Chapter 2
Fundamentals and Structure of Aviation Systems

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Abstract

- The history of aviation beginning with the first drawings and flying items goes back to the fifteenth century.
- The aviation industry has grown to a remarkable size over the centuries and is one of the important industries of economic growth today.
- The aviation industry is structured along the aviation value chain.
- Air transport is characterised by high fixed costs, low profit margins in a growing market, and by its dependence on external factors.
- The stakeholders of aviation profit from the economies and drivers of aviation.
- The aviation system model includes different environments, such as the economic, ecological, social, technological and political environments, which are the platform of the aviation market.

2.1 Introduction

The aviation industry is characterised by constant change. The ongoing liberalisation of markets, technological progress and the establishment of new business models are just a few examples that illustrate the dynamic development of air transportation within the last years. The fact that there are various fields of development indicates that the industry development is not only influenced by the industry actors themselves, but

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also by its structures and institutional surroundings. In turn, the development of the industry shapes its actors and competition structures. The interdependencies among the different stakeholders in aviation and the continuous industry development thereby constantly raise new questions for both theory and practice.

Due to the industry's importance as a provider of employment and as an enabler for social exchange and international trade, its ongoing development is of high practical relevance. The aviation industry is worth over USD 1,000 billion (directly, indirectly and induced effects), employs about 15 million people (ATAG 2008), and transports and services about 4.8 billion passengers a year (ACI 2008). About 40% of the world's manufactured exports (by value) reach their markets by air (Saling 2004), making air transportation an important part of international trade. Today, air transportation is an essential component of leisure and business related travelling, and thus of human connectivity and worldwide economical integration (Sterzenbach and Conrady 2003). Aviation is also at the heart of travel and tourism, the world's largest industry, employing one in nine workers (Chan 2000).

From a theoretical point of view, there are two aspects that justify the selection of the aviation industry a research subject. First, the industry's complexity and its dynamism constantly raise new questions and open up fields that have hardly been investigated by academia. Secondly, theoretical findings about the aviation industry may be applied beyond this context to other industries. In regard to various developments, e.g. alliance formation, aviation serves as an industry precursor, making the research results valuable for broader application.

2.2 Historical Development of Air Transport

This section provides an overview about the history and development of the aviation industry. It is partly derifed from different Authors' comments in Wikipedia and verified with stated references in the Text and by the Authors.

The aviation history can be split into different stages of development:

- Technical development 1783–1929
- Political development 1929–1944
- Development of quality and cost 1945–1973
- Networks, alliances and low-cost operations 1974–1990
- New perspectives – customer value 1991–2010

Aviation history deals with the development of mechanical flight. It ranges from earliest attempts at flying kite-powered devices or gliders to person-controlled and -powered flying.

Humanity's desire to fly possibly first found expression in China, where flights by humans tied to kites (as a punishment) are recorded from the sixth century AD (Anno Domini, After Christ). Subsequently, the first hang-glider was demonstrated by Abbas Ibn Firnas in Andalusia in the ninth century AD. Leonardo da Vinci's (fifteenth century) dream of flying found expression in several designs, but he did

not attempt to demonstrate that flying was possible. It was in post-industrial Europe, from the late eighteenth century onwards, that serious flight attempts were made, with progression from lighter-than-air flight (hot-air balloons, 1783), to un-powered heavier-than-air flight (Otto Lilienthal 1891), and finally, to powered sustained flight (Wright Brothers 1903).

The dream of flying is fuelled by the observation of birds and is illustrated in myths across the world (e.g. Daedalus and Icarus in Greek mythology, or the Pushpaka Vimana of the Ramayana). The first attempts to fly often drew on the idea of imitating birds, like Daedalus did building his wings out of feathers and wax. Attempts to build wings of various materials and jump off high towers continued well into the seventeenth century.

2.2.1 Technical Development 1783–1929

It all began with hot air balloons and kites in China. The Kongming lantern (proto hot air balloon) was known in China from ancient times. Its invention is usually attributed to the general Zhuge Liang (AD 180–234, honorific title Kongming), who is said to have used them to scare the enemy troops. The balloon was made of a large paper bag, below which an oil lamp was installed. Due to the lamp heating the air below the bag, the bag floated in the air. According to Joseph Needham,[1] hot-air balloons in China were known since the third century BC (Before Christ). During the Yuan dynasty (thirteenth century), under rulers like Kublai Khan, it became popular to use rectangular lamps at festivals where they would attract huge crowds. In 559 AD, human flight using a kite was documented during a dispute over succession in the Northern Wei kingdom. In 852 AD, first parachutes and gliders were flown in Spain and England. Some five centuries later, Leonardo da Vinci came up with a hang-glider design in which the inner parts of the wings are fixed, and some control surfaces are provided towards the tips. While his drawings still exist and are deemed flight worthy in principle, Leonardo da Vinci himself never flew such a hang-glider.

The first published paper on aviation was the "Sketch of a Machine for Flying in the Air" by Emanuel Swedenborg published in his periodical 1716. This flying machine consisted of a light frame covered with strong canvas and equipped with two large oars or wings moving on a horizontal axis, arranged in such a way that the upstroke met with no resistance, while the down stroke provided lifting power. Swedenborg knew that the machine would not fly, but he thought of it as a good starting point and was confident that the problem would be solved. He said,

[1]Joseph Terence Montgomery Needham (9th December 1900 – 24th March 1995) was a British biochemist, best known for his work on the history of Chinese science. He was elected a fellow of both, the Royal Society and the British Academy. In China, he is known mainly by his Chinese name Li Yuese.

"It seems easier to talk of such a machine than to put it into actuality, for it requires greater force and less weight than exists in a human body. The science of mechanics might perhaps suggest a means, namely, a strong spiral spring. If these advantages and requisites are observed, perhaps in time to come someone might know how better to utilize our sketch and cause some addition to be made so as to accomplish that which we can only suggest. Yet there are sufficient proofs and examples from nature that such flights can take place without danger, although when the first trials are made you may have to pay for the experience, and not mind an arm or leg." Swedenborg would prove prescient in his observation that powering the aircraft through the air was the crux of flying.

The first generally acknowledged human flight took place in Paris in 1783. Jean-François Pilâtre de Rozier and François Laurent d'Arlandes went 5 miles (8 km) in a hot air balloon invented by the Montgolfier brothers. The balloon was powered by a wood fire. Ballooning became a major "rage" in Europe in the late eighteenth century, providing the first detailed understanding of the relationship between altitude and the atmosphere. Work on developing a steerable (or dirigible) balloon (today called an airship) continued sporadically throughout the 1800s. The first powered, controlled, sustained lighter-than-air flight is commonly believed to have taken place in 1852 when Henri Giffard flew 15 miles (24 km) with a steam engine driven craft in France.

During the last years of the eighteenth century, Sir George Cayley started the first rigorous study about the physics of flight. In 1799, he exhibited a plan for a glider which, except for its form, was, from today's perspective, already completely modern. It showed a separate tail for control and provided for the pilot to be suspended below the centre of gravity to ensure stability. Cayley flew it as a model in 1804. Over the next five decades he worked on the problem, inventing most of basic aerodynamics and introducing such terms as "lift" and "drag". He used both internal and external combustion engines, fuelled by gunpowder, but it was left to Alphonse Penaud to make powering models simple, using rubber power. Later, Cayley turned his research to building a full-scale version of his design. First, he flew it unmanned in 1849; in 1853, his coachman made a short flight at Brompton near Scarborough in Yorkshire.

First test flights with gliders began in the middle of the nineteenth century when several pioneers made short flights or jumps. Scientists started to publish more papers about aerodynamics and the subject of flying in general. In the 1880s, first advancements were made in the construction of gliders which led to the first truly practical gliders. Otto Lilienthal was one of the particularly active researchers who flew with and controlled his glider. He produced a series of good gliders, and in 1891, was able to make flights of 25 m or more routinely. He rigorously documented his work, including photographs, and therefore is one of the best known of the early pioneers. He also promoted the idea of "jumping before you fly"; suggesting that researchers should start with gliders and work their way up, instead of simply designing a powered machine on paper and hoping it would work. Lilienthal knew that once an engine was attached to the plane, it would be difficult to further study the laws of aviation. Finding and describing many of those laws

was the greatest heritage he made to his successors. Thanks to Lilienthal, they were able to construct their planes according to his laws and save themselves years of trial and error. By the time of his death in 1896, he had made 2,500 flights on a number of different designs of gliders. His death was caused by a gust of wind that broke the wing of his latest design. He fell from a height of roughly 56 ft (17 m) fracturing his spine. Lilienthal died the next day, his last words being "sacrifices must be made". Up to his death, Lilienthal had been working on small engines suitable for powering his designs.

Picking up where Lilienthal had left off, Octave Chanute took up aircraft design after an early retirement and funded the development of several gliders. In the summer of 1896, his troop flew several of his designs a number of times at Miller Beach, Indiana, eventually deciding that the best was a biplane design that, from today's point of view, looked surprisingly modern. Like Lilienthal, he documented his work meticulously, using also photographs, and was busy corresponding with like-minded hobbyists around the world.

Chanute was particularly interested in solving the problem of natural stability of the aircraft in flight; birds did this by instinct, but humans would have to do it manually. The most disconcerting problem was longitudinal stability because as the angle of attack of a wing increased, the centre of pressure moved forward and made the angle increase more. Without immediate correction, the craft would pitch up and stall.

On the basis of the research documented by Lilienthal and Chanute several other researchers worked on better controllable aircrafts with engines. At the same time that non-rigid airships were starting to have some success, rigid airships were also becoming more advanced. Indeed, rigid body dirigibles would be far more capable than fixed-wing aircraft, in terms of pure cargo carrying capacity, for decades. Dirigible design and advancement was brought about by the German count Ferdinand von Zeppelin.

Between 1900 and 1902, the Wright brothers built and tested a series of kite and glider designs before attempting to build a powered design. The gliders worked, but not as well as the Wrights had expected, based on the experiments and writings of their nineteenth century predecessors. In 1903, the first sustained flight with a powered controlled aircraft took place successfully. Flyer I and II were used for several test flights; a number of crashes happened. When rebuilding the flyer, calling it Flyer III, after a severe crash on 14 July 1905, the Wrights made radical changes to the design. They almost doubled the size of the elevator and rudder and moved them further away from the wings – about twice the distance than before. They also added two fixed vertical vanes (called "blinkers") between the elevators and gave the wings a very slight dihedral. They disconnected the rudder of the rebuilt Flyer III from the wing-warping control and, as in all future aircraft, placed it on a separate control handle. When testing of Flyer III resumed in September, the results were almost immediate. The bucking and veering that had hampered Flyers I and II were gone and the Wrights experienced no more minor crashes, which had happened frequently with the two previous models. The flights with the redesigned Flyer III started to last over 20 min. Thus, Flyer III became a practicable as well as dependable aircraft, flying solidly for a consistent duration, bringing back its pilot to the starting point safely, and landing without causing damage to itself.

On 5 October 1905, Wilbur flew 24 miles (38.9 km) in about 40 min. In 1908, the Wright brothers conducted the first passenger flight in the USA.

Several researchers built and tested powered planes within the following years. On 25 July 1909, Louis Blériot flew the Blériot XI monoplane across the English Channel, winning the Daily Mail aviation prize. His flight from Calais to Dover lasted 37 min. On 22 October 1909, Raymonde de Laroche became the first woman to pilot and solo a powered heavier-than-air craft. She was also the first woman in the world to receive a pilot's licence. The first seaplane was invented in March 1910 by the French engineer Henri Fabre. Its name was Le Canard ("the duck"). The plane took off from the water and flew 800 m on its first flight on March 28, 1910. His experiments were closely followed by the aircraft pioneers Gabriel and Charles Voisin, who purchased several of the Fabre floats and fitted them to their Canard Voisin airplane. In October 1910, the Canard Voisin became the first seaplane to fly over the river Seine, and in March 1912, the first seaplane to be used militarily from a seaplane carrier, the La Foudre ("the lightning").

In World War I, planes were used for the first time for military purposes. During that time the military supported the development of planes strongly.

Mail and single passenger transport became more popular, but it was an adventurous mode of transport, which was dependant on weather. The Warsaw Convention for limitation of liability was reached.

2.2.2 Political Development 1929–1944

Aircraft evolved from being constructed mostly of wood and canvas to being constructed almost entirely of aluminium. Engine development proceeded apace, with engines developing from in-line water cooled gasoline engines to rotary and radial air cooled engines, constituting a commensurate increase in propulsive power. All of this development was pushed forward by prizes for distance and speed records. Charles Lindbergh, for instance, took the Orteig Prize of $25,000 for his solo non-stop crossing of the Atlantic. He was the first person to achieve this, although not the first to carry out a non-stop crossing. Latter was achieved 8 years earlier when Captain John Alcock and Lieutenant Arthur Brown co-piloted a Vickers Vimy non-stop from St. John's, Newfoundland, to Clifden, Ireland, on 14 June 1919, winning the Northcliffe prize worth GBP 10,000 (USD 50,000).

In the 1930s, development of the jet engine began in Germany and England. In England, Frank Whittle patented a design for a jet engine in 1930 and started building an engine towards the end of the decade. In Germany, Hans von Ohain patented his version of a jet engine in 1936 and began developing a similar engine. The two men were unaware of each other's work and both, Germany and Britain, had developed jet aircraft by the end of World War II.

World War II saw a drastic increase in the pace of aircraft development and production. All countries involved in the war stepped up the development and production of aircraft and flight-based weapon delivery systems, such as the first

long-range bomber. Fighters were critical to the success of the heavy bombers, as they ensured that the number of losses was lower than it would have been without fighter protection. A number of technological advances that were remarkable for its day are the following: The first functional jet plane was the Heinkel He 178 (Germany) flown by Erich Warsitz in 1939. The first cruise missile (V-1), the first ballistic missile (V-2), and the first manned rocket Bachem Ba 349 were also developed by Germany; however, the small number of Jet fighters did not have a significant impact. The V-1 was not very effective, as it was slow and vulnerable and the V-2 could not hit targets precisely enough.

With the emergence of longer flights and the possibility to fly over other countries, some international regulation was needed. The central convention in the field of international air law is the agreement concerning international civil aviation reached on December 7, 1944 (Chicago Convention – CHI) (SR 0.748). Due to its universal character the Chicago Convention is the fundamental policy for the post-war development of international civil aviation. Following the agreement, the International Civil Aviation Organisation (ICAO) was built.

Art. 1 CHI states that: "The contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory". The claim of every state having a sovereign power over the airspace above its territory contradicts the nature of aviation, which is, by definition, international. To allow international aviation, states need to negotiate for multilateral agreements and/or bilateral aviation conventions. Therefore, the preamble of the CHI states that "the undersigned governments [have] agreed on certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically".

The preparations for the conference of Chicago had started when the ending of the Second World War was conceivable.[2] On 1 September 1944, the US invited to a diplomatic roundtable in Chicago to discuss the future of the aviation industry. Before the negotiations had started a multilateral system of traffic rights was aspired (Wenglorz 1992).

The US disposed of an extraordinarily strong military aviation force (300,000 aircrafts) after World War II – including countless transportation aircrafts. Those, they could easily convert into a civil armada. With this in mind, the US delegation argued in favour of open skies. Britain, in contrast, wanted an orderly market development (Larsen et al. 2006), meaning a contract that regulates all aircraft transport services. In bilateral aviation agreements, important factors in the competitive environment should be negotiated – the number of seats, the type of aircraft, the frequency of flights, the routes, the rights to land, etc. In contrast to this British scheme was the idea of a worldwide opening of the aircraft transportation market (open skies) (Larsen et al. 2006).

[2]In June 1944, after the Normandie offensive of the United States.

Due to the differing positions, long-lasting and difficult negotiations about the "eight freedoms of the air" were necessary (refer to Chap. 11) (Wenglorz 1992).

2.2.3 Development of Quality and Cost 1945–1973

Commercial aviation took hold after World War II, using mostly ex-military aircraft in the business of transporting people and goods. Within a few years many companies existed and flight routes criss-crossed North America, Europe and other parts of the world. This development was accelerated by the glut of heavy and super-heavy bomber airframes, like the B-29 and Lancaster, which could easily be converted into commercial aircraft. The DC-3 also permitted easier and longer commercial flights. The first North American commercial jet airliner, the Avro C102 Jetliner, flew in September 1949 shortly after the British Comet. By 1952, the British state airline BOAC had introduced the De Havilland Comet into scheduled service. While it represented a technical achievement, the plane suffered a series of highly public failures. The shape of its windows led to cracks due to metal fatigue which was caused by cycles of pressurisation and depressurisation of the cabin, and eventually led to a catastrophic failure of the plane's fuselage. By the time the problems were overcome, other jet airliner designs had already taken to the skies. USSR's Aeroflot became the first airline in the world to operate sustained regular jet services with the Tupolev Tu-104 on 15 September 1956. Boeing 707, which established new levels of comfort, safety, and passenger expectations, ushered in the age of mass commercial air travel as it is enjoyed today.

Even after the end of World War II there was still a need for advancement in aircraft and rocket technology. Not long after the war had ended, in October 1947, Chuck Yeager took the rocket powered Bell X-1 past the speed of sound. Although anecdotal evidence exists that some fighter pilots may have crossed the sound barrier while dive-bombing ground targets during the war, this was the first controlled level flight to achieve this. Further barriers of distance were overcome in 1948 and 1952 as the first jet crossing of the Atlantic was conducted.

In 1961, the sky was no longer the limit for manned flight, as Yuri Gagarin orbited the planet within 108 min. His achievement heated up the space race, which had started in 1957 with the launch of Sputnik 1 by the Soviet Union, even further. The United States responded by launching Alan Shepard into space on a suborbital flight in a Mercury space capsule. With the launch of the Alouette I in 1963 Canada became the third country to send a satellite into space. The space race between the United States and the Soviet Union would ultimately lead to the current pinnacle of human flight, the landing of men on the moon by Neil Armstrong in 1969.

However, this historic achievement in space was not the only progress made in aviation at this time. In 1967, the X-15 set the air speed record for an aircraft at 4,534 mph or Mach 6.1 (7,297 km/h). This record still stands as the air speed record for powered flight, except for vehicles designed to fly in outer space.

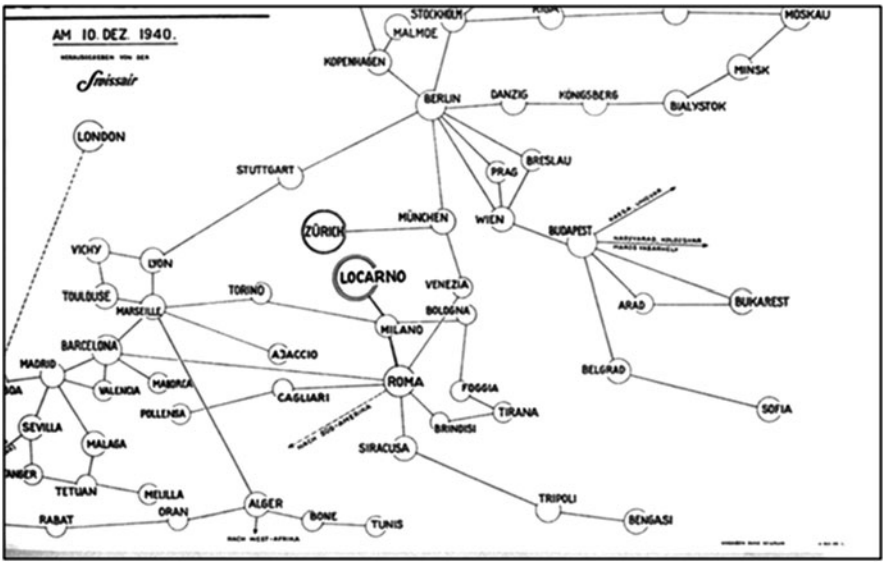

Fig. 2.1 Swissair routes in the 1940s (Source: Schroeder 2002)

Fig. 2.2 Swissair routes in the 1980s (Source: Schroeder 2002)

At the same time commercial aviation became more reliable and the industry grew. Airlines were established and route networks were set up. Figures 2.1 and 2.2 show the development of Swissair and its route networks from the 1930s to the 1970s. The network evolved from a European point-to-point network to a hub-and-spoke network with connections through the hub Zurich-Airport. First, some European destinations were served. The planes still had to stop over on longer

routes to refuel. Since planes were still small, they carried mostly only one passenger.

Figure 2.1 illustrates the development from a point-to-point network to a raster network. As the planes became bigger, they allowed for more passengers to be transported. This development enabled the airlines to offer several destinations on one route, which meant that they could serve more passengers in a small market and thus finance their operation.

Figure 2.2 shows the hub Zurich located in the centre and European domestic connections going through the hub Zurich to long-haul destinations. With the establishment of the long-haul market, it became important for airlines to have enough passengers to fill the large long-haul planes. Therefore, short and long-haul flights were connected.

The route development of Swissair, as illustrated in the following route network figure (Fig. 2.2), was a consequence of deregulation. The competitive environment changed and led to competitive prices and more efficient network management in the airline business.

While the European aviation is still in a continuing process of deregulation, the US has undergone this development more than 30 years ago. Therefore, research concerning the consequences of deregulation is much further advanced for the American area than for the European area, since many consequences can only be empirically tested and quantified with a time lag. This is the reason why the development of deregulation in America and its consequences are outlined in the following paragraphs.

2.2.3.1 Deregulation of the American Air Transport

The regulation of aviation was questioned strongly in the 1970s. On the one hand, this was based on the general critique concerning the regulation policy of the government stemming from new economic approaches like the "contestable markets" approach (Baumol et al. 1982). On the other hand, the aviation industry found itself in a serious crisis: the oil crises lead to higher fuel costs, simultaneously there was a low demand for flights due to the recession and airlines had considerable debts from investments in wide-bodied aircrafts.

At this time, countless government regulations existed which aimed at securing an area-wide supply and avoiding too strong a competition that would ruin the aviation market. However, these regulations led to a favouritism of large airlines and a slackening of competition (Grundmann 1998).Although flight prices were high, airlines did not achieve returns. As a consequence, and to meet the rising political pressure, the Airline Deregulation Act was signed in 1978 (Pompl 2007). This was the beginning of the deregulation of the inner-American air traffic between 1979 and 1983 (Schäfer 2003), in which the regulations concerned with market access, capacities and prices were abandoned.

This was an important development because, from then on, the US actively aimed at deregulating the aviation market. The so-called Open-Sky policy of the US

strived for the signing of agreements with other states which then got the permission for the 3rd, 4th and 5th freedom: opportunity of code-sharing, capacity for free tariffs, freedom in the appointment of capacities and frequencies (Schäfer 2003).

The impacts of deregulation on the American market have been assessed in countless studies and have been discussed controversially. In the following, the decisive effects for the airlines (supply) as well as for the consumers (demand) are presented.

Supply

Especially the deregulation of prices in conjunction with the reduction of entry barriers led to fierce price pressure through new market entries for existing airlines. Therefore, in the first 8 years after the abolition of regulations, 200 new airlines were founded. Many of those newly founded airline companies quickly became victims of the strong competitive pressure. Approximately two thirds of the newly founded airlines disappeared from the market because they ceased business, were absorbed or involved in mergers (Pompl 2007). Consequently, the concentration within the aviation industry rose. Prior to the deregulation, the eight biggest airlines possessed 81% of the domestic market, which shifted to 95% by 1991 (Dempsey and Goek 1992). The rise in economic pressure from competition and the high number of fusions during that period show that economies of scale, scope and density had been idle and could be fully utilised after the deregulation of the market (Dempsey and Goek 1992).

Altogether the first 5 years of deregulation were characterised by bad revenues in the airline industry. The American airlines lost USD 900 million and suffered from the worst profit situation the aviation industry had ever experienced (Pompl 2007). In this context, it is important to remember that the general economic climate was marked by a recession and the second oil crises. Therefore, the situation for the aviation industry was difficult worldwide.

The airlines confronted with competitive pressure reacted by massively cutting costs, mainly labour costs. As a result, the real unit labour costs fell by more than 50% in the period between 1978 and 1984. In contrast, the decline in Europe only amounted to 15% (Card 1996).

Besides introducing cost cuts, airlines also adapted their business models and strategies towards the new competitive environment. In particular the new competitors were forced to position themselves in niches. The “no frills” concept and the introduction of low-cost carriers are supply strategies which have developed into a widely spread concept among airlines.

The pressure, however, also opened up new opportunities for increased flexibility which led to an augmentation of productivity. The flight routes could be restructured and adjusted to better suit customer needs. Since price regulations had been abolished, price differentiation became possible. The newly founded airlines in particular profited from the fact that their employees were not unionised and that they could therefore cut costs thanks to more flexible conditions of employment and

lower wage levels (Baltagi et al. 1995). The emergence of hub-and-spoke networks was also a development promoted by the deregulation. The canalisation of routes through hub-and-spoke networks allowed for cost cuts, while the mounting of hubs also led to a natural monopoly for certain airlines at the different locations. These airlines could avoid the price pressure up to a certain degree (Card 1996). Except for three cases, all hubs were controlled by airlines that generated at least 60% of all flights, gates and passengers (Dempsey and Goek 1992).

The large airlines adopted computer-based reservation systems as an entry barrier for new suppliers. They used these computer-based reservation systems as a marketing instrument and paid commissions to travel agencies for using the systems prohibiting the use of competing systems (Williams 1994). The travel agencies could request price information and capacities, as well as carry out bookings in these systems. These developments increased the concentration on only a few airlines (Kennet 1993). Frequent flyer programs also emerged during that time – another measure of customer loyalty which boosted big airlines (Martinez et al. 2001).

In general, the supply developed positively with rising demand. Between 1978 and 1988 the number of passengers increased by 88% and the kilometres flown by passengers rose by 62%. The supply, in form of available seat kilometres, rose by approximately 65% during the same period (Kennet 1993).

Demand

The consumers are often considered the real beneficiaries of deregulation because it resulted in lower flight prices. In fact, the prices sank by 22% on average between 1978 and 1993 (Morrison and Winston 1997). In addition, a large number of passengers was able to benefit from lower prices. In the year 1989, for instance, 89% of all passengers benefited from an average price reduction of 89% (Pompl 2007). Prior to the deregulation a decrease of flight prices would already have been possible through technical advances, i.e. the introduction of large capacity aircrafts, but it was forwarded further by the deregulation.

The increased number of flights and air connections after deregulation also meant that customers had a greater choice of offers to choose from (Pompl 2007; Edelman and Baker 1996). Additionally, with the establishment of the hub-and-spoke systems, fewer passengers had to change between aircrafts or even airlines during their travels (Borenstein 1992). The hub-and-spoke system, however, also led to higher prices at the hubs. In 1988, the average prices at the 15 most frequently passed hubs were 27% higher than the prices at the 38 not concentrated airports (Dempsey and Goek 1992). One reason for this is the market power of the dominant airlines at different locations. As a consequence, prices for air travel which ended at hubs became more expensive in comparison with prices for connecting flights towards hubs. The major competition and consequently the decrease in prices happened on those routes that were direct connections with much traffic (Button 1996).

Overall, the service offering has increased because of the differentiation of performance; however a distinction has to be made between hubs and remote areas. Although at large, the number of offered flights has increased, since the deregulation, smaller towns are generally only serviced by one airline and therefore the availability of flights is worse for those regions (Dempsey and Goek 1992). However, the number of hubs has increased and thus the number of non-stop connections has also risen.

Then again, the increase of the total number of flights has also led to a capacity overload and consequently, the number of delayed flights and the noise exposure in the area surrounding the hubs have increased. Furthermore, passengers have to cope with having to spend more time on aircrafts and airports (Dempsey and Goek 1992).

In general, studies on deregulation conclude that, on average, consumers have benefited distinctively from lower flight prices and higher service offerings. It is estimated that consumers saved up to USD 11 billion in the year 1986 alone (Kahn 1988).

2.2.3.2 Deregulation of the European Air Transport

In Europe, the same development happened with a time lag of 15 years. Since 1993 freedom of services has existed in European aviation, and since 1997 full cabotage has been allowed in the framework of the third liberalisation package. Since that year there is an actual domestic market for aviation among the members of the European Union. The delay of the deregulation development in Europe is due to the heterogeneous structure of the European Union which did not allow for an implementation at the same pace as in the US. A faster development would most likely not have been successful, as will be demonstrated in the next chapter.

Besides the harmonisation of the law and the deregulation, accompanying measures were implemented. Therefore, in view of the higher number of flight delays and cancellations, passenger rights were strengthened. Furthermore, a number of regulations concerned with flight noise emissions were implemented and flight security was further Europeanised (O'Reilly and Stone Sweet 1998).

Still, the European market cannot be referred to as a liberalised market. There are still countless regulations which have an impact on the aviation industry. In particular, the following are significant (Heitmann 2005):

- The regulation of extra-European routes and extra-European airlines
- The regulation of the access to lean airport capacities
- The hindrance of pan European fusions
- The payment of open and hidden subsidies

Because of the structure of the European aviation, deregulation was implemented over a longer period of time and has different impacts compare to the impacts deregulation has had in the US. Those differences are explained in the following.

2.2.3.3 Differences Between the European and American Market

Unlike the US aviation industry, which was affected by private companies from its very beginning (Grundmann 1998), the European aviation industry was always heavily influenced by governmental interventions and governmentally funded companies.

The liberalisation of the European civil aviation industry was an evolutionary process, whereas the Deregulation Act constituted an abrupt change in policy (Button et al. 1998). Incremental developments give advantages to small companies entering a market, as they may provide a chance for consistent development (Martinez et al. 2001).

As mentioned before, the political process of deregulation is significantly different to the one in the US (Nijkamp 1996). The European Union is a collective of sovereign states which makes deregulation to a process of negotiation. Due to differing interests of various states, deregulation was only slowly implemented. The majority of states had a governmentally funded flag carrier and an infrastructure they wanted to protect. These national interests were reasons for the gaps in deregulation pointed out earlier. These regulations lead to an inefficient deregulation process.

The structure of airlines in different nations and the state funding scheme of those states, differ significantly. The company culture, the terms of employment and the claims of the environment differ between the US and EU regions. A further difference may be noticed in the structure of customers. Customers in the US market are relatively homogenous, whereas European airlines have to cope with customers that have heterogeneous demands and differ in their cultural backgrounds.

A significant difference also exists in the Hub-and-spoke systems. In contrast to the US system, in Europe these systems are nationally coined. Although since 1997, when cabotage has been permitted, the possibility exists to establish hubs at optimal locations outlying the home market, this possibility is strongly limited by the stringency of slots.

2.2.4 Networks, Alliances and Low Cost Operations 1974–1990

In the early 1970s, Boeing came out with its vision for the future of air travel, unveiling the Boeing 747 for the first time. Still, this plane is one of the largest aircraft that has ever been flying, carrying millions of passengers each year. In 1975, commercial aviation progressed even further when the Soviet Aeroflot started regular service on Tu-144 – the first supersonic passenger plane. In 1976, British Airways inaugurated supersonic service across the Atlantic, courtesy of the Concorde. A few years earlier the SR-71 Blackbird had set the record for crossing

the Atlantic in less than 2 h, and Concorde followed its footsteps with passengers in tow.

In the air passenger market the competition among national airlines increased. National airlines charged high amounts for tickets and were supported by their governments. They operated in a controlled environment, where they had monopolies in their countries. With the deregulation in the USA, prices started to decrease and the first low-costs carrier (South West Airlines) was founded in the USA in 1971. In Europe, the deregulation process took much longer. Price competition started in Europe in the 1980s. Several low-cost carriers commenced their operations in Europe following the start of the price competition and new business models emerged with different cost allocations. New pricing schemes were introduced which followed new booking behaviours using Internet booking services.

Network carriers strengthened their hub-and-spoke networks searching for economies of scale, scope and density by growing organically or by mergers and acquisitions. Instead of merging with other airlines, Lufthansa decided to start loose alliance networks by founding the Star Alliance. Wide-body planes, such as the Boeing 747, the DC 10, and the MD 11, were generating profits on long-haul routes.

Charter airlines became more popular and were integrated into tour operators. The latter offered the tourist the whole value chain, from the transportation to the holiday destination, to the stay in the destination, as well as the transportation back to his/her home.

Figure 2.2 illustrates the growth of the Swissair network in the 1980s. "Hubbing" became more important to fill the large wide-body planes on long-haul routes.

2.2.5 New Perspectives – Customer Value 1991–2010

During the 1990s, especially in Europe further deregulation took place. Today, online sales channels become more efficient and are very popular. Under the pressure of an increasing number of low-cost carriers on short-haul routes as well as international threats such as wars, epidemics and terrorism, network carriers had to become more efficient to be able to survive in a liberalised market which is dominated by prices. Network management was intensified. Alliances grew independently, while mergers were less successful. The path through alliances towards mergers seems to be a successful one. Best examples for this are the integration of Swiss International Airlines into Lufthansa and KLM into Air France. The trend moves towards continental hubs. Dubai, which is a major hub in the Middle East, is an example of continental hubbing, connecting intercontinental flights. In the future, network carriers can develop in two ways. They can either become so called mega carriers like Emirates Airlines, Lufthansa, British Airways, Air France/KLM or they become niche players with smaller networks focusing on specific routes or a specific group of travellers (e.g. Private Air).

Low-cost airlines developed an anti-network model, which has been successful on the domestic markets around the globe for several years and enticed away passengers from existing network carriers. In addition, this business model managed to attract new target groups for low-cost trips within continents, consisting of those persons, who did never fly before. Developments indicate that there even might be a market for long-haul low-cost travel as Oasis Hong Kong airlines served the route between London and Hong Kong, although this carrier had to suspend its operations for economic reasons. Due to high numbers of new low-cost airline entries in the market, consolidation is becoming an issue among low-cost airlines. In recent years, takeovers have occurred more frequently than they used to and some low-cost carriers such as Air Berlin offer mileage programs. Furthermore, paperless ticketing is commonly used by network and low-cost carriers.

After Open Skies Agreements had been relaxed in the USA, they also have been further relaxed in Europe. This had an impact on connectivity and pricing of airline tickets. In the future, new pricing schemes are likely to be evaluated and implemented. As prices are increasing due to overfilled airspaces and airports and also due to high fuel costs, a seamless customer service becomes a highly relevant issue. A new level of quality is required in premium classes (business and first class) which are growing in their popularity and represent the business field of network carriers which is most profitable. Consequently, some airlines introduced new aircrafts, even all-business class aircrafts, to the market. Business aviation is growing as it has never done before and it will experience further growth with the emergence of new Very Light Jets.

In the beginning of the twenty-first century, aviation has focused on remotely operated or completely autonomous vehicles. Several unmanned aerial vehicles or UAVs have been developed. In April 2001, the unmanned aircraft Global Hawk flew from Edwards AFB in the USA to Australia non-stop and without being refuelled. It took 23 h and 23 min and was the longest point-to-point flight ever undertaken by an unmanned aircraft. In October 2003, the first completely autonomous flight of a computer-controlled model aircraft occurred across the Atlantic.

In commercial aviation, the early twenty-first century has seen the end of an era with the retirement of the Concorde. Supersonic flights turned out not to be commercially viable, as the planes had to fly over the oceans if they wanted to break the sound barrier. Furthermore, the Concorde featured high fuel consumption and could only carry a limited number of passengers due to its highly streamlined design. New developments in the area of supersonic flight can be recognized, however, for an airline, they are not yet at a sustainable level for implementation.

2.3 Size of the Aviation Industry

This section provides an overview and some statistics of the aviation industry based on different data sources. The largest airlines in the world can be found in the Unites States of America. Carrying over 100 million passengers each year, Southwest

Table 2.1 Top ten network and cargo airlines (Source: IATA 2007)

Total international and domestic passengers			Scheduled freight ton kilometers flown		
Rank	Airline	Thsds.	Rank	Airline	Thsds.
1	American Airlines	98,165	1	Federal Express Corp.	15,759
2	Delta Air Lines	73,086	2	United Parcel Service Company (UPS)	11,107
3	United Airlines	68,363	3	Koran Airlines	9,666
4	China Southern Airlines	56,522	4	Deutsche Lufthansa	8,615
5	Northwest Airlines	54,696	5	Cathay Pacific Airway	8,438
6	Deutsche Lufthansa	54,164	6	Singapore Airlines	8,029
7	Air France	50,465	7	China Airlines	6,344
8	Continental Airlines	49,058	8	Air France	6,268
9	All Nippon Airways	48,987	9	Emirates	5,597
10	Japan Airlines International	47,204	10	Cargolux Airlines International	5,482

Airlines is the largest passenger airline in the world. Federal Express Corporation (FedEx) is the largest scheduled freight transporter with almost 16,000 freight ton kilometres. The second and third largest passenger airline are also American airlines, China Southern Airline ranks fourth. A further American airline ranks fifth, the Deutsche Lufthansa ranks sixth and Air France ranks seventh. The ranks and passengers carried are presented in Table 2.1.

When airlines are ranked according to the group net profits, a different picture emerges. Singapore Airlines group is on top of the ranking list before Air France, KLM and Lufthansa group. The first American airline, South West Airlines, is a low-cost carrier which ranks 11th. This emphasizes the structure of the airline industry around the world with profits in the American market rather being low when compared to the European markets. Table 2.2 shows the net profits of the top 20 ranked airlines in the years 2006 and 2005.

However, airlines and freight forwarders are not the only important partners of the aviation industry. Airports handle all passengers and represent the key infrastructure for the industry. Atlanta, which is the largest airport in the world, handles almost 90 million passengers each year. Chicago O'Hare, the second largest airport, handles more than 76 million passengers and London Heathrow being the third largest airport, handles almost 70 million passengers each year. Table 2.3 provides an overview of the 20 largest airports in the world.

The size of airports can also be looked at from the perspective of total movements per year. Ranking airports according to this perspective shows that Atlanta handles almost one million movements, which represents the largest number of departures and landings of all airports worldwide. Considering the perspective of movements, Paris which ranks eighth on the world ranking list, is the largest European airport American airports take seven of the first seven positions. Table 2.4 shows the movement rankings of the largest airports worldwide.

Table 2.2 Twenty top airline groups based on net profits (Source: Airline Business 2007)

		Net profits USD million		
Ranking	Airline group	2006	2005	Top 150 rank
1	Singapore Airlines Group	1,366	747	15
2	Air France-KLM Group	1,150	1,108	1
3	Lufthansa Group	1,014	561	2
4	Emirates Group	941	674	18
5	SAS Group	647	34	19
6	British Airways	578	829	8
7	Qantas Airways	542	575	13
8	Cathay Pacific Airways	526	424	20
9	Ryanair	518	380	43
10	Air Canada	505	221	14
11	Southwest Airlines	499	484	16
12	Korean Air	363	196	17
13	Continental Airlines	343	-68	9
14	Air China	338	294	24
15	US Airways Group	304	−537	12
16	ANA Group	279	235	10
17	GolTransportesAereos	262	213	54
18	TAM LinhasAéreas	256	78	33
19	Aeroflot Russian Airlines	255	190	39
20	LAM Airlines	241	147	38

Table 2.3 The largest airports in the world according total number of passengers carried (Source: Airport Council International 2008)

Rank	City	Code	Total passengers	% Change
1	Atlanta GA	ATL	89,379,287	5.3
2	Chicago IL	ORD	76,177,855	(0.1)
3	London	LHR	68,068,304	0.8
4	Tokyo	HND	66,823,414	1.1
5	Los Angeles CA	LAX	61,896,075	1.4
6	Paris	CDG	59,922,177	5.4
7	Dallas/Fort Worth TX	DFW	59,786,476	(0.7)
8	Frankfurt	FRA	54,161,856	2.6
9	Beijing	PEK	53,583,664	10.1
10	Madrid	MAD	52,122,702	13.9
11	Denver CO	DEN	49,863,352	5.4
12	Amsterdam	AMS	47,794,994	3.8
13	New York NY	JFK	47,716,941	11.9
14	Hong Kong, China	HKG	47,042,419	7.3
15	Las Vegas NV	LAS	46,961,011	3.2
16	Houston TX	IAH	42,998,040	1.1
17	Phoenix AZ	PHX	42,184,515	1.8
18	Bangkok	BKK	41,210,081	(3.7)
19	Singapore	SIN	36,701,556	4.8
20	Orlando FL	MCO	36,480,416	5.3

Table 2.4 The largest airports worldwide according to the number of movements (Source: Airport Council International 2008)

Rank	City	Code	Total movements	% Change
1	Atlanta GA	ATL	994,346	1.8
2	Chicago IL	ORD	926,973	(3.3)
3	Dallas/Fort Worth TX	DFW	685,491	(2.0)
4	Los Angeles CA	LAX	680,954	3.7
5	Denver CO	DEN	614,065	2.8
6	Las Vegas NV	LAS	609,472	(1.6)
7	Houston TX	IAH	603,656	0.2
8	Paris	CDG	552,721	2.1
9	Phoenix AZ	PHX	539,211	(1.3)
10	Charlotte NC	CLT	522,541	2.6
11	Philadelphia PA	PHL	499,653	(3.1)
12	Frankfurt	FRA	492,569	0.7
13	Madrid	MAD	483,284	11.1
14	London	LHR	481,479	0.9
15	Detroit MI	DTW	467,230	(3.0)
16	Amsterdam	AMS	454,360	3.2
17	Minneapolis MN	MSP	452,972	(4.6)
18	New York NY	JFK	446,348	17.2
19	Newark NJ	EWR	435,691	(2.0)
20	Munich	MUC	431,691	5.0

These data all present the historical development of the airlines and airports mentioned. However, for economists and managers an important question is "how the future will develop". Airbus, for example has looked at the scheduled world air traffic today and compared it to forecasts made in regard to the year 2020. In 2000, the big air transport market has still been in the United States of America. By 2020, it is expected to move towards other continents. In Europe, the Middle East and in the Asia-Pacific area, a general growth trend can be recognized, whereas the American market is declining. Moreover, the number of connections between the USA and Europe is likely to decline, whereas there are a growing number of connections between Europe and the Asia-Pacific area. In addition, the Middle Eastern area is expected to realize an increase in the volume of passengers carried and movements in the next few years. Figures 2.3 and 2.4 illustrate the shares of revenue-passengers-kilometres (RPK) between different areas of the world in the year 2000 and the year 2020. RPK's are the revenues per passenger per kilometre.

Airports and airlines are not the only representatives of the aviation market. Further suppliers play a significant role in the aviation industry along the supply chain: manufacturers, e.g. Boeing and Airbus, which depend on orders of airlines, maintenance, leasing, ground handling, reservation system providers, catering and fuelling organizations and travel agents. All those suppliers generate their incomes entirely or at least to some extent from the aviation industry. This fact highlights the relevance of the aviation industry in the economy.

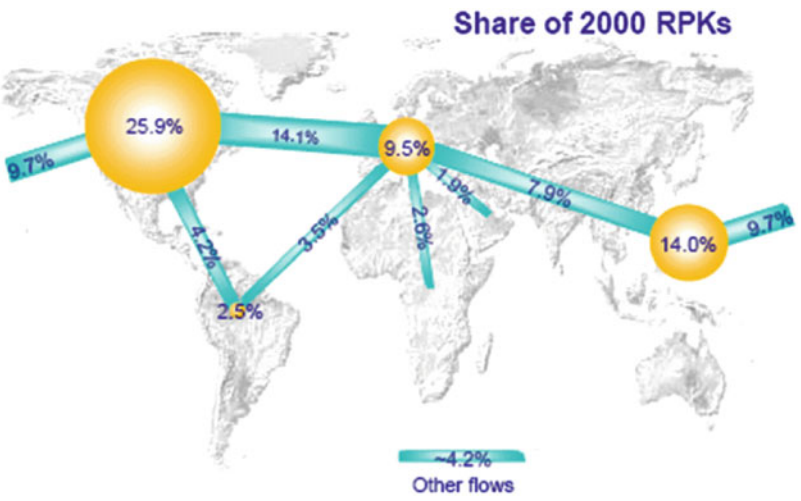

Fig. 2.3 World air traffic flow in the year 2000 (Source: Airbus 2005)

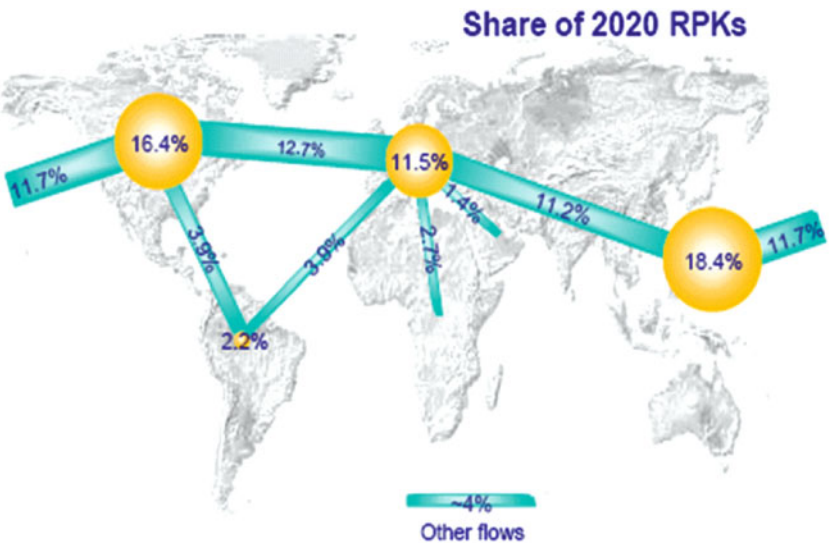

Fig. 2.4 World air traffic flow forecast by the year 2020 (Source: Airbus 2005)

As for the drivers of development we can conclude that the biggest airlines are located in the United States of America. A reason for this is that in the United States of America large distances have to be covered and big centres have to be connected. Asia has the strongest growth in the demand for air travel, due to its economic boom and population growth. In total, the aviation industry generates approximately USD 1,000 billion and about 15 million people are working in this industry

(ATAG 2008). In established markets, e.g. in the USA, some saturation effects can already be observed.

2.4 Structure of the Aviation Industry

The aviation industry is a service industry providing transport services (Pompl 2006). Air transportation shows many characteristics which are typical for service industries, e.g. the intangibility and perishability of the product and the high importance of personal contact to the customer.

As mentioned before, airlines and airports are the two main actors in the industry. Airlines offer the actual transport service; airports provide the ground infrastructure to handle aircraft movements. The manufacturing industry and aviation suppliers assemble aircrafts and provide spare products. As a provider of supplementary processes, the industry relies on general service providers such as air traffic control. Figure 2.5 illustrates the value chain in the aviation industry.

This section provides an overview about the overall supply chain and industry competition structures. Each group of actors will be then be described in the following chapters.

Apart from the airline industry, the aviation value chain is generally dominated by monopolistic or duopolistic structures.

Concerning the *general service providers*, the airline industry is characterized by monopolies for air traffic control services. The aircraft *manufacturing industry* forms an oligopolistic structure regarding small and mid-sized aircrafts and a duopoly regarding the market for wide-body aircrafts. Some markets, for instance the market for very large aircrafts (more than 400 seats), are merely served by single companies (Airbus with its A380), which leads to monopolies for individual aircraft segments.

The *airline industry* is characterized by fierce competition. Airlines compete on a polypolistic market. On the one hand, the latter is characterized by low entry

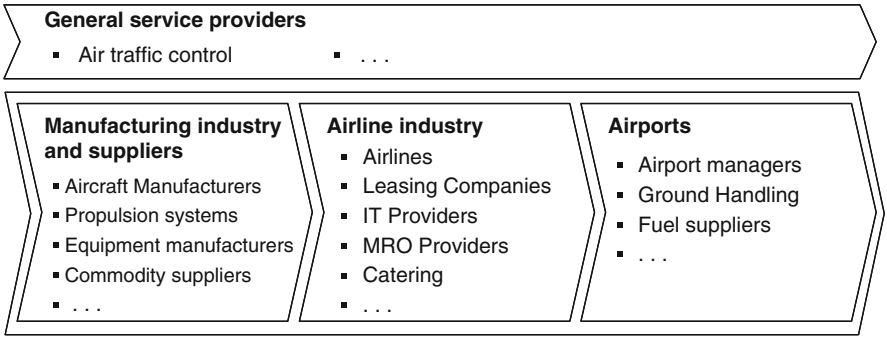

Fig. 2.5 The aviation industry value chain (Source: Own illustration)

barriers and a variety of different business models (Wells and Wensveen 2004). On the other hand, the airline industry is extremely capital intensive and comprises specific investments in long-term assets that create high exit barriers. While Information Technology (IT), maintenance, repair and overhaul (MRO) and catering providers are usually located nearby the respective airlines (commonly large airlines), the airline leasing market is dominated by two companies (duopoly). Oligopolistic structures occur in regard to airports, usually one or a few of them dominating whole regions or nations. At airports, often only limited competition exists concerning ground handling services. Fuel companies are structured in an oligopoly (Kangis and O'Reilly 1998).

While airlines and airports are enclosed by the manufacturing and supplying industry on the upstream side, the final customer is located at the downstream side. In addition to competition stemming from within the industry, airlines and airports have to cope with new competitors and are subject to potential substitutes (Fig. 2.5).

The value chain is just a part of a bigger system, which consists of different market forces and environments. Figure 2.6 shows the market forces surrounded by the different market environments and helps us to define the aviation system as a simplified framework for defining and understanding the aviation business. The following sub chapters will focus on the main market forces such as new competitors, substitutes and customers. The force "manufacturing industry and suppliers" is dealt with in Section 2.6. A description of the environments is included in Chapter 3.

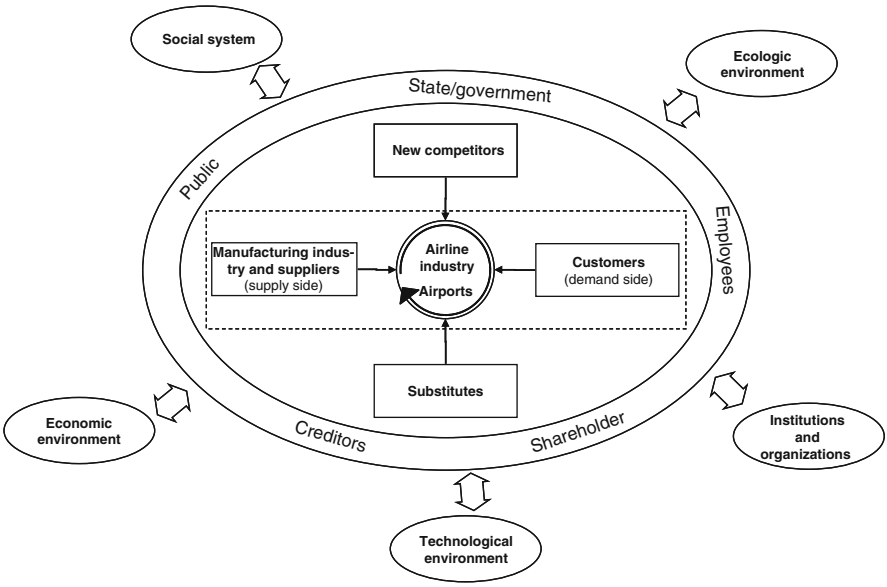

Fig. 2.6 The aviation industry system (Source: Own illustration in relation to Porter 1980)

2.4.1 New Competitors

As the airline market is characterized by low entry barriers and increasing market liberalization, new competitors are a constant threat to existing airlines (Pompl 2006). However, not all new entrants are successful in building a permanent market position and thus may exit the market after some time (such as all-business carriers or long-haul low-cost carriers).The establishment of "low-cost" airlines in the 1990s is an example for successful market entries.

Market entrance barriers of airports are much higher than the ones of airlines, due to extremely high initial infrastructure investments. As a consequence, the number of newly established airports remained rather low during the last years. In Europe, notable exceptions are the conversions of former military airfields into low-cost airports, whereas in Asia and the Middle East an exception is the emergence of all-new airports in the strongly growing traffic regions.

2.4.2 Substitutes

High-speed trains offer transportation alternatives and have an impact on airlines – and consequently on airports (Pompl 2006; O'Reilly 1995). On the one hand, high-speed trains may pose a threat to airlines, particularly on short-distance routes. On the other hand, however, they may also provide an opportunity for airlines and airports to alleviate air- and landside airport congestion and gain new customer groups. Thus, rail transport cannot be considered being a substitute for air transportation per se. A further potential threat to air transportation is the increasing usage of telecommunication technologies as a means for communication (such as video-conferencing). This phenomenon might reduce the volume of passenger movement which was made possible by air transportation in the first place.

2.4.3 Customers

The demand side of the aviation industry can be distinguished between persons who are flying for business purposes (those passengers, who demand frequent flights to a wide range of destinations, seek service quality and are willing to pay a premium for these benefits) and leisure travellers (who seek the lowest prices and are less concerned about the service being offered, frequency of flights or the number of destinations being served) (Rothkopf 2009). However, the group of airline passengers is becoming increasingly heterogeneous (Huse and Evangelho 2007). The competition in aviation results in a high customer persuasion as consumers have the choice between different options for travelling and transportation providers. In regard to the product, an extraordinary high transparency exists, as

customers may compare prices of almost all products available. Even though the customer may choose from a large variety of sales channels (such as travel agencies, Internet, telephone), the air transportation market is characterized increasingly by online distribution (Pompl 2006).

In general, air freight is booked over the forwarder, who in turn reserves cargo capacity at an airline. Since key freight forwarders usually make the largest bookings, cargo airlines typically deal with a very small client base, which therefore disposes of a high bargaining power (Becker and Dill 2007).

The air transportation industry is encompassed by a number of stakeholders. The stakeholders form the aviation industry's "inner-circle" and are directly connected to the industry players. Actors within that circle are airline and airport employees or shareholders that are financially engaged in the aviation industry.

As the "outer-circle" shows, the air transportation industry as a whole is embedded in its environment (stakeholders). Major linkages exist to its ecological environment, to institutions and organizations, to its technological and economic environment as well as to its social system (see Chap. 2).

2.5 Special Characteristics in Air Transportation

The aviation industry features a number of characteristics which make it unique and distinguish it from other industries. As these peculiarities are fundamental to the industry and have implications on competition structures, the most important characteristics are introduced briefly in the following:

- *Cyclicality of the industry development*: The aviation industry is characterized by a highly cyclical development of passenger and freight transportation (Joppien 2006; Pompl 2006). Years of high profits and strong demand are regularly followed by years of substantial losses. In general, the development of air transportation is coupled to the overall economic state of the industry (Sterzenbach and Conrady 2003; Wells and Wensveen 2004). Nevertheless, the cyclical up- and downturns in aviation appear to be amplified, i.e. more volatile than the overall economic development. The development of air cargo thereby is often found to feature a trend which is slightly ahead the development of the general economy. Therefore, it can be used as an indicator for the overall development of the economy (Joppien 2006) (Fig. 2.7).
  On the one side, the reasons for the high cyclicality in aviation lay in its external surrounding, with air transportation only reacting and following the overall state and development of the economy. On the other side, long supply chains and procurement cycles often lead to over and under capacities. The time between the order of an airplane and the actual start of operations can take up to several years. Thus, an aircraft which has been ordered in an economic upturn often arrives in a recession and may even worsen this downturn (Wells and Wensveen 2004). Inversely, intended capacity growth due to increasing demand might not

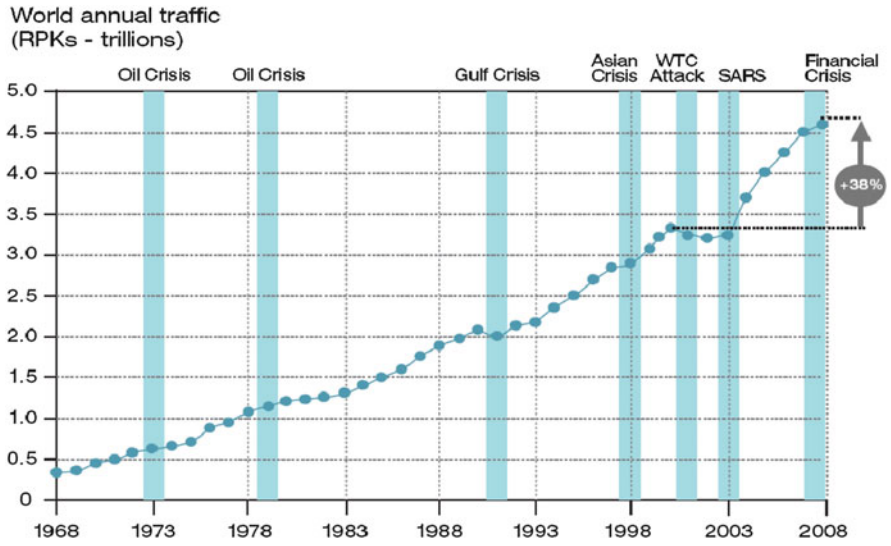

Fig. 2.7 Influence of external shocks on air travel in the long term (Source: Airbus 2009)

completely be met, as there is only little possibility to respond quickly to increasing demand if airlines, which have been ordered, are not delivered in time (Joppien 2006).

- *High fixed cost structure*: When compared to other industries, air transportation is characterized by a high fixed cost structure and rather low variable costs (Pompl 2006; wells and Wensveen 2004). Air transportation is an extremely capital-intensive industry with very specific investments in long-term assets that create high exit barriers (Joppien 2006).
  The reasons for this cost structure are high – and often very specific – investments at either manufacturers (development of new aircraft), at airlines (financing of new aircraft), or at airports (provision of ground infrastructure such as runways and terminals). Consequently, for airlines marginal costs are important, regarding a possible implementation of lower price limits which may be offered over a short period of time. This peculiar cost structure often leads to fierce price competition, in which, e.g. airlines are selling their seats close to variable costs (as a marginal return to the fixed costs) (see Chap. 3).
- *Strong growth coupled with low profit margins*: The airline industry has always been characterized by strong growth numbers. In the past 50 years, global aviation has grown at an average rate of about 5 % per annum (Boeing 2009). The reasons for this strong growth are the on-going industry liberalization and the resulting opening up of new markets as well as the decreasing costs of flying (Pompl 2006). Nevertheless, growing passenger numbers are accompanied by ever decreasing margins. Doganis (2005) describes the latter as the "paradoxon" of aviation. Historically, returns in the airline business have been low, and can be compared to those in commodity industries (Gillen and Lall 2004). Airlines in

particular are characterized by rather low profit margins that regularly fall short of those realized at airports, caterers, aircraft manufacturers and ground service providers (Doganis 2005). Overall, many airlines do not earn their cost of capital. However, in terms of profitability, there are high variances among airlines. A number of airlines are able to realize profits and above-average growth rates, widely independent from economic cycles and the chosen business model. For example Southwest and Singapore Airlines show that this is possible both in the low-cost as well as in the premium segment (Heracleous et al. 2006). The reasons for the low margins, particularly at airlines, can partly be found in the specific industry cost structure introduced before. A further reason is the high competition within the airline industry. Moreover, airlines often claim that their low profitability arises from a 'hostile' environment in which airlines are caught in a 'sandwich position' between monopolistic or oligopolistic providers that are able to generate much higher profit margins at the expense of the airlines.

- *Dependency on external input factors*: Aviation is highly dependent on and thus vulnerable to external input factors. This is especially true in regard to fuel prices (Wells and Wensveen 2004). At airlines, kerosene bills alone regularly sum up to approximately one third of the overall costs. Sharply de- or increasing prices for input factors can therefore either foster or slow down industry growth.

2.6 Stakeholders in Aviation

In the aviation industry, three main groups of actors can be distinguished: the aircraft manufacturing industry, airlines and airports. These stakeholders are briefly introduced in the subsequent paragraphs. A further important stakeholder is the air traffic control. As it is in most countries heavily regulated and very often state owned, it is excluded here as are the regulatory governmental bodies.

2.6.1 Manufacturing Industry and Suppliers

The aircraft manufacturing industry is characterized by two dominant manufacturers: Boeing and Airbus. These two companies represent the only manufacturers on the market (Newhouse 2007), particularly regarding wide-body aircraft. These two players as well as smaller manufacturers such as Bombardier and Embraer play a role for small to medium-sized aircraft (up to about 150 seats). Profit margins of aircraft manufacturers are commonly higher than those of airlines and airports, however, when compared to the total manufacturing industry, they are below average (Doganis 2005).

According to Wells and Wensveen (2004), the characteristic features of the aircraft manufacturing industry are extremely high capital requirements, high entry and exit barriers, dynamic economies of scale, a high research and

development (R&D) intensity and relatively long periods between initial investment and returning cash flows resulting from aircraft sales. As a consequence, prices for aircrafts must be calculated long time before the sale the aircraft on the basis of sales forecasts. Furthermore, due to dynamic economies of scale, production costs vary greatly depending on the output. Thus, an exact prediction of production levels is critical. Overall, the high investment needs, the long planning horizon and the dependence on the cyclical demand for aircraft significantly enhance the manufacturers' business risks (Clarke 2001). Launch costs for new aircraft such as the Airbus A380 or the Boeing 787 can amount to more than EUR 10 billion (Wells and Wensveen 2004). Mostly, a large part of the construction is sourced out to a network of international suppliers. While this measure aims to reduce the business risk for aircraft manufacturers, today it is considered as one of the main reasons for delays in the delivery schedule of new aircrafts (Pritchard and MacPherson 2004).

Suppliers to aircraft manufacturers mainly constitute of propulsion systems manufacturers (a market dominated by General Electric, Rolls-Royce, Pratt & Whitney), equipment manufacturers (e.g. avionics, cabin, electrical and hydraulic systems), as well as commodity suppliers (e.g. metallic and composite assemblies). Nowadays, up to 70% of the added value of aircrafts may stem from the supplying industry (Pritchard and MacPherson 2004).

2.6.2 Airline Industry

In the aviation industry, airlines represent the most visible group of actors. Even though every airline offers the same core service (the transport of passengers or cargo from one destination to another), by no means the group of airlines is a homogeneous one. Between airlines, fundamental differences exist in regard to the underlying business model, i.e. the service level offered, the regional reach, and the main function.

The business model of the *international full-service network carriers* or *flag carriers* is largely based upon the operation of a hub-and-spoke network with a strong focus on transfer traffic. By carefully synchronizing inbound and outbound flights, passengers can optimally transfer and connect to different flights at an airport hub and by this has the opportunity to reach a greater number of destinations. Direct services between the major cities (mainly national) complement the network. In the main international traffic regions, important international network carriers can be found, for example in North America (carriers such as Delta Airlines, American Airlines or United Airlines), in Europe (e.g. Air France-KLM, Lufthansa and British Airways), and in the Asia/Oceania region (e.g. Emirates, Singapore Airlines and Qantas Airways). As the main source of revenues in this group of airlines is the actual transport fare, the majority of traditional airlines still offer all-inclusive prices (O'Connell and Williams 2005). Full-service network carriers offer a highly service-intensive product. On the one hand, this allows

them to attract business traffic and to realize a price premium. On the other hand, it leads to highly complex and expensive network designs and operational structures.

Network niche carriers represent a modification of the traditional network carriers. Due to their smaller size, network niche carriers merely operate regional networks with a few connections to major international hubs (e.g. SAS, Austrian Airlines, SWISS). Often, niche carriers are a subsidiary of the so-called "mega-carriers" such as Lufthansa or Air France/KLM.

Smaller *regional carriers* (e.g. BA City Flyer, Air Dolomiti) pursue a different business model. They focus on linking remote areas with thin flows or on feeding into the hubs of network carriers.

Further relevant business models are the fast growing groups of low-cost carriers (e.g. Southwest, Ryanair, easyJet, AirAsia) and charter airlines (e.g. Condor, TUIfly). In contrast to traditional network carriers, *low-cost carriers* (LCC) concentrate on a high volume short to medium-haul point-to-point traffic based on a minimum service approach ('no frills') and lean operations (no seat reservation; no frequent flyer programs, narrow seating) (Vlaar et al. 2005). The carriers either use smaller (and cheaper) secondary airports (e.g. Ryanair) or fly into major airports and thus, directly compete with established airlines (e.g. easyJet). LCCs heavily rely on ancillary revenues, which are generated for example from offered catering as well as from luggage fees. LCCs usually pursue unbundled pricing strategies which are in contrast to the ones pursued by traditional carriers.

Charter airlines service tourist markets. Their strategy is a combination of service quality, low-cost structures, and their integration into tour operators (Pompl 2006). However, charter airlines are more and more substituted by low-cost carriers on highly frequented traffic routes (e.g. from the UK to Southern Spain). Therefore, they need to focus stronger on remote and specialized tourist destinations (Vlaar et al. 2005).

Air cargo carriers are a special form of an airline business model. The network carriers introduced above generally have their own cargo fleets (e.g. Korean Cargo, Lufthansa Cargo) whereas in the field of air cargo carriers, some airfreight-only carriers exist (e.g. FedEx, Polar Air, Cargolux). These companies ship cargo in their freighters as well as in the cargo compartments of their passenger fleet.

2.6.3 Air Taxi Services

In the USA, air taxi services have been existing for many years and they are growing remarkably in the European market remarkably. Operators like e.g. NetJets are at service for individual travellers and companies who prefer to travel on business jets. They operate partly as feeders to mega-carriers regarding first class passengers. The saving of travel time and the direct reachability of all regions in the world are some of their main advantages. By means of significantly lower air fares, New Very Light Jets (VLJ) are supposed to change the air taxi business.

2.6.4 *Airports*

Airlines are complemented by airports, which are providers of ground infrastructure (e.g. runways and terminals). Airports have an extremely high specificity of their infrastructure investment. A large number of national and international airports still are under public ownership; noteworthy privatization trends have only recently been observed (Graham 2003).

Airports are not a homogeneous group. Among others they differ in their size, function and regional reach. Airports like Chicago O'Hare, London Heathrow or Singapore Changi are international hubs ('megahubs'). They concentrate on intra-regional and international transport and serve as starting and end point for intercontinental long-haul services. Secondary airports focus on intra-regional services (e.g. intra-European or intra-American air transportation). Regional airports, which habitually are only served by smaller aircrafts, focus on feeder flights to international or national hubs. Overall, there is a high degree of concentration among passenger flows at airports, with the 100 biggest airports worldwide accounting for more than 60% of all passengers (ACI 2008). In numerical terms, small airfields represent the largest group of all airports. Small airfields serve general aviation like private business aviation and leisure/sports flying.

Airports pursue different business models that depend on their sizes, functions and locations. Particularly at major international airports, traditional revenue sources e.g. landing fees, merely represent a small part of all income sources. Non-aviation income sources, such as parking and real estate, often represent more than half of the total revenues (Graham 2003; Jarach 2005). Usually, the service level provided at these airports (e.g. infrastructure connections to other modes of transportation, lounges) is relatively high. Airports that mainly serve low-cost airlines, however, only provide a minimum of services. Due to their remote locations, ground infrastructure connections are usually poor. In contrast to the group of airports introduced above, these airports often generate losses and thus operate at the taxpayers' expenses.

2.7 Main Drivers and Economies

The potential market of airlines depends on the extent of economic growth and the internationalization of economies. Furthermore, a country´s regulation and international global regulation create boundaries of the air transport market. Technical developments have a great impact on cost structures of airlines and air transport companies which, in turn influences the air transport market. The most important economies in the air transport market are presented in the following:

Economies of technology:

- New planes have lower costs per available seat/km (CASK) (e.g. Airbus A380)
- Smaller planes are able to fly longer distances (e.g. Boeing 787, Airbus A350)

Economies of scale:

- Bigger planes have lower costs of available seat/km (CASK) (e.g. Airbus A380)
- Bigger airports are cheaper per passenger

Economies of scope:

- Bigger airlines provide more origin and destinations with comparably fewer legs (e.g. Alliances like Star Alliance)

Economies of density:

- Airlines dominating hubs show comparably higher market shares

2.8 Approach Toward an Integrated Aviation System

The aviation system can be seen in a framework where social, economic, technological, ecological and political feathers create a platform of the air transport market place. The social and political systems profit from aviation. Moreover, they profit from the opportunity to getting to know new cultures and thus, to create a mutual understanding between cultures. However, there are negative factors as well, such as safety and security. Furthermore, noise emissions belong to social and political systems. The economic system deals with demand and supply in the air transport market. A demand growth contributes to the growth of direct economic factors like jobs and revenues of air transport companies but also indirect and induced economic factors along the supply chain. Furthermore, catalytic effects such as accessibility (e.g. for international companies or tourism) play an important role for a countries international attractivity compared to other countries. On the other side, factor cost and the absorption of resources are compared to positive economic effects in the economic system. The technological system focuses on a better performance of for example engines and aerodynamics. New innovations that help the aviation industry to perform more economically and ecologically are of great importance in the technology system. Technology puts pressure on aviation operators to reinvest in new innovation in order to become more efficient in the market. Safety and security also play a very important role in the technology system. The environmental system mainly deals with natural resources and the fact that resources are for free (e.g. oxygen, CO_2 emissions, airspace, etc.). The development of sensitivity for natural beauty and on the negative side pollution in high altitude and pollution at airports are dealt with in the environmental system.

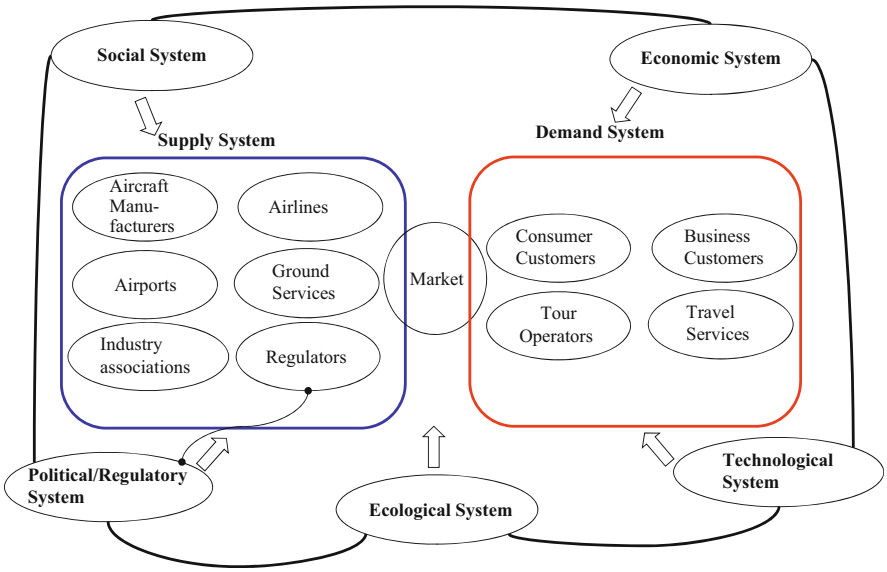

Fig. 2.8 The aviation system (Source: Bieger/Wittmer)

In summary, these systems represent the framework in which the air transport market works. The market consists of a supply system and a demand system. The supply system consists of all partners along the supply chain that deliver to airlines and airports. On the demand side, there are consumers, like leisure and business customers, tour operators and travel sources that pay for an air service. Airlines generate their revenues from the market. The whole supply system is being paid from these revenues. By this the airlines are the most important factor in the supply system, in the aviation market and for whole aviation system. Figure 2.8 illustrates the aviation system.

In the following chapter, the aviation system will be looked at in detail.

Review Questions

- Who are the main players in the aviation industry value chain?
- Who are the main stakeholders of the aviation industry?
- What are special characteristics of air transportation?
- How are economic development and the aviation industry linked?
- What is the problem of industries with high fixed costs?
- What are economies of technology of airlines?
- What are economies of scale of airlines?
- What are economies of scope of airlines?
- What are economies of density of airports?
- What are the environments of the aviation system?

Appendix: Airline Key Figures (Fig. 2.9)

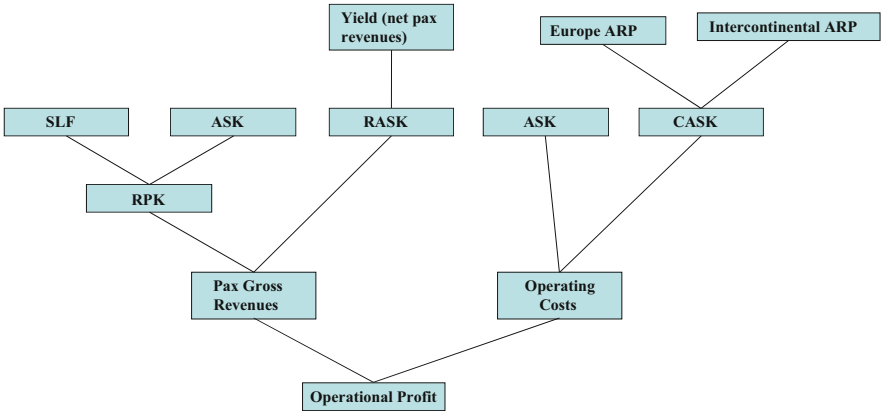

Fig. 2.9 Airline key figures (Source: Own analysis). *SLF* seat load factor, *ASK* average seat kilometre, *RASK* revenue per average seat kilometre, *CASK* costs per average seat kilometre, *RPK* revenue passenger kilometre, *ARP* airport reference point

Figure 2.9 shows how different Key Figures are related to each other and also depend on each other.

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