ISSN: 2279-7807

Quaderni di Dipartimento

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165 (02-12)

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Febbraio 2012

Coalitions in the airline industry: an empirical approach*

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February 2012

Abstract

This paper conducts an empirical analysis of the determinants of airline alliances. Well established airlines with large passengers' volumes are more likely to participate in an alliance and are also essential for alliance survivability. In line with this finding, older airlines have a higher probability of being part of an alliance. Airlines operating with high load factors consider alliance participation as a significant alternative to fleet capacity expansion. As their market share grows, alliances become more appealing to airlines. Competitors' decision to enter an alliance tends to have a positive impact on alliance participation. The relatively similar magnitude and effect of the regressors' coefficients across different alliance choices, suggests that the airline's major decision is not to choose a specific alliance, but rather considering whether to enter into an alliance, as a possible strategy within its business model.

JEL Classification: C23, L10, L93.
Keywords: Discrete choice model, Oneworld, Sky Team, Star Alliance.

*We wish to thank Volodymyr Bilotkach, Michael Blunt, João Santos Silva, Edna Solomon and 2010 GARS workshop participants in Amsterdam. Gaggero kindly acknowledges financial support provided by Hans-Martin Niemeier and Jürgen Müller. The responsibility for the arguments and results expressed in this paper is entirely ours.

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1 Introduction

Airline alliances began in the 1990s, but have experienced most of their expansion in the last five to eight years. The three current global alliances, Oneworld, Sky Team and Star Alliance, account for more than two-thirds of the entire industry capacity. Of the world's top 20 airlines, only two carriers, Southwest Airlines and Ryanair, are not affiliated to any alliance. The phenomenon of airline alliances is however industry pervasive, since Oneworld, Sky Team and Star Alliance also include several minor airlines among their members. Moreover, additional minor carriers will join one of these alliances in the near future.[1]

As they continue to expand, alliances eventually tend to include members which are actual or potential competitors. There are several aspects of competition involved, as airline alliances affect factors such as: fares, airport facilities, frequent flyer programs, flight schedule, flight frequency, etc. Their potential to have negative implications for both the industry and consumers alike have always concerned competition authorities over the globe.[2]

From the perspective of the airline, participating in an alliance might be beneficial for several reasons. Firstly, alliances allow to extend the network and reduce costs, by exploiting economies of scale and density. Secondly, and more importantly, an alliance might be a useful way to test for compatibility among members, which could lead to tighter forms of cooperation such as joint ventures, code-sharing,[3] franchising, or even a merger. Indeed, alliances often correspond to the engagement ring before the merger of two alliance members, as shown by the following recent mergers: Air France-KLM in 2004, Delta-Northwest in 2008, not to mention the possibility of a future merger between British Airways and Iberia.

Several economists[4] have discussed the costs and benefits of airline alliances and hence the incentive to form an alliance in theory. However, to the best of our knowledge, there does not exist any empirical investigation

[1] For instance, Kingfisher Airlines and S7 Airlines will join Oneworld; TAROM and Vietnam Airlines will join Sky Team; Air India, Olympic Air and TAM Airlines will join Star Alliance.

[2] The most relevant antitrust authorities are the Department of Transportation in the United States and the European Commission, which collectively represents the countries of the European Union.

[3] Bamberger et al (2004) offer a clear explanation of the way airline alliances split the seats and revenues of a code-shared service.

[4] See Button et al (1998), Oum et al (2000), Pels (2001) for instance.

of the determinants of airline alliances. The aim and contribution of this paper are precisely to fill this gap. We apply a discrete choice model on a sample of the world's major airlines observed over the past twenty years. We control for airline and alliance specific characteristics, as well as for macroeconomic conditions. We find that well established airlines are more likely to participate in an alliance rather than recently established airlines. As their market shares continue to increase, alliances become more appealing to airlines. Competitors' choice to enter an alliance tends to positively affect the observed airline's decision to participate in an alliance in the future. Furthermore, the key decision made by the airline is not about finding the most suitable alliance to meet the airline's needs, since with their widespread route network, all alliances may look equivalent in the eyes of the airline. Rather, the key decision involves a choice of whether to adopt the alliance model as a sustainable business strategy. In other words, the decision made by the airlines is whether or not to enter an alliance, but not which particular alliance to enter.

The rest of the paper is structured as follows. A description of airline alliances and their antitrust implications is offered in the next section. Section 3 presents some theoretical considerations on airline alliances followed by the specification of the econometric model in section 4. Section 5 discusses the results, which are checked for robustness in Section 6. Finally, concluding remarks are made in Section 7.

2 Airline alliances

An alliance is a form of cooperation between two or more airlines with the intention of enhancing the competitiveness and performance of its members. Besides operating some flight services in partnership, the cooperation may consist in sharing operational facilities such as sales offices, computer systems, catering; operational staff such as ground handling personnel at check-in and boarding desks; airport facilities such as aircraft parking, airport lounges.

The world's major airline alliances considered in our empirical analysis are: KLM-Northwest (Wings), Qualiflyer, Oneworld, Sky Team and Star Alliance. The first established form of cooperation among airlines began in 1989 with the partnership between Northwest and KLM, which about a decade later started to cooperate with Continental and Alitalia through

code-sharing and frequent flyer program coordination. Although no formal association was ever announced, these airlines were to form an alliance called Wings. This proposed alliance, however, became superfluous in 2004 when all of its participants joined Sky Team.

Qualiflyer was created in 1992 by Austrian Airlines and Swissair, it rapidly expanded as new airlines joined (LOT, Sabena, TAP Portugal, Tuskish Airlines), but it was dissolved after Swissair's bankruptcy in 2002.

The remaining three alliances, Oneworld, Sky Team and Star Alliance, are still active and therefore will probably represent the main set of alliance alternatives for non-member airlines in the future. Star Alliance is the alliance with the largest number of members, whilst Oneworld and Sky Team have similar dimensions in terms of members. Star Alliance was founded by Air Canada, Lufthansa, SAS, Thai Airways and United Airlines in 1997; Oneworld was founded by American Airlines, British Airways, Canadian Airlines, Cathay Pacific and Qantas in 1999; and Sky Team was founded by Aeroméxico, Air France, Delta Air Lines, and Korean Air in 2000.

Table 1 lists the members of each alliance, together with the year of entry and (if any) the year of exit from the alliance.

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TABLE 1 HERE

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Two important features of airline alliances can be deduced from the table. First, apart from the obvious cases related to Qualiflyer's extinction and to KLM-Northwest members joining Sky Team, airlines generally remain in an alliance, once they are affiliated to it. There have been very few cases of airlines switching alliances. We observe only three examples of airlines switching alliances in our data set: Continental, which moved from Sky Team to Star Alliance in 2009; Canadian Airlines, which, after being incorporated into Air Canada, left Oneworld to join Air Canada's alliance in 2000, Star Alliance; and Mexicana, which quitted Star Alliance in 2004 to pursue more effective code-sharing relationships with other airlines and then joined Oneworld few years later. Excluding Qualiflyer and KLM-Northwest from the analysis, the remaining cases of alliance exit (Ansett Australia and Varig, both leaving Star Alliance) are associated with the airline's bankruptcy and thus do not represent examples of alliance switches.

The second important feature deduced from table 1 is that three out of four cases of Mergers and Acquisitions (M&A) - not to count the possible future merger between British Airways and Iberia - occur between airlines

affiliated to the same alliance[5] and thus show that airline alliances often represent the most common prelude to M&A.

Under the competition policy perspective, M&A represents one of the main source of concern, because of their potential negative impact on consumers' surplus. Also the mere alliance between airlines, could have a negative impact on consumers' welfare, though. For instance, the alliance between two carriers operating overlapping routes, can simply results in cooperatively setting higher fares.

For this reasons, the possibility to closely coordinate fares among alliance members is subject to antitrust immunity, which is granted by the competition authorities of the countries where they operate, after an assessment of the welfare impact of such cooperation. To illustrate the implications of antitrust immunity, let us consider the route New York - London served by American Airlines and British Airways. These two Oneworld members obtained antitrust immunity by the US Department of Transportation and by the European Commission in July 2010. Before antitrust immunity American Airlines (British Airways) operated the flight service New York - London only hoping to have enough feed from its New York (London) hub and from British Airways' (American Airlines') code-shared passengers; and that was all. Under antitrust immunity, instead, American Airlines and British Airways can work directly to coordinate schedules and set fares. In other words, they can now jointly look at how much traffic they are taking over all their hubs and decide for their best.[6]

Antitrust immunity is often obtained after a long bargaining process between airlines on one side and the antitrust body on the other side. The negotiations often conclude with member airlines relinquishing some take-off and landing slots on selected routes to allow new flight services by "true" competitors (i.e., non-members of the alliance under analysis), necessary to guarantee some extent of genuine competition. For instance, the antitrust

[5] The only case of inter-alliance M&A is the acquisition of Canadian Airlines by Air Canada, the other three cases (Air France-KLM, Delta-Northwest, Continental-United) all concern intra-alliance members.

[6] The schedule coordination policy, for instance, is evident if we consider the current winter schedule Los Angeles to Europe of the Star Alliance members Lufthansa, Swiss International and United Airlines, which have been granted antitrust immunity for several years. Lufthansa flies to Frankfurt at 3 pm and to Munich at 9 pm; Swiss International flies to Zurich at 7.20 pm; United flies to London at 5 pm. It is clear that these airlines coordinate their flights to Europe throughout the whole afternoon, so that passengers connecting beyond their hubs can choose among different departure time options.

immunity obtained by American Airlines and British Airways in July 2010 has been granted by the European Commission only after the surrender of some slots at London Heathrow and London Gatwick airports for flights to Boston, Dallas, Miami, New York and after the promise of making available slots at New York JFK airport for services to London in the future if deemed necessary.

3 Why alliances? Some theoretical considerations

Most of the theoretical contributions regarding airline alliances focus on their impact on consumers' welfare and the importance of antitrust immunity, taking the alliance structure as given (see Park (1997) and Brueckner, 2003). For instance, Brueckner (2001) considers a model with two carriers that serve remote locations and two hubs. Without any alliance, the two carriers are competitors in the segment between the two hubs, while they are monopolists in the remote areas. In this case the author shows that alliance formation reduces competition between the two hubs, so that the price is higher, but for long distance flights (i.e., from remote to remote areas) the total price is lower. Since the alliance structure is taken as given, the incentives to form such alliance are not investigated.

In general, the benefits to form an alliance are: a lager network realized by the joint route map of every member and cost reductions by sharing operational facilities (e.g., sales offices, computer systems and catering), operational staff (e.g., ground handling personnel at check-in and boarding desks), airport facilities (e.g., aircraft parking, airport lounges). Caves et al. (1984) introduce the distinction between returns to density and returns to scale: the former are the reduction of unit costs due to the increase of the magnitude of passengers (or merchandize) for a given network size, while the latter are the proportional increase in both network size and services offered. They find statistical evidence only in favor of returns to density, while returns to scale seems to remain constant. In line with those findings, Brueckner and Whalen (2000) propose a model in which the advantage of alliances comes from the internalization of the negative externality that arises when setting fares non-cooperatively; this internalization allows the alliance to set lower fares, thus attracting more costumers, and the economies of density allow for

a reduction of the unit costs. Therefore, forming an alliance allows to better exploit the economies of density.

It is not clear, however, why some airline do not enter any alliance. There might be some costs associated with the formation of alliances. Flores-Fillon and Moner-Colonques (2007) consider an environment similar to Brueckner and Whalen (2000), where the formation of an alliance allows to internalize the price fixing externality on long distance flights, which, in turn, allows to attract more passengers and, consequently, exploit the return of density.[7] They show the existence of asymmetric equilibria, in which only some companies decide to form an alliance, while others prefer to remain independent. The intuition behind this result lies on the fact that with more alliances the competition to attract passengers, in order to exploit the return of density, is tougher, leading to lower profits. Therefore, the reaction of some carriers to the formation of an alliance might be to remain independent. For this result to emerge we need a certain degree of market power by the independent firms, so that if the formation of an alliance does not hinder too much this market power, the company may prefer to remain independent.

The key element that seems to distinguish airline alliances from the formation of cartels is the segmentation of the market in short and long distance flights. Therefore, the formation of alliance depends on the economic conditions in both markets. The effect underlined by Flores-Fillon and Moner-Colonques (2007) may disappear as competition is introduced in the local market, making the formation of alliances a good strategy to face the increased competition in the domestic market.

The theoretical approach seems to predict that the probability to be part of an alliance would depend on the possibility to exploit the returns to density. The higher those returns, the larger the incentive to create or join an alliance. Moreover, the competition in the market also plays a crucial role. For this reason our empirical strategy focuses on the following two dimensions:

- company and alliances' size
- degree of competition

The first dimension should capture the possibility to exploit the returns of density, while the second dimension should shed some light on the way in which competition affects the incentives to form an alliance. We would

[7] See also Flores-Fillol (2009).

expect a positive impact of variables linked with size, such as the number of passengers, the load factor, and the alliances' market share.

The theoretical literature suggests that an increase in competition among alliances should reduce the incentive to form an alliance, while the increase in competition faced by the single airline should push toward the alliance strategy. In this case, a potential *prisoner's dilemma* type of problem may arise, were the singleton strategy more profitable than the equilibrium strategy (where some alliances have formed). Empirically we cannot distinguish between the two forms of competition, however, we can consider *Alliance pressure*, that is, the number of airlines that joined a network in the previous period, as a measure of the pressure to join an airline given that other airlines have already joined. Moreover, we can consider *National carriers' traffic*, that is the total number of passengers carrier by national airlines as an indirect measure of the potential market power of the airline in its national market, which is less influenced by the formation of the alliance. Therefore a positive sign on *Alliance pressure* would suggest a strong competition faced by single airlines toward the airlines in the alliance, and a negative sign on *National carriers' traffic* would suggest that the larger market for national carriers, the less the company is affected by the alliances' competition, because the airline can turn to the domestic market where the advantages of the alliance are limited.

Finally, it is worth noting that our empirical analysis does not distinguish between the creation of an alliance and joining an existing alliance. This is an important topic that necessitate the construction of a dynamic model of alliance formation, where it is possible to disentangle the incentives to create a new alliance from the incentives to join an existing one. We leave this for future research.

4 Empirical specification

The econometric model of this paper is represented by the following equation.

$$\left\{\begin{array}{c}\text{Alliance\_choice}_{it} \\ \text{No-alliance} \\ \text{KLM-Northwest} \\ \text{Oneworld} \\ \text{Qualiflyer} \\ \text{Sky Team} \\ \text{Star Alliance}\end{array}\right\} = \begin{array}{l}\alpha_1\text{Passengers}_{it} + \alpha_2\text{Load\_factor}_{it} + \\ +\alpha_3\text{International\_business}_{it} + \\ +\alpha_4\text{Years\_in\_business}_{it} + \\ +\gamma_1\text{Alliance\_pressure}_{it} + \\ +\gamma_2\text{Alliances\_market\_share}_{it} + \\ +\delta_1\text{National\_carriers\_traffic}_{it} + \\ +\delta_2\text{Capita\_GDP}_{it} + \delta_3\text{Country}_i + \varepsilon_{it}\end{array} \quad (1)$$

Time t is set yearly, i characterizes the airline. The dependent variable, *Alliance choice*, represents the airline's choice among different alliances. There are six alternative alliances, namely the five alliances previously mentioned in table 1 (KLM-Northwest, Oneworld, Qualiflyer, Sky Team and Star Alliance), plus the counterfactual "No-alliance" if the observed airline does not participate in any alliance during the observed year. Table 2 provides evidence on patterns of airline alliances in the sample.

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TABLE 2 HERE

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No-alliance is the most frequent observation, representing over 50% of the sample of airline alliances. Its high frequency is because several airlines join the alliance later on during the sample period[8] and because the sample comprises airlines which are not members of any alliances.[9] For ease of comparison, we set the No-alliance category as the reference group in the econometric estimations. Thus, we will estimate the probability of joining an alliance with respect to not participating in any alliance.

The independent variables consist of three categories capturing airline characteristics (denoted by α parameters in equation 1), alliance characteristics (γ parameters) and country characteristics (δ parameters). More specifically:

- *Passengers* is the total number of passengers in millions carried by the observed airline in a given year. This variable aims to capture

[8] See table 1 for several examples.

[9] For instance Emirates, Easyjet, Ryanair and Southwest Airlines.

the absolute size of the airline. In principles the effect of *Passengers* on alliance participation can be ambiguous. On one hand, airlines characterized by a large traffic volumes have already their own extended network and thus have less need to join an alliance. On the other hand, they are well established on the market and thus they may be willing to enter or even form an alliance in order to seek further development and market expansion. Given that the alliances of this sample count different big airlines among their founding members, we expect the latter effect to prevail over the former effect.

- *Load factor* is the average load factor of the observed airline in a give year. This variable should control for possible capacity constraints and their implications in favor of alliance participation.

- *International business* is the ratio of the revenues originating from international passengers over the total passengers' revenues. It captures the importance of international business for the observed airline. We expect larger share of international business to be associated with a positive alliance participation, since member airlines can benefit from the international route network offered by the alliance.

- *Years in business* is the elapsed years since airline's foundation and controls for the different length of the operating period of different airlines. We presume older airlines to be more likely to participate in an alliance because they are better consolidated on the market and thus more inclined to take a further step in their development process, which consists in joining an alliance.

- *Alliance pressure* is the total number of airlines entering any alliance during the previous year. It aims to control for the indirect pressure to which an airline is subject whenever it observes several competitors joining an alliance. Thus a larger amount of *Alliance pressure* is expected to have a positive impact on the observed airline's likelihood of entering an alliance.

- *Alliances' market share* is the world's market share of the airline alliances. It controls for the overall effect of the alliance phenomenon in the airline industry; therefore a larger market share should be associated with a broader alliance participation.

- *National carriers' traffic* is the total number of passengers (domestic and international) in millions carried by all the airlines registered in a given country. It aims to capture the market size for national carriers. In principles a larger market for national carriers should imply less need for alliance membership, since the relative larger importance of domestic market overcomes the small potentials of international market expansion due to alliance participation.

- *Capita GDP* is the Gross Domestic Product (GDP) per capita of the country in which the observed airline is registered. The unit is thousands U$, it aims to control for the economic fundamentals of the country in which the airline is based.

- *Country* represents two dummy variables, one for airlines registered in Europe and one for airlines registered in the United States. It aims to control for some important country-specific effects, typically antitrust concerns: for instance, US carriers might consider domestic antitrust repercussions when deciding whether to enter into a partnership.[10] Note that European carriers are represented by one single European dummy rather than by a set of country dummies, because antitrust cases in Europe are assessed at European level by the European Commission in Brussels.[11]

- ε is the random term, assumed with zero mean.

A brief description of the sample and of the data sources is provided in the appendix.

5 Results

The results from estimating our model as multinomial logit are reported in Table 3. The Hausman test of the Independence of Irrelevant Alternative (IIA)[12] strongly supports the IIA hypothesis, hence, the estimates of the

[10] We are grateful to one anonymous referee for giving us this suggestion.

[11] A relatively recent airline antitrust case assessed by the European Commission is for instance the blocked merger between Aer Lingus and Ryanair in June 2007. For further discussions on this topic see Gaggero and Piga (2010).

[12] See Hausman and McFadden (1984) or Train (2003).

multinomial logit model are not undermined. Standard errors are clustered by the pair country-year, to control for possible correlation, within the same year, between the residuals of different airlines registered in the same country.[13]

Note that the whole econometric analysis does not report the estimates relative to KLM-Northwest and Qualiflier. The reason is not merely to save space, but also because these two alliances have a poor current interest due to the fact that Qualiflier has ceased its operations in 2002 and that the KLM-Northwest cooperation has become superfluous since its founding members have joined Sky Team in 2004. Thus, the focus of the discussion will be on the three active alliances: Oneworld, Sky Team and Star Alliance, which represent the main set of alliance alternatives for non-member airlines in the future.

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TABLE 3 HERE

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The positive sign on *Passengers* implies that airlines characterized by high traffic volumes are more likely to participate in an alliance. "Big"airlines (i.e., well established and with large passengers' volumes) are welcome in any alliance as they normally have a large route network, which they bring into the alliance as a valuable asset, because it allows to better exploit the economies of density. Indeed the participation of several big carriers as founding members of an airline alliance is probably a key factor in the survival of the alliance itself. As shown in Table 1, all the three active alliances include more than one big carrier among their founding members: for instance America Airlines and British Airways for Oneworld, Air France and Delta Airlines for Sky Team, Lufthansa and United Airlines for Star Alliance. On the contrary, the establishment of Qualiflier involved only one distinguished airline, namely Swissair. The alliance was too dependent on Swissair, thus, when airline became bankrupt, Qualiflier also broke down. Even if Qualiflier started its operations before Oneworld, Sky Team and Star Alliances, it was too reliant on a particular airline and hence its destiny appeared doomed from the beginning.

When an airline operates near its full fleet capacity (high *Load factor*),

[13] Examples of country-year-specific shocks may be a change in politics (elections, legislative national reforms in the airline sector, etc.) or a change in the economy (negative shock on financial markets, country entering the recession, September 11^{th}, etc).

it has a positive probability to become a member of an airline alliance. This result shows the importance of the returns of density on the formation of alliances. Moreover, forming an alliance may represent an alternative way of expanding fleet capacity, in particular for airlines lacking financial resources and/or unwilling to bear the risk of increasing their fleet.[14]

The positive and statistically significant coefficient on *Alliances' market share* is in line with the assumption that alliances become more appealing as they grow in market power.

These three variables - *Passengers*, *Load factor* and *Alliances' market share* - show that the returns to density play a crucial role as one of the main determinants for airline alliances.

As regards the role of competition, *Alliance pressure* has a positive impact on the probability of forming an alliance, while *National carriers' traffic* has a negative impact. This finding suggests that the incentive to form an alliance to face the competition of airlines that already formed (*Alliance pressure*), is hindered by the market power in the domestic market.

The positive sign on *Alliance pressure* could be explained by the following argument: the larger the number of airlines entering the alliances' business, the higher the threat that the alliance network would become saturated and hence that the marginal benefit to the alliance from the entry of the observed airline would be minimal.[15] Therefore, due to the fear of remaining excluded from any alliance in the future, the observed airline has a greater incentive to join the alliance as the number of non-alliance members shrink.

The variable *National carriers' traffic* represents the size of the market for nationally registered carriers.[16] Should such a market be large, a given national airline may wish to exploit it with no need for the international network offered by any alliance. For this reason, the impact of *National carriers' traffic* on the likelihood of participating in an airline alliance is negative. Note that this result can be read together with the finding of the positive, although insignificant, sign on *International business*: if there is some potential for national business expansion, the benefits of participating

[14] Expanding the fleet involves high sunk costs and high operating costs. Participating in an alliance and code-sharing members' aircraft zero those costs and the associated risk of their recovery.

[15] See Agusdinata and de Klein (2002).

[16] Note that the inclusion of the dummy variables for Europe and for the United States aims to control for the overall country-effect, whilst *National carriers' traffic* should capture the genuine effect of the national market size.

an alliance are minimal. On the contrary, if the airline has an international orientation, then joining an alliance becomes a priority.

Although statistically insignificant[17] from zero, *International business* has the correct, positive sign and thus does not deny the presumption that a larger proportion of international business requires alliance participation in order to take advantage of the international route network of the members.

The elapsed number of years since a company's foundation, *Years in business*, has a positive and statistically significant impact on the probability of joining an alliance across all the three alliances. This result is in line with the idea that older airlines are better consolidated in the market and are thus ready to take a further step in their development process, which consists in joining an alliance. Furthermore it could be argued that the longer the company has been on the market, the more likely it establishes a reliable reputation, which, on the contrary, is less likely to be observed in younger companies. If the prospective member has a good reputation, it speeds up the steps of entering an alliance, since airline alliances, as any other form of coalition, are the result of a negotiation process.

Except for the estimates relative to Sky Team with a weak level of statistically significance (i.e., insignificant below 5% level), the Gross Domestic Product per capita, *Capita GDP*, is positive and highly statistically significant (i.e., beyond the threshold of 1% level). The variable itself has no specific meaning in terms of alliance determinant, but captures the country specific, macroeconomic effects influencing the demand of air travel and thus it indirectly affects airlines' business and behavior.[18] Yet, to give an interpretation to the estimates, the two positive and highly statistically significant coefficients on *Capita GDP* may indicate that richer countries, which are possibly associated with well established airlines, are generally more likely to have more alliance members.

Finally, from a general overview of the results, we observe a very interesting pattern in the estimates. Table 4 reformulates the coefficients of Table 3

[17] We acknowledge that *International business* might not be too accurate in its purpose because on one hand some countries (typically European countries) are so small that all airline's traffic can be classified as international, whilst on the other hand some countries (typically the United States) comprise a domestic market so large that even a substantial international traffic by an airline does not suggest that the airline is active in the international arena. Nevertheless, the inclusion of two dummy variables - one for Europe and one for the United States - in the regressions should purge part of this imperfection.

[18] See Brueckner and Spiller (1994), Park and Zhang (2000).

in terms of relative risk ratio,[19] which is defined as the ratio of the probability of choosing one outcome category over the probability of choosing the reference category. Comparing the relative risk ratios across the three different alliance choices, we notice that their magnitude is quite similar, especially if we restrict the analysis to only those statistically significant values. This result means that the probability of entering a given alliance over the probability of not participating in any alliance does not fluctuate much across different alliances. In other words, the airlines view the different alliance groups as similar. Thus the main decision for the airline is not to choose a specific alliance, but rather to consider whether or not to enter an airline alliance as an option in its business strategy.

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TABLE 4 HERE

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6 Robustness

Using a multinomial logit model we find that the probability of participating in an airline alliance can be explained by looking at different points of view. From an airline perspective, the size and the age of the airline increase the likelihood of membership. Focusing on competitors' behavior, the decision by other carriers to enter an alliance pressurizes the observed airline to join an alliance sooner rather than later. From an alliance perspective, the recent expansion of airline alliances in the world market induces many carriers to apply for membership, but if the market of national carriers is large enough, the need for an alliance fades. Finally, the relative risk ratio analysis suggests that the main decision for an airline does not consist in *which* alliance to choose, but rather on *whether* to join any alliance.

This section tests the validity of the above results by performing the following robustness checks.

1. Generalize alliance choice as a binary rather than multinomial choice and estimate the model with logit.

2. Estimate the model with nested logit as an alternative to multinomial logit.

[19] Recall that the relative risk ratio is simply calculated by taking the exponential of the multinomial logit estimate.

3. Control for possible endogeneity using instrumental variables.

6.1 Logit

Following up from the key conclusion of the multinomial logit analysis, which suggests that the main choice of the airline is whether to be in or out of an alliance, rather than on the choice of a specific alliance, we re-consider the alliance decision as a binary choice: Alliance versus No-alliance. That is, the dependent variable is now a dummy variable equal to one if the observed airline is a member of any airline alliance and equal to zero otherwise.

We therefore estimate the logit model,[20] whose results are reported in the second column of table 5. The sign and level of significance of the coefficients confirm the results of the previous tables. Larger and older airlines are more likely to be alliance members (positive sign respectively on *Passengers* and *Years in business*); competitors' choice to enter an alliance has a positive effect on observed airline's alliance decision (positive sign on *Alliance pressure*); as alliances consolidate on the market, they recruit more members (positive sign on *Alliances' market share*); a larger market for national carriers has a negative effect on the probability of joining an alliance (negative sign on *National carriers' traffic*).

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TABLE 5 HERE

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6.2 Nested Logit

As a further and alternative way of modeling the fact that each airline generally chooses whether or not to enter into an alliance and the choice of a specific partnership is conditional on the carrier having chosen to enter into the alliance, we re-consider alliance participation in terms of a nested logit model. The decisional tree is now formed by two main branches: Alliance and No-alliance, with the former branch splitting into five final twigs representing the five alliance alternatives previously mentioned.

[20] As further robustness checks we have also considered the probit and multinomial probit models respectively in lieu of the logit model of table 5 and multinomial logit model of table 3. The main conclusions remain unaltered. The results are not reported to save space and are available upon request.

The nested logit estimates are reported in the third column of table 5 and are overall in line with the results discussed previously. *Passengers* and *Load factor* remain highly statistically significant and with their correct, positive sign. As in the previous estimates, *International business* is insignificant in statistical terms, but with the correct, positive sign. The high statistically significant level of *Year in business* confirms the idea that older airlines can take advantage of their consolidated position on the market - possibly by holding a well established reputation - and thus enter an alliance more easily. *Alliance pressure* is statistically insignificant but positive, thus it may still weakly support the presumption that, although the airline industry is characterized by a large number of carriers, the conduct of few airlines may have an impact on the behavior of the observed carrier. *Alliances' market share* has its correct, positive sign, even though it looses its level of statistically significance. The negative and statistically significant coefficient on *National carriers' traffic* confirms the thesis that a larger market for national carriers may induce the national airline to stay out of an alliance, since alliances are normally unnecessary when the airline wishes to expand its national network. The positive and statistically significant sign on *Capita GDP* supports the idea that richer countries are associated with a broader alliance participation of their carriers.

Finally and perhaps more importantly, except for the cases of *Alliance market share* and *Alliance pressure*, the estimated coefficients of the nested logit model are similar in terms of magnitude and significance level to the estimated coefficients of the logit model. Therefore the combined reading of the logit and nested logit results seems to lend support to the aforementioned idea that airline's main decision in terms of alliance participation is to be in or out an alliance, rather than to choose a specific alliance.

6.3 Instrumental Variables

Because alliance members may take advantage of the alliance route network to expand their traffic, our estimates could suffer from the endogeneity bias. In other words, together with the model's causal relation of a larger volume of passengers implying a higher likelihood of alliance participation, it may also occur the reverse causation of alliance participation increasing the number of passengers. By the same token, because it is a function of passengers, load factor may be also considered endogenous. Finally, for the presumption that alliance participation boosts airline business, alliances' market share may be

endogenously determined.

If this were the case, then our previous estimates would be biased and an instrumental variable approach required. From an econometric point of view, however, the aforementioned simultaneity may be weak, because it usually requires some time before the alliance participation would boost traffic, hence in principle passengers, load factor and market share would not be simultaneously determined with alliance participation. Indeed the Wald test of exogeneity[21] does not reject the null hypothesis of exogeneity with a χ^2 equal to 1.52 and a corresponding p-value of 0.47. Thus the potential endogeneity of *Passengers, Load factor* and *Alliances' market share* may not represent a big concern in this sample.

Nevertheless, the last column of table 5 reports the results of the instrumental variable analysis. We use different instruments to control for the different aspects of the potential endogeneity bias. Our set of instruments includes: the population of the country in which the airline is registered, to capture the whole market's size effect; the growth rate of population, to control for the potential expansion of the demand; the percentage of population between 15 and 64 years old, to represent the percentage of people more likely to demand for air travel; the average exchange rate of the local currency of the country of airline registration versus the dollar, to control for possible cost-shifter - e.g., the price of kerosene - that may influence the market shares.[22]

Acknowledging that some variables loose their level of significance in statistical terms, all the regressors maintain the sign of the previous estimates and therefore their directional effect on alliance participation remains unaltered. In other words the main conclusions of the analysis carried in the previous section can be retained.

[21] Recall that the Wald test of exogeneity is a test of joint correlation between the error terms in the structural equation (second stage) and those in the reduced-form equation (first stage) for the endogenous variable. The residuals from the first stage are included as regressors in the second stage, the two-step estimator. If those residuals are statistically significant from zero the null hypothesis (exogeneity) is rejected and the estimates of the ordinary probit model are biased; on the contrary if those residuals are statistically significant from zero the null hypothesis (exogeneity) is not rejected and the ordinary probit model is sufficient. See Wooldridge (2002).

[22] For further discussions on the instruments see Gaggero and Piga (forthcoming).

7 Conclusion

In this paper we have studied empirically the determinants of airline alliances applying a discrete choice model approach to a sample of 60 airlines observed from late 1980s until 2008. We have implemented different model specifications and different estimation techniques, including instrumental variables. The results of the empirical analysis support the idea that one of the main factors influencing the formation of airline alliances is the possibility to exploit returns to density. The effect of the number of passengers, of the load factor, and of the alliances' market share are all positive and significant. Moreover, our results seem to suggest a separation between the long and short distance markets, as alliances' competition puts a lower pressure on airlines that are mainly focused on the domestic market.

Of course, other factors may influence the formation of alliances. For instance, we have found that older airlines are better consolidated on the market and thus more inclined to take a further step in their development process, which consists of joining an alliance.

Finally, and more importantly, the same sign and similar magnitude of the regressors across different alliance alternatives, as indicated by the relative risk ratio analysis, suggest that the airlines' major decision is not to chose a specific alliance, but rather to consider whether or not to enter into an airline alliance as a viable strategy option.

Thus, we conclude that the airline industry is now characterized by carriers adopting one of two mutually exclusive strategies: airlines either follow the modern Low Cost Carrier model and hence ignore any form of alliance, focusing on the short-haul domestic market, or they adopt the traditional Full Service Carrier model, in which alliance participation will probably become a key factor for airline future survivability.

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Appendix: the data set

The sample of this empirical analysis covers the world's main airlines and includes, besides the carriers listed in table 1, also the major airlines which have never been a member of any alliances, such as Emirates, Easyjet, Ryanair and Southwest Airlines. The total number of carriers comprised in the sample is 60. The sample period technically spans from 1989 to 2008, but, because of initial less frequent observations, the core of the sample period ranges from the middle of the 1990s to 2008. Note also that, as shown in table 1, the three currently active alliances (i.e., Oneworld, Sky Team and Star Alliance), which represent the major focus of our empirical analysis, are formed at the end of the 1990s and therefore our estimation period fully covers both their pre-alliance formation period and their post-alliance formation period.

Data are collected from two different sources: airlines' annual reports and the World Bank. Airlines' annual reports are the major source to gather specific information on each airline (passenger traffic, load factor, foundation year, etc.), as well as general information on alliances (world's market share, list of participating carriers, entry and exit of members, etc.).

The World Bank Development Indicators database contains several macroeconomic variables, such as the exchange rate, the Gross Domestic Product (GDP) and its different specifications (GDP per capita among others), population, growth rate of population and population in age classes, as well as the total number of passengers carried by all the airlines registered in a given country.

Table 1: History of airline alliances

KLM-Northwest (Wings)	Oneworld	Qualiflyer	Sky Team	Star Alliance
KLM (1989-2004)	Aer Lingus (2000-2007)	Austrian Airlines (1992-1999)	Aeroflot (2006)	Adria Airways (2004)
Northwest (1989-2004)	American Airlines (1999)	LOT (1998-2002)	Aeroméxico (2000)	Air Canada (1997)
Continental Airlines (1998-2004)	British Airways (1999-)	Sabena (1998-2001)	Air France (2000)	Air China (2007)
Alitalia (1999-2001)	Canadian Airlines (1999-2000)	Swissair (1992-2002)	Alitalia (2001)	Air New Zealand (1999)
	Cathay Pacific (1999)	TAP Portugal (1998-2002)	China Southern Airlines (2007)	All Nippon Airways (1999)
	Finnair (1999)	Turkish Airlines (1998-2002)	Continental Airlines (2004-2009)	Ansett Australia (1999-2001)
	Iberia (1999)		Czech Airlines (2001)	Asiana Airlines (2003)
	Japan Airlines (2007)		Delta Airlines (2000)	Austrian Airlines (2000)
	LAN (2000)		KLM (2004)	Blue1 (2004)
	Malév (2007)		Korean Air (2000)	BMI (2000)
	Mexicana (2009)		Northwest Airlines (2004)	Brussels Airlines (2009)
	Qantas (1999)			Continental Airlines (2009)
	Royal Jordanian (2007)			Croatia Airlines (2004)
				EgyptAir (2008)
				LOT (2003)
				Lufthansa (1997)
				Mexicana (2000-2004)
				SAS (1997)
				Shanghai Airlines (2007)
				Singapore Airlines (2000)
				South African Airways (2006)
				Spanair (2003)
				Swiss International (2006)
				TAP Portugal (2005)
				Thai Airways (1997)
				Turkish Airlines (2008)
				United Airlines (1997)
				US Airways (2004)
				Varig (1997-2007)

Source: authors' own calculation based on airlines' official annual reports. The first four digits and the second four digits in brackets indicate respectively the year of entry and exit the alliance. If the year of exit is not specified, the airline is at present - 2011 - still a member of the alliance.

Table 2: Frequency of airline alliances in the sample

Alliance	Frequency	Percent
No allliance	398	50.73
KLM-Northwest (Wings)	18	2.40
Oneworld	85	11.35
Qualiflyer	21	2.80
Sky Team	67	8.95
Star Alliance	178	23.77

Table 3: The determinants of airline alliances - Multinomial Logit Estimation

	Alliance choice		
	Oneworld	Sky Team	Star Alliance
Passengers	0.030**	0.054***	0.029***
	(0.013)	(0.014)	(0.007)
Load factor	0.259***	0.297***	0.143***
	(0.055)	(0.060)	(0.053)
International business	1.980	0.509	1.421
	(1.268)	(1.831)	(1.025)
Years in business	0.052***	0.058***	0.026**
	(0.014)	(0.015)	(0.013)
Alliance pressure	0.092*	0.010	0.053
	(0.051)	(0.057)	(0.040)
Alliances' market share	0.071***	0.049***	0.048***
	(0.015)	(0.016)	(0.010)
National carriers' traffic	-0.014***	-0.004	-0.012***
	(0.005)	(0.006)	(0.005)
Capita GDP	0.076***	-0.042*	0.079***
	(0.021)	(0.022)	(0.023)
Observations = 377			

Dependent variable: *Alliance choice*, No-alliance is the omitted category.
Europe and US dummies included, but not reported.
Robust standard errors to heteroscedasticity and serial correlation in parenthesis, clustered by country of airline's registration and by year.
Coefficients *** statistically significant at 1%, ** at 5% and * at 10%.

Table 4: Relative Risk Ratios of Table 3

	Alliance choice		
	Oneworld	Sky Team	Star Alliance
Passengers	1.031**	1.056***	1.029***
Load factor	1.296***	1.346***	1.153***
International business	7.245	1.663	4.14
Years in business	1.053***	1.060***	1.026**
Alliance pressure	1.097*	1.01	1.054
Alliances' market share	1.074***	1.050***	1.049***
National carriers' traffic	0.986***	0.996	0.988***
Capita GDP	1.079***	0.959*	1.082***

Relative Risk Ratio = Probability(Observed alliance)/Probability(No-alliance).
Coefficients *** statistically significant at 1%, ** at 5% and * at 10%.

Table 5: Logit, Nested Logit and Instrumental Variable (IV) Estimation

	Logit	Nested Logit	IV
Passengers	0.034***	0.038***	0.019
	(0.008)	(0.007)	(0.066)
Load factor	0.189***	0.148***	0.147
	(0.048)	(0.055)	(0.117)
International business	0.787	0.808	0.480
	(0.977)	(1.089)	(1.004)
Years in business	0.036***	0.039***	0.016
	(0.011)	(0.012)	(0.018)
Alliance pressure	0.053	0.010	0.041*
	(0.035)	(0.038)	(0.022)
Alliances' market share	0.054***	0.008	0.026**
	(0.011)	(0.014)	(0.011)
National carriers' traffic	-0.010***	-0.013***	-0.006
	(0.004)	(0.004)	(0.006)
Capita GDP	0.048***	0.058**	0.020
	(0.018)	(0.024)	(0.051)
Observations	377	1713	374

Dependent variable: *Alliance dummy* (for the columns labeled "Logit" and "IV"), equal to one if the observed airline participates any alliance and equal to zero otherwise; *Alliance choice* (for the column labeled "Nested Logit").
Europe and US dummies included, but not reported.
Robust standard errors to heteroscedasticity and serial correlation in parenthesis, clustered by country of airline's registration and by year.
Coefficients *** statistically significant at 1%, ** at 5% and * at 10%.
Instruments for Passengers, Load factor and Alliances' market share (assumed endogenous in the IV model): population of the observed airline's registration country, growth rate of population, percentage of population between 15 and 64 years old, exchange rate with the U$ dollar.
Note that in order to estimate the Nested Logit model, Stata requires to include, for each chosen alternative representing the "genuine" observation, also the observations on all the available alternatives. Therefore, by construction, the sample observations of the Nested Logit model outnumber the sample observations of the other models.