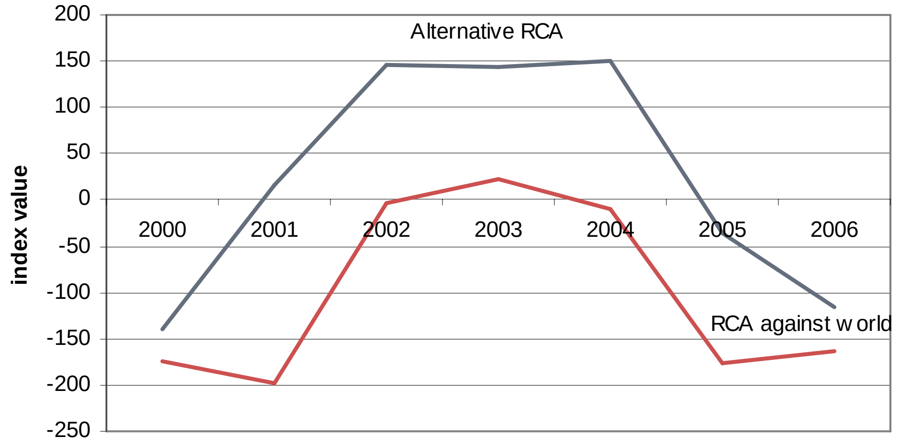
Figure 5.11 Russia's Relative Comparative Advance (RCA) against the RoW in 2006 and 2000



Source: UN Comtrade, authors' calculations.

During the boom of the Russian aerospace exports from 2001 to 2005 the sector did show a comparative global advantage according to the global and alternative RCA indexes from 2002 to 2004 (Figure 5.12). However, Russia lost the advantage again in 2005 due to the drop in exports and increase in imports. The interim improvement of the RCA indexes is interpreted as a statistical effect only and has turned out not to be sustainable. If the Russian aerospace industry has potential for becoming a noteworthy player in the global market, has to be proved in the years to come.

Figure 5.12 Yearly RCA indexes for total Russian aerospace industry from 2000 to 2006



Source data: UN Comtrade, authors' calculations.

5.2.3 Conclusion

The transition of the Russian aerospace industry from the socialistic area to a more economically driven sector has not yet come to an end. Public measures were taken to create a group that has the potential to become a competitive supplier in the civil aircraft market. With UAC the government has created such a company and politicians' benevolence secures good access to public schemes. However, the Russian aerospace value chain has not yet reached international standards by technology and manufacturing processes. As a consequence the Superjet 100 project of UAC was set up as a joint effort with numerous well-known manufacturers from Western countries.

The capabilities and international competitive capacities of the Russian civil aerospace industry are limited. The necessary has not yet made sufficient process. This has turned out to the detriment of the Russian airlines that urgently need to replace outdated planes and procure more efficient advanced equipment. As a consequence the government has abolished tax barriers on imports of aircraft with the exception direct competitors for the Superjet 100.

The integration of the Russian AI has progressed. There is a growing exchange in intermediary products within the value chain. In particular the US AI has been busy to exploit the advantages of Russia as a location for engineering and production. It was reported that Russian deliveries do not contain key-technologies. Western manufacturers have invested in engineering services in Russia but the acquired capacities are occupied in most cases with standard development and design activities, but not with key elements. The evaluation of production quality, reliability and the ability to manufacture light weight parts and components among European experts differs between "western standard" and "product characteristics are not adequate". Considering the missing experience in the manufacturing of advanced aircraft it will not be easy to get quality required by western OEMs in any case.

5.3 The Canadian Aerospace Industry

5.3.1 The Size and Development of the Aerospace Industry

Overview

Canada is one of the few countries producing complete commercial aircraft through Bombardier, its principal aircraft manufacturer. Bombardier is the world's third largest civil aircraft manufacturer. Originally founded as a manufacturer of snowmobiles, Bombardier diversified into the aerospace market in 1986 with the purchase of Canadair, the leading Canadian aircraft manufacturer of widebody business jets. In 1989 Bombardier launched the 50 seat Canadair Regional Jet (CRJ) program. A 70-, 86- and a 100-seat version followed later. Today, the CRJ Series is the world's most successful regional aircraft program. In 1992, Bombardier acquired Boeing's de Havilland division, based in Canada, manufacturer of the Twin Otter aircraft and Dash turboprop airliner. De Havilland's Dash 8 turboprop and the CRJ Series established Bombardier as one of the world leaders in regional aircraft. Through acquisitions of Short Brothers plc, the pioneering aviation manufacturer based in Northern Ireland, in 1989 and Learjet Corporation a manufacturer of buiness jets, Bombardier established an international presence in the AI[216]. Driven by the expansion of the production of commercial aircraft Canada experienced a boom of sales since the early 1990s. Today, the AI is heavily dependent on the production of commercial aircraft, which accounts for over half of the industry's output (National Aerospace and Defence Strategic Framework, 2005, p.13).

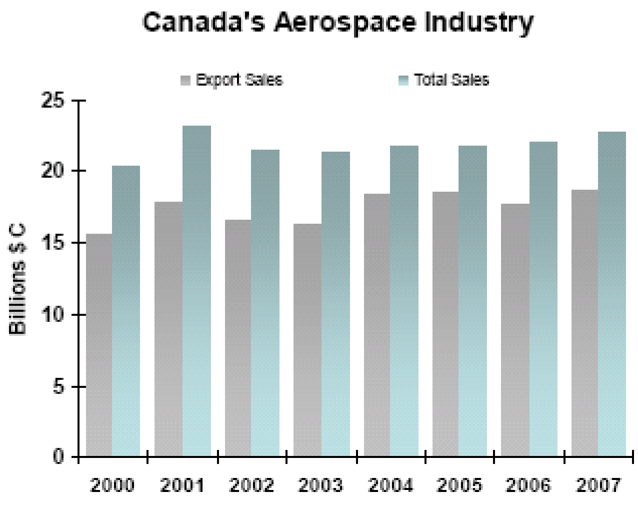
Canada's success in the world market is due to the role of a number of Canadian owned companies, such as Bombardier, CAE and CMC Electronics and several subsidiaries of international firms often with world product mandates (like Pratt&Whitney Canada, Boeing Canada, Bell Helicopter Textron, Honeywell Canada and Rolls-Royce Canada).

Current development

Canada has been one of the main players in the aerospace sector in addition to the US and the EU for a larger period. In 2007, it accounted aerospace sales of around USD 22.7 billion (EUR 16.2 billion[217]), of which around 80% was exported. The sector contributed CND 9.2 billion (5%) to the value-added of the total Canadian manufacturing sector. The over 400 firms of the sector in Canada employed around 82,000 employees in 2007 and the sector accounted for substantial 11% of all Canadian industrial R&D spending. [218]

However, since 2000 the total aerospace sales in Canada have stayed in rather stable level at around the CND 22 billion (EUR 16 billion). (Figure 5.13)

Figure 5.13 Canada's Total Export and Sales from 2000 to 2007



Source: Aerospace Industries Association of Canada.

Canada's AI is the fourth largest aerospace industry (after the US, France and the UK) and commands significant shares in key segments of the world market. Canada's dominance is particularly striking in the markets for commercial flight simulators (world market share of 80%), visual simulation sector (70%), new large aircraft landing gear (60%), transport aircraft environmental control systems (60%), 20-90 seat regional aircraft (47%) and small gas turbine engines (34%).

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216 http://www.bombardier.com/index.jsp?id=1_0)=de&file=/de/1_0/1_0.jsp

217 Average exchange rate of CAD 1.4 / EUR 1.0 from 2007 was used.

218 Industry Canada, 2008, Pursuing Excellence – Canada's Aerospace Sector, September 2008, http://www.ic.gc.ca/eic/site/ad-ad.nsf/vwapj/Invest0707-Investir0707_eng.pdf/USDfile/Invest0707-Investir0707_eng.pdf

Figure 5.14 Key Segments of the Aerospace Industry dominated by the Canada

Segment	World Market Share
20–90 seat regional aircraft	47%
Small gas turbine engines	34%
Commercial flight simulators	80%
Visual simulation sector	70%
Civil helicopters	14%
Landing gear	31%
New large aircraft landing gear	60%
Transport aircraft environmental control systems	60%

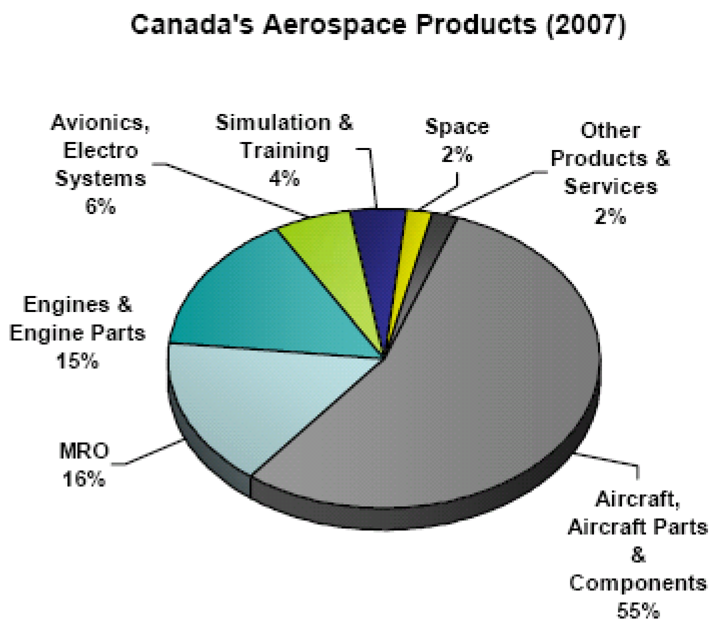
Source: Aerospace Industries Association of Canada, Teal Group.

Supply structure

The military sector does not have a great significance in the Canadian aerospace industry. Only around one fifth of aerospace related revenues proceed from products with military applications, the majority revenues are from civil applications. This is reflected by the structure of employment, but as for other AIs too the share of people employed in the defence sectio of the industry is somewhat below the share revenues

In terms of the importance of different aerospace sub-sectors in Canada, the aircraft and aircraft production is the most important sub-sector also in Canada (though the specific shares of different types of aircraft and helicopter production are not specified). Also MRO (maintenance, repair and overhaul) and Engines manufacturing accounted for significant shares as Figure 5.15 demonstrates.

Figure 5.15 Share of Canada's Aerospace Products of Total



Source: Aerospace Industries Association of Canada.

Public policies

The Canadian federal government supports the AI through several schemes (AIAC, Future Major Platforms Report, June 2009):

- Natural Sciences and Engineering Research Council of Canada (NSERC): until recently the AI did not make much use of NSERC funds, possibly due to a lack of awareness, concerns regarding intellectual property rights. Only when the Consortium for Research and Innovation in Aerospace in Quebec (CRIAQ) has been created the program became more attractive. The NSERC has allocated CDN 4 million in additional funds for the AI through CRIAQ-sponsored university-industry collaborative projects.
- National Research Council (NRC): the NRC's Institute for Aerospace Research (NRC-AIR) employs 370 researchers and technicians and coordinates aerospace expertise from NRC Research Institutes across Canada. It has managed to fund programs relevant to the industry. However, insufficient volume of funds limits its ability to collaborate with the industry, particularly with lower-tier companies.
- Industrial and Regional Benefits (IRB): the IRB Policy provides the framework for using federal (defense) procurement as a means to promote industrial and regional development objectives. The chosen prime contractor must undertake quality economic activities in advanced technology sectors of the Canadian economy. The IRBs are intended to be used to leverage foreign OEMs to build long-term business relationships with Canada's aerospace companies. As Canada is currently in the process of re-equipping its military forces (procurement amount to CDN 18 billion) this could provide an opportunity to secure lasting benefits for the Canadian AI.
- Strategic Aerospace and Defence Initiative (SADI): on 2 April 2007, the SADI was launched under the mandate of Industrial Technologies Office (ITO), a special operating unit of Industry Canada, the Canadian Ministry of Industry. It provides funds, mainly repayable investments, to support private sector strategic industrial research and pre-competitive development in the Canadian aerospace, defense, security and space industries. Besides its task to encourage strategic R&D, the SADI is to foster the collaboration

between research institutes, universities and the private sector. SADI is expected to invest nearly CDN 900 million over the next 5 years, with a maximum funding of CDN 225 million per year.[219] By far the largest investment was a repayable investment of CDN 250 million to support CAE in the development of modelling and simulation technologies[220]. The investment is spread over six years and will help to develop simulators for a wider range of aircraft.

To guide future government policy the Ministry of Industry, in cooperation with stakeholders of the AI, has developed the National Aerospace and Defence Strategic framework in 2005. The framework sets out Canada's position in the global AI, a vision, objectives and strategic areas that require attention over a 20-year time frame. The underlying goal is to enhance and maintain the competitiveness of the Canadian AI. To achieve the goal the framework identified seven strategic areas that require the focus of all stakeholders and government policy. The seven pillows are

- Securing Strategic Aerospace and Defence Investments
- Technology Development and Commercialisation
- Skills Development
- Trade policy and Trade Development Initiatives
- Sales Financing
- Security and Environment
- Procurement

An evaluation of the different forms of federal government support instruments by a national Commission disclosed a concentration of projects for basic and applied research and for manufacturing methods development is noticeable. Investment in the area of technology and demonstration is much less of importance. Other governments are much more generous in supporting the Technology Demonstration Phase. The European Union supports technology demonstration projects, for instance through the 7th Framework Program with EUR 5 billion for the 2007-2013 period. Similarly, support of the European Union for the development of greener aerospace technologies with a fund of EUR 800 million through the CleanSky Initiative (CND 1.2 billion) dwarfs the Canadian budget of CND 11.8 million through NRC's Green Aviation R&D Network (AIAC, Submission to the House of Commons Standing Committee on Finance, August 2009).

The public incentives could not hinder that total investment in R&D of the Canadian AI has remained relatively constant over the past 10-15 years, at approximately CDN 1 billion annually, but sales have risen dramatically in the late 1990s and early 2000. As a result R&D intensity (expenditure on R&D as a share of sales) fell from over 12% to around 6%. With 6% of sales dedicated to R&D, the Canadian AI lacks behind its international competitors, which show a much higher R&D intensity with a share of 10-15% of revenues.

The substantial gap in R&D expenditure between Canada and its international competitors can constrain future competitiveness and growth. First potentially worrying results of the low investments in R&D have already shown: Canadian industry participation in the A350, A380 and the Boeing 787 projects is significantly smaller than in earlier projects like the 757 or the 767. Participation in the A350 is negligible despite significant effort of Canadian firms and support of

[219] http://www.ic.gc.ca/eic/site/ic1.nsf/eng/02125.html
[220] http://ito.ic.gc.ca/eic/site/ito-oti.nsf/eng/h_00715.html

Industry Canada, the government department of industry. A similar effort to assist the Canadian industry to bid on major work packages for the Embraer family of business aircraft proved also not to be very successful. An exception was CAE, who created, together with Embraer, a joint venture to provide training for the new light and very light jets (the Phenom 300 and the Phenom 100).

Industry structure

The Canadian AI is highly concentrated. The largest 30 firms represent 95% of the production. Bombardier, Canada's major aerospace firm and important OEM, represents about 45% of sales (National Aerospace and Defence Strategic Paper, 2005). Bombardier is a transportation company with core businesses in rail transportation and aerospace. Total employment and revenues are divided fairly equally between the two businesses: as of 2009 32,500 people were employed in the aerospace sector generating CND 10 billion (51% of total revenues). Bombardier is well positioned in the global market. 96% of revenues were generated outside of Canada. The aerospace unit has production sites in the U.S., the United Kingdom (Northern Ireland) and since recently in Mexico. Bombardier has a wide product range of business and regional aircraft. Its latest addition to its portfolio is the 100-seat CRJ-1000, the largest of Bombardier's regional jets, which is scheduled to enter service in 2010. Bombardier is planning to design a new class of fuel efficient and environmentally friendly regional aircraft with the CSeries, a 110- to 130-seat single aisle jet. The CSeries program was launched in July 2008.

CAE, the second largest Canadian owned aerospace company, is a world leader in providing simulation and modelling technologies and training solutions for the civil aviation and defence industry. CAE generates CND 1.6 billion annually, 90% of which are derived from exports. With a share of revenue of 34% from the U.S., it is the largest single export market. But as an aggregate European countries make up the more important source of revenues (35%).

The largest regional aircraft MRO company in North America is ExelTech Aerospace. The Tier-1 company has generated revenues of CND 62.2 million in 2008. Another MRO provider with a Canadian background is Aveos. In 2007 it became an independent company when investment firms Sageview Capital and KKR Private Equity Investor acquired a 70% stake in Air Canada Technical Services, as the company was names then.

The most important Tier-2 companies are Héroux Devtek (Sales in 2008 of CND 338 million) and Magellan (CND 686 million). Both are manufacturing aeroengine and aerostructure components. Héroux Devtec also has capabilities in the area of landing gears.

The aerospace activity of these indigenous firms is complemented by the activity of foreign owned companies. Many foreign owned companies have large subsidiaries in Canada, often with mandates to produce for the global market. One of the largest subsidiaries is Pratt&Whitney Canada (P&WC), a United Technologies Corporation company. United Technology has assigned P&WC with a world mandate to produce smaller aircraft engines, while larger engines are produced by the American branch, P&W[221]. Today, P&WC is a world leader for the production of engines for business-, regional-, utility- and military aircraft and helicopter markets. Of a total of 10,000 employees, 7,000 are employed in Canada. With an investment in R&D of CND 400 million annually, P&WC is the top R&D investor in the Canadian AI.

[221] Canada and the New World Economic Order, Strategic Briefing for Canadian Enterprise, Tom Wesson, 2007.

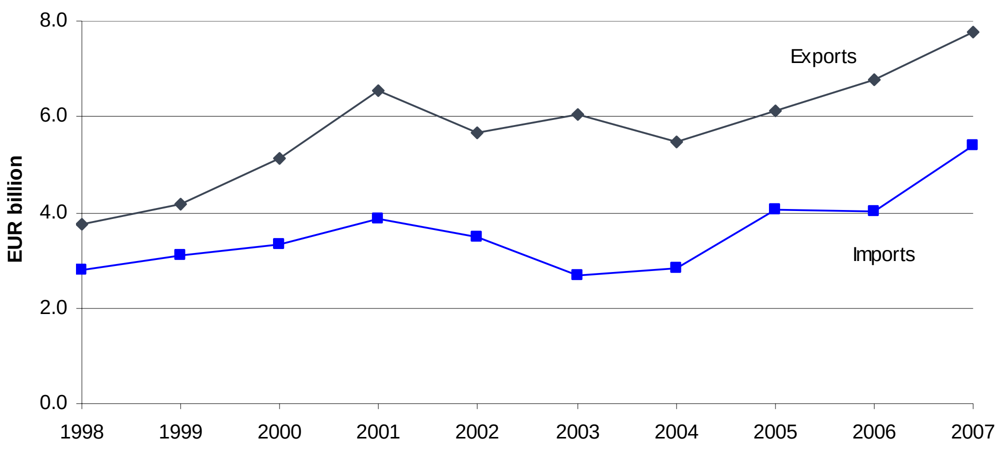
Boeing has a strong presence in Canada: 1,500 people are employed at three facilities, the largest of which is the Winnipeg division in Manitoba, which is also the largest aerospace composites manufacturer in Canada. Boeing Winnipeg produced composite parts for all of the 7-series Boeing commercial airplanes. It is a Tier-1 and Tier-2 supplier to the 787 Dreamliner programme. Operating revenues at the plant were CND 300-400 million in 2008. A supplier base of over 200 companies support Boeing's operations and generate approximately CND 1 billion in revenues annually for the Canadian economy[222].

The shift in the aerospace business model that works in favour of large System Integrator companies (or Tier-1 suppliers) is a major challenge to the Canadian AI. OEMs are increasingly transferring risks and responsibilities of the development of new aircraft to Tier-1 firms. Tier-1 firms are expected to engage in risk-sharing partnerships, which involve considerable investment in R&D but Canada has few System Integrators of the size required to take the risks demanded by the OEMs.This is another explanation for limited Canadian participation in many important programs (like the 787, A350 or the A380 program).

5.3.2 The External Trade of the Canadian Aerospace Industry

Canada has been also a strong player in the global trading of aerospace products, but with considerably lower trade levels than the US or the EU. Both exports and imports have been growing steadily during the last ten years, but with a mild increase in the trade surplus (Figure 5.16). Similar to the larger aerospace countries, the US and EU, Canada experienced a period of limited growth for few years after 2001. Since 2005 its exports and imports have been growing again at a higher pace.

Figure 5.16 Development of Canadian Total Aerospace Trade from 1998 to 2007



Source: UN Comtrade.

Table 5.6 shows that Canadian exports have indeed had a slightly higher average annual growth rate than the imports. large (> 15,000 kg) and medium (2000 kg to 15,000 kg) size aircraft account for the largest share of both exports and imports, but also aircraft parts and e.g. flight simu-

222 http://www.boeing.ca

lators account for a relatively large share of exports. The growth of, small aircraft, aircraft under-carriages and flight simulators exports have been the highest, while e.g. small helicopters exports and flight simulators imports have been decreasing.

Table 5.6 Share of Canada's Exports and Imports per Subsector in 2007 and 1998

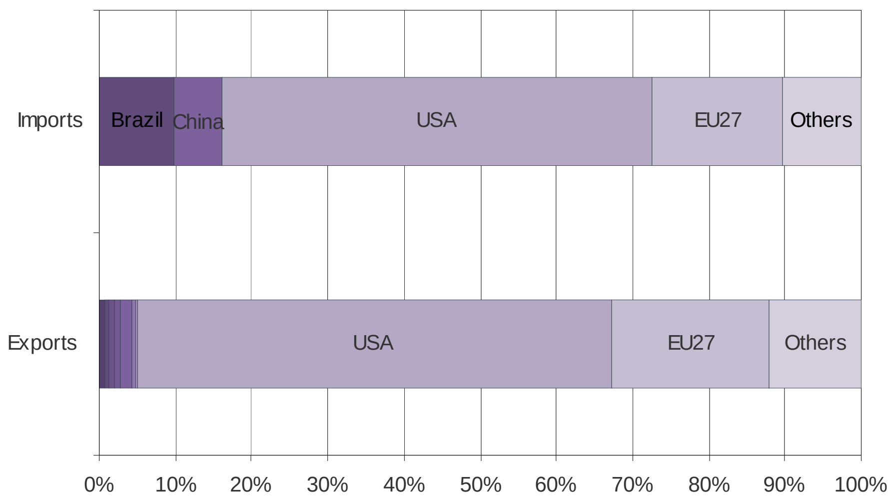
Sector	Exports, share		Growth exports, average annual	Imports, share		Growth imports, average annual
	2007	1998	1998-2007	2007	1998	1998-2007
Total aerospace (EUR value and average annual growth rates 1998-2007)	7.8 billion	3.7 billion	10,8%	5.4 billion	2.8 billion	9,4%
Fixed wing aircraft, unladen weight > 15,000 kg	40,2%	--	--	41,8%	33,4%	14,2%
Fixed wing aircraft, unladen weight 2,000-15,000 kg	26,8%	52,5%	0,6%	10,3%	9,0%	12,2%
Aircraft parts nes	14,3%	25,4%	1,7%	35,5%	47,2%	4,6%
Aircraft under-carriages and parts thereof	6,5%	5,0%	16,8%	5,8%	4,3%	16,0%
Flight simulators, parts thereof	4,8%	6,4%	5,8%	1,3%	2,9%	-1,3%
Helicopters of an unladen weight > 2,000 kg	4,4%	5,9%	5,2%	1,2%	0,8%	16,9%
Helicopters of an unladen weight < 2,000 kg	1,9%	4,2%	-0,9%	1,5%	0,6%	39,3%
Fixed wing aircraft, unladen weight < 2,000 kg	0,9%	0,4%	41,4%	0,7%	0,8%	8,8%
Aircraft propellers, rotors and parts thereof	0,2%	0,1%	17,0%	1,9%	1,0%	25,4%

Source: UN Comtrade.

In terms of exports, the US is by all measures the most important partner for Canada, with over 60% of its aerospace exports heading to the US. In addition, another 20% of the exports go to the EU. Countries included in the grouping of "other export partners" includes among others: United Arab Emirates, Mexico and Libya.

The distribution of import partners is more varied. According to the 2007 figures reported by Canada, the EU was the most important import partner for aerospace products, in addition to Brazil, China and Russia. Even though the US was not reported to be a source of almost any imports to Canada, this is most likely a mistake in the data. The US did report to export nearly 6% of their total exports to Canada in 2007. Hence, the US is also assumed to be an important import partner for Canada.

Figure 5.17 Total Canadian Aerospace Export and Import shares and values by Partner in 2007, EUR million

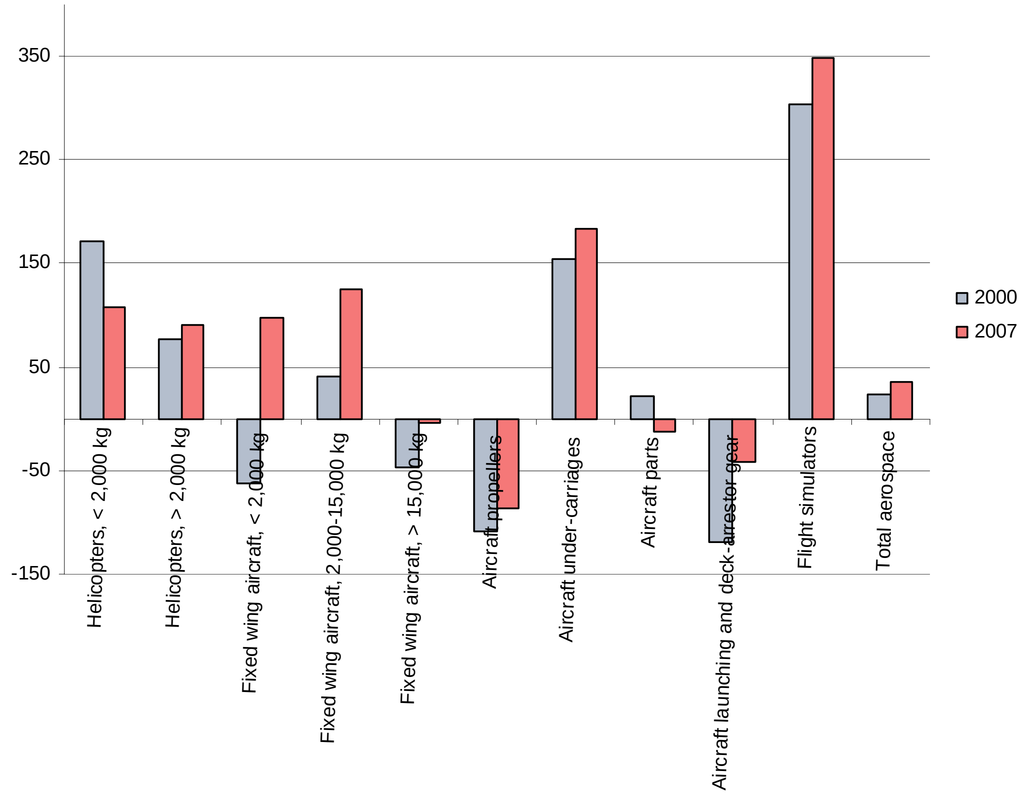


	Exports	Imports
Others	941	556
EU27	1598	928
USA	4837	3036
South Africa	28	0.4
Russia	27	10
Japan	127	334
India	46	0.3
China	60	6
Brazil	38	524
Australia	67	2

Source: UN Comtrade, own calculations.

Canada has a rather strong position in the flight simulators market (see also: supply structure) and their competitiveness in the sector has been increasing further during the first years of the 21^{st} century. In addition, according to the RCA index against the world Canada has an increasing comparative advantage e.g. in the production of aircraft under-carriages, medium size aircraft and large helicopters.

Figure 5.18 Canada's Relative Comparative Advance (RCA) against the RoW in 2007 and 2000



Source: UN Comtrade, own calculations.

Figure 5.19 Yearly RCA Indexes for Total Canadian Aerospace Industry from 2000 to 2007

Source: UN Comtrade, own calculations.

Conclusion

The Canadian AI is part of a wider aerospace cluster. The cross-border linkages between the US and Canada are implemented primarily by US investments. Canada has always been a location for production. Although labour costs are lower than in the US Canada has never been a low-wage country, but provided comparative advantages by a supply of qualified labour and engineering know-how. Typical for this combination is P&W Canada that is an independent business area with full responsibility for the design and production of aircraft propulsion. The manufacture of landing gears is another area of gravity where the Canadian AI is integrated in international production networks. The strong linkages with the US are reflected by a share of more than 60% of total exports.

Bombardier is the most prominent Canadian AI company. With its regional aircraft it is head-to-head with the other big player in the market, the Brazilian Embraer. Other final products are business aircraft and helicopters. Moreover Canada has specialized in some market segments, such as flight simulators, and became a global leader.

Since 2000 the R&D efforts of the Canadian AI are on a level much lower than for most other AI. To a certain extent this might be caused by public R&D schemes that are criticised by the industry. The financial means are small as compared with other nations and the focus is on basic and applied research.

The Canadian AI experienced only a moderate growth over the past ten years. In particular it did not benefit much from the global upsurge in recent years. The picture of some problems in international competitiveness is confirmed by the fact that the application of Canadian companies in big aerospace projects has not been very successful.

5.4 The Brazilian Aerospace Industry

5.4.1 The Size and Development of the Aerospace Industry

Overview

The first initiative for the creation of a Brazilian AI dates back to 1941. The Ministry of Aeronautics, also known as Aeronautical Command, was established to provide the Brazilian airforce and civil aviation with technological support. In 1954 the Aerospace Technical Centre (CTA) was established with headquarters in Sao Jose dos Campos, in the State of Sao Paulo, as the scientific and technical body of the Aeronautics Ministry, thus implementing policy of the Ministry. Under the auspices of the Ministry Embraer (Empresa Brasileira de Aeronautica) was created in 1969 with the mandate to produce the Bandeirante aircraft[223]. Today the Brazilian AI is the largest aerospace manufacturer in the Southern hemisphere and the fifth largest in the world. In 1994 Embraer was privatised. The company is the backbone of the industry. It is the third or fourth largest producer of commercial airplanes and a leader in the market for regional aircraft. Currently, Embraer is suffering from the consequences of the financial and the credit restrictions in the international markets: orders dropped by USD 700 million in comparison to the last trimester of 2008. The downturn at Embraer, responsible for 89% of the aerospace industry's annual turnover, affects the whole industry.

Performance

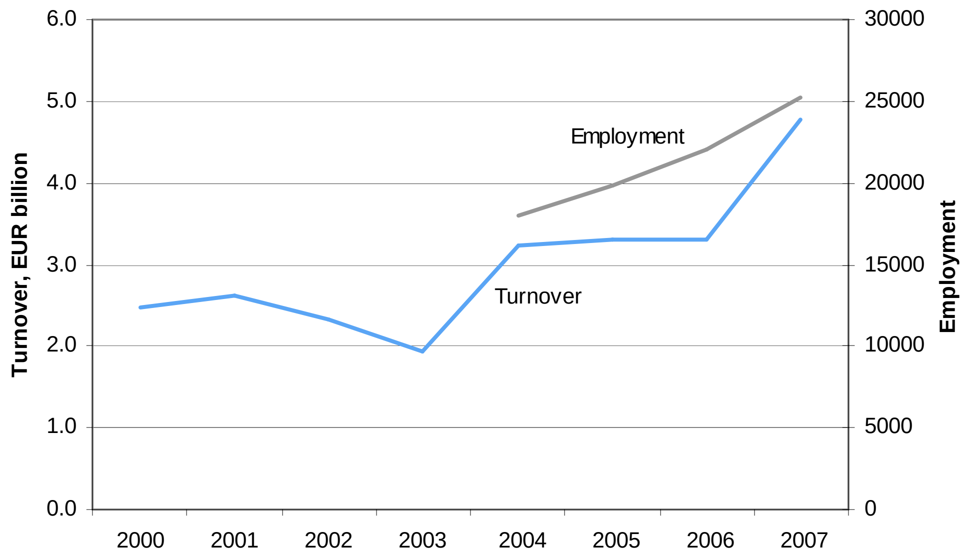
In the past two decades Brazil has become a serious competitor in the global AI market. As Figure 5.20 shows, the turnover of the Brazilian aerospace industry[224] has been growing rapidly

223 Embraer, Timeline.

224 Aeronautics accounted for around 90% of the total aerospace production in Brazil according to the Aerospace Industries Association of Brazil.

since year 2000 up to 2007. The Brazilian AI enjoyed an extremely high growth momentum and nearly tripled between 2003 and 2008, in current prices[225]. Similarly, from 2004 to 2007, the total employment in the sector in Brazil has risen with nearly 10% average annual growth rate. Hence, Brazil has experienced in relative terms a significant increase in the sector, but it should be noticed that in absolute terms they are still far behind the main players (the US, the EU and Canada). According to Marconini (2006)[226] the Brazilian aerospace (aeronautics) sector had a total of 28 companies operating in 2006 and their revenues accounted for around 1.9% of the total GDP in 2007.

Figure 5.20 Value of Brazilian Aerospace Turnover 2000-2007 and Employment 2004-2007



Source: Aerospace Industries Association of Brazil Data and Marconini, 2006.

Note: Original values in USD billion, exchange rate of USD 1.3 / EUR 1.0 used.

The extremely high growth momentum of the Brazilian AI is remarkable, in particular in comparison with Canada that only experienced sluggish growth during this period. The leading OEMs of both of these countries are direct competitors in the market for regional aircraft.

Supply structure

The annual turnover of the Aerospace and Defence industry of USD 7.55 billion (EUR 5.8 billion[227]) in 2008 is to a disproportionately large part made up of activity in the civil aeronautics sector (the share of total turnover is 89.13%). The defence sector accounted for 8.79% to total turnover, other aerospace subsectors (1.51%) do not play a much of a role in Brazil. The Brazilian space sector is insignificant in terms of revenue (0.57%) despite a complete space program, the construction of rockets and satellites and an own launch site. 90% of total aerospace and defence production was exported.[228]

225 In 2008 turnover reached EUR 5.8 billion.

226 http://www.cuts-citee.org/documents/Marconini-IBSA-Johannesburg.ppt
IBSA is a joint initiative of the aerospace industries of the southern hemisphere (India, Brazil, South Africa)

227 Using an exchange rate of USD/EUR 1.3.

228 Statistics: Aerospace Industries Association of Brazil - AIAB.

Public policies

The aerospace technology development and R&D activities are divided between the Ministry of Defence, which is responsible for aeronautics programs and the Ministry of Science and Technology which focuses on space programs[229]. The organisation within the Ministry of Defence which concentrates on aeronautics activities is the CTA. Several institutes are linked to the CTA, the most important are:

- Institute of Advanced Studies (IEA): performs basic research
- Institute of Aeronautics and Space (IAE): focuses on research and development
- Aeronautic Technology Institute (ITA): provides education and research in Science and Technology areas to the AI in general and especially to the Aeronautical Command

The rise of Embraer would not have been possible without concentrated and well co-ordinated government effort. Public sector institutions such as the BNDES (Brazilian development bank) and FINEP (Finance Fund for Studies and Projects, part of the Ministry for Science and Technology) have supported Embraer; for instance contributing 22% of the development costs of the ERJ-145/135 family. Through the PDTI (Industrial Technology Development Program) Embraer was able to benefit from funding and tax breaks. Since the privatisation of Embraer in 1994, direct government funding has been diminished and replaced by more indirect forms of support. Proex (Export Promotion Program), created in 1991 and managed by the federally owned Banco do Brasil (with funding from the National Treasury), has provided a 3.5% rebate on interest rates on loans to buyers of exported Embraer aircraft. It has been claimed that the rebate offsets the higher risk of pursuing business in Brazil. However, Canada, worried that this might adversely affect its manufacturer of regional aircraft, Bombardier, charged Brazil of unfair trading practices. The WTO ruling of 2000 called for the withdrawal of the Proex aircraft subsidies. Embraer subsequently challenged the legality of Canadian government loans to Bombardier. After Canada was also found guilty of unfair trade practices, Brazil and Canada were forced to negotiate. The settlement which was reached seems to allow both countries to continue to support their national manufacturer with export financing loans[230]. The current administration is using the loans to exert influence over Embraer to develop a domestic supply chain and thus consolidating the Brazilian supplier base in the AI. In June 2004, a USD 222 million loan to Embraer for the export of 10 EMB-170 aircraft to Alitalia, Lot and US Airways was linked to the condition that Embraer increases its local content of parts and components to 55% within two years[231]. Currently, as a reaction to the economic and financial crisis fewer strings are attached to loans and interest rates have been lowered by the BNDES. For instance, the interest rate associated with loans for financing for executive jets has been lowered from 8% to 4.5% per year and the amount of loans capture up to 100% of the value of the aircraft. The lower interest rate does not apply exclusively to airplanes but includes a wide range of capital products and is valid till the end of the year 2009[232].

It is reported that government R&D funding of the industry is scarce. The design and development funding for civil aircraft comes from private sources, mainly stock markets and risk sharing partners. The sectoral funds program, which was established in 2002, is the main instrument for R&D funding and provides financial resources exclusively to universities and research institutes. The aeronautics sectoral fund has resources of EUR 8 million annually and will focus on projects and infrastructure of research institutes and education (AIAB, Aeronautics Days 2006).

229 Department of Trade and Industry, South Africa, Aerospace Sector Technology Development Trends, 2004.
230 Montreal Economic Institute, 28 June 2004.
231 Massachusetts Office of International Trade and Investment, Brazil Aerospace, 2007.
232 http://www.brazzilmag.com/content/view/11115/1/

Clusters of aerospace industry

San Jose dos Campos which, in 1946 by the newly formed Ministry of Aeronautics, was chosen as the site for technological centre facilities due to its favourable topographic and climatic characteristics has persisted to be the largest cluster of the Brazilian AI. San Jose dos Campos, in the State of Sao Paulo, is less than 100 km away from the state capital Sao Paulo. Apart from CTA and ITA, San Jose dos Campos is home to Embraer and most of its suppliers. In total the cluster comprises of around 130 companies. These include numerous domestic smaller enterprises but also some well known international firms such as Aeronnova (Spain), Latecoere (France) or Gamesa (Spain).

Industry structure

Embraer is by far the largest company in the Brazilian AI and dominates the industry. Embraer employed 23,509 people in 2008 (70% in Brazil) and is estimated to be responsible for another 5,000 indirect jobs[233]. In 2008 the company accounted for revenues of USD 6,335 million, of which 96% was exported, mainly to the US (43% of total revenues). Embraer focuses on commercial aviation (66.7% of revenues), Executive Aviation (14.3%) and Defence Systems (6.9%). 2008 has been a record year for Embraer, both the total of new aircraft delivered (204 jets delivered) and the order backlog reached unprecedented highs (USD 20.9 billion). Due to the ongoing financial crisis it is unclear, to date, if similar results can be reached in 2009; in the second quarter 2009 the order backlog was down to USD 19.8 billion and after a massive cut in its workforce the employment number is at 17,237.

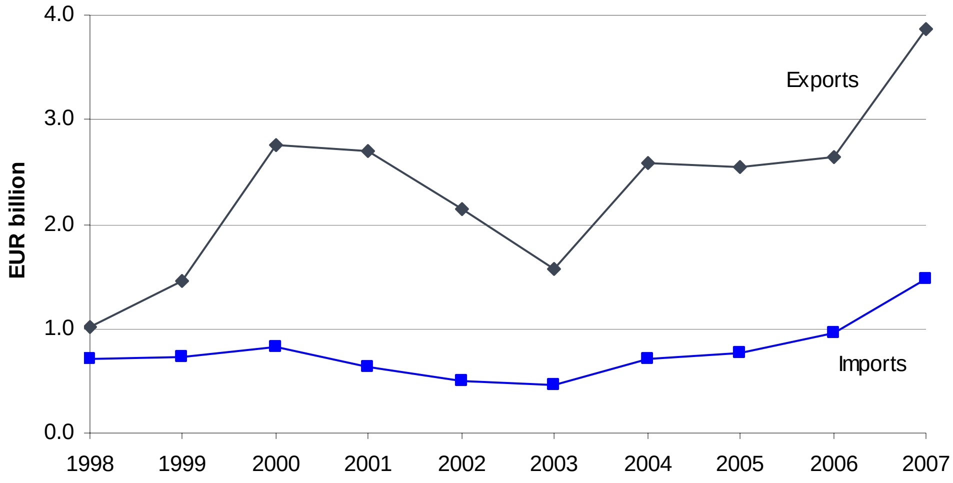
Companies in the Brazilian AI include Aeromot a MRO provider, predominantly for regional aircraft, Helibras, the only helicopters manufacturer in Latin America, responsible for the manufacturing, sale and maintenance of the Eurocopter aircraft line in Brazil, and two Embraer companies, Nieva, manufacturer of light aircraft and ELEB. ELEB is an aerospace system and component manufacturer, which has a focus on landing gear systems, hydraulics and electro-mechanical equipment, mainly for the medium size commercial aircraft, helicopters, executive aviation and defence aircraft segments. ELEB, founded in 1984 as a division of Embraer, has only gained international recognition after it was established as an independent company in 1999. Initially the company has become a joint venture of Embraer and Liebherr Aerospace. In 2008 Embraer bought the 40% stake of Liebherr Aerospace and has become the sole owner. ELEB in 2007 had 766 employees and an income of USD 92.7 million.

5.4.2 The External Trade of the Brazilian Aerospace Industry

During the last ten years Brazil has been one of the fastest growing suppliers in the global aerospace market. As Figure 5.21 illustrates, the Brazilian aerospace product exports have been increased rapidly in addition to a growing trade surplus. While the total exports to the world were around EUR 1 billion in 1998, in 2007 they had increased to a total of nearly EUR 4 billion. During the same period the trade surplus grew from EUR 300 million to around EUR 2.4 billion.

233 Massachusetts Office of International Trade and Investment, Brazil Aerospace, 2007.

Figure 5.21 Development of Brazilian Total Aerospace Trade from 1998 to 2007



Source: UN Comtrade.

Most of the growth has been taken place in the exports of regional aircraft, while the exports of smaller aircraft (business, general aviation) that used to dominate trade earlier have been decreasing. See Table 5.7. In 2007, the exports of regional aircraft accounted for some 75% of the total exports. At the same time, the majority of aerospace imports to Brazil took place in the imports of aircraft parts (65% of total imports) and in smaller sized aircraft (20%). In addition to previously mentioned, e.g. the exports of aircraft propellers, exports and imports aircraft under-carriages and imports of flight simulators have been increasing substantially in relative terms.

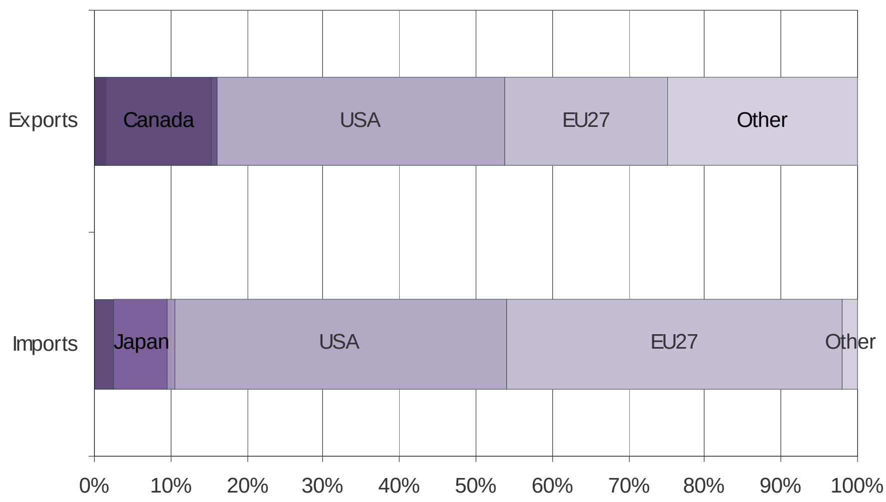
Table 5.7 Share of Brazil's Exports and Imports per Subsector in 2007 and 1998

Sector	Exports, share		Growth exports, average annual	Imports, share		Growth imports, average annual
	2007	1998	1998-2007	2007	1998	1998-2007
Total aerospace (EUR value and average annual growth rates 1998-2007)	3.9 billion	1.0 billion	28,3%	1.5 billion	0.7 billion	10,0%
Fixed wing aircraft, unladen weight > 15,000 kg	74,7%	1,7%	1689,2%	3,4%	40,5%	-8,3%
Fixed wing aircraft, unladen weight 2,000-15,000 kg	19,1%	86,7%	-1,5%	19,9%	5,2%	66,3%
Aircraft parts nes	5,1%	11,0%	7,8%	64,8%	39,0%	23,3%
Aircraft under-carriages and parts thereof	0,6%	0,2%	86,4%	3,4%	1,7%	30,8%
Helicopters of an unladen weight > 2,000 kg	0,3%	0,0%	--	2,4%	2,9%	6,3%
Helicopters of an unladen weight < 2,000 kg	0,1%	0,3%	6,4%	2,6%	7,4%	-3,0%
Flight simulators, parts thereof	0,0%	0,0%	--	0,1%	0,0%	204,9%
Fixed wing aircraft, unladen weight < 2,000 kg	0,0%	0,1%	6,8%	2,9%	2,8%	10,7%
Aircraft propellers, rotors and parts thereof	0,0%	0,0%	134,6%	0,5%	0,5%	8,6%

Source: UN Comtrade, own calculations.

The US and the EU form the main trade partners of Brazil in both exports and imports. However, the imports in 2007 were most concentrated and the above mentioned countries accounted for some 90% of total imports, while only around 60% of the Brazilian exports were bound towards either one of the two countries. Large shares of exports were also going to Canada and to countries not specifically mentioned in the partner list of Figure 5.22.

Figure 5.22 Brazilian Exports and Imports shares and values by Main Trade Partners in 2007, EUR million

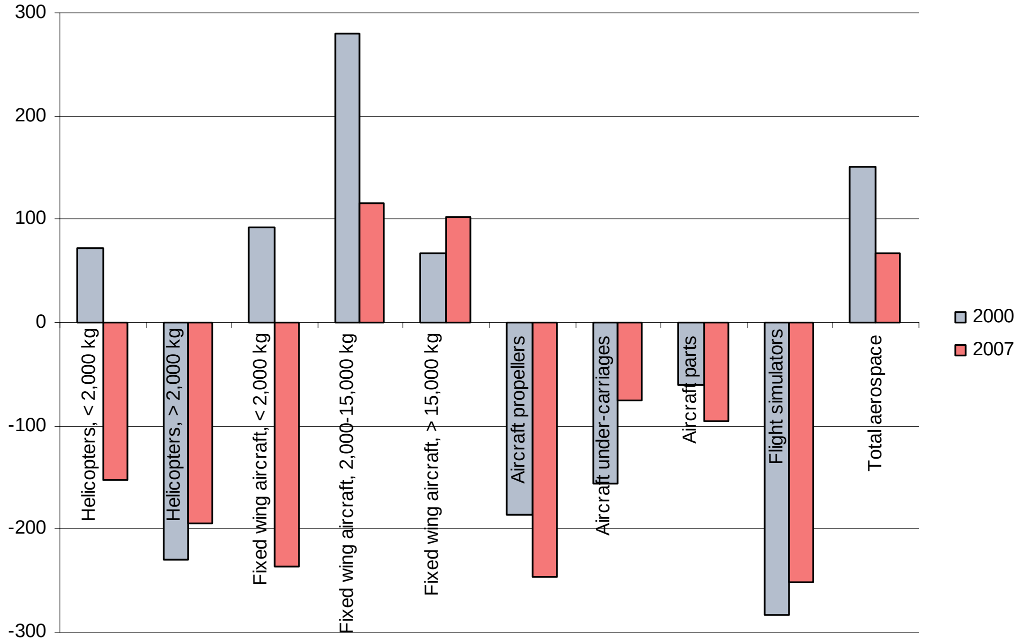


	Imports	Exports
Other	29	964
EU27	651	825
USA	639	1460
South Africa	15	0
Russia	0.2	0
Japan	103	1
India	0	0
China	0.01	27
Canada	38	536
Australia	0.1	55

Source: UN Comtrade, own calculations.

While the exports of Brazil have been increasing strongly and the country has a comparative advantage in total aerospace production. But it is only the manufacture of regional aircraft and business / general aviation aircraft manufactured by Bombardier that have a global relative comparative advantage as Figure 5.23 shows.

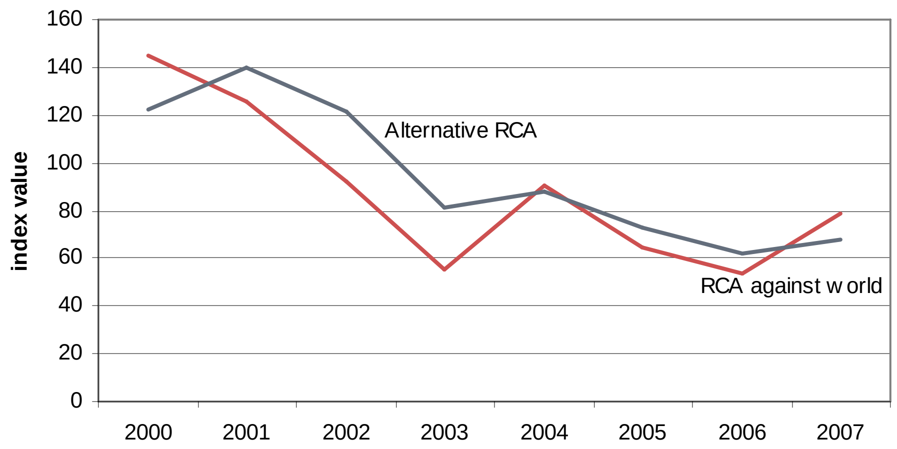
Figure 5.23 Brazil's Relative Comparative Advance (RCA) against the RoW in 2007 and 2000



Source: UN Comtrade, own calculations.

The yearly RCA index figures for the total aerospace production in Brazil show that while the industry has had a comparative advantage every year from 2000 to 2007 according to the global and alternative RCA indicators, the relative index value (competitiveness indicator) has been decreasing over the years (Figure 5.24).

Figure 5.24 Yearly RCA Indexes for Total Brazilian Aerospace Industry from 2000 to 2007



Source: UN Comtrade, own calculations.

Conclusion

Brazil is perceived as the first emerging country that entered the manufacture of aircraft. The development of the AI took place in a region far away from highly industrialized areas. In contrast to Canada Brazil could not trust in a supplier base close-by. This is a challenge for an industrial policy dedicated to the creation of an AI that is dependent on a broad suppliers' base. Much of the Brazilian AI is clustered around Embraer, the backbone of the industry. In contrast to Canada the Brazilian AI participates to a lesser extend in cross-border value chains.

The specific structure of the industry is reflected in the RCA index. They underscore that Brazil is of outstanding competitiveness in the aircraft >15,000 kg. This category comprises among others regional aircraft. But also as compared to other Brazilian manufacturing industries the AI has performed better during this decade.

The Brazilian AI is much smaller than the AIs of the US, Canada and the bigger EU Member States. Its activities are focused on few market segments and trade analysis has disclosed that strengths are in regional and smaller aircraft. The Brazilian AI has not been strongly integrated in international value chains as a supplier, due to its remote location from major industrialized regions. As compared to Canada FDI of foreign companies plays a minor role only.

A coordinated industrial policy has contributed much to the development of the AI in Brazil. The Ministry of Defence and the Ministry of Science and Technology are responsible for the AI and provide the infrastructure via affiliated bodies, such as the CTA. It has been reported that public funding for R&D is scarce and many resources originate from private investors and the financial market.

In recent years Brazil faced a WTO suit in connection with export credits. Bombardier had raised the issue of unfair trade support. But also Bombardier was found guilty on unfair practices. Both competitors were forced to negotiate and to find a solution.

5.5 The Japanese Aerospace Industry

5.5.1 The Size and Development of the Aerospace Industry

Overview

After World War II, the U.S. prohibited the production of aircraft in Japan until 1952. During the years of the ban the aircraft technology shifted from piston- to jet-engines which meant that Japan was soon lagging behind. When Japan regained sovereignty and its authority to produce aircraft, it slowly began to rebuild its industry, initially maintaining and repairing U.S. aircraft, then co-producing aircraft under license agreements with U.S. companies. Later, as Japanese firms acquired expertise and technology they started to domestically produce military and civil aircraft. While most of the military aircraft programs have been successfully concluded, civil aircraft programs not: the production of the only civil aircraft developed in Japan, the YS-11, a small turboprop plane (50-60 seats) was stopped after 10 years in 1973 due to huge financial losses. The YS-11, even though technically advanced, was not able to generate sufficient international sales cover development costs of the project and the domestic market turned out to be too small. It was recognised that Japan did not posses the capabilities to market its product in the international market and to provide the necessary after sales support (R. G. Bent, The Japanese Aerospace Industry: Is the Sun Rising on the World Market, 1992).

Despite the failure in the YS-11 program, the Japanese AI, carried on in its pursuit to become an important player in the global AI and teamed above all with US companies in joint ventures. The government provided subsidies to Japanese companies which participated in international programs (S. McGuire, 2006[234]). This allowed Japan to further acquire high technology and maintain a skilled workforce while sharing the risks and development costs of international aircraft programs. Initiated by the private industry and the Ministry of International Trade and Industry (MITI) the first international joint venture was the 767 program together with Boeing. All major Japanese airframe manufacturers participated in the program. While in earlier (military) programs, Japan had duplicated the production under licensing agreements, this joint venture provided work shares of aircraft parts for design and production under sole responsibility of Japanese firms. A similar partnership was formed for the 777 project and the total work share of Japanese firms accounts for approximately 21% of the aircraft structures (SJAC, 2009[235]). The contract for the 777 established the participation of Japanese firms in all phases of the program including sales and marketing (the area where Japan needed help). Apart from airframe manufacturers more than 30 suppliers and subcontractors were involved in these programs.

Participation of Japanese firms in the 787 Dreamliner program is even higher: in total Japanese firms will produce around 35% of the structures and systems. Unlike in earlier programs, in which Japanese firms had mainly been involved in the production process, now they are full-fledged risk-sharing partners designing major structural components and subsystems of the aircraft. The large Japanese firms in the AI, Mitsubishi Heavy Industries (MHI), Kawasaki Heavy Industry (KHI), Fuji Heavy Industries (FHI) are all Tier 1 supplier to the 787 Dreamliner program. The 787 is going to be equipped with the GEnx of General Electric (GE) and the Trent 1000 of Rolls-Royce. Both engines are joint developments and Japanese companies are involved in both. IHI participates in the development of the GEnx, KHI and MHI participate in the development of the Trent 1000 (SYAC, 2009).

Boeing's involvement in the Japanese AI has had a favourable effect on sales of its products. For commercial airplanes with more than 100 seats Boeing has gained a market share in Japan of 86%[236].

Possibly linked with the intention to capture a larger share of the Boeing-dominated Japanese market for large commercial aircraft Airbus has partnered with 21 Japanese companies for the production of A380. Partners include MHI, supplying cargo doors, FHI, supplying the vertical tailplane, leading and trailing edges, Nippi (a subsidiary of KHI) supplying the horizontal tailplane tips and ShinMaywa Industries working on the wing ramp surface (SYAC, 2009).

One of the most ambitious projects of the Japanese AI is the development of the Mitsubishi Regional Jet (MRJ). The program was launched by Mitsubishi Heavy Industries on 28 March 2008. The Mitsubishi Aircraft Corporation, a company launched by MHI to carry out the MRJ program (including development, manufacture and sales) will be the first Japanese company to produce a commercial jet. Considerable financial assistance for the project will come from the Ministry of Economy, Trade and Industry (METI). With total development costs for the MRJ in the range of JPY 150 billion (EUR 1.03 billion) to JPY 180 billion, the METI could provide up to JPY 50 billion[237]. The MRJ is a 70 to 90-seat jet which will have improved operational efficiency (a re-

234 Steven McGuire, Boeing's Diffusion of Commercial Aircraft Technology to Japan: Surrendering the U.S. Industry for Foreign Financial Support, 2006, p.18.

235 SJAC, Aerospace Industry in Japan, 2009.

236 S. Roth, Vice President, International Government Relations, Boeing International, speaking at the Invest Japan Symposium, available at http://www.jetro.org/content/629

237 The Japan Times Online, 8 May 2008, available at http://search.japantimes.co.jp/cgi-bin/nb20080508a1.html

duction of fuel consumption of 20% over existing regional jets) and improved cabin comfort. To lower fuel consumption composite materials are adopted for the wings and the vertical fin on a significant scale. Further fuel saving comes from the highly efficient Geared Turbofan engines from Pratt&Whitney. As suppliers of major systems MHI selected reputable international firms including Rockwell Collins (for avionics and the flight control system), Parker Aerospace (hydraulic systems), Hamilton Sundstrand Corporation (Electrical power system, air management system, auxiliary power unit, inert gas system, high lift actuation system, and fire & overheat protection system) and domestic firms such as Nabtesco Corporation (flight control system), Sumitomo Precision Products Co. (landing gear)[238]. Boeing will be consulting on the marketing, development and post-sales activities of the MRJ, mainly to substantiate its longstanding partnership links with MHI. Boeing's assistance with marketing and post-sales activities is especially useful as Mitsubishi has little experience in the area, and these are key elements for an aircraft to be commercially successful. The first flight of the MRJ is scheduled to take place in the second Quarter of 2012 and the first delivery in the first quarter of 2014[239]. Japan will add to competition in the regional aircraft market and put additional pressure on the established producers, Embraer and Bombardier.

Performance

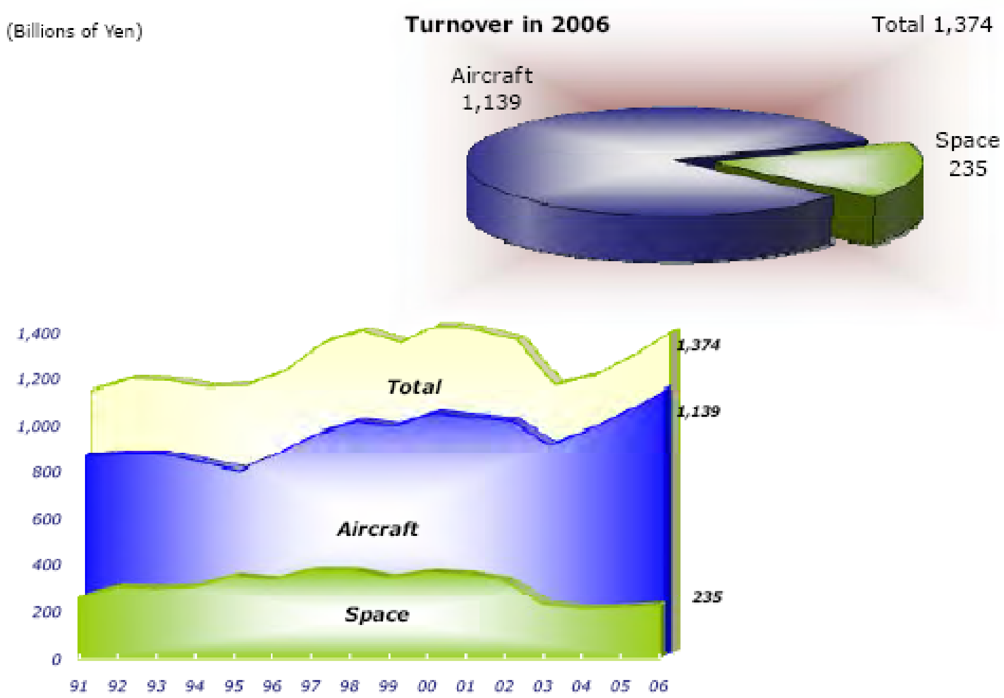
According to the Society of Japanese aerospace companies the Japanese AI production amounted to JPY 1,139 billion in 2006, which translated to around EUR 7.8 billion. The industry has been also growing, but with a relatively slow pace[240]. Figure 5.25 provides the association's estimates of the turnover values for aircraft and spacecraft production. It discloses that the moderate growth has been caused by a reduction of turnover with space products, whereas the aircraft segment enjoyed a high growth momentum.

[238] MHI, Press Release, 14 February, 2008, available at http://www.mhi.co.jp/en/news/story/200802141223.html

[239] MRJ, Press Release, 9 September 2009, available at http://www.mrj-japan.com/

[240] The industry has increase with around 1.5% average annual growth rate during the last ten years based on the values provided by the Society of Japanese aerospace companies.

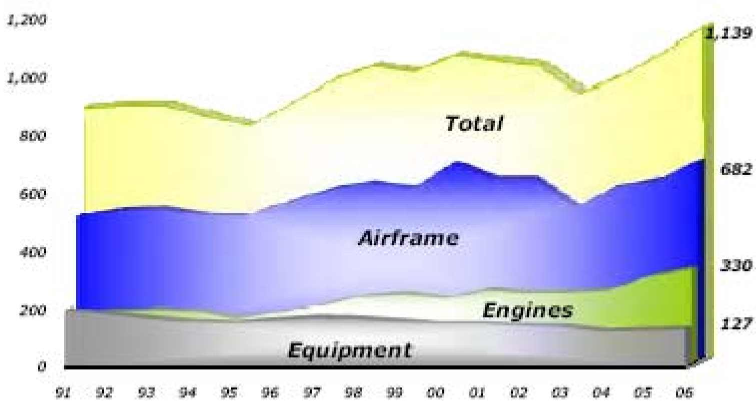
Figure 5.25 Value of Aerospace Turnover in Japan until 2006



Source: The Society of Japanese Aerospace Companies, Aerospace Industry in Japan, 2008.

Nearly 60% of the production took place in airframes, around 30% in engines manufacturing and some 10% in the production of aerospace equipments in 2006. See Figure 5.26. The production of aerospace engines and airframes has increased the most during the last ten years in Japan.

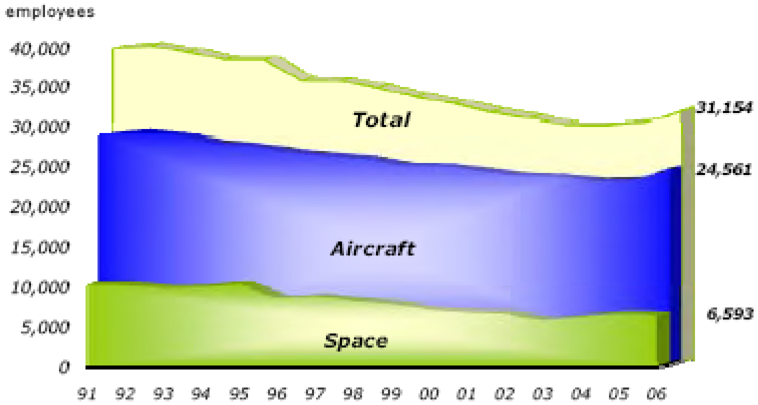
Figure 5.26 Aerospace Production in Japan



Source: The Society of Japanese Aerospace Companies, Aerospace Industry in Japan, 2008.

The employment in Japan in the production of aircraft has been again decreasing somewhat since the beginning of the 1990's and reached around 25,000 in 2006. See Figure 5.27. This has resulted in Japan having about the same size of aerospace industry as Brazil.

Figure 5.27 Employment in the Japanese Aerospace Industry

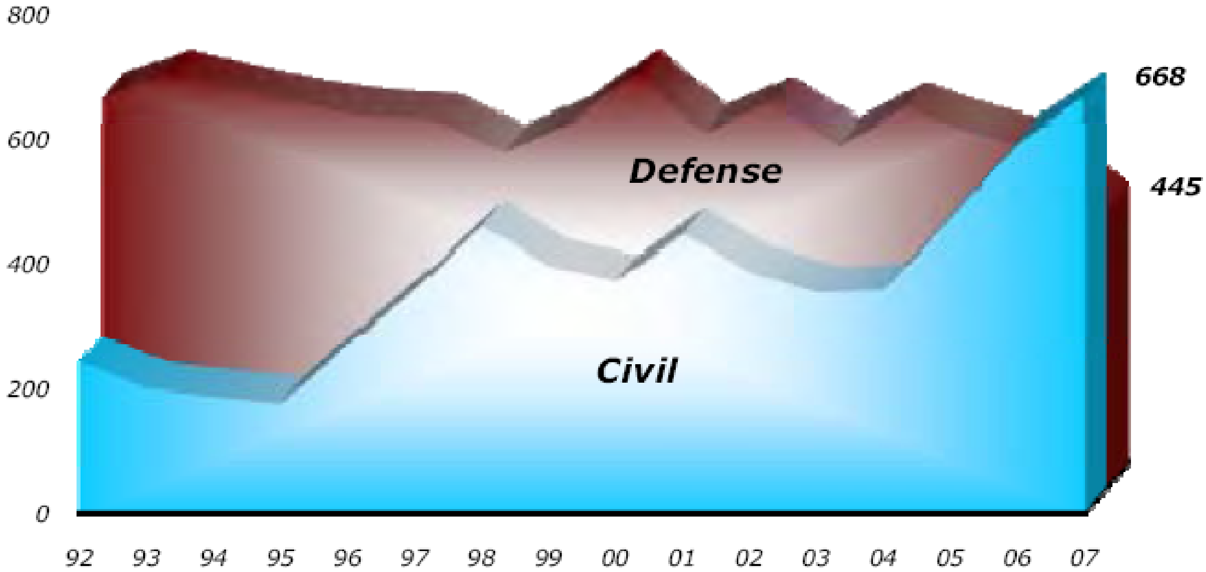


Source: The Society of Japanese Aerospace Companies, Aerospace Industry in Japan, 2008.

Supply structure

While the Japanese AI acts predominantly as a supplier to international manufacturers, Japanese companies also produce complete small jet and turboprop aircraft and helicopters and military aircraft and trainers. In 2008 about 48% of Japanese aircraft were sold to the Japanese Defence Agency[241]. These aircraft were produced under license agreements or in cooperations with foreign (mainly U.S) firms. An export ban on military products which was imposed by the Japanese government in 1967 has restricted production of military aircraft. In combination with falling federal expenditure on defence programs this has lead to a significant reduction in military output of the AI. The civil sector, on the other hand has experienced stronger growth during the last 10 - 15 years. As a consequence the share of defence on total output declined. (Figure 5.28)

Figure 5.28 Civil and Defence Output of the Japanese Aerospace Industry



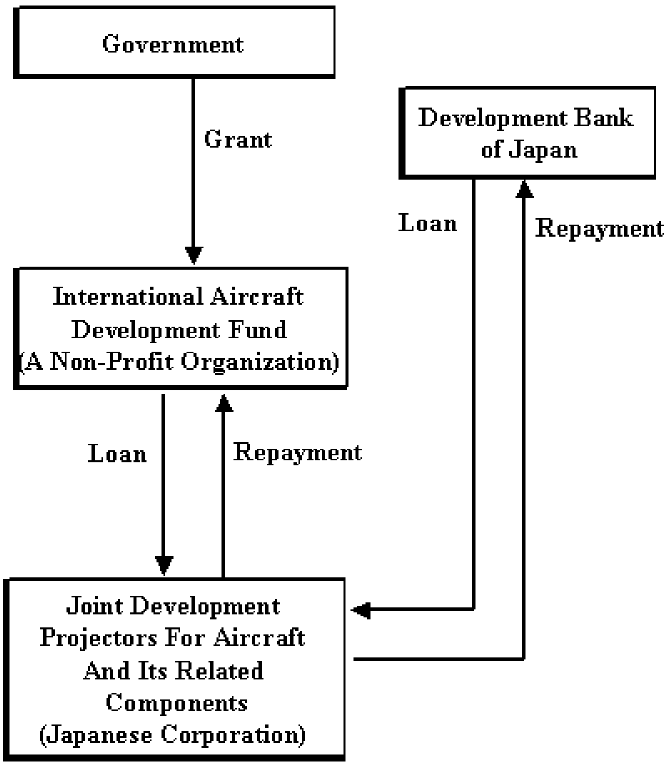
Source: SJAC, Aerospace Industry in Japan, 2009.

241 SJAC, Aerospace Industry in Japan, 2008.

Public policies

Government support has been an important factor in the advancement of the Japanese AI. From 1978 to 1983, the Japanese government covered about half the costs of developing parts built by Japanese companies for the Boeing 767. In the 1990s, Japanese firms spent JPY 104.5 billion to develop parts for the Boeing 777, with government assistance in form of a JPY 60 billion loan (Belson, 2004[242]). Much of the funding comes through the International Aircraft Development Fund (IADF). The IADF, a METI-financed non-profit organisation, provides financial support to Japanese firms involved in international collaborations.

Figure 5.29 Public Financial Support for the Japanese Aerospace Industry



Source: IADF.

To promote international joint ventures the IAFD provides loans, collects and supplies information. For instance, for the 777 program, the government provided through IADF JPY 2.9 billion and for the International Aero Engines V2500 engine project JPY 1.6 billion[243] (EUR 10.96 million). To ensure Japan's participation in the 787 program it offered USD 1.58 billion in loans and subsidies to a consortium of five Japanese manufacturers (Pritchard and MacPherson, 2004[244]).

Clusters of aerospace industry

Aichi is the prefecture with the largest AI cluster. Aircraft parts (if engines are excluded) manufactured in the prefecture make up 33% of total Japanese output. MHI, KHI, FHI and Mitsubishi

[242] Belson, K., 2004, Parts Makers in Japan are crucial for Boeing, The New York Times, available at http://www.nytimes.com/2004/03/12/business/parts-makers-in-japan-are-crucial-for-boeing.html?pagewanted=1

[243] Flight Plan, 2009.

[244] Pritchard, D. and MacPherson, A. (2004), Industrial subsidies and politics of world trade: the case of the Boeing 787, Industrial Geographer, Spring 2004.

Regional Jet are all located in Aichi and many public testing and research institution and universities. Japanese deliveries for the 787 exclusively come from the prefecture. The production value for the Chubu region, the region that comprises five prefectures including Aichi, has a production value of JPY 507.1 billion (EUR 3.47 billion) or a national share of 52.6%.

Industry structure

The Japanese AI is dominated by four firms: Mitsubishi Heavy Industries (MHI), Kawasaki Heavy Industry (KHI), Ishikawajima-Harima Heavy Industries (IHI) and Fuji Heavy Industries (FHI). These firms are not specialist aerospace firms but are widely diversified across many segments, such as automobiles, shipbuilding, industrial machinery and power systems, and generally aerospace products make up a mere 15 - 20% of total sales. MHI (Net sales of the aerospace division in 2008: JPY 512.3 billion (EUR 3.51 billion), aerospace sales as a share of total sales: 15.2%), KHI (JPY 1,338 billion (EUR 9.16 billion), 15%) and FHI (JPY 80.9 billion (EUR 554.11 million), 18.9%) concentrate on the development and manufacture of airframes and related components.

Even though MHI and KHI are also involved in the production of engine components IHI is the national leader in the production of jet aircraft engines. Since 1959 IHI has won virtually every prime engine contract from the Japanese military[245] and is the main company for international engine cooperation. The company is together with General Electric in the consortium for the development, design and manufacturing of the GEnx. IHI net sales in 2008 came to JPY 1,388 billion (EUR 9.51 billion), with aero-engine and space operations responsible for 20.9% of total net sales.

Similar to other major companies in the Japanese AI, Shin Maywa has a diversified product portfolio, with a focus on aircraft, special purpose trucks and industrial machinery. Even though the company, when founded in 1918 was Japan's first aircraft manufacturer, today the aircraft segment accounts for only 19.3% of total net sales of JPY 127.78 billion (EUR 875.2 million) in 2008.

The principal composite material supplier for the 787 Dreamliner is Tokyo-based Toray Industries. The advanced materials company produces the Torayca epoxy prepreg (carbon fibre sheets impregnated with epoxy resin) for the 787's primary structure. The contract with Boeing is determined for a 16 year period and a contract volume of USD 6 billion[246]. To meet the growing demand of composites, Toray has expanded production capacity at its manufacturing bases in Japan, France and the U.S. and built a second prepreg manufacturing facility in Japan. Toray is one of the world leaders in the production of carbon fibre composite materials with a global market share of 34% in 2007[247]. In the sub-sector carbon fibre composite materials for aircraft the company had sales in 2008 of JPY 31.3 billion (EUR 214.38 million) or 2.1% of total sales of JPY 1,471.6 billion.

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[245] Samuels, Richard J. (1994) *"Rich Nation, Strong Army": National Security and the Technological Transformation of Japan*, Ithaca, NY, Cornell University Press.

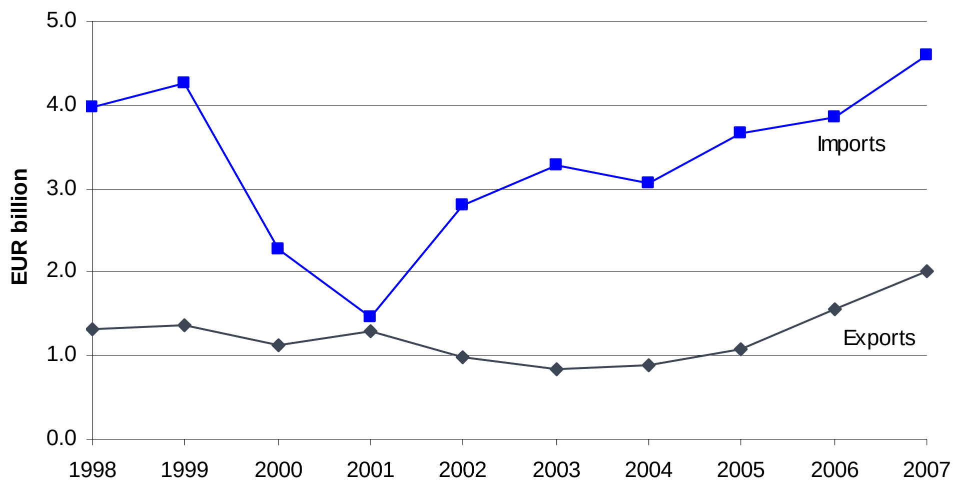
[246] Wall Street Journal, Started Carbon Fibre Output for Boeing 787, July 2009, available at http://online.wsj.com/article/BT-CO-20090709-717745.html

[247] Toray Group, Press Release, 9 February 2007, available at http://www.toray.com/news/carbon/nr070209.html

5.5.2 The External Trade of the Japanese Aerospace Industry

While Japan had a relatively high value of exports in aerospace products during the past ten years, the trade balance has been negative the whole time. (Figure 5.30) In 2001 the world faced a decline in the overall trading of aerospace products and similarly a drop in imports was witnessed in Japan. However, after that year the rate of the trade deficit has been rather constant, i.e. exports and imports have been increasing in similar paths.

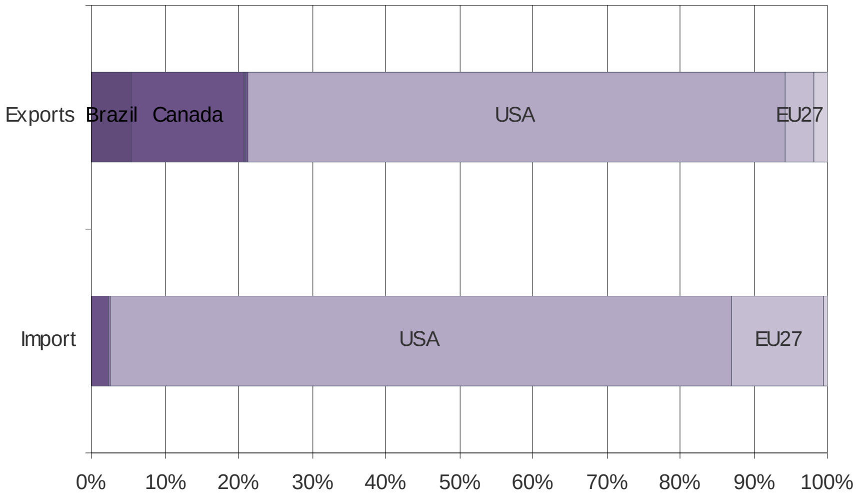
Figure 5.30 Evolution of Japan Aerospace Trade from 1998 to 2007



Source: UN Comtrade.

The Japanese trade relations are concentrated on few partners only. Around 85% of imports originate from the US and 73% of exports are directed towards the US. The trade relations with the EU are far less intense. They contribute around 12% to Japanese imports and receive 4% of exports. Canada is another important trade partner. Its share on Japanese exports comes up to 15% and on imports only 2.4%. All other countries are of minor importance only. (Figure 5.31)

Figure 5.31 Japan's Exports and Imports shares and values by Main Trade Partners in 2007, EUR millions



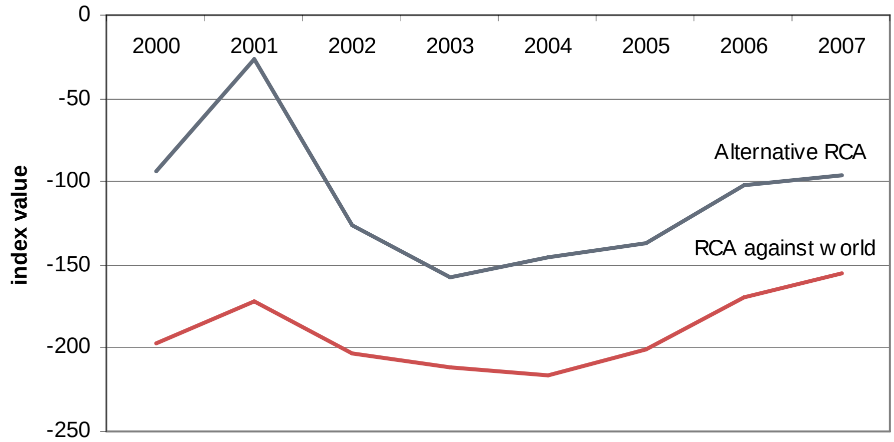
	Import	Exports
Other	28	34
EU27	568	82
USA	3868	1468
South Africa	0.4	0.03
Russian Federation	4	0
India	0	0.3
China	3	10
Canada	109	303
Brazil	0.2	110
Australia	0.4	2

Source: UN Comtrade, own calculations.

Japan is an industrialized country with a highly competitive manufacturing sector. The aerospace industry is one of the less competitive branches, as measured by indicators for international trade. This is a legacy of the lost World War II and the self-imposed ban on exports of military products. With aerospace products Japan has a high trade deficit and both of the RCA indicators (global and alternative) are deep in the negative. (Figure 5.32)

The sudden rise of the indicators in 2001 is only an outlier and need not be interpreted. The low value of the indicators has been caused by the fact that Japan is above all a manufacturer of parts and components, but not of OEM. Japan is strongly dependent on foreign deliveries of LCA and regional aircraft.

Figure 5.32 Yearly RCA Indexes for the Total India's Aerospace Industry from 2000 to 2007



Source: UN Comtrade, own calculations.

Conclusion
The Japanese AI is one of the smaller suppliers in the global market. By employment it is of similar size as the Brazilian. However, the structure is quite different. Military production for the indigenous defence sector is of noteworthy importance. Civil OEM does not play a role, only small aircraft are manufactured. The Japanese strength is in the aircraft value chain.

Public policy has pursued a strategy to integrate the Japanese AI in the global value chain. Participation in the big projects of Boeing has been purchased by public funds dedicated to R&D. Japan has managed to focus on promising technologies and became an important supplier in aircraft related composites. In exchange the US OEMs have become the dominant players in the Japanese market for commercial aircraft.

Now Japan is about to enter the regional aircraft market with own products. The major problem for entering the global market will be the set up of a distribution and service network. Japan had failed during the 1960s with a civil aircraft project for this reason. Mitsubishi has arranged an agreement with Boeing to overcome this detriment.

5.6 The Aerospace Industry of Emerging Competing Nations

5.6.1 Aerospace Industry of India

Overview
The growing prosperity of the Indian population has lead to a rapid rise in the demand for air transport. In recent years, the Indian airline operators grew at an average annual rate of 18%. It was among the fastest growing aviation industries in the world. The government's open sky policy allowed international airlines to enter the market which lead to a rapid expansion of both players and number of aircraft. (IBEF, 2009[248]) Airbus expects that until 2025 India will have a demand of more than 950 aircraft with 100 seats and more (Airbus Global Market Forecast 2007-2026).

[248] Indian Brand Equity Foundation, July 2009, available at http://www.ibef.org/industry/aviation.aspx

The rapid expansion of air transportation stands in stark contrast with the often outdated airports with insufficient capacity. Recognising this bottleneck the government is undertaking significant efforts to improve the existing airport infrastructure, including policy measures such as a 100% tax breaks for airport projects in the coming 10 years and plans to invest USD 9 billion to modernise existing airports by 2010. This includes investment of USD 4 billion to upgrade the airports in Mumbai and Delhi and USD 5 billion for 23 other non-metro airports. In 2006 a program was announced to invest USD 12.5 billion in regional airports through 2009 (Flight Plan, 2009).

The growing demand for aircraft in India was seen as an opportunity to launch a domestic aircraft project. The Saras is the first indigenously designed and developed commercial civil aircraft. It will carry between 8 and 14 passengers and it is intended to be used as air-taxi and commuter service aircraft on short hauls (Frontline, 2004[249]). The aircraft was an initiative of the National Aerospace Laboratories (NAL), a constituent laboratory of the Council of Scientific and Industrial Research (CSIR) and the Hindustan Aeronautics Ltd. (HAL).

HAL has produced different military and small civil aircraft belonging to the Saras class under licensing agreements since the 1980s. It has started the production of a first military aircraft, but the Saras is the first domestically designed and manufactured civil aircraft. In the 1980s NAL gathered initial expertise in aircraft design when it produced the Light Canard Research Aircraft. In the1990s, NAL designed an all-composite two-seater trainer aircraft, the Hansa. With the successful experience in the aircraft project it saw itself sufficiently qualified and equipped with know-how to develop a commercial aircraft like the Saras.

While being discussed since the mid-1990s, the project was only approved in June 1999 by the Cabinet Committee for Economic Affairs. It was calculated that the project should cost Rs. 13,138 million and should last three and a half years. The project received nearly half of total costs (or Rs. 6,530 million) from the Technology Development Board (TDB), Rs. 5380 million in form of a grant (the largest sum committed by the TDB for a single project so far) (Frontline, 2004).

All government support was not able to prevent the project being delayed several times, initially due to US sanctions imposed on NAL following the nuclear tests at Pokran which made the import of required intermediary products difficult and later due to problems with the empty weight of the aircraft. Up until now only two prototypes have been produced, but NAL expects that the production of the weight optimised Production Standard Aircraft (which targets a weight reduction of 500kg over the prototypes) will not take much longer and scheduled the first flight for the end of 2009.

Despite the considerable effort to produce an indigenous aircraft, this is merely a first attempt and as a share of total activity in the AI still relatively minor. Much more important is the involvement of international firms in India. Overseas companies have invested in India since many years taking advantage of the highly educated workforce (mainly in the area of IT services), and since recently are seeking engineering and manufacturing partnerships as part of offset obligations (local content requirements). Under the offset obligations all foreign vendors to the Indian Ministry of Defence must source one-third of the price of defence equipment worth over Rs. 30,000

[249] Frontline, 2004, Volume 21, Issue 13, available at http://www.flonnet.com/fl2113/stories/20040702002408900.htm

million from India (SBAC, 2006[250]). As the Indian aerospace and defence budget is expected to reach USD 100 billion in the next 10 years this will generate several billions worth of contracts for the Indian AI (Outlook India, 2008[251])

Airbus and Boeing have long-standing business relations with Indian companies and recently scaled up their investment in India. Boeing has been working with Indian software development companies since 1997, such as HCL, Infosys and Tata Consultancy Services on numerous information technology projects, including projects to support aircraft design activity. Boeing selected HCL as a software development partner for the 787 Dreamliner program. Boeing has also contracted HAL and Tata for several manufacturing projects and opened the Boeing Research and Technology centre in Bangalore in March 2009 which will work with strategic research partners to develop high-end technologies, particularly in the areas of aero structures and avionics. Boeing has successfully sold aircraft to Indian airline operators. In 2006 the orders for commercial aircraft amounted to more than USD 11 billion.[252]

However, Airbus still is the largest supplier of commercial aircraft to Indian airlines. In 2006, Airbus had a market share of 75% up from 70% in the year earlier (Airbus in India[253]). Airbus aircraft form the backbone of the Indian Airlines and the Air India fleet, with Indian Airlines now the largest operator of the A320 in Asia. Recently established low-cost airline such as Kingfisher Airlines play an increasingly important role as buyers of Airbus aircraft. The Indian AI also benefits from the close ties with Airbus, manufacturing parts and sub-assemblies. HAL has been producing passenger doors for Airbus aircraft since 1988. Due to the successful supplier relationship, there have been numerous of follow-on contracts, the latest an order to supply 2,000 doors for the Airbus single aisle family in July 2009[254].

For the purpose of further expanding its presence in India, EADS India Private Limited, was established in 2006 as a 100% owned subsidiary of EADS to lead the development of the Group in India. The EADS Technology Centre India, a campus-style institution, will foster the cooperation between EADS subsidiaries and the Indian partners. The EADS Technology Centre India will become a major employer in the aerospace and defence sector in India with the potential to create up to 2,000 jobs. Over the next 15 years the investment for high-tech activities carried out by the EADS Technology Centre will reach approx. EUR 2 billion. A state-of-the-art engineering unit, called Engineering Centre Airbus India will be erected as part of the EADS campus. This site will be a 100% owned subsidiary of Airbus and focus on high-end engineering analysis and design working in cooperation with Indian suppliers[255].

Public policies

2001 private investment in the Indian aerospace and defence sectors is made possible. Prior to this year the aerospace and defence industries were exclusively reserved for the public sector. Foreign Direct Investment (FDI) is limited to 26% investment in a company's equity capital and the government can ask for specific contract conditions. In the civil aerospace industry there is nearly no longer any restriction. In nearly all areas 100% FDI is possible. In combination with the

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250 SBAC, India: Defence Ministry set to sign offset agreements, 13 December 2006.
251 Outlook India, 16 April 2008, available at http://news.outlookindia.com/item.aspx?562808
252 Boeing in India, Overview, available at http://www.boeing.co.in/ViewContent.do?id=1962
253 Available at http://www.airbus.com/store/mm_repository/press_kits/att00005586/media_object_file_India_Update.pdf
254 Machinist, 28 July 2009, available at http://machinist.in/index.php?option=com_content&task=view&id=2230&Itemid=2
255 EADS to increase industrial footprint in India, 29 August 2006, available at http://www.eads.com/1024/en/investor/News_and_Events/news_ir/2006/2006/20060828_eads_india.html

defence offset policy introduced 2006 and further liberalisation in 2008 significant opportunities for Indian companies are offered if they decide to entering this sector (Changing Dynamics, 2009[256]).

India has a complex and multi-tiered tax system that has turned out to be a burden in particular for manufacturing companies.[257] This applies to the defence sector and the civil AI. There are tax incentives available for R&D and for economic activity in Special Economic Zones but these are not broad-based enough to provide a significant relief.

Clusters of aerospace industry

The hub of the Indian aerospace activity is Anekal and Malur near Bangalore. Bangalore is also the venue for the Aero India Show, one of the largest of its kind in the whole of South Asia.

Recently smaller clusters around the city of Hyderabad have been initiated. In the proximity of the Rajiv Gandhi International Airport an aerospace park is being developed by GMR Hyderabad International Airport Ltd. (GHIAL). Already the Malaysian Airlines have agreed to develop an airframe MRO service at the site, and CFM, the joint venture between GE and Snecma, has signed a Memorandum of Understanding to set up the first CFM Engine Training Centre in India at the Hyderabad aerospace park. The government of the State is promoting an aerospace cluster in the Adibatla villarge. It has already won the support of Tata Advanced Systems, Samuha and Nova Integrated Systems, which will together invest around Rs. 30,000 million and generated about 10,000 jobs over the next five years[258].

Industry structure

The state-owned Hindustan Aeronautics Ltd (HAL) is the predominant Indian AI company. The company was ranked 40th in the Flight International's list of the top aerospace companies in the world (Flight International, 2009[259]). In the Financial Year 2008-09 the company reported sales turnover of Rs. 103.730 billion and profits after tax of Rs. 17.400 billion. Even though officially a state-owned company, the Indian government granted the company the 'Navaranta' status, which allows greater autonomy in almost all business areas, including the possibility to create joint ventures with private companies. HAL produces a range of military aircraft under licensing agreements such as the BAE Hawk 132 advanced jet trainer, Sepecat Jaguar and Sukhoi Su-30 MKIs and several helicopters. But it is attempting to expand its civil aviation segment. Together with Boeing it is trying to bring USD 1 billion in manufacturing work to India over the next 10 years and plans to convert passenger aircraft to cargo use at a proposed MRO joint venture with Boeing. It also manufactures doors for the A320 and is investing Rp 1 billion in an engine component manufacturing joint venture with Pratt&Whitney.

HAL will dominate the Indian AI for years to come. But with the growth of the aviation industry and the offset agreements India has witnessed the emergence of several private sector firms. As a result of the private sector opportunities for highly qualified workers HAL finds it increasingly

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256 Changing Dynamics, India's Aerospace Industry, Confederation of Indian Industry, PriceWaterhouseCoopers, 2009, available at http://www.pwc.com/en_GX/gx/aerospace-defence/pdf/india-aerospace.pdf

257 For a detailed discussion see: Changing Dynamics.

258 Express Buzz, Jul 31, 2009, available at http://www.expressbuzz.com/edition/story.aspx?Title=Aerospace+cluster+to+get+AP+10,000+jobs&artid=z7hpM/8d79U=&SetionID=XT7e3Zkr/lw=&MainSectionID=XT7e3Zkr/lw=&SectionName=HFdYSiSIflu29kcfsoAfeg==&SEO=TASL,%20Y%20S%20Rajashekhara%20Reddy,%20Davinder%20Kumar,%20GoAP#

259 Flight International, 2 March 2009, Can India's aerospace manufacturers step up?.

difficult to recruit new talent. To increase the manufacturer base the government provides incentives to the private competitors to HAL with tax breaks (Flight International, 2009).

A company that is pushing into the aerospace market is Larsen & Toubro. L&T is a private technology, engineering, construction and manufacturing company with total sales in 2008 of USD 8.5 billion. It has already signed some deals with EADS, Boeing and Raytheon, mainly for space and military projects but is trying to expand its participation in the AI.

Mahindra & Mahindra, similar to L&T a company with an extensive engineering business (total group sales of USD 6.3 billion), has acquired Plexion Technology in 2005 to gain a foothold in the aerospace market. Since then it has signed an agreement for the design and development of a new General Aviation Aircraft with National Aerospace Laboratories and the Council of Scientific and Industrial Research (Mahindra, 2007[260]).

But the biggest challenge to HAL is the conglomerate, the Tata Group. With total revenues of USD 70.8 billion in 2008-09 and employment of 357,000 the company is one of the biggest in the Indian economy. Tata has the intention to move into full-scale aircraft assembly and production in both the civil and the military markets. This would create a direct competitor to HAL, which is currently the only Indian company with the facilities to produce aircraft. Tata has been highly successful initiating international partnerships. Together with Boeing, Tata has formed a joint-venture which will carry out USD 500 million of defence-related component work in India for export to Boeing and its international customers (Aviation News, February 2008), with EADS it agreed to jointly bid on a USD 1 billion contract to supply the Indian Army with tactical communication systems and with Sikorsky is arranged that Tata would produce helicopter cabins in India (Aviation Today, 12 June 2009).

Dynamatic Aerospace, a division of Dynamatic Technology, is a private sector manufacturer of aircraft parts and components and develops complex aerostructures. It maintains a close partnership with the Ministry of Defence, HAL and other defence establishments. It is also working together with EADS and Spirit AeroSystems to assemble Flap-Track Beams for the Airbus single-aisle A-320 Family of Aircrafts. This is the first time that an aero-structure assembly for a major commercial jet is carried out by an Indian private sector firm.

HCL, a software development partner of Boeing on the 787 Dreamliner program, is one of Indian's leading IT services companies. For Boeing it provides software services as well as its Tier-1 systems suppliers for the 787 program. HCL, which had revenues in 2008 of USD 2 billion, is also a defence offset partner for Boeing.

The external trade of the Indian aerospace industry

The general development of India during the last decades has not had much impact on the AI's exports. Quite the opposite is true for imports. The liberalization and opening up of the Indian economy at the beginning of the decade had stimulated imports. Within a couple of years an enormous trade deficit has developed. (Figure 5.33)

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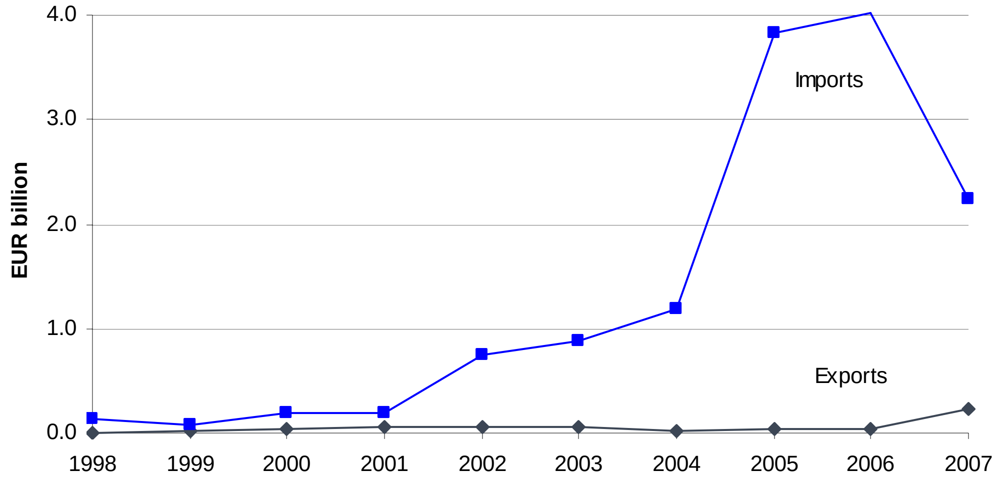
[260] Communiqué, February 2007, available at http://www.mahindra.com/Admin/tmpupload/CommuniqueforFeb07.pdf

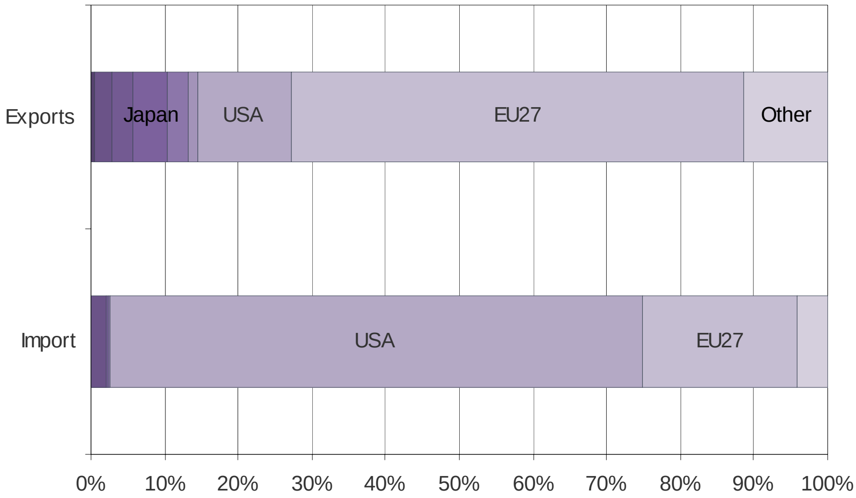
Figure 5.33 Development of Indian Total Aerospace Trade from 1998 to 2007



Source: UN Comtrade.

The largest share of imports to India arrive from the US (over 70% of total) while the EU is second in the import ranking, as demonstrated in Figure 5.34. For the exports, the EU is, on the other hand, the most important destination. The structure of exports per partner is also more diversified and India exports aerospace products also e.g. to Japan, Russia, China, Canada and South Africa. However, the absolute value of their exports to most of the partner countries is still very small.

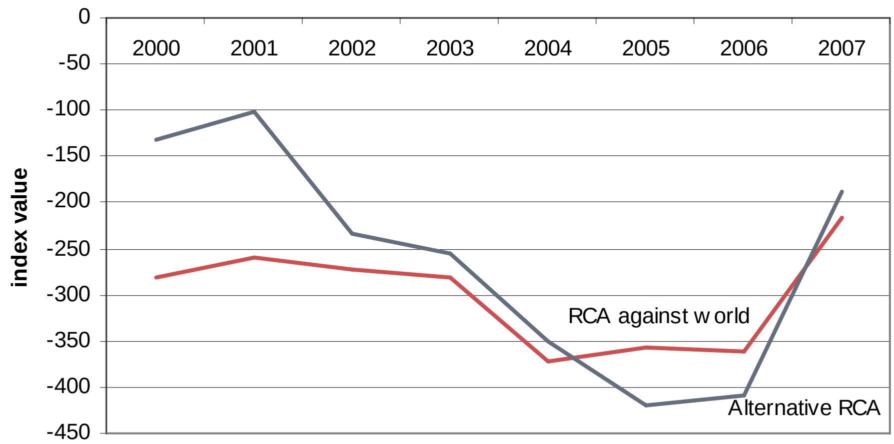
Figure 5.34 India's Exports and Imports shares and values by Main Trade Partners in 2007, EUR million



	Import	Exports
Other	91	26
EU27	474	139
USA	1622	29
South Africa	0.6	3.1
Russian Federation	1.6	6.4
Japan	9.4	10
China	1.0	6.3
Canada	42	5.3
Brazil	0	0.03
Australia	2	1.4

Source: UN Comtrade, own calculations.

Figure 5.35 Yearly RCA Indexes for the Total India's Aerospace Industry from 2000 to 2007



Source: UN Comtrade, own calculations.

As the trade balance indicated already, India does not have a global comparative advantage in the production of aerospace products and the industry is performing worse in the trade than other industries within the economy. (Figure 5.35) During the period from 2000 to 2007 the RCA indicator indexes have been dropping, meaning that their competitiveness has decreased even further especially due to the large increase in imports.

Conclusion

For decades the Indian economy has been shielded from foreign competition. Only at the beginning of this century markets have been opened up and foreign companies are allowed to sell products and to invest in India. For the Indian economy the AI has not yet been of noteworthy importance. The government's interest in this sector was above all the manufacture of military aircraft based on licences. With strongly growing air traffic the economic importance of the AI has been recognized and the government tries to stimulate a sustainable economic development of the sector. However, the Indian AI is dominated by a big state-held group and structural changes will take some time. The government tries to push forward this development by the application of offset obligations, if foreign companies want to get access to the market. Indian companies that want to get a stake in the AI have been attracted by the opportunities provided with governmental support.

The Indian air traffic market is among the most promising in the world. The opening up has incited the big players to strengthen linkages to indigenous companies. Boeing as well as Airbus has invested to get a foothold. The integration of India in the global AI does not only follow a simple strategy on the relocation of production, but the exploitation of comparative advantages. Engineering and software development are high on the agenda. All in all the pattern of the growing integration of the Indian AI in a global network is understood as a typical for emerging markets that provide promising perspectives for the big manufacturers of aircraft.

5.6.2 Aerospace Industry of China

Overview

In its pursuit to produce commercial aircraft, China experienced several setbacks. The first attempt in the 1970s was the Y-10, which was based on reverse engineering of the Boeing 707. The aircraft could not compete with other large civil aircraft and after only two produced airplane the programme was stopped[261]. Another failure was the Y-7, a Chinese produced regional aircraft[262]. Determined to produce a LCA the Ministry of Aviation devised a 'three-step take-off plan' which, through international cooperations, would allow China to acquire the necessary skills to self-design and manufacture a LCA[263]. However, each of the three steps was unsuccessful.

To consolidate the aircraft industry the National People's Congress united the entire aviation industry under Aviation Industries of China (AVIC) in 1993. But the core aerospace business of AVIC remained small and widely diversified across unrelated production facilities. To this end, and after failed cooperations with McDonnell Douglas and Airbus, the Chinese government decided in 1999 to split AVIC into two fully integrated parts, China Aviation Industry Corporation 1 (AVIC 1) and China Aviation Industry Corporation 2 (AVIC 2). Designed as a measure to promote competition, the separation into two units went against the trend of consolidation in the

261 China's Growing Market for Large Civil Aircraft, US International Trade Commission, 2008.
262 The Political Economy of Industrial Policy in China: The Case of Aircraft Manufacturing, Andrea Goldstein, 2005.
263 http://www.globalsecurity.org/military/world/china/civil-aircraft.htm

rest of the world[264]. AVIC 1 was created to focus on the market for medium and large aircraft while AVIC 2 was to concentrate on the market for small aircraft and helicopters. Inefficiencies within the structure of the companies lead to a major reorganisation of the aerospace industry in 2008. The Commercial Aircraft Corporation of China (COMAC) was created for the development and production of large civil aircraft. COMAC was assigned the national monopoly for the production of complete jet airliners with more than 70 seats[265].

Later in 2008, AVIC 1 and AVIC 2 were merged into China Aviation Industry Corporation, AVIC. AVIC is now structured into 10 business segments (units defence, transport aircraft, aviation engines, helicopters, avionics, general aviation aircraft, aviation research and development, flight tests, trade and logistics, and asset management), contrasting with the former structure along geographic lines, which had lead to regional duplication of resources and capabilities[266]. AVIC has 200 subsidiaries. Total asset of AVIC is estimated to be over RMB 290 billion and employment is estimated to be 400,000[267]. AVIC Aircraft, the company created from the business segments Transport Aircraft, is focussing on large airplanes. Due to the monopoly of COMAC, AVIC Aircraft is limited to cargo lifters, propeller passenger aircraft, bombers and specialty aircraft (large airplanes excluding passenger jets) and building aircraft sections for the COMAC. AVIC Aircraft intends to become the third largest producer of large aircraft[268].

In 2000 the Commission of Science, Technology and Industry for the National Defence (COSTIND) provided CNY 5 billion (around USD 600 million) for research and development of the Asian regional jet of the 21st century (ARJ-21). To develop the ARJ-21 the AVIC 1 Commercial Aircraft Company (ACAC), a consortium of 15 Chinese investors, was founded in September 2002. The ARJ-21 is the first short and medium range jet produced by China with completely independent intellectual property rights[269]. Former Chinese aircraft had often been based on Russian design (like the MA-60) or were reverse-engineered from Western models. While Chinese subcontractors are building the structure, major systems are supplied by foreigners. (Risk-sharing) Partners include GE for propulsion, Rockwell Collin for avionics, Liebherr Aerospace for the landing gear, Honeywell for the primary flight control among others. Half of the equipment on the ARJ-21 comes from foreign companies (mostly US companies). The aircraft is designed principally for domestic needs but later models might also be exported. However, FAA endorsement of the ARJ-21 has not yet been achieved. Even though the company currently holds orders of 210 units, this figure is inflated by options. With most customers being Chinese it is not clear that they committed themselves with large deposits[270]. COMAC, the parent company of ACAC, estimates a market for 850 ARJ-21's over the next 20 years[271].

[264] Nolan and Zhang 2002, 2003.
[265] Aviation Week & Space Technology, 6 April 2009.
[266] http://www.avbuyer.com.cn/e/2008/30424.html
[267] http://www.avbuyer.com.cn/e/2008/30220.html
[268] Aviation Week & Space Technology, 6 April 2009.
[269] http://www.acac.com.cn/site_en/about.asp
[270] Aviation Week & Space Technology, 22 June 2009.
[271] http://www.geae.com/aboutgeae/presscenter/cf34/cf34_20081104.html

Table 5.8 Western Partners/Suppliers in the Production of the AVIC ARJ-21

Strategic Partner	Bombardier Aerospace (Canada)
Engine	General Electric (USA)
Landing Gear	Liebherr Aerospace (Germany)
Wheels, Brakes	Goodrich (USA)
Hydraulic System	Parker (USA)
Flight Control System	Honeywell (USA)
Air conditioning/Ventilation	Liebherr Aerospace (Germany)
Electrical System	Rockwell Collins (USA)
Avionics	Sagem (France), Zodiac (France)
Fuel System	Parker (USA)
APU	Hamilton Sundstrand (USA)
Cabin Interior	FACC (Austria)
Fire protection system	Kidde Aerospace (USA)

Source: Handelsblatt, 17 June 2009.

The current situation

The Chinese industrial policy wants more than entering the market for regional aircraft. COMAC, which has developed the ARJ-21, is planning to produce the C919, a narrow body aircraft similar to the Airbus A320 and the Boeing 737 families. The development of a LCA was listed as one of the country's 16 major development plans in the 11th Five-Year Programme for the 2006-2010 period[272]. China will invest a total of Yuan 200 billion (USD 29 billion) in the COMAC produced C919 (seating 130-200 passengers) with Yuan 30 billion spend of research and development. It is expected to have its first flights in about eight years[273]. If the C919 enters service in 2016, it should enjoy the title of the world's most advanced narrow-body aircraft since Airbus and Boeing are unlikely to have introduced their replacements for the A320 and the 737[274]. Foreign supplier which are contracted to supply parts and systems (including the engine) make a contribution that the aircraft will be composed of advanced technology, including in those areas in which China lacks competitiveness.

The resources invested in the development of domestic aircraft and a competitive aerospace industry is to an extent motivated by the growth in the domestic air traffic. Air traffic has increased at a rate of 7.9% per year and by 2027 there is a potential demand for 3,200 new aircraft (mostly large (> 15,000 kg) and medium (2000 kg to 15,000 kg) sized aircraft)[275]. Airbus expects China to become the world's second biggest aviation market by 2025. China is unwilling to cede the booming domestic market to the established foreign producers. Instead, China is trying to leverage the interest that foreign firms have in accessing the Chinese market to negotiate favourable terms for partnerships in order gain access to Western technology[276].

272 http://english.peopledaily.com.cn/200603/10/eng20060310_249535.html
273 Aviation Week & Space Technology, 16 March 2009.
274 Aviation Week & Space Technology, 22 June 2009.
275 Boeing Current Market Outlook, 2008.
276 The Political Economy of Industrial Policy in China: The Case of Aircraft Manufacturing, Andrea Goldstein, 2005.

All large aircraft manufacturers are pushing access to the Chinese market. China is an important market, as well as a strategic partner and supplier[277]. The first programme to co-produce Western airplanes in China (and one of the most extensive civil aircraft manufacturing cooperations) was a licensing agreement of McDonnell Douglas Corporation to assemble the MD-80 aircraft in Shanghai. Between 1985 and 1994 thirty five aircraft were produced. A follow-on programme was signed in 1992 (commonly known as the 'Trunkliner' programme) to co-produce the MD-90 aircraft. However, the programme failed after only three aircraft were produced[278]. The Chinese factories that were involved in the production of the MD-90 - the Shanghai Aviation Industrial Corp., Xi'an Aircraft Co., Chengdu Aircraft Co., and Shenyang Aircraft Co. - are now partnered on the ARJ21 program and have divided the responsibilities between them in the same way as for the MD-90.

Boeing has extensive cooperations with China dating back to the 1970s. Its investment in China includes industrial cooperations and joint ventures. Support to civil aviation has been provided by training and technical assistance to develop the country's domestic airlines and airport infrastructure.

Airbus set up a training centre in 1998 and the Airbus Engineering Centre in 2006, a joint venture with AVIC, where design and development programmes for the A350 XWB are carried out. The most important project is the Airbus final assembly line in Tianjin for the A320 with production to serve the Chinese market. The production site, opened in September 2008, is a joint venture between Airbus and a Chinese consortium of Tianjin Free Trade Zone and AVIC. With a minority share of 49% (Airbus owns 51%) the Chinese partners provided most of the financing (USD 630 million for the production line and an additional investment of USD 375-630 million[279]) reflecting the Chinese interest to accommodate a state of the art production site of a LCA. In May 2009 the first A320 build in China completed its maiden flight. Production will be expanded to four aircraft per month by 2011.

As for regional jets, Embraer signed an agreement with AVIC 2 companies in 2002 to build a production facility in Harbin. The joint venture will be responsible for manufacture, assembly, sales and after-sales support for the ERJ 135/140/145 families. The first ERJ 145 was finished in December 2003. A large order by Hainan Airlines over 50 ERJ-145's and 50 ERJ-190's was placed in 2006. But so far only 11 ERJ-145 aircraft have been delivered[280].

Bombardier entered a long term strategic cooperation in the five-abreast, 90 to 149-seat commercial aircraft market with AVIC 1 in June 2007. In particular Bombardier will be participating in the development of the five abreast ARJ21-900[281]. As a risk and revenue sharing partner Bombardier will invest USD 100 million in the project and be paid through royalties form the sale of the jet. AVIC, in pursuit of its goal to become an international Tier 1 structural supplier, will invest USD 400 million for research, development, construction of facilities for the Bombardier C-Series programme have been be launched.

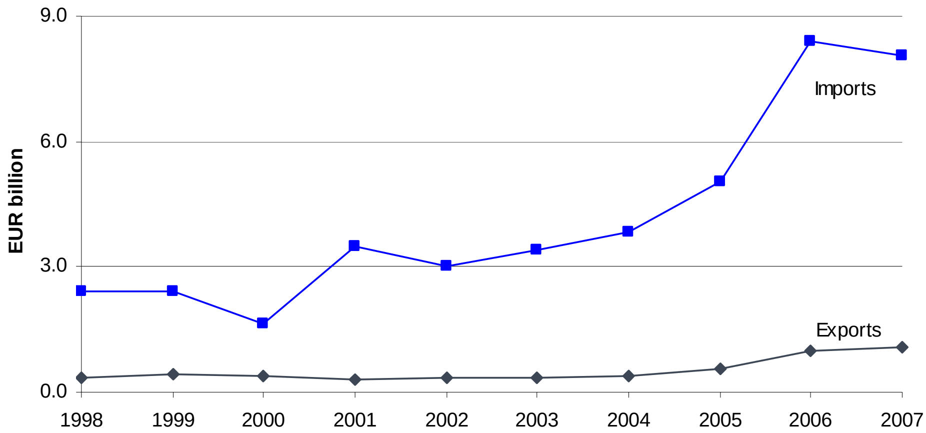
277 http://www.airbus.com
278 China's Growing Market for Large Civil Aircraft, US International Trade Commission, 2008.
279 China's Growing Market for Large Civil Aircraft, US International Trade Commission, 2008.
280 http://www.flightglobal.com/articles/2009/02/09/322301/harbin-embraer-appears-closer-to-new-erj-145-deal-with.html
281 http://www.deagel.com/news/Bombardier-to-Participate-in-the-AVIC-I-ARJ21-900-Regional-Jet-Development_n000002160.aspx

China is at the leap to become an international competitor on the market for regional jets but – in the long-term perspective – also of LCAs. At the moment and despite the efforts to create internationally competing aircraft, China' main influence as a manufacturer comes not from OEM but from producing parts used by the established manufacturers and a growing integration in the value chain.

The external trade of the Chinese aerospace industry

The Chinese trading structure and developments in the aerospace trade follow largely a similar pattern as in India. The imports have been rising fast since the end of 1990's, while exports have had a more modest growth path. This has widened the trade deficit significantly and in 2007 the deficit was around EUR 7 billion.

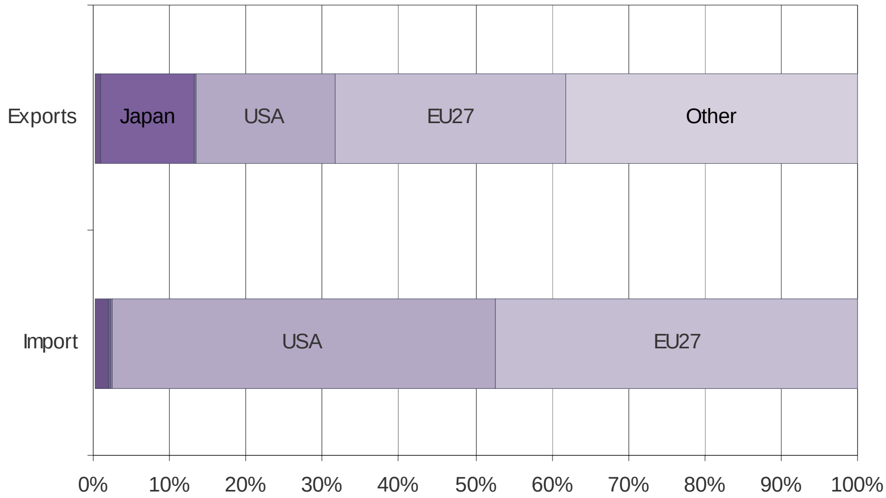
Figure 5.36 Development of China's Total Aerospace Trade from 1998 to 2007



Source: UN Comtrade.

The imports of aerospace products to China come around 50%-50% from the US and from the EU, respectively. The small amount of exports is more diversely directed − the Chinese exports are destined mainly to the EU, US, Japan and other countries (not listed in the partner country list below), with the EU as the main single destination with 30% of the export flows (Figure 5.37). The largest exports partners of China under the grouping of other export partners include e.g. Hongkong (27%), Indonesia, Zambia and Singapore.

Figure 5.37 China's Export and Import shares and values by Main Trade Partners in 2007, EUR million

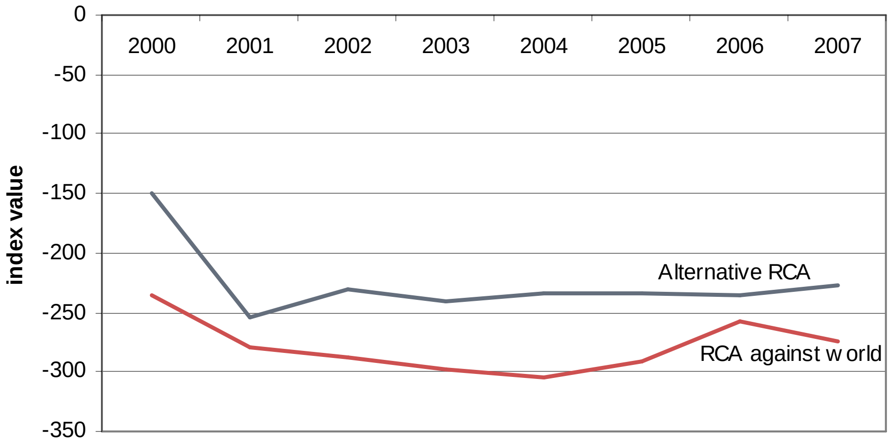


	Import	Exports
Other	0.1	402
EU27	3808	320
USA	4039	191
South Africa	0.1	0.1
Russia	12	4.1
Japan	23	128
India	0.1	1.1
Canada	135	7.5
Brazil	21	1.2
Australia	0.5	1.0

Source: UN Comtrade, own calculations.

China has also not yet gained a strong position in the global aerospace market, as indicated by the global and alternative RCA indexes in Figure 5.38. On the contrary, the competitiveness of Chinese products seems to have fallen compared to year 2000 even further on the negative side.

Figure 5.38 Yearly RCA Indexes for the Total China's Aerospace Industry from 2000 to 2007



Source: UN Comtrade, own calculations.

Conclusion

The opening up of the Chinese economy started during the early 1980s. It has been a cautious development, and the government has always pursued a clear industrial policy directed to guiding strategic sectors and maintaining. The AI is one of those industries in the focus of public authorities. The development of aircraft based on Chinese design has not been very successful in the past. Most of the production was under licenses agreements.

Although China claims that the most recently developed aircraft is fully based on Chinese intellectual property rights, there has been made much use of former licence production of McDonnell Douglas aircraft and many key-components are supplied by industrial groups, well-known in the global AI market. Generally speaking, there is much know-how in the value chain and not only in the final production of aircraft. It cannot be transferred or acquired within a short time, the industrial infrastructure must be made available and the generation of independent know-how takes time.

In the long run China will manufacture own civil aircraft that are state of the art. China will not only benefit from the big and strongly growing Chinese market. Chinese aircraft will globally be marketed. However, the competitiveness of these aircraft will remain dependent on the ability to exploit the specialized knowledge in the global AI and integrate subsystems of manufacturers who are leading technological progress. As a consequence international companies are about to get part of the Chinese AI's value chain and to benefit from the long-term perspectives, not only in the Chinese market, but of Chinese OEMs in the world. Likewise all major OEMs for the production of LCAs and regional aircraft are eager to strengthen their linkages with Chinese companies to participate in the market perspectives that as a prerequisite needs the ability to fulfil offset obligations.

5.6.3 Aerospace Industry of South Africa

Overview

One of the remains of the apartheid policy in South Africa is a relatively large military sector. This was an effect of the isolation and the inhibited access to modern military technology was an incentive to concentrate resources in the development of aviation technology. One of the well-known products was the South African Rooivalk Combat Support Helicopters. In the nineties the political and societal conditions changed, South Africa did no longer interfere in neighbouring countries and the country could leave its isolation from international military technology. The aircraft industry had, and still has, to bear this heir and to transform military industrial structures in a more diversified range of products. An example for this development and transformation is the Aerosud Company, an established leader in the South African aviation industry.[282] The company was formed in 1990 by the key designers of South African Rooivalk Combat Support Helicopter, together with similar leaders from Cheetah fighter and the Product Support Environment. First contracts were of military nature, but in 1995 Aerosud embarked on diversification into the commercial aviation market with the design of galleys and other interior systems. Later Aerosud expanded it s production capacity and manufactures now around 2000 parts and assemblies a day and supplies these to the assembly lines of Airbus, Boeing, BAE Systems, Augusta Westland Helicopters and Spirit AeroSystems.

It comes from this military focused history that there is a strong governmental influence on the aerospace industry and a strong relationship between industry and the government. The government is committed to develop the country's aerospace and to make it internationally integrated and competitive. The national industrial policy regards international collaboration of one of the mechanisms to promote development in a mutally beneficial and sustainable manner. The main technologies that the government has identified are advanced electronics, advanced light materials and production technologies.

Another aspect concerns the maintenance sector. South Africa is increasingly becoming important as a regional hub for maintenance repair organizations serving operators flying in sub-Saharan Africa. Airports Company South Africa (ACSA), a state-owned corporation and the largest airport operator in South Africa spent USD 234 million in smaller airports during 2000-2005 to turn them into more competitive international facilities.

Public policies

The South African government regards the aerospace industry as a prestigious and strategic industry that reflects the countries ongoing transformation. It is an element of the strategy to intensify the country's industrialisation and to move towards a knowledge economy which is exposed in the National Industrial Policy Framework. The aerospace sector is regarded as an enabling sector for other manufacturing sectors, because of its cutting edge technology profile and its use of highly skilled people. Therefore the government is highly committed to develop the country's aerospace potential. The vision is that by 2014 the South African aerospace industry would be growing, empowered, sustainable and internationally recognised. Politics and industries regard international collaboration and the integration into global supply chains as central mechanisms to promote the national aerospace industry. Efforts to promote the growth and competitiveness of the local aerospace industry were led by the "Advanced Manufacturing technology Strategy

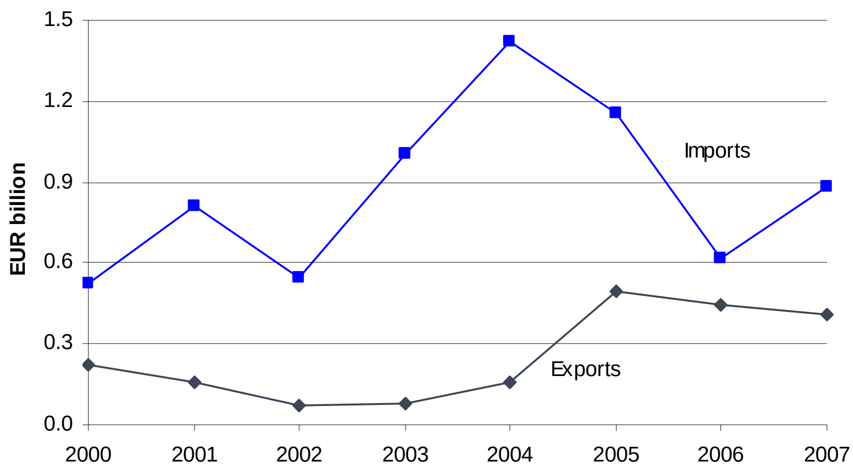
[282] http://www.aerosud.co.za/

(AMFT). This is a programme which has taken the approach to focusing on advanced niche technologies that can benefit more than only one industrial sector. In this sense there is also a European-South African initiative called Estap (European South African Science and Technology Advancement Programme), which is jointly funded by te South African Department of Science and Technology and the European Commission. In 2009 a long-anticipated strategy to boost South Africa's aerospace sector is about to see the light of day. Although details are not available, the aerospace industry plan, called Aerospace Industry Support Initiative (AISI), will aim to achieve improved cooperation and organization in the industry. It is not the first initiative to bolster the aerospace industry in this decade but the new initiative, which is developed together with six large aerospace companies in South Africa, is aimed at linking all previous initiatives to provide a comprehensive implementation plan. This new programme expresses the difficulties of the industry and the government to turn the aerospace industries to an internationally competitive player.

The External Trade of the South African Aerospace Industry

Similar to the other developing nations in the production of aerospace products, the trade in South Africa has been in deficit until now. However, the value of imports has been varying yearly largely during the period from 2000 to 2007, while the exports have increased more steadily. This has lead to a decrease in the trade deficit.

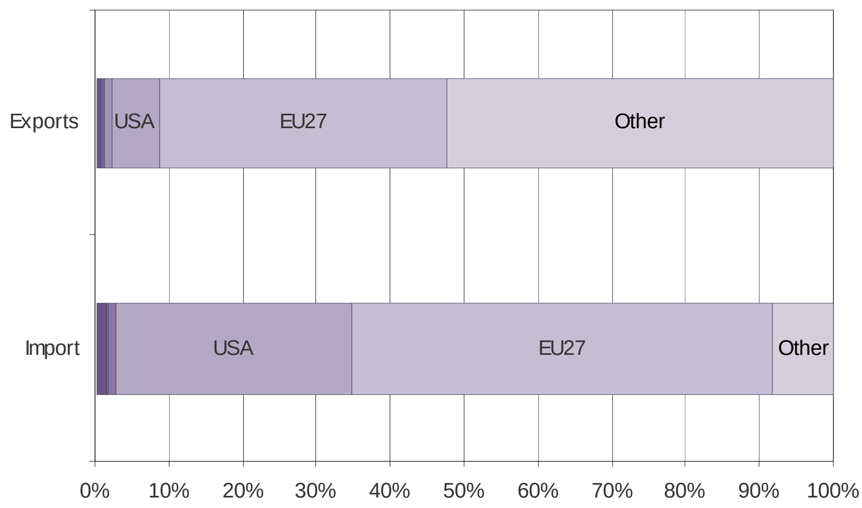
Figure 5.39 Development of South Africa's Total Aerospace Trade from 2000 to 2007



Source: UN Comtrade (data available only from 2000 onwards).

With regards to the trade structure per partner, the imports to South Africa come mainly from the EU and US. In addition, a relatively large share of exports goes to the EU as well, although most of the exports (52%) still go to other markets than the ones listed below. Main partners falling in the table under the "other export partners" category includes e.g.: Bermuda, Israel, Angola, Seychelles and Kenya.

Figure 5.40 South Africa's Export and Import shares and values by Main Trade Partners in 2007, EUR million

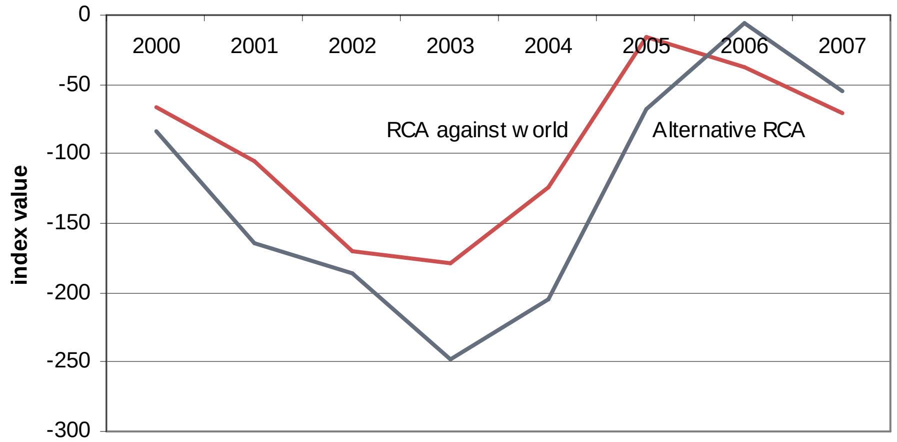


	Import	Exports
Other	74	214
EU27	501	159
USA	283	27
Russian Federation	0.3	3.9
Japan	9.2	0.6
India	1.5	1.5
China	0.1	0.0
Canada	12	1.9
Brazil	0.0	0.8
Australia	1.8	0.7

Source: UN Comtrade, own calculations.

South Africa has also not yet gained a global comparative advantage in the production of aerospace products according to either one of the RCA indexes. They have, however, increased their competitiveness during the last years, but without gaining a comparative advantage yet. See Figure 5.41.

Figure 5.41 Yearly RCA Indexes for the Total South Africa's Aerospace Industry from 2000 to 2007



Source: UN Comtrade, own calculations.

Conclusion

Under the apartheid rule and influence by international export of arms control, South Africa developed a relatively strong military sector. The inhibited access to modern military technology was an incentive to concentrate resources in the development of (military) aviation technology. When the political and societal conditions changed the aircraft industry had, and still has, to transform capacities into a more diversified range of products.

The military focused history leaves its mark in terms of the governmental influence on the aerospace industry and a strong relationship between industry and the government. The government is committed to develop the country's aerospace and to make it internationally integrated and competitive. The national industrial policy regards international collaboration of one of the mechanisms to promote development in a mutually beneficial and sustainable manner. The vision is that by 2014 the South African aerospace industry would be growing, empowered, sustainable and internationally recognised. Politics and industries regard the integration into global supply chains as central mechanisms to promote the national aerospace industry.

Like other developing nations in the production of aerospace products, South Africa has been in trade deficits until now. South Africa has also not yet gained a global comparative advantage in the production of aerospace products, although they have increased their competitiveness during the last years.

5.6.4 Aerospace Industry of Australia

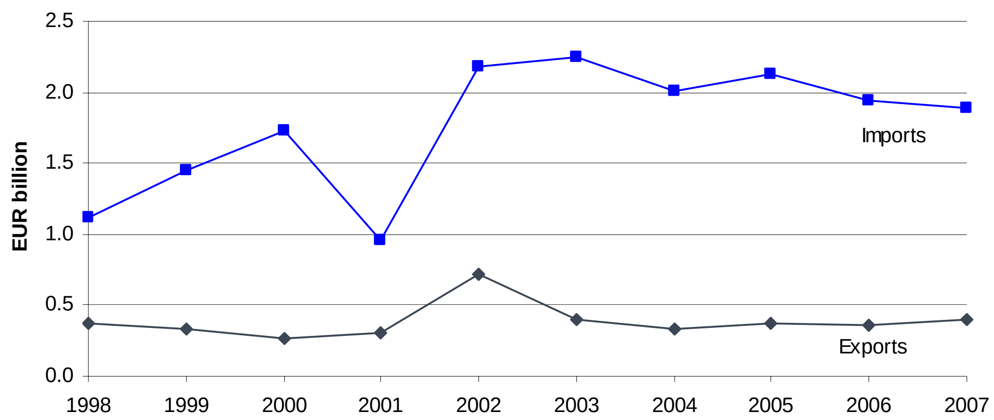
Overview

Australia is not one of the main major manufacturers of aeroplanes, but Australian-based firms are well integrated into global supply chains. Australian companies offer a broad range of capabilities to the international aerospace, sector and supplies products and services integral to major programmes such as the Airbus A380 and the Boeing 787. Australian industries are also highly integrated in military projects. The integration in supply chains for major programmes confirm the competitiveness of companies such as Metaltec Precision International, Marand Presision Engineering, Aerostaff Australia, Production Parts, Hawker De Havilland (HdH), Rosebank Engineering and Lovitt technologies. Major competencies are in the area of aerostructures, precision machines, robotic systems, tooling and ground handling systems. Australia has pioneered a new and highly cost-effective scheme for field or in situ repairs of aircraft components suffering from cracking caused by fatigue or stress-corrosion. The big players like Boeing, EADS, BAE Systems and GKN run Australian subsidiaries. The strengths of Australian aerospace industry are the long-term, close strategic relationship with the US and the long-term experience as a reliable supplier to the world's major commercial (and military) aircraft manufactures. One of the competitive advantages is the knowledge and skill of its workforce. In the Asia Pacific region, Australia competes with developing economies such as China, Indonesia and Malaysia which are prepared to support the aerospace industry through government intervention. The Australian aerospace industry is lacking such support and therefore companies must compete on price and lead-time in a relatively high wage market to survive.

The External Trade of the Australian Aerospace Industry

Australia has also faced a relatively large trade deficit in aerospace products during the last ten years. The deficit has been even increasing further in the past years as imports have risen around 100%, while exports have hardly changed at all. See Figure 5.42.

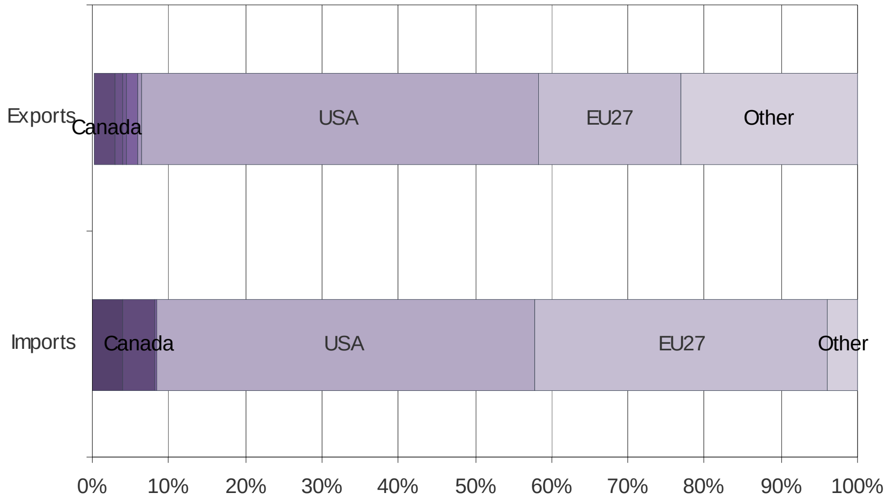
Figure 5.42 Development of Australia's Total Aerospace Trade from 1998 to 2007



Source: UN Comtrade (data available only from 2000 onwards).

The majority of aerospace imports to Australia come from the main aerospace producer countries – the US, the EU and Canada. Similarly, over 50% of their exports go to the US, around 20% to the EU and 23% to other markets, as Figure 5.43 indicates.

Figure 5.43 Australia's Exports and Imports by Main Trade Partners in 2007

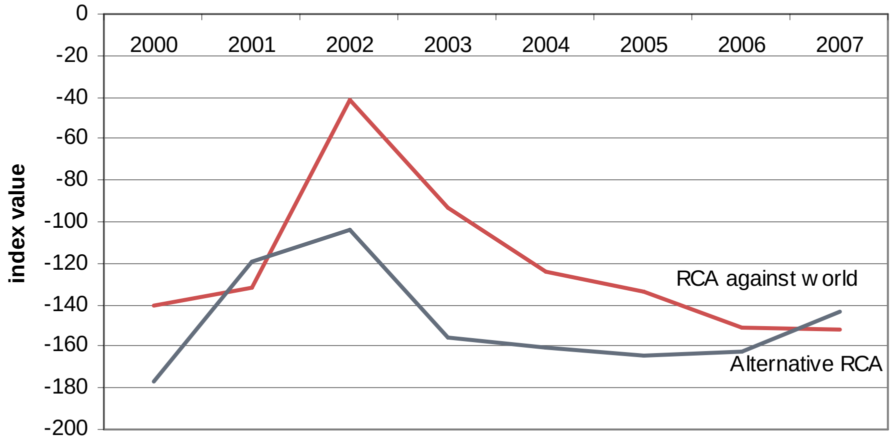


	Imports	Exports
Other	75	93
EU27	723	75
USA	934	210
South Africa	1.8	2.3
Russia	0.2	0
Japan	4.7	5.7
India	0	2.1
China	0.8	4.1
Canada	80	10
Brazil	74	1.4

Source: UN Comtrade, own calculations.

According to the RCA index values for the total Australian aerospace trade presented in Figure 5.44, Australia has also no comparative advantage in the trade of aerospace products. As the trade deficit has been increasing, the RCA indexes have been also decreasing further.

Figure 5.44 Yearly RCA Indexes for the Total Australians Aerospace Industry from 2000 to 2007



Source: UN Comtrade, won calculations.

Conclusion

The Australian aerospace industry is, compared with the great players, a small and unfortunately statistically insufficient covered small industry. Australian companies offer a broad range of capabilities to the international aerospace, sector and supplies products and services integral to major programmes such as the Airbus A380 and the Boeing 787. Australian industries are also highly integrated in military projects. Australia competes with developing economies such as China, Indonesia and Malaysia which are prepared to support the aerospace industry through government intervention. The Australian aerospace industry is lacking such support and therefore companies must compete on price and lead-time in a relatively high wage market to survive. Australia has faced a relatively large trade deficit in aerospace products during the last ten years.

6 The Competitiveness of the EU Aerospace Industry

This chapter is dedicated to a comprehensive assessment of the competitiveness of the European AI based on the quantitative and qualitative analysis of the preceding chapters. (Figure 6.1)

The first section is dedicated to a direct comparison of the European aerospace industry with its US competitor. Officially available sectoral statistics are applied for the comparison of the European and the US AI's productivity. Then an evaluation of the profitability and the financial viability is carried out that receives its importance by the current financial crisis and the economic problems of the clients. This assessment is based on microeconomic analyses. (Chapter 6.1.1) The concept of comparative advantages is applied to disclose the relative strength of the AIs in relation to their indigenous manufacturing industries (Chapter 6.1.2).

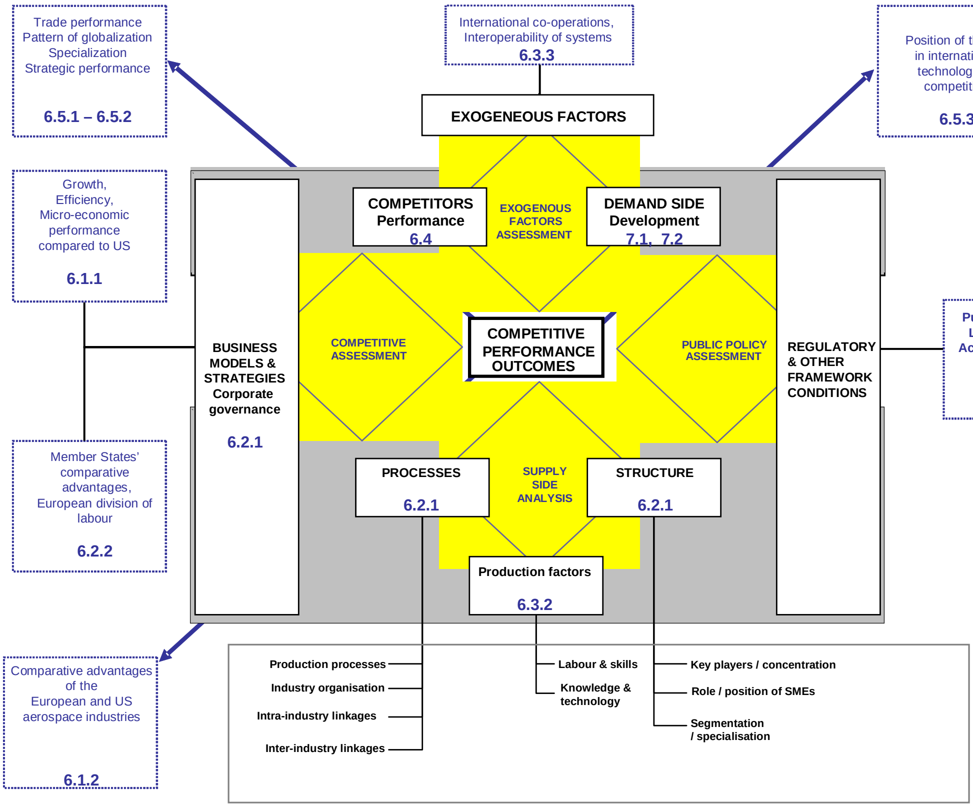
The second section tackles the supply side of the European AI. It starts with the corporate governance of EADS/Airbus that is perceived as of major importance for the structure and the changes in the European industry. The – generally speaking – bigger players are assessed as an asset for the US. Currently the European AI is about to adapt its regional supply chains to exploit the comparative advantages in the new Member States. This has made much progress and contributes to the competitiveness of the AI.

The third section is dedicated to the framework conditions. Firstly, national and Eurpean public policies are evaluated; special attention is paid to the interaction and coordination of the numerous schemes dedicated for the AI. Secondly, an assessment of the labour supply, qualification and long-term availability is carried out to highlight its impact on the future competitiveness of the European sector. Thirdly, the openness of international markets is evaluated. The last topic is dedicated to access to finance is analysed, special attention is paid to schemes dedicated for smaller companies and European and US funds dedicated to support the sale of aircraft.

The fourth section discloses strengths and weaknesses of the competing economies under consideration.

The fifth section evaluates the performance of the EU AI in international markets. It highlights the overall results of the quantitative assessment based on trade statistics for all of the AI and - more in detail – the position of the EU in the subsectors. Patterns in international trade are disclosed. In particular the driving factors of globalization, the interaction of the big OEMs growth strategies and the emerging countries' interest in industrialization are evaluated. Finally the state of technology is evaluated.

Figure 6.1 Analytical Framework Competitiveness EU Aerospace Industry



Source: Framework Consortium (FWC).

6.1 The Economic Performance of the European Aerospace Industry

The evaluation of the economic performance of the European AI has turned out to be difficult. The reason for that problem lies in different new projects set up during the period under investigation. They did not only induce additional expenditure for product development, but technical problems and delays above all with the A380, A400M increased costs further on. Moreover, with the A350 another new project started that needed additional investment and acquisition of staff.[283] The related cost increase is not yet balanced by an according increase in revenues, which is a typical pattern for this industry. As a consequence economic indicators are distorted for years preceding the introduction of a new product into the market. The current problems are – to a certain extent – understood as an investment in the future, but a final assessment can only be carried in the future.

6.1.1 Comparison of Efficiency and Financial Performance

The focus of this section is on the direct comparison of the EU27 primarily with the US. In a first step the results of the analysis of the sectoral statistics are interpreted. In a second step the results of the analysis of the microeconomic statistics are interpreted.

283 In particular for Germany and France the economic indicators have been affected (Chapter 3.1).

Table 6.1 depicts the number of employees and value added of the AIs of the US and the EU. The comparison provides the remarkable result that – as measured by the workforce - both industries are of similar size, whereas the value added of the US AI is roughly twofold the European. As a consequence labour productivity is much lower in Europe. This result can partly be explained by delays and technical problems with new aircraft programmes, the deferred rollout of the A380, the A400M that only at the end of 2009 passed its first test flight, years behind the schedule and the A350 programme that has been launched only recently.

Moreover time series analysis disclosed that 2006 was a tough year for the European AI and the productivity figure is distorted. Labour productivity has improved markedly the years after. The calculation presented in Table 2.1 highlights the productivity for the European AI in 2008, based on preliminary figures. It exceeds the 2006 level by more than 15%. However the general shortfall against the US AI does not disappear.[284]

Table 6.1 The Productivity of the US and the European Aerospace Industries

		Unit	2006
EU27			
Value-added	2006 prices	Billion EUR	30.0
Labour force	Employees	1,000	384.0
Productivity	Value-added per employee and year (constant prices)	1,000 EUR	78.0
US			
Value-added[2)]	2006 prices	Billion EUR	58.4
Labour force	Employees	1,000	381.1
Productivity[2)]	Value-added per employee and year (2006 prices)	1,000 EUR	153.2
1) Exchange rate USD 1.3 / EUR 1.0, - 2) Value for 2006, growth rate estimated.			

Source: Eurostat (NACE 35.3), US Census Bureau (NAICS 3364), own calculations.

The profitability and the financial viability have been investigated by the application of micro-economic statistics. The key players of the EU and US AI were compared by an analysis of balance sheets. The European manufacturers' profitability is worse than their US counterparts. Over the period under investigation the status has even deteriorated further on. To a certain extent this negative development is owed to the already mentioned problems and delays with big Airbus projects, but the overall economic performance was already worse at the beginning of the period under investigation. One can conclude that there is a disadvantage of the European AI in the economic performance, even without the problems that put pressure on the profitability. It is of note

[284] The most recent available figures for the calculation of the US labour productivity are from 2006.

that in particular the Return on Shareholders funds is lower for the European AI whereas the Return on Capital Employed is somewhat higher.

The indicators on the ability to meet financial obligations disclose that European firms are definitely more on strain than their US competitors in the short-term. It is of note that scarce liquidity is a tough challenge in the current environment, laden with the financial crises and a declining economic activity in the client industry. The situation is not much alleviated by the fact that the European AI is financial healthy with regard to their long-term solvency that is secured.

6.1.2 The EU27 Comparative Advantage against the US

This section tackles the topics related to the general performance of the AI. It starts with an assessment of the comparative advantage in relation to the indigenous manufacturing industries. For the US and the EU the relative strength of the AI as compared to all of manufacturing is evaluated. The indigenous manufacturing is used as a benchmark. Following the EU27 and the US AI are compared directly and the development over the period under consideration is analyzed.

The concept of comparative advantages is a traditional theory well-suited for the explanation of an industry's performance in international markets in relation to other national sectors. The driving factor for an industry's performance is the availability of different resources and their marginal products. Differences between countries in the availability of factors provide an explanation for the international division of labour.

For the purpose to assess the competitiveness of the European AI the value-added per capita is the marginal product of labour and the labour costs indicate the scarcity of labour for the sector. The productivity of 1 Euro labour input provides the standardized information that is used for a comparison with the European manufacturing. The first impression of the result does not look promising. One EURO shifted from manufacturing industries to the AI provides a marginal product of 0.83 EUR only. However, a comparison with the US discloses that this relationship is not bad at all. The marginal product of the same decision in the US only provides a marginal product of 0.72 EUR. As a result we can conclude that the European AI has a comparative advantage against the most important competing nation the US. (Table 6.2) This is a convincing result if one takes into account the initial statement on the current economic problems with the new projects.

This quantitative analysis needs some explanation. Firstly the US AI is more productive as measured by the value-added per employee. This result is typical and can be found in most other US industries too and need not be a general disadvantage because labour costs must be taken into account to. But even this result discloses that the EU27 is behind its US competitor. This difference is high and indicates that for 1 EUR labour costs the US AI generates a value added of EUR 2.18 whereas for the European AI it is only EUR 1.32. But if one compares all of the manufacturing the same indicator discloses the disadvantage of Europe is even higher.[285]

[285] The theory suggests as an explanation for this result differences in the scarcity and quality of input factors capital and labour that affect relative prices. In praxis additional problems add to such discrepancies, such as the functioning of markets. Moreover there is not a satisfying harmonisation of statistics on the international level that can contribute to these differences. The exchange rate must also be taken into account.

The point highlighted by the concept of the comparative advantage is the performance of the European AI relative to the European manufacturing industries as compared with the US counterparts. This indicates that the US can trust on a better price efficiency ratio than the European manufacturing industries on average. There exists a comparative advantage for the EU and it must be taken in mind that its economic performance is currently distorted by the one-time effects mentioned above.

Table 6.2 The Comparative Advantage of the European Aerospace Industry 2006

Indicator	Unit	EU27 1)	USA 2)
	Aerospace industry		
Value-added per employee	1000 EUR	78.0	153.2
Labour costs per employee	1000 EUR	59.4	70.39
Value-added per 1 EUR labour costs	EUR	1.32	2.18
	Total manufacturing industries		
Value-added per employee	1000 EUR	53.0	135.2
Labour costs per employee	1000 EUR	33.28	44.86
Value-added per 1 EUR labour costs	EUR	1.59	3.02
	Comparative performance of the aerospace industry		
Marginal value-added per employee in the aerospace industry by shifting 1 EU labour costs from manufacturing	EUR	0.83	0.72
1) In nominal prices; 2) in nominal prices and exchange 1.3 EUR = 1 USD			

Source: Eurostat (NACE (Rev. 1.1) D, 35.3), US Census Bureau (NAICS 31–33, 3364), own calculations.

6.2 The Impact of Companies' Strategies on the Performance of the European Aerospace Industry

6.2.1 Industrial Organization

Corporate governance

Formally the industrial shareholders of EADS/Airbus, Daimler and Lagadère, have the right to appoint the members of the board. But in practice key-positions are allocated in accordance with the objective to balance national interests. There is no direct national influence of politics in strategic decisions. However, national networks and informal relationships communicate between industrial groups and political decision makers. Beyond this more or less strategic adjustment governments indirectly influence via the funding of projects EADS/ Airbus' decision making processes. The apportionment of the workload follows the funding by the countries and secures the backflow. Economic decision making is diluted and incorporates the risk of suboptimal decisions in the supply chain. This must be understood as a disadvantage in an environment of growing competitive pressure for the biggest European OEM.

Supply chain

In recent years structural changes in the AI have been driven above all by actions initiated by the OEMs. The competitive pressure in sales markets and the ever bigger projects for the development of advanced aircraft needed new forms of cooperations. OEMs search for risk sharing partners that have the capability to allocate sufficient resources. Boeing has been in the lead with integrating major Tier-1 and suppliers on lower levels in its supply chain characterized by pooling risks and focusing own manufacturing activities on system integration. However, Boeing had to back down.

European representatives assess this failure not as a principle problem of this kind of organization but as a problem of the specific setup in combination with the introduction of advanced technologies.

The EADS/Airbus sourcing strategy follows this trend. Four major goals have been made explicit:

- improve market access (meet offset obligations),
- value to cost (low cost production),
- access to resources (raw materials and human capital) and
- risk management (e.g. currency volatility).

In consequence the share of non-EU procurement has to rise and risk sharing partners have to assume the responsibility for larger subsystems and equipment work packages. The dollarization of the procurement requires suppliers on higher levels to take the exchange rate risk. The US has become an attractive country for “natural hedging”.

However, in many Member States the structure of the AI is not well-suited to meet the related challenges. Smaller companies are urged to cooperate and form larger entities in order to remain preferred partners in the value chain. The current structure is as well a detriment for the OEMs and their European suppliers. Compared with the US there are fewer companies in the European AI that are able by their size, strategic orientation and their capability to allocate enough resources in order to become strong risk sharing partners and system suppliers. Caused by consolidation of the US AI high-potential Tier-1 players, such as Spirit emerged. The European AI faces a structural deficit in this respect that cannot easily be overcome. This is one reason why more big US manufacturers have been selected as suppliers for the more recent projects than before.

Currently about three quarter of all EADS suppliers are smaller enterprises, but they provide only one fifth of the total purchasing volume. Many of these companies are not prepared for the envisaged changes in the value chain. Cooperations have been recommended, but they are not always a practicable solution. In many cases an adequate management to handle big projects and risks taking capabilities are not with potential partners. Moreover OEMs prefer to have a central contact point (one-stop-shop) that takes all of the risk for all of the partners.

Industrial policy should therefore support activities to ease the access to financial resources and to strengthen management knowledge. The objective must be to create framework conditions for companies that can evolve towards subsystem integrators who have a certain kind of potential to take risks. These could serve as a crystal nucleus on the one hand to integrate smaller, technological driven firms and on the other hand to become preferred partners for OEMs and Tier-1 companies.

Structural changes in the aerospace industry

Airbus has spun-off Aérolia (F), Premium Aerotech (D) and sold the German Laupheim plant and the British Filton plant as part of its strategic objectives. Heavy investment has been carried out to strengthen the viability of these facilities. However, it has turned out to be difficult to trade sale the facilities. If this transformation will be successful in the future it will contribute to the strength of the European AI. Tier-1 supplier can emerge and serve as integrators for smaller companies.

As compared to the US it must be stated that - up to now - within the value chain there are not that many high-potentials with risk sharing abilities. This has enabled US companies to successfully acquire higher shares in the most recent Airbus project than in preceding ones.

Moreover, there is some interest in non-European companies to acquire European enterprises. As long as M&A are directed to get a foothold in the European market and value chains this is not assessed as a threat, but part of the ongoing globalization. But in particular smaller, technological driven firms that currently contribute to the European excellence in the market can come in the focus of potential competitors, above all from emerging countries. The risk of a knowledge drain or even loss of technology can be the result, e.g. takeover of the Austrian FACC by a Chinese firm.

6.2.2 Regional Development

Presumably the European AI is more integrated than any other European industry by cross-border ownerships and manufacturing networks. However there, have been identified noteworthy differences between Member States. They can turn out to be positive for international competition if the Member States succeed in focusing on their respective comparative advantages. However, there is the risk that decisions on production locations do not follow the economic ultima ratio (see above: Corporate governance).

The French, German and Spanish AIs are shareholders of Airbus. The British AI is an important stakeholder and strongly involved in the Airbus business, above all with the production of wings. Major projects, such as A380 and A400M have provided technical problems and delays. Moreover France and Germany have started to allocating resources to the new A350 project. The stresses and strains as well design activities which will result in revenues only in the future have strongly knocked on the economic performance and induced a reduction of the calculated productivity in France and Germany. Spain has much less affected by these burdensome factors. Additionally Spain has compared to for example Italy – enjoyed a very strong development and integration into major European AI activities. Within these Member States there exist a certain specialization in the manufacture of parts and components. (Table 6.3)

Table 6.3 Strengths of the Bigger Member States in the Aerospace Inudustry

	France	United Kingdom	Germany	Italy	Spain
Major Competencies	Cockpit technologies and manufacture, engine manufacturing, broadest range, e.g final assembly of wide-body aircraft, helicopter, aircraft funding	Manufacturing of wings, strong in related composite applications, engine manufacturing, military products, MRO	Avionics, fuselages, complex cabin equipment, high-lift-systems, vertical tails, manufacture of and technologies for engines, final assembly of large civil aircraft, helicopter	Electronics, military aircraft, helicopter manufacturing, strong integrated in non-EU value chains	Tail, fin and pitch elevator, growing strength in composites, assemblage of military transport aircraft and helicopters

Source: BHL, Ifo.

Italy has become a stronghold in electronics for the aerospace industry and strengthened its integration in international projects. Italy has primarily fostered relationships with non-European AI partners (as Boeing in the USA and Sukhoi in Russia) and has therefore a relatively weak integration into major European civil AI programmes. Major competences are in military aircraft and helicopter manufacturing. The Sukhoi project is envisaged to contribute to a strengthening the Italian position in civil aircraft. Italian smaller enterprises perceive competition above all from North Africa. The Italian government has incited companies to give these companies a hand to keep them in the value chain.

BAE has sold its stake in Airbus and the United Kingdom's linkage to the European civil aircraft activities has been loosened. The British AI perceives its distance to Airbus as a detriment and fears to lose some of its competencies. In particular its leading position in composite wings is perceived as endangered. In particular British smaller enterprises reported a growing competition from the new Member States and see only few opportunities to respond adequately. Niche strategies are preferred, such as quick response deliveries, manufacture of prototypes and challenging machining operations. Major competencies of the British AI are in wing and engine manufacturing and the military business.

The integration of the accession states (2004 and later) has made noteworthy progress. The pattern of the intra-European trade indicates that the division of labour has increased. Cost advantages and well educated technicians on all levels of education are driving factors. Changes in the structure of imports and exports provide a clear indication for such a tendency.

The integration of the new Member States in the OEMs' value chains improves the overall price competitiveness of the European AI. However this positive development is accompanied by wage increases that have not been outbalanced by productivity gains. Experts reported that Polish and Czech companies are relocating some of their work to neighbouring eastern countries. This concerns manufacturing as well as engineering services. Although current wage levels are far below the other Member States the increase of labour costs will weaken price competitiveness in the long-run as compared to non-EU eastern countries and can turn out as a detriment in the future and result in a loss of workplaces. Similar developments have been taken place in other industries in the new Member States too and led to losses of workplaces.

The AI in the new Member States is upgrading manufacturing processes and expanding research activities to catching up to international standards. This will give some leeway for higher wages but simultaneously it increases intra-European competition.[286]

6.3 The Impact of Regulatory Framework Conditions on the Performance of the Aerospace Industry

6.3.1 Public Initiatives directed towards the Aerospace Industry

In all of the Member States with a noteworthy stake in the AI the sector is perceived as of major importance for the country's international competitiveness. Measures are taken to support its development. In most of the countries clusters have been defined that are envisaged to strengthen comparative advantages in manufacturing and exploit synergies in R&D. In most cases these clusters have emerged in parallel and not in a coordinated approach.

Assessment of national policies
France has been the only identified country that pursues with noteworthy success a co-ordinated strategy in a division of labour between different clusters. Specific R&D initiatives are funded and resources are allocated for these purposes. The financial market has turned out to be supportive for the AI too. There is a joint initiative of Airbus and Safran with a French bank to strengthen the equity capital of smaller enterprises and in particular to support companies in the value chain which own the potential to take key positions in the value chain. With CALYON France is home of the globally leading bank in aircraft funding. Further on it was reported that the overall good infrastructure for childcare provides one explanation for the higher share of female engineers in the French AI.

The British government has changed its R&D approach. In former times a vertical stance was taken to support the AI. In the recent past it was given up and a horizontal approach to support high-tech developments has been introduced. This is perceived as a detriment by AI companies in particular in an environment where other nations pursue vertical approaches for the sector. Moreover, the publicly available infrastructure for R&D is evaluated as insufficient, in particular as compared to Germany and France. However, the regional development agencies (RDAs) in the United Kingdom may play a role model for other countries to help smaller enterprises with current challenges by growing international competition. But the lacking coordination of initiatives in the United Kingdom and the independence of the RDAs has resulted in a loss of efficiency. The UK has achieved the largest productivity gains in the restructuring/consolidation process. Other countries should learn from the related success factors.

In Germany the coordination of clusters is carried out by the association of the industry, BDLI). This is a challenging task. Due to the federal constitution the German States are funding the clusters in their Länder by own means. The leading role of the industry association (BDLI) to coordinate cluster initiatives could complement the French example of coordination. The well inter-

[286] In particular small British companies complained about rising competition from the new Member States.

linked German R&D environment (good cooperation of universities, research institutions and industry) may serve as an example for other countries.

Table 6.4 Strength of the Bigger Member States in the Aerospace Industry

	France	United Kingdom	Germany	Italy	Spain
Possible role model for	Cluster initiatives: distribute R&D tasks coordinated approach by region (avoid double funding of similar activities)	Support for SMEs: Regional Development Agencies Productivity gains through restructuring/ consolidation	R&D environment well interlinked (cooperation of universities, research institutions and industry)	Decreasing dependency from defence sector (non-EU value chains) Strengthening of subsystem integrators	Clear industrial policies toward aerospace investment and R&D conditions

Source: BHL, Ifo.

In Italy public initiatives for the AI are based on close ties to the industry and the financial markets. Currently an adjustment to the challenges in the global market is taking place. There is a dedicated interest to maintain its strengths in electronics, but to improve the access to the civil market, e.g. by the joint venture with Sukhoi. A second area of activity is to better integrate the numerous small companies in the value chain by supporting subsystem integrators who have the necessary financial and management resources. A third area of activity is the set-up of production sites in North Africa and global sourcing.

The Spanish AI was most dynamic among the bigger States. The government pursues a clear-cut strategy for Spain to become stronghold for this industry. This development is part of an industrial upgrading as other industries, such as the automotive sector, lose some of their former growth momentum.

European level

The interviews with stakeholders of the industry disclosed that there are some weaknesses in the European R&D landscape. Criticism was highlighted that European schemes are too bureaucratic. Furthermore, the access of potential competitors to key know-how is a bigger risk than in national projects. This is why for certain projects national schemes are preferred.

European aerospace initiatives are confronted with the difficulty that national governments watch over their autonomy in R&D in the relevant areas for this industry. As a result there are some high-tech areas, for instance composites that are funded by public schemes in several Member States. There is some likelihood for duplication of research activities. The multitude of national and even regional, non-mutually adjusted programmes have been perceived as extremely inefficient. Often even within Member States the coordination is not well established.[287]

[287] It has been reported that the US R&D landscape is confronted with a similar problem. A project has been carried out how to solve the problem, but so far no initiatives have been taken.

The EU has created platforms for the coordination of initiatives. The EACP has turned out as a successful tool for common European cluster initiatives of the aerospace industry, in particular in the area of labour related activities. Another, horizontal platform ERA-NET is available that could also be used but has not been exploited much by the industry. It offers the creation of platforms to communicate on the European level. It is not restricted to official representatives of the Member States and research bodies but also researchers are invited to exploit the opportunites offered by ERA-NET.[288]

The AI has criticised the organization of far-reaching and extremely important JU, as the most prominent example the CleanSky Initiative was mentioned. The creation of PPPs is not adequate with regard to the size of these projects. The European Commission has been bound by inadequate rules and the necessary authority for decision making has not been delegated. Moreover the industry is not sufficiently integrated in governing these projects.

The European space industry is well coordinated within the Community. There are national programmes too, but transparency is warranted. It has been suggested to use this as a benchmark for the aerospace industry, but simultaneously it has been assumed that it will be much more difficult to find a suitable solution for the civil aircraft industry with companies driven more by their business interests.

It is suggested that the European Commission invites the Member States to join an initiative that is dedicated to bundle the European efforts for the strengthening of the competitiveness of the aerospace industry. The initial objective is to create a comprehensive basis on available public schemes, national and European initiatives, dedicated for the industry. This could give national authorities the opportunity to take into account the activities of other countries' initiatives when they are about to design own schemes It will be a more challenging task to incite the Member States to design schemes that are well adjusted to each other and lead to a more coordinated and efficient framework for the improvement of the competitiveness of the European aerospace industry.

6.3.2 Labour Market

The aerospace industry is a high-tech industry and dependent on an adequate supply of a skilled workforce. Generally the quality of education and training in Europe shows a high standard, in particular when compared with the US. Mechanical and electronic engineering, metalworking and aerospace engineering have a longstanding tradition in European countries. But there is no guarantee that Europe can keep pace with the changing world and will be able to maintain or enhance its technological position by available human resources. Although short- to medium-term demand for labour is affected by the recession, in the long-term demand for engineers and technicians will increase on all levels of the value chain. This is implied by a trend growth at around 5% expected for the AI. The recruitment of qualified personnel could turn out to be even more difficult than experienced in the latest boom period.

Worries about skill shortages are widespread in aerospace industries. Experts assume that Europe faces a shortage of perhaps 25,000 engineers per year.[289] Exact numbers are not available and for

[288] European Commission DG Research, The European Research Area: New Perspectives (Green Paper, 4 April 2007), http://ec.europa.eu/research/era/pdf/era-greenpaper_en.pdf

[289] Wall, Robert, 2009.

the most part such figures are based on industry assessments, but it should not be concealed that the view on this subject differs. Some major companies like Finmeccanica and Dassault do not expect a noteworthy skills shortage. Primarily in Great Britain and Germany skill shortage in engineering causes concern. However, information about skill shortage and excess demand in certain qualifications are very selective and piecemeal. Therefore a better and consistent monitoring of the skill base and the skill demand in European AI could clarify this important value chain issue.

The predominant demographic development in Europe and elsewhere in mature industrialized countries aggravates the shortcomings in the supply of skilled labour and can turn out to become a detriment in competition with emerging countries. Skill shortages are also a concern for non-European industrialised countries. In Japan the demographic situation – a generation of engineers is retiring – and dwindling numbers of math and science graduates coincide. The US industry is also concerned about future provisions of skills. Top US companies like Boeing are looking how they can address a potential shortage of aerospace engineering graduates. The science community in the US relies on greater inputs from other countries. It would barely function without foreign born members.

The aging of the baby boomer generation means that a growing percentage of the workforce will be eligible to retire in coming years whereas younger age cohorts become smaller. The development is aggravated by a decreasing interest in mathematics, information technology, natural sciences and technology (MINT) disciplines. Replacement rates for engineers will rise and aerospace companies compete for a shrinking pool of technical talent not only within the industry but also with other engineering industries.

In emerging countries the long-term perspectives of the AI to satisfy its skilled labour demand improves. A declining labour supply induced by demography will not take place. In these countries the AI is nurtured by public policies and employment policies are less dependent on cycles in the aerospace market. This is an asset that will contribute to their efforts to strengthening competitiveness of the AI.

Mature industrialized countries try to overcome the detriment by public initiatives to attract young people for MINT disciplines. In particular women are by far underrepresented and they are addressed to apply for a career in the AI. Female students and trainees could contribute to reduce the shortage of qualified staff in the future. But it has turned out to be a tough task to attract women.

Traditionally the US labour market is attractive for high skilled scientists, engineers and technicians from all over the world is a competitive advantage for the US aerospace industry that to a certain extent outbalances the detriment of domestic supply.[290] Canada has reported a brain drain to the US that cannot be balanced out by the influx European engineers to the Canadian AI.

European economies are less attractive for high-skilled applicants from all over the world. They have to rely more on their indigenous supply. If this will not be satisfying the aerospace industry's companies have to address foreign human resources and set up research centres abroad. This

[290] In recent years repatriation has become a phenomenon for the US economy, but no information if it has gained a relevant magnitude.

can contribute to tendencies that are already observed. In the long-term an erosion of the skill basis can become a threat for the European AI.

The long-term labour quantity and quality is influenced by business strategies and structural changes. Prevailing business strategy shifts production and risks down the supply chain and puts growing economic pressure on contractors. Among the measures to meet the challenge employment strategies have changed. This has led to a reduction of the traditional employment relationships. Labour leasing and temporary employment contracts have become more common in the AI to more flexible adjust the staff to cycles of the AI. The situation is more pronounced in the US than in Europe.

Staffing policies and cost saving business programmes are directed to keep capacities lean. As a consequence additional demand for high-skilled and experienced staff can hardly be met in upswing phases. Massive lay offs in downswing phases have reduced the attractiveness of the US AI and aggravated recruitment. Large scale lay offs in downturns turn out as disadvantages in the long run. The way the industry treats employees and especially young people in downturns affects the ability to retain and attract qualified work force in the future. Long-term reliable employment policy has to be supported by flexibility tools as a precondition for the protection of staff over an economic downturn. The instruments to avoid job losses are well known: reduced working-hours, short-time work, furloughs, work-time accounts or temporary shut-downs. It should be discussed if they are well adapted to the needs of the AI's cycles. Salary policies that combine base pay with flexible wage fractions are another tool.

European workforce mobility is lower than in the US. Cultural, linguistic and legal differences among European nations are barriers. This is a challenge for companies who want to assign employees cross-border. Europeanization and internationalisation of production requires transparent and recognised training courses and graduations. It increases the demand for an internationally focused workforce and for language and cultural competencies. National cluster initiatives and the new European Aerospace Cluster Partnership (EACP) constitute opportunities to develop and expand transnational education and training programmes. It was reported by interviewees that sufficient flexibility for cross-border activities for a limited period is available. However a permanent occupation abroad is often hampered by families' willingness to move.

6.3.3 The Openness of Third Markets

The strengthening of transnational institutions in the field of standards, technical requirements, certification and mutual acknowledgement is cost-saving as it reduces bureaucratic burdens and encourages competition. The establishment of EASA was an essential move and has improved Europe's strategic position. It has increased the European weight in international organizations and enabled Europe to become a counterbalance to the FAA. A strengthening of EASA competences and the transfer of more national responsibilities will increase the international bargaining power further.

For a couple of years the EU-US LCA agreement regulated the tension filled relationship of LCA manufacturers successfully. The latent discontent with the praxis how new aircraft projects were launched and the success of Airbus in international markets actuated the US' withdrawal from the agreement. But the framework conditions have changed since then. In the aftermath of the financial crisis a trade conflict which could be carried to the extremes can turn out as a threat for the recovery of the industry and lead to incertitude on the admissibility and compatibility of public schemes with WTO rules. Another aspect is the emergence of new competitors that could alter the US-EU relationship. China and Russia launched ambitious commercial aircraft programmes and within the next decade new competitors will tap into the market for regional aircraft. The emerging competitors' programmes are supported by massive state aid. An unresolved Boeing Airbus trade dispute increases incertitude on the admissibility and compatibility of public measures with fair international trade and offers a bad example to newcomers. Alone for this reason US and EU should reconcile before the WTO final judgement. The "cost" of the dispute might turn out to be higher as any possible gentlemen's agreement for both sides.

6.3.4 Access to Finance

The global economic crisis has imposed financial pressure on the air transport sector and forced the majors to dump capacities and consolidate route networks. The decline in demand has devastated airlines' profits and prospects are troubled. IATA's financial estimations foresee losses from commercial airline operations worldwide to reach USD 11 billion in 2009.[291] For the next few years it will be difficult for airlines to grow revenue. Low profitability of the airlines and lacking liquidity of the financial sector is a risk to new order intakes of the AI.

Already in 2009 customer financing has become more difficult and emerged as a challenge for aircraft manufacturers. The financial situation will remain strained 2010 and perhaps beyond. Leasing companies are part of the financial sectors which run into serious trouble and holdings want to get rid of their subsidiaries. The financial crisis has deeply shaken the leasing sector. For lessors the access to investors and the cost of funding have become a serious problem. Their business model is based on long-term leasing contracts that are financed by a permanent roll over their shorter-term debts. The growing uncertainty of the leasing sector and the lack of bank financing will fully weight on lessors only in 2010 and later.

These general tendencies in the financial market are independent from an individual country and do not distort competition. However, the liquidity status of the European AI indicates that it is more under stress and strain than the US.

The absence of affordable credit has been softened by a sustained and increased government support. Export credits guarantees have been increased by public schemes. As liquidity and financing are at risk industry is asking European governments to increase export credits and default guarantees in 2009 and beyond to support airline orders. In 2009 France pledged to guarantee EUR 5 billion of loans to airlines to buy aircraft and the German government announced to increase HERMES guarantees. Government backed export credit agencies (ECA), such as the French COFACE[292] have significantly added on their aircraft financing activities. The US backs the exports of its AI massively by the Ex-Im Bank. In 2008 loan guarantees for Boeing reached a value of USD 10 billion that was around 65% of total guarantees.

The impact of the financial crisis coincides with structural effects of growing risk sharing in the value chain and aggravates not only the situation for OEMs. Financial resources for acquisitions and investment are not provided on the necessary magnitude which threatens the consolidation of the sector. As banks reduced credit lines suppliers are having harder times. Additionally parts of the aerospace sector are suffering from technically caused delays of aircraft deliveries. The pre-

291 IATA Economics: http://www.iata.org/economic
292 COFACE is a financial institution with a horizontal mandate.

funding of programme parts in the value chain is not counterbalanced by anticipated cash-flows. In combination with the recession and the credit squeeze the homemade difficulties complicate the economic situation mainly of smaller enterprises. If suppliers of strategic importance - due to unique technological competences - are endangered, subcontracting companies consider direct financial support or direct shareholding.

Smaller enterprises are in particular affected by the financial crisis. This has been acknowledged by Airbus and set up funds to strengthen the financial viability of these companies in the value chain.

The US banking system suffers more from the crisis in the financial market than the European and public debts have reached non-sustainable heights. One of the measures of the Obama government was to trench the defence budget. The financial environment is worse then in Europe. European companies have been above all affected by the delays in the big projects. In combination with higher strain on liquidity internal factors aggravate the financial situation.

6.4 Positioning of Competing Nations in the Global Aerospace Market

This section provides an overview on the global AI's supply side. The state of the industry and its more recent projects are evaluated. Special attention is paid to public policies and international cooperations that in particular affect the competitive position of the European AI.

The analysis discloses that with the exception of Japan emerging competitors from industrializing countries are not on the leading edge in aircraft technologies and remain dependent on foreign deliveries. The upgrading of next generation regional aircraft by Bombardier and Embraer increases competitive pressure on the lower end of Boeing's and Airbus' product programs.

The strong position of the US in global markets is underscored by its high shares in other competing countries' imports of aerospace parts and not only the delivery of final products. This provides scale effects to manufacturers in the value chain who not only benefit from the big domestic US market but by the demand of foreign OEMs.

United States
The US AI is a direct competitor in the area in the OEM markets for large civil aircraft (LCA) and helicopters to Europe. On average over the period the European output grew at a somewhat higher pace with final products and in 2008 it surpassed the US output. By and large both industries are of similar size in the civil sector. However the US aerospace industry is still perceived as the world's leading player and in terms of globalization and access to foreign growth markets this remains true.

Traditionally the US AI has been closely linked to Canada. Wage differentials were a driving factor but in the area of globalization engineering and key-components have become of importance in the North American cluster.

The restructuring of the US AI has led to the creation of big manufacturers, not only Tier-1, but also Tier-2 and Tier-3. This is an asset and contributes to the strength of the US. Such companies, as Spirit, own the potential to allocate financial and human resources necessary to meet better the more recent requirements of OEMs on their suppliers, to take over the role as system integrators and to become risk sharing partner.[293] This view is supported by the argument that US firms have proven to be successful in light weight construction and this has eased their access to the more recent Airbus projects.

To a large extent the leading position of US firms is based on their longstanding experience to cope with complex tasks. For instance experts of the industry argued that the advantage of the US firm Hexcel in the area of composite as compared to competitors lies in its size and its track record, but not in its technological lead. Since long Airbus is leading in the share of CFK applied in new aircraft launched in the market. Only the Dreamliner has reached the leading edge in the dissemination of CFK.

To a large extent the strong technological position of the US originates from the defence industry and R&D in areas with dual use potential. The interviews disclosed that there are spill over effects and economic advantages by the exploitation of available know how. However, with regard to technologies applied in the area of civil aeronautics there may not be a US lead and a noteworthy dependency from US know-how. But simultaneously it was reported that there are above some electronics components that usually are imported by the European AI. There is no European supply and it was reported that US manufacturers try to bar potential European competitors from market access by pricing strategies. This threat holds off potential European competitors.[294]

The US has always given strong support to the AI. There are numerous programs to foster R&D. The coordination of these initiatives has been evaluated as insufficient. US States have launched own schemes for the AI side by side, but reconciliation of measures and not even an exchange of information take place. There was an initiative to overcome this detriment, but satisfying actions have not yet been taken. The Obama government envisages to reducing defence projects of importance for the AI.[295] This will induce additional financial stress on companies that are suffering from a slowdown in demand and face stricter funding conditions in the civil market. This could affect aversely the US AI in the coming years in a growing difficult market environment.

The analysis of international trade disclosed that the US has a strong focus on the AI. As compared with other US industries the aerospace companies have been more successful in global markets and the performance has even improved in course of the past decade. This result is based on a specialization in aircraft exports that has been more pronounced in US trade than in global trade. Not only in exports, but also the trade balance of the US AI has improved during the period under consideration between 2001 and 2008. In contrast to many other manufacturing industries the US has always enjoyed a trade surplus in aerospace products.

For the US the AI is an industry of outstanding importance not only because of its close relations to the defence industry, but it is one of the very few industries left where the US is globally in the lead. This is reflected in US support to exporting companies. Boeing is the one company that gets much more aid than any other US firm for export sales (loan guarantees etc.). Moreover the US administration uses the strength in the global defence market to incite client countries to also purchase civil aircraft.

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293 Apart from the current problems (e.g. necessary bail out of Vought Industries) in the Boeing value chain - induced by its high-risk value chain strategy – this evaluation is retained.

294 However, the Dassault fighter Rafale was mentioned as an example that Europe has the capabilities to manufacture high performance aircraft without the use of US supplies. However it has not succeeded in the market.

295 Aviation Week, budget constraints.

Close transatlantic trade relations link Europe and the US. The European imports from the US have a share of more than 70% of all aerospace imports, whereas the European share of US imports also reaches more than 40%.

Russia
The transition of the Russian aerospace industry from the socialistic area to a more economically driven sector has not yet come to an end. Public measures were taken to create a group that has the potential to become a competitive supplier in the civil aircraft market. With UAC the government has created such a company and politicians' benevolence secures good access to public schemes. However, the Russian aerospace value chain has not yet reached international standards by technology and manufacturing processes. As a consequence the Superjet 100 project of UAC was set up as a joint effort with numerous well-known manufacturers in particular from Europe.

Capabilities and state-of-the-art production capacities of the Russian civil aerospace industry are limited. The structural change has not yet made sufficient process. This has turned out to the detriment of the Russian airlines that urgently need to replace outdated planes and procure more efficient advanced equipment. As a consequence the government has abolished tax barriers on imports of aircraft with the exception direct competitors for the Superjet 100.

The integration of the Russian AI in international value chains has progressed. There is a growing exchange in intermediary products. In particular the US AI has been busy to exploit the advantages of Russia as a location for engineering and production. It was reported that Russian deliveries do not contain key-technologies. Western manufacturers have invested in engineering services in Russia but the acquired capacities are occupied in most cases with standard development and design activities, not with key know-how elements. The evaluation of production quality, reliability and the ability to manufacture light weight parts and components among European experts differs between "western standard" and "product characteristics and reliability are not adequate". Considering the missing experience in the manufacturing of advanced aircraft it will not be easy to get quality required by western OEMs in any case.

Canada
The Canadian AI is part of a wider aerospace cluster. The cross-border linkages between the US and Canada are implemented primarily by US investments. Canada has always been a location for production. Although labour costs are lower than in the US Canada is not a low-wage country, but provides comparative advantages by a supply of qualified labour and engineering know-how. The strong linkages with the US are reflected by a share of more than 60% of total exports.

Bombardier is the most prominent Canadian AI company. With its regional aircraft it is head-to-head with the other big player in the market, the Brazilian Embraer. Other final products are business aircraft and helicopters. Moreover Canada has specialized in some market segments, such as flight simulators, and became a global leader.

Since 2000 the R&D efforts of the Canadian AI are on a level much lower than for most other AIs. To a certain extent this might be caused by public R&D schemes that are criticised by the industry. The financial means are small as compared with other nations and the focus is on basic and applied research.

The Canadian AI experienced only a moderate growth over the past ten years. In particular it did not benefit much from the global upsurge in recent years. As compared with the Canadian manufacturing industries the performance of the AI in international trade has even worsened. As a result it is concluded that Canada is challenged in international markets. The picture of some problems in international competitiveness is confirmed by the fact that recent applications of Canadian companies in big aerospace projects were not very successful. Canada's future performance will be strongly dependent on the success of its new products to be launched in the market in coming years. The Bombardier CSeries Regional Jet trusts in widespread application of components and the use of the Geared Turbofan propulsion concept is envisaged.

Brazil

Brazil is understood as the first emerging country that entered the manufacture of aircraft. The development of the AI took place in a region far away from highly industrialized areas. In contrast to Canada Brazil could not trust in a supplier base close-by. This is a challenge for an industrial policy dedicated to the creation of an industry that is fully dependent on a broad suppliers' base. Much of the Brazilian AI is clustered around Embraer, the backbone of the industry.

The Brazilian AI is much smaller than the AIs of the US, Canada and the bigger EU Member States with around 25,000 employees and a turnover of EUR 5 billion in 2007. Its activities are focused on few market segments and trade analysis has disclosed that strengths are in regional and smaller aircraft. The Brazilian AI has not been strongly integrated in international value chains as a supplier, due to its remote location from major industrialized regions. As compared to Canada FDI of foreign companies plays a minor role only.

The competitiveness of the AI has improved as compared to the development in the global AI market. But also as compared to other Brazilian manufacturing industries the AI has performed better during this decade.

A coordinated industrial policy has contributed much to the development of the AI in Brazil. The Ministry of Defence and the Ministry of Science and Technology are responsible for the AI and provide the infrastructure via affiliated bodies, such as the CTA. It has been reported that public funding for R&D is scarce and many resources originate from private investors and the financial market.

In recent years Brazil faced a WTO suit in connection with export credits. Bombardier had raised the issue of unfair trade support. But also Bombardier was found guilty on unfair practices. Both competitors were forced to negotiate and to find a solution.

The Brazilian AI's exports are OEM driven. Other product groups only play a minor role. In contrast the imports of parts and components play an important role. This pattern underscores the specific structure of the Brazilian AI.

Japan

The Japanese AI is one of the smaller suppliers in the global market. By employment it is of similar size as the Brazilian. However, the structure is quite different. Military production for the indigenous defence sector is of noteworthy importance. Civil OEM does not play a role, only small aircraft are manufactured. The Japanese strength is in the aircraft value chain.

Public policy has pursued a strategy to integrate the Japanese AI in the global value chain. Participation in big US projects has been purchased by public funds dedicated to US R&D. Japan has managed to focus on promising technologies and became an important high-tech supplier in aircraft related parts and components. In exchange the US OEMs have become the dominant players in the Japanese market for commercial aircraft.

Mitsubishi has decided to enter the regional aircraft market and make use of the latest technology available such as the Geared Turbofan propulsion concept. The major problem for entering the global market will be the set up of a distribution and service network. Japan had failed during the 1960s with a civil aircraft project for this reason. Mitsubishi has arranged an agreement with Boeing to overcome this detriment. It can be assumed that there is mutual interest in this cooperation and Boeing gets the opportunity to indirectly control a market segment it has no stake in, but this segment is close to the lower end of Boeing's product programme. Potential new competitors are on the fringe and could access the LCA market by upgrading their regional aircraft and increase pressure in the market.

As measured by the Japanese imports the US is by far in the lead with around 80% of imports whereas the EU27 only comes up to around 10%.

China

The opening up of the Chinese economy started during the early 1980s. It has been a cautious development, and the government has always pursued a clear industrial policy directed to guiding strategic sectors and maintaining. The AI is one of those industries in the focus of public authorities. It is a key industry as for all other nations with a stake in the AI. But industrial policies are carried out more strictly in China. This can turn out to be a detriment for competitors if China decides on own production and supporting own companies.

Development of aircraft based on Chinese design was not successful in the past. Most of the production was under licenses agreements. China claims that the most recently developed aircraft is fully based on Chinese intellectual property rights. But there has been made much use of former licence production of McDonnell Douglas aircraft and many key-components are supplied by foreign industrial groups, well-known in the global AI market. Generally speaking, there is much know-how in the value chain necessary that cannot be transferred or acquired easily within a short time by China. The manufacture of aircraft needs an industrial infrastructure and the generation of independent know-how takes time.

In the long run China will manufacture own civil aircraft, state of the art. China will not only benefit from the big and strongly growing Chinese market but aircraft will globally be marketed. However, the competitiveness of these aircraft will remain dependent on the ability to exploit the specialized knowledge in the global AI and integrate subsystems of foreign manufacturers who are leading technological progress. As a consequence international companies are about to get part of the Chinese AI's value chain and to benefit from the long-term perspectives. Likewise all major OEMs for the production of LCAs and regional aircraft are eager to strengthen their linkages with Chinese companies to participate in the market perspectives that as a prerequisite needs the ability to fulfil offset obligations.

As measured by the Chinese imports the EU27 and the US are on eye level with similar shares. Other countries of origin play only a minor role.

India

For decades the Indian economy has been separated from foreign competition. Only since the beginning of this century markets have been opened up and foreign companies are allowed to sell products and to invest in India. For the Indian economy the AI has not yet been of noteworthy importance. The government's interest in this sector was above all the manufacture of military aircraft based on licences. In some areas a cooperation with Russia is carried out. With strongly growing air traffic the economic importance of the AI has been recognized and the government stimulates a sustainable economic development of the sector. Heavy support for the creation of an efficient infrastructure with future oriented capacities has been launched and inducate bright perspectives for the aerospace industry.

Currently the Indian AI is yet dominated by a big state-held group and structural changes are difficult. The government tries to push forward this evolution by offset obligations. Foreign companies are pressed to find indigenous partners if they want to get access to the market. This has been recognized by Indian companies. In particular big groups such as Tata are eager to get a foothold in the aerospace industry and are poised to participate in international cooperations.

The Indian air traffic market is among the most promising in the world. The opening up has incited the big players to strengthen linkages to indigenous companies. Boeing as well as Airbus has invested to get a foothold. The integration of India in the global AI does not only follow a simple strategy on the relocation of production, but the exploitation of comparative advantages. Engineering and software development are high on the agenda. All in all the pattern of the growing integration of the Indian AI in a global network is understood as a typical for emerging markets that provide promising perspectives for the big manufacturers of aircraft.

As measured by the Indian imports the US is by far in the lead with around a share of 70%. The EU27 only commands around one fifth.

6.5 The Performance of the European Aerospace Industry in International Competition

6.5.1 The Performance of the EU27 in International Trade

The success of an industry in global competition is reflected in its performance in international trade. Such an analysis does provide information on the result of the sectors competitiveness that is driven by numerous factors, such as prices, costs, technology, product policy and so on. The trade analysis for the European AI disclosed a good position, second in the ranking by trade shares behind the US, third in the ranking by the RCA indicator behind the US and Brazil.

The best performing economies are the leading manufacturers of aircraft, the US, EU27, Brazil and Canada. All other countries do not possess comparative advantages in international trade. The leading position of the US is not only confirmed by its strength in OEM, but by its competitive supply of aircraft parts. This is reflected in its high share in international trade and – among others - its importance as a supplier to the European AI. In total more than 70% of aircraft related imports of the EU27 originate from the US. 30% of these imports are parts and components. This means that the US AI enjoys a noteworthy benefit even from the success of European OEMs.

A more detailed analysis by subsectors of the AI provides a clear picture of the European competitiveness. It has gained market shares in LCAs.[296] Europe commands an extremely strong position in large civil aircraft (LCA) and in helicopters.

Large civil aircraft

Europe was quite successful in the past decade to break the US dominance in the large civil aircraft segment (the Airbus-Boeing duopoly). However, this development is expected to come to an end for a couple of years with the market introduction of the B787 “Dreamliner”, after Boeing has solved all the current delays and problems. Major challenges for Airbus are the current backlog management, the automation of the A380 final assembly, the setup and execution of pending and upcoming programs (the military A400M, the A350XWB, and the A30X), and the handling of new competitors. To a certain extent the success of both firms will also be dependent on the development of the air traffic structure. If the infrastructure tends to “large hubs and spokes” Airbus could benefit more than Boeing due to different strategic decisions. (Chapter 7.2.2)

Regional aircraft

In the regional aircraft segment there are also two dominant players, Embraer and Bombardier, but the third largest manufacturer is a European one: the French/Italian ATR. But short-to-medium-term forecasts predict a shrinking market share for the European player, who relies solely on conventional turboprop technology, which has drawbacks in passenger comfort, cruise-speed and perceived safety.

With the launch of new aircraft Bombardier and Embraer - based on the application of latest technology - reach out to the smaller market segment for LCA of Boeing and Airbus.

Business and General Aviation

Business and General Aviation, the segment with the smallest aircraft, is dominated by US and other American manufacturers. However, the French Dassault plays here a relevant role with about 20% market share. In General Aviation Europe holds about a third of the relevant market with the three firms Piaggio (Italy), Pilatus Aircraft (Switzerland), and SOCATA (France).

Helicopter

In the civil helicopter market Europe is in the global lead with Eurocopter and Agusta Westland. A major success factor of Eurocopter, the civil world market leader, is the technological leadership in several domains. Interviews suggest that this leading position is (at least partially) due to a higher daringness and farsightedness of the European firm (or its French and German predecessors), which have based their R&D investment decisions on long term goals. American companies, by contrast, have put more emphasis on short-term return on investment targets.

Propulsion

In the engine market the two main European OEMs, Rolls Royce (UK) and Snecma (F), hold almost 40% of the world market compared to about 52% for US American manufacturers. Furthermore many first tier suppliers in this sector are European companies. A major political challenge in this very collaborative market is to maintain enough competition in order to avoid pricing agreements without compromising the necessary dynamics in the joint technology development process, which is so cost- and therefore risk-intensive that single players can and will not

[296] Trade data do not allow a differentiation between LCA and regional aircraft.

perform it alone. The dominant alliance for the manufacture of engines for LCAs is CFM a joint-venture of GE and SNECMA. GE has not only a major stake in the production of engines for LCAs, but with its affiliated firm GECAS, one of the leading leasing companies, it has a stake in the funding of aircraft sales.

MRO

Europe plays also a significant role in the market for maintenance, repair and overhaul (MRO). This market is closely tied to the airline market and reacts with a shorter time-lag to air traffic fluctuations then the manufacturers. A future challenge will be an accelerated fleet modernization due to tougher environmental regulations. Such a change in the regulatory framework may be good for the manufacturers, but harms the maintenance service providers. New marketing concepts based on flight hours instead of maintenance hours are a possible way to alleviate the related risk. (Table 6.5)

Table 6.5 The International Competitiveness within the Subsectors of the Aerospace Industry

Indicator / Subsector	Large civil aircraft	Regional Aircraft	Business / general aviation	Helicopter	Engines	MRO
Market situation	Duopoly	Two dominant players plus smaller ones	Dominance of US players	Dominant European and US players	CFM, dominant US-F alliance for LCA engines IAE US-UK-JP alliance	Many independent and dependent players
Development	Regional supplier enter the market, China builds A320/B737 competitor	Japan, Russia and China enter the market	Current decline offers the potential for consolidation	Ongoing trend growth due to lower dependency on civil market	Strong cooperation as potential problem for anti-trust authorities. Counter-movement: dissent about future technology inside IAE	<u>Negative:</u> Environmental schemes may foster fleet renewal <u>Positive:</u> Delayed replacement, high energy prices foster upgrading of aircraft by new engines, winglets etc.
European AI	Gained market shares, balance to USA, common challenges	Small player, conventional technology	Dassault and some smaller players	Civil market leader, technology leader	Two large OEMs are in both relevant alliances	Strong European position
Trade surplus	Strong growth since 2001 2008: 30.2% (responsible segment LCA)		Losses in trade shares and increased trade deficit	Strong growth since 2001 2008: >40%	na	na

Source: Ifo Institute, Bauhaus Luftfahrt.

6.5.2 Patterns in International Markets for Aerospace Products

The investigation in the international trade was accompanied by an analysis of the major players in the global market in Chapter 5. Cross-border linkages in the value chain and trade flows have been analysed. The strength of the US AI has been confirmed by the investigation in trade flows. Most of the economies are – at least by the volume - dependent on US exports of aerospace products and the US command high shares of these economies' total imports. This is to a certain extent owed to tendencies of globalization. Additionally US companies have become part of the European value chain by FDI.

The US has a longstanding cooperation with Japan that provided different advantages. Japan has been solvent and technological advanced partner in the value chain. The government contributed to the funding of new projects and in exchange Japanese companies have been involved in the development and production of new aircraft. These close linkages have eased market access for US OEMs and put entrance barriers to potential competitors, such as Airbus.

Offset obligations have become an important topic in the global AI. The major OEMs are poised in particular to access emerging markets and target countries' governments have become interested in the industrialization of their own economies and ask for local content and inward investment. International interdependencies are growing in a similar way as the US Japan relationship, although usually target countries are less developed. The analysis in the trade flows and in the penetration of the market of OEMs confirms that companies leading the pace of the development have an edge in the access to the market. The general impression from the investigation in this development is that Boeing is a leader in this kind of opening up the markets. Airbus is following suit.

OEMs know that by this strategy they are nurturing emerging competitors, but there is not an option to abstain from this strategy if one does not want to give leeway to current competitors. From this standpoint the OEMs' strategies to develop global supply chains is not only driven by the exploitation of comparative advantages and cheap labour but by the objective to open up markets. This provides the target countries' governments with bargaining power.

The investment in foreign production sites and research centres in emerging countries is indispensable. To a certain extent it is also an investment in the future with regard to the perspectives for the supply of highly qualified labour in the mature industrialized countries. The demographic development and the decreasing interest in MINT disciplines will lead to scarce labour supply. However, an extrapolation of this trend underscores the risk that the know-how basis will be weakened in the long-term and can endanger the competitiveness of the European AI.

6.5.3 The European Aerospace Industry's State in Technologies

Large aircraft

The recent market launch of the A380 has set new standards in the segment of very large aircraft. The overdue market launch of Boeing's Dreamliner B787, the most successful civil airplane ever as measured by its pre-launch orders, has suffered of the risky combination of introducing new technologies and materials (CFK) simultaneously to the introduction of a new, global supplier's base. It is a challenge for future aircraft programs, such as the A350XWB, to avoid the current problems in the future. The replacement of the most successful aircraft of Boeing and Airbus, the A320 and B737, is postponed to after 2017. Bombardier, in the smaller regional jet segment, is preparing its CSeries, which is an advance in the same, profitable segment and can get a lead with aircraft based on the latest technology.

New aircraft configurations, like the Blended Wing Body, are not a probable and foreseeable option for the new civil projects within the next 10 years. If once the concept will become feasible the US manufacturer own know-how from the defence industry.

Advanced materials
The use of advanced composites is currently the most important innovation in the domain of materials for aviation, primarily due to its lightweight and stiffness. But also the newly developed aluminium alloys (e.g. Al-Li and Al-Mg-Sc type) are regarded as competitive materials due to moderate cost, low risk, and the possibility to use existing production techniques and tooling. Europe has always been in the lead with the application of CFK in new aircraft launched in the market. Only with the Dreamliner the US has reached the leading edge as measured by the share of CFK in aerostructure. From a technological standpoint Europe and the US are head-on-head. However, the US Hexcel has an edge by its capability and experience to take over big projects and as a risk sharing partner. It was reported that this was an important argument to award Hexcel a big contract to deliver composites for the A380.

Propulsion
In the propulsion segment the major two competing future concepts are the Geared Turbofan (of P&W and MTU) and the unducted fans or Open Rotor (of GE and Rolls Royce). Both are quite promising concepts in terms of emission reduction and fuel burn, but the Geared Turbofan concept seems to be closer to its market launch (in the Mitsubishi and the Bombardier CSeries Regional Jet) and has additional advantages in noise reduction. No decision is possible which economy is on a leading edge in propulsion technologies for LCAs. Most important players in the market are part of transcontinental consortia in the area of these engines, for instance SNECMA with its 50/50% joint venture with GE to develop and manufacture engines.

Design and development tools for aircraft projects
As for the product development process some players in the aerospace industry have expressed the need for a multidisciplinary virtual design in the future. It is essential to improve the European research infrastructure in order to achieve world leading standards. Furthermore, the entire supply chain needs to be more competitive at all levels and suppliers actively have to contribute to the necessary research. Virtual design tools are perceived as an indispensable tool. This will contribute to a more efficient communication along the value chain and simultaneously ease the very strict testing, certification and approval processes. Thus it is of great importance to assist the rapid introduction of new and innovative technologies. The basic tool for the AI has been developed by Dassault. The company started its activities in 1974 when it purchased licenses from Lockheed. The latest version is design and development tool marketed under the brand name CATIA is CATIA)Version). Some experts were convinced that Europe is lagging behind the US, whereas other denied. No decision is possible.

Air traffic management systems
The US has been in the lead with the introduction of its Global Positioning System (GPS). Its NAVSTAR GPS was introduced between 1985 and 1995 and provides comprehensive services worldwide. Europe has installed EGNOS and is about to develop it towards a full-blown GPS system. The European ATM will be based on EGNOS and the certification procedure for the application of EGNOS for air traffic will be concluded mid-2010. Europe is head-on-head with the US. Close interaction of the responsible bodies in Europe and the US shall guarantee interoperability. Moreover a cooperation of Boeing and Airbus contributes to this objective.

Fuels
The search for alternative fuels has been accelerated by the fuel crisis in 2008. However, besides the unsolved general challenges of sustainability and availability there is a third even more relevant factor for aircraft application than for ground-based mobility sectors: the suitability. A drop-

in solution is favoured that allows the use within the existing fleet. A time horizon for a large scale application of these fuels in the next 10 -15 years is unrealistic.

The European Union is currently funding several activities to develop alternative aircraft fuels (Alpha bird, SWAFEA). SWAFEA is dedicated to a comparative assessment of the most promising short-to-medium term options for alternative fuels, including bio fuels and shall provide an analysis of the environmental sustainability in view of a possible roadmap for policy measures. Europe has alos participated in the US Commercial Alternative Aviation Fuel Initiative (CAAFI) for the development of a new aircraft fuel. A common generic standard has been created and certified by ASTM International for the application in aircraft.[297]

[297] M. Kuhn; Alternative fuels specifications win certification designation; 5 August 2009; http://www.flightglobal.com/articles/article.aspx?liArticleID=330645&PrinterFriendly=true

7 The Strategic Outlook for the EU Aerospace Industry

The results of the study are summarized in Chapter 7.1. An evaluation of the competitiveness of the European AI will be carried out by summing up discussions of the different analysed areas, the performance in global markets, the microeconomic performance, technology, labour qualification and the efficient use of resources, combined in a SWOT analysis. Strengths and weaknesses of the European AI will be named and interdependencies within the framework conditions will be detected. This creates the basis for suggesting measures to be taken by the industry itself, other stakeholders and policy makers.

Chapter 7.2 continues with an outlook for the aerospace industry that is based on the assumption of status quo ante. This means that we assumed stable framework conditions and regulation set by public authorities. Much emphasis is given to the investigation of the medium-term development that is presented in Chapter 7.2.1. The AI has always been strongly affected by business cycles (Figure 7.4). Its final product, aircraft, is an investment good with a long lifespan, which in part explains the strong cyclicality of demand.

The long-term perspectives of the AI are analysed in Chapter 7.2.2. They are based primarily on the forecasts provided by the major manufacturers. The plausibility and consistency of macroeconomic assumptions are checked. An important topic is the structure of the AI market and changes during the period under investigation.

7.1 Evaluation of the EU AI and Policy Recommendations

This section summarizes the findings of the study. They are based on desk research, statistical analyses and interviews carried out. They are clustered by using the SWOT approach and include the results of the discussions with the Commission and the Monitoring Committee. The views of the European Economic and Social Committee have also been taken into account.[298] On this basis recommendations have been developed.

7.1.1 The SWOT-Analysis

Performance of the EU AI

The European AI was very successful over the current decade and gained market share in the domain of large civil aircraft and helicopters. The industry heavily invested in new products (A380, A400M and A350 programmes). This has provided the industry with bright long-term

[298] The European Economic and Social Committee on „The European aeronautics industry: current situation and prospects", Official Journal of the European Union, 28 July 2007, (2009/C175/09).

perspectives, but the current economic performance of the industry is squeezed by problems with proper project execution. This is a challenge in the current global economic environment.

Moreover the EU commands a strong position in engines with RR and SNECMA (CFM). The international competitive position of the EU in engines is also reflected by the big European share in the global market for aircraft related services (MRO).

Europe has been leading in the application of composites in aircraft over the past decades. With the development and production of the Boeing 787 Dreamliner, Boeing has however caught up to this lead. The strength of the US in developing this technology is based on companies of sufficient size with a potential to carry out big projects and the necessary risk sharing potential.

The EU AI is on par with US key-technologies, such as flight mechanics and aerodynamics that are of major importance for new aircraft concepts that have the potential to contribute much to energy efficiency. The EU is also on par with the US in ATM technology. There is a strong communication to warrant interoperability of the advanced systems, currently developed in the US and in the EU. Implementation in the EU is challenged by the fact that between EU 27 Member States has to be coordinated.

The envisaged project for the successor to the A320 has been rescheduled and a new aircraft will only be launched late in the next decade and not be on sale before 2020. This gives leeway to emerging competitors like Bombardier (Canada) and COMAC (China) that are about to launch new aircraft based on the latest technologies and by their size will access the lower end of the LCA market, in the most profitable segment of 100 up to 150 seats.

The EU does not command a leading position in the market for regional aircraft. In the market for business aircraft the North American suppliers are in the forefront.

Innovation and R&D

The European AI is a leading innovator in advanced aircraft, helicopter, engines, and related subsystems. Airbus launched the first LCA with fly-by-wire technology and has been leading in the dissemination of composites in aerostructures. Other technological strongholds are flight mechanics and aerodynamics. Compared to the US, EU spill-over effects from the defence industry have been less important for the European AI in the race for technological progress.

During this decade the European AI has launched new aircraft programmes dedicated to strengthen its position in the global competitive arena. In the face of the global economic slowdown these efforts have become a challenge to the industry. Delays and technical problems have also contributed to this situation. The investment returns on current investment expenditure have been shifted more into the future than originally expected.

Organisation and industry structure

In spite of the success of the European aerospace industry the most important private owners of the dominant firm EADS are – if one refers to their communiqués – ambivalent with regard to their involvement. This could be or become a potential weakness for the EU AI. Decisions made by EADS are of outstanding importance for the industry and a lack of vision, reliability and consistency of its strategic orientation could hurt the whole industry. Without a strategic investor with long-term involvement every company – especially in the AI – risks losing its strategic position in the market. This is a consequence of economically suboptimal investment decisions.

Table 7.1 SWOT-Analysis

Internal Elements	External elements
Strengths	**Opportunities**
Performance of the European AI: • Market leader with technologically advanced final products: LCA (A320, A380), civil helicopters • Strong in engine manufacturing and MRO services • Strong in ATM technology (but: deficiencies in procedural implementation of SESAR) Innovation and R&D: • Strong position in flight mechanics and aerodynamics • Heavy investment in new projects Organisation and industry structure: • Long experience in the integration of increasingly outsourced subsystems • Strategic commitment to increase efficiency along the value chain, but: outsourcing to non Euro-area goes to the detriment of European locations • Integration of neighbouring countries in North Africa, eastern countries	Innovation environment: • Clear guidelines for future requirements on aircraft, in particular emissions and noise (ACARE SRE, FP7) • Demanding environmental obligations (ACARE goals, ETS) and adjusted R&D funding (e.g. FP7) foster clean technology development, which may promote an important international winning margin (while it is a burden for European airlines) National policies: • Strong interest of Member States in the AI and related initiatives Labour supply: • Qualified personnel (but constant supply and necessary mobility are endangered) • Accession of new Member States provided the opportunity for the exploitation of efficiency gains and cost savings by integrating these neighbouring countries in the value chain
Weaknesses	**Threats**
Performance of the European AI: • Weak position in the regional aircraft market • Delay in market launch of A30X opens the opportunity for competitors to enter this profitable market segment Innovation and R&D: • Economic performance has come under pressure in recent years (caused by too many new simultaneous aircraft programmes and delays) Organisation and industry structure: • Corporate governance affected by national interests (ambivalent position of important private owners of EADS) • Fewer companies of sufficient size and capability for large risk sharing projects than in the US	Innovation environment: • Spill-over effects for civil aeronautics from defence R&D less important than for the US • Growing public budget constraints reduce R&D in the defence sector. Authorities' requirements for "reverse dual use" ask for spillovers that put more strain on the AIs financial situation • Big European projects (PPP) with far-reaching objectives not adequate organized • Stability of framework conditions for aerospace industry at risk by frequent changes in environmental and security regulations National policies: • Insufficient coordinated national R&D schemes, even within the Member States • National interest in local employment and technology lead to non-complementary policies in the AI (duplication of activities) Labour supply and image of the Industry: • Long-term decline in labour supply as in other mature countries, but a disadvantage compared to emerging countries • Difficulties in cross-border acquisition of staff (language, different social systems) • Europe still less attractive for foreign high-skilled staff than the US • Growing labour costs endanger comparative advantages and profitability in the long run Financial markets and exchange rate risk: • Europe as a production location suffers from exchange rate risks, as revenues are in USD • European financial market provides less funding opportunities than the US • Loss of attractiveness of the AI (general decline of manufacturing industries in the public opinion • and environmental aspects in particular)

Source: Ifo Institute, Bauhaus Luftfahrt.

The European AI supplies products on the leading edge of technology and has gained the lead in the global market for large civil aircraft and civil helicopters. It has increased its international competitiveness through a (partially painful) consolidation process throughout the value chain.

However, within the European AI some structural weaknesses have remained. There are fewer large suppliers on Tier-1 to Tier-3 of the value chain than in the US and numerous smaller enterprises face difficulties to meet their clients' requirements to take over larger work packages and become risk sharing partners.

With the spin-offs of production facilities, Airbus has started to focus its activities more on system integration and to creating potential Tier-1 suppliers. However, not all break-ups have been sufficiently attractive for investors.

Currently about 75 percent of all EADS suppliers are smaller enterprises, only providing one fifth of the total purchasing volume. Many of these companies are not prepared for the envisaged changes in the value chain. Cooperations have been recommended, but they are not always a practicable solution. In many cases an adequate management to handle big projects and risks taking capabilities are not possible with potential partners. Moreover OEMs prefer to have a central contact point (one-stop-shop) that takes all of the risk for all of the partners. In general, cooperation of smaller enterprises in the form of self-organized partnerships is not evaluated as promising.

Integration of the new Member States in the value chain of the AI contributes to the competitiveness of Europe. Comparative advantages are exploited and wage differentials add to price competitiveness. However, wage increases in the accession states exceed productivity gains and in the long run this will weaken their competitive advantages as compared to neighbouring countries east of the EU. Already some outsourcing and relocation into these countries is taking place.

Southern European countries like Italy and France prefer outsourcing to North Africa, whereby traditional and historical close ties are exploited. This also contributes to improved levels of competitiveness of the European AI but simultaneously increases competition among production locations within and outside the EU.

Financial market and exchange rate risk

Production locations in the Eurozone face the disadvantage that the market for aircraft is based on USD-invoicing. The strategy of risk sharing within the value chain shifts the exchange rate risks to suppliers on lower tiers (usually not below 3rd level) of the AI. In combination with the outspoken interest of EADS to increase the share of non-EUR denominated procurement, EU production locations are confronted with an important negative macroeconomic element.

Restructuring the value chain of the EU AI has induced OEMs to spin-off corporate divisions and to focus more on their core activity: system integration. However, it has turned out to be difficult to find investors. This might partly be caused by a change for the worse of the perspectives in the sales markets of late, but unlike the US in Europe there are fewer potential financial and industrial investors available. This aggravates initiatives for structural change in the value chain that is perceived as global trend and needed to strengthen competitiveness.

The recession and the credit squeeze complicate the economic situation of the AI. Short-term funding of the EU AI has come under strain over the past years, more than for its US counterpart. Because of the current global financial crisis and the slowdown in sales markets, it is expected that the situation will become even worse.

Labour supply and image of the industry

The aerospace industry suffers from a generally worsening assessment of manufacturing industries by the public and in particular by growing environmental concerns. This has the potential to stop qualified people from applying for work in the AI. This is of particular importance for the EU because it is less attractive to a high-skilled workforce in the global labour market than the US and is more dependent on the domestic labour supply.

Generally speaking the EU has a well qualified supply of labour as compared to the US, but concerns about a shortage of skilled labour are prevalent in European countries. It is not straightforward to verify the true situation. Available information does not consistently underpin the concerns. For example, cyclical effects of the imbalance between skilled labour demand and supply are embedded in long-term trends. A short-term relaxation (i.e. increase) in labour supply should not be taken as a signal to allow endeavours to promote job opportunities in AI to scale back.

Staffing policies and cost saving business programmes are directed to keep capacities lean. This has led to a reduction of the traditional employment relationships. Labour leasing and temporary employment contracts have become more common in the AI to more flexibly adjust staff to cycles of the AI. The way the industry treats employees and especially young people that are laid off earlier in downturns affects the ability to attract qualified work force in the future.

The explicit commitment of EADS to adjust the value chain to the needs of a globalized market and to broaden worldwide production networks is a necessary step, which puts pressure on suppliers at all levels to adjust to changing requirements. This initiative will provide new tasks for qualified personnel, but reduce demand for those tasks with a low value-added. A structural change in the AI will take place that further reduces the low-wage share on total value-added of European locations of the AI. The perspectives for higher qualifications are better, but they will only be bright if the industry succeeds in an early adjustment to the global challenges. However demographic developments and declining interests endanger the long-term supply of qualified labour, up to now a comparative advantage for Europe.

Women are not much attracted by mathematics, informatics natural sciences, technology (MINT) disciplines, but there is a certain potential that can be exploited by adequate policies as shown by the French AI. The share of female engineers in the aerospace industry is higher than in other European Member States. A better infrastructure for childcare is the underlying reason for this. A better environment for women to combine a professional career with family can incite women to select MINT disciplines.

The companies of mature industrialized countries do relocate some of their design work to industrializing economies. Although core competencies on key-components are not relocated in the long run these activities contribute to emerging competitors' efforts to catch up the state-of-the art technology. A new international division of labour could emerge. The competitive position of the European AI in the global market will be strongly dependent on its success to maintain its lead in key-technologies in the value chain. Hollowing out of the know-how base must be prevented vehemently.

Innovation environment

European initiatives with a focus on aerospace are confronted with the difficulty that national governments watch over their autonomy in R&D on the relevant areas for their companies. As a result there are high-tech areas, for instance composites that are funded by public schemes in most of the Member States with a stake in the aerospace industry. Duplication of work can hardly be avoided. The multitude of national and even regional, non-adjusted programmes have been perceived as extremely inefficient. Often even within Member States the coordination is not well established.

Public authorities try to encourage the AI to reverse the classical idea of dual use that intends to use expertise from military R&D funding for the development of civil airplanes. The underlying reason is a growing constraint on budgets. Even more strongly, the reverse process implies the use of experience gained in civil programs in order to develop military products, which would imply lower governmental funding needs for R&D activities. This underscores the growing financial problems that the AI will face in the years to come. It contributes additionally to a disadvantage of the EU AI compared to the US. The US civil aerospace industry has the advantage to exploit dual use effects from a much bigger defence and space industry than Europe.[299]

7.1.2 Recommendations

Organisation and industry structure

The structure of the European AI has been identified as a drawback. There are less large companies in the value chain with high risk-sharing potential and the ability to become strong system integrators as Tier-1 and Tier-2 suppliers. Moreover many smaller companies are in the value chain and face difficulties to meet requirements from their clients to take over larger work packages and become subsystem integrators.

> It is recommended that industrial policy supports activities to ease the access to financial resources and to strengthen management knowledge. The objective must be to create framework conditions for companies to allow them to evolve towards subsystem integrators who have a sufficiently large potential to take risks. These companies should get special support and could serve as crystal nuclei on the one hand to integrate smaller, technological driven firms and on the other hand to become preferred partners Tier-1 and Tier-2 companies that are to meet growing requirements of OEMs.

Currently the worsening economic situation in the sales market puts financial stress on firms in the value chain. In particular smaller high-tech companies can become targets for foreign industrial investors. Takeovers can result in a knowledge drain and provide an edge to emerging competitors.

> It is recommended that special attention is paid to smaller companies in the value chain that are of key importance. Clients should have a close look at their supplier base. Funds provided by big OEMs and public authorities can be crucial for this purpose. Additionally the AI's associations and governing bodies of cluster initiatives are well-suited for this task.

Financial market and exchange rate risk

The European financial markets are not sufficiently developed to meet the requirements of the AI that is in the process of restructuring towards larger companies with sufficient risk sharing potential to participate in ever bigger aircraft programmes.

299 One approach that has turned out to raise problems has been the application of terms of contract for public funding of civil aircraft programmes on defence projects (A400M)).

It is recommended that the AI becomes more pro-active and launches common initiatives to attract financial and industrial investors to become stakeholders of the industry. Such activities can complement schemes provided by OEMs to stimulate the structural improvement of the European AI.

Short-term funding has become more difficult to obtain in recent years. The delays in aircraft programmes, the global financial crisis and the slowdown in sales markets have contributed to this trend. The expected slowdown in the sales market even dampens the perspectives.

It is recommended that companies in the value chain closely monitor their suppliers of key importance. It could become necessary to take measures to secure the European value chain. In particular smaller, technology-driven firms should be given a hand, not only to stay in the business, but to remain linked to the European value chain.

It is recommended that national authorities take care of the AI and provide funds to be made available during the global economic crisis to secure the industrial basis on a temporary basis.

The reduced liquidity as well as solvency of airlines and restrictions in the financial markets have aggravated doing business for the AI. Public initiatives to support the sale of aircraft gain importance. Government backed export credit agencies (ECA) are frequently used tools for a horizontal industrial policy. The US government provides significant support to Boeing via the EXIM bank.

It is recommended to extend the credit lines of ECAs and to provide more funds and guarantees to support the European AI.

Exchange rate risks are more challenging to the European AI than to other industries because traditionally its sales market is based on USD-invoicing.

It is recommended to introduce hedging schemes for the AI. They should tackle this problem in line with WTO rules. Such tools can complement the supply of credit agencies that exist in most of the Member States as a horizontal measure to support exporting companies.

Labour supply and image of the industry

Air traffic is a subject of growing concern by the public. Disturbances in the surroundings of air ports and CO_2 emission worsen the image of the AI. This hinders investment and investment potential in infrastructure for more capable and efficient air services. Moreover, this includes deterring qualified people to apply for work in the AI.

It is recommended to start an image campaign for the AI and to improve its access to the EU labour market. It is also of importance to attract women.

The major detriment of the EU labour market as compared to the US is less labour mobility caused by social, cultural and linguistic differences between Member States. In combination with the demographic development bottlenecks in the labour supply must be expected.

It is recommended for a better understanding of the present and future human resource situation of the AI to introduce regular monitoring of supply of and demand for skilled labour. Monitoring could be carried out by national associations, coordinated on a European level. This could also contribute to measures taken by EACP to increase the flexibility of labour supply and to counterbalance regional shortages.

The AI is confronted with contradictory requirements. On the one hand it needs highly qualified employees with professional experience. On the other hand it is exposed to strong business cycles that need a flexible adjustment of capacities to stay economically sound. A long-term reliable employment policy is a precondition not only for the protection of staff over an economic downturn but to remain attractive for applicants in the long-run.

It is recommended to better use well-known instruments to avoid job losses. These are reduced working-hours, short-time work, furloughs, work-time accounts or temporary shut-downs. It should be discussed how these tools can be adapted to the needs of the AI's business cycles. Salary policies that combine base pay with flexible wage fractions are other tools.

The demographic development and the decreasing interest in MINT disciplines with the younger generation are a challenge for the AI. Only to a certain extent, relocation to non-EU sites can ease the situation otherwise the risk of hollowing out of the know-how basis of the European AI will emerge.

It is recommended that access to qualified female labour supply by adequate measures be improved. Public authorities should contribute with horizontal measures to improve the infrastructure for childcare. But also big companies have the potential to provide an attractive environment for women that has to be added by specific working time schemes and curricula.

The AI is a strategically important sector for technological leadership and security. It creates spillover effects for other sectors by its demand and know-how transfer. The consequences of the consolidation of the supply chain which could, on the long run, lead to job losses, as well as concerns about skill shortages and restricted sectoral labour mobility in Europe confronts the sector with challenges.

It is recommended to intensify already existing considerations to prompt the development of a European Social Dialog for the sector. This Social Dialog could utilise the contributions of the social partners to frame structural changes and reforms of the AI.

Innovation environment

Growing constraints in public funding ask for more efficient R&D schemes. However, it will be difficult to reach better targeted and concerted activities within the EU. The Member States are strongly interested to design schemes that are well adjusted to their domestic aerospace companies, which may be sub-optimal at an overall EU level.

It is recommended to improve the interaction of Member State initiatives related to AI. With EACP a cluster network has been created that shows promising results related to labour issues. The European Commission should invite the Member States to join an initiative that is dedicated to bundle the European efforts for the strengthening of the competitiveness of the aerospace industry. The already available platform ERA-NET could be of use for this purpose. The initial objective must be to create a platform on available national and European initiatives, dedicated for the industry. This shall provide national authorities with the opportunity to take into account the activities of other countries' initiatives in their own planning. This is understood to be a first step to come to a more concerted R&D environment by mutual adjustments.

It is recommended to strengthen cooperation in R&D of defence projects between Member States. This will not only contribute to more efficiency of the defence sector but spill-over effects will stimulate innovation in civil aeronautics.

The AI has criticised the organization of far-reaching and extremely important Joint Undertakings (JU). The European Commission has been bound by inadequate rules. Moreover, the integration of the industry into governing these projects is not sufficient.

It is recommended to introduce special rules for PPPs dedicated for the needs of Joint Initiatives (JI) and that do not follow normal regulation to be applied for other schemes. A governing body for PPP is built up of representatives from industry and the Commission and has the authority needed to govern a PPP commonly. These are prerequisites for the successful execution of big projects with far-reaching implications for the industry.

Although the amount of funds dedicated to the AI by the EU has increased much over time some criticism has surfaced with complaints about growing administrative requirements. For example, experts agreed on the fact that compared with FP6, the administrative burden of FP7 has become higher.

Another point of concern for experts of the AI was the protection of IPR. Companies have to provide comprehensive information and references on technologies if they want to apply for EU funded projects. In combination with the requirement of joint tenders with partners at least from three different Member States they fear to lose know-how to competitors.

It is recommended to carry out a detailed survey with applicants and participants of FP7 to identify the topics of concern, such as administrative burden and IPR.

International cooperations

It is recommended that the EU and the US reconcile before the WTO final judgement and find a bilateral solution on how to guarantee fair trade in the global market for aircraft. Otherwise the situation will become more complex and difficult to resolve, especially if new competitors tap the market – competitors that are supported massively by their governments – without clear rules having been agreed upon.

7.2 The Perspectives for the European Aerospace Industry

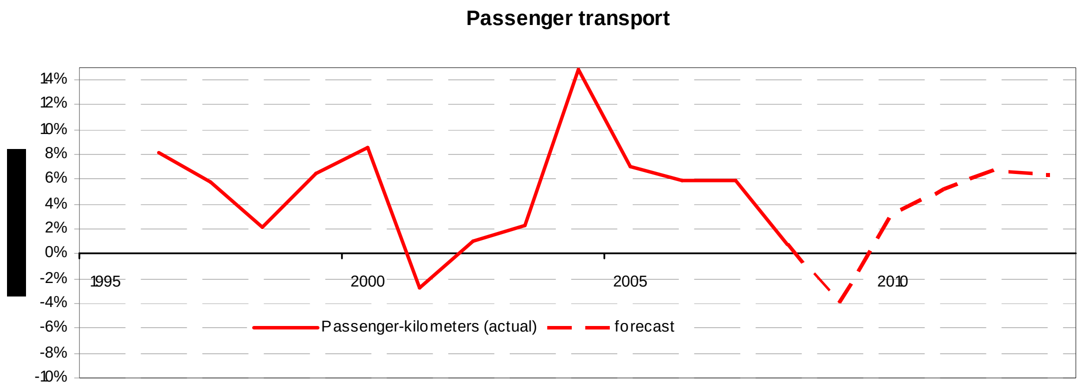
7.2.1 The Impact of the Current Crisis on the Demand for Aircraft

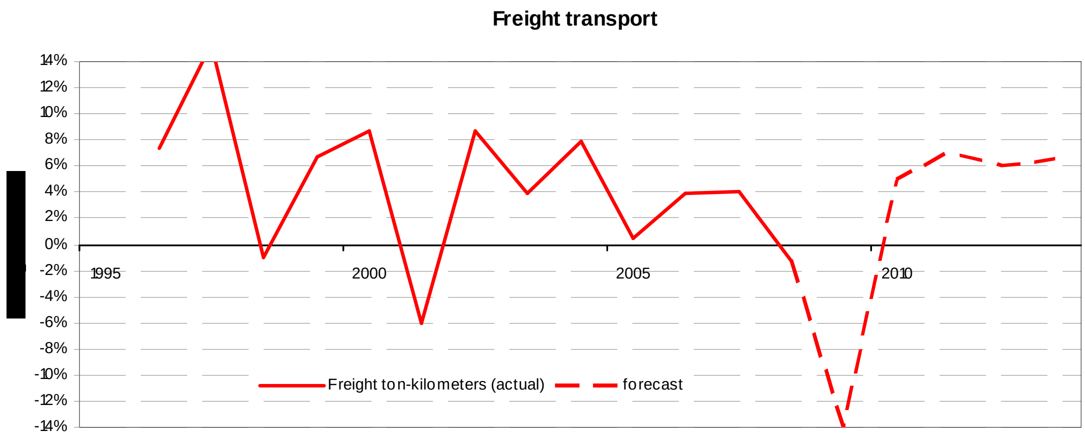
The financial crisis affects the AI via two channels.

The first refers to the worsened access to credit, which endangers the funding of the operative business (short-term) as well as the participation in large (long-term) aircraft programmes. Scarce funding has a negative impact on the launch of projects and the allocation of resources. Therefore a further delay in new projects (A350, New Short Range) is expected. The scarcity of short-term credits affects liquidity (negatively). Large companies and firms affiliated to industrial groups (OEMs and Tier-1 suppliers) have not reported noteworthy bottlenecks yet. But for independent smaller enterprises the financial crisis has induced some frictions and several firms are endangered to the brink of applying for insolvency.

The second channel of the financial crisis affects the sales market. We investigated the global economic development and its effects on passenger and air cargo transport. This is the setting for the necessary capacities and the investment needs of airlines. It provides an impression of the current global recession on the future demand, the depth and the length of the slowdown. The following years, the market for aircraft will swing in past developments, with a higher growth than worldwide GDP.

Figure 7.1 The Medium-term Development of the Global Market for Airlines

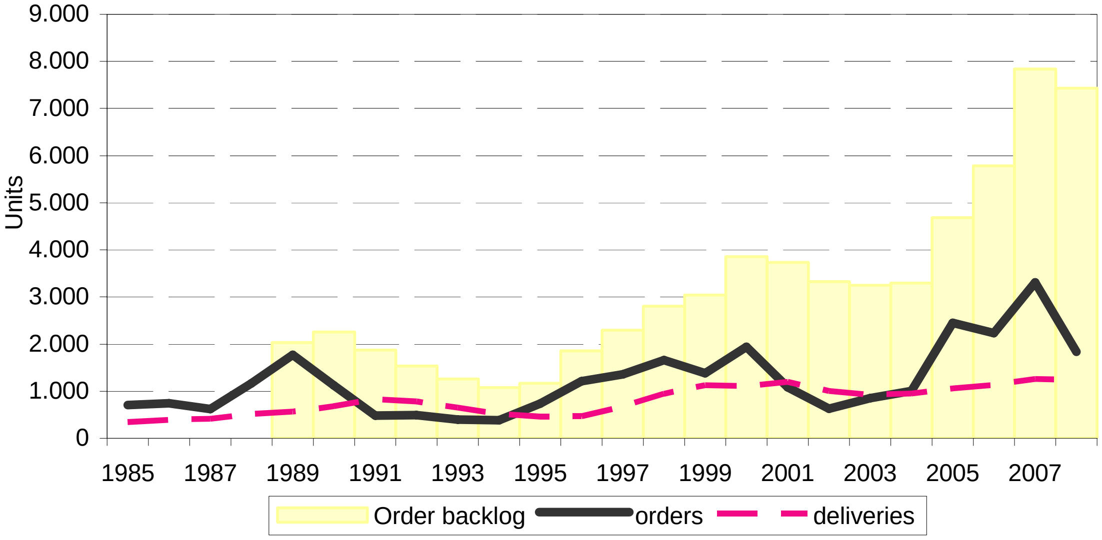




Source: Updated with Short-term IATA Forecast of September 2009, own calculations; http://www.airtransportnews.aero/print_analysis.pl?id=614, http://www.iata.org/NR/rdonlyres/DA8ACB38-676F-4DB1-A2AC-F5BCEF74CB2C/0/Industry_Outlook_Sep09.pdf

The quantitative impact of the current crisis on airlines is an important lead indicator for the assessment of the future demand for the AI. The impact of the financial crisis and the global recession on air transport services has been investigated by IATA in December 2008. IATA has subsequently updated the short-term outlook in September 2009. It forecasts a more severe breakdown in 2009, but sees a more dynamic recovery in 2010 than at the end of last year. However, the upswing in 2010 is not sufficient to compensate for the slump in 2009, in particular in air freight. (Figure 7.1) As a consequence next year, airline operators will be reducing their capacities once more to limit the reduction of utilization.

Figure 7.2 Evolution of the Order Backlog for Commercial Aeronautics



Source: Decision, own calculations.

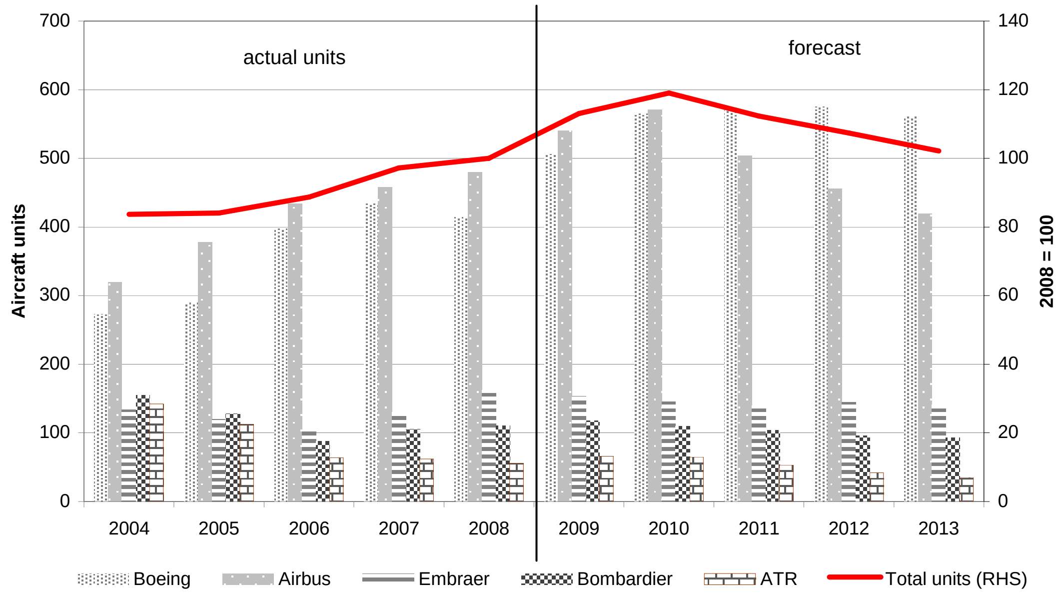
The slowdown in air traffic has already started during the second half of 2008 and has not yet come to an end, although some moderation in the decline has been reported recently. This has had only an impact on the reduction of new orders for the aerospace industry, because of the record height of order backlog, deliveries have not yet been affected much (Figure 7.2). There are further factors that have to be taken into account for the medium-term AI outlook: the vintage structure of the air fleet, the necessity to adjust their fleet to changing requirements in the market and the supply of new generations of more fuel efficient products. In the medium-term the capacity utilization and the access of investors to financial markets is of outstanding importance.

Concerns are raised that the financial crisis and the global recession will have a strong impact on AI prospects. Available forecasts - for instance provided by Forecasting International Inc. and published by the Aviation week at the end of 2008 – foresee that the aircraft manufacturers industry only will experience a phase of decline between 2009 and 2013.[300] Currently the crisis has not yet affected the industry. For 2009 and 2010 the number of delivered aircraft shall grow based on the order backlog. Only for the years after a correction should take place. However, deliveries are not foreseen to fall back to the level of 2008. (Figure 7.3)

Even delays in the delivery of aircraft newly introduced or expected to be introduced in the market will contribute to cushioning the decline. Further arguments are provided by the fact that much of the order backlog stems from emerging countries that are expected to recover earlier than the mature industrialized countries.

300 More recent forecasts made available by Boeing and Airbus (see below) only refer to long-term average growth rates. They do not provide insight in the current cycle.

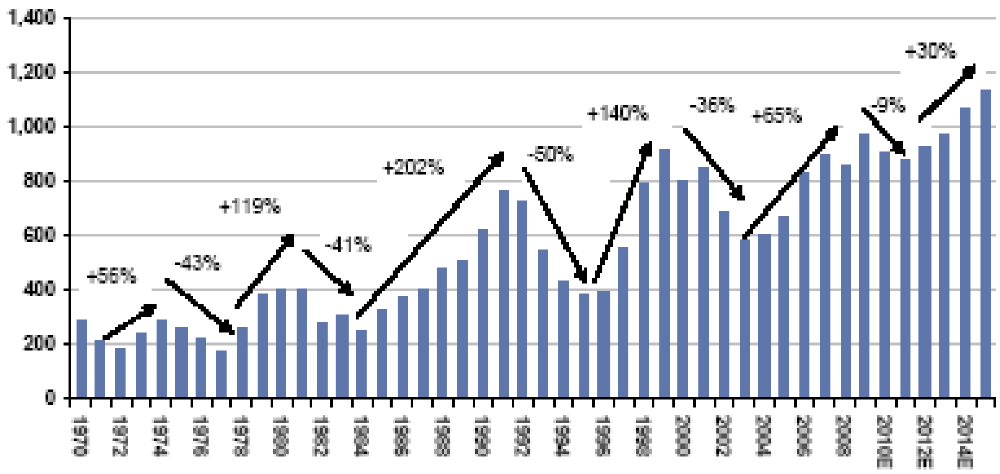
Figure 7.3 Medium-term Forecast for the Commercial Aerospace Industry (Units)



Source: AW Source Book 2009, Forecast International, Company information, own calculations.

A more upbeat scenario has been delivered by Goldman Sachs in September 2009. It trusts in a fast recovery of the global economy and assumes that governments will take strong measures to support the financing of aircraft sales. In this scenario, the large stock of parked aircraft will not have a big impact on new orders that are also driven by sustainable high oil prices. The outlook foresees a decline that will level out in 2011 after which a strong recovery is expected to take place. (Figure 7.4)

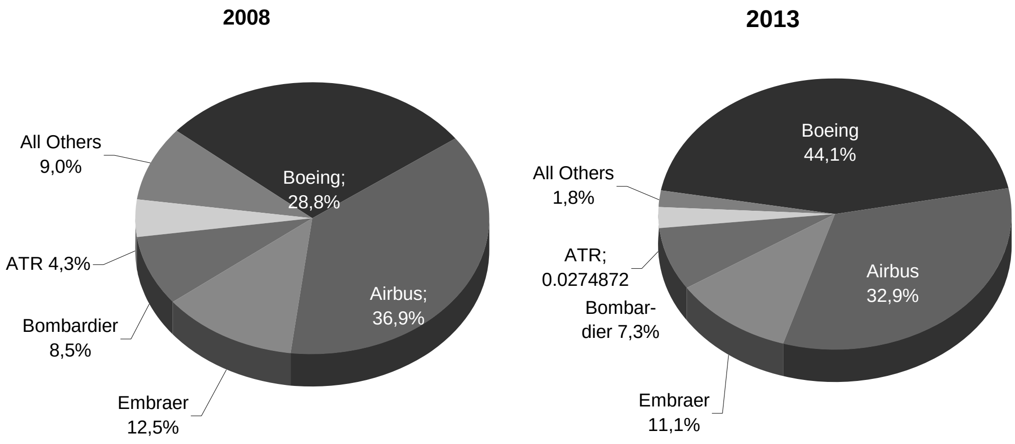
Figure 7.4 Global Deliveries of Large Aircraft



Source: Airbus, Boeing, Lockheed Martin, Goldman Sachs Research Estimates.

Both developments are presented here to give an impression on possible developments. The first forecast is perceived as the downside path and the second as the upside path of what will happen in the years to come. The Forecasting International Inc. does not only provide a global outlook, but also differentiates by major manufacturers. It is of note that a loss of market share by Airbus as depicted in Figure 7.5 is expected to take place. This is to a large extent caused by the fact that in spite of the global boom, Boeing deliveries were poor in 2008. Product lifecycles also play a major role. Currently Airbus is successful with the A380 and benefits from the delay of the Boeing 787 in the market. In the years to come this aircraft will enter the market and the order backlog will be reduced.

Figure 7.5 Global Market Shares of the Commercial Aerospace Industry (Units)



Source: AW Source Book 2009, Forecast International, Decision, own calculations.

7.2.2 The Long-term Outlook

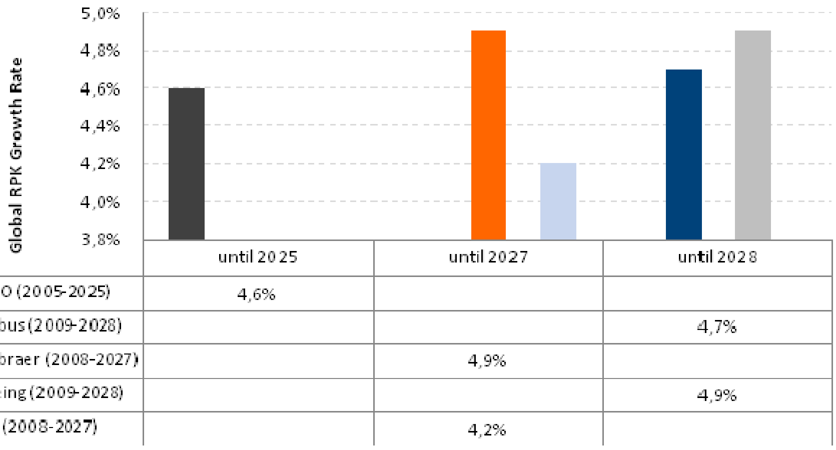
The long-term outlook is carried out under the ceteris paribus assumption. This means that the impact of political measures that might be taken in the future and changes in the regulatory framework are not considered. The exception will be changes that have been already agreed upon, such as the introduction of ETS in 2012.[301]

Boeing, Airbus and Embraer are by and large unanimous about RPK growth in the next two decades and predict a value of about 5%.The most pessimistic view on future revenue passenger kilometre development comes from ACI, forecasting a worldwide growth of 4.2% per annum until 2027 (Figure 7.6). The more recent assumptions of Boeing for its outlook have not changed for growth in passenger air traffic. For freight traffic an average growth rate of 5.4% is assumed. The latest forecast has been provided by Airbus. It confirms its assumption for passenger traffic growth of 4.7% and gives for freight traffic 5.2%, only a slightly smaller figure than Boeing.[302]

[301] The design of the long-term perspectives for the AI will be based on available scenarios supplied by the European Commission, International Energy Agency (e.g. peak-oil scenario), OECD etc. for the evaluation of the economic environment for the aerospace industry.

[302] http://www.airbus.com/en/corporate/gmf2009

Figure 7.6 Long-term Air Traffic Forecasts, Average Global RPK Growth



Source: ICAO 2007, Airbus 2009, Embraer 2008, Boeing 2009, ACI 2009.

The big OEM-manufacturers of the AI carry out their own long-term forecasts. They take into account the global fleet, its vintage structure and the expected global development. These forecasts provide a good insight in the kind of demand, replacement and expansion that could be expected. Table 7.2 discloses the latest Boeing forecast divided by fixed wing aircraft categories that are in the product portfolio of the company. The key assumptions are a long-term trend growth of 3.1% for GDP and above trend developments of passenger (RPK) and freight transport (RTK) with annual average growth rates of 4.9% and 5.4% respectively.

Table 7.2 Long-term Forecast of Boeing for Commercial Aircraft

Category	Airplane fleet					New deliveries 2008 – 2028			Replacement as a % of 2008 fleet
	2008		2028		Aagr % [1)]	Units	Thereof		
	Units	Shares	Units	Shares			replacement Units	expansion Units	
Large	870	4,6%	1070	3,0%	6,1%	740	540	200	62,1%
Twin aisle	3510	18,7%	8080	22,7%	11,5%	6700	2130	4570	60,7%
Single aisle	11360	60,4%	24230	68,1%	10,7%	19460	6590	12870	58,0%
Regional jets	3060	16,3%	2220	6,2%	3,6%	2100	2940	-840	96,1%
Total	18800	100,0%	35600	100,0%	9,5%	29000	12200	16800	64,9%

Source: Boeing 2009, own calculations.

Table 7.3 discloses the long-term forecast of Bombardier that covers the same period as Boeing. However, the results are not comparable. Bombardier uses a baseline scenario with an annual average growth rate of 2.98% for global GDP. Bombardier uses different indicators to forecast the demand for aircraft than Boeing. Moreover, the product coverage is different than that of Boeing. Bombardier takes into account not only regional aircraft as defined by Boeing, but even bigger planes with up to 150 seats.

Table 7.3 Long-term Forecast of Bombardier for Commercial Aircraft

Category	Airplane fleet					New deliveries 2008 – 2028			Replace-ment as a % of 2008 fleet
	2008		2028		Aagr %[1)]	Units	Thereof		
							replace-ment	expan-sion	
Size by seats	Units	Shares	Units	Shares			Units	Units	
25 - 59	3800	33.0%	1500	8.8%	2.0%	300	2600	-2300	68.4%
60 - 99	2100	18.3%	6900	40.6%	16.4%	5800	1000	4800	47.6%
100 - 149	5600	48.7%	8600	50.6%	7.7%	6300	3300	3000	58.9%
Total	11500	100.0%	17000	100.0%	7.4%	12400	6900	5500	60.0%

Source: Bombardier Commercial Aircraft Market Forecasts 2009, p. 24, own calculations.

Bombardier has a stake in the business jet market and provides a long-term outlook, but up to 2018 only (Table 7.4). Remarkable is the much lower replacement rate that is caused in this market by a much smaller utilization of the capacities. The business jet market has suffered a major breakdown of demand early during the crisis. Representatives of the segment expect an early recovery based on an US business cycle that will be ahead of most other economies.

Table 7.4 Long-term Forecast of Bombardier for Business Jets

Category	Airplane fleet			New deliveries 2008 – 2018			Replace-ment as a % of 2008 fleet
	2008	2018	Aagr %[1)]	Units	Thereof		
					replace-ment	expan-sion	
	Units	Units			Units	Units	
Business jets	13600	23900	8,8%	11500	1200	10300	8,8%

Source: Bombardier Business Aircraft Market Forecasts 2009, p. 5, own calculations.

The latest forecast has been made available by Airbus. The overall development does not differ much from Boeing. The number of new aircraft delivered is somewhat higher, but also the market definition is wider. (Table 7.5) Changes in the structure of the market are more important. Airbus expects, due to higher oil prices and a consolidation of airlines, that not many new long distance city pairs will be introduced over the next 20 years. Large hubs will benefit from this development and their strengths will be above all dependent on their regional networks. These changes will stimulate the demand of very large aircraft and commuter planes. Although the categories of the Airbus and the Boeing forecasts are not compatible, it becomes obvious that the expectations differ with regard to the structure of the demand in the next 20 years. There will be strong growth ahead when the crisis has ended, but with Airbus the large and the smaller aircraft will be winners of this change in the air traffic network. The Boeing forecast expects a different demand.

Table 7.5 Long-term Forecast of Airbus for Commercial Aircraft

Category	Airplane fleet					New deliveries 2008 - 2028			Replacement as a percentage of 2008 fleet in %
	2008		2028		Aagr	total	thereof		
							replace-ment	expan-sion	
	Units	Shares	Units	Shares	% 1)	Units			
VLA	24	0.1%	1318	3.6%	22.2%	1294	0	1294	0.0%
Intermediate twin aisle	924	4.4%	1861	5.1%	3.6%	1705	768	937	41.3%
Small twin aisle	2261	10.9%	4454	12.3%	3.4%	4097	1904	2193	42.7%
125 / 250-seats	9254	44.6%	18047	49.7%	3.4%	14734	5941	8793	32.9%
100-seats	1553	7.5%	2431	6.7%	2.3%	2243	1365	878	56.1%
70 / 85-seats	1305	6.3%	4053	11.2%	5.8%	3610	862	2748	21.3%
50-seats	5444	26.2%	4139	11.4%	-1.4%	2468	3773	-1305	91.2%
Total	**20765**	**100.0%**	**36303**	**100.0%**	**2.8%**	**30151**	**14613**	**15538**	**40.3%**

Source: Airbus 2009, own calculations.

The big manufacturers of the AI are eager to expand their integration in the global economy. Their activities are directed to exploit comparative advantages for R&D and manufacturing in foreign countries and also to tap into promising sales markets. Traditionally the US is leading the development. It uses its strength in the worldwide defence market to support the sale of civil aircraft in foreign countries. The EU AI is following suit to this strategy and has been successful in some of the big emerging economies, such as China and India.

Investments in emerging markets are part of offset obligations to be acknowledged as a potential supplier. However, this strategy has also been used by EU companies to use qualified labour, as has been done for instance in Russia and India. The companies of mature industrialized countries do not relocate key-technologies or design work on core components, however, in the long run these activities contribute to emerging competitors' efforts to catch up the state-of-technology. It can be expected that a new international division of labour emerges. The competitive position of the European AI in the global market will be strongly dependent on its success to maintain the lead in key-technologies in the value chain. The strength of US companies within the value chain (Tier-1 and below) in global markets is an indication for the importance of such positive effects.

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9 Annexes

9.1 Annex 1: List of Abbreviations

Acronym	Explanation
ACARE	Advisory Council for Aeronautics Research in Europe
AEO	Authorised Economic Operator
AI	Aerospace Industry
AIA	Aerospace Industries Association
AIAC	The Aerospace Industries Association of Canada
AIG	American International Group
AMADEUS	Pan-European database containing financial information
ASD	Aerospace and Defence Industries Association of Europe
ASK	Available Seat Kilometer
ASM	Available Seat Miles
ATM	Air Traffic Management Systems
BAA	Buy American Act
BASA	Bilateral Aviation Safety Agreements
BDLI	Bundesverband der Deutschen Luft- und Raumfahrtindustrie (Association of the German Aerospace Industry)
BI	Balassa Index
BLS	Bureau of Labour Statistics
BRIC	Brazil, Russia, India and China
BMWi	Federal Ministry of Economics and Technology of Germany
BWB	Blended Wing Body
CAD	Computer Aided Design
CARAD	Civil Aeronautics Research and Technology Demonstration
CATIA	Computer Aided Three-Dimensional Interactive Application
CLUNET	Cluster Networking
CTA	Aeronautics Technology Centre
C-TPAT	Customs-Trade Partnership against Terrorism
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center
DoD	Department of Defence
Dolores	Dollar-Low-Rescue
EADS	European Aeronautic, Defence and Space Company
EASA	European Aviation Safety Agency
EBIT	Earnings Before Interest and Taxes
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EGNOS	European Geostationary Navigation Overlay Service
EQF	European Qualification Framework

ERA-NET	European Research Activities-Network
EU	European Union
FAA	Federal Aviation Administration
FDI	Foreign Direct Investment
FP	Framework Programmes for research and technological development
GATT	General Agreement on Tariffs and Trade
GMES	Global Monitoring of the Environment
IATA	International Air Transport Association
IFF	Introduction to Fighters Fundamentals (US Air Force flight training)
IFR	Instrument Flight Rules
IMMARSAT	International Maritime Satellite
ITAR	International Traffic in Arms Regulations
JTI	Joint Technical Initiative
JU	Joint Undertaking
LuFo	Luftfahrtforschungsprogramm (Aerospace Research Programme of the Federal Ministry for Economics and Technology
LCA	Large Civil Aircraft
LCC	low-cost carriers
MEMS	Micro-Electro-Mechanical Systems
MINT	mathematics, information technology, natural sciences and technology
MRO	Maintenance, Repair, and Overhaul
NASA	National Aeronautical and Space Administration
NSF	National Science Foundation
NTM	Non-Tariff Measures
NTSC	National Science and Technology Council
OECD	Organisation for Economic Cooperation and Development
OEM	Original Equipment Manufacturer (i.e. Aircraft Manufacturers, Manufacturers of Final Products)
RCA	Relative (or Revealed) Comparative Advantage
RDA	Regional Development Agencies
ROCE	Return on capital employed
ROSF	Return on Shareholders Funds
RoW	Rest of World
RPM	Revolving per minute
RPK	Revenue passenger kilometres
RTK	Revenue ton kilometres
R&D	Research and Development
SBS	Structural Business Statistics (from Eurostat)
SCM Agreement	WTO Agreement on Subsidies and Countervailing Measures
SME	Small and Medium Enterprises
SRA	Strategic Research Agenda
STAR 21	Strategic Aerospace Review for the 21st century
SWOT	Strengths, Weaknesses, Opportunities and Threats
UAV	Unmanned Aerial/Airborne Vehicle
UDF	Unducted Fan
UN Comtrade	United Nations Commodity Trade Statistics Database
USTR	US Trade Representative
VLCA	Very Large Civil Aircraft
VLJ	Very Light Jet

WTO	World Trade Organization (formerly GATT)

9.2 Annex 2: Indicators Applied in the Sectoral Statistical Analysis

The data used for the analysis are based mostly on the Eurostat Structural Business Statistics (SBS) database, NACE DM 35.5 code, and UN Comtrade HS 1996 data on 6 digit-level (for trade data). NACE sector D, Manufacturing, data has been used for the comparisons between the aerospace sector and other manufacturing industries. The Eurostat data comprises both aerospace and space production, while the trade data is divided in to the following sub-section:

- Helicopters of unladen weight less than (<) 2000kg;
- Helicopters of unladen weight more than (>) 2000kg;
- Fixed wing aircraft with unladen weight less than 2000kg;
- Fixed wing aircraft with unladen weight between 2000kg and 15000kg;
- Fixed wing aircraft with unladen weight more than 15000kg;
- Aircraft parts;
- Aircraft propellers, rotors and parts thereof;
- Aircraft under-carriages and parts thereof; and
- Flight simulators and parts thereof.

For the assessment of the size of a civil airplane: A plane with around 100 seats weighs between 33,000 and 55,000 tons.

In addition, other data sources, such as national association data, have been used (the exact coverage of the data is mentioned in the relevant sub-sectors).

The following includes a detailed description of the used indicators.

(Eurostat) Turnover values comprises the totals invoiced by the observation unit during the reference period, and this corresponds to market sales of goods or services supplied to third parties; it includes all duties and taxes on the goods or services invoiced by the unit with the exception of the VAT invoiced by the unit to its customer and other similar deductible taxes directly linked to turnover; it also includes all other charges (transport, packaging, etc.) passed on to the customer. Price reductions, rebates and discounts as well as the value of returned packing must be deducted.[303]

(Eurostat) Production value measures the amount actually produced by the unit, based on sales, including changes in stocks and the resale of goods and services. The production value is defined as turnover, plus or minus the changes in stocks of finished products, work in progress and goods and services purchased for resale, minus the purchases of goods and services for resale, plus capitalised production, plus other operating income (excluding subsidies). Income and expenditure classified as financial or extra-ordinary in company accounts is excluded from production value.[304]

(Eurostat) Value-added at factor costs is the gross income from operating activities after adjusting for operating subsidies and indirect taxes. Value adjustments (such as depreciation) are not subtracted.[305]

303 http://europa.eu/estatref/info/sdds/en/sbs/sbs_sm.htm
304 Ibid.
305 http://europa.eu/estatref/info/sdds/en/sbs/sbs_sm.htm

(Eurostat) Number of persons employed is defined as the total number of persons who work in the observation unit (inclusive of working proprietors, partners working regularly in the unit and unpaid family workers), as well as persons who work outside the unit who belong to it and are paid by it (e.g. sales representatives, delivery personnel, repair and maintenance teams). It excludes manpower supplied to the unit by other enterprises, persons carrying out repair and maintenance work in the enquiry unit on behalf of other enterprises, as well as those on compulsory military service. [306]

(Eurostat) Apparent labour productivity is calculated as value-added per number of employees. The values are reported in EUR thousand per head.

(Eurostat) Wage adjusted labour productivity is calculated as:
Apparent labour productivity/ Average personnel costs.
It is reported in percentage terms (where a value over 100% means that the value-added per employees is higher than the wage costs). The indicators corrects for the bias in the apparent labour productivity indicator caused by simple price levels (so that higher developed countries with higher prices and hence higher value-added value tend to show higher labour productivity).

(Eurostat) Value-added per hour worked is the last labour productivity indicator, which reports indeed the value-added divided by the number of hours worked by the employees during the year to produce that value-added. The values are reported in EUR per an hour.

(Eurostat) Gross investment in tangible goods is defined as investment during the reference period in all tangible goods. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e. Capitalised production of tangible capital goods), having a useful life of more than one year including non-produced tangible goods such as land. Investments in intangible and financial assets are excluded. [307]

The Balassa Index (BI), which is used to measure the revealed competitiveness of a sector in the global trade, is based on the share of the exports out of total exports compared to the share of the exports in a competing country or in the world. The exact formula for the above calculations is

$$BI = \ln \frac{X_{ij} / X_{tj}}{X_{ir} / X_{tr}} \times 100$$

where i is the subsector, j is the main country, t refers to all products and r refers to the reference country or country group. A value higher than 0 refers to a competitiveness advantage of the sector in country j compared to the reference country (group) r. Similarly**,** a value under 0 refers to a potential competitiveness disadvantage.The methodology is based on the initial theory of Balassa (1965) on the accounting of international competitiveness (i.e. revealed comparative advantage).

The Alternative RCA index, which takes account also the imports of the country in determing the competitiveness (and calculated hence the competitiveness compared to other domestic industries) is calculated as

306 Ibid.
307 Ibid.

$$Index = \ln \frac{X_{ij}/M_{ij}}{X_{tj}/M_{tj}} \times 100 ,$$

where X is exports, M imports, i is the subsector, j is the country, t refers to all products. Similarly to the BI, index values over 0 refer to high (domestic) competitiveness.

Current values vs. constant values

The change of current values reported in the Eurostat database to constant price values is done with the help of the Eurostat Producer Price Index (PPI) index values, due to lack of aerospace product specific inflation data. The constant prices are used for the time series presentation in order to separate productivity effects from the price changes.

Exchange rate corrections

All time series in foreign currencies have been transferred to EUR with constant exchange rates in order to separate the production (or productivity) effects from the exchange rate fluctuations in line with the standards statistical methodologies. For the USD/EUR changes, the constant exchange rate of USD 1.3/EUR 1 has been used.

9.3 Annex 3: Different Statistical Approaches for Sectoral Analyses: Eurostat Statistics and Statistics of the European Association of the Aerospace Industry (ASD)

For the analysis of the aerospace industry two different statistical sources are available. Both of them contribute to the assessment of the performance of the industry, but from a different angle.

The officially available statistics are based on nomenclatures and collect data from companies and their establishments that are obliged to provide information on production, turnover employees etc. It is a 100% collection of data of products manufactured in a country.

In Europe there exists a harmonized nomenclature that has to be applied by all statistical bureaus of the Member States. Therefore the data collected and transmitted to Eurostat are based on the same taxonomy and procedure.

The aerospace industry is mirrored in NACE 35.3. It contains civil-, defence and space vehicles and related parts and components necessary for the production and assemblage of aircraft. There exists one problem because not all stages of production dedicated for the aerospace industry fall under this NACE category. This does not only concern basic and semi-manufactured parts but complex opto-eletronic components and actuators that are assembled in aircraft.

The statistics of the aerospace industry's associations are based on surveys among member firms. There might be some relevant companies that are not covered in the census because they are no members or do not want to participate. However, the scope of these statistics is not limited to the definition of the nomenclature and they contain information of those companies who are of relevance for the aerospace industry and not covered by official statistics.

Although the scope of the associations' statistics is the aerospace industry the coverage might be different, dependent on the members and their product programs. Structural changes induced by M&A and changes in the membership have an impact on the consistency of time series, such as the turnover, production etc. Frequently they are not corrected and necessary revisions of time series have not been carried out. These statistics do not provide indicators necessary for the measurement of performance, such as the value-added. This is a major problem for the assessment of an industry that is in a process of noteworthy changes in the value chain.

The indicator turnover does not only contain the value creation within a certain period but stock sales and traded goods. Because of this the turnover is not the output variable well-suited for a performance analysis. For this purpose the production or – derived from this indicator - even more adequate is the value-added. The value-added consists by definition the value created within a company in a given period. This indicator is only available in official statistics and companies' annual reports.

The project team has become aware of these problems in discussions with sectoral experts. This has led to the decision – in contrast to our first intention to use the associations' statistics – to exploit also Eurostat as a source for performance analyses and international comparisons.

9.4 Annex 4: List of Aerospace Companies in Microeconomic Sample

Mark	Company name	Country
1	ROLLS-ROYCE PLC	UNITED KINGDOM
2	AIRBUS DEUTSCHLAND GMBH	GERMANY
3	AIRBUS FRANCE	FRANCE
4	SNECMA	FRANCE
5	DASSAULT AVIATION	FRANCE
6	AIRBUS UK LIMITED	UNITED KINGDOM
7	EUROCOPTER	FRANCE
8	ZODIAC	FRANCE
9	CFM INTERNATIONAL	FRANCE
10	MTU AERO ENGINES GMBH	GERMANY
11	EUROCOPTER DEUTSCHLAND GMBH	GERMANY
12	ALENIA AERONAUTICA S.P.A.	ITALY
13	EADS CONSTRUCCIONES AERONAUTICAS SA	SPAIN
14	MEGGITT PLC	UNITED KINGDOM
15	TURBOMECA	FRANCE
16	AVIO S.P.A.	ITALY
17	THALES AVIONICS SA	FRANCE
18	AUBERT ET DUVAL (CIRAM)	FRANCE
19	BOMBARDIER AEROSPACE EUROPE LIMITED	UNITED KINGDOM
20	ALERIS ALUMINUM KOBLENZ GMBH	GERMANY
21	AIRBUS ESPANA SL	SPAIN
22	SHORT BROTHERS PLC	UNITED KINGDOM
23	SENIOR PLC	UNITED KINGDOM
24	GOODRICH CONTROLS HOLDING LIMITED	UNITED KINGDOM
25	MESSIER-BUGATTI	FRANCE
26	LIEBHERR - AEROSPACE LINDENBERG GMBH	GERMANY
27	HISPANO SUIZA	FRANCE
28	EUROPEAN AERONAUTIC DEFENCE AND SPACE COMPANY	FRANCE
29	LATECOERE	FRANCE
30	AGUSTA WESTLAND INTERNATIONAL LIMITED	UNITED KINGDOM
31	BRP-ROTAX GMBH & CO. KG	AUSTRIA
32	GROUPE MANOIR INDUSTRIES	FRANCE
33	TECHSPACE AERO	BELGIUM
34	PILATUS FLUGZEUGWERKE AG	SWITZERLAND
35	LABINAL	FRANCE
36	AERNNOVA AEROSPACE, S.A.	SPAIN
37	HEXCEL HOLDINGS (UK) LIMITED	UNITED KINGDOM
38	MECACHROME FRANCE	FRANCE
39	MESSIER-DOWTY LIMITED	UNITED KINGDOM
40	MECACHROME SAS	FRANCE
41	SOCIETE NATIONALE DE CONSTRUCTION AEROSPATIALE	BELGIUM
42	LE JOINT FRANCAIS SNC	FRANCE
43	SPIRIT AEROSYSTEMS (EUROPE) LIMITED	UNITED KINGDOM
44	B/E AEROSPACE (UK) LIMITED	UNITED KINGDOM

45	GOODRICH ACTUATION SYSTEMS SAS	FRANCE
46	GKN AEROSPACE SERVICES LIMITED	UNITED KINGDOM
47	GOODRICH ACTUATION SYSTEMS LIMITED	UNITED KINGDOM
48	DAHER AEROSPACE	FRANCE
49	AERO VODOCHODY, A.S.	CZECH REPUBLIC
50	LIEBHERR AEROSPACE TOULOUSE SAS	FRANCE
51	HONEYWELL AEROSPACE GMBH	GERMANY
52	ELBE FLUGZEUGWERKE GMBH	GERMANY
53	PFW AEROSPACE AG	GERMANY
54	HYDE GROUP HOLDINGS LIMITED	UNITED KINGDOM
55	HEXCEL COMPOSITES	FRANCE
56	PIAGGIO AERO INDUSTRIES SOCIETA' PER AZIONI	ITALY
57	AERAZUR	FRANCE
58	RATIER FIGEAC	FRANCE
59	GE AVIATION SYSTEMS AEROSTRUCTURES HAMBLE LIMITED	UNITED KINGDOM
60	ALENIA AERONAVALI S.P.A.	ITALY
61	ALCOA FIXATIONS SIMMONDS SAS	FRANCE
62	DASSAULT BELGIQUE AVIATION	BELGIUM
63	OGMA-INDUSTRIA AERONAUTICA DE PORTUGAL, S.A.	PORTUGAL
64	SOCIETE ANONYME BELGE DE CONSTRUCTIONS AERONAUTIQUES	BELGIUM
65	AIRCELLE LIMITED	UNITED KINGDOM
66	SETFORGE	FRANCE
67	FORGES DE BOLOGNE	FRANCE
68	FABRICATIONS MECANIQUES DE L'ATLANTIQUE (FAMAT)	FRANCE
69	ZODIAC INTERNATIONAL SA	FRANCE
70	AD INDUSTRIE	FRANCE
71	TIMET SAVOIE	FRANCE
72	SKF AEROSPACE FRANCE	FRANCE
73	PZL - SWIDNIK SA WYTWORNIA SPRZETU KOMUNIKACYJNEGO	POLAND
74	EADS ATR	FRANCE
75	DAHER LHOTELLIER AEROTECHNOLOGIES	FRANCE
76	AIM GROUP PLC	UNITED KINGDOM
77	MT AEROSPACE AG	GERMANY
78	SKF AEROENGINE FRANCE	FRANCE
79	DASELL CABIN INTERIOR GMBH	GERMANY
80	GARDNER GROUP LIMITED	UNITED KINGDOM
81	SA CREUZET AERONAUTIQUE	FRANCE
82	SPS AEROSTRUCTURES LIMITED	UNITED KINGDOM
83	THALES AVIONICS LIMITED	UNITED KINGDOM
84	INDRAERO-SIREN	FRANCE
85	THALES AVIONICS ELECTRICAL SYSTEMS SA	FRANCE
86	GOODRICH AEROSPACE EUROPE	FRANCE
87	ARTUS	FRANCE
88	ASSISTANCE AERONAUTIQUE ET AEROSPATIALE	FRANCE
89	FIGEAC AERO	FRANCE
90	AUXITROL SA	FRANCE
91	GRUPO EMPRESARIAL ALCOR S.L.	SPAIN

92	STE D ETUDES ET DE CONSTRUCTIONS AERONAVALES (SECAN)	FRANCE
93	IPECO HOLDINGS LIMITED	UNITED KINGDOM
94	CAPARO VEHICLE PRODUCTS LIMITED	UNITED KINGDOM
95	SICAMB - S.P.A.	ITALY
96	APPH LIMITED	UNITED KINGDOM
97	CAV AEROSPACE LIMITED	UNITED KINGDOM
98	THIELERT AIRCRAFT ENGINES GMBH	GERMANY
99	PRATT & WHITNEY KALISZ SP. Z O.O.	POLAND
100	MORA AEROSPACE, A.S.	CZECH REPUBLIC
101	TECHNOFAN SA	FRANCE
102	HAMPSON AEROSPACE MACHINING LIMITED	UNITED KINGDOM
103	SA EXAMECA	FRANCE
104	ATELIER CONSTRUCT COMPIEGNE LA JONCHER	FRANCE
105	RUAG AEROSPACE STRUCTURES GMBH	GERMANY
106	EADS COMPOSITES AQUITAINE	FRANCE
107	AUVERGNE AERONAUTIQUE	FRANCE
108	CONSTRUCTION ET REPARATION DE MATERIEL AERONAUTIQUE (CRMA)	FRANCE
109	GKN AEROSPACE TRANSPARENCY SYSTEMS (LUTON) LIMITED	UNITED KINGDOM
110	SODIELEC	FRANCE
111	CROSS MANUFACTURING COMPANY (1938) LIMITED	UNITED KINGDOM
112	AIM AVIATION (JECCO) LIMITED	UNITED KINGDOM
113	BHW (COMPONENTS) LIMITED	UNITED KINGDOM
114	BROOKHOUSE HOLDINGS LIMITED	UNITED KINGDOM
115	SOCIEDAD ANDALUZA DE COMPONENTES ESPECIALES S A.C.E. S.A.	SPAIN
116	COMPANIA ESPANOLA DE SISTEMAS AERONAUTICOS SA	SPAIN
117	OFFICINE MECCANICHE AERONAUTICHE S.P.A. (IN SIGLA O.M.A. S.P.A.)	ITALY
118	REX COMPOSITES	FRANCE
119	ARIES COMPLEX SA	SPAIN
120	THALES AVIONICS LCD SA	FRANCE
121	JEHIER SA	FRANCE
122	COMMATECH HOLDINGS LIMITED	UNITED KINGDOM
123	PRECI-SPARK LIMITED	UNITED KINGDOM
124	J.S. CHINN HOLDINGS LIMITED	UNITED KINGDOM
125	GARDNER AEROSPACE - ILKESTON LIMITED	UNITED KINGDOM
126	TURBOMECANICA SA	ROMANIA
127	S.E.I. SERVIZI ELICOTTERISTICI ITALIANI S.P.A., CHE PUO' ESSERE BREVE	ITALY
128	COMPOSITE INDUSTRIE	FRANCE
129	TURBOMECA UK LIMITED	UNITED KINGDOM
130	SA MALICHAUD ATLANTIQUE	FRANCE
131	GAESA ESTRUCTURAS AERONAUTICAS S.A.	SPAIN
132	EUROPEAN AIR-CRANE S.P.A.	ITALY
133	FIBERTECNIC, S.A.	SPAIN
134	ELTA	FRANCE
135	TECHNICAL AIRBORNE COMPONENTS INDUSTRIES	BELGIUM

136	328 SUPPORT SERVICES GMBH	GERMANY
137	ETS CURTIL	FRANCE
138	ASG LUFTFAHRTTECHNIK UND SENSORIK GMBH	GERMANY
139	ARITEX CADING, SA	SPAIN
140	MICROCAST	FRANCE
141	SENIOR AEROSPACE ERMETO	FRANCE
142	GOODRICH AEROSPACE UK LIMITED	UNITED KINGDOM
143	MAGNAGHI AERONAUTICA S.P.A.	ITALY
144	KID-SYSTEME GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG	GERMANY
145	ESTRELLA GROUP LIMITED	UNITED KINGDOM
146	STE DES FONDERIES D'USSEL (SFU)	FRANCE
147	BROOKHOUSE COMPOSITES LIMITED	UNITED KINGDOM
148	FONDERIE MESSIER	FRANCE
149	WALTER ENGINES, A.S.	CZECH REPUBLIC
150	LE PISTON FRANCAIS	FRANCE
151	STE TOULOUSAINE DE TRAITEMENTS DE SURFACES	FRANCE
152	STE POTEZ AERONAUTIQUE	FRANCE
153	AIM AVIATION (HENSHALLS) LIMITED	UNITED KINGDOM
154	IXMECA	FRANCE
155	MESSIER-DOWTY INTERNATIONAL LIMITED	UNITED KINGDOM
156	MECANIZACIONES AERONAUTICAS SA	SPAIN
157	LACROIX LUCAERO	FRANCE
158	RECAERO	FRANCE
159	COMPONENTES AERONAUTICOS COASA S.A.	SPAIN
160	MECANIQUE AERONAUTIQUE PYRENEENNE	FRANCE
161	FARSOUND INVESTMENTS LIMITED	UNITED KINGDOM
162	LETOV LETECKA VYROBA, S.R.O.	CZECH REPUBLIC
163	ANDRE LAURENT	FRANCE
164	MS COMPOSITES	FRANCE
165	PFW AEROSPACE UK LIMITED	UNITED KINGDOM
166	GROB AEROSPACE GMBH	GERMANY
167	GOODRICH KROSNO SP. Z O.O.	POLAND
168	JSCC REALISATIONS LIMITED	UNITED KINGDOM
169	FLEXIDER - S.R.L.	ITALY
170	MICRO MECANIQUE PYRENEENNE	FRANCE
171	REIMS AEROSPACE	FRANCE
172	SIMAIR	FRANCE
173	RAFAUT	FRANCE
174	ECA SINTERS	FRANCE
175	AERO TECHNIQUE ESPACE	FRANCE
176	MECAPROTEC INDUSTRIE	FRANCE
177	MACH AERO BRETIGNY RECTIFICATION	FRANCE
178	CHATAL	FRANCE
179	EADS PZL WARSZAWA - OKECIE S.A.	POLAND
180	ATHOS AERONAUTIQUE	FRANCE
181	SENSOREX	FRANCE
182	FUSELAJES AERONAUTICOS S.A.	SPAIN

183	STE INDUSTRIA	FRANCE
184	INTEC-AIR SL	SPAIN
185	SAS ASQUINI MGP	FRANCE
186	ARIES ESTRUCTURAS AEROESPACIALES SA	SPAIN
187	SK10 ANDALUCIA SA.	SPAIN
188	EA SERVICES	FRANCE
189	" COSTRUZIONI AERONAUTICHE TECNAM S.R.L. "	ITALY
190	ISSOIRE AVIATION	FRANCE
191	MEGGITT DEFENCE SYSTEMS LIMITED	UNITED KINGDOM
192	AERNNOVA ANDALUCIA ESTRUCTURAS AERONAUTICAS S.A.	SPAIN
193	CASTILLA Y LEON AERONAUTICA S.A.	SPAIN
194	"OFFICINE MECCANICHE AEROSPAZIALI DEL SUD -SPA"	ITALY
195	SERTA AEROSPACE & DEFENCE	FRANCE
196	VIGNAL ARTRU INDUSTRIE	FRANCE
197	VULCANAIR S.P.A.	ITALY
198	AIM COMPOSITES LIMITED	UNITED KINGDOM
199	DUQUEINE RHONE ALPES	FRANCE
200	VIBRO METER FRANCE	FRANCE
201	INIZIATIVE INDUSTRIALI ITALIANE S.P.A.	ITALY
202	NU-PRO SURFACE TREATMENTS LIMITED	UNITED KINGDOM
203	SLINGSBY ADVANCED COMPOSITES LIMITED	UNITED KINGDOM
204	BODET AERO	FRANCE
205	EUROCOPTER ROMANIA SA	ROMANIA
206	AERONAUTICA DEL SUR S.A.L.	SPAIN
207	A.D.R	FRANCE
208	AIRPORT EQUIPMENT SOCIETA A RESPONSABILITA LIMITATA	ITALY
209	LE BOZEC FILTRATION ET SYSTEMES	FRANCE
210	NMF EUROPA S.A.	SPAIN
211	ANJOU ELECTRONIQUE	FRANCE
212	MOASA MONTAJES AERONAUTICOS S.A.	SPAIN
213	ETUD FABRIC INDUST TOLERIE AERO MECANIQ	FRANCE
214	SK 3000 AERONAUTICA SA	SPAIN
215	SK EPSILON AERONAUTICA S.L.	SPAIN
216	STE NOVINTEC	FRANCE
217	EA PRODUCTION	FRANCE
218	AIRCRAFT INTERIOR REFURBISHMENT ESPANA S.L.	SPAIN
219	CABLAGE FRANCAIS (LE)	FRANCE
220	ALCOA FASTENERS SAS	FRANCE
221	TECHNOMETRA RADOTIN, A.S.	CZECH REPUBLIC
222	SOCIETE DE MOTORISATIONS AERON AUTIQUES	FRANCE
223	LISTRAL - ESTRUTURAS AERONAUTICAS, S.A.	PORTUGAL
224	TL-ULTRALIGHT, S.R.O.	CZECH REPUBLIC
225	ALERIS ALUMINUM GMBH	GERMANY
226	DIAMOND AIRCRAFT DK APS	DENMARK
227	DIAMOND AIRCRAFT INDUSTRIES DEUTSCHLAND GMBH	GERMANY
228	DIAMOND AIRCRAFT INDUSTRIES GMBH	AUSTRIA
229	DIAMOND AIRCRAFT UK LIMITED	UNITED KINGDOM

230	FISCHER ADVANCED COMPOSITE COMPONENTS AG	AUSTRIA
231	KAEFER ISOLIERTECHNIK GMBH & CO. KOMMANDITGESELLSCHAFT	GERMANY
232	OTTO FUCHS -KOMMANDITGESELLSCHAFT-	GERMANY
233	SILCOMS LIMITED	UNITED KINGDOM
234	ZF-LUFTFAHRTTECHNIK GMBH	GERMANY

9.5 Annex 5: Indicators Applied in the Microeconomic Statistical Analysis

Code Ama-deus	Indicator / Ratio	formula		code	Parts of formula
517	Operating Revenue per Employee (monetary value)	= 448 / 425	where	448	Operating Revenue/turnover
				425	Employees
508	Profit Margin (%)	=(((448 – 441 - 443) + (444 -445)) / 448) * 100	where	448	Operating Revenue/turnover
				441	Costs of Goods Sold
				443	Other Operating Expenses
				444	Financial Revenue
				445	Financial Expenses
523	EBITDA Margin (%)	= [((442 - 443) + 436) / 448] * 100	where	442	Gross profit
				443	Other Operating Expenses
				436	Depreciation
				448	Operating Revenue/turnover
524	EBIT Margin (%)	= [(442 - 443) / 448] * 100	where	442	Gross profit
				443	Other Operating Expenses
				448	Operating Revenue/turnover
521	Cash Flow / Turnover (%)	= (((448 – 441 – 443 + 444 – 445 - 430) + (446 - 447)) + 436) / 448) * 100	where	448	Operating Revenue/turnover
				441	Costs of Goods Sold
				443	Other Operating Expenses
				444	Financial Revenue
				445	Financial Expenses
				430	Taxation
				446	Extr. and Other Revenue
				447	Extr. and Other Expenses
				436	Depreciation
500	Current Ratio (x)	= (409 + 410 + 411) / (420 + 421 + 422)	where	409	Stocks
				410	Debtors
				411	Other Current Assets
				420	Loans
				421	Creditors
				422	Other Current Liabilities
501	Liquidity Ratio (x)	= ((409 + 410 + 411) - 409) / (420 + 421 + 422)	where	409	Stocks
				410	Debtors
				411	Other Current Assets
				420	Loans
				421	Creditors
				422	Other Current Liabilities
503	Solvency Ratio (%)	= ((414 + 415) / ((405 +406 + 407) + (409 + 410 +411)) * 100	where	414	Capital
				415	Other Shareholders Funds
				405	Intangible Fixed Assets
				406	Tangible Fixed Assets

				407	Other Fixed Assets
				409	Stocks
				410	Debtors
				411	Other Current Assets

509	Return on Shareholder Funds (%)	= (((448 – 441 - 443) + (444 - 445)) / (414 + 415)) * 100		448	Operating Revenue/Turnover
				441	Costs of Goods Sold
				443	Other Operating Expenses
				444	Financial Revenue
				445	Financial Expenses
				414	Capital
				415	Other Shareholders Funds

510	Return on Capital Employed (%)	= ((448 - 441 - 443 + 444 - 445 + 437) / (414 + 415 + 417 + 418)) * 100		448	Operating Revenue/Turnover
				441	Costs of Goods Sold
				443	Other Operating Expenses
				444	Financial Revenue
				445	Financial Expenses
				437	Interest Paid
				414	Capital
				415	Other Shareholders Funds
				417	Long Term Debt
				418	Other Non-Current Liabilities

	Added value per employee	= (430 + 448 – 441 – 443 + 444 – 445 – 430 + 446 – 447 + 435 + 436 + 437) / 425		430	Taxation
				448	Operating Revenue / Turnover
				441	Costs of Goods Sold
				443	Other Operating Expenses
				444	Financial Revenue
				445	Financial Expenses
				446	Extr. and Other Revenue
				447	Extr. and Other Expenses
				435	Cost of Employees
				436	Depreciation
				437	Interest Paid
				425	Employees