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ABSTRACT

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

by Damien J. Neven, Lars-Hendrik Röller, Zhentang Zhang*

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 find that the welfare effects of rent sharing work mainly through reducing firms' profits, rather than consumers surplus. As a consequence the static impact of unions is more on equity rather than efficiency.

ZUSAMMENFASSUNG

Gewerkschaftsmacht und Produktmarkt-Wettbewerb: Evidenz aus der Luftfahrtindustrie

In diesem Beitrag wird ein strukturiertes Modell spezifiziert und geschätzt, das den Zusammenhang zwischen Produktmarkt-Wettbewerb und Gewerkschaftsmacht abbildet. Das Modell ist zweistufig. In der ersten Stufe werden im Rahmen von Verhandlungen zwischen Management und Gewerkschaften die Löhne bestimmt und auf der zweiten Stufe folgt ein Preissetzungsspiel. Anhand von Daten für acht europäische Fluggesellschaften für die Zeit von 1976 bis 1994 läßt sich empirisch ein Zusammenhang zwischen Preis-Kostenspanne und der Messung der Marktmacht in einem Modell des „rent sharing" feststellen. Dabei wird deutlich, daß sich Wohlfahrtseffekte des „rent sharing" hauptsächlich durch eine Verringerung der Unternehmensgewinne ergeben und nicht so sehr aus der Konsumentenrente. Daraus ergibt sich, daß der statische Einfluß der Gewerkschaften auch mehr auf Gleichheit als auf mehr Effizienz abzielt.

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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))[1]. 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)[2]. 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

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1 Slightly higher market power is found in Röller and Sickles (1997). However, a model of capacity competition followed by price competition results in substantially lower levels of market power.

2 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 sudied in Brueckner, and Spiller (1991), and empirically tested in Brueckner, Dyer, and Spiller (1992). Evans and Kessides (1994) investigate 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.

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 (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 in be 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 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[3].

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[4]. To the extend that rent-sharing takes place in the European airline industry, market power is underestimated through the evaluation of price-cost margins. This, in turn, will seriously complicate the tasks of competition policy authorities. For example, the observed prices in a market might be consistent with monopoly pricing, yet price-cost margins are low. To put it differently, prices in Europe are consistent with significant market power, if one deflates costs by accounting for rent-sharing. We will address this claim in detail below.

The methodology proposed in this paper endogeneizes 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 decides on prices in the market game. We solve for the perfect equilibrium of this model. We implement the model empirically using data on European airlines for the period 1976-1990.

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3 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 extend 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).

4 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.

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,

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

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,

$$C(q_i, w_i, R_i) \tag{2}$$

That is, total costs depend on quantity (q_i), the wage rate (w_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,

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

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

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

where $q \equiv \P p_j / \P p_i$ is firm i's conjectural variation, $h_{ii} \equiv -\frac{\P q_i}{\P p_i}\frac{p_i}{q_i}$ is the own-price elasticity, $h_{ij} \equiv \frac{\P q_i}{\P p_j}\frac{p_j}{q_i}$ is the cross-price elasticity, and $MC(.) = \frac{\P C(.)}{\P q_i}$ is marginal cost function. The firms behavior parameter q can be interpreted as the degree of coordination in a price-setting game. In particular, when $q = 0$, 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 $q < 0$, firms behave more competitive than Bertrand-Nash. On the other hand, when $q > 0$, firms behave more collusively than Bertrand-Nash. In particular, cartel pricing is associated with a $q = 1$. Finally, as $q \rightarrow -\infty$, price approaches marginal costs and the market outcome can be categorized as perfectly competitive.

At stage 1, firms bargain with their respective unions over the total wage bill. We assume that the solution is characterized by a Nash bargaining outcome given by the following program: $\max_{w_i}\left\{(w_i\ L_i)^d p_i^{(1-d)}\right\}$, where d is the degree of union bargaining power and ($1-d$) is the firms' bargaining power. Whenever d is unity, unions have all the bargaining power. Conversely as d close to zero, management has the maximum bargaining power. The above Nash solution thus assumes that management attempts to maximize p_i, whereas unions like to achieve high wages.

There are two 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. The main 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. The second 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 government: government are prepared to ensure that the airlines do not exist. Given these considerations, we implement the presence of government by impose a zero profit constraint on p_i.

The corresponding first-order conditions are given by,

$$\frac{\partial p_i}{\partial w_i} = -\left(\frac{d}{1-d}\right)\frac{p_i}{w_i} \tag{4}$$

Let us denote the equilibrium prices defined by (3) as $p_i(w_i, w_j)$. Substituting them into the profit function p_i and taking derivative w.r.t. w_i, we have that

$$\frac{\partial p_i}{\partial w_i} = (p_i - MC)\frac{\partial q_i}{\partial p_j}\left\{\frac{\partial p_j}{\partial w_i} - q\frac{\partial p_i}{\partial w_i}\right\} - \frac{\partial C}{\partial w_i}$$

Substituting them back into the first-order condition (4), we get,

$$(p_i - MC)\frac{\partial q_i}{\partial p_j}\left\{\frac{\partial p_j}{\partial w_i} - q\frac{\partial p_i}{\partial w_i}\right\} - \frac{\partial C}{\partial w_i} + \frac{d}{1-d}\frac{p_i}{w_i} = 0 \tag{5}$$

Note that the sequential strategic dependence of wage and price can be tested by $\partial p_i / \partial w_i \neq 0 \neq \partial p_j / \partial w_i$. 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. w_i and w_j yields,

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

where $A = \frac{\partial^2 p_i}{\partial p_i^2}$, $B = \frac{\partial^2 p_i}{\partial p_i \partial p_j}$ and $H^p = A^2 - B^2$. In addition, $\Delta_i = \left(\frac{\partial q_i}{\partial p_i} + q\frac{\partial q_i}{\partial p_j}\right)$ and $\Delta_j = \frac{\partial q_i}{\partial p_j}$ 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, $\frac{\partial p_i}{\partial w_i} > \frac{\partial p_j}{\partial w_i}$.[5] Also note that $\frac{\partial MC}{\partial w_i} > 0$ 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 extend to which rent sharing occurs. A competitive labor market would set wages as follows,

$$w_i = MRP_{Li} = MR_i * MP_{Li} = p_i(1 - \frac{1}{h_{ii}} + \frac{q'}{h_{ij}}\frac{q_i}{q_j}) * \frac{\partial q_i}{\partial L_i}. \tag{7}$$

where $q' = \frac{dq_j}{dq_i}$; $\frac{\partial q_i}{\partial L_i}$ is firm i's marginal product of labor; h_{ii} and h_{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 the extend 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,

$$q_i = a_0 + a_1 p_i + a_2 p_j + a_3 GASOLINE_i + a_4 GDP_i + a_5 GCONS_i + a_6 RAIL_i + a_7 NETWORK_i + e_{1i} \quad (8)$$

where e_{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.

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,

$$\frac{\partial C}{\partial q_i} = MC = b_0 + b_1 w_i + b_2 PK_i + b_3 PM_i + b_4 LOADF_i + b_5 STAGEL_i + b_6 PWIDEB + b_7 PTURBO \quad (9)$$

Using the above functional specifications, we can substitute $\Delta_i = a_1 + q \cdot a_2$ and *MC* into (3) yielding,

$$p_i = MC - \frac{q_i}{a_1 + q a_2} + e_{2i} \quad (10)$$

5 The strategic complementarity condition $B > 0$, and the second-order conditions $A < 0$ and

where e_{2i} is the error term.

For the first-order condition for wage bargaining in stage one (5), note that under the above functional specifications, $A = 2a_1 + qa_2$ and $B = -a_2$. Moreover, we can make use of Shephard's lemma such that $\frac{\partial C}{\partial w_i} = Li$. Substituting into (5), making use of (6), we arrive at our empirical specification for the management-union bargaining process,

$$\left(p_i - MC\right)\frac{2a_1a_2(a_1 + qa_2)b_1}{(2a_1 + qa_2)^2 - a_2^2} - L_i + \frac{d}{1-d}\frac{p_i}{w_i} + e_{3i} = 0 \qquad (11)$$

where *MC* is given by (9). Using non-linear three stages, we estimate above system of three equations (8), (10), and (11), where the endogeneous 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[6].

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

$H^p = A^2 - B^2 > 0$ will be empirically tested below cross-demand effect, i.e. $-\Delta_i > \Delta_j > 0$. Moreover, the second order condition in stage 1 is satisfied, i.e. $\frac{\partial^2((w_i\, L_i)^d p_i^{1-d})}{\partial w_i^2} < 0$ (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, $\partial MC/\partial w_i$, is positive. As mentioned in the previous section, this implies that the own-sequential effect ($\partial p_i / \partial w_i$) is greater than the cross-sequential strategic effect ($\partial p_j / \partial w_i$) in absolute value than and that they have the same sign.

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 (at the sample mean), which indicates that the services provided by airlines are substitutes.

Many of the remaining parameters have the expected signs. For the demand equation, GDP, the price of railroad transportation, and the size of the network all have positive and significant effects. 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. Consumption growth has a positive and significant effect on demand for air travel. 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

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

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, $\P MC/\P w_i$, 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 market power parameter q is -.047 (t-stat of -0.35) in this two-stage set-up. This implies that q is insignificantly different from zero, that is, we cannot reject Bertrand-Nash behavior in the product market. Furthermore, the q that would correspond to Cournot-Nash conjectures for the linear model above can be shown to be 0.37. As can be seen in Table 2 we reject Cournot-Nash behavior with a t-stat of -3.15. 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 d of 0.813 (t-stat of 33.88). However, as we mention above, we need to compare this to the d which corresponds to the competitive labor market solution which is given by (7) and can be written as,[7]

$$w_i = p_i(1 - \frac{1}{h_{ii}} + \frac{q'}{h_{ij}}\frac{q_i}{q_j})*\frac{\P q_i}{\P L_i} = (p_i + \frac{a_1 + q'a_2}{a_1^2 - a_2^2}q_i)\cdot\frac{\P q_i}{\P L_i}. \qquad (12)$$

Since we do not estimate productivity of labor in this paper, we have operationalized (12) by using the estimate obtained by See Good, Nadiri, Röller and Sickles 1993. They estimate a Cobb-Douglass production function where $\frac{\P q_i}{\P L_i} = 0.347 * \frac{q_i}{L_i}$ is firm i's marginal product of labor. Using this estimate and the estimates in Table 2 we jointly calibrating the two first-order conditions (10) and (12). This calibration exercise yields

7 With our specified demand and cost function forms, $q' = \frac{qa_1 + a_2}{a_1 + qa_2} = 0.41$.

a d of 0.712 which corresponds to the competitive labor market solution. More importantly, a test comparing the two d's reveals that the estimated union power is significantly higher than the competitive labor market solution (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.

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: the level of wages, prices and mark-ups. Focusing on the estimated product market conduct (column one of Table 3) we compare the actual market scenario (top-left) to that which would happen when unions have no power (corresponding to a d of 0.712). As can be seen the effect of union power on wages is quite significant, raising wages from 16.52 to 25.56[8]. 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. 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 are consistent with significant market power, if one accounts for rent-sharing". To investigate this statement, we perform the following calibration of equations (10) and (11). We hold prices at observed levels (1.77) and reduce wages to their marginal productivity (16.52). In other words, we test whether observed prices are actually monopoly prices, once costs are deflated to the level of competitive wage setting. Using the estimates in Table 2, we solve for the implied conduct parameter in the product market. The result is a q of 0.170, which is still significantly less than Cournot

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8 It should be stated that the impact on wages due to union power might be overstated 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 decrease due to wage reductions and that the marginal productivity of labor would increase as a consequence. This implies that the wage reduction due to the loss of union power would be offset by an increase in marginal product of labor, leading to a higher wage than 16.52. However, most of our results below would be strengthened by including this effect, except for the magnitude of rent-sharing which would be reduced accordingly.

behavior, and consequently statistically inconsistent with monopoly pricing as well. We therefore find no evidence to support the above claim.

Even though the impact of unions on prices is small, there is significant rent-sharing. The amount of rent being transferred to labor can readily be calculated from Table 3 as $\Delta w_i * L_i$. This amounts to some $242 million per carrier per year, which is a sizable amount. By comparison the average loss of the European carriers in our sample period over 1976-1994 is approximately $157 million. This implies that the rent being shared more than offsets the average loss.

In sum, the above findings imply that the impact of unions is far from being insignificant, however there is not much of an effect on consumer surplus. In terms of welfare the above results suggest that the effect of unions does not create much allocative inefficiencies in the product market. It appears that unions impact more on equity than efficiency in this context. However, since airlines are making losses, and are being subsidized by their respective governments, one has to include the cost of raising public funds. In addition, 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.

4. Implications

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.
- rent-sharing in European airlines is significant and its magnitude is sizable
- price cost margins and consumer surplus are less affected by rent-sharing
- observed prices in Europe are not consistent with cartel pricing, once rent-sharing is accounted for
- the static impact of unions is more on equity rather than efficiency

The above results imply that the impact of unions is a significant transfer from owners of the firms to labor, while consumers are not being affected much. This suggests that unions do not have a welfare reducing effect.

However, there are other welfare considerations. Given that there have been significant subsidies by the respective governments (both explicit and implicit), in effect the transfers have been from tax payers to labor. As mentioned above, one has to include the cost of raising public funds. In addition, rent-sharing of this magnitude might influence the ability of firms to stay in business, thereby inducing excessive exit. Moreover, entry barriers (for instance slot allocations to incumbents) which might be partially created by governments, prevent efficient entry. In this context, rent-sharing might prevent the evolution of an efficient market structure, which would benefit consumers.

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, seems 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. The data can be organized into three broad categories: production and cost data, network data and demand data.

Production and cost data: 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 inputs: Labor, Materials and Aircraft Fleet. 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].

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.

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.

Data on output (both services available and services provided) is obtained from ICAO's *Commercial Airline Traffic Series*. They disaggregate airline output along physical dimensions (classification into passenger output and cargo (classification into available output and purchased output), along utilization dimensions, along functional dimensions (classification into scheduled and non-scheduled output), and finally on geographic dimensions (classification into domestic and international output). This leads to 16 sub aggregations of airline output.

The revenues for the carriers are obtained from the - *Digest of Statistics (Financial Data - Commercial Air Carriers)* from the International Civil Aviation Organization (ICAO). Revenues are available for passenger, freight, mail and non-scheduled output. The price is calculated as a ratio of the carrier's passenger revenues (including excess baggage) to passenger ton-kilometer miles performed.

Network and Fleet Specific Data: The primary source for the network data is the *World Air Transport Statistics* publication of the International Air Transport Association (IATA).

Three characteristics of airline output and two characteristics of the capital stock are calculated. These included load factor, stage length, a measure of network size, the percent of the fleet which is wide bodied, and the percent of the fleet which uses turboprop propulsion. 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. The number of route kilometers provides a measure of total network size.

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: The demand data for the same period 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.

The price of the "other" airlines (Pj) in the duopoly model is computed by weighting all the individual prices by their respective revenue shares in the market. 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 OECD Economic Outlook publication, *Historical Statistics* is the source of the growth in private consumption expenditure data. They are reported as an implicit price index with year to year percentage changes. The annual short-term interest rates were also obtained from this publication. The rates are reported by the respective countries on the basis of the following financial instruments: Belgium (three-month Treasury certificates), Denmark (three-month interbank rate), France (three-month Pibor), Germany (three-month Fibor), Italy (interbank sight deposits), Netherlands (three-month Aibor), Norway (three-month Nibor), Spain (three-month interbank loans), Sweden (three-month Treasury discount notes) and the United Kingdom (three-month interbank loans).

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 was calculated as the ratio of passenger (and baggage) 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.*

The retail gasoline prices (prices plus taxes) 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,

$$\frac{dp_i}{dp_i} = q_i + (p_i - MC)\left(\frac{\partial q_i}{\partial p_i} + q\frac{\partial q_i}{\partial p_j}\right) = 0$$

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

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

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 $U_i = (w_i L_i)^d p_i^{(1-d)}$, for linear demand function and constant marginal cost, we can simplify the second order condition to

$$D = \frac{\partial^2 U_i}{\partial w_i^2} = L_i (w_i L_i)^{d-1} p_i^{-d}\left(\frac{\partial p_i}{\partial w_i} + (1-d)w_i \frac{\partial^2 p_i}{\partial w_i^2}\right) ,$$

Note that $\frac{\partial p_i}{\partial w_i} = -\frac{d}{1-d}\frac{p_i}{w_i} < 0$. Furthermore $\frac{\partial^2 p_i}{\partial w_i^2} = \left(\frac{\partial p_i}{\partial w_i} - \frac{\partial MC_i}{\partial w_i}\right)\frac{\partial q_i}{\partial p_j}\left(\frac{\partial p_j}{\partial w_i} - q\frac{\partial p_i}{\partial w_i}\right) < 0$, since $\frac{\partial p_i}{\partial w_i} - \frac{\partial MC_i}{\partial w_i} = -2\left(\frac{\partial q_i}{\partial p_i}\right)^2 - q\frac{\partial q_i}{\partial p_i}\frac{\partial q_i}{\partial p_j} + \left(\frac{\partial q_i}{\partial p_j}\right)^2 < 0$ and $\frac{\partial p_j}{\partial w_i} - q\frac{\partial p_i}{\partial w_i} > 0$ for any $q < -\frac{B}{A}$. Therefore, $D < 0$.

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	152	1.134	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	152	0.715	0.311	1.270
GDP	152	670.244	147.900	1766.300
GCONS	152	7.031	-0.900	23.700
RAIL	152	0.053	0.0143	0.136
NETWORK	152	446981.550	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 (q = 0)	*Cournot (q= .370)*
Behavioral Parameter			
θ	-0.047	-0.35	-3.15

The estimates reported in the demand equation are converted into elasticities. The t-statistic for δ corresponds to the t-statistic on $(\delta/(1-\delta))$. For number of observations, see Table 1.

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

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

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

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