Union Power and Product Market Competition: Evidence from the Airline Industry[1]

by

Damien J. Neven
Université de Lausanne

Lars-Hendrik Röller
Wissenschaftszentrum Berlin (WZB), Humboldt University, and INSEAD

Zhentang Zhang
Wissenschaftszentrum Berlin (WZB)

May 1999

Abstract

In this paper we specify and estimate a structural model which links product market competition and union power. The model has a two-stage setting in which wages are determined through bargaining between management and unions in the first stage, with a price-setting market game to follow in the second stage. Using data for eight European airlines from 1976-1994, we provide evidence on price-cost margins and the measurement of market power in a model of rent sharing. In particular, we provide evidence on the amount of rent being shifted and its impact on prices, wages, and consumer surplus. According to our estimates, the inefficiency resulting from rent-shifting is only 1.2 cents for every dollar of rent shifting. In this sense, the static impact of unions is largely on equity and less on efficiency: the winners are the unions and the losers the consumer, while economic efficiency is relatively unaffected.

---

1. Introduction

Casual empiricism reveals that prices in the European airline industry have traditionally been considerably higher than in other parts of the world, in particular in relationship to North-America, for routes of roughly equivalent length. One popular explanation as to why that is the case is that European airlines have substantial market power, either because of protected market niches or because of outright cartel pricing practices. In particular, it is argued that the *bilateral agreements* between member states is an important device to implement collusive practices. Such an environment is commonly thought to have favored the exercise of market power by individual carriers (see e.g. Seabright and McGowan, 1989). In fact, the rationale for the "liberalization" program in the European airline industry is based on the presumption to end monopolies and bring prices down to "more competitive" level.

However, when measuring market power in the European airline industry one finds little or no evidence that firms price above non-cooperative levels. The standard conjectural variations model yields pricing behavior that is consistent with Cournot type conduct (see for example Good, Röller, and R.C. Sickles (1993b))[2]. It is worth emphasizing that the European studies are based on aggregate data, i.e. they do not measure market power at the route level. To the extent that there are significant differences in the competitive conduct at the route-level, and that these heterogeneities are not linear, aggregate models may not accurately measure market power.

It is interesting to compare these findings to the estimated market power in the U.S. airline industry, where route-specific data are more readily available. Specifically in the U.S. airline industry, market power has been studied by Brander and Zhang (1990)[3]. They conclude that the Cournot model is much more consistent with the data in general than either Bertrand or cartel behavior. Moreover, Brander and Zhang (1993) estimate a switching regime model for the U.S. airline industry based on the theory of repeated games. They reject the constant behavior models in favor of regime-switching models, where the punishment phases are best described by Cournot competition. A related strand of literature suggests that market power is quite significant in the U.S. airline industry. Hurdle et al. (1989) and Whinston and Collins

---

[2] Slightly higher market power is found in Röller and Sickles (1999). However, a model of capacity competition followed by price competition results in substantially lower levels of market power.

[3] Other important contributions on pricing in the airline industry include Borenstein and Rose (1994) who analyze price dispersion on a given flight. The effect of networks on competition and pricing are studied in Brueckner, and Spiller (1991), and empirically tested in Brueckner, Dyer, and Spiller (1992). Evans and Kessides (1994) investigate

(1992) study the hypothesis of contestability of the U.S. airline industry. Overall they find that the airline market is not contestable and that excess profits are being earned. In addition, Berry (1990, 1992) and Borenstein (1989, 1990) argue that airlines are able to increase average prices through strong airport presence and hub dominance.

Overall the available evidence from Europe and the U.S. is thus that market power in European markets is not substantially higher relative to the U.S. market. In addition, the available aggregate (non route-specific) evidence suggests that European carriers do not exercise any collusive pricing practices - observed price costs margins are consistent with a non-cooperative Nash behavior. Given these findings, it appears that one has to look elsewhere to explain the relatively high prices in Europe.

There have been several explanations as to why that is the case, all of which are focused on high costs. The first one relates to productive efficiency. Whenever firms are less efficient, low margins in the product market could be associated with excessive costs that firms can afford because of a lack of competitive pressure, rather than low prices. In this case, prices would be high because costs are high, whereas price-cost margins would be small. Evidence regarding productive efficiency is given in a number of studies (see for example Encaoua, (1991) and Good, et.al. (1993a)). These comparisons between European carriers and U.S. carriers have shown that the European carriers are less productive than U.S. carriers, with the relative efficiency scores ranging from 50%-70%.

Excessive cost level can be associated either with productive inefficiencies (such that European carriers use larger amounts of factors for given level of outputs relative to US carriers), or with excessive factor prices. Excessive factor prices is the topic of this paper. Indeed, firms which enjoy substantial market power may have a tendency to pass on some of the rent they earn to the factors they use. In particular, one can expect that the personnel working for carriers with substantial market power will be in a favorable position to bargain for wage increases. Some evidence in favor of this hypothesis has been provided by Seabright and McGowan (1989), who compare the wages and labor productivity of European carriers to those found among US carriers. They find that European airlines pay a significant mark up over US rates for all

---

the ability to exercise market power in the airline industry through multimarket contact. They find that fares are higher on routes where the competing carriers have inter-route contact.

categories of personnel whereas their labor productivity tend to be lower. It is the second element of costs, i.e. rent-sharing, that this paper focuses on[4].

More generally, in order to identify econometrically whether prices are high in Europe because of high costs or collusive pricing practices one needs to develop a framework that endogenizes costs and product market competition. The mechanism that is investigated in this paper is that of rent sharing between management and unions[5]. To the extent that rent-sharing takes place in the European airline industry, high prices might be consistent with low price-cost margins. This, in turn, will seriously complicate the tasks of competition policy authorities. For example, if one were to reduce marginal costs to those levels that would prevail under no rent-sharing, then observed prices might in fact be close to monopoly prices. To put it differently, prices in Europe might be close to monopoly prices, if one deflates costs by accounting for rent-sharing. We will evaluate this claim in detail below.

The methodology proposed in this paper endogenizes costs by explicitly taking into account the link between product market competition and costs: market power and its pass-through on costs are simultaneously estimated. More specifically, we propose a methodology to measure empirically the link between competition and rent sharing, focusing on one potential channel, namely the settlement of excessive wages. We formalize airlines decisions as a two stage game, in which wage settlement occurs in the first stage and is modeled as a bargaining game between management and a representative union. At the second stage, the airlines decide on prices in the market game. We solve for a subgame perfect equilibrium of this model. We implement the model empirically using data on European airlines for the period 1976-1994.

Besides the papers cited above there are two recent empirical contributions that are very much related to our work. The work by Hirsch and Macpherson (2000) analyze relative earnings in the U.S. airline industry using data from 1973-1997. They find that Labor rents are "attributable largely to union bargaining power, which in turn is constrained by the financial health of carriers." In contrast to their approach, our approach explicitly models the interdependence between product market competition, union power, and wages arriving at three simultaneous equations. Ng and Seabright (1999) estimate the effect of competition on productive efficiency.

---

[4] Yet another explanation for higher costs might be that the technology used is different in the U.S. than in Europe. Productivity is usually decomposed into technical efficiency and technological progress. Nevertheless, to the extent that technological progress is not picked up by the efficiency scores, there remains little empirical evidence that technological progress has been larger in the U.S. relative to Europe (Good et al. 1993a).

[5] There are other approaches to establish a link between competition and efficiency. As shown by Hart (1983), a competition in the product markets can indeed tighten the incentives constraints faced by managers and reduce the scope for managerial slack.

They estimate that "the European airline industry is currently operating at cost levels some 25% higher than they would be if the industry had the same ownership and competitive structure as the US industry." Unlike our approach, Ng and Seabright use a cost function approach with a second equation that explains the rent to labor.

Compared to some of the other contributions in the literature, our approach is more "structural", in the sense of imposing more functional forms as well as a specific equilibrium concept. An advantage of this approach is that the interdependence between product market competition, union power, and wages are explicitly accounted for. However, structural empirical work is also subject to several criticisms (see also Genesove and Mullin 1998). For once, the results may be rather sensitive to the functional form assumptions or the precise specifications of demand and cost conditions. Another problem lies with the static framework which will introduce a bias in estimating the conduct parameter, especially when conduct is correlated with demand and cost variables (see Corts 1999). A third problem might occur when "average conduct" estimates are assumed, even though the industry is asymmetric, which introduces an aggregation bias (see Neven and Röller, 1999).

The present paper proceeds as follows. Section 2 introduces the theoretical model of rent sharing. Section 3 develops the empirical implementation, discusses the results, and interprets the findings. Section 4 concludes.

2. A Model of Rent Sharing and Market Competition

In this section we specify a two-stage game in which a representative union bargains with management over the wage rate in the first stage, with a price-setting product differentiated market game to follow in stage two. We assume that neither unions nor management coordinate their bargaining behavior in stage one. However, both parties will take the product market game into account when bargaining takes place in stage one. In other words, the more profitable (rent) the product market game in stage two, the higher the equilibrium wage which unions are able to extract from management (holding bargaining power constant). Higher wages, in turn, will lower the rent in stage two which will reduce the ability by unions obtain higher wages. In equilibrium these two effects will offset each other. In this sense the product market outcome and the resulting cost function are simultaneously determined.

We begin by modeling demand in the European airline industry in the following fashion,

$$q_i(p_i, p_j, Z_i), \qquad i = 1, .., N \qquad (1)$$

where N is the number of carriers (or countries), q_i is the quantity demanded, p_i is a price index for carrier i, and p_j is a price index of the competitors prices. Z_i is a vector of country-specific, exogenous factors affecting demand. The implicit duopoly assumption in (1) can be justified by the existence of *bilateral agreements*. While the European carriers were engaged in moderate competition in Transatlantic travel, the domestic scheduled market remained heavily regulated through bilateral agreements until the mid-eighties. The resulting duopolistic market structures created by the bilateral agreements also prevented new entry in the intra-European market. Moreover, we maintain the usual assumption on price elasticity of demand: $-\frac{\partial q_i}{\partial p_i} > \frac{\partial q_i}{\partial p_j} > 0$. That is, the own-price effect is larger in absolute value than the cross-price effect.

We specify the firm-level cost function as follows,

$$C(q_i, \omega_i, R_i) \qquad (2)$$

That is, total costs depend on quantity (q_i), the wage rate (ω_i), and a vector of exogenous cost characteristics R_i.

The structure of the game which firms and unions are engaged in is a two-stage set-up. At stage 2, firms compete in the product market by choosing prices to maximize profits, i.e. firms solve the following problem,

$$\max_{p_i} \pi_i = q_i(.) p_i - C(q_i(.) | \omega_i, R_i) \qquad i = 1, .., N$$

where $q_i(\cdot)$ is given in (1). Note that the wage rate is assumed to be exogenous at this stage. The corresponding first-order conditions, which endogenize pricing, are given by

$$\frac{p_i - MC(.)}{p_i} = \frac{1}{\eta_{ii} - \theta \frac{p_i}{p_j} \eta_{ij}} \qquad i = 1, .., N \qquad (3)$$

where $\theta \equiv dp_j / dp_i$ is firm i's conjectural variation, $\eta_{ii} \equiv -\dfrac{\partial q_i}{\partial p_i}\dfrac{p_i}{q_i}$ is the own-price elasticity,

$\eta_{ij} \equiv \dfrac{\partial q_i}{\partial p_j}\dfrac{p_j}{q_i}$ is the cross-price elasticity, and $MC(.) = \dfrac{\partial C(.)}{\partial q_i}$ is marginal cost function. The firms

behavior parameter θ can be interpreted as the degree of coordination in a price-setting game. In particular, when $\theta = 0$, firms behavior is consistent with that under a Bertrand-Nash pricing game. In this case (3) reduces to the well-known case in which firms price according to their own elasticities. When $\theta < 0$, firms behave more competitive than Bertrand-Nash. On the other hand, when $\theta > 0$, firms behave more collusively than Bertrand-Nash. In particular, cartel pricing is associated with a $\theta = 1$. Finally, as $\theta \to -\infty$, price approaches marginal costs and the market outcome can be categorized as perfectly competitive.

At stage 1, firms bargain with their respective unions over wages. We assume that the solution is characterized by an asymmetric Nash bargaining outcome given by the following program: $\max\limits_{\omega_i}\left\{ (\omega_i L_i)^{\delta} \pi_i^{(1-\delta)} \right\}$, where δ is the degree of union bargaining power and $(1-\delta)$ is the firms' bargaining power. Whenever δ is unity, unions have all the bargaining power. Conversely as δ close to zero, management has the maximum bargaining power. The above Nash solution thus assumes that management attempts to maximize π_i, whereas unions like to obtain high wages.

There are a number of qualifications with the above set-up that are important to mention at this point. First, we assume that unions take employment as given and bargain only over wages. One reason for doing this is to keep the model tractable. However, we believe that during the sample period under investigation this is not unrealistic. Only with the recent pressures from deregulation have unions and management begun to explicitly reduce their wage demands in exchange for employment security. In addition, we do not consider other type of work rule negotiations and benefits (such as working hours, vacations, social benefits, etc.). Even though these other benefits are on the negotiation table, it is not unreasonable to assume that in Europe the main object over which bargaining takes place are wage demands. To the extent that other factors are not correlated with wages (and enter the objective functions of management or the unions differently) our results need to be qualified.

Second, we model the situation as a single union bargaining with management. As similarly skilled workers segregate into many smaller unions (pilots, mechanics, flight attendants), one

could think of a more complicated bargaining set-up. Modeling several unions bargaining independently over several factors - possibly simultaneously - with management is well beyond the scope of this paper. Essentially, our set-up assumes that labor interests are represented by a representative union (or by a collusive set of unions) and that the primary factor of conflict are wages.

The final caveat is that we need to account for the subsidies which airlines receive from their respective governments. These subsidies, or more precisely the *potential* subsidies, should be included in the "cake" which management and unions bargain over. In order to control for the subsidy effect, we assume that airlines are subsidized to the extent that they are always bailed out by their governments: governments are prepared to ensure that their airlines do not exist. Given these considerations, we implement the presence of government by imposing a non-negative profit constraint on π_i.

The corresponding first-order conditions are given by,

$$\frac{\partial \pi_i}{\partial \omega_i} = -\left| \frac{\delta}{1-\delta} \right| \frac{\pi_i}{\omega_i} \tag{4}$$

Let us denote the equilibrium prices defined by (3) as $p_i(\omega_i, \omega_j)$. Substituting them into the profit function π_i and differentiating w.r.t. ω_i, yields

$$\frac{\partial \pi_i}{\partial \omega_i} = \left[q_i + (p_i - MC)\frac{\partial q_i}{\partial p_i} \right] \frac{\partial p_i}{\partial \omega_i} + (p_i - MC)\frac{\partial q_i}{\partial p_j} \frac{\partial p_j}{\partial \omega_i} - \frac{\partial C}{\partial \omega_i} .$$

From (3), we have $q_i + (p_i - MC)\frac{\partial q_i}{\partial p_i} = -(p_i - MC)\theta \frac{\partial q_i}{\partial p_j}$, so that we get

$$\frac{\partial \pi_i}{\partial \omega_i} = (p_i - MC)\frac{\partial q_i}{\partial p_j} \frac{\partial p_j}{\partial \omega_i} - \theta \frac{\partial p_i}{\partial \omega_i} - \frac{\partial C}{\partial \omega_i}$$

which upon substitution allows us to rewrite the first-order condition (4) as,

$$(p_i - MC)\frac{\partial q_i}{\partial p_j} \frac{\partial p_j}{\partial \omega_i} - \theta \frac{\partial p_i}{\partial \omega_i} - \frac{\partial C}{\partial \omega_i} + \frac{\delta}{1-\delta} \frac{\pi_i}{\omega_i} = 0 \tag{5}$$

Given the two-stage set-up, the effect of the stage 1 variable (wages) on stage two variables (prices) is given by $\partial p_i / \partial \omega_i$ and $\partial p_j / \partial \omega_i$, which we call the sequential strategic effect. In a simultaneous Nash game, wages and prices are chosen simultaneously, which implies that $\partial p_i / \partial \omega_i$ and $\partial p_j / \partial \omega_i$ must be zero. Accordingly, we are able to perform a specification test for the appropriateness of the sequential set-up by testing whether the sequential strategic effects are statistically different from zero. This will be done below.

Rather than specifying specific functional forms, we use the structure of the model to solve explicitly for sequential strategic effects. Implicit differentiation of (3) w.r.t. ω_i and ω_j yields,

$$\frac{\partial p_i}{\partial \omega_i} = \frac{A\Delta_i}{H^p}\frac{\partial MC}{\partial \omega_i} \quad \text{and} \quad \frac{\partial p_j}{\partial \omega_i} = \frac{B\Delta_i}{H^p}\frac{\partial MC}{\partial \omega_i} ; \tag{6}$$

where $A = \dfrac{\partial^2 \pi_i}{\partial p_i^2}$, $B = \dfrac{\partial^2 \pi_i}{\partial p_i \partial p_j}$ and $H^p = A^2 - B^2$. In addition, $\Delta_i = \left| \dfrac{\partial q_i}{\partial p_i} + \theta \dfrac{\partial q_i}{\partial p_j} \right|$ and $\Delta_j = \dfrac{\partial q_i}{\partial p_j}$ are own and cross partial demand derivatives including the conjectural variations, respectively.

Note that the conditions for the existence and stability of stage 2 equilibrium, $A < 0$ and $H^p = A^2 - B^2 > 0$, together with the condition of strategic complementarity, $B > 0$, imply that the own-sequential effect has the same sign but is greater than the cross-sequential effect. That is, $\dfrac{\partial p_i}{\partial \omega_i} > \dfrac{\partial p_j}{\partial \omega_i}$.[6] Also note that $\dfrac{\partial MC}{\partial \omega_i} > 0$ is the effect of wages on marginal costs in stage two. This is an important parameter of the model, since whenever it is zero there is no strategic link between the two periods. The significance of this parameter will be a testable hypothesis in the empirical section below.

Before estimating the above model, we need to determine wages if there were no unions. By comparing wages obtained by unions to the wages determined by marginal productivity of labor, we are able to assess the extent to which rent sharing occurs. A competitive labor market would set wages as follows,

$$\omega_i^C = MRP_{Li} = MR_i * MP_{Li} = p_i(1 - \frac{1}{\eta_{ii}} + \frac{1}{\eta_{ij}}\frac{dq_j}{dq_i}\frac{q_i}{q_j}) * \frac{\partial q_i}{\partial L_i} . \tag{7}$$

---

[6] The strategic complementarity condition $B > 0$, and the second-order condition and its Hessian $A < 0$ and $H^p = A^2 - B^2 > 0$ will be empirically tested below.

where $\frac{\partial q_i}{\partial L_i}$ is firm i's marginal product of labor and η_{ii} and η_{ij} are the own and cross price elasticity of demand, respectively. By comparing the equilibrium wage and prices given by equations (3) and (5) to those given by equations (3) and (7), we can asses the extent of rent sharing.

3. Empirical Implementation

3.1 Functional Specification, Data and Estimation

The empirical implementation of the model in the above section involves simultaneously estimating the demand equation (1), the two first-order condition (3) and (5) subject to (6). The endogenous variables are therefore prices, quantities, and wages. The demand equation corresponding to (1) is specified as follows,

$$q_i = \alpha_0 + \alpha_1 p_i + \alpha_2 p_j + \alpha_3 GASOLINE_i + \alpha_4 GDP_i + \alpha_5 GCONS_i + \alpha_6 RAIL_i + \alpha_7 NETWORK_i + \varepsilon_{1i} \qquad (8)$$

where ε_{1i} denotes the error term. The exogenous variables influencing demand are: an index of the price of all other airlines (Pj), an index of the price of gasoline (GASOLINE), a measure of country size (GDP), a measure of economic activity - consumption growth (GCONS), an index for the price of rail transportation (RAIL), and a measure of the size of the carriers' network (NETWORK).   The data and their construction are described in more detail in Appendix A. Summary statistics of the data are given in Table 1.

Specification (8) assumes that p_j is exogenous. Essentially there are three alternatives if one were to use firm-level data. The first alternative is to assume symmetry. This is clearly a strong assumption and empirically simply false [footnote: In fact, under symmetry (or alternatively under some more restrictive assumptions on the cost function, see Neven and Röller, 1999) one could aggregate the first-order condition over all firms such that only aggregate data are necessary for estimation].   The second alternative, is to estimate another equation which endogenizes p_j.   Given the already extensive structure in the current paper (we already estimate three equations) this is likely to be asking too much from the data. Finally, there is the alternative which we have chosen in (8), namely to assume that p_j is exogenous, which may lead to simultaneity bias. Besides imposing more structure (i.e. add another equation), the main

trade-off is between potential bias stemming from imposing symmetry and the simultaneity of p_j. Since we know that imposing symmetry is simply incorrect, we have taken the other approach in this paper.

Regarding the cost function, we must specify the derivatives of (2). The marginal cost equation ($\partial C / \partial q_i$) defined implicitly in (2) is assumed to be linear in wage, the price indexes for capital and materials, as well as a variety of cost and quality characteristics such as the load factor (LOADF), the stage length (STAGEL), the percentage of wide-bodied planes in the fleet (PWIDEB), and the percentage of turboprop planes (PTURBO). That is,

$$\frac{\partial C}{\partial q_i} = MC = \beta_0 + \beta_1 \omega_i + \beta_2 PK_i + \beta_3 PM_i + \beta_4 LOADF_i + \beta_5 STAGEL_i + \beta_6 PWIDEB_i + \beta_7 PTURBO_i \quad (9)$$

Using the above functional specifications, we can simplify (3) into,

$$p_i = MC - \frac{q_i}{\alpha_1 + \theta \alpha_2} + \varepsilon_{2i}$$

(10)

where ε_{2i} is the error term and *MC* is given by (9).

For the first-order condition for wage bargaining in stage one (5), note that under the above functional specifications, $A = 2\alpha_1 + \theta \alpha_2$ and $B = -\alpha_2$. Moreover, we can make use of Shephard's lemma such that $\frac{\partial C}{\partial \omega_i} = L_i$. Substituting into (5), making use of (6), we arrive at our empirical specification for the management-union bargaining process,

$$\left(p_i - MC\right)\frac{2\alpha_1 \alpha_2 (\alpha_1 + \theta \alpha_2)\beta_1}{(2\alpha_1 + \theta \alpha_2)^2 - \alpha_2^2} - L_i + \frac{\delta}{1-\delta}\frac{\pi_i}{\omega_i} + \varepsilon_{3i} = 0 \quad (11)$$

where *MC* is given by (9). It should be stated that the above specification assumes that both the conduct parameter as well as the degree of union power parameter are time and firm invariant. However, given the rather small number of observations and the considerable amount of structure already imposed, we are unable to get significant results out of further firm-specific effects. Therefore, our results are to be interpreted as averages (over firms and over time) as far as the conduct and the bargaining power parameter are concerned.

Using non-linear three stages, we estimate above system of three equations (8), (10), and (11), where the endogenous variables are given by wages, prices and output. The results are reported in Table 2.

3.2 Consistency Checks

Before interpreting the results, we perform several consistency checks on whether the theoretical model is in line with the empirical estimates. These tests can be thought of as specification tests of having chosen the "right" structure for the data in hand. Given that we have imposed a considerable amount of structure, there are a number of conditions which need to be satisfied but have not been imposed *ex ante*. The purpose of this subsection is to investigate whether the "data reject the model".

As can be seen in Table 2, the demand estimates are in line with our maintained assumptions. Both the own-price elasticity (-0.887) and cross-price elasticity (0.331) have the expected signs at sample mean. In addition, our maintained assumption that the own-price effect is larger in absolute value than the cross-price effect, is confirmed by the data at each sample point[7].

Also the estimates in Table 2 imply at all sample points that the partial own-demand effect is negative ($\Delta_i < 0$) while the cross-demand effect is positive $\Delta_j > 0$, and the partial own demand effect (at all sample points) is larger in absolute value than the cross-demand effect, i.e. $-\Delta_i > \Delta_j > 0$. Moreover, the second order condition in stage 1 is satisfied, i.e. $\dfrac{\partial^2 ((\omega_i L_i)^\delta \pi_i^{1-\delta})}{\partial \omega_i^2} < 0$ (See Appendix 2), which guarantees the existence of stage 1 equilibrium. The second order conditions (for both existence and stability) in stage 2 are also satisfied, i.e. $A < 0$ and $H^p = A^2 - B^2 > 0$ (See Appendix 2). In addition, the strategic complementarity condition is satisfied, i.e. $B > 0$. Finally the effect of wage on marginal costs, $\partial MC / \partial \omega_i$, is positive. As mentioned in the previous section, this implies that the own-sequential effect ($\partial p_i / \partial \omega_i$) is greater than the cross-sequential strategic effect ($\partial p_j / \partial \omega_i$) in absolute value and that they have the same sign.

---

[7] For example at the sample mean ,we have $-\partial q_i / \partial p_i = 1820962.40 > \partial q_i / \partial p_j = 673322.84$.

In sum, the estimates in Table 2 are consistent with all the restrictions and maintained assumptions of theoretical model developed above.

3.3 Interpretation of Parameters

We now interpret the results given in Table 2 in more detail. The price elasticity of demand is estimated at -0.887, which indicates an elasticity close to unity (in fact the estimate is statistically not significantly different from one). The cross-price elasticity is estimated at 0.331, which indicates that the services provided by airlines are substitutes.

Many of the remaining parameters have the expected signs. For the demand equation, GDP, consumption growth, and the size of the network all have positive and significant effects. The price of railroad transportation also has a positive impact on airline demand, which suggests that air travel and rail travel are significant substitutes. By contrast, the price of gasoline has a negative and significant effect on airline demand, indicating that automobiles and air travel are complements. This might be explained by the fact that gasoline prices are highly correlated with fuel prices. The cost parameters have the expected signs as well. The price of capital and the price of materials are positively related to marginal costs. In addition, both the load factor and the length of stage lower marginal costs. An increase in wide-bodied planes lowers marginal costs, and more turboprop planes raise marginal costs.

Finally, the price of labor (wages) increases marginal costs. Hence, rent sharing raises airline's marginal costs by raising wages. As mentioned earlier, the effect of wage on marginal costs, $\partial MC / \partial \omega_i$, determines whether the two-stage model can be reduced to a one-stage model. Since this effect is positive and significant (t-stat of 4.93), we reject a one-stage model in favor of the two-stage specification.

Note that the estimated conduct parameter θ is -.047 (t-stat of -0.35) in this two-stage set-up. This implies that θ is insignificantly different from zero, that is, we cannot reject Bertrand-Nash behavior in the product market. Furthermore, as is shown in Appendix-C, the θ that would correspond to Cournot-Nash conjectures for the above model can be shown to be $\theta = -\alpha_2 / \alpha_1$, which is equal to 0.37. As can readily be calculated, we reject Cournot-Nash behavior with a t-stat of -3.15 (see Table 2). Moreover, we reject cartel pricing behavior with a t-stat of -7.90.

Regarding competition in the product market, we can therefore conclude that the data is consistent with a rather non-collusive environment. In fact, we find conduct to be consistent with Bertrand pricing, which is even more competitive than previous estimates for European airlines.

Turning to the measurement of union power, it appears that there is strong evidence suggesting that unions do have significant bargaining power with a δ of 0.813 (t-stat of 33.88). However, as we mention above, we need to compare this to the δ which corresponds to the competitive labor market solution which is given by (7) and can be written as,[8]

$$\omega_i^C = p_i(1 - \frac{1}{\eta_{ii}} + \frac{1}{\eta_{ij}}\frac{dq_j}{dq_i}\frac{q_i}{q_j}) * \frac{\partial q_i}{\partial L_i} = (p_i + \frac{\alpha_i^2 + 2\theta\alpha_1\alpha_2 + \alpha_2^2}{\alpha_1^2 - \alpha_2^2}q_i) \cdot \frac{\partial q_i}{\partial L_i}.$$

(12)

To obtain a δ corresponding to the competitive labor market, we jointly calibrate equations (8), (10) and (12) for the three endogenous variables prices, wages, and quantities. This is done by setting all exogenous variables to their sample means and using the estimates in Table 2[9]. The obtained values of the endogenous variables can be interpreted as the 'anti-monde', i.e. what would happen if no union power was present, holding the structure of the estimated model constant. We then use the 'anti-monde' values of the endogenous variables, substitute them into (11), and solve for δ. This procedure yields a δ of 0.712 which corresponds to the competitive labor market solution. Comparing this value of δ to the estimated value of δ in Table 2 reveals that the estimated union power is significantly higher than the competitive labor market solution (a t-stat of 4.21). This implies that wages are higher and that rent sharing is significant. In other words, unions do have an impact.

3.4 Calibrations, Scenario Comparisons, and Welfare Implications

In order to assess and quantify the effect of product market competition and union power on the market outcome we have summarized various scenarios in Table 3 in terms of the level of wages, prices and product market mark-ups. The entries in Table 3 are computed by using the

---

[8] As can be seen in Appendix C, $\frac{dq_j}{dq_i} = \frac{\theta\alpha_i + \alpha_2}{\alpha_i + \theta\alpha_2}$.

[9] Since we do not estimate a production function, we are unable to get an estimate of the marginal product of labor ($\frac{\partial q_i}{\partial L_i}$) directly. We therefore use the estimate obtained by Good, Nadiri, Röller and Sickles 1993. They estimate a Cobb-Douglass production function where $\frac{\partial q_i}{\partial L_i} = 0.347 * \frac{q_i}{L_i}$ is firm i's marginal product of labor.

estimates in Table 2, setting all exogenous variables at their sample means, and solving the three equations ((8), (10), and (11)) for the three endogenous variables (wages, prices and quantities). This procedure is then done for various values of product-market imperfections (θ) and labor market imperfections (δ) yielding the corresponding numbers in Table 3.

Focusing on the actual estimated product market conduct (column one of Table 3, corresponding to a θ of –0.047) we compare the actual market scenario (top-left) to that which would happen when unions have no power (bottom left, corresponding to a δ of 0.712). As can be seen the effect of union power on wages is quite significant, raising wages from 16.52 to 25.55[10]. However, the impact on price-cost margins as well as prices is relatively small, with prices being increased from 1.72 to 1.77 due to unions. This implies that the path-through effect of unions is mainly through fixed costs and less through marginal costs and prices. Moreover, this finding is robust across the varies product market scenarios in Table 3 (compare across columns). The impact of unions is consistently the same: mainly through wages, but less on prices and mark-ups. As expected, Cournot competition would imply significantly higher prices and mark-ups (see the second column in Table 3). However, as mentioned above, the estimated conduct in the product market is not consistent with Cournot, but with Bertrand.

We are now in a position to evaluate the claim " prices in Europe might be close to monopoly prices, if one deflates costs by accounting for rent-sharing". To investigate this statement, we perform the following calibration of equations (10) and (11). We hold prices at the level predicted by our model (i.e. 1.77), but reduce wages to their marginal product (i.e. 16.52). Using the estimates in Table 2 once again, we solve for the implied conduct parameter in the product market (θ). In other words, we solve for the level of product market competition, assuming that costs are deflated to the level of competitive wage setting. The result is a θ of 0.170, which is still significantly less than Cournot behavior, and consequently statistically inconsistent with monopoly behavior. We therefore find no evidence to support the above claim, namely it is incorrect to the suggest that airline prices in Europe are close to monopoly prices, if one accounts for rent-sharing.

Even though the impact on mark-ups appears to be rather small, it would be incorrect to suggest that rent-sharing is insignificant. The amount of rent being transferred to labor can

---

[10] It should be stated that the impact on wages due to union power might be understated here because we do not allow for labor to adjust when we calibrate the "without union power" scenario in Table 3. It is reasonable that employment might increase due to wage reductions and that the marginal productivity of labor would decrease as a consequence. This implies that the wage reduction due to the loss of union power would be magnified by an decrease in marginal product of labor, leading to a lower wage than 16.52.

readily be calculated from Table 3 as the change in wages multiplied by the amount of labor, i.e. $\Delta \omega_i * L_i$. This amounts to some $242 million per carrier per year, which is fairly sizable. In comparison with the average loss of the European carriers in our sample period over 1976-1994, which is approximately $157 million per carrier per year, this implies that the rent being shared more than offsets the average loss. Moreover, even though the mark-ups are only affected by a small percentage, the loss in consumer surplus is non-negligible. Using our estimated linear demand function the loss in consumer surplus can be calculated in the usual way to be some $130 million per carrier per year, out of which roughly $3 million are deadweight loss. This implies that some $127 million per carrier per year are transferred from consumers to labor, which is about 52% of the total rent being shifted.

In sum, the above findings imply that the impact of unions is far from being insignificant. Even though the impact of unions on prices is relatively small, there is substantial amount of loss in consumer surplus. The deadweight loss, however, is only $3 million per carrier per year, which implies that the effect of unions is mostly in terms of shifting rents from consumers (and presumably owners and tax payers) to labor. According to our estimates, the inefficiency of unions is only 1.2 cents for every dollar of rent shifting[11]. In this sense, the static impact of unions is largely on equity and less on efficiency: the winners are the unions and the losers the consumer, while economic efficiency is relatively unaffected.

---

[11] This is obtained by comparing the $242 million of rent shifted to the $3 million deadweight loss.

4. Conclusion

In this paper we specify and estimate a structural model which links product market competition and union power. Our findings can be summarized as follows:

- product market competition is high and statistically consistent with Betrand behavior.

- observed prices in Europe are not consistent with cartel pricing, once costs are deflated by hypothetically eliminating rent-sharing.

- price and price-cost margins are less affected by rent-sharing as the impact of unions is mainly through fixed costs and less through marginal costs

- nevertheless, rent-sharing in European airlines is significant and its magnitude is sizable ($242 million per carrier per year)

- the transfer from consumers to labor is significant, about 52% of the total rent being shifted is shifted from the consumer

- the static impact of unions is largely on equity and less on efficiency.

Even though the *static* impact of unions on efficiency less dramatic, one should not underestimate the *dynamic* impact of unions. Rent-sharing of this magnitude might influence the ability of firms to stay in business, thereby inducing excessive exit. In this context, rent-sharing might prevent the evolution of an efficient market structure. Moreover, entry barriers (for instance slot allocations to incumbents) which might be partially created by governments, prevent efficient entry. Finally, there are other welfare considerations. Given that there have been significant subsidies by the respective governments (both explicit and implicit), part of the transfers have been from tax payers to labor. Therefore, the cost of raising public funds has to be taken into account.

Besides the market structure explanation just mentioned, the question of why prices in Europe have been so much higher still remains. Given that there is little evidence of collusion, and given that the rent sharing arrangements in European airlines do not provide much explanatory power either, it appear that the most reasonable explanation is the relative lack of productive efficiency. Understanding the precise mechanism by which competition increases productive efficiency, and quantifying it empirically, seem to be an important area for further research.

Appendix A: Data Description, Sources and Construction

This study uses a panel of the eight largest European carriers - Air France, Alitalia, British Airways, Iberia, KLM, Lufthansa, SABENA and SAS with annual data from 1976 through 1994. There are therefore in principle 152 observations. Since some variables for SABENA and KLM are missing for the years 1991-1994, as well as for Air France, LH, and Alitalia for 1994, we are left with a total of 141 observations.

In general, the data can be organized into three broad categories: factor prices, output, output prices, airline characteristics, and demand data.

Factor Prices

The primary source for the production data is the *Digest of Statistics* from the International Civil Aviation Organization (ICAO). Good, Röller, and Sickles [1993] constructed a set of three airline input prices: (i) Labor, (ii) Materials and (iii) Capital.

(i) Labor (variable ω): The labor input is an aggregate of five separate categories of employment used in the production of air travel. Included in these categories are all cockpit crew, mechanics, ticketing, passenger handlers and other employees. Information on annual expenditures and the number of employees in each of the above categories were obtained from the International Civil Aviation Organization (ICAO) *Fleet and Personnel Series*. These indices are aggregates of a number of sub components using a Divisia multilateral index number procedure [Caves, Christensen and Diewert, 1982].

(ii) Materials (variable PM): Expenditures on supplies, services, ground-based capital equipment, and landing fees are combined into a single input aggregate called materials. It is not necessarily true that the purchasing power of a dollar or its market exchange rate equivalent is the same in all countries. Consequently we use the purchasing power parity exchange rates constructed from Heston and Summers [1988]. These are adjusted by allowing for changes in market exchange rates and changes in price levels. Use of airport runways is constructed by using landing fee expenses and using aircraft departures as the quantity deflator. The service price for owned ground based equipment is constructed by using the original purchase price, 7

% depreciation and the carrier's interest rate on long term debt. Fuel expenses are given for each carrier in ICAO's Financial Data Series. Unfortunately, there are no quantity or price figures given in that source. There are two possible solutions. The first is to estimate fuel consumption for each aircraft type in the fleet, given the consumption of U.S. carriers on similar equipment for the specific number of miles flown and adjusting for stage length. Alternatively, fuel prices for international traffic in several different regions is available through ICAO's Regional Differences in Fares and Costs. The airline's fuel price is then estimated as a weighted average of the domestic fuel price (weighted by domestic available ton-kilometers), and regional prices (weighted by international available ton-miles in the relevant region). This method explicitly recognizes that for international carriers not all fuel is purchased in the airline's home country. As with the labor input, these sub components are aggregated using a multilateral index number procedure and are termed materials.

(iii) Capital (variable PK): A very detailed description is available for aircraft fleets. These data include the total number of aircraft, aircraft size, aircraft age, aircraft speed, and utilization rates. This information is available over the course of a year from ICAO and a calendar year's end inventory is available from IATA's *World Air Transport Statistics*. Asset values for each of these aircraft types in half-time condition is obtained from Avmark, one of the world's leading aircraft appraisers. This data source provides a more reasonable measure of the value of the fleet since it varies with changing market conditions. Jorgenson-Hall user prices for the fleet are constructed by using straight line depreciation with a total asset life of 20 years and the relevant long term interest rates.

Output

Output (variable q_i) is obtained from ICAO's *Commercial Airline Traffic Series*. ICAO disaggregate airline output along physical dimensions (classification into passenger output and cargo), along utilization dimensions, along functional dimensions (classification into scheduled and non-scheduled output), and finally on geographic dimensions (classification into domestic and international output). We utilize the classification based on physical dimensions and on services provided. Total airline output is gotten by aggregating quantities of passenger and cargo tonne kilometers of service, and incidental services where weights are based on revenue shares in total output.

Output Prices

The output price (variable p_i) is calculated as a ratio of the carrier's passenger revenues to passenger ton-kilometer miles performed. The revenues for the carriers are obtained from the - *Digest of Statistics (Financial Data - Commercial Air Carriers)* from the International Civil Aviation Organization (ICAO). The price of the "other" airlines (variable p_j) in the duopoly model is computed by weighting all the individual prices by their respective revenue shares in the market.

Airline Characteristics

Three characteristics of airline output and two characteristics of the capital stock are calculated. These included load factor (LOADF), stage length (STAGEL), the percent of the fleet which is wide bodied (PWIDE), and the percent of the fleet which uses turboprop propulsion (PTURBO).

The primary source for the network data is the *World Air Transport Statistics* publication of the International Air Transport Association (IATA). Load factor provides a measure of service quality and is used as a proxy for service competition. Stage length provides a measure of the length of individual route segments in the carrier's network. Both the percent of the fleet which is wide bodied and the percent using turboprop propulsion provide measures of the potential productivity of capital. The percent wide bodied provides a measure of average equipment size. As more wide bodied aircraft are used, resources for flight crews, passenger and aircraft handlers, landing slots, etc. do not increase proportionately. The percent turboprops provide a measure of aircraft speed. This type of aircraft flies at approximately one-third of the speed of jet equipment. Consequently, providing service in these types of equipment requires proportionately more flight crew resources than with jets.

Demand Data

Demand data was collected for the respective countries - France, Italy, Great Britain, Spain, Netherlands, Germany, Belgium and the three Scandinavian countries, Denmark, Sweden, Norway. The different data series for Denmark, Sweden and Norway are weighted by their respective GDP's in order to create single representative indices for the Scandinavian countries, which share the majority of the equity in SAS.

A measure of network size (NETWORK) is constructed by the total number of route kilometers an airline operates on. Gross Domestic Product (GDP) was obtained from the *Main Economic Indicators* publication of the Economics and Statistics Department of the Organization for Economic Cooperation and Development (OECD). It is reported for the above countries, in billions of dollars. The growth in private consumption (GCONS) is defined as an implicit price index with year to year percentage changes as reported by the OECD Economic Outlook publication, *Historical Statistics*. *Jane's World Railway* is the source of the rail data. Rail traffic is reported in four categories: passenger journeys, passenger tone-kilometers, freight net tone-kilometers and freight tones. The three revenue categories are passengers and baggage, freight, parcels and mail, and other income. To be consistent with the price of air travel, the rail price (RAIL) was calculated as the ratio of passenger revenue to passenger tone-kilometers. We thank S. Perelman for making available to us some of the more recent rail data which were not available in *Jane's World Railway.* Finally, the retail gasoline price (GASOLINE) were obtained from the OECD, International Energy Agency's publication, *Energy Prices and Taxes*.

Appendix B

Second-order conditions and strategic complementarity condition

In this appendix we derive the second order conditions in stage 1 and 2 and also the strategic complementarity condition. We start with stage 2 by rewriting its first order condition (3) as,

$$\frac{d\pi_i}{dp_i} = q_i + (p_i - MC)(\frac{\partial q_i}{\partial p_i} + \theta \frac{\partial q_i}{\partial p_j}) = 0$$

For a linear demand function and constant marginal cost, the second order conditions and its Hessian can be derived as,

$$A = \frac{\partial^2 \pi_i}{\partial p^2_i} = 2\frac{\partial q_i}{\partial p_i} + \theta \frac{\partial q_i}{\partial p_j}, \quad B = \frac{\partial^2 \pi_i}{\partial p_i p_j} = \frac{\partial q_i}{\partial p_j} \text{ and } H^p = A^2 - B^2 .$$

The usual assumption on price elasticity of demand $-\frac{\partial q_i}{\partial p_i} > \frac{\partial q_i}{\partial p_j} > 0$ guarantees that prices are strategic complements, i.e. $B > 0$, as well as the existence and stability condition in stage 2, i.e. $A < 0$ and $H^p > 0$.

At stage 1, denoting $U_i = (\omega_i L_i)^\delta \pi_i^{(1-\delta)}$, for linear demand function and constant marginal cost, we can simplify the second order condition into

$$D = \frac{\partial^2 U_i}{\partial \omega_i^2} = L_i (\omega_i L_i)^{\delta-1} \pi_i^{-\delta} (\frac{\partial \pi_i}{\partial \omega_i} + (1-\delta)\omega_i \frac{\partial^2 \pi_i}{\partial \omega_i^2}) ,$$

Note that $\frac{\partial \pi_i}{\partial \omega_i} = -\frac{\delta}{1-\delta}\frac{\pi_i}{\omega_i} < 0$. Furthermore $\frac{\partial^2 \pi_i}{\partial \omega_i^2} = (\frac{\partial p_i}{\partial \omega_i} - \frac{\partial MC_i}{\partial \omega_i})\frac{\partial q_i}{\partial p_j}(\frac{\partial p_j}{\partial \omega_i} - \theta \frac{\partial p_i}{\partial \omega_i}) < 0$, since

$\frac{\partial p_i}{\partial \omega_i} - \frac{\partial MC_i}{\partial \omega_i} = -2(\frac{\partial q_i}{\partial p_i})^2 - \theta \frac{\partial q_i}{\partial p_i}\frac{\partial q_i}{\partial p_j} + (\frac{\partial q_i}{\partial p_j})^2 < 0$ and $\frac{\partial p_j}{\partial \omega_i} - \theta \frac{\partial p_i}{\partial \omega_i} > 0$ for any $\theta < -\frac{B}{A}$. Therefore, $D < 0$.

Appendix C

The relationship between the conjectures in a pricing and quantity game

In this appendix, we derive the relationship between a pricing game and a quantity game for differentiated products. Denote firm i's profit function as $\pi_i = q_i(.)p_i - c(q_i)$, where q_i is carrier i's quantity, p_i is a price index for carrier i, and p_j is a price index of the competitors prices, and $q_i(.) = q_i(p_i, p_j)$ denotes the demand function for firm i.

(1). Pricing Game

The first order condition in a pricing game is

$$p_i - MC_i = -\frac{q_i}{\dfrac{\partial q_i}{\partial p_i} + \theta \dfrac{\partial q_i}{\partial p_j}},$$

where $\theta = dp_j/dp_i$ is firm i's conjectural variation in the pricing game. In particular, when $\theta = 0$, firm's behavior is consistent with Bertrand-Nash.

(2) Quantity Game

From the demand function $q_i(.) = q_i(p_i, p_j)$, we can derive the inverse demand function, $p_i(.) = p_i(q_i, q_j)$. Rewriting the profit function in terms of q_i, we have $\pi_i = p_i(.)q_i - c(q_i)$. The corresponding first order condition in a quantity game is then given by

$$p_i - MC_i = -q_i \left(\frac{\partial p_i}{\partial q_i} + \theta_q \frac{\partial p_i}{\partial q_j} \right),$$

where $\theta_q = dq_j/dq_i$ is firm i's conjectural variation in the quantity game. In particular, when $\theta_q = 0$, firm's behavior is consistent with Cournot-Nash.

(3) The relationship between θ and θ_q

The pricing game and the quantity game are equivalent when the first order are the same. That is,

$$\frac{q_i}{\left(\dfrac{\partial q_i}{\partial p_i} + \theta \dfrac{\partial q_i}{\partial p_j} \right)} = q_i \left(\frac{\partial p_i}{\partial q_i} + \theta_q \frac{\partial p_i}{\partial q_j} \right) = -(p_i - MC_i) \qquad \text{(E1)}$$

Under linear demand $q_i = \alpha_0 + \alpha_1 p_i + \alpha_2 p_j$, we have

$$\frac{\partial q_i}{\partial p_i} = \alpha_1, \quad \frac{\partial q_i}{\partial p_j} = \alpha_2, \quad \frac{\partial p_i}{\partial q_i} = -\frac{\alpha_1}{\alpha_2^2 - \alpha_1^2}, \quad \frac{\partial p_i}{\partial q_j} = \frac{\alpha_2}{\alpha_2^2 - \alpha_1^2}.$$

Which reduces the equivalence expression (E1) to

$$\theta_q = \frac{\theta\alpha_1 + \alpha_2}{\alpha_1 + \theta\alpha_2}$$

Therefore, the θ that corresponds to a Cournot-Nash quantity game $\left(\theta_q = 0\right)$ is $\theta = -\alpha_2/\alpha_1$.

Table 1. Summary Statistics

Variable	Number of Observations	Mean	Minimum	Maximum
P_i	141	1.123	0.626	2.021
Q_i	141	2304691.910	69085.130	8839172.470
ω_i	141	31.913	3.677	70.863
P_j	141	1.119	0.745	1.647
PK	141	1900.780	533.980	5800.890
PM	141	138.883	79.740	225.663
L_i	141	26809.890	6277.000	54919.000
K_i	141	98.594	23.500	233.000
M_i	141	12924.570	2148.400	53386.780
GASOLINE	141	0.691	0.311	1.270
GDP	141	679.375	147.900	1737.400
GCONS	141	7.313	-0.900	23.700
RAIL	141	0.052	0.014	0.136
NETWORK	141	445878.140	188787.000	1072390.000
LOADF	141	0.639	0.535	0.727
STAGEL	141	1.202	0.689	3.660
PWIDEB	141	0.234	0.080	0.529
PTURBO	141	0.029	0.000	0.195

For variable definitions see Appendix A.

Table 2. European Airlines - Two-Stage Game

(Non-Linear Three-Stage Least Squares Estimates)		
Variable	**Estimates**	**t-statistics**
Demand Equation		
INTERCEPT	-1.091	-5.61
P_i	-0.887	-4.25
P_j	0.331	9.99
GASOLINE	-0.852	-5.57
GDP	0.338	5.73
GCONS	0.088	2.04
RAIL	0.677	9.21
NETWORK	0.315	3.53
Marginal Cost $(\partial c / \partial q_i)$		
INTERCEPT	1.190	2.19
ω_i	0.012	4.93
PK	0.000	3.51
PM	0.005	4.98
LOADF	-0.978	-1.17
STAGEL	-0.463	-3.81
PWIDEB	-1.205	-2.40
PTURBO	0.307	0.62
Union Power Parameter		
δ	0.813	33.88
		Bertrand ($\theta = 0$)	*Cournot* ($\theta = .370$)
Behavioral Parameter			
θ	-0.047	-0.35	-3.15

The estimates reported in the demand equation are converted into elasticities evaluated at their sample means. For number of observations, see Table 1.

Table 3. Union Power, Market Power and Price-Cost Margins under Alternative Specifications

		Product Market		
		Estimated Conduct $\theta = -0.047$	Bertrand $\theta = 0$	Cournot $\theta = 0.370$
Labor Market	$\delta = 0.813$ (with union power)	$\hat{P}_i = 1.770$ $\hat{\omega}_i = 25.553$ $\dfrac{\hat{P}_i - \hat{MC}_i}{\hat{P}_i} = 0.302$	$\hat{P}_i = 1.805$ $\hat{\omega}_i = 25.898$ $\dfrac{\hat{P}_i - \hat{MC}_i}{\hat{P}_i} = 0.313$	$\hat{P}_i = 2.323$ $\hat{\omega}_i = 27.610$ $\dfrac{\hat{P}_i - \hat{MC}_i}{\hat{P}_i} = 0.457$
	$\delta = 0.712$ (without union power)	$\hat{P}_i = 1.715$ $\hat{\omega}_i = 16.524$ $\dfrac{\hat{P}_i - \hat{MC}_i}{\hat{P}_i} = 0.340$	$\hat{P}_i = 1.751$ $\hat{\omega}_i = 16.654$ $\dfrac{\hat{P}_i - \hat{MC}_i}{\hat{P}_i} = 0.353$	$\hat{P}_i = 2.312$ $\hat{\omega}_i = 3.010$ $\dfrac{\hat{P}_i - \hat{MC}_i}{\hat{P}_i} = 0.578$

Where $\hat{P}_i$ and $\hat{\omega}_i$ are the fitted value of price and wage rate. $\left|\hat{P}_i - \hat{MC}_i\right| \Big/ \hat{P}_i$ is the price-cost margin.

References

Berry, S., 1990, "Airport presence as product differentiation", *American Economic Review* (Paper and Proceedings) 80, 394-399.

Berry, S., 1992, "Estimation of a model of entry in the airline industry", *Econometrica ,*60, 889-917.

Borenstein, S., 1989, "Hubs and High Fares: Dominance and Market Power in the U.S. Airline Industry," *Rand Journal of Economics*, Vol. 20, 344-365.

Borenstein, S., 1990, "Airline Mergers, Airport Dominance and Market Power," *American Economic Review,* 80, 400-404.

Borenstein, S., and N. L. Rose, 1994, "Competition and Price Dispersion in the U.S. Airline Industry," *Journal of Political* Economy, 102, 653-683.

Brander, J. A. and A. Zhang, 1990, "Market Conduct in the Airline Industry: An Empirical Investigation", *Rand Journal of Economics*, Vol. 21, 567-583.

Brander, J. A. and A. Zhang, 1993, "Dynamic Oligopoly Bevavior in the Airline Industry", *International Journal of Industrial Organization*, Vol. 11, 407-436.

Bresnahan, T. F., 1989, "Empirical Studies in Industries with Market Power," in <u>Handbook of Industrial Organization</u>, Vol. II, 1011-1058.

Brueckner,J.K. and P.T. Spiller, 1991, "Competition and Mergers in Airline Networks", *International Journal of Industrial Organization*, Vol. 9, 323-342.

Brueckner,J.K., N.J. Dyer, and P.T. Spiller, 1992, "Fare Determination in Airline Hub-and-Spoke Networks", *Rand Journal of Economics*, Vol. 23, 309-333.

Caves, D.W., L.R. Christensen, and W.E. Diewert, 1982, "The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity", *Econometrica*, 50,1393-1413.

Corts, K.S., 1999, "Conduct parameters and the measurement of market power," *Journal of Econometrics*, 88,227-250.

Encaoua, D., 1991, "Liberalizing European Airlines: Cost and Factor Productivity Evidence", *International Journal of Industrial Organization*, Vol. 9, 109-124.

Evans, W. N. and I. Kessides, 1994, "Living by the "Golden Rule": Multimarket Contact in the U.S. Airline Industry," *Quarterly Journal of Economics*, CIX, 2, 341-366.

Genesove, , D. and W.P. Mullin, 1998, "Testing static oligopoly models: conduct and cost in the sugar industry, 1890-1914," *Rand Journal of Economics*, Vol. 29, No. 2, 355-377.

Good, D., M.I. Nadiri, L-H. Röller, and R. C. Sickles, 1993a, "Efficiency and Productivity Growth Comparisons of European and U.S. Air Carriers: A First Look at the Data," *Journal of Productivity Analysis*. Vol. 4, 115-125.

Good, D., L-H. Röller, and R.C. Sickles, 1993b, "U.S. Airline Deregulation: Implications for European Transport", *Economic Journal*, 103, 1028-1041.

Hirsch, B., T. and D.A. Macpherson, 2000, "Earnings, Rents, and Competition in the Airline Labor Market", *Journal of Labor Economics*, forthcoming.

Hurdle, G.J., R.L. Johnson, A.S. Joskow, G.J. Werden and M.A. Williams, 1989, "Concentration, potential entry, and performance in the airline industry", *Journal of Industrial Economics* 38, 119-139.

Heston, A. and R. Summers, 1988, "Comparison of Price and Gross Domestic Product for Several Countries", *Review of Income and Wealth*, 34, 1-28.

McGowan, F, and P. Seabright, 1989, "Deregulating European Airlines, "*Economic Policy*, 9, 284-344.

Neven, D. J. and L.-H. Röller, 1996, "Rent Sharing in the European Airline Industry", *European Economic Review*, 40, 933-940.

Neven, D. J. and L.-H. Röller, 1999, "An Aggregate Structural Model of Competition in the European Banking Industry", *International Journal of Industrial Organization*, forthcoming.

Ng, C.K. and P. Seabright, 1999, "Competition, Privatization, and Productive Efficiency: Evidence from the Airline Industry, *The Economic Journal*, forthcoming.

Hart, O. D., 1983, "The Market Mechanism as an Incentive Scheme," *The Bell Journal of Economics*, Vol. 14, pp. 366-382.

Panzar, J. and J. Rosse, 1987, "Testing for 'Monopoly' Equilibrium"*, Journal of Industrial Economics,*XXXV, 4, 443-456.

Porter, R.H., 1983, "A study of cartel stability: The Joint Executive Committee, 1880-1886", *Bell Journal of Economics* 14, 301-314.

Röller, L.-H. and R.C. Sickles, 1999, "Capacity and Product Market Competition: Measuring Market Power in a 'Puppy-Dog' Industry", *International Journal of Industrial Organization*, forthcoming.

Sutton, J., 1991, "Sunk Cost and Market Structure: Price Competition, Advertising, and the Evolution of Concentration", MIT Press.

Taneja, N., 1988, <u>The International Airline Industry: Trends, Issues and Challenges</u>, Lexington Books.

Whinston, M.D. and S.C. Collins, 1992, "Entry, contestability, and deregulated markets: An event study analysis of People Express"*, Rand Journal of Economics ,*23, 445-462.