Measuring Competition in Air Transport

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Abstract  After a short discussion of the background, the term „competition“ and its framework are defined in the first two chapters. The third chapter deals with the measurement of competition in air transport and the fourth chapter presents results of some strategic scenarios. Overall, the paper shows that it is possible to measure competition by considering consumer behaviour in a consistent way as it pertains to various levels of decision: choice of mode, airport, access/egress, slot and airline. The results shown in chapter 4 are based on elasticities used within the strategic simulation instrument VIA to forecast effects of supply changes on travel demand. The approach uses own as well as cross elasticities of demand with respect to supply side characteristics and the scenario analyses focus on consumer reaction to strategic supply changes at airports.

Keywords  Air transport, strategic simulation, strategic supply changes, consumer behaviour, scenario analyses, travel demand, discrete choice, multimodality, competition of modes, intermodality, co-operation of modes, intramodality, competition of airports or air services, elasticity of demand, trip purposes, market shares, catchment-area, passenger charges, aircraft fees, airport pricing strategy, airport choice, access / egress choice.
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1. BACKGROUND

The ongoing European process of liberalisation and deregulation is accompanied by increasing privatisation in the air industry. Obviously this new situation has fundamental impacts and needs consideration in strategic planning. Hence, the necessity is given to know more about existing competition and - in prospective context - possibilities to assess it so that different market situations can be evaluated.

While airlines faced the rules of competition already for some time the airports were mostly excluded due to a number of reasons. Airlines react to the new competitive situation with large productivity optimisation programs to cut down costs and the lease of aircrafts to enlarge the short-term financial flexibility. In parallel, they defend their markets by using marketing strategies like frequent flyer programs, lounge membership schemes or in future by the planned project 'virtual airline' as well as by establishing international alliances (code sharing, cross-share holding, franchising).

The concentration of the supply side by the alliances reduces the competition so that almost two thirds of the existing O-D’s are monopoly services, one quarter of the routes is served by two carriers (which often belong to the same alliance) and only on the remaining routes there are three and more competitors. In the last case - which covers a third of the total passenger volume transported - the consumers benefited from a significant drop in price in the past.

Further competition could be expected due to new entrants offering low-cost services, established ‘national’ airlines extending their businesses to other European areas, increasing capacity constraints and improved high speed services.

The situation at most airports in Europe is different because they are still owned by the public and with some exceptions (hubs and privatised airports) the necessity for competitive behaviour was not given. While the privatisation process is going on, subsidies are cut down and productivity has to be increased, secondary airports withdraw passengers from the major ones, capacity constraints exist at a lot of airports and huge investments are requested to solve existing problems. Furthermore airline alliances redirect passenger flows to secondary hubs and various airports offer special services on the non-aviation side.

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1 These includes restrictive bilateral air agreements, the lack of deregulation and privatisation, the procedures to define aircraft fees and passenger charges, the available capacity resources and the missing or small sensitivity of the public to environmental effects, etc.
This could be interpreted as airports are starting to act like private companies in a competitive market. They have to fight for customers, increase their attractivity for passengers as well as for airlines and cope with competition at the airport itself (e.g. ground handling). Marketing and market analysis becomes more important to be able to react fast and precisely to market changes and to develop strategies for mid- and long-term investments. If the management fails well established airports of today will be downgraded by the consumers and airlines to second or third league airports of tomorrow.

The European air market is facing additional policy interventions in form of new deregulations and regulations. There is international pressure to follow an open sky policy\(^2\) and to cut down subsidies rigorously to allow fair competition. Further on politicians are approached by the public to internalise external costs due to increasing environmental sensitivity.

Fees or taxes on aircraft emissions and demand-based aircraft fees as well as passenger charges or quotas for air movements and noise are applied or taken into consideration. Additional interventions are expected to harmonise the market conditions with respect to airport cost structures, local landing fees and passenger charges.

Demand and supply should be the only forces in a free market but the existing access to the market conditions needs some additional rules to transform e.g. the restrictive grandfather rights on the slot allocation side into an open system where slots can be traded. The necessity to install such rules is given in the light of the capacity constraints faced by nearly any big airport and the slot blocking politics specially of home carriers at hubs, which prevent new competitors from entering the market.

New regulations are welcomed by privatised airports as opportunities to maximise their revenues by optimising resource management. Therefor peak pricing could be used to cope with capacity constraints - but one has to ensure by price caps that airports do not withdraw monopoly rents extensively and that new entrants will have a fair chance. So scarce resources at congested airports handled at market price will lead to shifts to other airports or landbased modes. In parallel, aircraft fee structures can be used as instruments to meet quotas of noise and aircraft movements.\(^3\)

Airlines and airports have to show great flexibility in adjusting their supply to the changing demand and regulatory framework in order to survive

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\(^2\) Non-European carriers should have ‘unrestricted’ access to the European air market. Naturally such harmonisation issues have to be in-line with other actions, for example the assignment of a landing point to a specific airport in a bilateral agreement discriminates all other airports which are not considered.

\(^3\) Modified aircraft fees could force airlines also to increase their load factors above the miracle barrier of 70 per cent.
in the evolving market. Therefore the decisions for long- and mid-term strategies become more and more difficult and decisive as they might comprise costly investments in air-related infrastructure (including high speed railway stations at airports), new services in the non-aviation sector or the extension of hub&spoke versus point-to-point air schedules.

The resulting complexity in decision-making processes in the air industry requires enhanced planning instruments to apply appropriate means from the administrative side and to adjust supply structures that will enable the carriers and airports to stand the increasing competition. The following two sections will answer the question of how ‘competition’ could be considered and measured in strategic planning instruments.
2. NOTIONS OF COMPETITION

After having shed a light on the general background we will now turn to the question which forms of competition appear and how they can be explained.\(^4\) For this purpose it is necessary to view the air market from the outside to identify all structural components of competition.

The following different types of competition in the air market can be distinguished:

- competition on a single route,
- competition between networks,
- competition for infrastructure and
- competition between access/egress points.

The classical notion of competition is the rivalry between two carriers on a certain route. This kind is usually expressed in market shares kept by the competitors. The second one is measured in more aggregated market shares and means the rivalry between two and more airlines as well as those between airline alliances.

Competition for infrastructure comprises e.g. the fight for slots or ground-handling capacities. In this case limited resources on airports\(^5\) are the reason for the conflict between the airlines. An often misinterpreted form of competition is that between airports, mostly owing to a special view of the air sector.

Out of a general transport point of view the supply side should be a result of the offered O-D services which include the airports and land-based access/egress modes while the demand side is given by the travellers with all their needs and priorities for a trip. But there is dissension concerning the question of what the demand is i.e. who are the clients or who is who’s client?

Specially the discussions with airport managers are at a dead end when they assert that their customers are only airlines. Neglecting their (possible) revenues on the non-aviation side, they refuse in addition the 'transitivity rule' which links the travellers via the airlines to the airports. Anyhow, in the light of the evolving privatisation and liberalisation processes competition among airports will increase.

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\(^4\) Naturally modellers prefer to explain the interdependencies instead of just describing observed situations because their aim is to understand the underlying structure of a system.

\(^5\) Due to the fact that at least two airports are required for air routes, the constraints must not necessarily exist on both airports because slots on unconstrained airports must fit to their counterparts on the constrained ones.
An airports’ attractiveness in a condensed European air market depends strongly on the capacities, the pricing structure, the land-sided accessibility and the non-aviation supply. Those factors and the carrier-related supply based on them, all together will finally attract customers, i.e. travellers and also shoppers. Hence, besides infrastructural matters the potential of customers is the major driving force for airlines to choose an airport.

The competition of airports on the cost side (passenger charges, landing fees, ground service) is already ongoing especially if one considers the non-harmonised airport costs in Europe in context of the air alliance network optimisation. Airports with ‘bad’ price structures, i.e. high costs for airlines (passed to the travellers through the fares), are already facing the problem that clients – travellers and airlines - look for alternatives. Therefore airlines try to combine their network synergies at ‘better’ airports.

While hubs are already working at this problem other airports still hesitate and focus on O-D market services. That is the reason why they estimate the influence of varied fees and charges on carrier decisions as relatively small in contrary to routing optimisation. But airlines want to satisfy the consumers needs as profitable as possible and consumers’ try to obtain their optimum from the supply offered.

Neglecting such obvious dependencies and standing at the side, waiting what airlines and travellers do, is certainly an unconventional strategy which might be applicable if the airport is in a monopolistic situation e.g. due to bilateral agreements but will not suit those airport managers that view travellers as their clients.

They will agree to the idea that persons intending to travel from an origin to a certain destination have to be convinced to choose a route via their airport. But this route competes with those through other airports and routes that use only ground-based transport modes like (high speed) trains or private cars. Hence, airports are in a very large competition that should be considered as completely as possible in the decision-making processes.

Taking into account only the air transport system, as airlines often do, is not sufficient, when one aims at the traveller as the final driving force. But more crucial is the scope of airports when analysing the market. Neglecting neighbouring airports and also those further away as competitors falsifies any serious evaluation and in consequence any planning.

The planning and analysis instrument must therefore cover all main modes - road, rail and air for the multi-modal competition. Further, the corresponding access/egress systems have to be considered for inter-modality beside detailed representations of the air transport system itself to assess the intra-modal rivalry between airports and/or carriers.
Well-developed planning instruments based on a system approach simulates the complete supply side a travelling individual is confronted with and from which it has to choose its path from the origin to a desired destination. Interpreting the different paths as alternatives in a choice process, competition could be measured in terms of the various probabilities to select one of the possible paths.

It is important to note that the traveller has to take a discrete decision about the alternative to be used because he can only use one alternative at each time. The choice among the set of available alternatives depends on subjective preferences and/or on the alternatives’ characteristics. Neglecting individual preferences for the moment, the traveller compares the alternatives on the basis of their measurable characteristics like e.g. travel cost, travel time, comfort and security.

The preferences come into the decision process when the travelling person weights the ‘objective’ characteristics for each alternative due to its personal rating. In economics the resulting measure is referred as ‘utility’, i.e. the satisfaction one receives from choosing one alternative. It is obvious that consumers evaluation varies between different individuals which for example can be segmented according to their socio-economic situation (income, age, gender) or their trip purpose (business, vacation, visiting friends and relatives).

\textsuperscript{6} We are focusing here on individuals who have just decided for a trip and do not cover those which are still in the process of decision whether to travel at all.
3. HOW TO MEASURE COMPETITION?

We can define competition as a situation in which two or more alternatives satisfy the same consumer needs in a different way. Consequently one can explain the competitive situation by the choice probability – or aggregated by the market share - of each alternative, whereby the alternatives themselves define the area of competition. From the theoretical point of view it is a discrete choice problem which reflects the comparative market situation by comparing alternatives and expressing the decision of consumers by the proportion of each alternative.

Following the definition of competition and the market hypotheses, it is obvious that competition can be expressed in a descriptive way by comparing the market shares \( p \) of the alternatives \( i \) or in absolute number of travellers when the total flow \( T \) (passenger volume) is applied to the shares \( p_i \), so that the flow per alternative \( T_i \) is available. This can be noted by:

\[
T_i = T * p_i = \frac{T_i}{T} \quad i \in C = \{1, ..., M\}
\]  

(1)

Such an approach is not satisfying because it is just an *ex post* description of competition. To explain consumer behaviour and to analyse strategic *ex ante* scenarios we have to go into more detail. Therefore it is necessary to know why a consumer \( n \in \{1, ..., N\} \) selects a specific alternative \( i \) out of a set \( C_n \) of competing alternatives. This is expressed in microeconomics using discrete choice models for computing the probability of a consumer \( n \) of choosing alternative \( i \) - \( P(i_n) \).

In reverse it is important to know how the different supply specific characteristics \( x_k \) - which describe the attractiveness of the alternatives - influence the consumers’ choice. Here we speak more formally of the consumer’s ‘elasticity’ in respect to any alternative’s characteristic.

The elasticity \( \eta \) just measures the ratio of the percentage variation of a dependent variable \( Y \) due to the percentage change of an independent variable \( x_k \) \( (k \in \{1, ..., K\}) \) given all other independent variables fixed at their observed value. As dependent variable one can use e.g. the total flow or market share - \( T_i \) or \( p_i \) – and assess the impact of passenger fare as an independent variable, keeping all other independent variables like travel time, frequency, service attributes, etc. unchanged.

Now as equation (1) is a product, the elasticity of demand \( \eta \) of alternative \( T_i \) with respect to a variable \( x_k \), can be decomposed in its impact on the total demand \( T \) and its impact on the alternative’s share \( p_i \).
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\[ \eta(T_i, x_k) = \eta(T, x_k) + \eta(p_i, x_k) \]  

(2)

The more general form for any elasticity is for the point measure:

\[ \eta(Y, x_k) = \frac{\partial Y}{\partial x_k} \frac{x_k}{Y} \]  

(3)

At this point please refer to Gaudry (1997) who is using the same approach in his paper for the COST 318 action concerning diversion and induction rates derived from elasticities defined in (2). This paper as well as Gaudry et al (1994a) are of interest if the reader wants to know more about substitution and complementarity in this context.

As we want to focus on individual aspects of consumer behaviour we choose — instead of an aggregate share approach \( p_i \) — a disaggregate probability approach \( P(i)_n \) with underlying Logit function such as (see Mandel (1992)):

\[ P(i)_n = \frac{U_{in}}{\sum_j U_{jn}} \quad i, j \in C_n \]  

(4)

where the utility function of an alternative \( i \) is of the following form

\[ U_{in} = \exp (\beta_i + \sum_k \beta_{ki} x_{kin}) \quad k \in \{1, \ldots, K\}; \ n \in \{1, \ldots, N\} \]  

(5)

The utility \( v_{in} \) reflects the characteristics of alternative \( i \cdot x_{kin} \) - weighted by the consumer (here expressed by \( \beta \)-factors) and the Logit function transforms the alternative-specific utilities into probabilities for choosing the related alternatives.

Now the direct elasticity \( \eta \) of the probability of a consumer \( n \) choosing alternative \( i \) with respect to a change in the characteristic \( x_{kin} \) is given by:

\[ \eta(P(i)_n, x_{kin}) = \frac{\partial P(i)_n}{\partial x_{kin}} \frac{x_{kin}}{P(i)_n} \]  

(6)

In addition it is interesting to know how the changes of a characteristic \( x_{jin} \) effects the probability \( P(j)_n \). Therefore the cross elasticity of the selected probability alternative \( i \) with respect to a variable of alternative \( j \) can be computed by:

\[ \eta(P(i)_n, x_{jin}) = \frac{\partial P(i)_n}{\partial x_{jin}} \frac{x_{jin}}{P(i)_n} \]  

(7)
\[ \eta(P(i)_n, x_{kn}) = \frac{\partial P(i)_n}{\partial x_{kn}} \frac{x_{kn}}{P(i)_n} \quad (7) \]

But due to the properties of the classical standard Logit approach such cross elasticities are equal. Equal cross elasticities of demand imply identical ‘values of time’ across all alternatives: this means e.g. that non-stop and via flight passengers value time identically.

To bypass this constraint and other IIA-property manifestations as well as interpretative problems of the standard Logit model (see Mandel et al (1994)) we use non-linear transformations of the following form (see Box-Cox (1964)):

\[
\begin{align*}
x_{kin} &= x_{kin}^{(\lambda_k)} = \begin{cases} 
\frac{\lambda_k}{\ln x_{kin}} (x_{kin} - 1) & \text{if } \lambda_k \neq 0, \\
\ln x_{kin} & \text{if } \lambda_k = 0.
\end{cases} \quad (8)
\end{align*}
\]

In consequence the utility term (equation 5) and the probability function (equation 4) change.

Now, as the computation of the cross elasticity depends on the models specification, e.g. the type of transformation and the use of the variable as generic or specific, the expression \( \frac{\partial P(i)_n}{\partial x_{kn}} \) is computed by (see Mandel (1992)):

\[
\frac{\partial P(i)_n}{\partial x_{kn}} = P(i)_n \left[ \frac{\partial V_{in}}{\partial x_{kn}} - \sum_h P(h)_n \frac{\partial V_{hn}}{\partial x_{kn}} \right] \quad h, j, i \in C_n \quad (9)
\]

For the interpretation of elasticities one should be aware that the values given are computed on the basis of a 1% change of the variable \( x_k \). As the formulas (6) and (7) show, the result is a share value and therefore the interpretation always has to be put in context to the demand an alternative attracts. If the elasticity is small but the attracted demand of that alternative is high the demand effects could be bigger than in the reverse case. More formally the own elasticity is:

\[
\eta = \beta_k x_k^{\lambda_k} [1 - P(i)] \quad (10)
\]

where the elasticity increases with \( \beta_k \) and falls with the level of \( P(i) \).
As we noted in chapter 2 there are various areas of competition which have to be considered in total to reflect consumer behaviour. Therefore equation (2) can be enriched by these elements when we go on decomposing the problem. Instead of using just one discrete choice part in the formula we can add the interesting fields of airport choice, access/egress choice, time slice choice and airline choice in the following way (with simplified notion).

$$(\eta \text{ of alternative}) = (\eta \text{ of total flow}) + (\eta \text{ of mode}) + (\eta \text{ of airport}) + (\eta \text{ of access/egress}) + (\eta \text{ of time slice}) + (\eta \text{ of airline})$$

(11)

Which is equal to:

$$\eta (T, x_k) = \eta (T, x_k) + \eta (P\text{(mode)}_{n, x_k}) + \eta (P\text{(airport)}_{n, x_k}) + \eta (P\text{(access/egress)}_{n, x_k}) + \eta (P\text{(time slice)}_{n, x_k}) + \eta (P\text{(airline)}_{n, x_k})$$

(12)

This expression allows us to compute the elasticity of demand of an alternative with respect to any variable $x_k$ considering the impacts on the following types of competitive situations:

- competition of destinations (substitution, complementarity)
- competition between the modes (air, rail and road),
- co-operation of modes (air-rail, air-road),
- competition between air services at airports,
- competition of access/egress modes to/from the airports,
- competition for time slices at airports and
- competition of airlines.

As already mentioned above this formula should be used for any market segment, for example business travellers tend to have a lower elasticity concerning travel expenses than for travel time and the reverse holds for vacationists.

Obviously to calculate such complex elasticity structures which allow detailed analyses at any point, a system approach is needed. It has to be assured that the interdependency of different models is reflected properly and therefor models have to be linked so that the results are consistent. One way of doing this is using the ‘quasi-direct format’ where the different model steps are linked by the representative utility function of preceding models in the subsequent ones as additional explanatory variable. This approach can be enriched by considering the probabilities of the preceding models as weights when the explanatory impedance variables in subsequent models are computed (see Mandel (1999)).
Instead of extending this paper by the theory of all modelling steps implied, it is referred to various publications. A detailed theoretical background of the modelling steps is given by the following literature.


As experts expect that the main focus of interest in the coming years will be on airport competition we will present some strategic scenario examples in the following chapter based on a restricted sequence of elasticities as shown in equation (13).

\[
\eta (T_i, x_k) = \eta (T, x_k) + \eta (P(mode)_i, x_k) + \eta (P(airport)_i, x_k) + \eta (P(access/egress)_i, x_k)
\]  

Finally it has to be stated that the results shown in chapter 4 are aggregated concerning destinations and trip purposes and that the elasticities used are documented in Mandel et al (1994), Gaudry et al (1994 a) and Mandel (1999).
4. SELECTED STRATEGIC RESULTS

To show the effects based on the approach outlined in the chapters above it is not sufficient to provide decision makers with results on the microeconomic level of individual consumers because the evaluation of strategic scenarios has to be done out of a global point of view. Therefore the simulations are computed on the specific consumers’ elasticity while the results are aggregated and displayed on the macroeconomic level. Instead of showing elasticity or response curves like in Mandel (1999) we will concentrate on situations of competition and the related consumer behaviour which can be influenced by strategic actions. For the sake of clarity, the results displayed will be restricted to the geographic shape of Germany although consumer behaviour beyond the German border is affected and of course considered in the computations.

Within this chapter three possibilities of strategic scenarios are shown. All of them are focusing on consumers’ reaction to supply changes. Thus the results are reflecting the elasticities of consumers.

The first and second example are dealing with a network change of air services and its impact on airports. While the first one is very simple and restricted to the inauguration of a new route at Berlin with the intention of showing the effects on the major competing airport in this market area, the latter example is quite complex in the actions considered and will show the effects on both airports involved. The last example presents the consumers’ elasticity to ceteris paribus fare variations at the airport Hamburg.

In all scenarios the results reflect the interaction of multi-, inter- and intramodal effects. Therefore a system approach was applied. As the examples should show the possibility to measure competition in air transport the analysis focuses on the consumer’s elasticity on variations of supply. Obviously other strategic scenarios can be simulated and evaluated in the same way and even in a more detailed manner depending on the client’s needs.

Scenario A. Route inauguration

The German airport that serves the North American market the most is without doubt the Frankfurt/Main airport. This airport hosts the homebase of the former national carrier ‘Deutsche Lufthansa AG’ and is ‘the hub’ in Germany. As our scope is on consumers’ behaviour in a competitive environment we want to study the impacts of changes on the supply side. Therefore the first step is to get an impression of the competitive situation of
this major airport, which is displayed in form of Frankfurts’ catchment area by Figure 1.

As Frankfurt is offering a large number of services to North America and the earthbound access/egress possibilities are above average, its market dominance covers a wide area of Germany. The white spots at Frankfurts’ hinterland do not indicate that Frankfurt doesn’t play a role in consumer decision they just reflect on the one hand the good air feeder system to Frankfurt, which is used as access alternative instead of the landbased modes, and on the other hand the strong influence of competitors - e.g. non-stop service at the airport or other routes via competing hubs.

Considering the status quo air network, an additional non-stop air service from Berlin to North America is installed in this scenario. The point of interest we want to show is the consumers’ reaction to a new competing alternative which enriches the existing set of possibilities. Here the question
about the demand elasticity plays a key role when arguments between airlines and airports are exchanged whether the originating market is big enough to install such a new service or not. Of course the transfer passengers will also partially use the new service, but for an airport manager it is more interesting to attract new customers than to shift air passengers from one flight to another. Obviously airlines will take another point of view. May be they compete with another airline and want to increase their market share or they want to enrich their service by another O-D pair without losing the economic surplus at the already existing service of this market area. Anyhow for both groups it is important to know how the travellers react to service changes.

Although Frankfurt Airport and the Berlin airport system (TXL, THF, SXF) are already quite far from each other, the catchment areas for originating/destinating passengers are overlapping with up to 10% Berlin travellers using earthbound systems to access Frankfurt. The majority of travellers (90%) are choosing transfer services offered at Berlin via airports like FRA, AMS, LHR and CDG. Now the question is whether this situation can be influenced by an airport located at the border lines of Frankfurt’s catchment area.

Fig.2. Market shares changes of Frankfurt Airport by regions if non-stop flights to North America are offered at the Berlin airport system

In figure 2 we simulated the consumer reaction, when new non-stop flights to North America are offered at the Berlin airport system out of the point of view of Frankfurt Airport. As indicated in figure 2 Frankfurt will lose market shares in some areas belonging to Berlin’s sphere of influence.
The maximum decrease doesn’t take place in Berlin directly — although the decline is up to 10% points which nearly diminishes Frankfurt’s market share to zero — but in two counties situated in the south-west of Berlin where losses reach up to 20%. The reason for this strong reaction can be found in analysing the consumers’ alternatives for reaching a destination in North America with and without non-stop flights offered at Berlin. Comparing the alternatives, consumers are making their choice in respect to their e.g. price and time elasticity which now results in passenger shifts to the new service at Berlin withdrawing them from Frankfurt.

This reflects the obvious rule that the closer the starting-point of a trip is to an airport, the more people prefer this airport even if then a transfer on their trip is needed, especially if the next airport offering non-stop flights to their final destination is far away. The main area of competition is at the regions where no airports are located.

So travellers not originating in the vicinity of an airport have to compare very carefully their impedances to airports which offer non-stop flights to their final destination and the ones who do not. If e.g. the difference in travel time is less than or equal to the time it affords to change a plane, they will choose the new opportunity. So in the case of additional destinations for non-stop flights being introduced to the market, people react more sensitively to a new alternative by changing their starting airport. Figure 1 points out that Frankfurt’s market share was up to 40% in such regions as the south-west of Berlin, although there were other airports closer situated but without a non-stop service to North America. The introduction of a new service at Berlin reduced Frankfurt’s market shares by half as shown in figure 2.

It has to be stated that the results differ by trip purpose and final destination so that the results shown are aggregated. In addition one has to be aware of the underlying access/egress infrastructure which is also mirrored by the catchment area of the airports.

**Scenario B. Secondary hub**

After the quite simple example A, a bundle of supply changes take place in the strategic scenario B. We assume that in addition to Frankfurt Airport a secondary hub in Germany at Munich airport will be established. The scenario consists of the following changes to the situation of the year 1991:

1. New additional intercontinental destinations are offered at Munich.
2. The feeder network is extended to strengthen Munich’s hub potential.
3. Some secondary destinations, offered in Frankfurt, are cancelled due to capacity constraints in favour of more flights to destinations with higher demand.
Such supply changes create a new competitive situation between the airports Frankfurt and Munich where also other international airports are affected. In the following, we will focus just on the two airports Munich and Frankfurt. At first, the changes in passenger volume at the two airports should be mentioned. While Frankfurt is losing 0.7 Mio., Munich gains 1.6 Mio. passengers in total and on intercontinental routes Frankfurt loses 0.15 Mio. which nearly can be attracted completely by Munich. Now it is interesting to know how these passenger shifts can be explained e.g. what was the consumers behaviour?

How consumers react in respect to the new situation can be summarised by the following five possibilities:

1. Travellers who used to depart from Frankfurt, now take off at Munich.
2. Travellers who came to Frankfurt by earthbound transport to use a non-stop or via service, now take a feeder flight to Munich and reach their destination after a transfer.
3. Some travellers who took a feeder flight to Frankfurt, now use a feeder flight to Munich.
4. Some other travellers who took a feeder flight to Frankfurt, now go to Munich by earthbound transport to use a non-stop or via service.
5. Travellers who used earthbound transport to reach Munich airport, now take a feeder flight to Munich.

It is important to note that there is no general consumer reaction due to the complex structure of the bundle of strategic supply changes which in addition causes synergetic effects. As the five possibilities show, the behaviour is always oriented to the individual situation reflecting a specific point of the elasticity curve.

The change of passengers’ demand on the flights between Frankfurt and Munich is also based on their consumer reaction described by possibility 2. Information about the other kind of consumer reactions is given in figures 3 and 4 which show the changes of the catchment area of Frankfurt and Munich caused by the new destinations offered at Munich for the market segments Asia and Africa.

For Frankfurt Airport (Figure 3.) a decrease of market share up to 4% points is shown for a number of traffic zones arranged in a wider circle around the airport location, but no significant change could be measured in the vicinity of the airport. The highest losses appear in regions situated close to other airports which are now connected to Munich by feeder flights (i.e. Saarbrucken (SCN), Nuremberg (NUE), Stuttgart (STR)).
For the Munich Airport (Figure 4.) a decrease of market share can be seen for the areas around the airports of Nuremberg, Hof (HOQ) and Friedrichshafen (FDH), which seems to be inconsistent with the extended schedules offered at Munich. The reason for this effect is listed as consumers’ reaction possibility no. 5 where consumers change from earthbound access to feeder flights. Additional market shares for Munich are shown especially for the area of Stuttgart and the traffic zones at the border to Austria. This increase is caused by the new intercontinental destinations offered at Munich that compete with supplies at other airports.
This short analysis just sheds a light on the possibilities which are available if one goes more into detail down to the assigned air services by the different trip purposes. But the focus was not to show losses and gains at the airports, the aim was to show the variety of the consumers’ behaviour in respect to supply changes and that new competitive situations arise by complex strategic scenarios which include synergetic effects which can even be measured \textit{ex ante}. The demand elasticities in respect to any air service variable considered in the model specification (e.g. time, fare, frequency, service attributes) allows to simulate and optimise strategies as well as to measure competition in air transport. In context with the system approach VIA (Last et al 1997) even the role of earthbound feeder systems can be considered which (as we saw) cannot be neglected.

Finally it has to be stated again that the results displayed, are aggregated concerning trip purpose and final destination. The role of the underlying access/egress infrastructure is mentioned in the consumers reaction possibilities.

\textbf{Scenario C. Local pricing strategy}

The last strategic scenario deals with an increase of passenger fares at an international airport which might happen in order to meet environmental benchmarks (e.g. noise, pollution) or to manage scarce resources (e.g. parking positions, aircraft movements) efficiently. Again such an action will
change the competitive situation between airports and the question arises how consumers react to the supply changes.

Here we assume that the international airport Hamburg charges an additional supplement — to airlines or passengers — so that the travel expenses increase by DM 50,- per passenger for any flight. The resulting question will be which kind of effects can be expected? Or the other way around, if one wants to reach a certain aim / benchmark which amount of money should be demanded from whom? In both cases the focus is on the price elasticity of demand.

Figure 5. depicts the simulated market share losses for the airport Hamburg. The pattern results from passenger shifts to competing airports as well as travellers using earthbound modes (rail and road) as substitutes. The highest reductions of Hamburg’s market shares can be found inside the extended area of Hamburg and in regions from where another airport (e.g. Hannover) is reachable in similar conditions, like the airport of Hamburg. The further interpretation of figure 4 is complementary to the one stated in scenarios A and B.

**Fig. 5. Market share losses of Hamburg Airport 1991: all destinations**

As we want to measure the competition we should have a look at the competitors. Where do consumers go to, which are the alternatives considered as substitutes, who are the winners or losers of such a scenario? Figure 6. summarises the passenger shifts between the competing alternatives.
As the tariff increase is relatively high for short-haul flights the major effect is a shift to earthbound modes for domestic destinations. Here air services are competing with high-speed train services which serve a city-city pair nearly as fast as airplanes.

Those airports connected with Hamburg by short-haul flights, like Frankfurt (FRA) and Duesseldorf (DUS) must be characterised as losers. But the total number of passengers on these airports decreases less than on the O-D flights because some of the travellers still reach these airports by plane just using a competitive airport like Hannover (HAJ) or Bremen (BRE). Others replace their former connecting flight (e.g. Hamburg - Frankfurt by car or rail trips to Frankfurt) and subsequently enlarge the catchment area of these airports.
Airports situated closer to Hamburg may be considered as winners in that situation, if they are not connected to Hamburg by plane and, in addition, provide a comparable number of destinations. Here, HAJ and BRE win more than 50 Tsd. passengers each, while at Kiel (KEL, in the north of Hamburg), there is only a little increase in the amount of passengers, due to the very few destinations offered there. A special kind of winner, although the number of changing passengers is quite low, is Copenhagen Airport (CPH). Despite losing passengers on the flights to and from Hamburg, the total number of people in Copenhagen increases. This result is caused by a combination of the two effects stated for Frankfurt and Hannover.

Of course one can go even more into detail by analysing the consumer structure at the Hamburg Airport and how the segments are affected by such an increase of fares. Obviously business travellers are less price sensitive than vacationists. But having a look at the passenger figures differentiated by trip purpose, figure 7 indicates that although the number of travellers diminishes by 835 Tsd. (8%) the reaction of vacationists is quite low - the total amount of travel expenditures is already quite high so that the extra charge does not have a tremendous influence on their decision - while trips belonging to the trip purpose private (non-business trips up to a total duration of four days) are affected strongly. Due to the high time elasticity of business travellers this consumer segment is not affected very much.

![Fig. 7. Passengers at Hamburg Airport by trip purpose 1991](image)
Now further analyses can follow concerning the effects on different routes, the aircraft movements, the environment or finally concerning the economic impact of such an action (see Mandel (1999)).

Again it can be stated that the elasticity of demand is dependent on the location of the traveller, the final destination and the trip purpose as indicated by the results.
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REFERENCES

Ben-Akiva M., Lerman S.R.: Discrete choice analysis; London; 1985
Domencich T., McFadden D.: Urban travel demand - a behavioural analysis; North-Holland; Amsterdam; 1975
Gaudry M.I.J.: Key substitution-Complementarity Features of Travel Demand Models, with Reference to Studies of High Speed Rail Interactions with Air Services; COST 318 <Interactions Between High Speed Rail and Air Passenger Transport>, Workshop <From Competition to Complementarity between Air and High Speed Rail: are Models telling the Same Story?>; Centre de recherche sur les transports, University of Montréal, 12’1997; forthcoming
Gaudry M.I.J., Mandel B., Rothengatter W.; Introducing Spatial Competition through an Autoregressive Contiguous Distributed (AR-C-D) Process in Intercity Generation-Distribution Models with Quasi-Direct Format (QDF), Centre de recherche sur les transports, University of Montreal; CRT 971; 1994a
Last J., Mandel, B.: VIA Systemkomponenten – software documentation; Karlsruhe; 1997
Last J.: Reisezweckspezifische Modellierung von Verkehrsverflechtungen; Institute of policy research - IWW, University of Karlsruhe; MKmetric GmbH; 1998
Mandel, B., Gaudry M. I. J., Rothengatter, W.: A Disaggregate Box-Cox Logit Mode Choice Model of Intercity Passenger Travel in Germany and its Implications for High Speed Rail Demand Forecast; The Annals of Regional Science, pp. 99 - 120; Springer Verlag; 1997
Mandel B., Gaudry M., Rothengatter W.: Linear or nonlinear utility functions in Logit models? The impact on German high-speed rail demand forecasts; Transportation Research Part B, Volume 28B, No.2, pp. 91-101; 1994
Mandel, B.: Schnellverkehr und Modal-Split; Nomos Verlag, Baden-Baden, 1992
Tran L., Gaudry M.: QDF a Quasi-direct format Used to Combine Total and Mode Choice Results to Obtain Modal Elasticities and Diversion Rates; Centre de recherche sur les transports, University of Montreal; CRT-982; 4/1994