Influence of Air Navigation Fees on Airlines' Decisions on Frequencies and Prices in the European Context

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1 Introduction

We investigate the behavior of airlines as a consequence of an exogenous change in their operating costs and studies how the airlines' reactions may influence the passenger demand and the revenues of the Air Navigation Services Providers (ANSPs). Since this work was developed within the Innovative Route Charging Schemes project sponsored by Eurocontrol (2002), we focus on changes in *en route air navigation fees* (in the following indicated as *route charges*) paid to European ANSPs by intra-European flights for the air traffic control services received. As a second instance, we also deal with changes in the marginal passenger costs. We consider decisions on prices and frequencies and not other strategic choices. Actually, due to the relatively reduced impact on the overall costs of the route charges, reasonable variations of such costs could hardly make an airline company rethink its long-term market strategy.

The analysis is carried out at two levels of detail: first, we deal with the consequences of an exogenous change in the airline operating costs at industry level, i.e., we study the aggregate behavior of all the airlines seen as a unique block. Then, we examine the behavior of a single company, considering its position within the transportation market.

We use elasticity as a measure of both airline and passenger responsiveness. The elasticity of a quantity with respect to a factor is the percentage change in the quantity in response to a percentage change in the factor. As an example, a 0.5 elasticity of ANSPs revenues with respect to the route charges should be read as that a 1% increase of the route charges leads to 0.5% increase in ANSPs revenues.

At industry level, we consider the elasticity of the following quantities with respect to the route charges: ANSPs revenues and number of passengers.

At firm level, we consider the elasticity of the following quantities with respect to the route charges: price, number of flights, and number of passengers.

We define the reactions of both airlines and passengers as inelastic if the elasticities considered have absolute values less than 1, i.e., a 1% increase in in the route charges leads to a less than 1% increase/decrease in the considered quantities, otherwise we define them as elastic.

The results of this work indicate that the reactions of airlines and passengers are inelastic with respect to the route charges. However, the fact that airlines and passengers have such an inelastic attitude does not necessarily imply that airlines have to be indifferent to variations to route charges. In fact, profit margins may be often very low, so even tiny percent cost variations may have a high impact on profits. Such an effect is clear, for example, in the monopoly case, where profit elasticity is shown to depend on a term expressing the ratio between fixed costs and profits.

2 Assumptions

We obtain the desired elasticities by developing appropriate microeconomic models based on the following assumptions.

Assumption 1: *An airline aims at maximizing its current operating profits and its response to an exogenous factor depends on its customers' reaction to its behavior.*

Assumption 1 states that one must investigate how the customers of an airline react to possible company decisions to determine the behavior of the airline. As an example, consider the event of an increase of an operating cost. Airlines decide the fraction of such a cost that must be passed to their customers on the basis of the price elasticity of passenger demand. If the demand is very elastic, the airlines reaction is null, since passing the cost would reduce too much the demand and the consequent revenues. On the other hand, in presence of inelastic demand, airlines pass completely the new cost to passengers. Assumption 1 allows approximating the real mission of an airline by an objective function corresponding to the operating profits (Holloway 2003).

Assumption 2: *Revenues increase with the amount of satisfied demand.*

Assumption 2 states that only airline companies, whose core business is to transport passenger and/or freight, are dealt with. The greater is the amount of passenger/freight transported, the higher are the revenues (but not necessarily the profits).

Assumption 3: *When planning medium-/short-term decisions, an airline makes decisions on:*

- *routes - which routes to serve,*
- *fleet capacity - which aircraft types, and with which capacities, to assign to each leg of a route,*
- *frequency of flights - how many flights for each leg and with which schedule,*

- *price - what is the price of the ticket paid by passengers for the transportation on each leg (including every tax, charge, fee, VAT directly charged on the final price of the tickets),*

Decisions are made according to the hierarchy introduced. Then, small perturbations of the operating costs generally induce an airline to change at most the price and the frequency of flights. Pricing is the first decision mechanism to be used.

In our models, the airlines decisions would regard only frequency of flights, price and consequently the number of passengers (cf. Carlsson 2002). We do not consider changes on the fleet capacity since contrasting a perturbation, which takes place along all the routes, by operating on the fleet capacity only by exchanging the aircraft from a route to another one may have little effect, it would have a benefic outcome on one route, but a negative one on another route. Note also that many regional and low-cost airlines have just one type of aircraft.

Assumption 4: *An airline cost function is composed by: fixed costs, marginal flight costs, marginal passenger costs. Airlines have optimized their costs before the considered perturbation.*

We include the (marginal) route and aircraft costs in the fixed costs since we limit our study to small perturbations of the operating costs. We include the route charges and all the other charges for air navigation services in the marginal flight costs.

Assumption 5: *The number of passengers served, i.e., the amount of satisfied demand by an airline, is a function of price, number of flights, and market demand specific characteristics. The demand is decreasing in the price and increasing in the number of flights.*

Assumption 5 states that we can model the passenger demand on the basis of the elasticity of the number of passengers with respect to the price and of the number of flights, and some economic and demographic determinants (Berechman and de Wit 1996, Brons et al. 2002, Morrison and C. Winston 1986).

In this work, we discuss how the expected airline reactions change depending on both the marginal costs considered in Assumption 4 and the elasticities implied in Assumption 5. In particular, on the basis of the models derived by the previous assumptions we obtain the results summarized in the following sections.

3 Behavior of the air transportation industry

We study separately variations of the marginal flight costs (which include route charges) and of the marginal passenger costs on the basis of simple log–linear economic model that describe the interactions between the three main actors involved in the system considered: market (the overall number of potential customers), industry (the overall set of companies) and the ANSPs, source of change in the operating costs.

The difficulties that arise are implied by the complex structure of the demand and the industry considered. Actually, both the market and the industry are made of a large number of decision makers with possible different objectives and economic capacities. For this reason, we do not try to describe in detail the behaviors of the demand and of the industry, but we study the different scenarios that can arise as consequences of different values of the elasticities.

Overall, the obtained results seem to indicate that limited changes in the route charges should not significantly influence the industry behavior.

3.1 Marginal flight costs

The elasticity of ANSPs revenues with respect to the route charges depends on how much route charges affect marginal flight costs. Since normally route charges cover less than 30% of the marginal flight costs, a positive value of the considered elasticity has to be expected, but less than 1. For small perturbations in the route charges, it may be practically 0, due to the possible aversion of the airline to changes in their schedule. However, if the route charge would cover a larger fraction of the marginal flight costs, and if larger perturbations in the route charges would be caused, then the elasticity of ANSP revenues could also turn out to be negative. Hence, an increase in the route charge would induce a decrease in the revenues of the ANSPs. In the assumption that the ANSPs pursue a total cost recovery policy (as it is usually done in Europe, UK excluded), an increase of the route charges is justified only by higher costs to cover. When such an increase induces a decrease of the revenues that is not compensated by a decrease of the costs due to the reduced number of flights to control, the ANSP may be tempted to further raise its prices in the attempt to cover its costs, but in doing so it may even worsen the situation.

As for the elasticity of number of passengers, when the companies implement policies that make the price inelastic to marginal flight costs (as could be expected according to some microeconomic models), the elasticity of number of passengers hardly exceeds the unity in absolute value in the worst case and, on the average, should be less than 1. However, the elasticity of number of passengers may increase, if companies adopt different policies. When the elasticity of price with respect to marginal flight costs is different from zero, it turns out that the expected elasticity of number of passengers should not exceed 2 in absolute value.

3.2 Marginal passenger costs

The elasticity of ANSP revenues with respect to marginal passenger costs coincides with the value of the elasticity of number of flights. The value of such latter elasticity obviously depends on the airline strategies. In general, it has a negative value, provided that the airline companies are implementing some profit optimizing strategy. Furthermore, the absolute average value of this elasticity is about 1, but with possibly significant variations. In addition, for small perturbations, the elasticity of ANSPs revenues may be practically 0, due again to the possible aversion of the airlines to changes in their schedule.

As for the elasticity of number of passengers with respect to the marginal passenger costs, it turns out that it may be even half a point greater than the elasticity of number of passengers with respect to the price and, in any case, it is much higher in absolute value than the elasticity of number of passengers with respect to the route charges.

4 Behavior of a single airline

In the second part of the work, we study the behavior of a single airline and we determine the elasticities with respect to changes in exogenous costs. In this case, the position of the considered company within the air transportation market becomes relevant. We consider different market positions and, correspondingly, we introduce different microeconomic models: the monopolistic case, which sets the baseline for further inquiries, and some versions of the oligopolistic case.

4.1 Monopolistic case

For the monopolistic case, we consider a single stage route operated with a single type of aircraft, under the simplifying assumptions of no risk of being undercut by competitors and no price discrimination. Furthermore, we also assume demand is elastic in order to produce a stable situation, as it is occurs in practice.

For a perfectly rational airline, it turns out that an increase of an operating cost induces a decrease of the airline profits. Such a decrease can be reduced, under appropriate conditions, by a price increase or by a reduction of the number of flights. Furthermore, it is worth pointing out that in this case the air transportation demand is not completely satisfied, and this may attract rivals in the market. In particular, low cost airlines could be the first candidates, since the unsatisfied demand is not willing to pay a high price. Finally, as aircraft size is concerned, it turns out that it is more profitable to use larger aircraft with a lower number of flights when the elasticity of number of passengers with respect to the number of flights is low, while the converse is true when the same elasticity is high and elasticity of number of passengers with respect to the price is low (but still above 1 in absolute value).

A perfectly rational attitude of a monopolistic airline then turns out to imply:

- raising price and reducing the number of flights if marginal passenger costs increase; then passengers decrease;
- keeping the same prices and decreasing the number of flights if marginal flight costs (such as route charges) increase; again, the passengers decrease;
- keeping unchanged both prices and flights if fixed costs increase; passengers do not change;
- raising price and reduce flights if a revenue tax is introduced; obviously, passengers decrease.

We perform an analogous analysis for a monopolistic airline implementing a cost based pricing and we obtain similar results, except when fixed costs raise. In this last case, both the elasticity of number of passengers and of number of flights are not zero anymore.

The results that we obtain concerning a monopoly airline, as well as the ones concerning the Cournot oligopoly airlines, are coherent with the one proposed by Carlsson (2002), who followed a similar approach in dealing with possible environmental taxes.

4.2 Oligopolistic case

In the oligopolistic case, initially we consider the two main possible strategies for airlines: they first decide the number of passengers to serve and let the market determine the price (the Cournot case), or they first decide the price and then let the market determine the demand (the Bertrand case).

In the Cournot model, it turns out that:

- price is less than in the monopoly case;
- if the passengers are quite inelastic to the number of flights, the number of passengers is greater than in the monopoly case.

On the other hand, the qualitative behavior of an airline in the Cournot case is similar as in the monopoly case, when a uniform percent rise in operating costs for all companies in the market occurs.

Conversely, in the Bertrand model the airline should both raise its price and decrease the number of flights if marginal flight costs increase. For any other change of operating costs, the qualitative behavior is again similar as in the Cournot and monopoly cases.

We also consider other kinds of multi-firm models. Unfortunately, these latter cases present some mathematical difficulties that prevent from the possibility of obtaining the same rich results of the other models. Among the different situations considered, we report in the following the case of monopolistic competition.

In the monopolistic competition two airlines provide services of different quality. When passengers consider separately price and service level, both airlines set price and service level as they were a monopolistic one. However, the more costly company gets lower profits than in the monopoly case, as it feels the effects of the cheaper airline. The above argument may justify the fact that a full-service airline may decide not to change its strategy even if a low-cost company enters its market, as long as the low-cost keeps its quality of service much lower than the one of the full-service company. However, in the long term, the presence of a low-cost airline may change the demand sensitivity to the quality of service, because passengers get used to lower prices/lower quality and change their behavior.

According to the considered models, and in view of the experienced values of the elasticities of number of passengers with respect to prices and to the number of flights, it turns out that the following elasticity value ranges should be expected:

- between 0 and 1 for the elasticity of price with respect to the marginal flight costs,
- between -3 and -1 for the elasticity of number of flights with respect to the marginal flight costs, with more probable values near -1,
- between -3 and 0 for the elasticity of number of passengers with respect to the marginal flight costs, with more probable values between -1 and 0.

Of course, the above values must be multiplied by the relative incidence of route charges on the marginal flight costs in order to get the corresponding values for the elasticities with respect to the route charges. Since such an incidence is always below 30%, and generally much less, we may conclude that prices, number of flights and passenger demand are inelastic with respect to the route charges (i.e., with elasticity values always less than 1 in absolute value). When the above results have been applied to companies whose data were available, for which incidence of route charges on the marginal flight costs never exceeds 16%, a possible 10% increase of the route charges should induce an increase of the price less than 1.6%, a decrease of the number of flights less than 4.8%, but more probably close to 1.6%, and, consequently, a decrease of the demand less than 4.8%, but more probably less than 1.6%.

5 Conclusions

In this work we have introduced some models that describe the expected reaction of airlines and passengers to an exogenous change in their operating costs.

The main limit of the models presented is that they are all based on the assumptions that airlines have reached the market equilibrium and that they pursue the maximization of the short term profits. Such hypotheses may be questionable in the currently very uncertain economical situation and due to the still relatively recent entrance in the market of low-cost carriers. By the way, observe that these last circumstances push the companies toward aggressive marketing practices, but may even allure them toward, at least implicit, collusion behaviors or request of government subsidies. Other limiting assumptions concern that only the average prices set by the companies are considered and that both the price elasticity of demand and the flight elasticity of demand are considered constant.

Future developments of this work should probably contemplate the opportunity of developing more general models capable of considering the dynamic behaviors of both the demand and the airlines.

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