Investment appraisal in commercial aviation

Replacement of the Fokker 100 operated by PGA

Fábio Henriques Martins
Instituto Superior Técnico – Departamento de Engenharia Aeroespacial
Avenida Rovisco Pais, 1096-001 Lisboa, Portugal
martins.fabio.h@gmail.com

Abstract

Investment appraisal is a procedure found in all kind of industries and organisations, independent of being profit or non-profit. Investors need to make informed and argued decisions according to the risk they are willing to take. This leads to the need to analyse, study and predict all cash-flows involved and to create tools and methodologies to impartially evaluate an investment, with the goal of better understanding the business.
Commercial aviation is now a key economic activity in the development of countries, not only due to its ability to create value and to employ a large number of workers, but also because it represents and sends a modern impression of the community it is inserted in. Therefore, fleet modernisation is not just a matter of reducing costs, but also a matter of branding.
The primary objective of this dissertation was to evaluate the acquisition of a new air fleet for an airline. This assessment starts with an analysis of the risks that comes with such an investment. It is followed by the commercial aviation's background, with a special focus on regulatory agencies and the airline that is part of the case study: TAP Portugal (Portuguese Airlines) and its subsidiary PGA (Portugália Airlines). For the case study, the replacement of the Fokker 100 regional jet fleet was chosen, an airplane developed and built by a company that went bankrupt in the 90's. Although all main competitors were taken into consideration, the planes chosen as the solutions to be studied were Embraer-190 and Bombardier CRJ900ENEU, in order not to impose any solution due to their clear differences. Several methodologies to evaluate investments were analysed, as all main cash-flows involved in this type of operation. After the calculus of the Net Present Value, a sensitivity analysis was done to better understand the cash-flows in question.

Keywords: investment appraisal, commercial aviation, regional jets, air fleet replacement

1 Introduction

Commercial aviation provides an irreplaceable service to virtually the whole planet and has been an important piece in the development of the global economy as we know it [1]. In numbers, the airline industry consists of more than 2000 airlines and more than 23000 aircrafts in operation. Many developments have changed commercial aviation lately, such as global alliances, "open skies", companies' privatisation and low cost companies [2].
Unfortunately, aviation has been suffering from a financial crisis for most of 21st century now and a continual pressure from the shareholders to achieve good results is a constant in any financial activity. Therefore, replacing fleet planes is not just a question of marketing and flight comfort, but also a way to optimise costs by choosing more efficient and reliable planes.
Replacing an old plane or simply acquiring a new one is nothing less than an investment and it should be financially evaluated as any other investment. Questions such as the following should be addressed before any investment:

- How much will the investment cost?
- How long will it be before the investment starts to yield returns?
- What are the expected profits from the investment?
- Could the money that is being ploughed into this investment yield higher returns elsewhere?

As any other industrial activity, carefully investing in new assets, in this case a jet plane, allows the company to healthily grow and achieve their goals, developing the surroundings and, as a result, the countries where it operates.
Summing up, this dissertation studied the acquisition of a new plane, to replace an older one, from the airline's financial point of view. For the case study, the replacement of the Fokker 100 operated by TAP's subsidiary, Portugália Airlines, was a great opportunity to assess the financial feasibility of the acquisition of an aircraft, with the collaboration of the Portuguese national airline.

2 Business Environment Review

2.1 Environment Assessment –

In business, the environment where a company operates is frequently changing. Therefore, it is common for managers to study external events, with the goal of understanding if such events are a menace to their activities [3].
There are grossly two different methods for risk assessment [4].

Table 1 – Methods for risk assessment

Prognostic	Agnostic
• Estimates probability based on historical data of risk occurrence • Calculates impact by multiplying risk probability and potential damage	• Simulates impact of key risks, without need for determining probability of occurrence (no prediction)

With the purpose of diagnosing the ventures that can jeopardise a company, a PESTEL assessment was done:

- Political-Legal
- Economics
- Social
- Technological
- Ecologic and environmental

2.1.1 Political-Legal

The political context of a country is often overlooked in the short term because there is an idea of some stability. In the case of the Portuguese political system, elections are held every four years, giving some political stability in the short term. However, the same does not happen in the long term, since it is difficult to predict what will be the political future as a result of constant interruptions and change of mandates.

Portugal is a clear example of that, because it lived a period of instability not long ago. This political instability undermines companies and regulations. Standards are not implemented and the perception of stability is corrupted. In addition to the instability, the sovereign debt crisis has taken Portugal to ask for help from IMF and the European Union. In order to fulfil the agreement, Portugal lost sovereignty over measures to restore national financial health. One of the points considered is the possibility of privatisation of TAP Portugal. This scenario affects the feasibility study for aircraft acquisition, due to the uncertainty in the future.

In a legal context, Portugal as a Democratic Republic is concerned with social equality and equal access to the market. Thus it is needed to facilitate the creation of a free market, regulated in order to avoid monopoly situations. There are risks in regulation, since changes in legislation are constant and can negatively influence any companies' investment through increased costs and reduced profits.

When investing in a new aircraft, human resources are a key component since it ensures full usage of assets. Therefore, employees who are considered inefficient are considered toxic assets and firing them is a priority. In a national context, this action is sensitive due to the difficulty in dismissing staff and the costs that it entails.

Summing up, the current political-legal environment does not help companies' performance, as well as new investments. It is important to note that political influence is always present in the remaining points of the PESTEL analyses.

2.1.2 Economic

The current trade balance deficit restricts the financial support, access and incentive for new investment. Therefore TAP Portugal is obliged to resort to other sources of financing, including bank loans, leasing and rental contracts for the acquisition of new assets.

According to the information available at the European Central Bank, the Euribor rates for various maturities have been growing in 2011[5]. Such occurrence shows an improved liquidity in the interbank market. However, it may show a likely increase in the costs of financing. Apart from this situation, it is intuitive that the difficulty to Portuguese companies to obtain credit is high in such economic environment.

2.1.3 Social

There are many different socio-cultural risks that may influence the decision to invest. Thus, Portuguese society should be studied in order to identify and evaluate these risk factors, such as population aging, low educational levels, and employment instability, among others.

Population aging is now a social problem in Portugal. About 18% of its population has more than 65 years [6]. The trend is a steady growth in population aging, which leads to various problems, including an increase in social security contributions, which the workforce will bear, thereby reducing the disposable income. In addition, workers with more than 40 years are seen as individuals resistant to change and not very productive, something that science and psychology have been advocating.

Coupled with productivity at work, a recurring issue in the labour market is the difficulty in finding qualified professionals. One of the factors contributing to this situation is the low level of education of the Portuguese population, which discourages private initiatives. The uncertainty associated with professional status, as a result of high unemployment and high precariousness of work contracts, is one of the adversities that society faces.

All these factors, a social perspective, can lead to the discontent of the people leading to demonstrations and / or revolt against the present government. For a company, and as a result of dissatisfaction among workers, a smooth running of operations may be at risk due to the occurrence of so-called strikes. In this context, under the law, the strike can be conceptualised as a collective suspension, temporary and peaceful, full or partial provision of personal services. Portugal has currently very high values regarding the number of strikes. This situation will not be difficult to justify in the face of social instability experienced in the country and has the support of labour unions, which are very influential social groups regarding population movements. Note that TAP Portugal is one of the companies with a high number of strikes, as well as in the sectors of rail transport.

In short, this social context leads to an uncertain environment, enhancing the existence of risks in new investments. The aging population, coupled with low education level, originates barriers to change and innovation to develop new business. Entrepreneurs who want to start new projects find themselves limited in the face of professional instability, which often leads workers to express their discontent.

2.1.4 Technological

The current climate of rapid technological development is forcing companies to constantly adapt in order to become more competitive.

To ensure survivability in a sector where they operate, organisations need to have strong capabilities to cope with constant technological changes. It is understood that, for the study of this dissertation, the technological capacity should be defined as the competence of a firm to assimilate and use technologies that are useful, to make changes and to find new solutions to the different challenges they face in everyday business life.
In the specific case of aviation, the technological changes appear as a critical issue. Therefore, buying a plane has to assume long-term studies (more than 10 years) to the extent that the large initial investment does not allow constant upgrades to the fleet.
Along with the modernisation of the fleet comes the problem of adapting the crew to the new implemented technologies, leading to a conflict with the social environment demonstrated previously. The technological level of a country still appears not as the only responsible for the weak development. The lack of liquidity in the country leads to decreased spending in various sectors, including the Research and Development, which is one of the engines for growth and progress of a society.

2.1.5 Ecologic and Environmental

Currently there is a growing concern with creating a sustainable ecological future. Therefore, a new investment in an aircraft may cause not only monetary and financial costs, but also environmental.
About 2% of carbon dioxide emissions are result from aircraft operations, which represents a high contribution to smog and global warming. However, technological advances have increased fuel efficiency and investments are being done in different fuels, such as biofuels [7]. Unfortunately, any development aiming to be more sustainable and efficient is preceded by investment, therefore representing costs for the companies involved.

2.1.6 Force Majeure Events

A Force Majeure Event is a concept that relates to the occurrence of events beyond the control of human beings. In aviation, natural disasters and terrorist attacks are the most common events to compromise operations and to create high expenses and losses and are difficult to predict.
Terrorist attacks such as September 11 and natural disasters like the eruption of the Icelandic volcano in March 2010 caused several million Euros in losses for the airlines concerned. These losses can be due to customers fear to fly after a terrorist attack or the need to invest in security, or the impossibility to operate specific routes and the need to perform not scheduled maintenance due to natural disasters.
In short, the terrorist attacks are a reality that managers of airlines have to take into account by performing all the preventive procedures and follow all security rules. However, in case of natural disasters, bad weather prevails as a strong element of uncertainty because an alternative to ensuring operation in such conditions has not been found.

2.2 Risk Assessment

After the analyses of the risks involved through the PESTEL assessment, the following risks were considered:

Table 2 – Type of Risk

Political-Legal	• Political instability • Constant legal changes • Strict work laws
Economic	• Difficulty in getting credit • Decreasing GDP • Low liquidity
Social	• Aged population • Job instability • Unemployment • Strikes and manifestations
Technical	• Resistance to change • Need to invest in education • Possible low financial availability to invest in education
Environmental	• Environmental pollution and costs • Need to invest in sustainability
Force Majeure Events	• Natural disasters • Terrorism

3 Commercial Aviation

3.1 Introduction

The concept that will be developed in this chapter is aviation. Aviation is one of the two branches of aeronautics, the other being aerostation (apparatus lighter than air).
The first major distinction to be done is the difference between civil aviation and military aviation, in which the first includes all types of non-military aviation, such as general aviation and commercial aviation, and the second is the use of aircraft for military purposes.
In this dissertation the scope is civil aviation, more specifically the commercial aviation, which involves operating aircraft for hire and is associated with scheduled flights, operated by different airlines, which provide air transport services for travelling passengers and freight.
Nowadays, aviation is a key service for both leisure and business activities and international travels have become a part of our daily life.

3.2 Aviation Characterization

3.2.1 Regulatory Agencies

Aviation is regulated by agencies that aim to increase safety and help orderly growth. There are many agencies and they can be categorised as: national, with INAC as the most relevant one, and international, with IATA and ICAO as two of the most known. INAC, *Instituto Nacional de Aviação Civil*, is a public institute which goal is to regulate and supervise aviation on Portuguese territory [8]. ICAO, International Civil Aviation Organization, is a specialised agency of the

United Nations for the aviation business and it aims to improve air navigation and fosters the planning and development of international air transport [9]. Finally IATA, International Air Transport Association, is an international industry trade group of airlines, which aims to provide safe and secure transportation to its passengers [10].

3.2.2 Airlines

By airline, a company that provides air transport services of passengers and/or goods should be understood. The airlines' goal is to be the best choice for its customers' travel needs at all times, as well as to ensure adequate levels of profitability for its shareholders and the best conditions for professional development for its employees.

As in most businesses, airlines can have different market approaches. After market recognition it is possible to find groups of clients with the same demands, creating different business segments, with a different strategy orientation [11]. This way, mainly two different approaches can be found: Low-cost airlines and full-service airlines.

3.2.2.1 Low-cost airlines

These companies have a low fare orientation, generally offering lower fares in exchange for services. Low-cost airlines appeared after market deregulation and forbiddance of state incentives to flag carriers. With a constant worry with cost optimization, most low-cost airlines have the following similarities:

Table 3 – Low-cost characteristics

Airplanes	Single type of aircraft High usage rates
Airports	Secondary ones/suburbs
Employees	Multiple roles Salary depends on profits Lower than in full-service airlines
Fuel	Fuel hedging (establishment of a fixed or capped fuel price in order to reduce explosion to fuel prices volatility)

In order to better understand a company's strategy, a tool called Marketing-Mix is used, which aims to clearly distinguish the four "P"s of business: Product, Price, Place and Promotion [12]. Therefore:

Table 4 – Low-cost's marketing-mix

Product	Single passenger class No meals included. Although snacks and light meals may be possible to buy on board No marked seats Luggage restriction (extra income through charging for luggage transport)
Price	Low fares Cost optimisation
Place	Call centers Ticketless
Promotion	Aggressive promotions, such as trips for free plus airport fees

Some of the best known low-cost airlines are Ryanair, Easyjet and Southwest Airlines.

3.2.2.2 Full-service airlines

Full-service or traditional airlines are the ones who kept their business approach after market deregulation, with the changes needed to assure competitiveness. Following the same model used for low-cost carriers, the following Marketing-Mix was obtained:

Table 5 – Regular airline's marketing-mix

Product	Several services included More spacious and booked seats Transfer flexibility
Price	Different price classes
Place	More complicated booking due to possible transfers
Promotion	Quality driven Branding Codeshare between partners

Some of the best examples of such airlines are: TAP Portugal, Lufthansa and Iberia.

- TAP Portugal

TAP Portugal is Portugal's leading airline and has been a member of Star Alliance since 14 March 2005. It is a company totally state owned and has its hub in Lisbon's airport. Portugália Airlines (PGA) is a TAP's regional subsidiary and together they serve 75 destinations in 34 countries worldwide and operate a fleet of 71 aircraft. TAP aims to become a top airline on the international scene and distinguishes itself by its operational efficiency and the quality of its services [13].

TAP was awarded "World's Leading Airline to Africa" (2011), "World's Leading Airline to South America" (2009, 2010 and 2011) and "Best European Airline" (2011).

3.2.3 Airline Alliances

An airline alliance starts and consists in an agreement between two or more airlines to cooperate, creating a network connectivity and convenience for passengers and cargo, helping passengers making inter-airline codeshare connections. The three biggest and most important airline alliances are: Star Alliance, SkyTeam and Oneworld.

TAP Portugal is part of Star Alliance, the world's first and largest global airline [14].

4 Investment Presentation

4.1 Case-study

In aviation it is necessary to bear in mind the needs that an aircraft requires in terms of financial and human capital. Globalisation, coupled with the need to transport goods and passengers to other countries and continents, has increased the growth of turnover by the airlines. Thus, given the increasing need for transportation, airlines have had to adapt to market demand, investing and increasing the ability of skilled labour, in addition to the acquisition of new equipment [15]. However, there are situations arising from the economic volatility and constant innovation, which can make certain assets and equipment outdated or even inefficient. This inefficiency is synonymous with higher

operational costs. As an example, the bankruptcy of the Dutch company Fokker leads to a lack of official updates and maintenance, with special attention to the future miss of spare parts. This situation puts the replacement of this airplane on the table [16].
Due to the development of the aviation industry, it is possible that older Regional Jets (RJ) may be withdrawn from the market or replaced [16]. These aircrafts are generally used by major airlines through regional subsidiaries to carry on with low-density routes in Europe. However, with the current financial crisis the strong competition between airlines and reduced purchasing power of passengers, it is possible to see a transfer of operations from major airlines to their regional subsidiaries, causing an increase in their rate of use [17].
With this in mind, the case study presented in this dissertation has as main objective to analyse the feasibility of a particular asset, the Fokker 100. This aircraft is operated by Portugália Airlines, a subsidiary from TAP. The analysis will be carried out focusing on the capital needs and cash-flows present in the operation of the replacement options considered in this dissertation. At the end, this thesis aims to present a result, which would impartially show which aircraft would be the best option to replace the Fokker 100.

4.2 Fokker 100

In order to develop a rational choice of the possible replacements for the Fokker 100, it is necessary to take the positioning concept into account. In other words, how the Fokker identifies and distinguishes itself from other regional jets.
The first step is to identify and characterise this aircraft. The Fokker 100, a jet powered aircraft specifically designed for domestic and regional flights, is the largest aircraft manufactured by Fokker, being currently part of PGA's fleet. Unfortunately this airplane does not have a good reputation after being involved in aviation accidents, even if it was not for reasons directly related with the aircraft, tarnishing its image and recognition. An example of such accidents occurred in 1996, on a scheduled flight between Sao Paulo and Rio de Janeiro (Brazil) from which there are no recorded survivors [19][20][21].

4.3 Replacement options

The planes considered in this dissertation to replace Fokker 100 were: Bombardier CRJ and C-Series, Embraer E-Jet, Mitsubishi MRJ and Sukhoi Sj-100.

4.3.1 Aircraft presentation

4.3.1.1 Bombardier

- CRJ

The Bombardier CRJ is a family of regional aircrafts with capacities between 50 and 100 passengers. The CRJ program, or Canadair Regional Jets, was officially launched in 1989 and in 1991 it performed its first flight with the CRJ100, a 50-passenger plane. The CRJ700, the model with a capacity between 70 and 78 passengers, was launched in 1997 and entered in service in 2001. In 1999, the CRJ900 was announced, a model that resulted from the growth of the CRJ700, which started its operation in 2003. The latest model and the one with the largest capacity from the CRJ family, the CRJ1000, saw its program beginning in 2007, the same year when Bombardier announced the NextGen program. The CRJ1000 had its first flight in 2008 and deliveries began in December 2010. This program was extended to different models of the CRJ family and had the intention to modernise and standardise the interior of their planes [22].
Until March 31st, 2012 Bombardier had 1717 orders for their CRJ's and Challengers (the executive version), from which 1665 have been delivered [23].

- C-Series

The Bombardier C-Series is a family of planes, designed for the commercial aircraft market with a capacity between 110 and 145 passengers, the main difference between the two models, the CS100 and CS300, respectively [24][25].
The C-Series had a troubled development, whose project has been abandoned and restarted several times. In July 2008, Bombardier has approved the program and it is expected to start to be in service in 2013 [26].
Despite being an interesting project and to promise lower fuel consumptions by 20% compared to similar aircrafts, this project will compete in a class of itself. The capacity of these planes makes them competitors of medium-ranged aircrafts, such as the Airbus A319. Besides its capacity, the range of the CS300 is longer than Airbus A320's and is similar to the A319's, two aircrafts operated by TAP.

4.3.1.2 Embraer E-Jet

Embraer is a Brazilian company that designs and produces aircrafts for various purposes. For the commercial aviation it should be pointed out that the Embraer-Jet family, known as E-Jet, is largely responsible for the company's success.
The commercial RJ family is based on the E-170, which was launched in 1999 and it saw its first unit being delivered in 2004. This family of aircrafts is fulfilled with four models: E-170, E-175, E190 and E-195. All models have three different versions, where the main differences lie on the MTOW and range. The passenger capacity of these planes varies between 70 and 124 passengers [27].

4.3.1.3 Mitsubishi MRJ

Mitsubishi Aircraft Corporation began operations on April 2008 with the goal to design, produce and perform all business and after-sales services of the new Mitsubishi Regional Jet, called MRJ.
The MRJ is the result of a new project from Mitsubishi and its partners for a new family of regional jets, with a passenger capacity between 70 and 90 passengers and with special focus on low maintenance costs and high reliability. The first delivery is planned for 2013 [28].

4.3.1.4 Sukhoi Sj-100

As a result of a partnership between Boeing Company and the Russian firm AVPK Sukhoi, a project was born for a Russian regional jet, which had its climax in 2011 with the delivery of the first Sukhoi Superjet 100, also called Ssj-100.Two versions can be found, the Superjet 100-95 and -75, with capacities between 78 and 98 passengers. Note that both versions have two variants, one with standard range and another one with a longer range [29].

4.3.2 Case-study chosen aircrafts

After analysing all options, the two planes chosen for this exercise were the Bombardier CRJ900ENEU and the Embraer E-190Std. These two models are some of the most successful ones in the RJ market. Bombardier had, until July 2011, a total of 314 orders for their CRJ900 and CRJ1000 with 265 delivered units. Until August 2009, Embraer delivered 417 from the 581 orders for E-190 and E-195 models [30].

From the CRJ family, the CRJ900ENEU was chosen due to its low MTOW, which will be relevant for the airport charges, and to be the one in production in 2011, year chosen for the production of both aircrafts with the goal of reducing non-scheduled maintenance services, even if it means higher lease rents.

It is important to point out that a thorough comparative analysis between all planes mentioned was not done because it is not the aim of this dissertation to present the aircraft that should replace the Fokker 100. The choice was done focusing on the information available for both aircrafts, because both are in production and are comparable to the Fokker 100. Besides that, they were chosen because they are not direct competitors. Subsequently, it is possible to proceed with the investment appraisal, to present an exercise regarding the replacement of a plane and presenting conclusions without being committed with any solution.

4.3.2.1 Bombardier CRJ 900 ENEU

The Bombardier CRJ900 is a RJ and consists in a stretched version of the CRJ700. With a capacity of around 90 passengers, this model was constantly upgraded in order to achieve better operational results. The constant upgrade business philosophy led to the CRJ900ENEU, the latest one, designed for European Airports, with a MTOW of 36.995kg, lower than the previous versions [22][23].

4.3.2.2 Embraer E190 Std

This specific plane was designed to be the main option for the 100 seats RJ. There are three different versions, being the standard one, with a MTOW of 47.790kg, the chosen for this exercise. With capacity for 98 passengers, special attention was taken regarding cabin comfort and versatility, without neglecting fuel consumption [27].

5 Investment Appraisal

5.1 Introduction

Aircraft acquisition, as any other investment, requires feasibility studies. In this chapter, several financial viability analysis methods will be presented, in order to implement the most appropriate one for the case-study.

The application of these methodologies shows how profitable it is to perform a new investment, regardless of their nature.

In this context, a project can be classified as a start-up (start-up companies) or as part of a company's program. In the last case, the project can be an expansion (leading to an increased production capacity), innovation (creating new areas of business) or replacement (assumes the maintenance of production capacity), the latter being the type applied in the case study [31].

5.2 Financial feasibility assessment methods

An investment in financial assets or real assets is a use of funds with the purpose of its full recovery and achieving a financial surplus.

In this manner, the procedure for an economic evaluation for such project is to identify all financial flows (cash flows) generated by the project, followed by applying a set of evaluation methodologies that allow us to conclude whether the project is economically viable. Cash flow is the result of confronting the inflows (cash inflow) with outflows (cash outflow). Therefore, cash inflows include all incomes from operating activities of the asset. Similarly, the cash outflow includes all payments resulting from this activity [32].

A peculiarity of the cash flow study is that it does not consider any financial cost with company's debt. Firstly the financial assessment was done considering that the project is fully funded by company's equity. Later, the costs with financing were included. However, in this case-study, any financing costs were not taken into account, assuming that the investment is done with equity. When it reaches the end of the project's life, a liquidation of assets, its sale or continuation should be assumed.

The cash flows calculus can be done following two methods: constant prices or current pricing. The last methodology is more accurate since the current price reflects the actual price behaviour [33].

An investment will generate cash flows over its life. In order to analyse the economic viability of the project, all cash flows must be reported to the same time, only then it will become comparable. In the process of updating the cash flows, it is necessary to determine the discount rate. Therefore, to invest in a project, an investor will require at least the remuneration that would get their money if applied in a risk-free asset (commonly government bonds). To this fee, a risk premium is added that arises from the risk specifically associated in the project under consideration.

Finally, the most common methods for financial appraisal are: Net Present Value (NPV), Internal Rate of

Return (IRR), Payback Period (PP) and Profitability Index (PI).

5.2.1 Net Present Value

The Net Present Value is a methodology that compares the current value of all cash flows, taking the discount rate (DR) demanded by the investors into account.
Formula:

$$NPV = \sum_{n=1}^{N} \frac{C_n}{(1+r)^n} - C_0 \quad (1)$$

C_n – Cash flow of year *n*
N – Project duration
r – Discount rate
C_0 – Initial cash flow or first investment
The project should be accepted if the NPV is higher than zero. If it is zero, the project should only allow recovering the investment done and can easily be harmful if any cash flow or the discount rate changes.
The NPV has some limitations, especially when comparing projects with different durations [32].

5.2.2 Internal Rate of Return

The internal rate of return shows the discount rate that makes the NPV of a project equal to zero.
Therefore, a project is considered viable if the DR demanded by the investors is lower or the same as the IRR.
The IRR is not the best option when it is assumed that the DR changes along the investment life. Moreover, when both projects are mutually exclusive, this methodology is not adequate [32].

5.2.3 Payback Period

The payback period represents the length of time needed to recover the cost of an investment. In other words, the time needed to achieve a NPV of zero.
Summing up, if the PP is shorter or the same as the duration of the project, it should be accepted. However, it ignores any cash flows that occur after the PP, not measuring profitability and acting more like a risk measurement tool. In addition, it does not suit the situation of mutually exclusive investments [32].

5.2.4 Profitability Index

The PI shows the ratio between the project's cash flow and the investment needed. A ratio of 1 is the lowest needed for it to be acceptable. However, like the IRR and PP, it is not the best option when the projects to be considered are mutually exclusive [32].

5.3 Method to be applied

As described, the best suitable method to assess the financial feasibility of mutually exclusive investments is the NPV, because the three other ones should not be used alone to compare mutually exclusive projects. In addition, NPV is the most commonly used method, regardless of the industry [31].

5.4 Discount Rate

The decision to choose a discount rate is a crucial point in the evaluation of any investment. The required rate varies with the industry or context where the project will take place. The DR is directly related to the risks the investors are willing to take.
In this case, the acquisition of an aircraft, the method used to estimate the DR has nothing to do with calculations, but with the expertise of people from the industry in question. Therefore, the method used is called Delphi, and consists of consultation and access to information provided by experts, in order to conclude what is generally the behaviour and demands of the investors in similar situations [34].
Thus, a DR of 11% was used as a benchmark value for similar projects, with an expected life cycle between 5 and 10 years.

6 Case Study

6.1 Cash-Flows

In order to get to a result from the model and to achieve a conclusion regarding which project to invest, it is necessary to set the cash flows resulted from the operation and acquisition of an aircraft.

6.1.1 Inflow

The inflow in such an investment refers to the income from the transport of passengers, in other words, the plane tickets paid by the passengers.
Regarding the scope of the inflow, the routes considered for the study of the income where the ones most flown from those operated with the Fokker 100. Due to the seasonality of flight tickets and to the different seat pricing in the same flight, charging different prices as a result of a more complex marketing-mix according either with service offered, seats available and/or the time of buying, several flights were considered in order to achieve a ticket value for each of the routes considered and an average one to the remaining routes [35][36][37][38].
The number of passengers was obtained through TAP's average passenger load factor, which was assumed constant along the project's life cycle for being a pessimist assumption [39].
Finally, regarding the cabin layout and passenger ticketing, the option chosen was the one CRJ900ENEU, in order to avoid unconformities with number of passengers flown in each service class.

6.1.2 Outflows

The four outflows considered were the lease rent, fuel costs, flight crew, maintenance cost and airport charges.

6.1.2.1 Lease rent

The lease rent is the main outflow to be considered in such investment. Although buying a plane is something normal, operational leasing is a common practice due to the high investment needed to buy a commercial plane. Therefore, leasing the plane for the duration of the project was the option chosen.
The airplanes chosen for the case study are currently in production, allowing to consider brand new planes for this case study. This decision implied higher lease rents, but allowed considering that there will be less non-

programmed maintenance costs and breaks. The values used for both planes came from a specialised company on aircraft values [40].

6.1.2.2 Fuel

Fuel cost is the hardest outflow to predict due to constant oil prices oscillations. Many studies are available and all have a common conclusion: there is a huge uncertainty regarding the future of oil prices [41].
As such an important cost for the airlines, the International Energy Outlook's reference oil prices were considered for this study [42]. The previous values in addition with the data available on IATA website, a reference price for the jet fuel, fuel used in jet planes, was obtained [43].
The fuel consumption of the aircrafts is a key figure on investment appraisal like this and the values used came from a tool developed by EUROCONTROL, the European organisation for the safety of air navigation, for the European Union Emissions Trading Scheme [44].
Finally, the considered fuel costs were possible to be estimated with the data regarding the jet fuel price, fuel consumption and the routes operated with the Fokker 100,

6.1.2.3 Flight crew

Flight crew costs change with market approach, between competitors and even inside an airline [18]. Due to the responsibility and job demands, pilots have a higher salary than cabin crew and together they represent a considerable part of the total costs. In addition, due to regulated work conditions, more than one flight crew is needed per aircraft at full use.
Summing up, for this study a crew was considered to have two pilots, each earning 157.000$ annually, and two cabin crew members, earning 28.500$ each per year [16]. With an imposed limit of 650 flight hours (FH) per year for the pilots and 750 FH for the remaining crew members, this means that 5 crews per plane are necessary when taking non-programmed flights into account. Finally, an annual raise on their salaries of 1,125 times the inflation rate was considered.

6.1.2.4 Maintenance

The maintenance of an aircraft is of extreme importance, not only for safety reasons, but also for cost optimisation. In addition, all the time a plane has a non-scheduled maintenance it is not flying and being used according to its potential.
The maintenance costs were obtained by studying the specialised users guide of the airplanes and depend on the flight hours, which were provided by TAP [45][46].

6.1.2.5 Airport charges

A commercial flight connects two airports, complex facilities with high costs, which are mostly covered thanks to aeronautical activities. Thus, planes pay charges for using airport's facilities and services.
Each airport has some autonomy and the formula that allows getting the fee to pay varies from airport to airport. However, all airports considered have at least one fee that is connected to the MTOW of the aircraft and other related with the number of passengers who were in that flight. Therefore, generally a lower MTOW means lower costs when regarding to airport charges.
The airport fees are available at their websites and only the most used by PGA's Fokker 100 were considered, using an average value for the remaining ones.

6.2 Assumptions

In order to accomplish this exercise, the following assumptions had to be made:

- The information about the routes operated with the Fokker 100 was provided by TAP Portugal.
- The cash flows were established taking the most flown routes operated with the Fokker 100 into account, using average results for the remained routes.
- The duration considered for the project life cycle was 10 years.
- The inflation rate is one of the most important variables to be estimate in such exercises. The results and estimation from the EUROSTAT for the inflation rates were used until 2017, assuming a constant value from there on.
- The exchange rate used through the exercise comes from the data available from the European Central Bank.

7 Results

7.1 Inflow

Since the same inflow was considered for both airplanes, the following results were obtained:

Table 6 – Inflow

€	Inflow
2012	17.247.384
2013	17.592.332
2014	17.926.586
2015	18.213.411
2016	18.468.399
2017	18.856.236
2018	19.252.216
2019	19.656.513
2020	20.069.300
2021	20.490.755

7.2 Outflow

7.2.1 Leasing rent

The leasing rents for both aircrafts are illustrated in the next table:

Table 7 – Leasing rent

€	CRJ900	E190
2012	273,084	285,753
2013	280,226	279,122
2014	287,929	288,772
2015	289,731	305,328
2016	307,549	330,273
2017	316,054	333,247
2018	299,124	323,722
2019	299,170	324,452
2020	305,545	328,972
2021	310,201	334,615

7.2.2 Fuel

According to all considered data for oil prices and fuel consumption, the following fuel costs were calculated for this investment appraisal:

Table 8 – Fuel

€	CRJ900	E190
2012	2.882.694	4.157.031
2013	3.039.935	4.383.782
2014	3.211.538	4.631.244
2015	3.392.536	4.892.255
2016	3.580.161	5.162.823
2017	3.770.932	5.437.927
2018	3.930.208	5.667.613
2019	4.133.663	5.961.008
2020	4.304.313	6.207.096
2021	4.480.471	6.461.127

7.2.3 Crew

Following the same model as the inflow, the crew cost was considered the same for both aircrafts:

Table 9 – Crew

€	Crew
2012	794.698
2013	815.361
2014	835.500
2015	852.878
2016	868.401
2017	892.108
2018	916.463
2019	941.482
2020	967.185
2021	993.589

7.2.4 Maintenance

In the same way as the other outflows, the costs with maintenance were:

Table 10 – Maintenance

€	CRJ900	E190
2012	2.518.745	1.074.505
2013	2.569.120	1.095.995
2014	2.617.933	1.116.819
2015	2.659.820	1.134.688
2016	2.697.057	1.150.573
2017	2.753.696	1.174.735
2018	2.811.523	1.199.405
2019	2.870.565	1.224.592
2020	2.930.847	1.250.309
2021	2.992.395	1.276.565

7.2.5 Airport fees

Finally, the last outflow that was taken into account was the airport fees:

Table 11 – Airport fees

€	CRJ900	E190
2012	2.312.153	2.491.545
2013	2.358.396	2.541.376
2014	2.403.206	2.589.662
2015	2.441.657	2.631.097
2016	2.475.840	2.667.932
2017	2.527.833	2.723.959
2018	2.580.917	2.781.162
2019	2.635.117	2.839.566
2020	2.690.454	2.899.197
2021	2.746.954	2.960.080

7.3 Net present value

After studying and getting all the cash-flows needed to calculate the net present value, the following results were achieved:

Table 12 – CRJ900ENEU Net Present Value

CRJ900	Inflows	Outflows	Present Value
2012	17,247,384	8,781,374	8,466,010
2013	17,592,332	9,063,038	8,529,294
2014	17,926,586	9,356,106	8,570,480
2015	18,213,411	9,636,622	8,576,789
2016	18,468,399	9,929,008	8,539,391
2017	18,856,236	10,260,623	8,595,612
2018	19,252,216	10,538,235	8,713,981
2019	19,656,513	10,879,996	8,776,517
2020	20,069,300	11,198,344	8,870,956
2021	20,490,755	11,523,609	8,967,146
DR	11%		
NPV	**50,760,831.11 €**		

Table 13 – E190 Net Present Value

E190	Inflows	Outflows	Present Value
2012	17,247,384	8,803,532	8.443.852
2013	17,592,332	9,115,636	8.476.696
2014	17,926,586	9,461,997	8.464.589
2015	18,213,411	9,816,246	8.397.165
2016	18,468,399	10,180,002	8.288.397
2017	18,856,236	10,561,977	8.294.259
2018	19,252,216	10,888,364	8.363.852
2019	19,656,513	11,291,100	8.365.413
2020	20,069,300	11,652,759	8.416.541
2021	20,490,755	12,025,977	8.464.778
DR	11%		
NPV	**49.490.759,62 €**		

7.4 Sensibility analysis

All cash-flows were based on estimations and forecast. However, due to unpredictable variables that can change the result obtained, a sensibility analysis was done in order to better understand the impact of variations of all cash-flow in the NPV. This assessment considers the oscillation of a single cash-flow at a time.
Regarding the CRJ900:

Table 14 – CRJ900 Sensibility Analysis 1

CRJ900 Sensibility Analysis Part 1/3			
DR	**NPV (€)**	**Fuel**	**NPV (€)**
9,0%	55.358.955	-20%	54.907.911
9,5%	54.150.313	-10%	52.834.371
10,0%	52.982.191	-5%	51.797.601
10,5%	51.852.900	-1%	50.968.185
11,0%	50.760.831	0%	50.760.831
11,5%	49.704.455	1%	50.553.477
12,0%	48.682.314	5%	49.724.061
12,5%	47.693.014	10%	48.687.291
13,0%	46.735.250	20%	46.613.751

Table 15 – CRJ900 Sensibility Analysis 2

CRJ900 Sensibility Analysis Part 2/3			
Airport Fees	**NPV (€)**	**Maintenance**	**NPV (€)**
-20%	53.678.688	-20%	53.939.400
-10%	52.219.760	-10%	52.350.116
-5%	51.490.295	-5%	51.555.473
-1%	50.906.724	-1%	50.919.760
0%	50.760.831	0%	50.760.831
1%	50.614.938	1%	50.601.903
5%	50.031.367	5%	49.966.189
10%	49.301.902	10%	49.171.547
20%	47.842.974	20%	47.582.262

Table 16 – CRJ900 Sensibility Analysis 3

CRJ900 Sensibility Analysis Part 3/3			
Crew	**NPV (€)**	**Leasing Rent**	**NPV (€)**
-20%	51.784.977	-20%	51.106.616
-10%	51.272.904	-10%	50.933.723
-5%	51.016.867	-5%	50.847.277
-1%	50.812.038	-1%	50.778.120
0%	50.760.831	0%	50.760.831
1%	50.709.624	1%	50.743.542
5%	50.504.795	5%	50.674.385
10%	50.248.758	10%	50.587.939
20%	49.736.686	20%	50.415.046

Finally for the E190, following the same model:

Table 17 – E190 Sensibility Analysis 1

E190 Sensibility Analysis Part 1/3			
DR	**NPV (€)**	**Fuel**	**NPV (€)**
9,0%	53.923.238	-20%	55.471.117
9,5%	52.758.466	-10%	52.480.938
10,0%	51.632.525	-5%	50.985.849
10,5%	50.543.801	-1%	49.789.777
11,0%	49.490.760	0%	49.490.760
11,5%	48.471.938	1%	49.191.742
12,0%	47.485.943	5%	47.995.670
12,5%	46.531.449	10%	46.500.581
13,0%	45.607.192	20%	43.510.402

Table 18 – E190 Sensibility Analysis 2

E190 Sensibility Analysis Part 2/3			
Airport Fees	**NPV (€)**	**Maintenance**	**NPV (€)**
-20%	52.635.004	-20%	53.939.400
-10%	51.062.882	-10%	52.350.116
-5%	50.276.821	-5%	51.555.473
-1%	49.647.972	-1%	50.919.760
0%	49.490.760	0%	50.760.831
1%	49.333.547	1%	50.601.903
5%	48.704.699	5%	49.966.189
10%	47.918.638	10%	49.171.547
20%	46.346.516	20%	47.582.262

Table 19 – E190 Sensibility Analysis 3

E190 Sensibility Analysis Part 3/3			
Crew	**NPV (€)**	**Leasing Rent**	**NPV (€)**
-20%	50.514.905	-20%	49.853.476
-10%	50.002.832	-10%	49.672.118
-5%	49.746.796	-5%	49.581.439
-1%	49.541.967	-1%	49.508.895
0%	49.490.760	0%	49.490.760
1%	49.439.552	1%	49.472.624
5%	49.234.723	5%	49.400.081
10%	48.978.687	10%	49.309.401
20%	48.466.614	20%	49.128.043

8 Conclusion

After analysing the outputs from the NPV, it can be concluded that both options are economically viable. This conclusion is intuitive since in both situations annual inflows are clearly higher than all outflows. Therefore, in case of mutually exclusive projects, the aircraft to be chosen would be the one with a higher NPV, which means that the choice would be the Bombardier CRJ900. However, it is important to emphasise that the choice is not that linear due to external and unforeseen variables, which are not reflected in this analysis.

Although there is a difference between the NPV obtained, the difference is only 2.6% of the E190's NPV. Despite it being predictable because the CRJ900 is clearly a smaller aircraft, which represents lower fuel costs and airport charges, the small difference between NPV allows us to question whether choosing the Embraer-190 would not be the most appropriate decision, as it offers better opportunities for growth, which was not considered in this dissertation.

As mentioned above, the aim of this work is not to present "The" solution for the replacement of the Fokker 100, but to study and present a dissertation on investment appraisal in commercial aviation.

According to the sensitivity analysis for both airplanes, the variable that causes the greatest impact on the NPV calculation is the DR required by the investors, since each change of medium percentage point positive causes a drop of roughly one million Euros. This impact makes sense since the rate at which cash flows are updated is higher than the current value will be reduced.

Regarding the other variables related to the outflows, it can be concluded that the percentage change in cost of fuel and airport charges are those that cause the greatest impact on the current value of the project. In an opposite way, income is the oscillating variable, which does not cause a major impact on NPV of the project. It is necessary to take the unpredictability and volatility that fuel prices may have into account, so that the application of this analysis is particularly relevant for this variable.

This analysis allows us to conclude that the characteristics of the airplane that were considered the most important when selecting an investment in an aircraft are fuel consumption and the weight of the aircraft which will influence the airport charges.

References

[1] O.CONNER, Willian E., “An introduction to airline economics”, 6th edition, Praeger Publishers
[2] DOGANIS, R., “The airline business in 21st century”, Routledge, 2005
[3] LINDON, D., LENDREVIE, J., RODRIGUES, J., DIONÍSIO, P., “Mercator XXI. Teoria e prática do Marketing”, 10th Edition, Lisbon, Publicações D. Quixote, 2004
[4] www.dp-dhl.com/en/career/dpdhl/inhouseconsulting.html, Maiy2012
[5] sdw.ecb.europa.eu/, November 2011
[6] www.ine.pt, October 2011
[7] www.repsol.com/pt_pt/corporacion/prensa/notas-de-prensa/ultimas-notas/03102011-repsol-iberia-biocombustibles.aspx, November 2011
[8] www.inac.pt, November 2011
[9] www.icao.int, November 2011
[10] www.iata.org, November 2011
[11] MINTZBERG, H., ”The Rise and Fall of Strategic Planning: Reconceiving the Roles for Planning”, Plans, Planners, 1994
[12] KOTLER, P., KELLER, K. L., CUNNINGHAM, P. H., “Marketing Management: Canadian”, 12th Edition. Pearson Prentice Hall, 2006
[13] www.tapportugal.com/Info/pt/Homepage, November 2011
[14] www.staralliance.com, November 2011
[15] "Large turboprops & RJs take on jetliners", Aircraft Commerce, Issue No 64, June/July 2009, 30-37
[16] "Replacement options for 80- to 150-seat jets", Aircraft Commerce, Issue No 44, February/March 2006, 36-42
[17] http://www.embraercommercialjets.com/img/download/121.pdf - THE RULE OF 70TO110, A Strategy for Right-sizing from Embraer Commercial Jets, February 2012
[18] "The economics of downsizing to large RJs", Aircraft Commerce, Issue No 60, October/November 2008, 31-39
[19] http://www.pgavirtual.com/v2/business_pages/dados_tecnicos_f100.php, February 2012
[20] http://www.airliners.net/aircraft-data/stats.main?id=221, February 2012
[21] http://www.fokker-aircraft.info/f100general.htm, February 2012
[22] CRJ NextGen Official Website, http://crjnextgen.com/en/#/home/, February 2012
[23] CRJ Series Program Status, www.bombardier.com/files/fr/supporting_docs/BA-CRJ_Series_Program_Status.pdf, February 2012
[24] CS100 Official Factsheet, http://cseries.com/en/medias/gallery/literature/factsheetcs100_en.pdf, February 2012
[25] CS300 Official Factsheet, http://cseries.com/en/medias/gallery/literature/factsheetcs300_en.pdf, February 2012
[26] "Large Regional Jets: the C Series, MRJ, Superjet 100 & E-Jet families", Airraft Commerce, Issue No. 63, April/May 2009, pages 24-30
[27] Official Embraer Jets Website, http://www.embraercommercialjets.com/#/en/products_detail/, February 2012
[28] MRJ Official News, http://www.mrj-japan.com/press_releases/news_100930.html, February 2012
[29] Sukhoi Superjet-100 Official Features, http://sukhoi.org/eng/planes/projects/ssj100/characteristic/, February 2012
[30] "World Airliner Census". Flight International: 37–59. 2009-08-18
[31] GOMES MOTA, A., NUNES, J.P., FERREIRA, M., BARROSO,C., “Finanças Empresariais – Teoria e Prática”, Ed. Publisher Team, 2007
[32] ESPERANÇA, J., MATIAS, F., “Finanças Empresariais”, 2ª edição, Texto Editora, 2009
[33] CARVALHO DAS NEVES, J., “Avaliação de Empresas e Negócios”, Ed. Mc. Graw-Hill, 2002
[34] http://project-management-knowledge.com/definitions/d/delphi-technique/, January 2012
[35] BISCHOFF, G., MAERTENS, S., GRIMME, W., “Airline Pricing Strategies Versus Consumer Rights”, Transportation Journal, Vol 50, No3, 2011, pag 232 – 250
[36] CURRIE, C., SIMPSON, D., “Optimal pricing ladders for the sale of airline tickets”, Journal of Revenue and Pricing Management, 2009, Vol 8, No 1, 96-106
[37] AKGUNDUZ, A., TURKMEN, B., BULGAK, A., “Using financial option in airline booking process”, Journal of Revenue and Pricing Management, 2007, Vol 6, No 2, 135-150
[38] PARK, J., ROBERTSON, R., WU, C., “Differences in air passengers’ buying behaviour: findings from Korean and Australian international passengers”, Transportation Planning and Technology, Vol 32, No 5, October 2009, 441-460
[39] http://www.aea.be/research/traffic/index.html, November 2011
[40] http://www.aircraft-values.co.uk/, November 2011
[41] http://www.aircraft-values.co.uk/, November 2011
[42] “International Energy Outlook 2011”, US Energy Information Administration, September 2011
[43] http://www.iata.org/whatwedo/economics/fuel_monitor/Pages/price_development.aspx, November 2011
[44] Small Emitters Tool Website, http://www.eurocontrol.int/articles/small-emitters-tool, November 2011
[45] http://www.team.aero/files/aviation_data/owners_n_operators_guide_e_jets.pdf, February 2012
[46] http://www.team.aero/files/aviation_data/owners_n_operators_guide_crj.pdf, February 2012

Acronyms List

DR	Discount Rate
FH	Flight Hour
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IMF	International Monetary Fund
INAC	Instituto Nacional de Aviação Civil
IRR	Internal Rate of Return
MTOW	Maximum Take-Off Weight
NPV	Net Present Value
PGA	Portugália Airlines
PI	Profitability Index Values
PP	Payback Period
RJ	Regional Jets
TAP	Transportes Aéreos Portugueses