WHAT DOES MARKET STRUCTURE REVEAL? EMPIRICAL EVIDENCE FROM THE U.S. AIRLINE INDUSTRY*

Giovanni Alberto Tabacco†

University of East Anglia – School of Economics

JOB MARKET PAPER

This version: June 20, 2012

Abstract

This paper studies competitiveness in the airline industry inferred by investigation of market structure. First, the paper documents evidence that endogenous sunk costs investments in advertising and in expanding route network play a crucial role in determining equilibrium market structure and, that the industry is a natural oligopoly. Secondly, it is performed an empirical analysis to explain market shares asymmetries. Finally, splitting firms into two types, leaders and non-leaders, it is proposed evidence that nature of competition depends on presence of leader airlines; in particular, it appears that non-leaders infer profitability of routes from the number and identity of leaders.

Keywords: *market structure, competitive process, airline industry*.

JEL Classification: *D43*, *L11*, *L13*, *L93*.

* This article is based on chapters 1, 2 and 3 of my UEA Ph.D. dissertation. I would like to thank my advisor Steve Davies for invaluable guidance and advice. I also greatly benefitted from valuable discussions with and suggestions from Bruce Lyons, Subho Modak Chowdhury, Bob Sugden, Neil Gandal, Iván Barreda-Tarrazona, Theresa Veer, Franco Mariuzzo, seminar participants at UEA, participants at the 2nd Workshop on Industrial Organization: Theory, Empirics and Experiments at the University of Salento, participants at the V Intertic Conference on Innovation, Competition, and the New Economy at the University Ca' Foscari, Venice, participants at the Workshop on Economics and Management of Leisure, Travel and Tourism at the Rimini Centre for Economic Analysis, University of Rimini-Bologna, and participants at the 7th RES Ph.D. meeting at Queen Mary University of London. Any remaining errors are my own responsibility.

† Contacts: g.tabacco@uea.ac.uk; http://www.uea.ac.uk/~wbw08dwu/

1 Introduction

The study of industrial market structure has always been one of major topics of interest among industrial organization economists since Bain (1956). In fact, it is well known that by studying market structure we can draw inferences about the underlying competitive process. This is not just of academic interest, but it also bears substantial relevance for antitrust policy.

A main motivation of this article comes from the observation of how little it is known about competitive forces that have generated the current structure in the airline industry. Indeed, most of literature on the economics of competition in air transportation[1] takes industry structure as given neglecting the underlying causes of it. However, this is not to ignore the voluminous literature on empirical models of entry and market structure in various industries[2], including airlines, but one emphasis in our paper is to uncover competitive mechanisms that have shaped market structure. One main competitive mechanism is the well known endogenous sunk costs escalation process which alters consumers' willingness to pay and its consequences on market structure. Another motivating reason relies on the fact that many models about the industrial organization of airline markets, if not most, consider competition with homogeneous goods[3] or at most symmetric product differentiation (e.g. Berry 1992). Finally, the U.S. airline industry may represent an excellent natural experiment for studying competitive forces that have generated industrial structure because deregulation took place in the early 1978; consequently, any imprint on current structure should be caused by the competitive process at work.

The formal analysis consists of three blocks. Firstly in section four, we apply the bounds approach developed by Shaked and Sutton (1987), Sutton (1991) and Vasconcelos (2006). The underlying hypothesis is that airlines compete in advertising and expansion of route structure.

[1] See for example Aguirregabiria and Chun-Yu Ho (2010), Borenstein (1989, 2005), Evans and Kessides (1993), Charles and Seabright (2001), Bamberger, Carlton and Neumann (2004), Neven, Lars-Hendrik Roller and Zhentang Zhang (2006), Lederman (2007, 2008).

[2] Berry (1992), Berry and Waldfogel (1999), Bresnahan and Reiss (1991), Ciliberto and Tamer (2009), Mazzeo (2002; 2007), Schaumans and Verboven (2008), Seim (2006), Toivanen and Waterson (2005).

[3] Lederman (2007, 2008) contributions represent rare examples of analysing product differentiation in the airline industry. In her empirical analyses of frequent flyer programs (FFPs), she considers a framework of vertical product differentiation where value of redeemed awards to travellers may be substantially different among carriers.

Nielsen Media research (May 2007) provides an advertising/sales ratio[4] for the UK airline industry equal to 8.37%. In the light of this there is no reason to expect that in the US the advertising/sales ratio would be dramatically less than the UK figure. Moreover various sporting event arenas in the US are named after airlines: the cost of these 'naming rights' is substantial. Thus, the industry can well be identified as advertising intensive. The other source of endogenous sunk costs is route structure. Firms may increase demand by increasing number of routes flown out from end points of each city pair market serviced. The establishment of a route network requires endogenous fixed sunk costs (e.g. personnel training programs, number of established check-in points, and number of slots acquired).

A crucial element for the validity of applying the bounds approach is that endogenous sunk costs are local markets' specific. In other words, the two identified types of endogenous sunk costs for the airline industry, advertising and route structure, should be relevant at route level. If the endogenous sunk costs pertain exclusively at national level we will not be able to distinguish the endogenous sunk costs model from the exogenous sunk costs model by estimating lower bound and upper bound to concentration. One claim of this article is that there are rather substantial endogenous sunk costs relevant at route market level.

Regarding advertising, we can observe that airlines establish a mix of investments in which some are more oriented at 'brand', often in newspaper advertising, while other investments are route specific, as observable from companies' website. Low cost carriers tend to advertise more specific city pairs. We can assert that at least a portion of advertising expenditure is held at route level. Regarding the other type of endogenous sunk costs, investments in establishing a set of destinations out from end points of a city pair are relevant at route market level. Overall, we are confident in claiming that the endogeneity of sunk costs is relevant at city pair market level.

We find evidence of a large and positive lower bound to concentration, suggesting competition in endogenous sunk costs. Second, at best of our knowledge, this paper is the first to

[4] Sutton (1991) defines an empirical cut-off point of 1%. Industries with an advertising/sale ratio greater than 1% are classified as advertising intensive, so, as endogenous sunk costs industries.

provide empirical evidence on the upper bound to concentration theory, developed by Vasconcelos (2006). In fact, the econometric analysis supports the theoretical predictions for endogenous sunk costs industries: i) equilibrium monopoly outcomes, and ii) maximal level of concentration which does not decline as market size becomes arbitrarily large. Furthermore, using the full set of firms we provide evidence that the airline industry is a natural oligopoly; each city pair market is dominated by one to three firms, irrespective of market size.

After applying the bounds approach to market structure, we continue the theme of studying concentration with the aim to deduce information on the competitive mechanisms at work; but, this time, we use an approach in the spirit of Bresnahan and Reiss's (1991) work. The methodology used in sections five and six complements the analysis performed in section four by analysing concentration above the lower bound and below the upper bound. A main difference with the bounds approach is that we use econometric techniques which provide a fit to the scatter of data points hence an average relationship between the variables of interest, rather than estimating frontiers. Under an economic point of view the analysis performed in those sections, enriches the bounds approach for means of describing how different market characteristics and identity of firms affect market share asymmetry, as well as investigating competitive effects between different types of airlines. Indeed, while in the bounds approach symmetric firms equilibria are involved, we attempt to explain firm market share asymmetry.

To investigate determinants of firm size inequality may uncover information on the underlying competitive process which may remain concealed when looking just at firm numbers or individual entry decisions. We find evidence that market size is irrelevant; whilst, in large hub routes and when major airlines are present market share asymmetry increases. In city pairs with longer distance there is strong evidence of less pronounced size inequality.

Finally, we perform an empirical analysis of competitive interactions between two different types of airlines we identify, leaders and non-leaders. Surprisingly, we find strong evidence that both number and identities of leading airlines affect positively the number of non-

leaders. After ruling out a number of alternative explanations, the empirical evidence appears to point to learning; non-leader airlines infer profitability of routes by the presence of rival type of firms.

This article through describing and explaining market structure of airline city pair markets offers a detailed picture of competitive processes at work in the industry. All the results are relevant for antitrust policy.

The rest of the article is organized as follows. Section 2 reviews the related literature. Section 3 describes the data set. Section 4 carries the bounds estimation. Section 5 provides empirical analysis of market share asymmetry. Section 6 studies empirically the nature of competition between leader airlines and non-leaders. Section 7 discusses main results. Finally, section 8 concludes.

2 Related Literature

This article investigates the nature of competitive process inferred by analysing market structure in the U.S. airline industry. A strand of the literature on industrial market structure refers to empirical cross-industry studies applying the bounds approach most fully developed by Sutton (1991, 1998), and based on a series of theoretical papers (Shaked and Sutton 1982, 1983, 1987). Vasconcelos' (2006) model complements Sutton work by deriving an upper bound to industry concentration. He develops empirically testable predictions about the relationship between market size and market concentration: i) for exogenous sunk costs industries the upper bound to concentration declines monotonically as market size increases; ii) for endogenous sunk costs industries the upper bound remains invariant to market size and monopoly can occur as equilibrium outcome in large markets.

The bounds approach is designed for looking for statistical regularities and robust results about the market size-structure relationship; these few robust results hold for a wide class of oligopoly models differing in a priori equally reasonable model specifications. Structure fragments

as market size becomes large for exogenous sunk costs industries, where price is the main competitive weapon and/or horizontal product differentiation is prominent; whereas, in endogenous sunk costs industries, where quality plays a crucial role and is sustained by investments in sunk outlays (e.g. advertising, R&D), fragmentation cannot occur regardless of how large the market becomes. The underlying theme is that endogenous sunk costs expenditure increases consumers' willingness to pay. The empirical cross industry literature confirms the theoretical predictions (Sutton 1991, 1998; Lyons and Matraves 1996; Robinson and Chang 1996; Symeonidis 2000; Lyons, Matraves and Moffatt 2001; Giorgetti 2003; Balasubramanian and Lieberman 2011).

More recently, the literature in the area of market structure has focused on applying the bounds' methodology to specific industries, such as online book sellers (Latcovich and Smith 2001), banking (Dick 2007), and supermarkets (Ellickson 2007). In addition, Berry and Waldfogel (2010) investigate the empirical relation between market size and product quality where data on number of products is used in place of market concentration, for the restaurant and newspaper industries. Our paper extends that literature by presenting econometric evidence on the endogenous sunk costs model for the airline industry, and providing for the first empirical evidence on the upper bound to concentration (Vasconcelos 2006).

A well acknowledge limitation of the aforementioned empirical articles, is that all what the econometric evidence is about is solely an estimation of the *lower bound* to all possible market structures admissible. Indeed, the theory is consistent with multiple equilibria. Our article complements the literature by investigating market structure above the lower bound to concentration.

A parallel strand of literature to which this article is related, refers to empirical models of market structure based on specific oligopoly theories tailored to the industry study in hand. Bresnahan and Reiss (1991), using ordered probit models, introduce the novel concept of *entry thresholds* which relates the equilibrium number of firms to market size (measured by population);

the estimated entry thresholds tell how much population is needed to support a given number of firms in a local market. Bresnahan and Reiss estimate also the *entry threshold ratios* which are ratios of per-firm market sizes; if this ratio is above one it means that entry increases competition. They find that the level of competition changes quickly as the number of firms increases, as well as most of competitive effect of entry is exhausted with the second or third entrant. Moreover, the literature has focused more explicitly on entry by solving the difficult problem of firm heterogeneity (Berry (1992) uses a simulated method of moments estimator proposed by McFadden (1989) and Pakes and Pollard (1989)). Other contributions extend the Bresnahan and Reiss's (1991) framework in allowing different types of firms (e.g. Mazzeo (2002) endogenizes product choice decisions for motels of high and low quality in Western U.S.; Cohen and Mazzeo (2007) estimate a cross-section endogenous equilibrium number of firms model for three types of banks). In addition, Berry and Waldfogel (1999) estimate the social inefficiency caused by free entry in radio broadcasting. Other recent applications involve the video rental industry (Seim 2006), health care professions in Belgium (Shaumans and Verboven 2008), supermarkets (Cleeren, Verboven, Dekimpe, and Gielens 2010) and the UK burger industry (Toivanen and Waterson 2005). However, just as the literature on the bounds approach, this empirical literature about entry and market structure explains the number of firms or firm's individual entry decisions, neglecting to account for firm size inequality. Our article attempts to fill this gap. Under this latter aspect, our article is also modestly related to the time-series literature on size distribution[5] which, part of it, is centred on the Gibrat's Law[6] (Gibrat 1931) by which firm's growth rate follows a random walk; that is, firm's growth rate is independent by its initial size and firms' size distribution conforms to skew Yule distribution.

[5] See the large literature of stochastic models of firm's growth; examples are Hart and Prais (1956), Simon and Bonini (1958), Ijiri and Simon (1964, 1977), Jovanovic (1982), Davies and Lyons (1982), Davies and Geroski (1997), Sutton (1998).

[6] For surveys and discussions of the Gibrat's Law, see, for example, Curry and George (1983), Hall (1987), Davies (1988), Geroski and Machin (1992).

3 Data and variables

Data

Coverage of the Sample

The econometric analysis of this article focuses on a newly assembled dataset about U.S. airline city pairs. Market shares and concentration data are for 2006, collected from the US Transportation Statistics Bureau (BTS); whilst, demographic variables (population) refer to year 2000 obtained from US census.

Belobaba (2010) reports that US industry profits in 2006-2007 are positive after five year period, 2001-2005, of losses accruing to forty billion US dollar; the years 2008-2009 brings further negative profits.

The dataset contains 661 city pair markets involving 58 cities, of which 25 are from the 50 largest U.S. cities; seventeen cities are in the largest top twenty in term of population. In addition, our dataset covers 66% of the revenue passenger boardings for all US large hub airports.

The focus is on domestic routes similarly to the industrial organization literature on the US airline industry.

Airports/Cities

The United States Code section at title 49 defines large hub as "a commercial service airport that has at least one percent of the passenger boardings". In this paper we adhere to such legal/institutional definition for identifying the large hub cities (containing at least one hub airport).

We define as tourist cities as those located in California and Florida plus two tourist snow and ski resorts, Aspen and Colorado Springs, which are both located in Colorado. A strategy for indentifying tourist city pairs could be that of collecting data on number of hotels in each city and setting up an arbitrary threshold of them, in order to classify the routes as either tourist or not. In contrast, the criterion followed in this article is simpler without the need of further data.

Essentially, it rests on the observation that U.S.A. do not have art cities as often it occurs in Europe, but rather tourism is motivated mainly by reaching seaside resorts which are located prominently in California and Florida. Therefore, in the empirical models it is introduced a dummy equal to one for all markets with at least an end point city located either in California or Florida, plus the other two locations, Aspen and Colorado Springs. The criterion of classifying tourist airline markets those having at least one end point in either California or Florida is also used by Berry (1992).

Airlines

The dataset contains 58 airlines. A distinction used in the analysis that follows is between leader airlines and non-leaders in base of number of routes serviced within our data set. Table 1 illustrates how the seven leaders service a number of routes equal to 95% of the number of those routes operated by the other fifty-one airlines in the dataset. In addition, each leader services on average 91 city pairs, while each non-leader on average offers only 13 routes.

A motivation for this distinction relies on following reasoning. Airlines servicing a wide route structure may obtain demand and cost advantages; as a result, vertical product differentiation may arise between those firms providing a large network of routes and those offering a handful of routes.

Routes

The 58 cities produce a sample of 661 ($57 * 58/29 = 1653$) city pair markets with at least one airline possessing positive market shares. Consistently with previous literature about the industrial organization in the airline industry, we define the relevant market at route level, and precisely the city pair markets are non-directional (e.g. Los Angeles – Miami is integrated with Miami – Los Angeles) since market shares are determined not directionally. We can mention several examples of contributions where economic investigation focuses on single routes each of them treated as a

separate market[7]. Also, competition authorities normally pursue investigations considering the relevant market at route level. In addition, Brueckner, Lee and Singer (2010) develop a market definition methodology for the airline industry, concluding that the most appropriate market definition is at route level.

Market size is measured following Berry (1992), that is, it is defined as the product of population of the two end point cities constituting each city pair. Alternative measures have been tried, including the sum of populations of the two endpoints, and the population of the less populated city of the city pair. However, the choice of the product is felt to be better because transportation demand is related to the probability of each person dwelling in city 2 is willing to visit city 1 depends on the number of people that such individual knows in city 1. Summing over such probabilities for all individuals leads to the product of populations[8].

Table 2 reports the number of markets for each market characteristic. Table 3 provides some descriptive facts on structure. We can note various facts i) that a large majority (84% with a share of at least 90% for the two biggest) of airline markets are dominated by two firms; ii) the first largest firm is on average eight times bigger than the second largest; iii) the Herfindahl-Hirshman index is on average extremely high; and iv) market share asymmetry is fairly low on average because of the large number of monopolies.

Variables

The variables used in the empirical analysis are:

- *Hirshman-Herfindahl Index of concentration, HHI*. This is used for estimating the lower bound to concentration and the upper bound to concentration.

[7] For example, Aguirregabiria and Chun-Yu Ho (2010), Berry (1992), Borenstein (1989), Brander and Zhang (1990), Evans, Froeb and Warden (1993), Evans and Kessides (1993) (where actually two different market definitions are used, at route and airport level), Marin (1995), Mazzeo (2003), Charles and Seabright (2001), Bamberger, Carlton and Neumann (2004), Neven, Lars-Hendrik Roller, and Zhentang Zhang (2006), Lederman (2007, 2008).
[8] Berry (1992, pp. 907 footnote 10).

- *Coefficient of variation of market shares, CV*. This represents the ratio of the standard deviation to the mean, $CV = \sigma/\mu$. In addition, for each city pair the Herfindahl and *CV* are linked by the following formula[9]:

$$CV = \sqrt{N \cdot HHI - 1}$$

  N stands for the number of firms operating in a given route.

- *Market size*. As explained earlier, market size is defined as the product of population of the two end point cities for each city pair. It is expressed in thousands of billions.
- *Distance*. This picks up costs and is expressed in thousands of kms.
- *Tourist dummy*. A dummy equal to one for all markets with at least one end point city located either in California or Florida, or if the city pair includes Aspen or Colorado Springs.
- *Two hubs*. This is a dummy for routes having large hubs at both endpoints.
- *One hub*. A dummy for city pair markets containing one endpoint as large hub is introduced in the empirical models.
- *One dummy for each of the seven leader airlines*. These are American, Delta Air, Southwest, Continental, US, United Air and Northwest.
- *Number of leaders*. This identifies how many of the seven leaders operate in each city pair market.
- *Number of non-leaders*: Number of non leading airlines in each route.

4 Empirical Analysis of Sunk Costs and Market Structure

In this section we document empirical evidence on various predictions of the endogenous sunk costs model (ESC). The first prediction that we test is about non-fragmentation by estimating a

[9] We can derive the formula for *CV* directly from the Herfindahl-Hirshman index, $HHI = \frac{1}{N} + N\sigma^2$. Now $N\sigma^2$ can be written as $\frac{\sigma^2}{N/N^2} \Rightarrow \frac{\sigma^2}{\left(\frac{1}{N^2}\right)N}$; replacing $\frac{1}{N^2}$ by μ^2 we obtain $\frac{\sigma^2}{\mu^2 N}$, so, $HHI = \frac{1}{N} + \frac{\sigma^2}{\mu^2 N} \Rightarrow HHI = CV^2\frac{1}{N} \Rightarrow HHI = \frac{CV^2+1}{N} \Rightarrow CV = \sqrt{NHHI - 1}$.

lower bound to concentration. Another one pertains to the upper bound to concentration which is invariant to market size and monopoly can appear in equilibrium in large markets. Finally, using the full population of firms, we provide evidence that the airline industry is a natural oligopoly: one to three firms have a dominant position in each market regardless of market size.

In this article we estimate the lower bound and the upper bound using stochastic frontier. This technique is robust to outliers and allows low concentration disequilibria. We estimate the following equation:

$$\ln(\mathrm{HHI}/1-\mathrm{HHI}) = \beta_0 + \beta_1/\ln(\mathrm{S}) + \nu_i + u_i \qquad (1)$$

The dependent variable is the natural logarithm of the logistic transformation of HHI. β_0 and β_1 are coefficients to be estimated. The odds transformation ratio for the dependent variable[10] is employed for ensuring that predicted values of limiting level of concentration are between zero and one, as well as to prevent heteroscedasticity. The variable S denotes market size. The reciprocal of natural logarithm of size employed in (1) is based on Sutton (1991) and subsequent authors (e.g. Lyons and Matraves 1996, Ellickson 2007). This functional form allows asymptotic HHI as market size tends to infinity to depend solely on the intercept term.

The set-up costs measure used by Sutton and subsequent authors had the role to provide a homogenization across different industries. Since our analysis involves a single industry, it is reasonable to assume that the costs necessary for obtaining a single plant of minimum efficient scale are homogeneous across all city pair markets. In the airline industry the set-up costs may be associated to being operative in an airport city from which an airline services various destinations at minimum efficient scale. These costs are broadly homogeneous across route markets. As a result, the stochastic frontier models do not include a measure for set-up costs.

[10] We set HHI equal to 0.99 in monopoly routes (where the HHI assumes value equal to 1) for the estimation of the upper bound to concentration.

In the present context, the simple framework consists of a two error structures: a two sided error term (ν_i) with a normal distribution for allowing low concentration disequilibria, that is, observations are allowed to be below the lower bound, and a one sided error (u_i) to reflect the theoretical relevance of the lower bound. There are not strong theoretical reasons in choosing one particular distribution for the one sided error; usually in the literature the truncated normal, half normal, standard exponential[11] estimators have been tried for estimating a lower bound, which all gave similar results in Lyons and Matraves (1996). $\nu \sim N(0, \sigma^2)$ represents the stochastic component for the two-sided error term; for the one-sided error term, we assume $\mathrm{u \sim Half - Normal\ (\delta), u \sim Truncated - Normal\ (\varphi), u \sim Exponential(\lambda)}$. Following Greene (fifth edition), the stochastic frontier model given by (1) states that it is defined a relationship between market size and concentration. For any given value of market size the observed value of concentration must be either equal to or greater than the lower bound function given by equation (1). The one-sided error term u_i needs to be positive (nothing can happen below the lower bound in the long-run). Whereas, the two-sided error terms ν_i can assume values of both sign and it serves to pick up disequilibria low concentration. Therefore since ν_i is a stochastic component which can take either positive or negative values makes the frontier stochastic. The error term u_i is a random variable which measures the distance from the bound. The stochastic frontier model for the upper bound follows the same logic.

Lower Bound to Concentration

The data set used in this article has the quite peculiar feature of right censored observations which refer to monopolies. There are 340 monopolies; these observations need to be excluded for two reasons. First, the theory underlying the lower bound to concentration does not predict monopoly outcomes; as a result, a pattern of data involving monopolies simply does not fit the theory. One theoretical explanation of monopoly outcomes, hence of the relationship between market size and

[11] It is worth noting that there are no theoretical reasons justifying either these three distributions or any others.

maximal level of concentration is provided by the upper bound theory (Vasconcelos 2006). Second, the exclusion is necessary in order to draw the graph of the stochastic fitted lower bound[12] requiring the majority of observations located above it. The distributions for the one sided error available for stochastic frontier models impose restrictions such that the estimated lower bound is dragged upward; for instance, the half normal distribution requires that much of the observation mass is close to the mode. The truncated normal and exponential distributions are similar to the half normal causing the same problem. This exclusion may raise concern of sample selection bias. However, excluding the upper bound should not bear any impact on the minimal level of concentration, as the stochastic frontier models just shift down the intercepts and there is almost no impact on the slope parameter.

Results for the lower bound estimation are shown in tables 4, 5 and 6. The three models produce similar results as they differ solely on their assumption on disturbance terms. The fitted lower bound is presented in Figure 1. The coefficient of market size is statistically significant at 10% level and points to a weak negative relation with structure. Robinson and Chiang (1996, p. 392) observe that the negative impact of market size on concentration in an endogenous sunk costs industry is evidence of the fact that markets have started with a relatively small number of firms; consequently, as market size increases number of firms increase (concentration falls) approaching the bound limit from below. For each of the three employed distributions the asymptotic HHI[13] as market size tends to infinity is well above zero. This non-fragmentation result suggests to rule out the exogenous sunk costs model while pointing to the endogenous sunk costs competitive mechanism.

We also perform lower bound regressions using alternative measures of market structure[14] (results are not reported here) which produce a null relationship between size and structure for one-firm and four-firm concentration ratios (coefficient of market size is never significant), whilst

[12] The three distributions used allow observations to be near the bound; therefore, since just over half of observations assume maximal value the distributions used tend, thus, to shift very much upward the estimated lower bound.

[13] $\text{HHI}^{\infty} = \frac{e^{\beta_0}}{1+e^{\beta_0}}$

[14] Concentration ratios C1, C2 and C4.

a similar lower bound for two-firm concentration ratio. These findings showing that sign and significance of the slope are not stable for all the market structure measures employed are suggestive that the data pattern appears consistent with endogenous sunk costs competitive mechanism.

Upper Bound to Concentration

Vasconcelos' model (2006) provides two empirically testable predictions for endogenous sunk costs industries:

1) There is a high maximum level of concentration (upper bound) even in large markets which does not depend on size;
2) Monopoly can occur at equilibrium regardless of market size.

Figure 2 shows that the maximal level of concentration, given by the estimated upper bound, does not decline as size increases, and monopoly can emerge in equilibrium. The upper bound to concentration is given by an asymptotic Herfindahl level, $HHI^{\infty} = 0.99$ using the Normal/half-normal model. In fact, in our data set we have 51% of our sample markets which are monopoly [15] lying indeed on our estimated upper bound. This empirical evidence supports Vasconcelos (2006) predictions about endogenous sunk costs industries.

A model of Bertrand competition with homogeneous products and fixed costs of entry would produce monopoly equilibrium outcomes. As a result, the upper bound to concentration could be explained alternatively by such model of Bertrand competition for homogenous products, where vertical product differentiation plays no role. The Nash equilibrium in the entry stage would be to enter if and only if no other rival has entered. Indeed, if more than one firm enters, then the usual Bertrand argument would lead to losses equal to the fixed cost of entry. The anticipation of this will suffice to get market structure equilibrium with only one firm charging at unit variable cost. However, the result found earlier of a positive and substantially high lower bound to

[15] As monopolies are considered markets with a dominant airline with at least 99% of market shares.

concentration as market size increases suggests vertical product differentiation. As a result, the maximal level of concentration coinciding with monopoly equilibria regardless of market size appears to be consistent with the empirical prediction of the upper bound theory.

Natural Oligopoly

Now, our objective is to provide evidence that structure of this industry is best explained by the natural oligopoly theory developed by Shaked and Sutton (1983). The Shaked and Sutton's early paper develops a necessary and sufficient condition for the *finiteness property*. The finiteness property states that there exists, for an interval of qualities $[\underline{u}, \overline{u}]$, a Nash equilibrium constituted by an upper bound to the number of single product firms with positive market shares charging price above marginal cost. Price competition drives down prices such that even the poorest consumer will not buy low quality products. The condition necessary and sufficient for existence of the finiteness property relies to the fact that there need to be no consumer indifferent between alternative products; consequently, all consumers agree in ranking the qualities in exactly the same order.

The finiteness property is more likely to be present in those vertically product differentiated industries where quality is enhanced through fixed costs; whereas, variable costs remain constant or increase very modestly or even decrease as quality rises.

Table 7 provides information on number of structures, in terms of firm numbers. We note that the majority, 93%, of markets have at most four firms.

Given the market structure of our sample, firm numbers and market share asymmetry can be shown by a simple geometric device, the oligopoly triangle (Davies, Olczak and Coles (2011)). It provides a useful representation of structural features of markets in terms of concentration and asymmetries. Figure 3 depicts the oligopoly triangle with S2 (second largest airline) on the horizontal axis and S1 (largest airline) on the vertical axis. The concentration in the triangle is given by the sum of top two firms in each market (S1+S2). Moving toward North-West we find

high concentration and extremely pronounced asymmetries up to the North-West vertex of the triangle which identifies monopoly; whilst, moving from the North-West vertex toward South-East along the edge we have markets less asymmetric up to the South-East vertex which represents symmetric duopoly. Also, starting from monopoly and moving down toward South we find markets with lower concentration and greater symmetry up to the South vertex representing a perfectly symmetric triopoly. The vast majority of airline markets of our sample are fitted into the small triangle delimited by the above described vertices. In addition, most of those markets inside the small triangle show very high concentration and strong market share asymmetry. Relatively few markets lie outside our small triangle, showing smaller concentration and smaller size asymmetry moving down toward South nearer to the forty-five degree line. These city pair markets appear to have a fairly sizeable fringe. In addition, all markets with three or fewer airlines must be inside the small triangle, but the reverse is not necessarily true. In other words, some markets with more than three firms may lie inside the small triangle[16].

Figures 4-6 depict the triangle for different market structures. First, we note that among the 159 duopolies we find, at one extreme, those with one dominant firm accounting for the majority of shares; while at the other extreme, we observe those duopolies that are, more or less, symmetric; in between, our sample includes genuine, but still, rather asymmetric duopolies. The triopoly triangle, along as a limited number of symmetric triopolies, shows many markets with considerable market share asymmetry. Also, there are triopolies dominated by one very big firm. Finally, figure 6 proposes the triangle for the 80 oligopolies with more than three firms. All markets inside the triangle are dominated by at most two firms; thus, having small third and following firms. In contrast, below the triangle we envisage 30 markets with more than two leading airlines; these are mainly triopolies and few quadropolies.

We can derive the following stylized facts:

FACT 1: from table 7 we learn that just above half of our observations consist of monopoly routes.

[16] Davies, Olczak and Coles (2011) develop and characterize fully the oligopoly triangle and its properties.

FACT 2: from the oligopoly triangles we infer considerable firm size inequality.

FACT 3: table 7 also suggests that duopolies account for about one-quarter, and triopolies represent a further 12% of the sample (eighty-two markets).

FACT 4: table 7 finally says that markets with more than four firms represent a rather negligible portion of our sample, approximately 6%.

FACT 5: of the 159 duopolies, 88 have the largest firm[17] with over three-quarter of market shares, that is, $s1 > 0.75$; then 33 are characterized by $0.6 < s1 < 0.75$; whilst, for the remaining 38 duopolies we have $s1 \leq 0.6$, constituting fairly symmetric duopolies.

FACT 6: 80% of the triopolies (66 markets) have a quite tiny third firm with a market shares up to 20%; for the remaining triopolies, 16 city pairs, the third airline has market shares sandwiched between 32% and 20%.

FACT 7: from tables 8-13, we can observe that among the 80 markets with four or more firms solely two (those highlighted in bold) have the first two largest firms possessing a combined share lower than 50%.

These facts lead to two obvious observations, i) just over half of our sample markets consists of monopolies; ii) we have considerable firm size inequality within oligopolies; and one more analytical result: inspecting tables 8-13, given figures 3-6 and using facts 5-7, we deduce that the number of dominant airlines, those taking up the majority of market shares, is between 1 and 3 regardless of market size. This evidence suggests that the industry is a natural oligopoly.

5 Market Share Asymmetry: Empirical Results

In the previous section we applied the bounds approach to market structure, providing evidence on various predictions of the ESC model. Here we continue the theme of studying concentration, again with the aim to deduce information on the competitive mechanisms at work; but, this time, we use an approach in the spirit of Bresnahan and Reiss's (1991) work. The methodology of this

[17] We denote with s_i the market shares of firm i-th.

section and the next one complements the analysis performed in section four by analysing concentration above the lower bound and below the upper bound.

In particular, the considerable asymmetry found within oligopolies deserves formal analysis. Our dependent variable is the coefficient of variation of market shares, taking into account the full set of firms in our dataset.

Clearly, monopoly city pairs produce a coefficient of variation equal to zero. Given the large fraction of monopolies in our sample (just over 50%), the distribution of our dependent variable appears to be censored; as a result, it calls for the need to apply Tobit estimation. However, the Tobit method is not valid under assumptions of non-normality; it produces, in fact, not consistent estimates when distribution of data for the dependent variable is not normal. We apply the Shapiro-Wilk test for normality (Shapiro and Wilk 1965) which suggests rejecting the null hypothesis of normal distribution; consequently, we cannot apply Tobit technique.

An econometric estimator which is consistent and asymptotic normal is the censored least absolute deviations estimator (CLAD) (Powell 1984). Essentially, the method generalizes the quantile regression (least absolute deviations, LAD) for censored data. In addition, CLAD proves robust to heteroscedasticity; indeed, the standard errors are estimated by bootstrap techniques.

Results are reported in table 14. Route markets with longer distance appear to be more symmetric with significance at 1% level; whereas, the large hub dummies have evidence of positive coefficients, thus of larger market share asymmetry. Market size and the tourist dummy bring evidence of bearing no effect. The distance variable proxies costs, essentially due to fuel, which are the same for all airlines within a market and it attenuates size inequality; as a consequence, routes with longer distance indicates an equal increase of costs for all the firms, then bringing down market share asymmetry.

To interpret meaningfully the estimates, we need to refer on what economic theory says about the link between market share asymmetry and product market competition. For the three dummies, *Tourist*, *Two-hub* and *One-hub*, more than one effect may be at work. First, there may

be a size effect; tourist and large hub markets may have real size which could not be represented by just the product of populations of end point cities, therefore these dummies control for possible bias of our market size measure. In addition, in these markets the nature of competition may differ. In particular, tourist markets may be characterized by tougher price competition since demand may be more elastic, making price undercutting more profitable. In large hub markets the nature of competition may lead a priori to either fiercer or softer competition. Previous literature tend to suggest that competition may well be limited in hub city pairs (Borenstein and Rose 2008 provides a good review); however, there may be the case that dominant firms running the hub need to compete fiercely in order to maintain and consolidate their leadership (e.g. Etro 2006). Consequently, the expected coefficient' sign for large hub markets is indeterminate.

City pairs with greater traffic flow, large hub routes identified by the two dummies two-hub and one-hub, show evidence of more pronounced market share asymmetry. Intuition and theoretical literature suggest that higher firm size inequalities may signal tougher product-market competition. Suppose a vertical differentiated products oligopoly in the sense of Shaked and Sutton (1982). If firms compete a' la Bertrand, the higher quality firm will get most of the market; whereas, in case of Cournot competition, the higher quality firm will obtain bigger market shares but not as much as in the Bertrand case. Supposing collusive conduct, we do not know exactly but generally the firms might split the market fifty/fifty. Also, the theoretical literature on collusion and, empirical evidence on cartels seem to point out that coordinated strategies are harder to sustain when firms are less symmetric in terms of market shares.

The set of dummies for identities of leaders have all statistically significant coefficients but that of Southwest, and positive in sign. Therefore, we have evidence of greater market share asymmetry when one leader is present. The strongest effect on size inequality appears to be that of US Airways, which has the biggest coefficient. Following the argument, as set above, of interpreting bigger size inequalities as signal of more intense product market competition, we can

infer that each leader, surprisingly except the low-cost airline Southwest, contributes to intensify product market competition.

6 Competitive Effects between Leaders and non-Leader airlines

This section asks the question: what is the competitive effect, hence nature of competition, between leaders and non-leader airlines? We assume that firms enter sequentially, where the most profitable move first. We argue that the leaders, having a wide route structure, are more profitable[18] hence enter first. Consequently, non-leaders entry decisions are taken when already one or more leaders are in the market. We employ ordered probit models using as dependent variables the number of non-leading airlines observed in city pair markets; among the covariates we include the number of the leaders. We also control for a vector of market characteristics, the same used in the previous section.

Table 15 shows results about the impact of number of leading airlines on non-leaders. The empirical analysis is restricted to those city pair markets with at least one leader. Market size and large one-hub bring evidence of being not significant. Distance appears to have a highly significant negative relationship with number of non-leaders. There is evidence that in tourist and in large two-hub markets the number of non-leaders is greater. Our variable of greatest interest here is the number of leaders. We note strong evidence that as the number of leaders increases so the number of non-leaders does.

The positive relationship we have found bears the question whether using identities of leaders confirms the results; in addition, we can explore whether specific leaders affect differently the number of non-leaders. In other words, the leaders may offer different quality among themselves, therefore there may be differences of vertical product differentiation among the group of leading airlines (e.g. some may engage in greater investments in advertising and for expanding route structure). The analysis continues to be restricted to those city pairs with at least one leader.

[18] Borenstein and Rose (2008) reviews a literature which argues in part that running a hub and spoke network bears demand and costs advantages. See also Levine (1987).

Table 16 reports the impact of the identities of the leaders; it shows that only the airlines American, Delta and US Airways have evidence of statistically significant coefficients. The evidence of a positive coefficient suggests that the number of non-leaders is bigger in routes where these three leaders operate.

To explore leader heterogeneity, we compare results shown in table 16 with a series of regressions reporting each leader in turn. Each dummy takes the value of one when the leader, say American, is present and of zero when one or more of the other six leaders are present. The logic is to ascertain if and at what extent the leading airlines differ among themselves in affecting the number of non-leaders. We report results of only those two regressions regarding American and US Airways that have statistically significant coefficients. Tables 17-18 report results which broadly confirm those of table 16, except of the not significant coefficient for Delta. To conclude, the two leaders, American and US Airways, appear to have an additional effect on the number of non-leaders compared to the other leading airlines.

The results documented in tables 15-18 are, somewhat, not explainable by traditional theories of entry. In fact, what we would expect is a negative effect of the number of leaders and their identities upon the number of non-leaders. This is because a firm choosing to enter in either a monopolistic market or into one in which it faces competition, all else equal, will choose the former. Entry deterrence would exacerbate this prediction. In particular, with sequential entry the first mover can prevent entry by product proliferation (e.g. Schmalensee 1978, Bonanno 1987, Hay 1976). In contrast, theories of learning (e.g. Baum, Li and Usher 2000; Caplin and Leahy 1998) provide a theoretical rationale for firms learning size and profitability of markets for means of observing rivals' decisions of entry and operation. In particular, Caplin and Leahy propose a formal model to capturing an information externality. This externality refers to the fact that firms assess demand and profitability of a market through waiting and observing for success (or failure) of rivals entering that market. Therefore, presence of the leaders in airline city pair markets may signal good profitability, thus, encouraging entry by small non-leader airlines.

Clearly, our analysis being in cross section does not really pick up dynamics, hence learning effects. However, the evidence seems consistent with the possibility of a learning process which would reflect the snapshot we observe.

Robustness checks. We re-estimate our ordered probit models inserting the market characteristic variables also in non-linear way (square and natural log) under the reasoning that possible nonlinearities may bias the coefficients of the market structure variables. In addition, we exclude the market characteristic with insignificant coefficients. Finally, we try different econometric techniques, OLS and Poisson model. The results of our market structure variables, documented in tables 19-24, are nearly the same as those in the baseline specifications.

Alternative Hypotheses

The results of section 6 appear to be consistent with evidence of learning. Non-Leader airlines infer size and profitability of routes from presence of leader airlines; in particular, American and US Airways appear to perpetrate an additional positive effect on the number of non-leaders. Now, we discuss potential alternative explanations to these findings.

A) Mature Industry

Our reading and interpretation of the results of this section may be subjected to criticism. Size and profitability of airline city pair markets should be well known as full deregulation took place in late seventies; therefore, the learning argument in our context may be flawed. However, the airline industry is subjected to extremely high demand volatility and uncertainty (e.g. Borenstein and Rose 2008); consequently, this high degree of uncertainty may warrant learning behaviour even in this mature industry.

B) Crowd Externality

The same phenomenon may be explained by a theory of crowd externality, Rauch (1993). The author formalizes the idea that later entrants benefit from a crowd made by two or more incumbents; the intuition is that there may be positive spillovers among firms. However, it is unlikely to get a story consistent with the crowd externality involving positive spillovers among airlines operating on a route. Actually, we may well obtain a negative crowd externality because of delays and congestion costs which can reduce demand.

C) Competition head-to-head

Consider that in section four we provide evidence that airlines engage in endogenous sunk costs escalation in advertising and in expanding route structure. A direct implication of the endogenous sunk costs model is that firms compete head-to-head. This is because, any firm vis-à-vis rivals can carve out a fraction of consumers by increasing sunk fixed outlays. Consequently, our results of positive effects of the number of leaders on non-leaders may be explained by competition head-to-head. However, this interpretation is not valid for the non-leaders. Each airline of this group has a fairly tiny route structure; as a result, they do not escalate investments in expanding network of routes from end points of the city pairs. Also advertising expenditure may be lower than that of leaders. The non-leaders then are not involved in competition head-to-head as they may operate at the lower end of the quality spectrum. In contrast, given the evidence of data patterns it appears more plausible the interpretation that non-leaders infer market profitability by observing leaders' behaviour, as rationalized by the theories of learning.

D) Strategic Complementarities

Non-leader and leader airlines offer air transport service between end points of city pairs; such competitive environment is characterized by strategic substitutability. However, this type of service can involve strategic complementarity when some non-leaders are regional airlines

operating routes on behalf or in partnership with some national leaders. This is, indeed, the case in our dataset; there are 16 non-leaders that are regional airlines with business links with some of the leaders. In order to account for this strategic complement activity, in the econometric analysis of this section we have excluded the regional carriers with links with the leaders, re-computing the variable number of non-leaders. Consequently, all the results reported in tables 15-24 are robust to the strategic complementarity effect.

7 Discussion

Results of this article paint a picture about the underlying competitive process at work in the airline industry. These results also help identifying those competition models that are and those which are not appropriate as candidate explanations of market structure and firms' conduct about the airline industry.

Models of competition with homogenous products and exogenous fixed sunk costs (Sutton 1991) are excluded in explaining the industrial organization of the airline industry, since fragmentation must occur. A fragmentation result is predicted also for horizontally differentiated industries with single-product firms and simultaneous entry (Shaked and Sutton 1990), contrasting therefore our finding. Models with either competition on a line, Hotelling (1929), D'Aspremont, Gabszewicz and Thisse (1979), or on a circle, Salop (1979) are not appropriate for two reasons: i) the airline industry is multi-product and more importantly ii) because a larger market size leaves room for a greater number of firms to enter in the market, and therefore concentration would be low, which here clearly it is not.

The finding of a lower bound to concentration not converging to zero when market size grows is inconsistent even with competition models of vertical differentiated products where quality investments are sustained by an escalation of variable costs, which gives rise to an increase of marginal costs. That context is identified, for example, by the restaurant industry. Indeed, Berry and Waldfogel (2010) finds that this industry fragments as market size grows and restaurant firms

provide distinct products in terms of quality. Clearly, serving better food (so higher quality) implies investments in variable costs.

The empirical findings of non-fragmentation and existence of an upper bound to concentration invariant to market size are suggestive of evidence that structure and behaviour of our industry is best explained by a model of endogenous sunk costs (Sutton 1991; Vasconcelos 2006), and by the early vertical product differentiation literature (Gabszewicz and Thisse 1979, 1980; Shaked and Sutton 1982, 1983). This strand of vertical differentiation literature is characterized by the idea that quality is improved through fixed sunk outlays, and variable costs either remain constant or increase modestly (‘*the increase of unit variable cost is strictly less than the marginal valuation of the richest consumer’*, Shaked and Sutton 1987, p. 136). High concentration is also proved in a theoretical framework combining vertical and horizontal product differentiation (Shaked and Sutton 1987), which is consistent with our results of concentrated equilibria.

In addition to the endogenous sunk costs model, the finding of maximal level of concentration constant at any size is supported by a class of models encompassing horizontal product differentiation: i) theoretical models of multiproduct firms entering sequentially, therefore filling all profitable niches by product proliferation (Schmalensee 1978); ii) of monopolist’s location choice (Bonanno 1987); iii) explanations of local monopolies (Prescott and Visscher 1977, Eaton and Lipsey 1979 and Reynolds 1987).

One of endogenous sunk costs sources in our industry, route structure, may be interpreted as investments in extra capacity with the goal to deter entry. In fact, airlines increasing the number of routes serviced from endpoints of a city pair are potentially prepared to supply bigger output (more routes may imply more flights hence more passenger miles travelled). Therefore, our results of high concentration are also consistent with the class of models involving capacity investment decisions to deter entry (Spence 1977, 1979; Dixit 1979, 1980; Bulow, Geanakopolos and Klemperer 1985).

Along as the results of non-fragmentation and monopoly at any size, we find evidence of a further prediction of the endogenous sunk costs model: natural oligopoly. Indeed, we find that dominant firms are between one and three in each market, regardless of market size. This result further suggests evidence consistent with vertical product differentiation where quality is improved with escalation of sunk costs. The findings of non-fragmentation and natural oligopoly are obtained also by Ellickson (2007) for the U.S. supermarket industry.

The result of greater firm size inequality in large hub city pair markets merits further discussion and clarification. Clearly, market share asymmetry may be the result of several factors such as, capacity differences, cost heterogeneity, differences in quality (vertical product differentiation). Our econometric model for size inequality cannot tell which of these factors have determined the asymmetry, since data on capacity, costs, or quality measures is hardly available. However, the results on firm size inequality seem to lend support to the hypothesis that product-market competition is tougher in large hub markets and in markets with airlines having a wide route structure (leaders). As a consequence, the evidence on asymmetries suggests that the nature of competition changes in large hub routes as well as in presence of leaders.

We have found in the previous section empirical evidence that, markets with a bigger number of leaders as well as those with presence of American, Delta and US show a positive relation with number of non-leaders. These patterns in the data suggest that markets with leaders receive more entry from non-leader airlines. The proposed interpretation, as discussed in the previous section, is that of learning. Toivanen and Waterson (2005) provide empirical evidence of learning for the UK counter service burger industry.

8 Conclusion

In this article we present empirical evidence on the determinants and competitive forces generating equilibrium market structure in the U.S. airline industry. Using a novel data set for a large cross-section sample of airline city pair markets, we find evidence that the ESC model

applies to the air transportation, where airlines can enhance consumers' willingness to pay through advertising and expansion of route structure from end points of the city pairs; consequently, we obtain evidence of non-fragmentation and monopoly even for many large routes. Second, using our full set of firms we find that irrespective of market size the number of dominant firms is between one and three, suggesting that the structure of our industry mirrors a natural oligopoly.

The next step in the analysis has been to model empirically market share asymmetry to deduce the nature of competition beyond the bounds approach. Main results refer to greater size inequality for large hub routes as well as for identities of leaders, apart from Southwest, which appears consistent with tougher product market competition for these city pairs.

We then empirically analyse competitive interactions between two types of airlines, leaders and non-leaders. The main finding is evidence consistent with learning; non-leaders tend to infer profitability of markets from leaders. In particular, the leaders American, Delta, and US Airways seem to have an additional effect in signalling market profitability to non-leader airlines.

The results of this article paint a rather detailed portrait of the underlying competitive process at work. To understand competition is of great importance for antitrust authorities, as well as for firms that need to comprehend the competitive environment in order to better interact strategically with rivals. In addition, we feel that our article contributes to the debate (Borenstein and Rose 2008) of how competition works in the airline industry, after more than three decades of deregulation.

References

Aguirregabiria, V., and Chun-Yu Ho, (2010), “A Dynamic Game of Airline Network Competition: Hub-and-Spoke Networks and Entry Deterrence”, International Journal of Industrial Organization, Vol. 28, pp. 377-382.

Bain, J.S., (1956), *Barriers to New Competition: Their Character and Consequences in Manufacturing Industries*, Harvard University Press, Cambridge, MA.

Balasubramanian, N., and Lieberman, M.B., (2011), “Learning by Doing and Market Structure”, Journal of Industrial Economics, Vol. 59, pp. 177-198.

G. Bamberger, G., Carlton, D., and Neumann, L., (2004), “An Empirical Investigation of the Competitive Effects of Domestic Airline Alliances”, Journal of Law and Economics, Vol. 47, pp. 195-222.

Baum, J.A.C., Li, S.X., and Usher, J.M., (2000), “Making the Next Move: How Experimental and Vicarious Learning Shape the Locations of Chains’ Acquisitions”, Administrative Science Quarterly, Vol. 45, pp. 766-801.

Belobaba, P., (November 2010), “US Airline Competition and Consolidation 2010”, Global Airline Industry Program, Massachusetts Institute of Technology.

Berry, S., (1992), “Estimation of a model of entry in the Airline Industry”, Econometrica, Vol. 60, pp. 889-917.

Berry, S., and Waldfogel, J., (1999), “Free Entry and Social Inefficiency in Radio Broadcasting”, Rand Journal of Economics, Vol. 30, pp. 397-420.

Berry, S., and Waldfogel, J., (2010), “Product Quality and Market Size”, Journal of Industrial Economics, pp. 1-31.

Bonanno, G., (1987), “Location Choice, Product Proliferation, and Entry Deterrence”, Review of Economic Studies, Vol. 54, pp. 37-46.

Borenstein, S., (1989), “Hubs and High Fares: Dominance and Market Power in the U.S. Airline Industry”, RAND Journal of Economics, Vol. 20, No. 3, pp. 344-365.

Borenstein, S., (1991), “The Dominant-firm Advantage in Multi-product Industries: Evidence from the U.S. Airlines”, Quarterly Journal of Economics, Vol. 106, pp. 1237-1266.

Borenstein, S., (2005), “US Domestic Airline Pricing, 1995-2004”, Competition Policy Center Working Paper CPC05-48, University of California, Berkeley.

Borenstein, S., and Rose, N.L., (2008), “How Airline Markets Work…or Do They? Regulatory Reform in the Airline Industry”, NBER working paper series.

Brander, J., and Zhang, A., (1990), “Market Conduct in the Airline Industry: An Empirical Investigation”, RAND Journal of Economics, Vol. 21, pp. 567-583.

Bresnahan, T.F., and Reiss, P.C., (1991), “Entry and Competition in Concentrated Markets”, Journal of Political Economy, Vol. 99, pp. 977-1009.

Brueckner, J.K., Lee, D., and Singer, E., (2010), “City-Pairs vs. Airport-Pairs: A Market-Definition Methodology for the Airline Industry”, working paper.

Bulow, J., Geanakopolos, J., Klemperer, P., (1985), “Holding Idle Capacity to Deter Entry”, Economic Journal, Vol. 95, pp. 178-182.

Caplin, A., and Leahy, J., (1998), “Miracle on Sixth Avenue: Information Externality and Search”, Economic Journal, Vol. 108, pp. 60-74.

Charles, Ng., and P. Seabright, P., (2001), “Competition, Privatisation and Productive Efficiency: Evidence from the Airline Industry”, Economic Journal, Vol. 111, pp. 591-619.

Ciliberto, F., and Tamer, E., (2009), “Market Structure and Multiple Equilibria in the Airline Industry”, Econometrica, Vol. 77, pp. 1791-1828.

Cleeren, K., Verboven, F., Dekimpe, M.G., and Gielens, K., (2010), “Intra- and Inter- Format Competition among Discounters and Supermarkets”, Marketing Science, Vol. 29, pp. 456-473.

Cohen, A.M. and Mazzeo M.J., (2007), “Market Structure and Competition among Retail Depository Institutions”, Review of Economics and Statistics, Vol. 89, pp. 60-74.

Curry, B., and George, K., (1983), “Industrial Concentration: A Survey”, Journal of Industrial Economics, Vol. 31, pp. 203-257.

D’Aspremont, C., Jaskold Gabszewicz, J., and Thisse, J.F., (1979), “On Hotelling’s ‘Stability in Competition”, Econometrica, Vol. 47, pp. 1145-1150.

Davies, S.W., (1988), “Concentration”, in Davies, Lyons, Dixon and Geroski, *Economics of Industrial Organization*, (London: Longmans).

Davies, S.W., and Lyons, B., (1982), “Seller Concentration: The Technological Explanation and Demand Uncertainty”, Economic Journal, Vol. 92, pp. 903-912.

Davies, S.W., and P.A., Geroski, (1997), “Changes in Concentration, Turbulence, and the Dynamics of Market Shares”, Review of Economics and Statistics, Vol. 79, pp. 383-391.

Davies, S.W., and Lyons, B., (1996), *Industrial Organization in the European Union: Structure, Strategy, and the Competitive Mechanism*, Oxford, Oxford University Press.

Davies, S.W, Olczak, M., and Coles, H., (2011), “Tacit Collusion, firm asymmetries and numbers: Evidence from EC merger cases”, International Journal of Industrial Organization, pp. 1-11.

Dick, A., (2007), “Market Size, Service Quality and Competition in Banking”, Journal of Money, Credit and Banking, Vol. 39, pp. 49-81.

Dixit, A., (1979), “A Model of Duopoly Suggesting a Theory of Entry Barriers”, Bell Journal of Economics, Vol. 10, pp. 20-32.

Dixit, A., (1980), “The Role of Investment in Entry Deterrence”, Economic Journal, Vol. 90, pp. 95-106.

Doganis, R., (2001), *The Airline Business*, 2nd edition, New York: Routledge.

Eaton, B. C. and Lipsey, R. G., (1979), "The Theory of Market Preemption: The Persistence of Excess Capacity and Monopoly in Growing Spatial Markets", Econometrica, pp. 149-158.

Ellickson, P.B., (2007), "Does Sutton Apply to Supermarkets?" RAND Journal of Economics, Vol. 38, pp. 43-59.

Etro, F., (2006), "Aggressive Leaders", RAND Journal of Economics, Vol. 37, pp. 146-154.

Evans, W., Froeb, L., and Werden, G., (1993), "Endogenous in the Concentration-Price Relationship: Causes, Consequences, and Cures", Journal of Industrial Economics, Vol. 41, No. 4, pp. 431-438.

Evans, W., and Kessides, I., (1993), "Localized Market Power in the U.S. Airline Industry", Review of Economics and Statistics, Vol. 75, No. 1, pp. 66-75.

Gabszewicz, J., and Thisse, J.F., (1979), "Price Competition, Quality and Income Disparities", Journal of Economic Theory, Vol. 20, pp. 340-359.

Gabszewicz, J., and Thisse, J.F., (1980), "Entry (and Exit) in a Differentiated Industry", Journal of Economic Theory, Vol. 22, pp. 327-338.

Geroski, P.A., and Machin, S., (1992), "The Dynamics of Corporate Growth", mimeo, London Business School.

Gibrat, R., (1931), *Les inégalités économiques ; applications : aux inégalités des richesses, a` la concentration des enterprises, aux popolations, des villes, aux statistiques des familles, etc., d' une loi nouvelle, la loi de l' effet proportionnel*, Librairie du Recueil Sirey, Paris.

Giorgetti, M.L., (2003), "Lower Bound Estimation – Quantile Regression and Simplex Method: An application to Italian Manufacturing sectors", Journal of Industrial Economics, Vol. 51 pp. 113-120.

Greene, W.H., (fifth edition), *Econometric Analysis*, Prentice Hall International Edition.

Hall, B., (1987), "The Relationship between Firm Size and Firm Growth in the US Manufacturing Sector", Journal of Industrial Economics, Vol. 35, pp. 586-606.

Hay, D.A., (1976), "Sequential Entry and Entry-Deterring Strategies in Spatial Competition", Oxford Economic Papers, Vol. 28, pp. 240-257.

Hart, P.E., and Prais, S.J., (1956), "The Analysis of Business Concentration: A Statistical Approach", Journal of the Royal Statistical Society, (Series A), Vol. 119, pp. 150-181.

Hotelling, H., (1929), "Stability in Competition", Economic Journal, Vol. 39, pp. 41-57.

Ijiri, Y., and Simon, H., (1964), "Business firm growth and size", American Economic Review, Vol. 54, pp. 77-89.

Ijiri, Y., and Simon, H., (1977), *Skew Distributions and the Sizes of Business Firms*, North-Holland, Amsterdam.

Jovanovic, B., (1982), “Selection and the evolution of industry”, Econometrica, Vol. 50, pp. 649-670.

Latcovich, S., and Smith, H., (2001), “Pricing, Sunk costs, and Market Structure Online: Evidence from Book Retailing”, Oxford Review of Economic Policy, Vol. 17, pp. 217-234.

Lederman, M., (2007), “Do Enhancements to Loyalty Programs Affect Demand? The Impact of International Frequent Flyer Partnerships on Domestic Airline Demand”, RAND Journal of Economics, Vol. 38, pp. 1134-1158.

Lederman, M., (2008), “Are Frequent Flyer Programs a Cause of the Hub Premium?” Journal of Economics and Management Strategy, Vol. 17, pp. 35-66.

Levine, M., (1987), “Airline Competition in Deregulated Markets: Theory, Firm Strategy and Public Policy”, Yale Journal on Regulation, Vol. 4, pp. 393-494.

Lyons, B., and Matraves, C., (1996), “Industrial Concentration”, chapter 6 in Davies and Lyons (1996) *Industrial Organization in the European Union: Structure, Strategy, and the Competitive Mechanism*, Oxford, Oxford University Press.

Lyons, B., Matraves, C., and P. Moffatt, (2001), “Industrial Concentration and Market Integration in the European Union”, Economica, Vol. 68, pp. 1-26.

Marin, P., (1995), “Competition in European Aviation: Pricing Policy and Market Structure”, Journal of Industrial Economics, Vol. 43, No. 2, pp. 141-159.

Mazzeo, M.J., (2002), “Product choice and oligopoly market structure”, RAND Journal of Economics, Vol. 33, pp. 221-242.

Mazzeo, M.J., (2003), “Competition and Service Quality in the U.S. Airline Industry”, Review of Industrial Organization, Vol. 22, pp. 275-296.

McFadden, D., (1989), “Method of Simulated Moments for Estimation of Discrete Response Models without Numerical Integration”, Econometrica, Vol. 57, pp. 995-1026.

Neven, D.J., Lars-Hendrik Roller, and Zhentang Zhang, (2006), ”Endogenous Costs and Price-Cost Margins: an Application to the European airline Industry”, Journal of Industrial Economics, Vol. 54, pp. 351-368.

Nielsen Media Research, (2007).

Pakes, A., Pollard, D., (1989), “Simulation and the Asymptotics of Optimization Estimators”, Econometrica, Vol. 54, pp. 1027-1057.

Powell, J.L., (1984), “Least Absolute Deviations Estimation for the Censored Regression Model”, Journal of Econometrics, Vol. 25, pp. 303-325.

Prescott, E., Visscher, M., (1977), “Sequential Location among Firms with Foresight”, Bell Journal of Economics, Vol. 8, pp. 378-393.

Rauch, J., (1993), “Does History Matter Only When It Matters Little? The Case of City-Industry Locations”, Quarterly Journal of Economics, Vol. 108, pp. 843-867.

Reynolds, S., (1987), “Capacity Investment, Preemption and Commitment in an Infinite Horizon”, International Economic Review, Vol. 28, pp. 69-88.

Robinson, W.T., and Chiang, J., (1996), “Are Sutton’s predictions robust? Empirical insights into Advertising, R&D, and Concentration”, Journal of Industrial Economics, Vol. 44, pp. 389-408.

Salop, S., (1979), “Monopolistic Competition with Outside Goods”, Bell Journal of Economics, Vol. 10, pp. 141-156.

Schaumans, C., and Verboven, F., (2008), “Entry and Regulation: Evidence from Health Care Professions”, RAND Journal of Economics, Vol. 39, pp. 949-972.

Schmalensee, R., (1978), “Entry Deterrence in the Breakfast Ready-to-Eat Cereal Industry”, Bell Journal of Economics, Vol. 9, pp. 305-327.

Seim, K., (2006), “An empirical Model of Firm Entry and Endogenous Product-Types Choices”, RAND Journal of Economics, Vol. 37, pp. 619-640.

Shaked, A., and Sutton, J., (1982), “Relaxing Price Competition through Product Differentiation”, Review of Economic Studies, pp. 3-13.

Shaked, A., and Sutton, J., (1983), “Natural Oligopolies”, Econometrica, Vol. 51, No. 5, pp. 1469-1483.

Shaked, A., and Sutton, J., (1987), “Product Differentiation and Industrial Structure”, Journal of Industrial Economics, Vol. 36, pp. 131-146.

Shaked, A., and Sutton, J., (1990), "Multiproduct Firms and Market Structure", RAND Journal of Economics, Vol. 21, pp. 45-62.

Shapiro, S.S., and Wilk, M.B., (1965), "An Analysis of Variance Test for Normality (complete samples)", Biometrika, Vol. 52, pp. 591-611.

Simon, H., and Bonini, C.P., (1958), "The Size Distribution of Business Firms", American Economic Review, Vol. 48, pp. 607-617.

Spence, M., (1977), "Entry, Capacity, Investment and Oligopolistic Pricing", Bell Journal of Economics, Vol. 8, pp. 534-544.

Spence, M., (1979), "Investment Strategy and Growth in a New Market", Bell Journal of Economics, Vol. 10, pp. 1-19.

Symeonidis, G., (2000), "Price Competition and Market Structure: The Impact of Cartel Policy on Concentration in the UK", Journal of Industrial Economics, Vol. 48, No. 1, pp. 1-26.

Sutton, J., (1991), *Sunk Costs and Market Structure: Price Competition, Advertising, and the Evolution of Concentration*, MIT Press, Cambridge, Massachusetts.

Sutton, J., (1998), *Technology and Market Structure: Theory and History*, MIT Press, Cambridge, Massachusetts.

Toivanen, O., and Waterson, M.., (2005), "Market Structure and Entry: where's the beef?" RAND Journal of Economics, Vol. 36, pp. 680-699.

Vasconcelos, H., (2006), “Endogenous Mergers in Endogenous Sunk Cost Industries”, International Journal of Industrial Organization, Vol. 24, pp. 227-250.

Appendix A: Figures

Figure 1 – Lower Bound

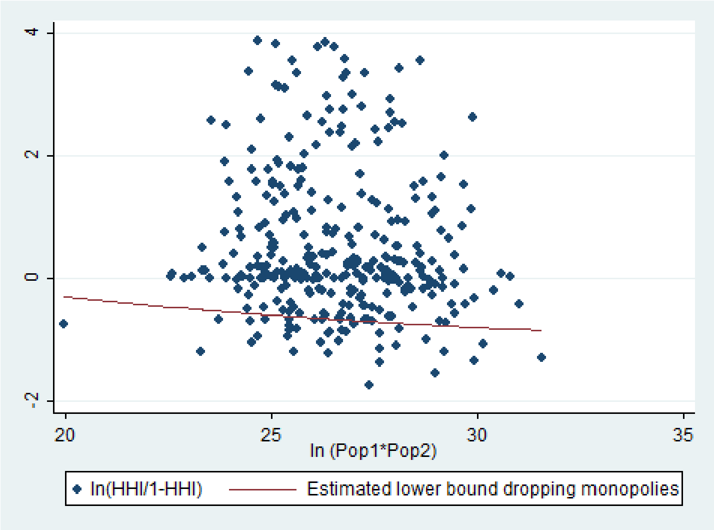


Figure 2 – Upper Bound

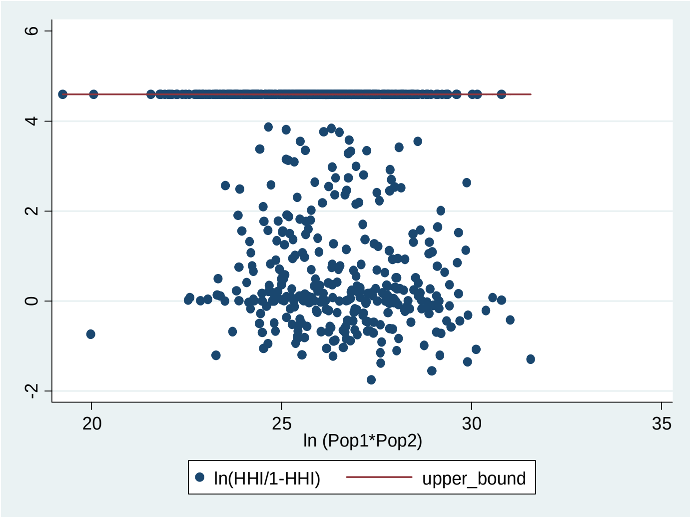


Figure 3 – Oligopoly Triangle

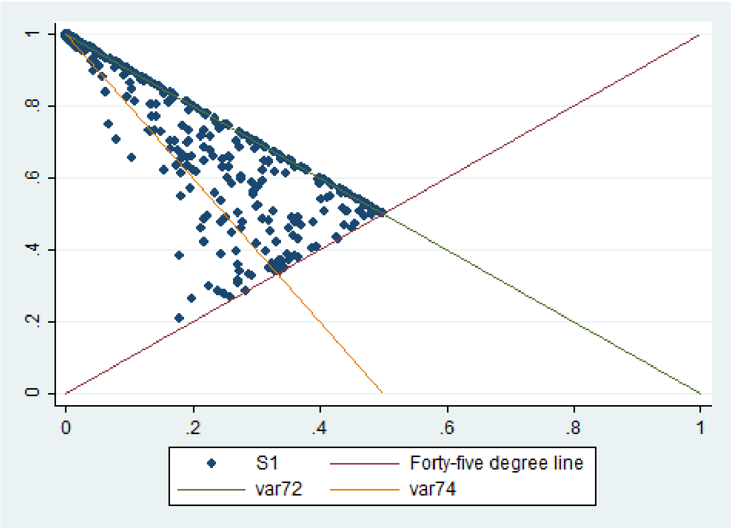


Figure 4 – Duopoly Triangle

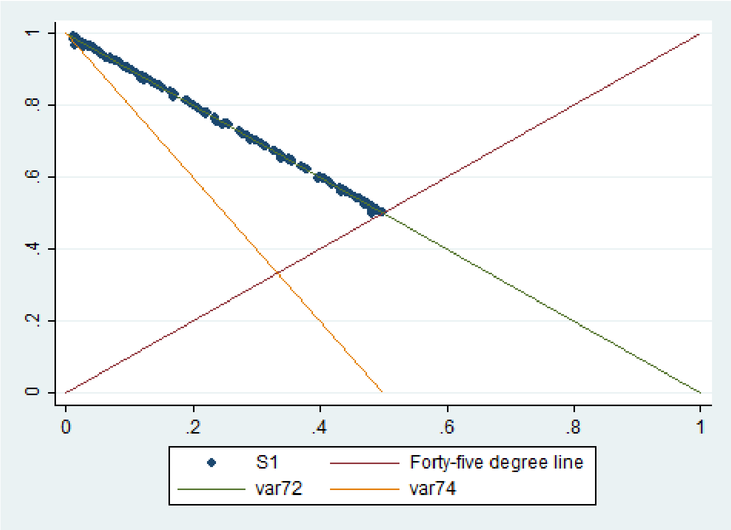


Figure 5 – Triopoly Triangle

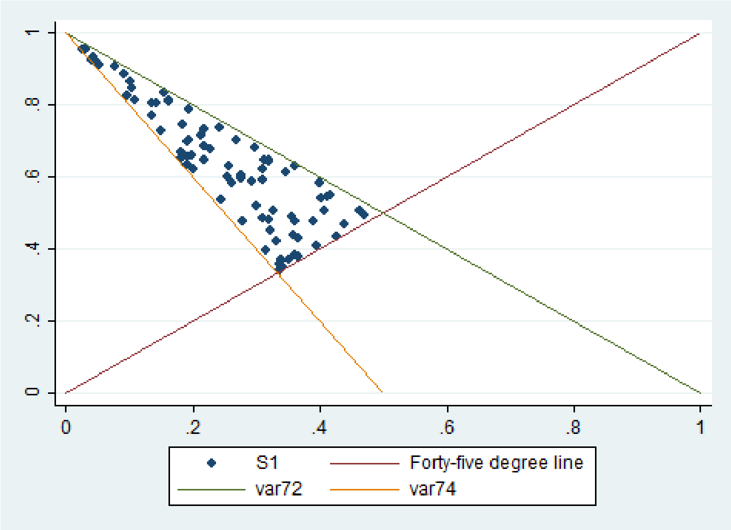
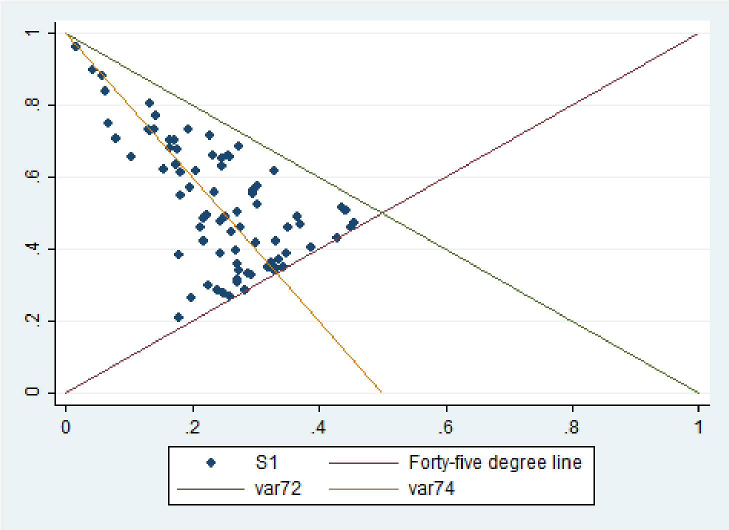


Figure 6 – Oligopoly Triangle for more than 3 firms



Appendix B: Tables

Table 1 – Number of Routes serviced by leaders and non-leaders

# Routes		
Non-Leaders		666
American	136	
Delta Air	113	
Southwest	107	
Continental	77	
US	69	
United Air	68	
Northwest	65	
Leaders		635

Table 2 – Number of markets across route characteristics

	#markets
Tourist	297
Two-Hub	115
One-Hub	370
No-Hub	176

Table 3 – Market shares and Concentration

Market shares (s1=first largest, s2= second largest)	# Markets	Mean	Std. Dev.	Min	Max
s1	661	0.840618	0.2135116	0.2077	1
s2	661	0.1162487	0.153907	0	0.499163
s1+s2	661	0.9568667	0.0969595	0.3859946	1
s1+s2≥ 0.9	557	0.9937052	0.0176541	0.90103	1
s1+s2≥ 0.7	635	0.9711814	0.0657388	0.7019867	1
HHI	661	0.7929685	0.2497254	0.1476615	1
C	661	0.3264376	0.4238894	0	1.92854
N	661	1.974281	1.387478	1	9

Table 4 – Lower Bound

Normal/Half normal	
HHI	Coef.
β_0	-2.1047**
	(0.67814)
β_1	32.7283*
	(17.79888)
$HHI^{\infty} = 0.11$	
Sample: 321	

*Significance at 10%; **Significance at 5%.

Table 5 – Lower Bound

Normal/Truncated normal	
HHI	Coef.
β_0	-1.810577**
	(0.6463253)
β_1	30.21918*
	(16.89784)
$HHI^{\infty} = 0.14$	
Sample: 321	

*Significance at 10%; **Significance at 5%.

Table 6 – Lower Bound

Normal/Exponential	
HHI	Coef.
β_0	-1.74809**
	(0.6360658)
β_1	29.67604*
	(16.72311)
$HHI^{\infty} = 0.15$	
Sample: 321	

*Significance at 10%; **Significance at 5%.

Table 7 – Number of airlines across routes

Relevant N	#Markets	Percent	Cum.
1	340	51.44	51.44
2	159	24.05	75.49
3	82	12.41	87.9
4	37	5.6	93.49
5	20	3.03	96.52
6	15	2.27	98.79
7	3	0.45	99.24
8	3	0.45	99.7
9	2	0.3	100
Total	**661**	**100**	

Table 8 – C2 for quadriopoly

S1+S2	Freq.	Percent	Cum.
0.67	1	2.7	2.7
0.6706311	1	2.7	5.41
0.6760563	1	2.7	8.11
0.6882907	1	2.7	10.81
0.6925859	1	2.7	13.51
0.7176471	1	2.7	16.22
0.7217183	1	2.7	18.92
0.73	1	2.7	21.62
0.7330416	1	2.7	24.32
0.7353135	1	2.7	27.03
0.7675993	1	2.7	29.73
0.7928994	1	2.7	32.43
0.8048381	1	2.7	35.14
0.823631	1	2.7	37.84
0.8398286	1	2.7	40.54
0.8444818	1	2.7	43.24
0.8497621	1	2.7	45.95
0.8547	1	2.7	48.65
0.8599591	1	2.7	51.35
0.8604002	1	2.7	54.05
0.8644846	1	2.7	56.76
0.8716518	1	2.7	59.46
0.8734696	1	2.7	62.16
0.8953593	1	2.7	64.86
0.9091731	1	2.7	67.57
0.9124482	1	2.7	70.27
0.9142221	1	2.7	72.97
0.9260471	1	2.7	75.68
0.9287896	1	2.7	78.38
0.9346456	1	2.7	81.08
0.9410416	1	2.7	83.78
0.9413638	1	2.7	86.49
0.9455377	1	2.7	89.19
0.9493834	1	2.7	91.89
0.9510371	1	2.7	94.59
0.9584435	1	2.7	97.3
0.9774776	1	2.7	100
Total	37	100	

Table 9 – C2 for markets with 5 firms

S1+S2	Freq.	Percent	Cum.
0.526767	1	5	5
0.565733	1	5	10
0.614144	1	5	15
0.619048	1	5	20
0.630865	1	5	25
0.636254	1	5	30
0.706139	1	5	35
0.717337	1	5	40
0.74028	1	5	45
0.773257	1	5	50
0.789488	1	5	55
0.80893	1	5	60
0.856253	1	5	65
0.858387	1	5	70
0.877023	1	5	75
0.89297	1	5	80
0.90103	1	5	85
0.916791	1	5	90
0.934777	1	5	95
0.947759	1	5	100
Total	20	100	

Table 10 – C2 for markets with 6 firms

S1+S2	Freq.	Percent	Cum.
0.523659	1	6.67	6.67
0.525892	1	6.67	13.33
0.563972	1	6.67	20
0.583433	1	6.67	26.67
0.620885	1	6.67	33.33
0.672443	1	6.67	40
0.703954	1	6.67	46.67
0.705991	1	6.67	53.33
0.751539	1	6.67	60
0.759834	1	6.67	66.67
0.775167	1	6.67	73.33
0.794185	1	6.67	80
0.821202	1	6.67	86.67
0.85157	1	6.67	93.33
0.87558	1	6.67	100
Total	15	100	

Table 11 – C2 for 7 firm markets

S1+S2	Freq.	Percent	Cum.
0.462521	1	33.33	33.33
0.630976	1	33.33	66.67
0.665541	1	33.33	100
Total	3	100	

Table 12 – C2 for 8 firm markets

S1+S2	Freq.	Percent	Cum.
0.525007	1	33.33	33.33
0.580445	1	33.33	66.67
0.815789	1	33.33	100
Total	3	100.00	

Table 13 – C2 for 9 firm markets

S1+S2	Freq.	Percent	Cum.
0.385995	1	50	50
0.784611	1	50	100
Total	2	100	

Table 14 – Determinants of market shares asymmetries

Coefficient of Variation	
Constant	-0.1765715
	(0.1323676)
Market Size	0.013
	(0.021)
Distance	-0.1986***
	(0.0546)
Tourist	-0.0239974
	(0.0895248)
Two-hubs	0.4288935***
	(0.1395093)
One-hub	0.3297011***
	(0.1248148)
American	0.2338126***
	(0.0890493)
Delta	0.3775103***
	(0.1003277)
Southwest	0.1176987
	(0.0879158)
Continental	0.4419512***
	(0.0980118)
US	0.5518142***
	(0.1016592)
United Air	0.3210188***
	(0.1230732)
Northwest	0.4122597***
	(0.1074958)

Initial sample: 661
Final sample: 340
Pseudo R^2 = 0.1663

***Significance at 1%.

Table 15 – (Ordered Probit) Effect of number of leaders

	N of non-Leaders
Market Size	0.00209
	(0.0156)
Distance	-0.2387***
	(0.0661)
Tourist	0.2583107**
	(0.1242839)
Two-hubs	0.3204127*
	(0.1775257)
One-hub	-0.0599889
	(0.1374644)
Number of Leaders	0.2465069***
	(0.053178)
Observations: 553	
Pseudo R^2 =0.0695	
Log likelihood = -427.64902	

*Significance at 10%**Significance at 5%; ***Significance at 1%.

Table 16 – (Ordered Probit) Impact of identities of leaders

Number of non-leaders	Coef.
Market Size	0.00295
	(0.0159)
Distance	-0.3322***
	(0.0000656)
Tourist	0.107342
	(0.1276621)
Two-hubs	0.2876692
	(0.1825354)
One-hub	-0.0467439
	(0.1376572)
American	0.4487804***
	(0.1302445)
Delta Air	0.354708**
	(0.1450246)
Southwest	0.1626526
	(0.1444892)
Continental	0.0089991
	(0.1608843)
US Airways	0.5264637***
	(0.1615175)
United Air	0.2527862
	(0.1768162)
Northwest	-0.0840234
	(0.1904133)
Observations: 553 Pseudo R^2 = 0.0738 Log likelihood = -425.66592	

**Significance at 5%; ***Significance at 1%.

Table 17 – (Ordered Probit) Impact of American

Number of non-leaders	Coef.
Market Size	0.0106
	(0.0154)
Distance	-0.3391***
	(0.064)
Tourist	0.1791114
	(0.1227938)
Two-hub	0.4965166**
	(0.1712169)
One-hub	0.0228884
	(0.1356346)
American	0.3406955***
	(0.1244861)
Observations: 553 Pseudo $R^2 = 0.0543$	
Log likelihood = -434.63653	

**Significance at 5%; ***Significance at 1%.

Table 18 – (Ordered Probit) Impact of US

Number of non-leaders	Coef.
Market Size	0.0171
	(0.0152)
Distance	-0.3134***
	(0.0636)
Tourist	0.1948426
	(0.1227109)
Two-hub	0.4417075**
	(0.1745801)
One-hub	-0.0024324
	(0.136049)
US	0.4211017***
	(0.1552741)
Observations: 553 Pseudo R^2 = 0.0541	
Log likelihood = -434.72525	

**Significance at 5%; ***Significance at 1%.

In tables 19-20 below, we run ordered probit models entering market characteristics in non-linear way.

Table 19

N of non-Leaders	Coef.
Market Size	0.03
	(0.0434)
Distance	0.9551*
	(0.5184)
Market Size^2	-0.000872
	(0.000965)
Distance^2	-0.207**
	(0.0893)
Ln Market Size	0.012581
	(0.04599)
Ln Distance	-0.5426072**
	(0.2570523)
Tourist	0.2347647*
	(0.1258934)
Two-hubs	0.2546031
	(0.1876702)
One-hub	-0.1023227
	(0.1415357)
N of Leaders	0.2609745***
	(0.0542042)

Observations: 553
Log Likelihood= -423.81996
Pseudo $R^2 = 0.0779$

*Significance at 10%**Significance at 5%; ***Significance at 1%.

Table 20

N of non-Leaders	Coef.
Market Size	0.0389
	(0.044)
Distance	0.5584
	(0.5295)
Market Size^2	-0.00114
	(0.000986)
Distance^2	-0.149
	(0.0907)
Ln Market Size	0.0274916
	(0.0464926)
Ln Distance	-0.44106*
	(0.2639054)
Tourist	0.0948916
	(0.1288717)
Two-hubs	0.1690407
	(0.1968855)
One-hub	-0.1056366
	(0.1424671)
American	0.4050736***
	(0.1327254)
Delta	0.3891683***
	(0.1476492)
Southwest	0.1333126
	(0.1466274)
Continental	0.0380359
	(0.1631367)
US Airways	0.5942807***
	(0.164757)
United Air	0.2698922
	(0.1797797)
Northwest	-0.0640271
	(0.1913023)

Observations: 553
Log Likelihood= -422.36773
Pseudo $R^2 = 0.0810$

*Significance at 10%; ***Significance at 1%.

In tables 21-22 we estimate ordered probit models dropping market characteristics with not significant coefficients.

Table 21

N of non-Leaders	Coef.
Distance	0.9896*
	(0.5139)
Distance^2	-0.212**
	(0.0887)
Ln Distance	-0.5516107**
	(0.2559089)
Tourist	0.2246996*
	(0.1249157)
Two-hubs	0.3822926***
	(0.1387359)
N of Leaders	0.255265***
	(0.0520977)
Observations: 553 Log Likelihood=-424.7712 Pseudo $R^2 = 0.076$	

*Significance at 10%; **Significance at 5%; ***Significance at 1%.

Table 22

N of non-Leaders	Coef.
Distance	0.6048
	(0.5162)
Distance^2	-0.147*
	(0.0889)
Ln Distance	-0.4475788*
	(0.2600395)
American	0.478701***
	(0.1269104)
Delta	0.4320289***
	(0.1406597)
Southwest	0.1859452
	(0.1427617)
Continental	0.0565525
	(0.1599735)
US Airways	0.6405332***
	(0.1557562)
United Air	0.3183849*
	(0.1725709)
Northwest	-0.0208678
	(0.1852906)

Observations: 553
Log Likelihood= -427.12532
Pseudo $R^2 = 0.0707$

*Significance at 10%; ***Significance at 1%.

In the following tables we report results using OLS and Poisson models for the baseline specification.

Table 23 – OLS

N of non-Leaders	Coef.
Constant	0.2340543***
	(0.0890672)
Market Size	-0.0019
	(0.00912)
Distance	-0.1087***
	(0.0324)
Tourist	0.1460501**
	(0.0648891)
Two-hubs	0.1756035*
	(0.0958921)
One-hub	-0.0546444
	(0.0707572)
Number of Leaders	0.1563044***
	(0.0297565)

Observations: 553
$R^2 = 0.66277$

*Significance at 10%; ** Significance at 5%; ***Significance at 1%.

Table 24 – Poisson model

N of non-Leaders	Coef.
Constant	-1.179836***
	(0.215922)
Market Size	-0.00772
	(0.0142)
Distance	-0.314***
	(0.0853)
Tourist	0.3760456**
	(0.1523001)
Two-hubs	0.3955389*
	(0.2047932)
One-hub	-0.1149848
	(0.1750198)
Number of Leaders	0.2600377***
	(0.0553179)

Observations: 553
Pseudo $R^2 = 0.0719$

*Significance at 10%; ** Significance at 5%; ***Significance at 1%.