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Capital structure in the world airline industry

Heloisa Márcia Pires Capobianco [a,1], Elton Fernandes [b,*]

[a] *FACC/UFRJ, Department of Administration, Av. Pasteur, 250 Urca, Rio de Janeiro, 22290-240, Brazil*
[b] *COPPE/UFRJ, Coordenação de Programas de Pós-Graduação de Engenharia, Centro de Tecnologia, sala F-108, Cidade Universitária, Ilha do Fundão Caixa Postal 68507, CEP 21945-970, Brazil*

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Abstract

This article presents a managerial approach to the airline capital structure through a definition of an efficient frontier. To develop the analysis a technique called data envelopment analysis was used. This paper tests the hypothesis that airline industry's financial performance depends on companies keeping a reasonable level of leverage and also seeks to establish this level. The research identifies the biggest airline companies which use capital efficiently to generate return with a low level of fixed assets. In these companies, shareholders' capital represents at least 40% of all funds employed. It could be seen by simplifying the analysis that it is possible to identify the most and the least efficient companies by studying their indebtedness and return on assets. A large proportion of the companies are moving to reduce their level of indebtedness and raise their returns over the course of time. The analysis by country revealed that countries do not offer comparative advantages, with the companies' performance depending fundamentally on their management.

Keywords: Capital structure; Airline industry; Efficiency; Data envelopment analysis

1. Introduction

Decisions concerning capital structure are strategic and involve choosing between third party and shareholders' capital. The decision is important as it involves possible changes to capital costs and therefore the risk perceived by the parties involved with the company. Past research

* Corresponding author. Fax: +55-21-2562-7044.
E-mail addresses: heloisam@pep.ufrj.br (H.M.P. Capobianco), elton@pep.ufrj.br (E. Fernandes).
[1] Fax: +55-21-2549-6861.

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concerning the subject has sought to identify the relevant factors for composing business funding by building hypotheses on the possible reasons behind them. Such research has led to the belief that fixed assets, non-debt tax shields, investment opportunities, firm size, volatility, advertising expenditures, probability of bankruptcy, profitability and uniqueness of the product are factors which influence the choosing of the optimal capital structure (Harris and Raviv, 1991). These factors have been tested by more than one theory (Booth et al., 2001), and there are several models. The most used are the Static Trade Off Model, Pecking Order Hypothesis and the Agency Costs model. In these cases, the tests are performed to search for an explicative relation, or a cause-effect relation of the variables. This paper does not seek to demonstrate the existence of the cause-effect relationship of the variables. By accepting that the relationship exists, this paper seeks to establish the optimal leverage range for airline companies taking into account their size and return with the lowest levels of fixed assets. Although other factors could be taken into consideration, this paper shall limit itself to this set of variables. In this paper, we intend to answer the following questions: which airline companies use third-party capital efficiently, how inefficient are the other companies and how are the companies and countries ranked with respect to indebtedness and return from operations.

Each industry has its own characteristics which may alter the standard format of the optimal capital structure. In the airline industry it is difficult to compare companies from the same country. This is because the number of regular air transport companies which are traded on stock markets per country is generally small. The civil aviation industry is capital and technology intensive, the global market is regulated (mainly by reciprocal agreements) and it is deemed a strategic industry for nations. Air transportation mostly entails the transportation of high added-value people and cargo, is unrivalled, and has the advantages of being safe and timesaving. The demand for air transportation is linked to economic growth, technological development, the need for people to meet and the lowering of trade barriers between countries. Because of this, airline companies must seek capital in order to meet the constant need for investment. This pressure for keeping technology updated has led several companies to high financial risk.

The study is structured as follows: Section 2 briefly details the methodology to be employed for analyzing the efficiency of the companies. Section 3 details the characteristics of the sample and the database and also discusses the selection of the variables from the capital structure theory. Section 4 presents the case study and Section 5 sets forth the conclusions.

2. Methodology

Data envelopment analysis is a non-parametric method used for measuring the performance of a firm, organization or program i.e. whatever is produced by decision-making units (DMU). It includes a mathematical technique based on linear programming which does not need the functional form relating inputs to outputs to be specified. DEA optimizes each observation with a view to constructing an efficiency frontier (Fig. 1). This consists of a discrete curve made up only of efficient DMU's. Obviously, we are dealing with relative efficiency as we are using samples. After determining the frontier we move on to the sample's benchmark for efficiency.

Charnes et al. (1994) posited that DEA involves an alternative principle for extracting information about a group of observations. In contrast to the parametric approaches whose objective

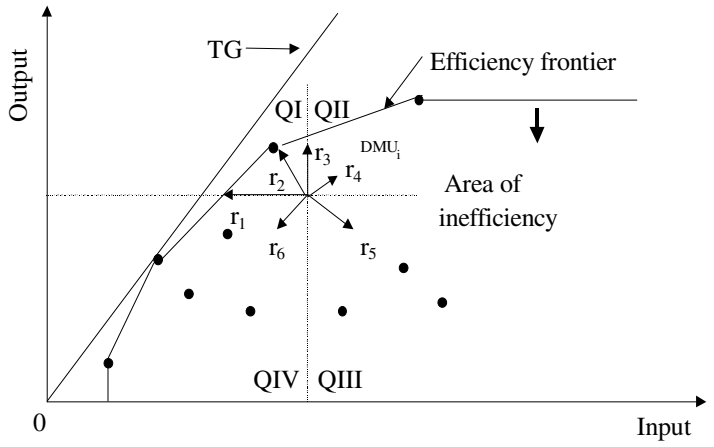

Fig. 1. Data envelopment analysis and routes to improving performance.

is to optimize a regression plan by data analysis, DEA optimizes every observation in order to calculate a frontier determined by Pareto-efficient DMU's. In this way DEA makes possible an efficiency analysis of each DMU and of possible ways of developing in the direction of the efficiency frontier (Fig. 1).

Taking as an example DMU_i in Fig. 1 it can be seen that an inefficient DMU can follow different development routes exemplified as r_1–r_6. DEA mathematical models work, basically, with alternatives r_1–r_3 which relate respectively to approaches oriented towards input, the shortest route to the frontier and output.

In this study the main question is with respect to the minimization of input that organizations are capable of (r_1). In this way an approach has been chosen which is input oriented in a model with a variable revenue scale as the work deals with organizations of different sizes. The convex shape of the efficiency frontier can be seen in the case we are analyzing. DMU's above the efficiency frontier with lower scale at the meeting of straight line TG with this frontier present returns growing in scale while those above represent returns diminishing in scale, as Banker et al. (1984) explain.

3. Data description

3.1. Data

In order to measure performance and capital structure with a set of data as unbiased as possible, we have used the corporate financial statement data compiled by Milne (1997, 1999). The study entails the analysis of companies using their balance sheets and profit and loss accounts. This data set makes a comparison possible between companies because it reflects adjustments made for this purpose. Restating the financial reports of international airlines for purposes of comparability is important but not easy. The companies do not always closely follow the regulations for the publication of such reports. The information made available is determined by

different countries' internal rules, so that it is difficult to construct an international sample. To the extent that they disclose the original accounting entries, it is possible to reconstruct the financial statements, using a single set of accounting principles. In general, this requires both the adoption of International Accounting Standards as prescribed by the International Accounting Standard Committee, and the standards that the International Air Transport Association (IATA) Accounting Policy Task Force have issued on specific topics affecting the airline industry.

However, despite this work having been carried out, there are still problems to be faced. A number of airlines' financial statements would need considerable additional disclosure. One point to be surveyed is the question of asset valuation (at historical cost or current value). Booth et al. (2001), Rajan and Zingales (1995), Nobes and Parker (1991) have drawn attention to the differences from one country to another. The analysis undertaken reveals that German accounting places greater emphasis on conservatism, adopting the historical approach. The asset values of German companies may therefore be understated relative to asset values in many other countries. Our findings based on book values must therefore be interpreted with appropriate caution. Another point to be addressed concerns the consolidation of the companies' financial statements, which has been performed in most, but not all, cases.

The only way of being able to work with this industry is to use an international database. The countries have few companies and performing tests by country could possibly result in greater error than that produced from the grouping presented here. The sample includes large regular transportation companies. Another option would be to address each country individually including smaller companies. However, book keeping complexities involving the companies along with market pressure concerning full disclosure gives us greater confidence in this selection of companies than in any other.

Another problem arises from the existence of both public and private companies. As far as civil aviation is concerned, as it is a strategic industry in the countries, the impact resulting from this existence of both private and public companies is smaller as the markets are not fully regulated, with government intervention occurring even in the case of private companies. Nevertheless, the authors of this study do not believe that these flaws could significantly effect its aims.

The initial database of the analysis is a pooling cross-section, time-series containing 260 observations. Table 1 denotes the characteristics of this data.

It can be seen from Table 1 that there are a significant number of companies making net losses. The accumulated continuing losses suffered by several of the companies have transformed their equities into negative ones. The bottom row in Table 1 denotes the number of companies per year considered in the DEA efficiency test. It can be observed that less observations underwent DEA analysis, which is justified in the case study.

Table 1
Database characteristics by year

	1993	1994	1995	1996	1997	Total
Number of companies	54	56	57	50	43	260
Companies making net losses	26	15	11	14	7	73
Companies with negative equity	6	7	7	3	3	26
Number of companies—DEA	26	37	41	35	34	173

3.2. Variables

The variables were chosen by analyzing the three aforementioned models which support the study into capital structure: the Static Trade Off Model, Pecking Order Hypothesis and the Agency Costs model.

The Static Trade Off Model assumes that the company's earnings and assets are fixed, and the company chooses its capital structure by means of the financial benefit and costs produced by financial distress or the probability of bankruptcy as a result of the debt.

The Pecking Order Hypothesis uses the informational asymmetry existing between the parties involved in the funding. This difference of information, which negatively influences the company, will be avoided or reduced by opting for a means of funding. First of all, the companies would opt for internal funding, using retained profits, followed by risk-free debt and finally a share issue (Myers and Majluf, 1984).

Agency Costs arise from the existence of conflicts of interest, whereby shareholders could be led to adopt self-serving strategies which incur agency costs for the companies. Jensen and Meckling (1976) suggested that there are two types of conflicts: one between the manager and the shareholder and a second between the debtholder and the shareholder. The first conflict on interests would lead to disagreement because the manager would be concerned with the project costs and not necessarily with the profits. In this situation, high degree of indebtedness is beneficial, as it lowers the cash flow because of the payments made on the debt, thereby inhibiting superfluous expenditure which does not raise the value of the company. However, the conflict of interests between debtholders and shareholders could result in an increase to the debt cost in order to discourage the shareholder from investing in high-risk projects causing losses to the debtholder. The optimal capital structure would be found by balancing the benefits and the costs of the debt. Stulz (1990) agrees that this would be the best way of ascertaining the optimal capital structure. Harris and Raviv (1990) have different views concerning the conflict of interests and the resulting appearance of agency costs. These authors believe the manager is always concerned with keeping the company afloat, whereas the shareholder considers bankruptcy possible in the event of a low cash flow. Indebtedness provides shareholders with easy information, and they did not need to run up costs searching for information to analyze a better alternative use of their funds. The decision concerning the optimal capital structure is a trade-off between the costs of acquiring information and a well-constructed liquidation decision. A high level of leverage would be associated with a high company value, which would be the best strategy in the event of liquidation. The authors propose that companies with high levels of tangible assets will be highly leveraged, and companies with lower research costs will have greater debt, as in both cases they would have greater market value in the event of liquidation.

The variables chosen in this study (financial leverage, size, asset and return) have been tested and discussed according to the several approaches, however, for the objectives of this paper it is important that a relation between leverage and the other variables is defined, establishing whether is positive or negative.

Financial leverage (FL) is the ratio of total assets to equity. This is a broad measurement which makes the error of including accounts which are used in company transactions, like those concerning suppliers, accounts payable, pension liabilities, etc., which do not represent debt.

However, to offset this, the calculation encompasses short-term debt, which according to Booth et al. (2001) is greater in developing countries than in developed countries. Another difference is the calculation of the ratio using the book value and not the market value. Tests involving market values would of course be interesting, but our limitation concerning the disclosure made by the companies meant that we have had to use this measurement. The diversity of the countries composing the sample may also make it impossible to perform accurate measurements, however, Rajan and Zingales (1995) did not find significant differences in indebtedness among the bank oriented countries of the G-7 (Japan, Germany, Italy and France) and the market-oriented countries of the G-7 (United States, United Kingdom and Canada). Upon comparing the level of indebtedness of 10 developing countries and those belonging to the G-7, Booth et al. (2001) discovered that virtually all the developing countries of the sample had smaller debts than the average of the developed countries, regardless of whether the measurement was made by book value or market value.

Firm size (Size) is computed as the natural logarithm of net sales. The research which involves the study of this variable has yielded conflicting results with respect to leverage. Ferri and Jones (1979) unearthed a positive relation, as did Rajan and Zingales (1995), for all the G-7 countries except Germany. This result can be explained by the fact that large companies have greater access to wider sources of capital, are more diversified and have a lower chance of going bankrupt. The low expected costs of bankruptcy enable greater leverage. Meanwhile, Chung (1993), Titman and Wessels (1988) discovered a negative relation. Size can be seen as the inverse proxy for the probability of bankruptcy which justifies a lower leverage—this inverse relation shall be used in the study.

Profitability is the ratio of net profit to total assets (ROA). Titman and Wessels (1988), Thies and Klock (1992) discovered a negative relation between the return on equity and financial leverage. Rajan and Zingales (1995) state profitability is negatively related with leverage in all countries of the G-7 except in Germany and is economically insignificant in France. Toy et al. (1974) detected a positive relation. Gritta (1979) looked into the relation between return on equity and financial leverage in the civil aviation industry and obtained a positive result. There is some difference in the results of the studies. In our model we will adopt the hypothesis that profitable companies prefer not to get into debt using internal funding, as stated by Myers and Majluf (1984). Further adding to this argument, Jensen (1986) stated that managers prefer not to get into debt, thereby avoiding the restrictions imposed by the debt.

Tangibility of assets is the ratio of fixed to total assets. Chung (1993) and Thies and Klock (1992) uncovered a positive relation with financial leverage. Rajan and Zingales (1995) obtained the same result in their research on all the countries in the G-7, considering the variables by book value or market value. The tests performed by Titman and Wessels (1988) did not yield statistical significance, whilst Ferri and Jones (1979) found a negative relation. In principle, the existence of tangible assets gives the debtholder security, as the assets act as guarantees on debt contracts. As we wished to find the lowest level of leverage for the companies, we considered the inverse of this ratio—total assets to fixed assets (Asset). We shall therefore be looking for companies with the lowest levels of fixed assets. As far as aviation is concerned, with respect to other industries, for example the retail industry, it is expected that the companies have large fixed assets, mostly represented by planes. Yet it is possible to lease rather than purchase airplanes in the aviation industry, which would have an impact on operating costs and not on assets. Despite the apparent

paradox, our tests concern efficiency and do not include a dependence relation between variables. Considering that we are looking for companies with low levels of indebtedness, which are large, profitable, and have low fixed assets, we will therefore find large companies which efficiently use their fleet of planes to generate return with low debt levels.

This fact is encouraging in as far as our research is concerned, in view of the strategic importance of airline companies in the context of economies constantly marked by globalization.

4. Case study

4.1. The efficiency of the companies

As this study addresses efficiency, it has been decided that observations containing negative ROA or negative equity should not be included in the tests. Companies with a negative return at a given period of time are not necessarily undergoing financial distress, as it is possible that they are investing and consuming large amounts of funds. However, we are looking for the best reflection of these companies, which is why we have excluded those with a negative financial performance. Should there exist negative equity this could compromise the company, as these liabilities takes a while to develop and it is likely that the company is experiencing tough times. Following these exclusions, the original sample shrank from 260 to 173 observations. Three observations were then eliminated leaving a total of 170. These observations were taken from 53 publicly held companies from 32 countries from the years 1993 to 1997. This final exclusion from the database was due to the outliers, i.e. the variable value was greater than three standard deviations above the average. [2]

DEA was the method used for measuring the efficiency of companies. It optimizes each observation with a view to constructing an efficiency frontier. Appendix A shows the proposed model that involves a linear programming problem.

Charnes et al. (1996) suggested that the discriminating power of the model is increased if the number of decision-making units (DMU's) is greater than three times $(m + s)$, where $m =$ number of inputs and $s =$ number of outputs. Financial leverage was treated as an input (one input) and return on assets, firm size and tangibility of assets were treated as outputs (three outputs). In the model adopted variable returns-to-scale are assumed. It is noted that the increase in financial leverage (third party funds entering the business) is not followed by proportional increases in the different outputs. An immoderate increase in third party capital does not pay.

Table 2 denotes the variables of the companies in the efficiency frontier and the reference percentages of each one.

Looking at this group of companies (Table 2) one can state that Singapore 95, Malev 95, Singapore 93, Federal Express 97 and TAM 96 are efficient in relation to the financial leverage they use for obtaining reported financial results. Their level of third party capital is the lowest

[2] As Booth et al. (2001) did.

Table 2
Efficient DMU's

Firms	AF	Size	Asset	ROA	References	% References	
Singapore 95	1.3	8.53	1.57	0.078	132	38	
Malev 95	1.9	5.92	5.73	0.008	94	27	
Singapore 93	1.3	8.27	1.32	0.073	44	13	
FedEx 97	2.4	9.67	1.63	0.052	41	12	
TAM 96	2.5	6.24	4.67	0.182	13	4	93%
Continental 93	7.1	8.66	2.99	0.510	9	3	
AMR 97	3.4	9.83	1.58	0.047	7	2	
ValuJet 95	2.1	5.94	1.76	0.196	6	2	
Lufthansa 97	3.6	9.50	1.97	0.039	2	1	
Continental 96	9.0	8.76	3.26	0.061	1	0	

possible in the context of the group of companies in question. These companies comprise the efficient frontier.

The other companies in the sample are considered inefficient in a varying degrees. A path to improvement is indicated in each case. These indications are based on the performance observed in efficient companies.

Continental 93, AMR 97, ValuJet 95, Lufthansa 97 and Continental 96 have few recommendations. The companies at the frontier, which were cited in many cases, are the ones we are looking for. The others were placed at the frontier by some special variable different from greater part of the sample. They should be viewed with caution, as their value is limited as an example and for purposes of comparison.

Ninety-three percent of the references indicated in Table 2 are from companies with a level of leverage smaller than or equal to 2.5. This signifies that 40–77% of the total funding is composed by shareholder capital. This result coincides with the result obtained by Fernandes and Capobianco (2001). This study (Fernandes and Capobianco) endeavored to identify an optimal financial leverage level using data from the civil aviation industry, but both the sample and variables were different to the present study.

The companies Singapore 95, Malev 95, Singapore 93, Federal Express 97 and TAM 96 which yielded this range of indebtedness are the benchmark of the sample for these years. However, we need to deepen our analysis in order to avoid the risk of being too rigorous in identifying companies with favorable conditions of competitiveness. Each company, of course, has its own core competence, which must be exploited in the quest for improvement, and there possibly exists a group of companies which need to substantially overhaul their operations.

It is prudent to rank the companies in terms of return on assets and indebtedness in order to obtain a strategic view of the business. These two variables reveal in-depth information on the company. Indebtedness is an expression of financial risk. Return from assets can be seen as a result of the company's actions in carrying out their business activities. It is essential that companies have a competitive structure in the long run which yields return. The short run is the exception to the rule. Large investment may be required and vast amounts of resources may have to be used in the short run, therefore leading to low returns, which must be made up for shortly afterwards.

4.2. Return from assets and indebtedness of the companies

For the purposes of the present analysis, we have calculated the mean average and standard deviation of the variables denoted in Table 3.

The profile of the companies can be ascertained from Table 3. Average net worth represents 17% of the total assets. The variation of this average is high. The average size is a net turnover of approximately US$4 billion (figures good for 1997) and the standard deviation is slightly higher than this figure. The companies have average fixed assets to the order of 54% of the total assets and an average return on assets of 4%.

Fig. 2 presents the structure of the ranking analysis of the companies by indebtedness and return on assets. This figure was inspired by the Product Portfolio Strategic Analysis of the Boston Consulting Group, known as BCG (Johnson and Scholes, 1999, p. 187).

Quadrant I (QI) contains the companies with lower indebtedness and greater return on assets, the case analysis reveal that 60% of the efficient companies were in this quadrant. Quadrants II and III (QII and QIII) represent companies with opposing situations with respect to indebtedness and return on assets, in our case analysis 20% of the companies indicated for the frontier are in QII and 20% are in QIII. Quadrant IV (QIV) contains the companies with higher indebtedness and lower return.

Table 3
Mean and standard deviation of the variables (170 observations)

Estatistic	AF	Size	Asset	ROA
Mean	6.0	7.70	1.85	0.043
Standard deviation	10.4	1.11	0.71	0.050

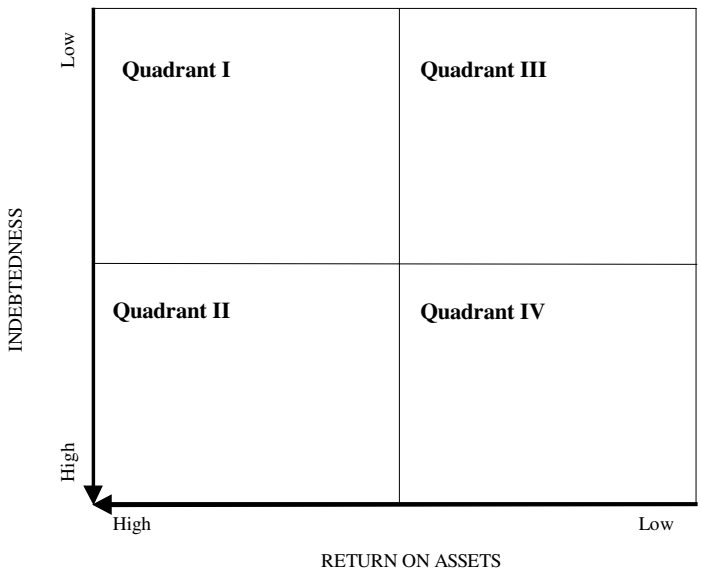

Fig. 2. Indebtedness and return on assets.

Table 4
Levels of efficiency and quadrants

Quartile	Efficiency (%)	Quadrant I		Quadrant II		Quadrant III		Quadrant IV		Total companies
		Number of companies	%	Number of companies	%	Number of companies	%	Number of companies	%	
1	31	0	0	7	64	16	19	20	95	43
2	43	6	11	0	0	35	42	1	5	42
3	58	20	37	2	18	21	25	0	0	43
4	100	28	52	2	18	12	14	0	0	42
Total		54	100	11	100	84	100	21	100	170

The efficiency ranking of the companies obtained via the DEA has been split into quartiles, as can be seen in Table 4.

Table 4 shows that 52% of the companies in QI appear in the quartile with the highest efficiency, whilst 95% of the companies in QIV appear in the quartile with the lowest efficiency. Analyzing from a different view it can be seen that around 67% of the company observations in quartile 4 are in the first quadrant, which could be declared as the 'star quadrant'—the quadrant to which all companies should seek to move.

There was no clear relation for the companies in QII and QIII. Companies with high return and high indebtedness can be found in QII. The efficiency test looks for companies with lower indebtedness for the output data and therefore companies with high indebtedness which do not have high compensatory outputs have a low level of efficiency. This is why 64% of the companies in QII are in the quartile with the lowest efficiency. QIII has the greatest number of companies from the sample, and 42% of these companies are in the second most efficient quartile.

Analyzing the positioning and/or movement of the companies in the four quadrants is worthwhile. We have therefore given an individual description of the indicated companies for the frontier. Singapore Airlines has the greatest degree of shareholder capital in total funding in the sample. The company maintains both its indebtedness and return on assets stable and its net earnings have grown over the five years under analysis. TAM made changes to its capital structure, lowering the percentage of third party capital. It was initially in QII but has moved to QI. The evidence suggests that the change to its financial structure along with the growth in net earnings has been made possible by the returns obtained. TAM increased its net earnings by 135% from 1993 to 1997. Federal Express enjoyed high levels of efficiency during the course of the study, reduced its level of indebtedness and fixed assets, whilst increasing earnings and returns. Malev is a small company which raised return, earnings and leverage whilst lowering asset levels, both tangible and total. American Airlines (AMR), the largest company in the sample group, is in QIII due to its low return. The data reveals a change to it financial profile. The company witnessed a modest 6% growth in earnings, but lowered its indebtedness whilst raising return thereby moving into QI. Lufthansa has a high level of efficiency, one of the highest in the sample group which may explain why it was taken to the frontier. Its return on assets, however, is below the average of the sample group. It is likely that the combination of these two factors prevented the company from being given benchmark status. Continental is a large company which obtains high levels of returns

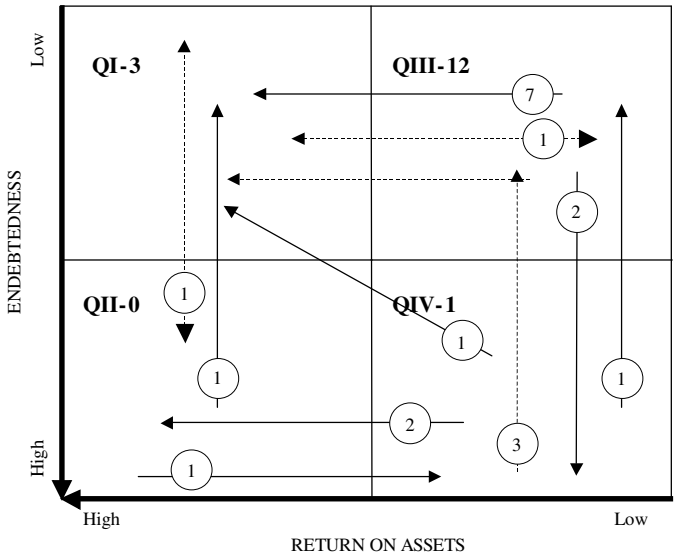

Fig. 3. Positioning of the companies by indebtedness and return on assets. Companies remaining unchanged: QI: Singapore, Southwest and Valujet; QIII: Aer Lingus, Air Índia, Austrian, China, Emirates, LOT, Malaysia, Martinair, Monarch, Pakistan, Qantas and Swissair; QIV: Ansett. Companies moving position: from QII to QI: Tam; from QIII to QI: Airborne, AMR, American West, Federal Express, Finnair, KLM and SAS; from QIV to QI: Alitalia; from QIV to QII: United and US Airways; from QIV to QIII: British Midland; from QII to QIV: Varig; from QIII to QIV: Amtran and Thai; from QI to QII to QI: Air 2000; from QIII to QI to QIII: Braathens Safe; from QIV to QIII to QI: Air Canadá, Alaska and Delta.

from its assets, but has a high level of leverage. Valujet is a small company, but its return, leverage, assets and earnings have all risen.

We analyzed the companies as a whole and observed the movement of the companies through the quadrants, and made a comparison with the efficiency percentages obtained through the DEA. The resulting outcomes are presented in Fig. 3.

The sample group is made up of 53 companies, of which eight [3] were observed for just one year, limiting our study into the movement by companies through the quadrants. This analysis is biased due to the fact that same period of time is not used for all the companies. The analysis is not meant to be final. On the contrary, a constant updating of data using the methodology presented is a useful management tool. Of the 45 companies for which it was possible to analyze movement through the quadrants, 20 (44%) changed quadrant in line with the levels of efficiency obtained from the DEA, i.e. increase (or decrease) in return and/or fall (rise) in financial risk with rise (fall) in efficiency. This justifies the regular analysis of the companies over the years. Harris and Raviv (1991) stated that companies tend to maintain their level of leverage. It can be ascertained from the statistical analysis that the observations of the above authors are not applicable to all cases. Sixteen companies did not change quadrant and registered a small change in their level of efficiency. A lack of relation between change and efficiency level could be observed in the nine

[3] Air UK, All Nippon, Garuda, Gulf Air, Iberia, Northwest, Olympic and TAP.

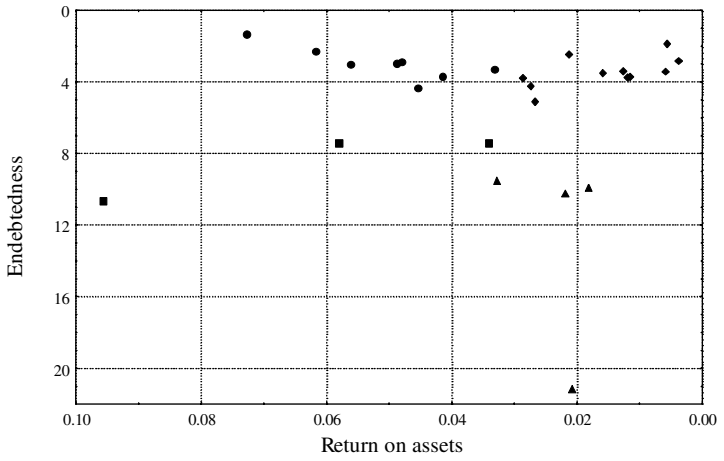

Fig. 4. Return on assets and indebtedness of the countries.

remaining companies [4] (20%), which could be due to the fact that the efficiency analysis takes into consideration other variables, making it more complex, and in other cases, the companies are very close to the limits of the quadrant.

The study evidences reveal that companies with good financial performance are able to maintain this indicator (efficiency) or are able to find ways of achieving the changes required to achieve better position. On the whole, the companies move towards better financial performance and lower leverage.

4.3. Return on assets and indebtedness of the countries

In order to analyze indebtedness and return on assets by country, we grouped the companies together and took the average of each variable. The average for the financial leverage of the countries was 5.3 and for return on assets the average was 0.033. Our sample of 32 groups was reduced to 26, as six of the countries [5] had just one observation. Fig. 4 shows the distribution of the companies in the quadrants.

Based upon the analysis of indebtedness, there is no clear difference between the position of developed countries and developing countries with respect to airline companies. Our analysis partly supports the findings of Rajan and Zingales (1995) and Booth et al. (2001). A number of developed countries possess airline companies with leverage levels greater than the sample average and some companies with leverage below the average. For example, there are companies in the USA with very high levels of leverage, like Northwest, Continental, US Airways and United Airlines, placing the country in QII. Canada also appears in this quadrant, whilst Italy appears in QIV. These two quadrants represent the highest levels of indebtedness, and have three different levels of ROA. Italy is in an unfavorable situation as it has a high risk and little return. Germany

[4] Air New Zealand, Britannia, British Airways, Cathay Pacific, Continental, Korean, Lufthansa, Malev and Vasp.
[5] Bahain, Greece, Indonésia, Japan, Portugal and Spain.

and the UK appear in QI. The companies of these countries have below-average indebtedness and above-average ROA. Japan and France were not included in this sample.

5. Conclusions

This study analyzed capital structure adopted by civil aviation companies. The analysis of companies' efficiency revealed that there is an optimal range for financial leverage, based upon size, return on assets and the level of fixed assets. Shareholder capital in benchmark companies represented at least 40% of the total capital.

Analyzing indebtedness and return on assets greatly simplifies the study of efficiency. For companies on the outer limits of the study, a direct relation with the level of efficiency was found for those with low (high) indebtedness and high (low) return. There was no clear relation for companies with high (low) return and high (low) indebtedness.

A significant percentage of the companies tended to change their financial profile with the goal of lowering their debt levels and raising return over the years.

Grouping the aviation companies by country and considering the indebtedness and return on assets does not reveal any significant comparative advantage between developed and developing countries. It can be observed companies with high and low levels of leverage and high and low returns on assets in both developed and developing countries.

Appendix A. The model

Input-oriented BCC primal (BCC_p-I)

$$\begin{aligned} \min_{\theta,\lambda,s^+,s^-} \quad & z_0 = \theta - \varepsilon.\vec{1}s^+ - \varepsilon.\vec{1}s^-, \\ \text{s.t.} \quad & Y\lambda - s^+ = Y_0, \\ & \theta X_0 - X\lambda - s^- = 0, \\ & \vec{1}\lambda \geqslant 1, \\ & \lambda, s^+, s^- \geqslant 0, \end{aligned}$$

where X is the input vector used in the DMUs, Y is the output vector produced by the DMUs, ε is a constant non-Archimedian (infinitesimal of the order 10^{-6}) that ensures no input or output is given a zero weight, s^+ and s^- are the slack vectors for the outputs and inputs, respectively. θ represents the level of efficiency of the decision-making unit. The optimal value of λ forms a composite unit outperforming the DMU under analysis and providing targets for this DMU to identify sources of its inefficiency.

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