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External determinants of airlines' financial performance

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The interest in the aviation sector has been present for a long time, and the idea of developing a Dissertation related to this sector arose four years ago, in a college assignment. This section serves to thank the teacher of that subject, who even without wanting to, encouraged this study to come true, to all the people, from college colleagues, to work colleagues, with whom I exchanged ideas and study perspectives that made the work to be developed increasingly enhanced, and finally, to my family and friends, who even knowing the limitations in which this work was developed, were always present and “never clipped the wings to my goals and dreams”.

Resumo

A aviação é um setor que gera elevadas receitas, mas dada a estrutura de custos que comporta, não é dos mais lucrativos, mas é dos mais desafiantes de gerir. Por conseguinte, avaliou-se de que forma é que determinados indicadores de origem externa são válidos para justificar os valores das performances financeiras das empresas aéreas.

Numa altura em que indicadores como a Covid-19 afetam inesperada e fortemente negócios como o da aviação, é importante munir a comunidade científica e os próprios gestores destas empresas de um maior número de fatores extrínsecos às empresas com capacidade de influenciar os lucros e até mesmo a viabilidade desses negócios.

Para tal, selecionou-se por país e para o período compreendido entre 2015 e 2020 o número de passageiros transportados por meio aéreo, o número de empregados, as receitas fiscais, as emissões de CO2 e as despesas por turismo internacional, em função do capital próprio disponível para os acionistas de um total de 46 empresas, e recorreu-se a um modelo de regressão linear múltipla para avaliar o grau de relação entre estes fatores.

Depois de aplicados vários e diferentes testes, os resultados mostraram que as variáveis selecionadas têm um papel individualmente residual nas flutuações dos resultados financeiros, enquanto que em grupo, o impacto aproxima-se dos 75%, o que deve servir de alerta para futuras definições estratégicas.

Espera-se com este estudo que os gestores destas empresas reajam mais prontamente aos efeitos destes indicadores, e que não fechem a porta às influências potenciais de muitos outros mais.

Palavras-chave: gestão de empresas aéreas, variáveis externas, desempenho financeiro.

Sistema de Classificação JEL: G32, L93.

Abstract

Aviation is a sector that generates high revenues, but given the cost structure it entails, it is not one of the most profitable but one of the most challenging to manage. Therefore, it was assessed how certain indicators of external origin are valid to justify the values of the financial performances of the airlines.

At a time when indicators such as Covid-19 unexpectedly and strongly affect businesses such as aviation, it is important to equip the scientific community and the managers of these companies themselves with a greater number of factors extrinsic to the companies with the ability to influence the profits and even the viability of these businesses.

To this end, the number of air passengers carried, the number of employees, tax revenues, CO2 emissions and international tourism expenditure were selected by country and for the period between 2015 and 2020, as a function of the shareholders' equity of a total of 46 companies, and a multiple linear regression model was used to assess the degree of relationship between these factors.

After applying several and different tests, the results showed that the selected variables have an individually residual role in the fluctuations of the financial results, while in group, the impact is close to 75%, which should serve as a warning for future strategic definitions.

It is hoped from this study that managers of these companies will react more readily to the effects of these indicators, and not close the door to the potential influences of many more.

Keywords: airline management, external variables, financial performance.

JEL Classification System: G32, L93.

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Glossary of Acronyms

ASK – Available Seat Kilometres

ATAG – Air Transport Action Group

BLUE – Best Linear Unbiased Estimators

CASK – Cost per Available Seat Kilometre

CEO – Chief Executive Officer

CI – Confidence Interval

CLM – Central Limit Theorem

CO2 – Carbon Dioxide

CSR – Corporate Social Responsibility

ECAA – European Common Aviation Area

ECB – European Central Bank

ESG – Environmental, Social and Governance

ESS – Explained Sum of Squares

GDP – Gross Domestic Product

GFS – Government Finance Statistics

IATA – International Air Transport Association

ICAO – International Civil Aviation Organization

ICTD – International Centre for Tax and Development

ILO – International Labour Organization

IMF – International Monetary Fund

IRR – Internal Rate of Return

KPI – Key Performance Indicators

LCC – Low-Cost Carrier

MLRM – Multiple Linear Regression Model

NCI – Non-Controlling Interests

NPV – Net Present Value

OECD – Organisation for Economic Co-operation and Development

OLS – Ordinary Least Squares

PP&E – Property, Plant and Equipment

R&D – Research and Development

RASK – Revenue per Available Seat Kilometre

ROA – Return On Assets

ROE – Return On Equity

RPK – Revenue Passenger Kilometres

RSS – Residual Sum of Squares

SE – Standard Error

SWOT – Strengths, Weaknesses, Opportunities and Threats

TSS – Total Sum of Squares

UNFCCC – United Nations Framework Convention on Climate Change

UNWTO – United Nations World Tourism Organisation

US – United States

USD – US Dollar

VIF – Variance Inflation Facto

1. Introduction

Aviation is a vast world and the companies that make it up, more or less small, with greater or lesser revenues, with a more or less complex business model, face daily challenges, often surmountable and sometimes unexpected, which makes it a very own and breathless industry to manage.

Mainly for these reasons, this is an area that arouses interest in various authors and under a huge variety of studies. Some authors have already tried to assess the most common and most sought characteristics in the leaders who occupy the management positions of these companies (Lohmann & Wilson, 2019), others have tried to measure the impact of certain categories of variables on the financial performance of these companies, namely indicators related to ESG (Environmental, Social and Governance) (Chen et al., 2021), others related to CSR (Corporate Social Responsibility) (Asatryan & Brezinova, 2014), and still others of a financial or economic nature or referring to internal indicators characteristic of this industry.

Other studies, spread across a large range of different models created, focus on the prediction of airline bankruptcy (Adrangi, Bright, et al., 2006). These studies seek, mainly through financial factors of the companies themselves, to find answers to the failure of some of these companies. This "failure" is not recent, and many claim to have started right after the Deregulation Acts (Debyser, 2022; Fleming et al., 2015), acts that brought more freedom of action to these companies, along with a wide range of other benefits, but which had as a counterpart the emergence of a fierce competition scenario, combined with other inherent seasonal, economic or just global challenges, making the volatility of results more expressive, opening doors to these bankruptcy scenarios, which in some cases were irreversible.

Having said this and resorting to the review of an extensive set of developed works, it soon became clear that it is still relevant to focus on the search for factors that may directly or indirectly influence the results of airline companies, without these coming from within the company, but rather from the surrounding scenarios in which they operate.

With these theoretical insights gained from the research carried out, it was possible to begin to have an increasingly concrete idea of the limits to be set in order to create the research hypothesis and, in this case, the model that will answer it. In practical terms, it was decided to choose the financial results of a set of airlines as the dominant variable. Why financial results? Because they are one of the main contributions to "the faces" of the internal strategies of these companies, faces that are nothing more than the final phase of paths of intermediate options that have been more or less studied, and also of reactions to adversities. Data was collected from a total of 46 airlines spread over the five major continents and was obtained directly from the Annual Reports made available by each company.

Regarding the explanatory factors, as this industry is very exposed to the globalisation factor and its inherent consequences (Bilotkach, 2017), whether good or bad, working on relationships between indicators at a global level will allow these relationships, if verified, to be more appropriate to the scenarios experienced by most airlines and therefore will have a much greater applicability for managers interested in integrating into their strategies new warnings for imminent factual situations. Furthermore, and globally speaking, it is now possible to make use of variables that in other scenarios would not have the same validity, namely through variables by country, making it possible to associate geographical influences on the performance of companies in this industry or through variables that are themselves of an international nature, such as those linked to inter-country tourism.

That being said, the indicators that appeared most relevant after reviewing the literature were the number of air passengers carried, the number of employees, tax revenues, CO2 (Carbon Dioxide) emissions and international tourism expenditure. These indicators were considered by country and the data collected correspond to the temporal period between 2015 and 2020, a total of six years that are an example of the different phases to which the aviation sector is subject, namely the boom years until 2019, and the beginning of the troubled period with the arrival of Covid-19 in 2020.

This set of variables was chosen with the utmost rigour, both in terms of the variables themselves and the origin of the data behind them. As for the option for each of the variables used, rather than resorting to mentions of them in other studies, it was pointed out the (in)direct relationship that they have with some of the main financial indicators of airlines, from revenues to the financial results themselves. This way, the respective applicability was assessed from both theoretical and practical points of view. As regards the origin of the data, some considerations were made, namely that one should opt for the same source/database (to be able to work with greater consistency), that one should choose sources or variables that gather a greater number of data for the years and countries under consideration (to be able to work with a greater number of observations) and that one should pay attention to the origin of the data for each variable, knowing in advance that the database uses third-party sources to obtain the data it reproduces (to be able to work with the most appropriate sources/origins for each type of variable).

Before further procedures, it was considered relevant to define a priori the motto for its development, which in this case corresponds to the main research question. Considering the review carried out, it was concluded that it was necessary to confirm whether other external and/or non-financial variables would also have an impact on the financial results of airlines.

To guarantee that the development of the work would follow a line of stages to answer this question, other questions were raised on a more specific level, namely the preference for stating the variables from an individual perspective or by category, the quality of the sources collected to have chosen the variables under study, the type of model which was chosen to try to answer the research question and, finally, the possible mismatch between the conclusions obtained by applying the model and those which would be obtained in common parlance.

Now turning to the structure of the dissertation, it is segmented into four main chapters, in addition to the Introduction, Conclusion and the others. The first refers to the Review of Literature, and was segmented into three sub-chapters, in order to present the information more cohesively in the following sequence: history of the sector's financial performance, sector management methods and measures of the sector's financial performance evaluation by means of variables, models and/or other tests.

The second chapter refers to the Work Field of Application, and here it was summarised the conclusions of the previous review and bridge the gap to the objectives of the study, together with the definition of the relevant research questions. The third chapter was also segmented into three subchapters, and here the aim was to make explicit the choice of variables under study, the sources (and other specificities) related to the data obtained and, finally, the type of model where the work was developed in practical terms. The last chapter refers to Results and Discussion, in which, through the choices made above, several tests were developed to show the relationship between all variables and to respond to the assumptions imposed by the type of model chosen.

In short, it is a simple but complete structure that covers all the essential points, from the formulation of the idea to its implementation. However, as expected, assumptions were made during the course of the work, especially in terms of the definition of the data to be used, and for this reason, a section for Limitations (and Recommendations) was included at the end.

Finally, and by way of conclusion, among the possible several initial ideas that triggered the interest in the preparation of this work, the main objectives are to contribute (marginally) to a more complete and richer academic basis in different studies with different action fronts and the intention that the conclusions obtained here will be considered by professionals in this sector, whose assessments or strategic definitions are in their charge.

2. Review of Literature

Chapter 2 was divided into three distinct parts, namely Subchapter 2.1 where it is presented the most outstanding facts and figures of the historical path that this sector has faced in recent years and even decades, Subchapter 2.2 where it is displayed how or in what ways performance evaluations are made of companies in this sector and, consequently, how the respective management teams monitor the viability of the businesses they are in charge of, and Subchapter 2.3 which aims to bring together the aspects that authors and researchers have taken into account and should take into account in the future to better build their methods for evaluating and forecasting the financial health of airlines.

2.1. Historical Performance of the Aviation Sector

Aviation, like any other industry, aggregates a set of stakeholders to whom it must be accountable, namely through positive results. These results should be verified, mainly, but not exhaustively, on three fronts.

Through management results, since, being generally large companies, they play a key role in national and international economies (ICAO, 2019), acting at the level of factors such as employment or state revenues (IATA, 2007). Through sustainability results, since the role of air travel remains significant regarding the issue of climate change, even though in recent times the main suppliers – Airbus and Boeing – have been presenting solutions that emit less and less and are more economical/profitable (Transport & Environment, 2022). And through financial results, in that strategic and financial management always end up being mirrored in the results, especially with the amount of fixed costs that companies in this sector face (Morrell, 2013).

In historical terms, the first major dates concerning this sector following its establishment were in 1978 in the United States of America (Fleming et al., 2015) and in 1986 in the ECAA (European Common Aviation Area) (Debyser, 2022). In 1978, "The Airline Deregulation Act" was passed, which, among many other benefits for all parties involved, saw the end of government regulation that essentially defined the fees charged, the routes US (United States) companies flew and even barriers to entry for newly created companies.

Although several authors point to different dates for the implementation of the same scope in the European Area[1], a European Parliament article (Debyser, 2022) points to 1986 as the year

[1] Fleming et al. (2015) suggest that the start of the turning point was in 1999, while Burghouwt et al. (2015) suggest it happened in 1993.

of the installation of the "Single European Act", followed by three successive packages aimed at phasing in this transition to the liberalised market (in 1987, 1990 and finally in 1992).

Bilotkach (2017) defined this whole process as a real success. The author pointed out that the pre-liberalisation period was characterised by a large number of bilateral agreements between companies and between countries (since these also owned companies, called "flag carriers"), agreements of a complex and very restrictive nature. This complexity made this means of transport high priced and, consequently, not within the reach of all users.

In the early 1990s, the first agreements were signed between the United States of America and European countries to "open the skies", allowing for more aggressive economic development.

In parallel with this deregulation achievement, which was pivotal for the global expansion of the aviation sector, at least at the level of competitiveness, the author reported two facts that emerged from it. Firstly, North American, and European strategies differed in the implementation of hubs for their respective companies (a hub is usually located at an airport and allows the companies that *own* it to manage connections between destinations more efficiently): in the United States, companies used *multi-hubs*, while in the European region, most companies only owned *single-hubs*, due to border restrictions. Secondly, the liberalisation of the market has allowed the emergence/strong growth of LCC (Low-Cost Carrier), further boosting the competitiveness factor, offering, in some cases, more precarious services, to cope with the low prices charged.

In financial terms, the periods that followed these dates showed an increase in revenues, however, the (marginal) profits did not follow this evolution, the first justified by liberalization, the second justified by competitiveness (Dempsey, 2008). According to this author's data, in the first decade after the American deregulation, North American airlines recorded record revenues of about USD (US Dollar) 500 billion, while, on average, the net profit margins were 0,16% negative in the first decade, 0,82% positive in the second and 5,57% negative in half of the third, against 1,19% positive in the pre-regulation decade.

In short, the end of government regulated control was beneficial for the stakeholders in general but did not rid the companies of a factor that, until then, was somewhat managed by governments: volatility (Borenstein & Rose, 2014). The normal volatility of the market, given its activity, combined with a new and increasing volatility that accompanies the expansion of these companies (more operations, greater demand, higher costs, and greater instability – since it is a sector in constant innovation) means that the management practices of these companies are also constantly adapting (Levine, 1987).

In the last two decades, according to data from the ICAO (International Civil Aviation Organization), this industry has faced numerous potential destabilisers, as was the case with the September 11 terrorist attacks in the United States of America in 2001, the spread of avian and swine flu in 2005, 2009 and again in 2013, the global financial crisis in 2008, the eruption of the Eyjafjallajokull volcano in 2010 and, more recently, diseases such as Zika and Covid-19 (Sehl, 2020).

Events such as these, and especially those involving terrorist attacks, heavily impact the value chains of area companies, and it is also left to the main suppliers – Airbus and Boeing – to deal with these *downsides* (Rhoades, 2014).

In order to cope with these troubled periods (and not only), alliances between companies played a key role in the exchange of resources and strategic points. The first alliance of this new era of aviation took place in the mid-1980s and by the end of the century, alliances already exceeded more than five hundred, according to Rhoades (2014). In parallel to these partnerships, large alliances also emerged, and which aggregate in themselves some of the major airlines of modern times, these being Star Alliance, SkyTeam and Oneworld. Also, according to the author, more than sharing resources among themselves, these alliances seek to establish numerous hubs around the world, using these positions to face the market shares consumed by LCCs.

Even in an alliance environment, the chances of bankruptcy are not ruled out; and they emerged soon after the liberalisation of the airline market (Dempsey, 2008).

Several authors, such as Dempsey (2008) and Morrell (2013), point out that nowadays there is hardly any airline that has not experienced an imminent or effective bankruptcy phase. Factors such as those previously announced or even a "simple" mismanagement, as in any company, may be at the origin of these situations.

Morrell (2013) further states that an insolvency proceeding differs from any other given the constitution of the body of creditors of the airline concerned.

In bankruptcy, regulatory procedures differ from region to region. In the United States, companies act under the "US Bankruptcy Code"[2], and the main chapters of note are Chapter 7, which refers to the "Liquidation" of the company, and Chapter 11, which gives the company a special status, under which the state of bankruptcy is imminent, but they can maintain operations, albeit in a different form than initially established (with fewer resources and where

[2] The most recent version (dated 16th of September of 2022) of the aforementioned Code, also titled "Title 11 – Bankruptcy", can be found on the Office of the Law Revision Counsel website at https://uscode.house.gov/download/download.shtml

new business plans have to be submitted). In the European region, although it is not done equally in all countries, Bankruptcy status can be requested due to several factors, but mainly when a company is no longer able to comply with at least one of its main obligations (namely, having in his possession a quantity of assets greater than the amount of debt it holds), as confirmed by ePortugal (2022), the Portuguese Public Services Portal. In these cases, a new management team is usually assigned to either seek to reverse the bankruptcy situation (Morrell, 2013), or to start the Liquidation process, in agreement with the creditors' conditions.

Today, even with constant innovation – instituted by choice or necessity – the industry is going through a phase of consolidation. This does not mean that periods of fragility and even declared bankruptcies have ceased to exist.

The 2010s decade was, considered by several authors and experts, the best in aviation, and so is confirmed by IATA (International Air Transport Association) data, which show an evolution of global net profits from just over USD 8 billion in 2011 to over USD 25 billion in 2019, with a peak of around USD 40 billion in 2017 (Dunn, 2019).

According to the same author, and using various studies, more and more of these companies have become profitable, and many have achieved results never obtained. The renewal of their fleets (with less polluting and more fuel-efficient aircraft) and the increase in the capacity offered (with an increase of about 35% in the number of flights operated and an increase of more than 60% in the number of seats offered) played an important role in the origin of these remarkable improvements, as well as the contracting and consolidation of new and/or giant partnerships (for example, the International Airlines Group is currently made up of British Airways, Iberia, Vueling and others) and the significant evolution in the share of LCCs (in particular Southwest Airlines in the United States and Ryanair in Europe).

The most recent decade began in recovery from the crisis installed at the end of the previous decade, derived from the declared pandemic situation derived from Covid-19, a factor which impacted on each and every commercial aviation company, given the restrictions on national and international mobility introduced by the various governments.

According to data from the latest IATA (2021a) Annual Report, the main indicators (RPK – Revenue Passenger Kilometres – which represents the total kilometres travelled by paying passengers, ASK – Available Seat Kilometres – which represents the total/potential seats to-be-sold multiplied by all kilometres flown, and Load Factor which represents the average percentage of available seats occupied per flight) showed significantly negative variations in 2020, with tenuous improvements in 2021 and recoveries to pre-pandemic levels in 2022.

In sum, an industry that until the end of the 1970s was highly regulated by governments around the world, since then it has seen the growth of business and expansion opportunities, and at the same time has seen the intensification of competitive practices, and in a scenario where everyone is on their own, it is up to each company to define and foresee its destiny.

2.2. Managing Results of a Company in this Sector

As seen above, the aviation we know today has undergone several changes from the aviation that was known a few decades ago, and these variations are not only not stagnant, but may be imminent when external variables such as crises or global diseases impact its operations.

As Doganis (2019) suggests, there is not just one business style in companies in this sector, quite the contrary. The starting point lies in the size of each company, followed by its strategy and extent of operations. The complexity and number of hubs also take a relevant place ("multi-hub" versus "single-hub" strategies, among others), as well as the Groups in which these companies are inserted (if they own only one airline or several, if they own one or more airlines and other company(ies) connected to the industry, or even if aviation is only one of the industries in which these Groups are present). Not least, the business models also differ if "LCC category airlines" enter into the equation.

The same author, and also supported by previous information from IATA (2021a), suggests that there are three essential pillars for any airline, regardless of its size, category, and strategy, to be able to profit. The first has to do with unit costs, for which the CASK – Cost per Available Seat Kilometre – (which is the result of the quotient between Operating Costs and the ASK previously announced), among others, was created. The second is related to unit revenues, for which, among others, the RASK (Revenue per Available Seat Kilometre) was also created. The last has to do with the average occupancy per flight itself, which is measured by the Load Factor.

A last factor to be considered by the author is technology, and the speed with which it is renewed and the immediate benefits when it is used. More than improvements in terms of, for example, automation, technology integrated in the constant evolution of aircraft allows airlines to offer more and more competitive services (aircraft with longer durability or more seats) and more profitable (aircraft with engines equally or more powerful than the previous ones, with more fuel efficiency). The main suppliers – Airbus and Boeing – although with different business visions, are increasingly investing in research and development of these improvements, which will also serve to renew relationships with airlines.

Before knowing the *Financial Body* of these companies, it is relevant to know their top managers. For this reason, Lohmann and Wilson (2019) conducted a study, which allowed to assess the profile and background of the CEOs (Chief Executive Officers) of the hundred largest airlines in the world. Of the various CEO profiles they considered, which included "finance", "operations" and "digital", the study revealed that Boards of Directors generally and consistently prefer to opt for "finance", since, in their eyes, they are professionals more suited to risk, and therefore better suited to face the volatile periods that the sector faces.

Similarly to other industries, the information produced by an airline's Finance Department is relevant for the decision-making of virtually any other department of the company, as reported by Hughes (2020). In this particular industry, the character and periodicity of the reports produced by this department have an additional relevance for the managers of the company and the other departments, given the speed and intensity with which volatility can affect the normal course of that airline's business.

The Accounting Department is in charge of preparing the respective reports of the Financial Statements (Fleming et al., 2015). Again, similarly to other sectors, airlines present the accounts at the current date and also those for the previous period, being subsequently reviewed by a team of external auditors (Morrell, 2013). As this is a sector with a very strong strategic aspect, according to the author, it is common for companies to share the minimum required by law, keeping information such as (specific) costs or even yields restricted from one of the most interested stakeholders: competitors.

According to IATA data from 2017, and echoed by Doganis (2019), the cost structure of these companies is occupied, on average, about two thirds by variable costs, with fuel (and oil), maintenance and staff costs taking the three places on the podium, which is nothing new, since they cover the "core" of the airlines' activity.

Given the assumed weight that this type of cost has in the overall structure of the Income Statement, what will determine who best and most efficiently uses their resources is the allocation of (operating) costs (Doganis, 2019). Knowing the detail of the typology of aircraft that make up your fleet (both in terms of fuel consumption and allocation of human resources), the regulatory requirements and prices practiced in destination countries and other specific costs of a route, it is possible to make closer estimates and, consequently, budgets will be more adjusted to reality.

Still, and as the author points out, even knowing the detail of the variables that directly or indirectly affect each flight and those whose contribution is marginal, it is not common practice for the management of these companies to eliminate routes that the numbers suggest are inefficient, given the relationship that, in the meantime, has been created with users of these routes and also for strategic reasons, at the level of connections made at hubs. However, if it were possible to point out a category of airlines more apt to reduce less efficient routes, it would be the LCCs, since their business model is precisely based on low prices and costs (Doganis, 2019; Rhoades, 2014).

In short, the Balance Sheet and the Income Statement are essential in these companies, given their outstanding business volume and their complexity regarding the maintenance of their assets, cost management and the forms of financing they opt for. Additionally, and already common practice in other companies, the Cash Flow Statement also plays a key role (Fleming et al., 2015), since cash allocations are many (low, medium, and high value) and of different scopes.

In addition to these findings, an independent study by Batrancea et al. (2021) revealed that, although with limitations such as the analysis period of only three years, the number of companies was reduced to twenty-two and that some financial indicators were considered and not others, one factor that potentially impacts the financial performance of an airline is the corporate reputation it has, and the higher it is, the more the positive impacts on profit generation.

A different study conducted by Chen et al. (2021) revealed that another non-financial factor that impacts airline performance is the adoption/application of ESG indicators. Although with some limitations, the study pointed out that these indicators effectively impact CSR of these companies which, consecutively, influence the KPIs (Key Performance Indicators), at least in a short-term perspective.

Another point that management and other decision-makers should address in terms of strategic definition is that of defining the scope of the market(s) in which they operate. As Bilotkach (2017) states, two definitions need to be considered for this case, which are market segments and market boundaries. The first, distinguishes the different classes for which needs and preferences are distinctly different, such as leisure travellers and business travellers. The second measures the limits to which such "market segments" are willing to yield in favour of the choice that is most convenient for them.

These two notions will enable airlines to maintain their internal strategic definitions by following the evolutions of those of their main competitors which may intersect with their own. Moving on to another perspective of analysis, having already seen that this is an industry that moves billions of Euros, it is important for stakeholders to know the companies' results in terms of specific metrics, namely through ratios and indicators. A study by Markhvida and Tretheway

(2014) revealed that, on average and across the entire industry, ROA – Return On Assets – (which measures how much companies' Net Profits cover their Assets) is relatively low and has even been surpassed by the industry's average cost of capital figures. With profit margins demonstrably residual, it is relevant to know the sources of investment of these companies.

Typically, companies can resort to raising funds internally, through Equity, or externally, through Debt (Hughes, 2020; Morrell, 2013).

Fleming et al. (2015) have devoted themselves to distinguishing the varied ways in which capital is raised, which is extremely necessary for the continuity of these businesses, whether by renewing their fleets, expanding their hubs, or even to meet the usual cash flow needs.

In terms of equity financing, the authors highlighted the Internal route, through Retained Earnings, which allows any company to reinvest its profits (net of dividends and stock repurchase), and the External route, through Preferred and Common Stock. Preferred Stock differs from Common Stock in that it has no voting rights but receives a kind of "periodic dividend" that is paid before dividends that are paid to other stockholders.

In terms of Debt financing, the options are many more, with the authors highlighting bonds, which are a common instrument in virtually all industries, and on which the aviation sector raises a large amount of capital. These are securities that represent the debt of these companies, and whose acquisition gives their holders the possibility of receiving periodic interest and, on a defined date, the reimbursement of the capital invested.

Once the internal allocations that an airline company can make from the point of view of capital and financing structure are known, it is relevant to turn to the macro perspective, based on the future perspectives, passing through the inherent risks.

As far as management risk is concerned, Donovan (2005) chose to refer to "yield management", which in practical terms measures the effort required when allocating internal resources, such as available seats, to the variety of potential stakeholders, with the objective of reaching the yield defined for that investment, or in other words, maximizing profitability. This is a strategy that carries risks, namely due to the possibility of those yields being hardly achieved, but from the author's point of view, it allows companies a continuous double effort of cost rationing and profit maximization.

To address other (external) risks, such as exposure to fuel price fluctuations (Hughes, 2020; Morrell, 2013) and currency fluctuations (Hughes, 2020), in parallel with the constitution of hedging strategies (instruments), it is essential for any airline to have controls in place when preparing budgets (overall and by department).

There is a wide variety of budgets that companies can opt for, but Morrell (2013) suggests that for airlines, the most relevant ones are those of a continuous nature, which show projections for two months in the presentations per month, those of a flexible nature, which highlight various future scenarios, and those relating to the use of cash, as it is a very relevant asset and on which these companies carry out various operations.

According to Hughes (2020), these forecasting plans, which can be built from scratch or compared to previous periods (Morrell, 2013), should not only focus on budgets, but also on KPIs. These indicators must be, not exhaustively, interesting for the business, consistent and, above all, referenced by the airlines' governing bodies – because it would make no sense to pool efforts to achieve a goal that is not recognised by management.

Doganis (2019) goes further, and states that establishing these forecasts ultimately plays a crucial role in an airline's activity. This is because forecasting models are often built on the premise that just by changing one variable, the impact would be brutally high; yet this is a very rudimentary way of looking at things, as the aviation sector is subject to many external trends and impacts, which "easily" involve more than one front at the same time.

In a contrary perspective – several factors interfering with a variable – a study was conducted by Behn and Riley (1999) which allowed for the validation of the previous assumption that there may be a direct impact of several conditioning factors on a variable (thus being relevant to conduct forecasts with several variables varying in several scenarios). It was concluded, in this case, that lack of delays, lost luggage, overbooking and in-flight service generally contribute to consumer satisfaction.

At the end of the past decade, Dogani (2019) reviewed the results of the 2010s upwards, while remaining reticent about the duration of this success (and, in this sector, of the "profit years"). He suggested a set of actions to be considered by the different types of airlines, but above all, he pointed out that the various administrations should not relax but should take advantage of the upswing to review the strategic plans they had in place.

Rhoades (2014), in future terms, recalled that the airlines' involvement in sustainability-related issues is recent, and that, even so, it ends up being executed in a more reactive than preventive perspective. Nevertheless, currently, and as previously verified, the green practices of these companies are evident in the option for aircrafts that emit less and less pollutant gases (Carou et al., 2022), a practice that is already transversal when building any new aircraft by the main suppliers (Dobre, 2021).

In conclusion once again, the secret to achieving financial stability in an airline is in anticipation. This anticipation is achieved by devoting much of its efforts and resources to planning budgets, budgets that should incorporate in their projections sufficiently pessimistic scenarios so that, when faced with the impact of (external) factors such as the Covid-19 pandemic, they will have (evidence of) a financial cushion. Being transversal to any sector, financial gaps are essential and require professionals with high knowledge and experience to know how to define and manage them.

2.3. Importance and Challenges in Aviation Business Analysis

As previously documented, aviation is a sector that moves large amounts of capital and requires large amounts of collateral to obtain financing. In addition to the already mentioned profitability indicators (RPK and ASK), Fleming et al. (2015) also point to the already known NPV (Net Present Value) which calculates the present value of the future cash flows of a project or investment, disregarding the initial capital invested and IRR (Internal Rate of Return) which is the discount rate for which the NPV is zero, or in other words, is the expected annual rate of return on the investment. This is because, with the continued progression of the industry and with long-term forecasts on the rise, several investments will be needed to cope with the increasingly fierce competitiveness as a result of the old market liberalisation already mentioned.

Bilotkach (2017) dedicated part of his studies to recognising the relevant contributions of the aviation sector, which add to its relevance and, cumulatively, the need for monitoring and evaluation. The two main scenarios pointed out by the author are the creation of a new/greater connectivity between regions and nations, in some cases with governmental support given its performance is central to the accessibility to certain geographical areas, and the contribution to a wider labour market, with a more fluid transmission of knowledge, more demanding and, ultimately, more global. Even so, these relationships are mainly theoretical, so the author is reluctant to point out an exact correlation between aviation and the effects in these two areas.

Previously, it was made known the strategic factors considered by managers in this industry, such as capital budgeting, risk management and forecasting. However, it is relevant to know the micro and macro perspectives of strategy definition in aviation, in order to justify the analysis methods established so far by several analysts.

Flouris and Oswald (2006) list the main factors to be considered by managers in this new era of aviation, which include validating, understanding and studying the surrounding market and the internal practices of other companies in the sector (and not only the main competitors), defining the concept of the final consumer and the demands that this will entail, knowing cost-efficient alternatives, such as using external specialised work, adopting e-commerce as a solution for innovation, speed and integrity of service and retaining talent and, above all, knowledge.

The authors emphasize the use of the definition of the points of a SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats), which are pivotal to the establishment of any strategy, and also state that the (future) uncertainty of the market is a factor to be considered when this definition is made, given that a strength or a weakness that does not fit into, for example, two disparate scenarios, possibly should not be considered in the final matrix. And for this reason, the authors further reinforce, it is essential that there be a concise internal communication policy so that, between the parties, these themes may be detailed so that the organizational strategy defined by the managers may not present relevant deviations in the future, the result of inefficient preparation.

As mentioned earlier and reiterated now once again, this is a sector that deals very closely with uncertainty, volatility, and improbability. This, coupled with a host of factors, can lead to these companies facing troubled scenarios and even reaching a state of bankruptcy.

Adrangi, Bright, et al. (2006), in a study of the North American sector between 1980 and 2005, confirmed that bankruptcies became increasingly frequent, something also validated by Dobre (2021), after yet another crisis – that arising from the Covid-19 pandemic. These authors pointed out that the studies were initially conducted only at the level of indicators and that later, several authors introduced their own bankruptcy prediction models into the scope of analysis of this sector.

Of the known models for predicting corporate bankruptcy, the first and most widely used by authors and researchers were statistical methods (Daubie & Meskens, 2002).

Of these, one can highlight the “Univariate Analysis Methods”, resorting, as the name implies, to the individual analysis of financial indicators, such as the percentage of Net Income over Total Assets (Gepp & Kumar, 2012), the “Multiple Discriminant Analysis Methods”, resorting to several response variables and their coefficients and their correlation to an explanatory variable (Gepp & Kumar, 2012), the “Logit and Probit Analysis Methods”, where the dependent variable is a binary response variable (usually 0 or 1) (Gepp & Kumar, 2012), and the “Machine Learning Methods”, using artificial intelligence decoded by computer software (Daubie & Meskens, 2002).

The first bankruptcy prediction methods were developed and tested in the 1970s by Beaver (1966) and Altman (1968), using univariate and multiple discriminant analysis methods, respectively (Deakin, 1972). Since then, and since none of them showed a 100% effectiveness rate (Deakin, 1972), several academics and researchers have been suggesting new models, more or less complex, depending on their purpose, in order to sustain or overcome the average effectiveness rate of this type of models, which in 2010 was around 85%.

Once its presence has been validated in most of the studies conducted, Altman's main models, which are transversal to several industries, should be highlighted, namely the Z Score (Altman, 1968), the Z'' Score (Altman, 1983) and the ZETA Credit Score (Altman et al., 1997).

Regarding the aviation sector, models of the various types mentioned above have been suggested (Adrangi, Bright, et al., 2006), among which we highlight the Air Score Model (Chow et al., 1991), the P Score Model (Dinh & Pilarski, 1999) the Gudmundsson Model (Gudmundsson, 2002), the Fuzzy Logic Model (Portugal et al., 2005), a model using Artificial Neural Networks (Davalos et al., 2002) and a model using Genetic Algorithms (Adrangi, Davalos, et al., 2005)[3].

From the research conducted, some of the studies that focused their analysis on a larger number of models were that of Dursun and Sakiz (2019), which measured management risk by "conventional" models with financial ratios and by others using artificial intelligence, for a total of nine models, that of Shome and Verma (2020), which assessed bankruptcies in the Indian airline market, for a total of five models, and that of Huang et al. (2014), which assessed bankruptcies in the North American airline market, for a total of five models.

In addition, some of the residual studies involving the O Score Model (Ohlson, 1980) and the Zmijewski Model (Zmijewski, 1984) should be highlighted, namely that of Ahmad, et.al. (2020), which again assessed bankruptcies in the Indian market, and that of Abdullah et al. (2020), which assessed bankruptcies in the Asian regional market in a period post-dating the onset of the Covid-19 pandemic, respectively.

Having presented the scenario of anticipation/confirmation of bankruptcy, it is worth remembering that this scenario is not definitive and can (more or less easily) be reversed. Townsend (2014) concluded that there are two different phases to be faced in these cases, namely the perception and braking of the decline and, subsequently, the impulse and strategic rowing towards (future) competitiveness. Dobre (2021), on the other hand, in relation to the post-Covid-19 recovery of the sector, indicated that it should take advantage of this global disease to review the composition, safety and engineering of its aircraft and the resources that

[3] Additionally, and of the various studies that exist, there is also room to highlight the F Score Model (Piotroski, 2000), the M Score Model (Beneish, 1999), and the K Score Model (Kroeze, 2005), although these are not within the scope of analysis of this work.

have access to them, and recalled that the ambitious European objective of aviation climate neutrality in the European region by 2050 remains in force.

From a perspective other than bankruptcy forecasting, other studies have naturally been conducted on the impact of various independent variables on selected dependent variables. There are studies of the most varied origins, such as Liedtka (2002), who measured the correlation between dependent and independent variables of non-financial nature, Demydyuk (2011a), who tested the main KPIs of the sector (number of passengers, indicators per kilometre and financial profitability ratios) in relation to the Operating Margin which is the quotient between operating revenue and net sales, and ROA, Asatryan and Brezinova (2014), who, in view of ROA and ROE (Return On Equity) which is calculated by dividing Net Income by (Shareholder's) Equity, assessed the correlation of variables within CSR, and Abdi et al. (2021), who assessed the relationship of variables within ESG with the Market-to-Book ratio and Tobin's Q ratio (Market Value divided by Total Assets).

After a review of many of these studies, it was possible to trace some common features and, above all, generic categories of variables used. Of these, the economic factors category – Liu (2009), Garg and Mahtani (2020) and Gudmundsson (2002) –, the external factors category – Ismail and Jenatabadi (2012) and Gardner (2009) – and the non-financial internal factors category – Alan and Lapre (2018) and Merkert and Swidan (2019) – stand out.

In addition, the existence of models that incorporate other models should also be mentioned, as is the case of Dresner et al. (2009), which integrates the output of Altman's Z Score Model (1968) into one of its explanatory variables.

In sum, there are several variables under study and, based on these, it is possible to segment them by category, group them and distinguish the respective studies by scope/subject.

3. Work Field of Application

Chapter 3 is designed to reflect on the main conclusions that were drawn from the previous chapter and to propose research questions as the motto for the start of the work.

3.1. Contextualization

Given what has been presented so far and taking special care under the limitations and recommendations of the generality of the studies that exist, it was realised that there is room for an endless number of possible new research, and that they may certainly be a contribution to the decisions of the managers of these companies.

From the analysis of a selection of studies, it is possible to conclude on a number of aspects. Firstly, the main KPIs of the aviation sector, commonly known as RPK, ASK, Load Factor, the number of passengers, among others, in addition to on their own allow concluding on the performance of the respective airlines, have already been widely targeted in studies[4] of correlations between variables that want to assess the impact on the financial performance of these companies, so that the marginal contribution of new studies to the scientific community, in this perspective of analysis, of new studies begins to be limited.

Secondly, the focus on economic variables has been growing[5] and goes beyond the classical GDP (Gross Domestic Product) and Inflation Rate[6], focusing on the current economic situation, on the fluctuation of prices of goods such as fuel and even on per capita income indicators. However, a wide scope of application is available for study, such as variables related to governmental policies or variables arising from the role of aviation in the world economy scale, as is the case of tourism.

Thirdly, the sustainability factor is not new to the aviation industry and its direct contributions to the emission of pollutant gases are known both by the managers of these companies and by the government and the general public, as evidenced by a recent report by ATAG (2020) – Air Transport Action Group – which reveals that in 2019, the industry alone emitted 915 million tons of CO_2, more than 2% of the total emissions by humans that year. For this reason and because it is an area of increasing interest denoted by stakeholders in this sector,

[4] For example, in Demydyuk (2011a, 2011,b), Dresner et al. (2009) and Gudmundsson (2009).

[5] For example, in Liu (2009), Garg and Mahtani (2020), Ismail and Jenatabadi (2012) and Gardner (2009).

[6] According to Eurostat (2019), GDP corresponds to the capital gains generated by the consumption of goods and services in a region. According to the ECB (2022) – European Central Bank –, inflation is the increase in the price of goods for the same availability of money.

there seems to be plenty of room to delve into the contributions of aviation to gas emissions and/or vice versa.

In a general perspective on the studies analysed, it can also be concluded that they do not take only one direction, that is, they are not necessarily dedicated to analysing the relationship of only one category of variables, and this category is not always Financial Factors (internal)[7].

With this being said, it is clear that there is scope for new studies, based mainly on the factors previously highlighted and for which there has already been some development. More specifically, one should take advantage of the fact that the KPIs used until now were mostly made from a company perspective and not from a broader perspective (at country level, for example), should try to explore other economic aspects that may have a contribution that may not be so obvious in aviation, and should realise/quantify the not-so-sustainable effects on the performance of these companies.

3.2. Research Questions

Having presented the possible and most probable fields of application, the conditions are now in place to formulate the questions that will guide the study to be developed.

Initially, with the emergence and growth of the impact of the Covid-19 pandemic on the aviation industry, proven by a report of the OECD (2020) – Organisation for Economic Co-operation and Development –, it was perceptible that one would be, academically speaking, facing the action of an external, non-financial and non-expectable variable.

That said, it was realised that perhaps there were (types of) variables for which their impact on the financial performance of aviation companies had not been studied (extensively). Hence the following main research question was raised:

«Are there any other external, non-financial variables that could impact the health and wealth of aviation companies?»

Having defined this as the main question on which the flow of the work would unfold, it was also considered fundamental to put into perspective other research questions on specific aspects, which would seek to reinforce the comfort in the conclusions to be obtained.

The first question concerns the real usefulness of choosing "categories of variables" rather than "single variables" when defining the explanatory terms of the model. This is an issue that will be further explored in the review of other studies, but in a summarised manner it appears

[7] The case in point is the study by Asatryan and Brezinova (2014), who studied the behaviour of variables related to CSR and Liu (2009), who studied the impact of variables related mainly to airport metrics and competing companies.

in an embryonic phase of the study, in which the intention is to attribute the scope of the study to something materialisable, such as "studying the impact of variables of a certain character on the financial well-being of airlines".

The second question is associated with the quality of existing studies that support the choice of the possible explanatory variables sought. This is relevant since it is fundamental that there is a previously established basis of application, otherwise the orientation of the use of a certain variable unknown to the academic environment would be different and (much) deeper.

The third issue has to do with the type of model that is chosen and its suitability for the relationships that are to be studied. This question will be clarified when calculating pre-defined metrics, such as correlation indicators between the determinants to be considered individually or in groups, and any assumptions that the type of model requires in order to generate conclusions that are closer to reality.

The last question is associated with the possible mismatch between the conclusions obtained from the relationships between the variables in the study and the conclusions that are implied in the real context. In other words, in addition to the conclusions that the econometric study will offer, it is necessary to be sensitive to interpret those conclusions, considering the conclusions that could be drawn only from a theoretical point of view or, at the limit, from the point of view of common sense. For example, it may be generally understood that increasing the value of what is considered an expense for an airline will have a negative impact on the financial results of that company; however, the output generated by the model applied may reveal a different type of relationship, and it is important to detail the two scenarios and seek the points of contact between them.

4. Methodology

Chapter 4 is a blank slate where the core of this study is about to the drawn. Subchapter 4.1 presents the model's players – the variables –, the selection metrics and the purpose for which they were selected together with the others. Subchapter 4.2 lists the sources for obtaining data and at the same time confirm whether the methods and even the extraction sources were thought out and whether they are adequate for a study of this nature. In Subchapter 4.3, there is an intention to finalise the details regarding the type of model chosen and there is also space to get to know the tests to be performed and which will give consistency to this choice.

4.1. Variables

As the study was set to assess the impact of external and non-financial factors on the financial performance of aviation companies, it was decided to choose explanatory variables that belong to previously studied categories, as suggested by Choueiry (2022).

In place of the dependent variable (Y), as a reference of financial performance, the annual and per company *Shareholder's Equity* has been selected. This indicator, in practical terms, is the net value a company retains after paying off all its debts (Hayes, 2022). More rigorously, and as companies present in their Annual Reports, Shareholder's Equity disregards NCI (Non-Controlling Interests) from Total Equity[8].

This is one of the main, if not the main, factor that reflects the viability of a business, essentially for two reasons (Clark, 2022). Firstly, it portrays the current position of the company, through Share Capital and Net Results for the period, and the trajectory of recent years, through Retained Earnings. Secondly, and as indicated by the author, a negative value in this indicator may indicate the company's entry into a state of bankruptcy. Or not. In fact, if Retained Earnings are excessively negative over a long period and exceed the values of other accounts such as Share Capital, Net Profit for the period and/or Reserves, then it is expected that Shareholder's Equity will also tend to be negative. But accumulated profits can also be negative within a given timeframe and can stem from strategic issues implemented by the company. In the aviation sector, a sector known for its short profit margins, it is not unusual to see large (re)investments in PP&E (Property, Plant and Equipment), as well as in technological sectors, one of the largest shares of investment is in R&D (Research and Development). And

[8] By definition, NCI refer to the share corresponding to shareholders with an interest of less than half of the total holdings and who therefore do not play a prominent and controlling role in the internal decision-making of the companies in which they have equity stakes (Hayes, 2021).

in these cases, negative Retained Earnings do not necessarily or consequently "transit" airlines into a state of bankruptcy.

For these reasons, this indicator asserts itself as a key tool for the financial position of companies, for which the correlation with other explanatory variables can be assessed.

The choice of independent variables (X_i) was based on three criteria, namely variables that had already been studied in econometric models, but in a different context, variables belonging to the economic factors category and variables belonging to the sustainability factors category.

In place of variable X_1, *Air Passengers Carried* was selected, but, unlike the studies of Demydyuk (2011b), Dresner et al. (2009) and Gardner (2009), which studied the sum of passengers per departure per company, here the sum of passengers per departure per country will be studied, increasing the range and since it will also be applied to the other variables. According to data from IBIS World (2021), the global aviation market share showed an increase of about USD 100 billion between 2016 and 2019, to a record figure of over USD 800 billion. The same source also points out that recent data reveals that the Global Aviation industry ranks second in Transportation, Mail and Warehousing and twenty-fourth in total industries. Furthermore, a report by Mordor Intelligence (2022) predicts that the 2027 market share will be around 1,25 times that of 2022. Finally, and representing the trajectory of profits in this industry, a study by IATA (2021b), revealed that it was relatively consistent between 2016 and 2019, with a peak of about USD 40 billion in 2017, so that in the last two years and until the beginning of the period affected by the Covid-19 pandemic, an improvement of more than 10% had been recorded.

In place of variable X_2, the *Labour Force* per country was selected which, in parallel with studies such as that of Liu (2009), where the Unemployment variable was considered, will provide an even more concrete perspective of one of the main socio-economic factors. A study by koç and Seçilmiş (2016) concluded that an increase in per capita availability has a positive impact on demand in the aviation sector, which indirectly determines that the higher the GDP per capita, the higher the revenues of airlines. Additionally, and according to Okun's Law[9], if there is a directly proportional relationship between employment and GDP, it can be suggested that employment also positively influences Aviation Revenues.

In place of variable X_3, *Tax Revenue* per country was selected as one of two economic variables to be applied in the model to be developed. An extensive and thorough study by Ortiz-

[9] Although it is disputed by some authors and economists, it is an empirical model that determines that there is a directly proportional relationship between the Employment and GDP factors, whereby a 1% rise in the former is supported by a 2% rise in the latter, and vice versa (Kenton, 2022).

Ospina and Roser (2016) revealed not only that more than 80% of government revenues come from fees/taxes, but also that the largest share of that 80% corresponds to indirect taxes, on, for example, revenues, exports, and imports. The same study further explored the trends in "taxation" between developed and developing countries using data from the ICTD (International Centre for Tax and Development) and found that richer countries tend to collect more tax revenue as a higher percentage of GDP. From this, and in conjunction with the point addressed in the previous variable, it can be concluded that if the higher the GDP the higher the Tax Revenues and the higher the GDP the higher the airline revenues, then it is possible to suggest that the effect of Tax Revenues in a country is also a positive factor for aviation revenues. Even so, and as this last study reminds us, caution should be taken when associating variables, since an increase in Tax Revenues does not necessarily always derive from higher GDP, and may be at the origin, for example, of austerity measures, which are generally associated with lower purchasing power and, in some cases, higher unemployment.

In place of variable X_4, *International Tourism Expenditure* per country was selected as the second of two economic variables. At the outset, the positive role of this variable is acknowledged because it is known to contribute to GDP and the positive relationship of GDP with part of the dependent variable under analysis has already been validated. According to UNWTO (2021) – United Nations World Tourism Organisation –, over the last decade the growth in international tourism receipts has exceeded world GDP growth by ten percentage points. The role of this "type of tourism" is undeniable for the proper functioning of any economy, and proof of this is the 2019 data, which shows this variable in third in the top of the largest export categories worldwide, with more than USD 1,7 trillion, of which, more than USD 250 billion came from passenger transportation alone. Derived from what was concluded earlier about the privileged position of this sector (as a market share) in the passenger transport industry, it can now also be concluded that these giant international tourism figures inherently contribute to the good rransport revenue figures.

Finally, in place of variable X_5, *CO2 Emissions* per country was selected. A pivotal study by Abdi et al. (2021) validated that performance at the financial level has a strongly negative impact on the internal ESG policy of aviation companies. The authors suggest that this is due to the fact that companies still prioritise financial prominence over social, governance and sustainability metrics and that, in the limit, this understanding may lead managers to perceive that the relationship between these two factors is even inversely proportional. A further study, and reviewed previously[10], also suggests that investment in ESG practices has an opposite contribution on the ratio that manages the difference between the airline's market and book value. The ATAG (2020) report pointed out several ratios concerning the share of aviation in the emissions of pollutant gases, of which one highlights that the share attributed to aviation in the role of emissions is about 12%, compared to, for example, 74% for land transport, that about 80% of CO2 emissions from aviation come from flights with distances greater than 1,5 thousand kilometres, practically inoperable by any other means of transport, and that the average occupancy rate per aircraft is about 83%, above most of the alternatives. This means that, while on one hand the inverse relationship between the low investment in ESG and a positive financial output has been proven, the contribution to CO2 emissions is partly justified by the specificities of the industry, and there is still room for improvement. Additionally, a Euro Control (2020) paper revealed that there are few known factors that, when varied, allow airlines to reduce CO2 emissions, neither the increased tax impact, nor the increase in fuel prices, nor the increase in tickets. The same paper revealed, however, that the local and/or international economic situation does play a fundamental role, since peak periods mean, from the outset, greater availability and, consequently, greater demand; this increase in demand contributes to an increase in GDP and, at the same time, to a greater frequency of flights and, therefore, categorically will also contribute to an increase in CO2 emissions. This situation is reversed if the economic period is one of greater recession. In summary, and restating previous understandings, if higher GDP contributes to higher CO2 emissions, and if higher GDP contributes to higher revenues for aviation companies, it is safe to suggest that increased CO2 emissions can contribute to increased Revenues for Aviation.

4.2. Data

The relevance of including this chapter is essentially based on two points. On one hand, it is necessary to acknowledge the reliability of the sources chosen, since this is the only way to affirm that true data is being used and, therefore, the conclusions reached will not be questionable from the point of view of bias. On the other hand, this chapter provides information on any assumptions that may have been made due to the type of data presented or simply to follow up on the tests to be carried out.

For the dependent variable (Y), the Annual Reports of each airline were chosen, disclosed in the appropriate media. These Reports have many functions, but essentially serve to make

[10] Abdi et al., 2021.

readers and stakeholders aware of the company's reality. Although non-financial information may be relatively biased to mirror the best image/position of the company that managers intend to put across, the financial data of companies such as those in the airline industry are generally always audited, given their size, public interest, among other factors, so they are reliable and it is on them that any stakeholder should focus greater attention and perform the metrics they consider necessary to make certain considerations about the real position of the company in question. In addition, the data chosen were the Consolidated Statements (of the respective Groups), since most companies only make information publicly available in this way.

For the independent variables (X_i), it was decided to select only one data portal, The World Bank[11]. This is an extensive database with a vast number of indicators divided into categories. It proved relevant during the research process of the variables previously selected, since these go beyond the financial scope, something that the portal foresees and rigorously separates.

Regarding variable X_1, the data were obtained by the portal from ICAO, which is more than a way of statistics of aviation companies, since it contributes to a cooperation among these companies and suggests a standardisation of guidelines, policies, and ideas at a global level; even so, it does not have any power nor acts as a regulator of the sector, as shared by the organisation in the official media. This indicator is composed of data sent by countries to this organization, according to the metrics by which it is governed, and in cases where there is no real data, the organization provides estimates based on information made public by these airlines.

For variable X_2, the data were obtained by the portal from the ILO (International Labour Organization), which is an agency of the United Nations and has at its core the promotion of decent work practices for all, as shared by the organisation in the official media. This indicator is complex, but mainly contains the number of people working and those in work-seeking processes and discards unpaid workers and students. Since the metrics used by each country are not cross-cutting, the agency has used standardised estimates to make the indicator more reliably comparable across countries.

For variable X_3, data were obtained by the portal from the IMF (International Monetary Fund), the GFS (Government Finance Statistics) database, the World Bank's own data and estimates from the OECD. These are all recognised and "certified" sources from the financial

[11] The database can be accessed at https://data.worldbank.org/indicator. Here, the variables are arranged by category. Within each page of each indicator, it is possible to see the data by year and by country. In addition, the portal offers the possibility of consulting the formula for calculating each variable and makes direct reference to the sources from which they were obtained, allowing readers and users to assess the veracity, usefulness, and reliability of both the information and the source used.

world, with the IMF being a product of around two-hundred-member countries that promote stability and financial cooperation policies, as shared by the organisation in the official media, the GFS produces documents with the most relevant economic and financial information from a macro perspective for governments around the world, as shared by the organisation in the official media, and the OECD promotes global standardisation policies for access to the most dignified living conditions, as shared by the organisation in the official media. This indicator is composed of the mandated contributions to the respective national governments and excludes data such as countervailing duties and much of the social security contributions.

Regarding variable X_4, data were obtained by the portal from the UNWTO, essentially through the Yearbooks of Tourism Statistics and the Compendium of Tourism Statistics. The UNWTO is the United Nations agency responsible for the unification of tourism worldwide, supported by practices that generically promote accessibility to it for all people, and uses the means indicated to provide data, indicators, and statistics to readers. This indicator is essentially composed of foreign visitor spending in countries other than their country of origin.

Finally, regarding variable X_5, the data were obtained by the portal from the Climate Watch platform, which has among its various partners the UNFCCC (United Nations Framework Convention on Climate Change). This platform aims to bring together databases from various sources and offer readers a broad, detailed, and concrete view of variables related to climate and its derivatives, as shared by the organisation in the official media. This indicator is composed of CO2 emissions from the burning of fossil fuels and, in part, in the manufacture of cement.

The period of analysis for this research was between 2015 and 2020, a total of six years, and to represent a sample of all airlines, 46 companies were selected (Annex A), spread across five continents.

For a total of 46 enterprises over a six-year period, it would be expected that a number of data per variable equal to 276[12] would be gathered. However, there are variables for which it was not possible to collect data either for all years or for all countries (Table 4.1). For example, indicator X_5 (CO2 emissions) was only available up to 2019. In addition, Table 4.1 shows the measurement units of the variables considered, which are different from each other. This will be fundamental to consider later in the execution of the tests.

[12] According to Boomsma (1983) and Kline (2011), an appropriate sample size reference value is at least around 200 observations.

Table 4.1:

Number of observationsand unit of measurements per variable

Variable	Number of observations	Unit of Measurement
Y (Shareholder's Equity)	276	US Dollar
X_1 (Air Passengers Carried)	250	Unit
X_2 (Labour Force)	258	Unit
X_3 (Tax Revenue)	232	Current US Dollar
X_4 (Int. Tourism Expenditure)	203	Current US Dollar
X_5 (CO2 Emissions)	210	Kt (Kiloton)

A country was associated to the companies so that the correlation relations with the other variables under study could be validated. The criterion for choosing the country per airline was the country in which each company has its head office.

All these variables were extracted on an annual basis, coinciding with the calendar year, although the dependent variable has some specificities. Most of the firms considered report their financial results in a period coinciding with the calendar year; nevertheless, some firms report in the March-to-March period, others in the June-to-June, in the September-to-September or even in the October-to-October period.

For the September and October reports, the criteria "September(N) reports, which cover the period from September(N-1) to September(N), and October(N) reports, which cover the period from October(N-1) to October(N), will be considered in the respective calendar year (N)" was chosen. In other words, for a report in September 2020, it was considered to correspond to the year 2020 (the same scenario for the month of October), since in both cases, at least two thirds of the reported year was considered in 2020 (N).

For March carryovers, the criterion "March(N+1) carryovers that cover the period from March(N) to March(N+1) will be considered in the respective calendar year (N)" was chosen. In other words, for a report in March 2021, it was considered that it corresponded to the year 2020, since at least two thirds of the reported year was considered in 2020.

For reports in June, the criterion "June(N+1) reports, which cover the period from June(N+1) to June(N) will be considered in the respective calendar year (N)" was chosen. That is, for a reporting in June 2021, it was considered that it corresponded to the year 2020, since only in this way would it be possible to capture a considerable value of the effects of the Covid-

19 pandemic in 2020, to which the other companies with distinct reporting period were subjected in the scope of this study.

This was the most appropriate way, as mentioned, and given the time constraints of reporting, to frame the effects of Covid-19 on airlines performances in 2020, which is the last year under study.

4.3. Conceptual Model

As was possible to validate in the analysis carried out mainly in Subchapter 2.3, the different authors who have already contributed to the scientific community with new models either for predicting corporate bankruptcy or for merely validating the correlation between variables have mostly resorted to univariate analysis, multiple discriminant analysis and analysis using artificial intelligence.

Gudmundsson (2002) recognised the relevance of the latter, nevertheless, he chose to create his bankruptcy prediction model using external variables based on multiple analysis. But instead of having opted for Discriminant Analysis between variables, which measures and quantifies the linear correlation between variables, he built a model based on a Logistic Regression, whose dependent variable is a binary variable and thus offers the author the probability of occurrence.

After studying the various options, it was decided that the preferred method of analysis to be developed in this study would be a Multiple Linear Regression Model (MLRM). This methodology has several advantages, whereby Montgomery et al. (2021) highlight the fact of being able to know the real impact of the variation of certain selected factors in a common indicator and of being able to use tests to assess the presence of unusual data, commonly known as *outliers*. One can also points out as possible challenges the reasonableness of the date chosen, especially regarding the amount of information collected – which may bias the results, the smaller it is – and the type of conclusions reached, since a strong correlation between variables does not mean that there is a causal relationship.

This type of model has specificities, which are characterised by the authors as assumptions. What gives strength and allows a correct interpretation of the outputs is a set of five assumptions[13], namely the existence of a linear relationship between the variables (where Y is assumed as endogenous variable and X_i as exogenous variables, since only the exogenous variables contribute to justify the endogenous one), the inexistence or existence of a weak

[13] O'Farrell and Poole (1971).

Collinearity between variables (since only then will it be possible to define coefficients/estimates highly distinct from each other for the parameters considered), the existence of independence among residuals (detected, generally, by checking "Autocorrelation"), the existence of a constant variation ("Homoscedasticity") among residuals, and the existence of a Normal distribution at the level of residuals (otherwise, one is in the presence of biased residuals which, therefore, no longer represent the real value of the associated parameter).

In order to implement this type of model with the respective assumptions, the OLS (Ordinary Least Squares) method was used, which is a type of linear regression that allows estimating the coefficients of the independent terms of a model and the respective residuals, which arise from the associated errors (XLSTAT, 2022). This method, as explained in the portal, arises in an attempt to minimise the differences between real/observed values and the values that the method will predict. It also minimises the error term and uses the sum of the square errors and not only the errors, since these can assume negative values and generate disparate conclusions.

This method has a generic regression expression (Buteikis, 2020; XLSTAT, 2022):

$$Y_i = \beta_0 + \sum_{j=1\ldots n} \beta_j X_{ji} + \varepsilon_i, i = 1, \ldots, t \tag{1}$$

Where Y_i is the dependent variable and i points to the observation number, β_0 is the intercept of the model, β_j is the coefficient per independent variable and j points to the number of independent variables, X_{ji} is the independent variable and ε_i is the error term (which has null expected value – validates the strict exogeneity condition – and a given variance).

Before knowing the tests that this method can apply, it is important to mention that the terms β_j are related to the model's coefficients and may have different scopes and, consequently, different interpretations.

According to Goyal (2021), the estimated coefficients ($\widehat{\beta_\iota}$) can be classified as unstandardized, if the explanatory variables are expressed in the same unit/scale, or as standardized, if these variables are expressed in different units/scales, which is the case in this work (Table 4.1). The unstandardized coefficients reveal the variation in the estimated value of the dependent variable ($\hat{Y}$) for each unit that varies in the respective explanatory variables of these coefficients (X_i). In turn, standardised coefficients reveal the variation in $\widehat{\beta_\iota}$ standard deviations in the estimated value of the dependent variable for each standard deviation that varies in the respective explanatory variables of these coefficients.

In short, the former allows interpreting the (direct) impact of each independent variable on the dependent variable, while the latter allow comparing the impact of each $\widehat{\beta_i}$ on the dependent variable.

In practical terms, one should initially start by assessing the reasonableness of each variable in terms of mean, variance, skewness, and kurtosis. This is relevant as it provides an insight into the distribution of the data, the locations of higher densification and the existence of outliers. Next, it will be possible to interpret the estimated coefficient values and test the individual correlation between each independent variable and the dependent variable.

Turning to significance tests (Montgomery et al., 2021), the use of coefficients of determination ("R-squared" and "Adjusted R-squared") allows one to measure "how well the model fits" between its variables (Darlington & Hayes, 2017), the F-Test validates that there is at least one exogenous variable that validates the variation in the endogenous variable and the t-Test validates the significance or contribution of each explanatory variable in justifying the independent variable.

In practical terms, the "R-squared" coefficient reveals in percentage terms how much of the variance of variable Y is explained by variations in variables X_i (whilst "Adjusted R-squared" only considers variations in variables X_i that expressively impact the model and is adjusted to the number of predictors) and therefore, the greater its value, the stronger the relationship between variables. This coefficient results from a joint operation of three metrics, namely the TSS (Total Sum of Squares), which evaluates all the variation of Y around its mean, the ESS (Explained Sum of Squares), which makes known the part of the variation that is explained by the model in question and the RSS (Residual Sum of Squares), which makes known the part of the variation that is no longer explained by the model. Mathematically:

$$TSS = \sum_{i=1}^{n} (Y_i - \bar{Y})^2 \quad (2)$$

$$ESS = \sum_{i=1}^{n} \left(\widehat{Y_i} - \bar{Y}\right)^2 \quad (3)$$

$$RSS = \sum_{i=1}^{n} \left(Y_i - \widehat{Y_i}\right)^2 \quad (4)$$

$$R^2 = \frac{ESS}{TSS} = 1 - \frac{RSS}{TSS} \quad (5)$$

$$\overline{R^2} = 1 - (1 - R^2)\frac{n-1}{n-p} \quad (6)$$

Where, $\bar{Y}$ is the overall mean of the dependent variable, $\widehat{Y_i}$ is the predicted value of the dependent variable in the sample i, n is the number of observations, and p is the total number of variables in the model.

The F-test has as its calculation method:

$$F = \frac{\frac{ESS}{p-1}}{\frac{RSS}{n-p}} \sim F_{(p-1;n-p)} \tag{7}$$

And is governed by the following conditions:

$$\begin{cases} H_0\colon \beta_i = 0 \\ H_1\colon \exists \beta_i \neq 0 \end{cases} \tag{8}$$

Therefore, it is preferable to reject the null hypothesis, validating the hypothesis that the model coefficients are significant.

The t-Test, on the other hand, has as its calculation method:

$$t = \frac{\widehat{\beta_i} - \widehat{\beta_0}}{s_{\widehat{\beta_i}}} \sim t_{(n-p)} \tag{9}$$

Where $\widehat{\beta_0}$ is the predicted value of the intercept's coefficient, $\widehat{\beta_i}$ is the predicted value of the X_i's coefficient, and $s_{\widehat{\beta_i}}$ is the standard deviation of the previous term. Therefore, this test is governed by the following conditions:

$$\begin{cases} H_0\colon \beta_i = 0 \\ H_1\colon \beta_i \neq 0 \end{cases} \tag{10}$$

Therefore, it is preferable to reject variables that are in the null hypothesis condition or those that are in the second hypothesis condition and for which the $p-value$ is higher than the defined significance level (Dempster & Schatzoff, 1965).

Among the specification tests most relevant to the scope of this work, the Reset-Test should be highlighted, which allows validating essentially three points, namely whether the proper forms were used in the variables considered, whether the most appropriate functional form was used ("Lin-Lin", "Log-Log", "Lin-Log" or "Log-Lin") and whether there is a strong correlation between variables and indicating the existence of errors in the model considered (Ramsey, 1969; Wooldridge, 2013).

In practical terms, this test is governed by the following conditions:

$$\begin{cases} H_0\colon \varepsilon \sim N(0, \sigma^2 \mathrm{I}) \\ H_1\colon \varepsilon \sim N(\mu, \sigma^2 \mathrm{I}), \mu \neq 0 \end{cases} \tag{11}$$

And, since it is expected that residuals follow a Normal distribution, for a null centre and a given variance, one should only accept the models for which the respective $p-values$ of the test were higher than the defined significance level, that is, one should accept the models where the null hypothesis is true.

Next, and until the end, it is expected that several tests will be applied to validate the assumptions of this type of model previously pointed out (Darlington & Hayes, 2017), namely at the level of the normality of errors (for example, by the Jarque-Bera Test), the collinearity between residuals (for example, by the VIF – Variance Inflation Factor –), the constant variance between residuals (for example, by the Breusch-Pagan Test) and the correlation between residuals (for example, by the Durbin-Watson Test).

5. Results and Discussion

For the analyses, Microsoft Excel or the R Studio software were used as study platforms. It should also be noted that for all tests performed, a significance level (α) of 0.05% was considered. The starting point was the individual analysis of each variable (Table 5.1) by comparing the means, variances, skewness, and kurtosis.

Categorically, the indicators in Table 5.1 have different meanings, and within the same indicator, the data must be interpreted differently.

In the case of the averages, except for variables X_3 and X_5, the higher the values, the better it is, since the higher the Shareholder's Equity (which potentiates a greater return for investors), the more passengers transported (which potentiates a greater volume of revenues), the greater the labour force (which translates, expectably, into a greater volume of consumption) and the greater the spending by tourists (contributing to an improvement in economic indicators). For variables X_3 and X_5, this understanding may be (even more) dubious, since high tax revenues may be a symbol of high tax burdens, which is not so positive for firms, or they may have to do with excellent corporate financial results, which will translate, *ceteris paribus*, into higher government gains; and high CO2 emissions may mean that local companies still have inefficient or even non-existent sustainable policies, which is negative from the environmental point of view and for consumers for whom this is a conditioning factor for choosing certain companies (and respective services), or it may mean that it is a region of a high presence of the business sector, of a high presence of people, and among many other factors beneficial for the proliferation of air business.

In the case of variances, in a generic way for all variables, the larger the values, the more challenging becomes the range of possible scenarios, also making the work of forecasting these scenarios themselves challenging, as variables can vary over a higher range of values.

As for skewness, which measures the distortion of the data and the slope of the data in relation to the average values, more median values indicate that the frequency of higher values is similar to the frequency of lower values, and there is greater equity/stability; while higher values suggest that the frequency of higher values overlaps with the frequency of lower values, which is not necessarily positive or negative, and depends on the scope of each variable, as seen above.

Kurtosis, which in graphic terms is known as the Gaussian Curve, shows how abundant the data are around the mean values. Here, for values below 3, the data follows a Platikurtic distribution, the Gaussian curve is flatter, which reveals greater similarity between the data for that variable, and strong variations are not expected; for values above 3, the data follows a Leptokurtic distribution, the Gaussian curve is steeper, which reveals that there is a smaller range of values between the data for a variable, and consequently a greater number of outliers.

Table 5.1:

Mean, variance, skewness, and kurtosis by variable

Variables	Mean	Variance	Skewness	Kurtosis
Y	3.221.770.099	2,1144	0,9463	3,2496
X_1	166.097.715	6,7535	1,9884	5,4937
X_2	98.738.774	3,4664	2,7819	10,072
X_3	475.050.011.960	4,8080	1,6255	4,1945
X_4	36.308.521.406	2,6333	1,8733	5,1604
X_5	1.409.076	6,3074	2,3083	7,8070

Given the previous understanding, and since it is not possible to compare the mean values of the variables, since they are expressed in disparate units, it is only possible to compare them by evoking the associated variances. The variables with the largest variances are X_1 and X_5, which means that some volatility can be expected in the number of air passengers transported, which can negatively influence revenue forecasts, the lower the actual values, and some volatility can also be expected at the level of CO2 emissions, which means that, since this is a variable per country, one can anticipate the existence of a group of countries where these emissions are higher and vice-versa, with the inherent contributions/benefits, as already verified previously in Subchapter 4.1.

As for the skewness values, it is expected that variables X_2 and X_5 show a higher frequency of higher data, which is positive in the first case, since higher employment levels suggest higher GDP levels and consequently higher demand and higher revenues for airlines, as seen in Subchapter 4.1, and a mixed effect in the second case, given the wide possibility of interpretations that the contributions of large CO2 emissions may have, as seen in Subchapter 4.1.

As for the kurtosis values, all values are above the reference axis "3", with variable X_2 standing out, which reveals that it is the variable where it is expected that there is a higher presence of outliers and, at the same time, where a higher density of values close to the average value is visible.

The evaluation of the correlation between the dependent variable and each of the independent variables (Table 5.2) was also carried out using simple linear regressions, by comparing the values of the t-Tests, their location in the respective CIs (Confidence Intervals), the p-values and the percentages of correlation.

Statistically, larger values of the t-Tests mean larger differences between the variables studied and vice versa, and the following hypotheses are considered about them:

$$\begin{cases} H_0: t_{(Y,X_i)} = 0 \\ H_1: t_{(Y,X_i)} \neq 0 \end{cases} \quad (12)$$

Therefore, for cases where the p-value is higher than the defined significance level, the null hypothesis should be accepted, which means that the outcome of the regression is statistically significant, which translates into a lower or non-existent probability of occurrence.

Correlation percentages, using the R-squared, reveal how much the variable Y varies according to a variation in X_i.

Table 5.2:

Correlation between the dependent and each independent variable

Relationships	t-Test	$CI_{95\%}$	p-value	Correlation (%)
$Y\ vs. X_1$	6,4420	[0,267-0,480]	0,0000	37,86%
$Y\ vs. X_2$	3,3198	[0,083-0,317]	0,0010	20,32%
$Y\ vs. X_3$	7,4843	[0,333-0,541]	0,0000	44,25%
$Y\ vs. X_4$	5,9773	[0,265-0,499]	0,0000	38,85%
$Y\ vs. X_5$	6,3444	[0,283-0,510]	0,0000	40,27%

From the interpretation of the data, one observes t-Test values outside (and above) the confidence intervals, which means that all variables are different from each other, which would already be expected. And as all p-values are less than 0,05 – the defined significance level –, the null hypothesis is rejected and it is concluded that, in all cases, there is a (higher) probability that there is a link between the variables.

This link is validated by the correlation levels, where the relationship $Y\ vs. X_3$ stands out as "positive", which means that around half of the variations in Tax Revenue justify the variations in Shareholder's Equity, and on the negative side the $Y\ vs. X_2$ relationship, which means that only around one fifth of the variations in "Labour Force" justify the variations in Equity. Even so, it should be noted that no relationship has percentage levels above 50%.

In addition to the results presented, it is also possible to have an insight into the degree of correlation between the independent variables, again using Pearson coefficients (Table 5.3). From the wide range of applications that this information offers, one must highlight that in the presence of two (or more) variables that are strongly related to each other, it is no longer useful to consider using them, not only because of their little different effects on the dependent variable, but also to anticipate future conditions of the type of model to be chosen.

Table 5.3:

Correlation between the dependent variables

Correlations	X_1	X_2	X_3	X_4	X_5
X_1	1,0000	0,4733	0,9368	0,9480	0,7996
X_2		1,0000	0,3877	0,3204	0,8618
X_3			1,0000	0,9139	0,7346
X_4				1,0000	0,9117
X_5					1,000

In order to validate the real conclusion of the results presented, the following hypotheses were considered:

$$\begin{cases} H_0: \rho = 0 \ (No\ Correlation) \\ H_1: \rho \neq 0 \ (Correlation) \end{cases} \tag{13}$$

And it was found that null p-values were obtained in all cases, so that, being below the defined significance level, the null hypothesis is rejected and it is confirmed that there is correlation between all explanatory variables. Once this scenario is confirmed, Table 5.3 shows that the variables with the highest degree of correlation are “Air Passengers Carried” (X_1) and “International Tourism Expenditure” (X_4). This was already an expected scenario since, even if a causal relationship is not stated, it is possible to recognise that a higher number of passengers transported (by air) generates/may generate a higher foreign consumption of goods in other regions.

Once the variables were analysed individually and among themselves, the study then moved on to the definition of the functional form of the model (Table 5.4). Here, some criteria were assumed. From the wide range of possible tests to be performed, it was noted in the previous chapter that there are some that validate the viability of the chosen structure more than others, namely the F-tests, the t-tests, the Reset-tests and the VIFs. Thus, it was decided to apply each of these tests, and also the R-squared, to the four functional forms ("Lin-Lin", "Log-Log", "Lin-Log", "Log-Lin") and conclude which of them would have a better fit.

As seen in Subchapter 4.3, the F-Test validates that there is at least one variable that contributes to the model, the t-Test assesses the individual significance of each independent variable, i.e., it measures its contribution within the model and suggests which of them should be disregarded, for presenting a statistical value higher than the chosen significance level, the Reset-Test validates the chosen functional form, and the VIFs indicate which variables are too justifiable among themselves, and should be disregarded from the model.

Table 5.4:

Main screening tests by functional form

$Y \sim X_1 + X_2 + X_3 + X_4 + X_5$			
R-squared	45,26%	t-Test	Disregard X_2 e X_3
F-Test	23,48	p-value	0,0000
Reset-Test	p-value = 0,0000	VIFs	> 10: X_1, X_3, X_4 e X_5
$\log(Y) \sim \log(X_1) + \log(X_2) + \log(X_3) + \log(X_4) + \log(X_5)$			
R-squared	72,97%	t-Test	Disregard X_2
F-Test	64,79	p-value	0,0000
Reset-Test	p-value = 0,1383	VIFs	> 10: X_5
$Y \sim \log(X_1) + \log(X_2) + \log(X_3) + \log(X_4) + \log(X_5)$			
R-squared	55,77%	t-Test	Disregard X_5
F-Test	35,81	p-value	0,0000
Reset-Test	p-value = 0,0000	VIFs	> 10: X_5
$\log(Y) \sim X_1 + X_2 + X_3 + X_4 + X_5$			
R-squared	43,24%	t-Test	Disregard X_3
F-Test	18,29	p-value	0,0000
Reset-Test	p-value = 0,0000	VIFs	> 10: X_1, X_3, X_4 e X_5

Of the four functional forms presented, two – the "Lin-Lin" and the "Log-Lin" – were automatically disregarded, since they are the options with a higher level of collinearity between variables (higher number of VIF values above "10"[14]) and are those whose R-squared values are lower, and below 50%, in contrast to the other two functional forms.

Of the two others, what ultimately distinguishes them is, first, the output of the Reset-Test, which is "not significant" in the "Lin-Log" case (since p-value is less than 0,05), and second, the output of the R-squared, which is about 20 percentage points higher in the "Log-Log" functional form.

Given that the measurement units of the selected variables are distinct, that the sizes of the selected variables are relatively large and distinct, and anticipating a high volume of errors between the variables and their estimates, it would be expected that the functional form that would obtain the "best" output would be "Log-Log".

Even though none of the forms passed all the tests, "Log-Log" was the one that presented the highest R-squared value and, at the same time, was the one that failed the least tests, so it is on this one that additional considerations will be made.

At this point, it is relevant to recalculate the initial metrics (mean, variance, skewness, and kurtosis) since they will be relevant when evaluating indicators such as the SE (Standard Error of regression) (Table 5.5). And also, the correlation between the dependent variable and each of the independent variables (Table 5.6).

Table 5.5:

Mean, variance, skewness, and kurtosis per variable for the "Log-Log" form

Variables	Mean	Variance	Skewness	Kurtosis
$\log(Y)$	21,3271	2,4339	-0,7873	3,4411
$\log(X_1)$	17,9459	2,5470	-0,2590	2,8667
$\log(X_2)$	16,8005	3,9056	0,0000	2,2590
$\log(X_3)$	25,6368	4,0322	-0,7141	3,6845
$\log(X_4)$	23,4819	2,0855	-0,1271	2,3617
$\log(X_5)$	12,4711	4,3703	-0,0404	2,4188

[14] Although some authors choose to validate the existence of Multicollinearity for VIFs above "2,5", as is the case of Aerts et al. (2010), here it was considered a higher and widely used threshold, "10" (Curto & Pinto, 2010).

Table 5.6:

Correlation between the dependent and each independent variable for the "Log-Log" form

Relationships	t-Test	$CI_{95\%}$	p-value	Correlation (%)
$\log(Y)\ vs. \log(X_1)$	9,6080	[0,458-0,648]	0,0000	56,01%
$\log(Y)\ vs. \log(X_2)$	4,6996	[0,181-0,426]	0,0000	30,85%
$\log(Y)\ vs. \log(X_3)$	5,5074	[0,246-0,493]	0,0000	37,61%
$\log(Y)\ vs. \log(X_4)$	9,1815	[0,471-0,674]	0,0000	58,15%
$\log(Y)\ vs. \log(X_5)$	7,3261	[0,360-0,586]	0,0000	48,13%

With the data in logarithmic form, the variance levels have not dissipated much from the original values. The main difference lies in the new values for skewness and kurtosis. As would be expected regarding skewness, with the exception of variable X_2 – which, even so, presents a tendentially null value – all variables started to present negative values, making the distribution more "Normal", with the extremes graphically positioned further to the left. Almost all variables also presented lower kurtosis values, even below the reference point "3", indicating that these now present fewer outliers and that there is a wider range between the minimum and maximum values along the respective regressions (no longer concentrated in the centre, over the respective means).

Analysing the relationships between the variables, all groups remain distinct from each other, which would be expected given the previous understanding. What does vary are the levels of correlation between the variables, which are now higher, now that the variables have become "closer" to each other, either due to a reduction in the differences in magnitudes of values between variables, or due to an improvement in the Normal distributions of each of them.

Recovering again the correlation matrix between independent variables (now in "Log-Log" form), there are some changes to report (Table 5.7). Firstly, the strongest relationship is no longer between variables X_1 and X_4 and is now between variables X_2 ("Labour Force") and X_5 ("CO2 Emissions"). Based on the review of literature carried out so far, there was no evidence of a possible (significant) relationship between these two variables, so one must wait for the remaining tests to be carried out in order to reach a more firm/reliable conclusion. Secondly, as expected, once it moved to the "Log-Log" form, the relationships between the variables became generally stronger. To support this conclusion, equation (13) was replicated for each correlation and, in all cases, a null p-value was found.

Table 5.7:

Correlation between the dependent variables for the "Log-Log" form

Correlations	log (X_1)	log (X_2)	log (X_3)	log (X_4)	log (X_5)
log (X_1)	1,0000	0,8145	0,7485	0,8858	0,8943
log (X_2)		1,0000	0,7460	0,7079	0,9463
log (X_3)			1,0000	0,7651	0,7740
log (X_4)				1,0000	0,8736
log (X_5)					1,000

In terms of unstandardized estimated coefficients ($\widehat{\beta_i}$), they are arranged according to Table 5.8. For the cases where $\widehat{\beta_i} = 0$ and $\widehat{\beta_0} \neq 0$, it should be interpreted that the expected value of log (Shareholder's Equity) is -0,2296. For the remaining cases, and since this is a "Log-Log" regression, one should interpret each $\widehat{\beta_i}$ as the expected percentage change, *ceteris paribus*, in variable Y for each 1% change in the respective X_i. That is, 0,8644% is the expected variance, *ceteris paribus*, in Y for each percentage change in X_1, and so on. Here, and as seen above, because they have different media units, it is only possible to quantify the individual impact of each variable on Y.

Table 5.8:

Coefficients estimated for the "Log-Log" form

Variables	$\widehat{\beta_i}$	p-value	$\widehat{\beta_i^*}$
$(Intercept)$	-0,2296	0,9159	-
log (X_1)	0,8644	0,0000	0,9153
log (X_2)	-0,1545	0,2016	-0,1775
log (X_3)	-0,1660	0,0051	-0,2300
log (X_4)	0,8755	0,0000	0,8895
log (X_5)	-0,6362	0,0002	-0,7976

Regarding the estimated standardized coefficients ($\widehat{\beta_i^*}$) (which can also be seen in Table 5.8), no intercept value is considered anymore, and in terms of interpreting the values, each $\widehat{\beta_i}$ corresponds to the percentage variation in standard deviations expected, *ceteris paribus*, in variable Y for each variation of a standard deviation in percentage terms in the respective X_i.

That is, 0,9153% is the variation in expected standard deviations, *ceteris paribus*, in Y for each variation in standard deviation in percentage terms in X_1, and so on. Here it is already possible to compare the contribution of each variable, whereby the one that contributed most positively to the variation in the dependent variable was X_4 and the one that contributed most negatively was X_5.

Going forward, one can look, through the Variance-Covariance Matrix in Table 5.9, at the type of relationships between the variables, i.e., whether they are positive or negative. However, since the data are not standardised, it is not possible to test the linear strength between the variables; the same will be achieved using the correlation percentages, checked earlier. Their analysis shows that, even in the case of a logarithmic regression, the relationships between the independent variables are mostly negative, which means that when one variable increases, the other variable tends to decrease.

Finally, and still on the "Log-Log" model, the SE of regression of 1,8648 stands out, which, since it is expressed in units (Frost, 2017), and since it is a logarithmic regression, is not an excessive value, but it is not particularly residual either, so it is expected that there is some distance between the data and the regression line.

Table 5.9:

Covariance matrix of the "Log-Log" form

Covariances	$(Intercept)$	log (X_1)	log (X_2)	log (X_3)	log (X_4)	log (X_5)
$(Intercept)$	4,7054	-0,0223	-0,1737	-0,0007	-0,2176	0,3038
log (X_1)		0,0124	0,0004	0,0004	-0,0064	-0,0053
log (X_2)			0,0145	-0,0014	0,0067	-0,0163
log (X_3)				0,0034	-0,0030	0,0002
log (X_4)					0,0190	-0,0120
log (X_5)						0,0277

Having presented the estimated coefficients in both their valences, one can now proceed to the definition of the final model, based on the suggested "Log-Log". Given that by the t-Test it was suggested that X_2 should be disregarded and by the VIF it was suggested that X_5 should be disregarded, all previous tests for these two realities were revalidated (Table 5.10).

Table 5.10:

Main screening tests by the new two modalities within the "Log-Log" form

$\log(Y) \sim \log(X_1) + \log(X_3) + \log(X_4) + \log(X_5)$			
R-squared	72,60%	t-Test	All variables are fit
F-Test	80,15	p-value	0,0000
Reset-Test	p-value = 0,3425	VIFs	All variables are fit
$\log(Y) \sim \log(X_1) + \log(X_2) + \log(X_3) + \log(X_4)$			
R-squared	68,60%	t-Test	All variables are fit
F-Test	73,20	p-value	0,0000
Reset-Test	p-value = 0,0004	VIFs	All variables are fit

Hence, one can conclude that the most feasible model is the first one, where variable X_2 is disregarded, for distinct reasons. Firstly, this model complies with all the conditions defined, unlike the second model, where the Reset-Test criterion is not validated (the p-value is below the significance level, which makes the functional form defined therein unfeasible). And since this is a model derived from another model, which itself was already derived from an initial model ("Lin-Lin"), it did not make sense to proceed to any of the main alternative routes, namely, to change the functional form again or add non-linear variables/functions, since the variables for study have already been selected. Secondly, the first model presents a higher correlation between the types of variables, making their relationships stronger and more explanatory (of each other). Furthermore, to disregard any of the variables, the option for X_2 becomes more appropriate, when one retrieves the outputs from Tables 5.2 and 5.6, which show that the correlation between this variable and the dependent variable is the weakest of all, in both linear and logarithmic versions. It is also possible to add that the SE for the first model was around 1,8630 and for the second around 1,8646. That is, although slightly different, they are not significantly low values (considering the values of Table 5.5, which considers the metrics for the "Log" versions of the variables), that give an "extra" security to consider, somehow, alleviations in the outputs of other tests.

Thus, the new unstandardised and standardised estimated coefficients to be considered are shown in Table 5.11. Of all coefficients, the one that most positively explains the variations of Y is the one concerning X_4 (0,9626) and the one that most negatively explains the variations of Y is the one concerning X_5 (-1,0152). That is, *ceteris paribus*, an increase in international tourism expenditure will drive the largest positive variation in the airlines' Shareholder's Equity among all remaining variables; and an increase in CO2 emissions will drive the largest negative variation in this dependent variable. From here, one begins to understand the real influence of this gas emissions in the airlines' vitality, which was initially defined as dubious, depending on the point of view of analysis.

Table 5.11:

Coefficients estimated for the "Log-Log" model form where variable X_2 is disregarded

Variables	$\widehat{\beta_i}$	p-value	$\widehat{\beta_i^*}$
$(Intercept)$	-2,0835	0,2017	-
log (X_1)	0,8690	0,0000	0,9202
log (X_3)	-0,1806	0,0020	-0,2503
log (X_4)	0,9475	0,0000	0,9626
log (X_5)	-0,8098	0,0000	-1,0152

Looking at the new variance-covariance matrix of the "Log-Log" model, now without variable X_2 (Table 5.12), the understanding with respect to the previous matrix is not very different, and therefore the relationships between the variables remain negative, i.e., when one variable increases in value, the other variable decreases.

Table 5.12:

Covariance matrix of the "Log-Log" model form where variable X_2 is disregarded

Covariances	$(Intercept)$	log (X_1)	log (X_3)	log (X_4)	log (X_5)
$(Intercept)$	2,6348	-0,0173	-0,0173	-0,1374	0,1092
log (X_1)		0,0124	0,0004	-0,0067	-0,0049
log (X_3)			0,0033	-0,0024	-0,0013
log (X_4)				0,0159	-0,0045
log (X_5)					0,0095

It is now of interest to validate the other four assumptions in order to verify, with no exceptions, the feasibility of the MLRM. Starting with the collinearity between the explanatory variables, there are several possible scenarios, of which ones highlights an exact relationship between the variables, where it is not even possible to calculate the estimated coefficients under the OLS, a strong relationship between the variables, where the estimated coefficients can assume values so large and, at the same time so distorted from the actual values, a weak relationship between the variables, which is the desired scenario, since it guarantees that the estimated coefficients are unique and expressly distinct from each other, and a null relationship between the variables, where the existence of linearly independent relationships between variables is verified (which, even so, is very difficult to obtain).

From the variety of tests that exist to assess this assumption, the VIF was chosen, since it is easy to interpret. According to the values in Table 5.13, none of the variables is in a Multicollinearity scenario, which means that an increase in the standard errors of the estimated coefficients is not expected, nor are any precision and interpretation flaws at their level.

Table 5.13:

Multicollinearity test in the "Log-Log" model form where variable X_2 is disregarded

$\log(X_1)$	$\log(X_3)$	$\log(X_4)$	$\log(X_5)$
6,1601	2,7679	7,2464	6,5604

The following assumption defines that the variance of errors must remain constant, so that the estimators remain BLUE (Best Linear Unbiased Estimators), which is a condition of the Gauss Markov theorem. This scenario is called Homoscedasticity, and when it is not verified, it means that the errors are no longer the most efficient ones, which makes the coefficients forecasts skewed, in a Heteroscedasticity scenario.

The Breusch-Pagan Test ("BP Test") was used and has the following conditions:

$$\begin{cases} H_0: Homoscedasticity\ (\sigma_j^2 = 0) \\ H_1: Heteroscedasticity\ (\sigma_j^2 \neq 0) \end{cases} \tag{14}$$

Therefore, to validate this assumption, it is optimal that the p-value is higher than 0,05, so that the null hypothesis is accepted. The test was performed (Table 5.14), and one can conclude for Homoscedasticity, being validated the assumption with no exceptions.

Table 5.14:

Homoscedasticity test in the "Log-Log" model form where variable X_2 is disregarded

BP Test	p-value
7,8273	0,0981

Next, the assumption of the Normality of Errors allows for a more comfortable F-Test and t-Test performances and results and to validate the BLUE assertion regarding the estimators. Still, it is not uncommon that this condition is not directly validated, so in these cases, if the model is under the CLM (Central Limit Theorem)[15], one can conclude that the estimators are BLUE and that the statistical inference is valid, even if only asymptotically.

To validate this assumption, the Jarque-Bera Test ("JB Test") and the Shapiro-Wilk Test ("SW Test") were performed (among many other tests like Anderson-Darling, Kormogorov-Smirnov/Lilliefors), and the following conditions can be associated to them:

$$\begin{cases} H_0: Errors\ follow\ a\ Normal\ Distribution \\ H_1: Errors\ don't follow\ a\ Normal\ Distribution \end{cases} \quad (15)$$

Therefore, to validate this assumption, it is preferable that the p-value is higher than the defined significance level, so that the null hypothesis is accepted. The tests were performed (Table 5.15), and one can conclude for the Normality of Errors, since the number of observations is higher than 30 – being, therefore, under the CLM –, and the assumption is asymptotically validated.

Table 5.15:

Normality of Errors test in the "Log-Log" model form where variable X_2 is disregarded

JB Test	p-value	SW Test	p-value
55,3100	0,0000	0,8744	0,0000

As for the last assumption, the intention was to validate that the residuals of the independent variables are also independent from each other, through a covariance between pairs of them equal to zero. When this is the case, one should maintain the assumption that the estimators considered validate the BLUE condition and, therefore, there is a No Autocorrelation scenario.

Conclusions can be drawn by applying, for example, the Durbin-Watson Test ("DW Test"), which is a test responsible for validating the first order autocorrelation and has the following conditions:

$$\begin{cases} H_0: No\ Autocorrelation \\ H_1: Autocorrelation \end{cases} \quad (16)$$

[15] According to Ganti (2022), this is a theorem which states that for regressions with a number of observations greater than 30 elements, the distribution of the data tends to follow towards a Normal distribution.

The Breusch-Godfrey Test ("BG Test") validates the second order autocorrelation and has as hypothesis:

$$\begin{cases} H_0: No\ Autocorrelation \\ H_1: Autocorrelation \end{cases} \quad (17)$$

Therefore, to validate this assumption, it is preferable that the p-value, in both cases, is higher than the defined significance level, so that the null hypothesis is accepted. The tests were performed (Table 5.16), and one can conclude for No Autocorrelation, being validated the assumption with no exceptions.

Table 5.16:

No Autocorrelation tests in the "Log-Log" model form where variable X_2 is disregarded

DW Test	p-value	BG Test	p-value
2,0543	0,5572	0,1987	0,6558

In short, after having chosen the MLRM, the disposition and dexterity of the variables individually (Table 5.1), the correlation of the independents with the dependent (Table 5.2) and the correlation between the independents (Table 5.3) were evaluated in linear form. Then, in order to find the most suitable functional form for the type of model chosen, some "core" tests were defined to make this selection (Table 5.4). From this, it was concluded that the "Log-Log" form was the best fit and the variables' behaviour was tested again as it was done initially (Tables 5.5, 5.6 and 5.7). With the variables analysed in the logarithmic view, the coefficients in both the unstandardised and standardised versions were listed (Table 5.8) and there was also room to know the levels of variance among all the variances (Table 5.9). Once all the individual analyses between the five independent variables were completed, the conclusions obtained in the initial screening tests were recovered, and two scenarios were created, one disregarding the variable X_2 and the other disregarding the variable X_5 (Table 5.10). From here, it was concluded that the model that disregarded variable X_2 ("Labour Force") was "more" effective, and the presentations performed previously in Tables 5.8 and 5.9 were remade (Tables 5.11 and 5.12). With the final form of the model in hand, tests were performed to check for compliance with the model's assumptions, namely the "Multicollinearity" (Table 5.13), the "Homoscedasticity" (Table 5.14), the "Normality of Errors" (Table 5.15) and the "No Autocorrelation" (Table 5.16).

This way, the model is considered to be viable and conclusions can then be drawn and applied in a real context.

6. Conclusion

This chapter is divided into three main parts. The first which draws conclusions from the results of the previous chapter and the second concludes on the achievement of the objectives initially set out, also providing answers to the research questions outlined previously. The last part refers to the Limitations and Recommendations and offers a perspective of continuity to other authors in investing in more and more rigorous methodologies for studying the (commercial) airline industry, so that factor interventions such as Covid-19 have a more controlled impact as suggested by Dobre (2021), or at least that managers are provided with more information so that they can act accordingly.

Recapping the trajectory assumed in the previous chapters, after having presented the scenario in which the aviation sector is inserted in financial terms in Chapter 2, Chapter 3 defined with greater rigour and certainty the desire to want to test the impact of external and/or non-financial variables on the performance of companies in this sector. Once the research questions had been raised, it fell to Chapter 4 to accommodate the structural determinants of the development of these questions, namely the definition of the variables ("Shareholder's Equity" as the factor to be explained and "Air Passengers Carried", "Labour Force", "Tax Revenues", "International Tourism Expenditure" and "CO2 Emissions" as explanatory factors), the origin of the data (from The World Bank databases) and the type of model where the relationships between the selected variables were tested. Throughout Chapter 5, and taking advantage of the summary in that section, different tests were carried out, concluding that the final version of the model considered was effective.

Individually, none of the five determinants showed a relatively strong correlation to Shareholder's Equity (at least of more than two thirds) but also, with the exception of Labour Force, none of the five showed a correlation that could be said to be weak (of less than one third). In practical terms, this means that, although the influence of these factors should not generate a warning or greater attention from airline managers, they should not be disregarded when defining the window of possible external impacts on the results of these companies. Going further into the question, once the impact of each factor has been verified, this fact alone should serve as a basis for considering all of them for discussion; the application of preventive and/or corrective measures/actions should arise from the profile of each company and each team that manages it.

When analysed together, these five indicators have shown that they have a relevant impact on Shareholder's Equity, with a value suggested by the model close to 75%. In practical terms, this means that, contrary to the greater "at will" suggested previously, managers must now consider the group impact of these variables on the backbone of the companies they are in charge of, since any volatility that may occur in these companies may have a greater influence than could be initially predicted (in a group perspective). It is also up to managers to further explore what has already been introduced in Subchapter 4.1 and the beginning of Chapter 5 and assess the direction of the impact of each variable, i.e., whether a positive variation of it has a positive or negative weight on the financial indicator it advocates and vice versa.

Now from a macro perspective, one can conclude that the objectives initially set out were achieved. More specifically, it was intended to build a work that would contribute to a richer and more diverse “academic database”, and that would serve as a motto for future studies (or that would even reinforce points of view that had already been raised). With recourse to an extensive number of diverse literature in its nature and scope and with the practical application of various tests, exploring different themes, it is now possible to say that the intended contribution was achieved, recognising, however, the obstacles that were encountered and overcome, mentioned below in the Limitations and Recommendations. In addition, it was set as one of the goals to use these findings in real-life scenarios. What makes these conclusions reliable for (future) application is, among other factors, the comprehensive coverage of both theoretical and practical issues. This means that various fronts and scenarios were explored, which gradually gave greater comfort to the interim conclusions and, in the end, allowed “final” conclusions to be drawn without exceptions.

As for the research questions raised at the beginning, it is now possible to give the appropriate answers to them. The conclusions of Chapter 5 serve to answer the first – and main one –, which questioned whether there were in fact other external and/or non-financial variables that contributed to justify variations in the financial performance of airlines. With greater or lesser influence on the results, at least one of the variables proposed (and, in this case, all of them) proved to have such a contribution.

As for the other more specific questions, in relation to the first one, on the usefulness of using categories of variables, the understanding is confirmed for various reasons, namely the quality of Literature that can be collected, the more rigorous definition and conclusion at the level of research hypotheses and the greater margin of manoeuvre "available" for future studies, giving the authors a perspective of "how studied a certain category has been until then". For the second, on the literary sources that support the choice of the variables chosen, they not only proved to be very positive in qualitative and quantitative terms, but, for all cases, they contributed to the assertion about the (proven) contribution in a structural point of the airlines, the Revenues, which ultimately contribute to the Equity structure. The third had to do with the type of model that would be chosen, and here the choice was very much motivated by the type of simpler conclusions that would be possible to obtain, and to this end the MLRM was chosen. The last issue, regarding the sensitivity to be had in interpreting the conclusions in relation to what would be expected, was resolved during the execution of the work, when doors were opened to a double interpretation of the results of each variable; in this case, the variables "Tax Revenues" and "CO2 Emissions" presented a negative regression coefficient, which means that when they increase, the Shareholder's Equity tends to decrease, which does not leave the spectrum of possibilities that was presented.

Turning now to the final considerations and starting with the Limitations faced, these are mostly related to the data of the variables chosen. It was identified that although all independent variables were reporting for the corresponding calendar year, the same was not true for the dependent variable, due to the issue of some companies having implemented a reporting period distinct from the calendar year. The main implication of this is that seeking to justify the correlation between variables that "report" in slightly different periods may lead to the results being partly biased. However, options to overcome this issue (seen in Subchapter 4.2) were taken in order to maximise standardisation across different realities.

Another limitation was identified in terms of the range of data available on random/external indicators. This is because, even though from a theoretical point of view it is possible to suggest that there is a link between certain variables, from a practical point of view it becomes more difficult to justify it when these variables do not present data either for all regions or for all years under study, as was the case in this work. To overcome this issue, a large number of firms in different regions and a large number of years were chosen in advance so that the total number of observations was high enough to support this downside.

Finally, another limitation concerns the fact that the tests have indicated that the best functional form of the econometric model initially suggested is the "Log-Log" form, and by turning all the terms of the regression equation into their respective "Log" forms, some observations were automatically lost, as they had negative original values, and for which it is not possible to apply this announced form. Having reduced the number of observations, even if not substantially, this increased the possibility of bias in the interpretation of the results, so greater caution was taken.

With regard to future Recommendations, one might suggest overcoming a possible obstacle in terms of the bias of the estimates in relation to reality, seeking to expand the number of observations as far as possible, considering both a larger number of companies and a larger number of years. In fact, opting for a larger number of companies opens the study to many more and different realities (financial and otherwise). Choosing a larger number of years, and specifically in the aviation sector, is an added value, insofar as, since it is an inconstant sector in terms of profit periods, it means that the study to be carried out encompasses a larger number of “trends” in its time space, making the study’s conclusions closer to their application in a real scenario. There is also room to verify the relationship between financial performance and other external non-financial variables since studies and theoretical foundations have been gradually increasing. And finally, it is possible that other methodologies are explored as to the types of models selected, since they may reinforce the results obtained in this work and, in this case, leave no doubt as to their impacts and the added value they have if considered by “airlines managers”.

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Annexes

Annex A - Selected Companies/Groups and countries/regions of their headquarters.

Airline Group	Country/Region
Aegean Airlines Group	Greece
Air Canada Group	Canada
Air China Limited	China
Air New Zealand Limited	New Zealand
ANA Holdings Inc.	Japan
Copa Holding, S.A.	Panama
Croatia Airlines Group	Croatia
Evergreen Group	Taiwan
Deutsche Lufthansa AG	Germany
SAS Group	Sweden
Singapore Airlines Group	Singapore
Grupo TAP	Portugal
United Airlines Holdings Inc.	United States of America
American Airlines Group Inc.	United States of America
Cathay Pacific Group	Hong Kong
Finnair Group	Finland
International Airline Group (IAG)	France
Japan Airlines Co., Ltd.	Japan
Qantas Group	Australia
Qatar Airways Group	Qatar
Royal Jordanian	Jordan
Aeroflot Group	Russia
Aeromexico Group	Mexico
Air France-KLM S.A.	France
China Airlines Group	Taiwan
China Eastern Air Holding Company	China
Delta Air Lines Inc.	United States of America
EasyJet plc	United Kingdom
Ryanair Holding plc	Ireland
Avianca Group International Limited	Colombia

Airline Group	Country/Region
LATAM Airlines Group S.A.	Brazil
Norwegian Group	Norway
PAL Group	Philippines
Thai Airways International	Tailand
Virgin Atlantic Group	United Kingdom
SriLankan Airlines	Sri Lanka
Southwest Airlines Co.	United States of America
Wizz Air Group	Hungary
Kenya Airways Limited	Kenya
Icelandair Group	Iceland
Air India Limited	India
InterGlobe Aviation Ltd.	India
Hawaiian Holding, Inc.	Hawaii
Emirates Group	United Arab Emirates
Spirit Airlines, Inc.	United States of America
Garuda Indonesia Group	Indonesia