POLITECNICO DI TORINO

College of Engineering and Management
Master of Science in Industrial Engineering

Project Report

Analysis of a NYSE listed company

Boeing Co.

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SUMMARY

1. COMPANY BACKGROUND

1.1. Boeing's history

Boeing was founded on July 15th 1916 by William Boeing and George Westervelt. In its first decade, Boeing also founded Boeing Air Transport, one of the first airline companies. The two companies were merged in 1928, but were later separated in 1934 in view of a new anti-monopoly law that prohibited the same company to both produce aircrafts and work as an airline. The company quickly grew and lived a moment of prosperity during WWII, when they produced a big number of bombers for the American army. After the war, military orders heavily decreased, and 70,000 people got laid off. Boeing therefore faced a quick conversion to commercial aircrafts.

During the 50's the new technologies allowed for a huge improvement in the quality of aircrafts. In 1952, Boeing started the development of the 707, which was employed in the inauguration of the New York-Paris route. Later in the decade, Boeing started producing the 727, which had a lot of success for its comfort and reliability. This aircraft model has been produced until 1984. In these years, Boeing's military division focused on the development of short-range and intercontinental missiles, which brought plenty of revenue during the first years of the Cold War.

During the 60's Boeing started the production of the Boeing 737, the most sold aircraft in the history of aviation. The 737 family is still being produced, also thanks to the continuous introduction of innovations to increase capacity and efficiency.

During the 70's, the American government cancelled the Apollo program, in which the aerospace company had heavily contributed in the earlier decade. Boeing tried to focus its efforts on the commercial division, but a recession in the airline industry lead to the decrease in aircraft orders. In 1971, the American Congress also stopped financing the project for the supersonic plane Boeing 2707, which lead to the unemployment of 40,000 workers. Boeing, faced with all these difficulties, decided to bet on the B747, a new long-range wide-body aircraft that later became the staple model of the company. Boeing maintained dominance on this market segment until 2001, when Airbus introduced the A380.

During the 90's, Boeing increased its influence on the market and almost reached a position of monopoly, thanks to the acquisitions of Rockwell International and McDonnel Douglas.

The start of the century was characterized by the increase in competition between Boeing and Airbus, the European aviation company. Airbus achieved a big

advantage in the growing segment of narrow-body airplanes, heavily employed in the new low-cost airlines' business model. As the competition grew, Boeing's business and design decisions started to change to ensure a competitive edge over Airbus. In 2006, Boeing started producing the 737 MAX in order to bounce back in the narrow-body aircraft market segment. In 2005, Boeing announced the production of a new 747 model in order to compete with the A380. In 2005, Boeing also started developing the 787 Dreamliner, the first ultra-long range plane that can travel more than half of the world's length with a full passenger load.

1.2. Company structure and divisions

Boeing is the world's largest company in the aerospace sector and leading manufacturer for commercial and military aircrafts. Boeing specializes in the production of satellites, weapons, electronic and defense systems, launch systems, advances information. It also provides financing solutions for its customers.

Boeing organization is composed by two main business divisions: *Boeing Commercial Airplanes* and *Boeing Defense, Space & Security*. Moreover, there are several other divisions, which support the main business, such as Engineering, Test & Technology, Boeing Research & Technology, Boeing Test & Evaluation, Intellectual Property Management, Information Technology, Environment, Health, and Safety, Boeing Shared Services Group, Boeing Realty, Boeing Travel Management Company and Boeing Supplier Management. The financing service is managed by another division, the *Boeing Capital Corporation*.

1.2.1. Boeing Commercial Airplanes

The *Boeing Commercial Airplanes* (BCA) is the most relevant company division. In 2015, it had the highest revenues, which amounted to $66,048 million. The same division provides jobs for about 83,500 employees. The commercial division focuses on the production of several type of families of airplanes, such as the 737, 747, 767, 777 and 787. Nowadays the product development mainly revolves around the Boeing 787 Dreamliner and the 737 MAX families. About 50% of the current global aircraft fleet (10,000 jetliners),and about 90% of the world's cargo fleet have been manufactured by Boeing. Boeing Commercial Aviation Services offers 24/7 support for any issues related to aftermarket parts, engineering, modification, logistics and information services to its cargo airlines as well as maintenance, repair and overhaul facilities.

1.2.2. Boeing Defence, Space& Security

The *Defense, Space & Security* division(BDS) is concerned with the design, production and support of military aircrafts, rotorcrafts, weapons, and satellite systems. In 2015, its revenues have been $30,388 million. BDS provided jobs for approximately 50,500 employees. Its main products are the 702 family of satellites, AH-64 Apache helicopter, cyber security, EA-18G electronic attack aircraft, KC-46 aerial refueling aircraft, and the P-8 anti-submarine/anti-surface warfare aircraft. BDS is continuing to invest in the R&D of new technologies.

1.2.3. Boeing Capital Corporation

The *Boeing Capital Corporation* division (BCC) provides financing solutions for Boeing customers around the world. It ensures *financing service* to customers buying Boeing products. Thanks to Boeing's financial strength, detailed knowledge of customers and equipment, and the expertise of a seasoned group of financial professionals, BCC reached, in 2015, $413 million of revenues.

1.2.4. Shared Services Group

The *Shared Services Group* division (SSG) supplies services that support the global operations of the whole company. SSG deals with the maintenance of Boeing sites, the acquisition of all property both leased and owned, the purchasing of non-production equipment, the recruiting and hiring, and the managing of the company's finance accounting and expense services. The Shared Service group is divided in three sub-units: *Boeing Realty*, *Boeing Travel Management Company*, and *Boeing Supplier Management*, providing work to 7,500 employees.

1.2.5. Engineering, Operations & Technology

The *Engineering, Operations & Technology* division (EO&T), working in collaboration with Boeing Commercial Airplanes and Boeing Defense Space and Security divisions, provides Boeing with technical and functional capabilities, including information technology, R&D, test and evaluation, technology strategy development, environmental remediation and intellectual property management. EO&T is divided in several little sub-units: *Boeing Research & Technology*, *Boeing Test & Evaluation*, *Intellectual Property Management*, *Information Technology*, *Environment, Health, and Safety*, providing work to 17,600 employees.

1.3. Company products

Currently, Boeing's most selling models are the 787 Dreamliner, and the 737 MAX. These aircrafts are designed to satisfy the growing demand for narrow/medium-body fuel-efficient aircrafts. The market forecast indicates that these two products will compose a very big portion of Boeing's total revenue in the next 20 years.

As far as the Space, Defense, and Security division, the most interesting products are the Delta rocket launch platforms. The Delta rockets have been employed in over 300 space missions with a 95% success rate. The most employed launch platform, nowadays, is the Delta II.

1.3.1. Boeing 787-Dreamliner

The Boeing 787-Dreamliner (Fig.1.1) is a long haul, mid-size wide-body, jet aircraft built by Boeing Commercial Airplanes; its capacity varies from 210 to 330 seats depending on both the model and the class configuration chosen by the client. It is currently the most fuel-efficient commercial aircraft on the market; this efficiency is due to the vast use of light composite materials, so this aircraft is 20% more efficient than the Boeing 767, which it replaces. The 787-Dreamliner represents a strong investment of Boeing in the *point-to-point* model of air travel.

Fig.1.1 Boeing 787-Dreamliner

Boeing began its development in the beginning of 2003 and planned to deliver the aircraft to the customers during 2008. The project had several delays for various reasons and the first 787 was delivered to All Nippon Airways on Sept. 26th, 2011. These delays occurred because the 70% of the 787 is built outside Boeing and the

suppliers are spread all over the world: parts come from various countries such as France, Italy, United Kingdom, Korea and Japan. Many parts didn't satisfy specifics and, during the assembly in the Seattle plant, they would not fit properly. For example, simple but vital parts such as fasteners could not stand the loads and they had to be rebuilt internally by Boeing, leading to double work time and costs. During the assembly, a dangerous structural flaw emerged; composite materials in the wings were too weak and failed the test of wind bending. Boeing engineers fixed this flaw with two titanium fittings put along a rib in order to reinforce the wing and add strength. Doing so, Boeing was able to keep the assembly line running and avoided a very expensive re-engineering and re-building of the whole wing section of the aircraft.

These flaws and delays are common with new-project airplanes, designing and building a brand new airplane is a complex process that requires a very big effort by the company. Boeing admitted that some of the sub-contractors did not have the capacity to meet the requirements.

As previously said, there are several models of this family. The 787-8 Dreamliner can carry 210 to 250 passengers on routes of 7,650 to 8,200 nautical miles (14,167 to 15,186 kilometers), while the 787-9 Dreamliner carries 250 to 290 passengers on routes of 8,000 to 8,500 nautical miles (14,816 to 15,742 kilometers).At the Paris Air Show on June 18, 2013, Boeing launched the 787-10 Dreamliner, the third and longest 787.The 787-10reached its final design in April 2014, and was scheduled for delivery in 2018. The new 787-10 was designed to fly up to 7,000 nautical miles (12,964 kilometers), covering more than 90 percent of the world's twin-aisle routes, with seating for 300 to 330 passengers.

Table 1.1 787-Dreamliner technical specifics

Technical specifics	**787-Dreamliner Models**		
	787-8	**787-9**	**787-10**
Seats	Up to 250	Up to 290	Up to 330
Length	56.7 m	62.8 m	68.3 m
Wingspan	60.1 m		
Overall height	16.9 m		
Cruising speed	Mach 0.85 - 913 km/h		
Fuel capacity	126,917 dm^3		
Range	14,200 – 15,200 km	14,800 – 15,700 km	13,000 km

The 787-Dreamliner program has reportedly cost Boeing $32 billion. The cost of producing a 787 exceeded the purchase price at the end of 2013. The actual cash flow reflects Boeing collecting most of the purchase price upon delivery; Boeing expects deferred costs to total $25 billion before the company begins to break even on production. Boeing plans to improve financial return by reorganizing the production line, renegotiating contracts with suppliers and labor unions, and increasing the 787 production rate to 14 airplanes per month by the end of the decade. The 787 program is expected to be profitable after 1,100 aircraft have been sold.

Table 1.2 787-Dreamliner orders and deliveries

	787-Dreamliner Models		
	787-8	**787-9**	**787-10**
Orders	431	614	163
Deliveries	318	163	-

1.3.2. Boeing 737 MAX

The 737 MAX is the latest development of the 737 aircraft. This program dates back to the 60s and this is the fourth generation of the 737 family. The primary changes are the use of the larger and more efficient CFM International LEAP-1B engines and modifications to the airframe. The 737 MAX is Boeing's newest family of *single-aisle* airplanes. The 737 MAX's more efficient structural design, lower engine thrust and less required maintenance are designed to give customers substantial cost savings. The 737 MAX will incorporate the latest quiet engine technology to reduce the operational noise footprint, and emissions will be approximately 50 percent below the required standards. The program includes the 737 MAX-7, 737 MAX-8 and 737 MAX-9. The program has also launched the 737 MAX-200, a new variant based on the 737 MAX-8.

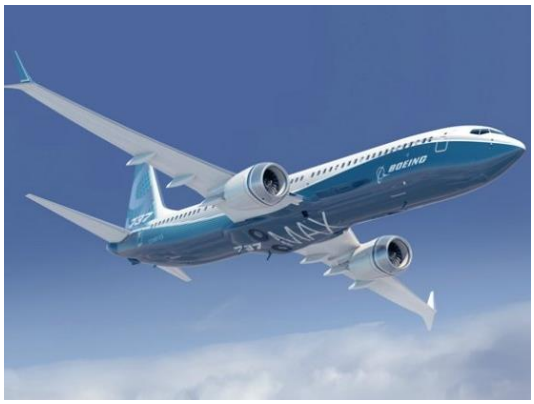

Fig. 1.2 Boeing 737 MAX

Since 2006, Boeing has discussed replacing the 737 with a new design that could follow the Boeing 787-Dreamliner. In November 2014, it was reported that Boeing intended to replace the 737 by 2030 with a new airplane, possibly with a composite airframe like the 787-Dreamliner. This project was internally named Boeing Y1. In 2010, Airbus launched the Airbus A320neo. Pressure from airlines for more fuel efficient aircraft forced Boeing to delete the Boeing Y1 program, and focus on upgrading the 737. On August 30, 2011, the company's board of directors approved the 737 MAX project. The first 737 MAX aircraft will be delivered in May 2017 to Norwegian Air Shuttle.

Table 1.3737 MAX technical specifics

Technical specifics	**737 MAX Models**		
	MAX 7	**MAX 8**	**MAX 9**
Seats	Up to 172	Up to 200	Up to 220
Length	35.6 m	39.5 m	42.2 m
Wingspan	35.9 m		
Overall height	12.3 m		
Cruising speed	Mach 0.79 - 839 km/h		
Fuel capacity	25,941 dm^3		
Range	7,084 km	5,000 - 6,510 km	6,510 km

At this day, Boeing received a total of 3278 orders for the 737 MAX, making it the fastest selling airplane on the market.

Table 1.4 737 MAX Orders

	737 MAX Models			
	MAX 7	**MAX 8**	**MAX 9**	**Unspecified**
Orders	70	1,740	418	1,050

Due to the early stage of the program, and its nature of being an upgrade of an existing plane, it is impossible to find information about the developing cost of the 737 MAX. Unfortunately, the decision of focusing on the newest projects in order to

understand future market opportunities leads to a lack of information about the economics of this program.

1.3.3. Delta II rocket launch system

Delta II is a rocket launch platform for space missions. It can be configured in two or three stages, that are discarded during the flight. The rocket is propelled by three, four or nine solid rocket boosters. There are two version of the cowlings with different size, depending on the mission. The Delta II carriers can carry loads from 890 to over 2,140 kg for missions in geo-synchronous orbit (GTO) and loads from 2.7 to 6 tons in low orbit (LEO). The Delta II rockets in two stages are typically employed in LEO missions, while the three-stage carry loads for GTO missions or for planetary exploration missions in deep space.

The Delta II is assembled on the launch platform by hoisting the stages into position, and then by adding the rocket boosters on the sides. When the final assembly is completed, the first stage is loaded with almost 38,000 liters of fuel, which takes about 20 minutes.

Delta II has been an excellent product, in terms of reliability. Delta II has achieved, in 2015, 98 consecutive successful launches. With the two launches scheduled for the near future, this launch system could achieve an unprecedented 100 successful missions.

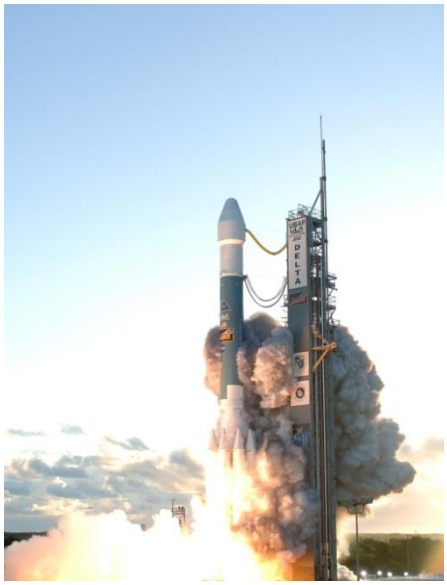

Fig.1.3 Delta II rocket launch platform

2. MARKET ANALYSIS

This market analysis will focus mainly on the *Boeing Commercial Airplanes*, as this division is the main source of revenue for the firm. Moreover, the availability of information on *Boeing Defense, Space & Security* and the other smaller Boeing divisions was found to be very lacking.

2.1. Long-term market outlook

Since 1980, the global airplane traffic has been on a steady rise. *Passenger air traffic* (measured in RPK[1]) has been increasing at a stable rate, with an annual average of 6%, while *cargo air traffic*(measured in FTK[2]) has been increasing at an average annual rate of 5% (Fig. 2.1 and Fig. 2.2). The air traffic market seems to be very resilient, surviving events such as 9/11 and the 2009 economic crisis.

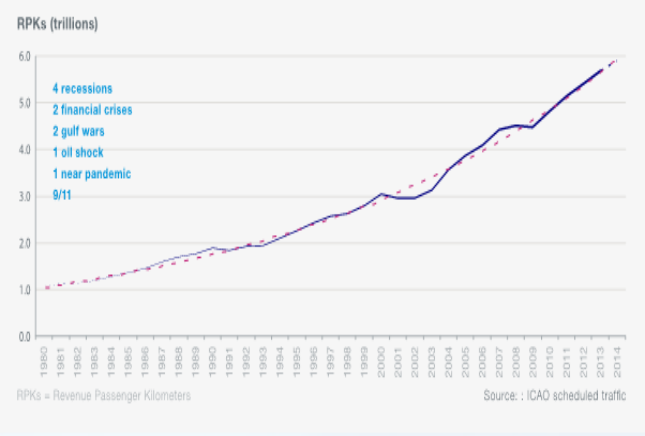

Fig. 2.1 Increase in air passenger traffic

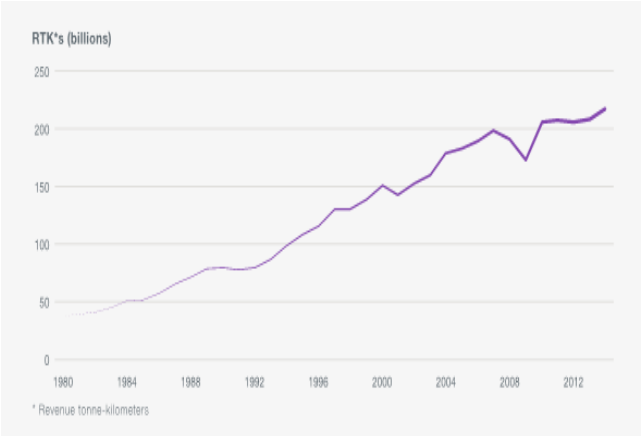

Fig. 2.2 Increase in air cargo traffic

With the steadily increasing market demand and the decreasing price of oil, airline companies have been thriving, reporting profits for $20 billion in 2014. This year has been a record also for airplane manufacturers like Boeing and Airbus. Over 1490 jet airplanes were delivered, and new orders were made for approximately 3,680 airplanes. In the next 20 years, air passenger traffic is forecast to grow by 4.9% and air cargo traffic by 4.7%. This steady growth would result for Boeing in 38,050 orders in the next 20 years, for a value of $5.6 trillion.

[1] RPK (Revenue passenger kilometers) is calculated by multiplying revenue passengers by the distance travelled.

[2]FTK (Freight ton kilometers) represents one metric ton of revenue load carried one kilometer.

2.2. Market trends

In the air travel market there are two main route policies that can be employed: the *hub-and-spoke network* and the *point-to-point network*. The first model is composed of routes that generally pass through hub airports (for example Atlanta, Dubai, Frankfurt) in order to minimize the number of existing routes (Fig. 2.3). Hub-and-spoke network make intensive use of high capacity aircrafts, such as the Boeing 747, to connect hub airports. The downside of this system is that passengers generally have to take more than one flight to arrive at their destination, and sometimes have to get farther from destination to catch the connecting flight (this might happen, for example, going from Turin to Buenos Aires and having to pass through Frankfurt). Moreover, since big airports are busier, the cost for docking into a large hub is bigger than the one for docking in a smaller airport. The point-to-point model, on the other hand, connects two (generally smaller) airports with a single flight (Fig. 2.4). In a point-to-point network, airlines usually employ smaller aircrafts due to smaller route demand. Smaller aircrafts generally require fewer airport operators, so personnel expenses tend to be lower.

Fig. 2.3 Hub-and-spoke network

Fig. 2.4 Point-to-point network

As air travel continues to grow, airlines have to make decisions on how to enlarge their fleet size. The two alternatives are increasing the capacity and size of the airplanes, or increasing *flight frequencies* and the number of *non-stop flight routes*. Passengers tend to prefer the latter option, because of the increase of flexibility and offered itineraries.

The production of new *low-cost carrier* (LCC) models (such as the 737) with high fuel efficiency, heavily favor the migration to the point-to-point network model. LCCs allow the creation of new and longer nonstop routes that can efficiently exploit the small demand of some itineraries. LCCs have seen the greatest increase in orders, growing at 10.3%.

In 2014, airline companies have responded to the demand growth of air traffic by deploying additional carrying capacity in the following fashion (Fig. 2.5):

- Increase in frequency of existing routes: 70%
- Creation of new routes (net of cancellation of old routes): 17%
- Increase in airplane size/capacity: 13%

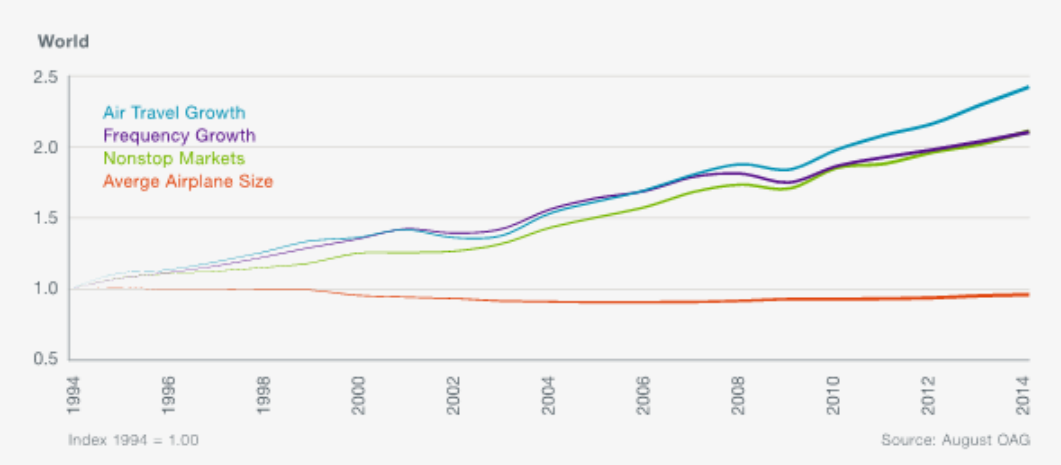

Fig 2.5 Comparison between air travel and capacity growth

History has shown that the aviation market tends to grow by providing passengers with more efficient ways to travel where and when they want to go. This can be achieved increasing the point-to-point flight routes in spite of routes that stop by a hub airport (Fig. 2.6). The market *fragmentation* is forecast to keep increasing, resulting in a higher demand in single-aisle airplanes, and a decrease in large body airplanes.

Fig. 2.6 Increase in non-stop markets between North America and Northeast Asia

2.3. Growth factors

The aviation industry, like any other business, is affected by changes in the external environment. Hence, a detailed analysis on the *growth factors* is required, in order to understand which aspects could influence this market.

2.3.1. Political and legal factors

Regulations and restriction introduced by international institution regarding trade, tax policy, and competition heavily influence the aviation business. Also global events such as disease outbreaks (Ebola), terrorist attack (9/11), and wars (Arab Spring, the war in Syria) require government intervention.

2.3.2. Economic factors

The airline industry performance is closely correlated with global macro-economic factors (Fig.2.7). The increase in real disposable personal income obviously has a strong relation with consumer spending on goods and services. In the U.S.A., the reports indicate a 3.5% increase in disposable income in the first quarter of 2014. This change in income increases the amount of money spent on leisure and travel, and consequentially benefits air travel companies. The healthy U.S. economy supported the growth of all the major American airlines.

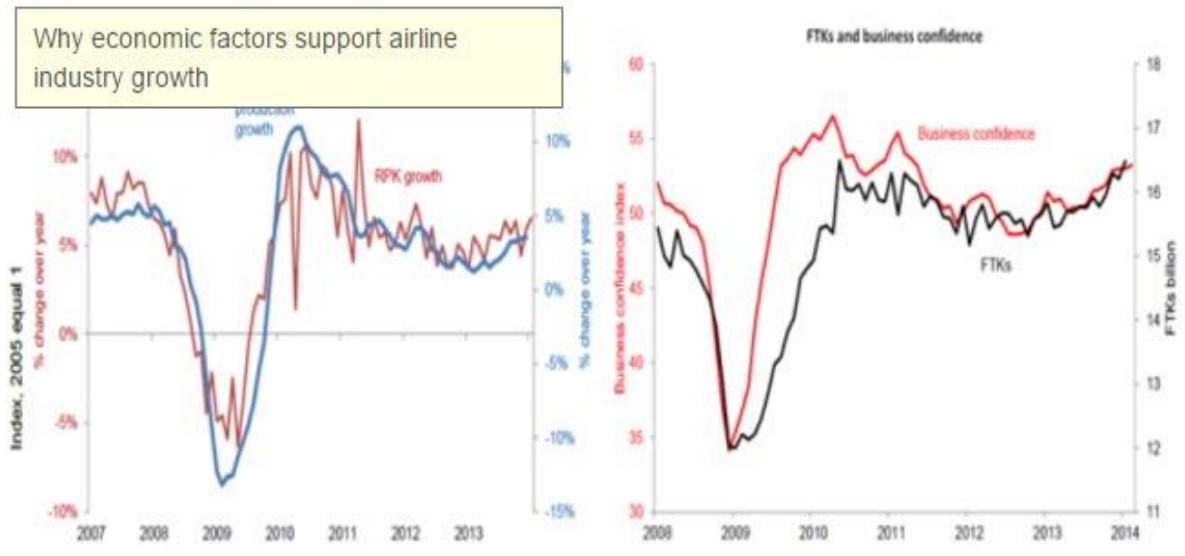

Fig. 2.7 Correlation between macroeconomic factors and air traffic

2.3.3. Social and demographic factors

Demographic factors have a key role in the forecast of demand. The increase of the global population translates to a larger customer pool, and therefore an increase in air traffic. There is a high difference in consumer behavior between generations.

The Millennial generation (which includes people born between 1980 and 1995), has a higher tendency to travel compared to the retiring generation of Baby Boomers (composed of people born between 1946 and 1964). The *Boston Consulting Group* states in its research that the growth in the Millennial generation will strongly define the future tourism and travel market. In around five years, the Millennial generation will reach its peak in terms of earning, spending, and travelling years. It's expected that this generation's spending will increase by 50% by 2020. Baby boomers, who currently hold the main share of the total travelling user base, are expected to decrease their spending on travelling to 16% in 2020, and to 11% in 2025.

Airlines are adapting to the change in their customer composition by starting to focus their attention on business strategies better suited for Millennials' preferences.

The growing middle class in developing countries also represent a strong factor for air traffic business growth. As will be later explained in this paper, China and India represent a strong driver for growth in the aviation market.

2.3.4. Technological and environmental factors

As explained earlier, the introduction of new aircraft models is fundamentally changing the business model adopted by airline companies. Since fuel represents about 30% of airline companies' expenses, new aircraft orders tend to lean more on fuel-efficient planes. These new models, moreover, can travel on longer routes. Increasing the range of low capacity carriers allows for the expansion of the routes network.

Lastly, other aviation operations such as maintenance, engineering, and in-flight have been significantly improved by innovative technologic solutions. The technologic advances of the new aircraft models greatly decrease expenses for airline companies, increasing profitability and fostering economic growth. Airline companies will therefore be highly attracted by investments in new aircrafts, both for replacing the current fleets and for coping with the increasing capacity demand.

2.4. Market regions

As previously said, the aviation market one of the most steadily growing markets in the recent years, in particular thanks to the rapid and exponential industrial growth of BRICS. In 1994, airlines in Europe and North America carried more than 73% of all the traffic, while the future forecast for 2034 indicates this percentage to decrease to 38%, due to the expansion of Asia and the Middle East.

It is fundamental to understand what factors in each regional market affect the demand of aircrafts, because each region has its own unique situation and specialized requirements. Hence, a detailed analysis for each of the world's regions is needed: *Asia* (with a focus on *China*, *Northeast Asia*, *Southeast Asia*, and *South Asia),Europe*, *North America*, *Latin America*, *Africa*, and *Oceania*.

2.4.1. Asia

Over the past 10 years, the region had an incredible growth of 24.5%, especially thanks to the *low-cost carrier* (LCC)business model. For example, in South Asia there are 20,000 weekly flights thanks to the LCCs model. Moreover, some companies such as Qantas, Singapore Airlines, and Thai Airways have also created their own LCCs to offer this kind of service. As shown in the Table 2.1, Asia is expected to be the largest travel market in the world with an annual traffic growth of 6.1%, related to an increasing economic growth (GDP) of about 4.3% over the next 20 years.

Table 2.1 Asia's key statistics

Growth Measures (%)	
Economy (GDP)	4.3
Traffic (RPK)	6.1
Cargo (RTK)	5.7
Airplane fleet	5.2

	New airplanes	**Share by size (%)**
Large widebody	140	1
Medium widebody	1,530	11
Small widebody	1,920	13
Single aisle	10,370	72
Regional jet	370	3
Total	**14,330**	

Market size	
Deliveries	14,330
Market value	$2,200B
Average value	$150M

	2014 fleet	**2034 fleet**
Large widebody	280	180
Medium widebody	530	1,620
Small widebody	780	2,270
Single aisle	4,130	11,730
Regional jet	130	380
Total	**5,850**	**16,180**

In Asia, Air Cargos play a crucial role in transporting goods from one place to another, due to the difficult terrain (for example mountain ranges such as Himalaya) and due to the long distances. An Air Cargo traffic annual growth of 5.7% is forecasted over the next 20 years. Lastly, about 14,330 new airplanes are required in order to expand the fleet to 16,180 aircrafts, about three time the current amount.

2.4.1.1. China

China's industrial development lead to an incredible economic growth in the past decade, with an annual 9% increase in GDP. Nowadays, China is gradually reducing its rate of growth as it rebalances toward a more consumption-oriented economy. The Chinese large population, economic mindset change, and a larger number of visitors took a fundamental role to increase the air traffic, especially into the *golden triangle* (Beijing, Shangai, and Guangzhou) where the traffic rate is increasing of about 8% annually.

Table 2.2 China's key statistics

Growth Measures (%)	
Economy (GDP)	5.6
Traffic (RPK)	6.6
Cargo (RTK)	7.0
Airplane fleet	5.3

	New airplanes	**Share by size (%)**
Large widebody	50	1
Medium widebody	650	10
Small widebody	810	13
Single aisle	4,630	73
Regional jet	190	3
Total	**6,330**	

Market size	
Deliveries	6,330
Market value	$950B
Average value	$150M

	2014 fleet	**2034 fleet**
Large widebody	60	70
Medium widebody	140	670
Small widebody	260	940
Single aisle	2,060	5,340
Regional jet	50	190
Total	**2,570**	**7,210**

As shown in the previous Table 2.2, China's GDP is growing at rate of 5.6% annually, while the passenger traffic and air cargo are expected to increase of 6.6% and 7% respectively. Chinese airlines are now providing 54% of total capacity and as the market continues to grow up, about 4,630 new single-aisle airplanes, valued at $490 billion, are needed out of a total of 6,330 new aircrafts required.

2.4.1.2. North-East Asia

North-East Asia, which includes Japan, North and South Korea, and Taiwan, accounts for 10% of the world GDP. Although the region's GDP is growing more slowly than the average world (about 1.3% annually), it is expected to maintain this trend during the following years. Even though North-East Asia has a *mature* aviation market, there still are opportunities for growth. As reported in the Table 2.3 below, it is expected that the passenger traffic rate will have an annual increase of 2.6% and the fleet is going to increase of 32%.

Table 2.3 North-East Asia's key statistics

Growth Measures (%)	
Economy (GDP)	1.3
Traffic (RPK)	2.6
Cargo (RTK)	4.6
Airplane fleet	2.0

	New airplanes	**Share by size (%)**
Large widebody	40	3
Medium widebody	400	28
Small widebody	320	22
Single aisle	630	43
Regional jet	60	4
Total	**1,450**	

Market size	
Deliveries	1,450
Market value	$310B
Average value	$210M

	2014 fleet	**2034 fleet**
Large widebody	120	60
Medium widebody	180	410
Small widebody	250	320
Single aisle	410	640
Regional jet	40	60
Total	**1,000**	**1,490**

2.4.1.3. South Asia

South Asia has a very large population. India, in particular, accounts for about 1.3 billion inhabitants in 2015, with a demographic growth rate of 1.25%. This trend reflects an increasing demand in aviation market and several investors are coming to India to build new infrastructures.

The regional GDP is increasing faster than the other Asian regions, with an annual 6.4% increase. Also passenger traffic and cargo traffic increasing rates are extremely high, both being nearly 9%. The most significant development in the south Asian domestic market is the growing dominance of the LCCs business model.

Table 2.4 South Asia's key statistics

Growth Measures (%)	
Economy (GDP)	6.4
Traffic (RPK)	8.6
Cargo (RTK)	8.8
Airplane fleet	8.4

	New airplanes	Share by size (%)
Large widebody	--	
Medium widebody	170	9
Small widebody	140	8
Single aisle	1,520	82
Regional jet	20	1
Total	**1,850**	

Market size	
Deliveries	1,850
Market value	$250B
Average value	$140B

	2014 fleet	2034 fleet
Large widebody	10	--
Medium widebody	40	210
Small widebody	50	290
Single aisle	360	1,850
Regional jet	10	20
Total	**470**	**2,370**

Lastly, the incredible forecast about the future fleet must be considered. According to the previous growth measures, fleet capacity is going to increase five times over the next 20 years, primarily lead by the single-aisle models.

2.4.2. Europe

Europe's aviation market remains strong, despite significant economic uncertainties. With a constant GDP growth of about 1.5-2%, Europe is one of the most *mature* market in the world, hence, also the aviation market growth is slower, in comparison to emerging economies.

However, this market is characterized by a continue strategic evolution, done in order to obtain new market segments. As a matter of fact, airline operations in Europe continue to evolve with the launch of new ventures, routes, and business models. For example, LCCs continue to grow short-haul markets, providing 42% of intra-Europe capacity in 2015.

The most important point in this regional analysis is the number of new airplanes orders over the next 20 years. About 7,310 aircrafts will be needed in order to replace the old models and to expand the fleet. In Europe, the *replacements* are much more important than in the other world regions, due to the internal traffic (based on small routes), that causes a higher exploitation of the airplanes' engine. The *cabin pressurization process* brings a very high stress for the fuselage. The rapid compressing and decompressing of the cabin each time that the airplane climbs and descends for landing, characteristic of shorter routes, increases this kind of stress, resulting in more frequent replacements.

Table 2.5 Europe's key statistics

Growth Measures (%)	
Economy (GDP)	1.8
Traffic (RPK)	3.8
Cargo (RTK)	3.1
Airplane fleet	2.7

	New airplanes	Share by size (%)
Large widebody	40	1
Medium widebody	510	7
Small widebody	910	12
Single aisle	5,770	79
Regional jet	80	1
Total	**7,310**	

Market size	
Deliveries	7,310
Market value	$1,050B
Average value	$140M

	2014 fleet	2034 fleet
Large widebody	180	100
Medium widebody	350	550
Small widebody	380	1,070
Single aisle	3,240	5,730
Regional jet	300	110
Total	**4,450**	**7,560**

2.4.3. North America

North America includes only two major countries: United States of America and Canada. As shown in the following Table 2.6, the market and the growth measures are very similar in comparison with Europe.

Table 2.6 North America's key statistics

Growth Measures (%)	
Economy (GDP)	2.5
Traffic (RPK)	3.1
Cargo (RTK)	2.9
Airplane fleet	1.7

	New airplanes	Share by size (%)
Large widebody	20	<1
Medium widebody	490	6
Small widebody	690	9
Single aisle	5,070	64
Regional jet	1,620	21
Total	**7,890**	

Market size	
Deliveries	7,890
Market value	$940B
Average value	$120M

	2014 fleet	2034 fleet
Large widebody	100	60
Medium widebody	320	530
Small widebody	730	910
Single aisle	3,850	6,190
Regional jet	1,700	1,660
Total	**6,700**	**9,350**

The key country in this region is USA, whose airline industry is riding a five-year wave of profitability. North America airlines' revenues are about $12 billions, representing in two-third of the entire global airline industry net income. To achieve this result, during the last years, American airlines undertook several tactics,

including M&As, fleet and network rationalization, capacity discipline, and strict focus on financial performance. Nowadays, the LCCs are the fastest-growing business segment of the domestic US market, since they provide a better service for customers.

2.4.4. Latin America

Long-term economic projections for Latin America and the Caribbean remain positive with an average GDP growth of 3.4% annually. The region is led by Panama with a growth of 5.6%, meanwhile, average growth rates for Brazil and Mexico (the region's two largest economies) are 3.8% and 2.3% respectively. Aviation is a *key component* of this dynamic growth because it facilitates trade, travel, and tourism, while promoting globalization and technology development. The past several years have seen significant *consolidation*, including the mergers of lots of small aviation companies, resulting in larger, more stable, and more competitive airlines.

As shown in Table 2.7, the passenger traffic growth is forecasted to average 6% per year over the next 20 years, especially thanks to *intraregional flows*. The region's commercial fleet is projected to more than double within 2034, with about 3,000 new deliveries. Most of them (about 2,500) are expected to be single-aisle airplanes, related to the continued growth of LCCs and the expansion of the internal flights.

Table 2.7 Latin America's key statistics

Growth Measures (%)			**New airplanes**	**Share by size (%)**
Economy (GDP)	3.4	Large widebody	-	-
Traffic (RPK)	6.0	Medium widebody	30	1
Cargo (RTK)	5.5	Small widebody	310	10
Airplane fleet	4.6	Single aisle	2,520	84
		Regional jet	160	5
		Total	**3,020**	

			2014 fleet	**2034 fleet**
Market size		Large widebody	-	-
Deliveries	3,020	Medium widebody	30	40
Market value	$350B	Small widebody	130	380
Average value	$120M	Single aisle	1,220	3,020
		Regional jet	90	180
		Total	**1,470**	**3,620**

Lastly, Latin America always had less technologically advanced airplanes and less productive fleets, but since 2005, a significant fleet renewal began (Fig. 2.8). The average fleet age is now below world average.

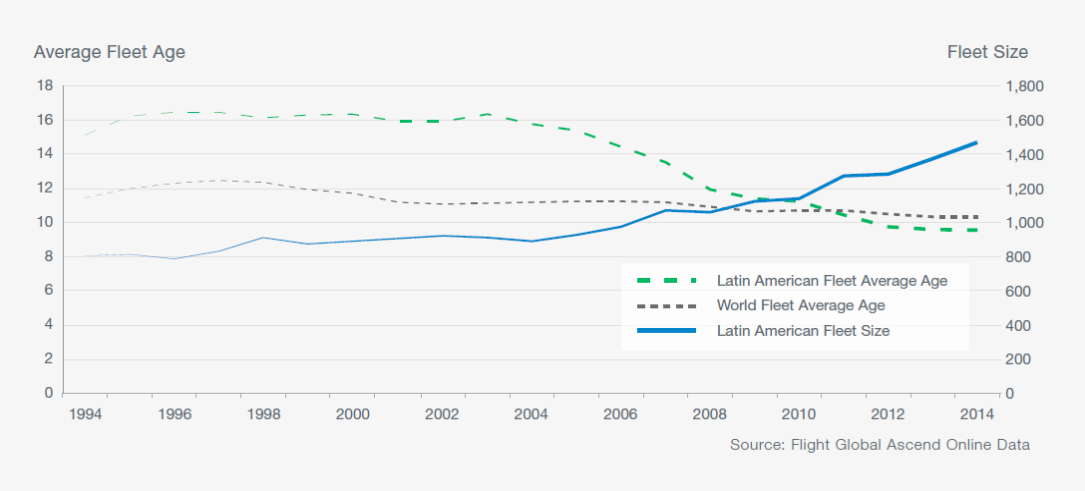

Fig. 2.8 Latin America fleet renewal

2.4.5. Middle East

Location is the main advantage to take into account when analyzing the Middle East region. Located at the crossroads between Asia, Africa, and Europe, airlines are well positioned to compete for traffic connecting these regions. About 80% of the world's population lives within an eight-hour flight, allowing companies to offer point-to-point service between many cities. The region's LCCs have also been innovative, in order to reduce costs and to enhance the appeal of services connecting the Middle East, for example mobile booking portals have been developed to improve accessibility to air services. With an expected 3.8% annually growth, especially related to air commerce, many investments in airport facilities started, in order to be able to receive the future fleet composed by 3,500 aircrafts, which represent three times the current region's fleet.

Table 2.8 Middle East's key statistics

Growth Measures (%)	
Economy (GDP)	3.8
Traffic (RPK)	6.2
Cargo (RTK)	6.3
Airplane fleet	5.2

	New airplanes	**Share by size (%)**
Large widebody	300	9
Medium widebody	880	28
Small widebody	560	18
Single aisle	1,410	44
Regional jet	30	1
Total	**3,180**	

Market size	
Deliveries	3,180
Market value	$730B
Average value	$230M

	2014 fleet	**2034 fleet**
Large widebody	110	260
Medium widebody	300	900
Small widebody	250	660
Single aisle	540	1,600
Regional jet	60	60
Total	**1,260**	**3,480**

2.4.6. Oceania

As for the Middle East, also for Oceania *location* is a key factor. Because of long distances, the region's airlines have invested highly in technology, in order to obtain the greatest efficiency and flexibility. Airlines in Oceania have long been at the forefront of purchasing aircrafts with the newest hi-tech innovation. Most of the regional fleet is composed by extended-range, twin-engine performance standard airplanes (ETOPS), which play a fundamental role in enabling Oceania's airlines to have more direct flights and saving fuel.

Table 2.9 Oceania's key statistics

Growth Measures (%)	
Economy (GDP)	2.6
Traffic (RPK)	4.6
Cargo (RTK)	4.1
Airplane fleet	3.1

	New airplanes	Share by size (%)
Large widebody	10	1
Medium widebody	60	6
Small widebody	140	15
Single aisle	730	77
Regional jet	10	1
Total	**950**	

Market size	
Deliveries	950
Market value	$140B
Average value	$150M

	2014 fleet	2034 fleet
Large widebody	30	10
Medium widebody	30	60
Small widebody	60	160
Single aisle	400	750
Regional jet	20	10
Total	**540**	**990**

The overall economy is similar to Europe and North America's economies, with a GDP growth rate increasing slower than the emerging countries' GDP. In comparison with these two regions, the increase in passenger traffic rate and the cargo traffic rate is higher in Oceania. According to this trend, in long-haul market, 12 new routes have opened in the recent years and the demand of aircrafts is increasing.

2.4.7. Africa

Africa's key factor is represented by the *urbanization rate*, which is now the lowest in the world, about 40%, but it has an extremely positive trend. Projections show that this growth will continue at a slightly more modest rate of 3.1% annually over the next 25 years, with urban growth outpacing the growth of the rural population. Certainly, urbanization and economic growth (4.5% annually) are intricately related as agrarian-based regional economies transition to urban economies

centered on industry and services. As a result, an increase in air travel demand is expected.

Table 2.10 Africa's key statistics

Growth Measures (%)			New airplanes	Share by size (%)
Economy (GDP)	4.5	Large widebody	–	–
Traffic (RPK)	5.7	Medium widebody	40	3
Cargo (RTK)	6.9	Small widebody	260	22
Airplane fleet	4.5	Single aisle	830	71
		Regional jet	40	3
		Total	**1,170**	

Market size			2014 fleet	2034 fleet
Deliveries	1,170	Large widebody	10	–
Market value	$160B	Medium widebody	60	70
Average value	$140M	Small widebody	80	300
		Single aisle	430	1,220
		Regional jet	110	60
		Total	**690**	**1,650**

The economic growth is reflected by the increasing cargo traffic rate, nearly 7% per year. However, also the passenger traffic rate is expected to rise, especially thanks to the younger African generations. Indeed, Africa has the youngest population of any continent (mostly Millenials). Unfortunately, Africa is still affected by high unemployment, poverty, and wars, in particular in eastern Africa. These factors represent a challenge to the aviation market and cause a slower development, due to the unstable situation.

2.5. Market competitors

In this section the main competitors in the commercial and military fields are analyzed, with a particular focus on the competitive factors of the different companies. Just as in the previous sections, the commercial branch is going to be analyzed more in-depth, as it's the biggest source of revenues for Boeing.

2.5.1. Aircraft manufacturing industry

The *aircraft manufacturing industry* is characterized by the *duopoly* between Boeing and Airbus. This competition has been going on since the 1990's, after a series of mergers in the aerospace industry. In this period Airbus was formed, beginning as a European consortium. On the other hand, In 1997, Boeing absorbed in a merger its former rival, McDonnell Douglas.

During these years, other jet airliner manufacturers (Lockheed Martin, Convair, Fairchild Aircraft, British Aerospace, and Fokker) withdrew from the market, since they were no longer in a position to compete with the main two businesses. In the years between 2004 and 2014, Boeing received orders for 8933 aircrafts and delivered 4824, while Airbus received 8428 orders and delivered 4458.

Other minor competitors account for less than 10% of the market. Bombardier and Embraer account for 6% and 3% of the market revenues, while the other producers such as Irkut, COMAC, and Mitsubishi Aircraft make up the remaining 1% (Fig. 2.9).

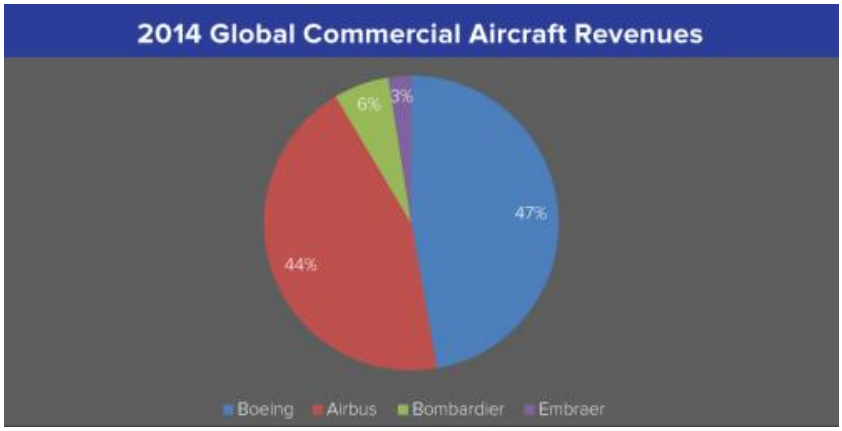

Fig. 2.9 Market share revenues

Airbus and Boeing have been very close in terms of aircraft orders in the last 15 years (Fig. 2.10). In2015, Airbus beat Boeing in terms of number of aircraft ordered, totaling 1080 orders to Boeing's 768. This difference however looks more substantial that it actually is: Airbus is ahead in the narrow-body market, but Boeing is ahead in the wide-body market. Since wide-body aircrafts are considerably more expensive, the total value of orders of the two companies is probably close to 50-50.

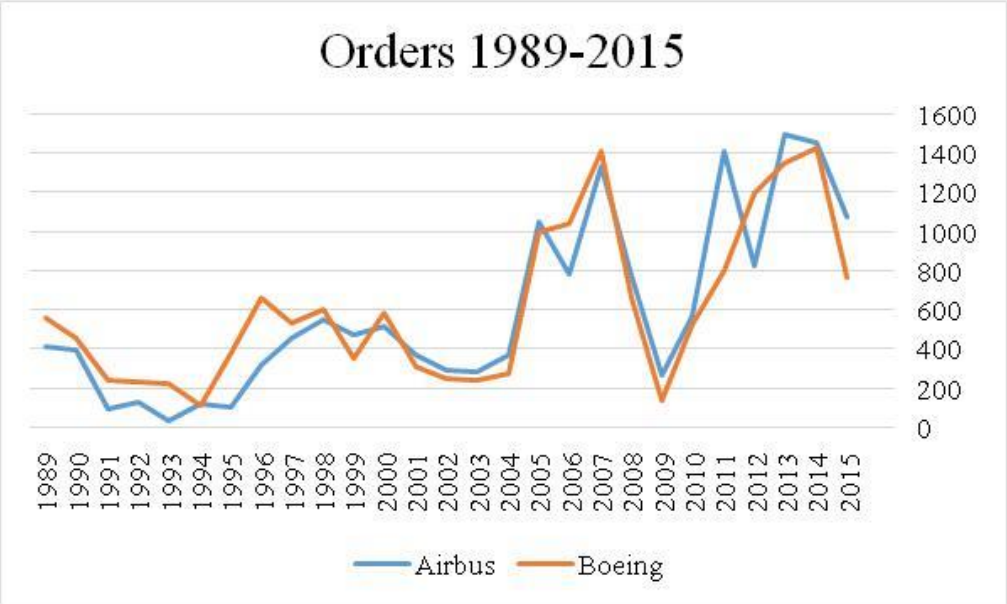

Fig. 2.10 Comparison between Boeing and Airbus orders received

Since 2004, Boeing and Airbus have been involved in a *legal war*. Boeing has protested over EU's financial aids to Airbus, while Airbus accused Boeing of receiving illegal tax cuts, and illegal subsidies for military contracts.

In March 2010, the WTO ruled against Airbus, stating that the European governments had unfairly financed the aerospace company. In September of the same year it also ruled against Boeing. The WTO had found that Boeing payments went against WTO rules, and that the American firm would have to repay $5.3 billion of illegal subsidies. The WTO Appellate Body partly overturned the earlier ruling against Airbus. In March 2012, the same institution released the findings that confirmed the legality of the loans made to Airbus.

2.5.1.1. Competition factors

The *competition factors* represent all the aspects that influence the competitive aspects of a company in a specific market. In the following paragraphs, the main factors are analyzed.

2.5.1.1.1. Labor outsourcing

Since a large number of airline companies are partially or fully owned by the government, aircrafts are often ordered from companies according to political criteria. Both Boeing and Airbus have adopted labor outsourcing strategies for their production by subcontracting components manufacturing and assemblies in countries with strategic importance. In 1974, Boeing started involving Japanese suppliers such as Mitsubishi Heavy Industries and Kawasaki Heavy Industries in the production of components, and with this strategy the American firm managed to completely dominate the Japanese aircraft market. In 2008, Airbus built a new assembly plant was opened in Tianjin, China, for the production of the A320 airliner series. This investment helped the European company reach a 50% share in this very key market. This September, however, Boeing announced a collaboration with COMAC (Commercial Aircraft Corporation of China, Ltd) for the assembly of the 737. The recent election of Donald Trump and his protectionist policy intentions, however, could represent a relevant issue for Boeing's recent investments. China is threatening USA to purchase all aircrafts from Airbus, in the case that the American government actually approves any protectionist laws that would disadvantage China. Airbus also recently opened a plant in Mobile, Alabama, striking on Boeing’s home turf. This assembly plant will be devoted to the production of the A320.

2.5.1.1.2. Currency fluctuations and exchange rates

Boeing, being an American firm, mostly operates with US Dollars, whereas Airbus operates with Euro. Whenever the US Dollar appreciates against the Euro, production costs for Boeing increase relatively to production costs for Airbus. Currency fluctuations also influence the competitiveness of aircraft prices.

2.5.1.1.3. Product planning, design, and manufacturing

Since Airbus joined the jetliners industry, the two aerospace production firms have been competing fiercely to provide the best products at the lowest prices. *Technology* has played an important role in this competition, as performance advantage provides a key driver for aircraft purchasing decisions. Airbus was the first manufacturer to make extensive use of composite materials, which allow for a higher fuel efficiency because of their lower weight. Airbus was also the first to introduce various electronic innovations, such as the automation of the flight engineer’s functions, and the introduction of digital fly-by-wire controls in airliners. Nowadays, most innovations focus on weight reduction and fuel efficiency.

Boeing and Airbus are always trying to one-up each other in every aircraft family type. For example, when the Airbus's A320 was introduced in the market, it eroded a lot of Boeing's demand for the well-established 737. Boeing, faced against customers (such as Southwest Airlines) that threatened to convert to Airbus, introduced the 737 MAX, that is now scheduled for its first delivery in 2017.

2.5.2. Space and defence industry

Since governments usually buy defence and aerospace products from producers of their own country, Boeing's main customer for the space and defence branch is the US government. The main competitors of Boeing Defence, Space, & Security, for this reason, are all American companies. As figure 2.11 shows, the American aerospace market is more fragmented. Many defence companies have dramatically increased their revenues in the last decade. Lockheed Martin, Northrop Gumman, and Rockwell Collins have more than doubled their profits since 2013. Boeing, however, still maintains a backlog of $45 billion, so it will be able to maintain a steady hold of its market share for the near future. Despite the strong competition, Boeing and Lockheed Martin have collaborated on some projects, such as the F-22 and the Hellfire Missile.

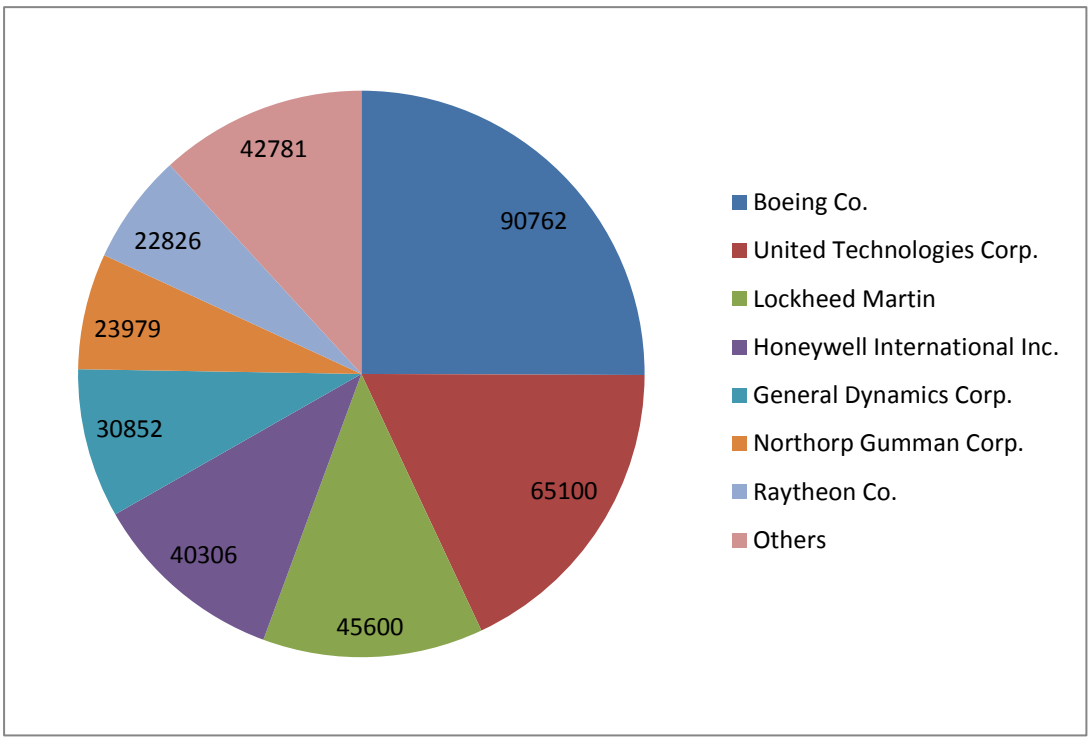

Fig. 2.11 Division of the US aerospace market in 2014, data in billions of dollars.

3. Financial analysis

Boeing’s strong position as the world largest aircraft producer is a key factor in its top industry ranking. Although Boeing can rely on a huge backlog for its future revenues, its increasing liabilities may pose a threat in the future. The following indexes have been computed using data obtained from the Boeing and Airbus' annual reports attached in the appendix. Although the market analysis mainly focuses on the commercial division of Boeing, the financial analysis takes into account the Boeing company as a whole. This is because the financial statements present the aggregate data of all Boeing divisions, and therefore one can't simply analyze the commercial division by itself.

3.1. Profitability

Boeing’s ROE is as high as 81.7%, which is good for attracting investors. The ROA is only 5.5%, which although a satisfying profitability value, is considerably lower than the ROE. This is caused by Boeing’s capital structure, which is characterized by a high financial leverage. This is also caused by Boeing’s liabilities are almost 14 times larger than the stockholders’ equity. The ROS is 7.8%, which is also quite positive. Boeing’s ROA and ROS have been stable in the last 4 years. On the other hand, the ROE has increased considerably, due to the increase in financial leverage.

Table 3.1 Boeing's profitability indexes

Profitability indexes	2015	2014	2013	2012
ROE	81.70%	62.85%	30.82%	66.47%
ROA	5.48%	5.86%	4.95%	4.39%
ROS	7.74%	8.23%	7.58%	7.70%

All of Boeing’s profitability indexes are higher compared to Airbus’ (Table 3.2). This is due to the fact that Boeing produces more large-body planes, which have a higher profitability. Boeing’s higher involvement in the defence industry also plays a fundamental role in this. Firms that operate in the defence market tend to have higher profitability, and therefore higher ROE’s and ROA’s. Lockheed Martin, for example, has a ROE of 116% and a ROA of 9.4%.

Table 3.2 Comparison between Boeing and Airbus

Profitability indexes comparison	2015		2014	
	Boeing	Airbus	Boeing	Airbus
ROE	81.70%	45.17%	62.85%	33.20%
ROA	5.48%	2.53%	5.86%	2.45%
ROS	7.74%	6.30%	8.23%	6.57%

3.2. Liquidity

Boeing's low liquidity ratios can possibly deter risk-averse investors from financing the company, as shown in Table 3.3. The current ratio is 1.35, which is an acceptable value. The quick ratio, however, amounts to 0.42. The quick ratio is so low mostly because of the fact that inventory is a huge portion of working capital. Normally, a quick ratio lower than 1 is considered worrying, but the management seems to be comfortable with this strategy, since the large backlog guarantees a reliable stream of future revenues. Moreover, since the receivable turnover is higher than the accounts payable turnover, the time needed to receive payments from customers is lower than the time to pay current liabilities from suppliers (Table 3.4 and Table 3.5). The low inventory turnover index (1.74) doesn't have much to do with the lack of demand, but with the complexity of aircraft production process. Boeing's liquidity indexes have been stable during the past years.

Table 3.3 Boeing's main liquidity indexes

Liquidity indexes	2015	2014	2013	2012
Current ratio	1.35	1.40	1.26	1.27
Quick ratio	0.42	0.44	0.43	0.43

Table 3.4 Boeing's turnovers

Turnovers	2015	2014	2013	2012
Accounts receivable turnover	11.03	11.74	13.23	14.10
Accounts payable turnover	7.60	7.20	7.71	7.31
Inventory turnover	1.74	1.64	1.71	1.82

Table 3.5 Boeing's turnovers in days

Turnovers (days)	2015	2014	2013	2012
Average age of receivable	33	31	28	26
Average age of payable	48	51	47	50
Average age of inventory	210	222	214	201

Airbus' inventory turns appear to be higher than Boeing's (1.91 vs 1.74). This could be interpreted as a more efficient use of working capital on Airbus' side. However, the fact that Airbus produces a larger number of smaller aircrafts (that are faster to produce) could play an important role in the matter. Compared to Boeing, Airbus accounts on lower inventories but a similar level of quick assets.

Table 3.6 Comparison between Boeing and Airbus

Liquidity indexes comparison	2015		2014	
	Boeing	Airbus	Boeing	Airbus
Current ratio	1,35	0,96	1,40	0,99
Quick ratio	0,42	0,42	0,44	0,45
Average age of receivable [days]	33	45	31	41
Average age of payable [days]	48	77	51	72
Average age of inventory [days]	210	191	222	178

3.3. Solvency

As mentioned before, Boeing and Airbus' capital structures are characterized by a very high D/E ratio. This is due to the fact that both companies can account on a very low cost of debt, having access to low interest financing from governments. This is very convenient for both firms, since the aviation industry is very capital-intensive due to the fact that technological obsolescence leads to high R&D costs. The huge backlogs of both firms allow for capital structures that lean so much on debt financing.

An eventual economic crisis, however, would pose an immense stress on the balance sheet, since the two aviation companies could have problems keeping up with the increasing debt. For now, anyways, Boeing can easily pay interests thanks to the solid incoming cash flows, and a good cash availability (the cash coverage index is 37.4).

Table 3.7 Comparison between Boeing and Airbus

Solvency indexes comparison	2015		2014	
	Boeing	Airbus	Boeing	Airbus
Debt/Total assets	0,93	0,94	0,91	0,93
Debt/Equity	13,90	16,86	9,72	12,58

Boeing has been recently criticized for its *pension policy*. Pension liabilities simply represent what the firm will pay employees when they retire. Boeing's pension liabilities have reached $17.9 billion at the end of 2015, and investors are unsure how the company will deal with this increasing debt. Although Boeing is not the only firm to conduct such a policy, this pension strategy has resulted in a wavering confidence on Boeing's shares value.

3.3.1. Stock price and dividend policy

As shown in Fig. 3.1, in the last 4 years, Boeing's stock price has been growing steadily. During these years, Boeing's financial statement's indexes have been improving, and investors seemed to be confident about the market outlook.

Fig. 3.1 Boeing historic stock price trend

Although Boeing's EPS is higher than Airbus's (7.52 vs 3.43), Boeing's current market price per share is also higher (146.59 vs 58.23). This results in a fairly similar price/earning ratio (19.49 vs 16.91). Dividends yields are also quite similar (2.48% vs 2.24% in the current year). This means that the two companies have an almost equal appeal from investors.

Table 3.8 Comparison on stock market indexes

Stock market information	2015		2014	
	Boeing	Airbus	Boeing	Airbus
Market stock price at 31/12 [$/share]	146.59	58.00	58.23	41.53
EPS [$/share]	7.52	3.43	7.47	2.99
Price/earning ratio	19.49	16.91	17.04	13.89
Dividends yield	2.48%	2.24%	2.29%	2.89%

As 2014 was a record year for Boeing and Airbus, the dividend yield decreased, as investors projected a very high growth for this industry.

Boeing releases dividends every trimester, and is considered a good dividend stock. In 2016, the dividend yield is considered to reach 3%. Boeing dividends have been steadily increasing in the last 20 years.

4. FUTURE PERSPECTIVES

Boeing is operating in a market that is expected to grow steadily for the next 20 years. In the nearby future, Boeing is assured to have a steady stream of revenue deriving from the future backlog. This factor partly mitigates the risk of having a capital structure heavily leaning on debt financing.

The recent election of Donald Trump as new US president might play a significant role in Boeing's future. Trump's protectionist policy has stressed relations with China, which has threatened to buy all aircraft for the government owned airlines from Airbus. This could be disastrous for Boeing recent investment in their new Chinese production plant. The consensus is that China's growth will significantly increase aircraft demand in this region, which makes this a key market to secure. Moreover, Trump announced his plans to increase his military spending, which could result in an increase in orders for Boeing's space and defense division. Lastly, republicans have usually leaned on tax reduction policies for businesses, and this could prove as an advantage for Boeing.

As far as new commercial products, both Boeing and Airbus have been relying on small steady incremental improvements on existing models. New more fuel-efficient engines and wing profiles have been introduced as updates to stay competitive on the market. During the past, aircraft design revolutions happened around every 10 years, which is more or less the time that it takes to design new engines and air fuselages. At the moment, however, it seems that the next big redesign will be introduced around 2030. Small incremental improvements are surely a safer strategy which appeals to risk averse investors. The huge backlog for both companies have also shifted the focus on faster production strategies. The increase in fuel prices and the increasing environmental problems awareness is likely to lead to a new electricity-powered aircraft design. Ben Moores, an analyst for IHS Jane's, stated that technology development for an all-electric aircraft will likely begin in the 2020's, and production will start around 10 years later. This is because current battery technology don't have enough capacity to support long range flights for commercial aircrafts.

Current US president Barack Obama has recently announced his intentions to send the man on Mars by 2030. Boeing, NASA, and SpaceX (founded by Tesla's CEO, Elon Musk) have announced the creation of a collaboration project to achieve this goal.