Market development of airline companies: A system dynamics view on strategic movements

Bernhard Kleer
University of Stuttgart
Betriebswirtschaftliches Institut
Lehrstuhl für Planung, Professor Dr. Erich Zahn
D-70194 Stuttgart, Germany
bernhard.kleer@gmx.net

Eva-Maria Cronrath
European Center for Aviation Development - ECAD GmbH
Lise-Meitner-Str. 10
D-64293 Darmstadt
Phone +49 6151 36 05 424
eva.cronrath@ecad-aviation.de

Alexander Zock
European Center for Aviation Development - ECAD GmbH
Lise-Meitner-Str. 10
D-64293 Darmstadt
Phone +49 6151 36 05 400
alexander.zock@ecad-aviation.de

The airline industry is characterized by strong dynamic developments. We aim to demonstrate the effects of entry and exit on city pairs, i.e. the routes between two airports, by presenting a System Dynamics model to simulate and analyze strategic movements of airline companies. By varying the preconditions, e.g. distinct business models and initial entry setups, we will show the various consequences of different market scenarios, comparing the results with hypotheses from a literature review. Additionally, we will show the effectiveness of a policy of predatory pricing against market entry under different conditions. To calibrate the System Dynamics model, data of German Antitrust law suit between Lufthansa and Germania is used.

Keywords: strategy, airline business, predatory pricing, antitrust law suit, market entry

1. Introduction

Airline markets are subjects to constant change yet for decades. Despite of international crises and increasingly intense debates on ecological sustainability the industry is growing rapidly. Globalization, deregulation of markets, privatization of airports and former national flag carriers, emerging new business models and hence the low cost revolution, world-spanning alliances and achievements like the Open-Sky Agreement are global growth drivers. With this paper we aim to contribute to the research on the most basic airline market: the route between two airports, i.e. the city pair.

The contents of this paper were developed as part of a project realized at the European Center for Aviation Development (ECAD) and funded by the Hessian Ministry of Economics, Transport and Development, Lufthansa German Airlines and Fraport AG. The project was to observe how strategic behavior would affect market development. As this research question focuses on the underlying feedback structure and the resulting dynamics that strategic behavior has on a markets development, we choose System Dynamics as our method of analysis. “The basic idea behind a strategic move is that when making an optimal choice now, an incumbent must try to anticipate how his rivals will respond in the future. [...] short-term ‘sacrifices’ [have to be accepted] by the incumbent aiming at obtaining long-term (discounted) gains, which at least outweigh the sacrifices” (Hüschelrath 2005). Therefore a strategic movement by change of price, frequency or tube size or any given combination of these is always a dynamic phenomenon.

Resulting from an intense literature review we assume the following hypotheses:

- latent demand post-entry benefits mostly the new entrant,
- revenues will sink post-entry with a low cost carrier entering a market (Joskow et al. 1994),
- post-entry prices will decline while outputs will be increased,
- a new entrant will probably need more than a decade to reach seat capacities comparable to an incumbent (Geroski 1995),
- as meta-hypothesis we assume that airline markets’ dynamics arise partly from entries and exits on a city pair and are driven by competitive interaction among airlines.

These hypotheses are to be tested by means of a System Dynamics model. The efficiency of strategic movements by change of frequency, price and tube sizes will be analyzed in various scenarios. Our goal is to present the model of a city pair market with two competitors, and to compose a scenario analysis to observe the airlines’ behavior under different sets of circumstances. The model will be calibrated with the German antitrust law suit between Lufthansa and Germania in the years 2001 and 2002 that provides the necessary information.

2. Market Dynamics

The above stated hypotheses are based on a literature review that will be presented briefly in the following. Main aspects of research are market entry, market barriers, behavior and reactions of incumbents on new competitors, especially crowding out.

Miller and Chen (1996) deal with the risks of dynamic markets in the airline industry by studying the tendency to simpler, lean organizations and their simplistic repertoire of competitive actions. They state that by focusing on core competences (Prahalad & Hamel 1990) and economies of concentration (Chandler 1992) the preconditions of

Ashby's Law (the larger the variety of actions available to a […] system, the larger the variety of perturbations it is able to compensate, Ashby 1956) cannot be met (Miller & Chen 1996). In highly competitive industries, like the airline business, a too close repertoire of competitive actions can compromise the successful continuity of a company. The authors show that past achievements reinforce the tendency to simpler patterns of behavior. Instead, broader experience with competition and multilateral market environments take effect against limiting the scope on few competitive actions. In contrast their study shows that neither age of an airline company nor the degree of market uncertainty have any influence on an airline's competitive repertoire. From these last findings we deduct that all sort of strategic movements as well as predatory actions are appropriate means of competition for incumbents as well as market entrants.

In 1995 Geroski summarizes the results of the then recent research on market entry (Geroski 1995). The most important stated facts are the following: Entry and exit rates show a strong positive correlation. Thereby net entry rates merely account for a fraction of gross rates. Survival rate of market entrants is low and even successful companies often need more than 10 years to obtain a size comparable to those of incumbents. "De-novo"-entries take place more often but are on average less successful than entries by diversification. Costs of adjustment seem to limit big-scale market entries and prevent fast market penetration. Geroski challenges some facts which his meta-analysis suggested. For example the explanation that market entries have solely a moderate influence on mean profit margins or the finding that incumbents normally do not utilize price cuts to prevent a market entry are doubted. Moreover, in contrast to his reviewed literature Geroski sees a positive coherence between size and age of a market entrant and its survival and growth rates.

Regarding price cuts to prevent market entries Schnell's project series on perception and effectiveness of market barriers from the perspective of airline managers provides evidence that post-entry unfair competition of an incumbent is expected in 98.5% of the cases on at least some routes (Schnell 2005). Because Schnell equates the effectiveness of a market entry barrier with the probability of applying a behavior that creates this barrier, effectiveness quotas yield 55.4% to 62.5% for deterrence. Evaluated measures range from post-entry incumbent capacity boosts to fostering an aggressive reputation against market entrants as well as excessive price cuts and retaliation on other common routes. Predatory actions will be part of the scenario analysis, we will examine its efficiency later discussing the scenarios' results. Especially in the airline business, these behaviors are facilitated by the availability of information and flexibility of capital goods (Greig 2005). For example services, fares and flight schedules of a company are publicly available yet before market entry. This can be perfectly observed within the Reference Case, in which Lufthansa cuts its prices as reaction to the announced fare of Germania even before the latter's market entry. Furthermore aircraft can be changed quickly on different routes and there is a great supply of second-hand or leasable aircraft to raise seat capacities on the short run. In a joint research report with Pitelis, Schnell shows that lacking disposability of attractive time slots at an airport are the single one exception to the otherwise completely differently assessed effectiveness of market barriers (Pitelis & Schnell 2002). Following the Grandfather rights when distributing time slots at an airport, the only way to overcome this market barrier is having patience and the financial backup to expand slowly, as we will see later in the scenario analysis.

Morrison's study to operationalize the Southwest Effect states three different types of impacts on competition that Southwest Airlines pursued (Morrison 2001). Factual competition between Southwest Airlines and an incumbent on a route leads on average to reduced ticket fares. Adjacent competition between Southwest on one route and a competitor on a geographically near city pair is suitable for the fact that the Southwest route is accounted as an adequate substitute to a high share of the second route's passengers. Potential competition between two airline carriers at an airport can lead to a limit pricing strategy of one competitor versus Southwest Airlines. Again, by reducing fares the competitor intents to lower a city pair's attractiveness for Southwest (compare Geroski and also Schnell above).

Output and price development triggered by market entry will be a basic part of the scenario analysis. Joskow, Werden and Johnson in 1994 present a study regarding entry, exit and performance on airline industry markets (Joskow et al. 1994): market entry and exit heap up in low price markets. The authors argue that supra-competitive prices do not provoke entry, however infra-competitive prices often result in market exit. In fact costs are the driving forces for entry and exit. Therefore, airlines will abandon high-cost city pairs, whenever they do not suit their network anymore, and enter low-cost routes, if they appear attractive for their networks, respectively. As a reaction to market entry, the authors observe a mean price reduction of 9.2% as well as an increase in output of 56% - 66%. With regard to market exits they find an average price increase of 10.5% and mean output decrease of 13% - 25%. The results argue against the effectiveness of an entry threat based on the theory of contestable markets, i.e. " ... one into which entry is absolutely free and exit is absolutely costless" (Baumol 1982, Bailey and Baumol 1984). Relating to the incumbent's reaction on entry, the results show notable price cuts while output is kept stable. In contrast, the remaining companies' prices as well as outputs rise post-exit.

In the context of an analysis of cost and demand shocks Geroski and Hall identify different consequences for supply and price (Geroski and Hall 1995). The authors observe a very weak effect of demand shocks on price but prove to some extent excessive, even if temporary adjustments of supply in the case of demand shocks. Their calculations show, cost shocks affect price while demand shocks impact quantities.

3. System Dynamics Model

The model is built to demonstrate the effects of an entry into a former monopoly city pair under different sets of preconditions. The market is defined as the route connection between two German airports of international importance. The model could also be used to simulate competition situations on European or intercontinental city pairs if appropriate reference data and elasticities would be applied.

Our stock-flow-model consists of 118 variables. Apart from 8 stocks and 14 flows, that compose the central structure, further 84 variables, parameters and levers as well as 12 table functions constitute the model. Model runs will be set to a default period of 60 time steps, with one time step defined as one month in real time. This definition enables observing effects that arise by changes in pricing, seat capacities, tube size and demand far better than with a simulation based on a flight plan time periods as a time step, i.e. 5 or 7 month per time step, respectively. Explicitly, the model does not contain substitutional competition between different types of transport systems or an intermodality concept (Maurer 2003), i.e. changing transport systems between origin and destination. Nonetheless the basic principles of substitution implicitly cause unsatisfied demand not to accumulate. Demand that surpasses a given supply will be discarded in each period as spill (Bish et al. 2004), a second decision for choosing a flight with another airline will not be taken.

The systems' boundaries do not contain a sub-model to simulate a realistic slot distribution process. The amount of slots or frequencies, respectively, is increased or reduced while undergoing a six months delay. This reflects the fact that major changes in frequency supply cannot be offered unless the next season begins. Airline companies' cost and revenue structures are reduced to few parameters. Detailed subsystems are not part of the model so far. Another simplification used in the model construction is the restrained use of one single aircraft type at a time. Therefore the resulting tube size always reflects the flight equipment used in a period, while in reality an airline company's fleet consists of different aircraft types that are used simultaneously in a period to match supply and demand in the short-run.

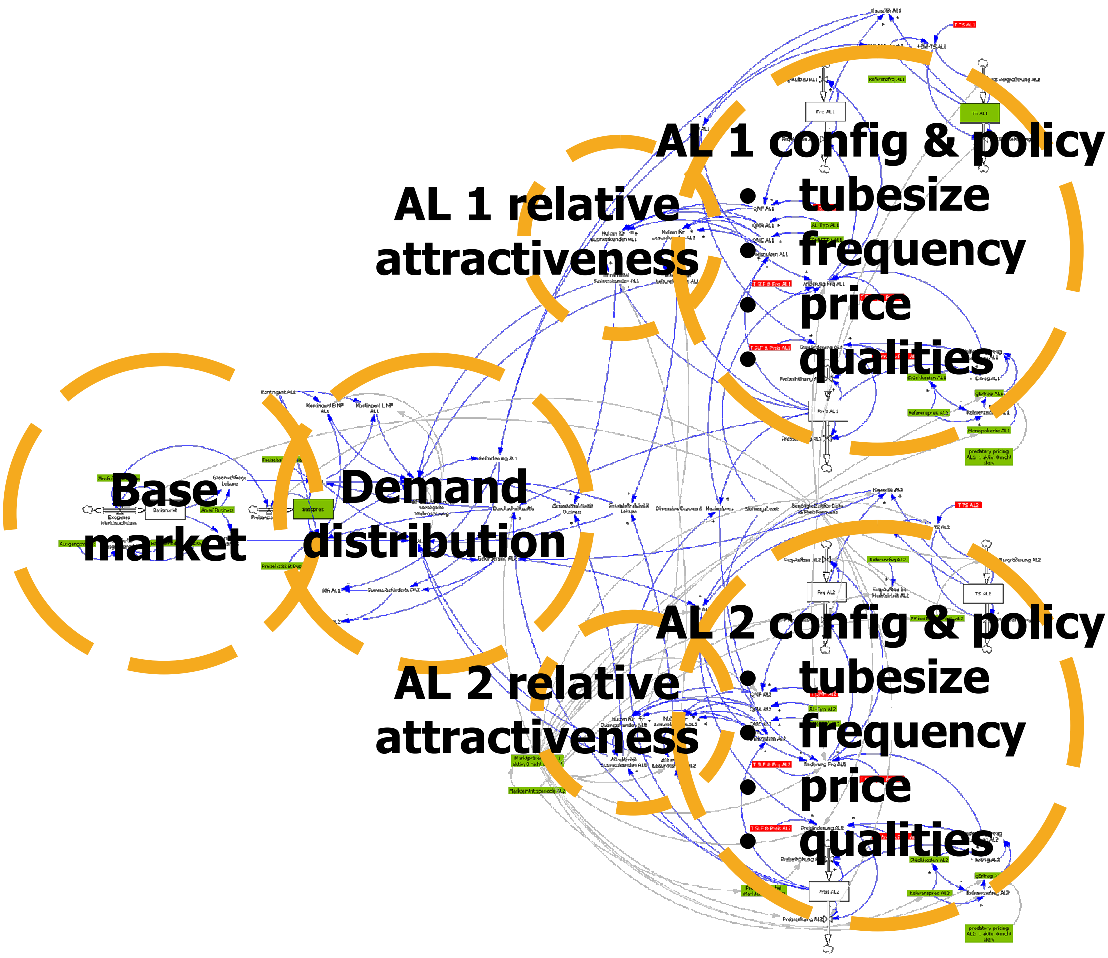

Figure 1: SFD with modules Configuration, Policy, Attractiveness and Demand

To simulate different situations of markets and competition, the entry of a second airline at any time can be triggered. To run a monopoly market situation the additional airline will be initialized with parameters equal to zero. Besides regular frequency competition and price competition, in particular predatory pricing can be enabled. Apart from utility and attractiveness parameters that are of virtual nature, and ticket fares that are indexed and normalized to 1, all of the system's elements contain real operators, flows and dimensions.

The before mentioned stocks and flows basically constitute the three subsystems: airline configuration and airline policy as well as demand. Together with another subsystem, the airline attractiveness, these four groups build the entire model that will be described in detail in the following. The above figure 1 shows the model as a whole in Stock-Flow-Diagram mode (The subsystems are arranged differently from the above classification in four subsystems. For a more comfortable view in the diagram, demand is split up in Base market and Demand distribution while Airline config & policy are summarized as one modul).

3.1 Airline Configuration

This module consists of the stocks *frequency*, *tube size* and *price*. Each of the stocks is varied by an inflow and an outflow. Inflows and outflows generally are determined by airline policy (which will be explained in the next module). Besides these elements, each airline is characterized by quality aspects such as amount of supplied frequencies, a parameter to simulate customer relationship management (e.g. frequent flyer programs) and a consolidated parameter indicating brand and product value, service and perceived safety as an emotional customer variable. The value of mean unit costs per passenger as part of the reference price defines an airline's cost structure and thereby indirectly the business model (Klingenberg 2005). Seat capacity, as the product of *frequency* and *tube size*, in combination with the number of served passenger endogenously yields the *seat load factor* (SLF) of an airline company. The seat load factor is thus the ratio of capacity usage.

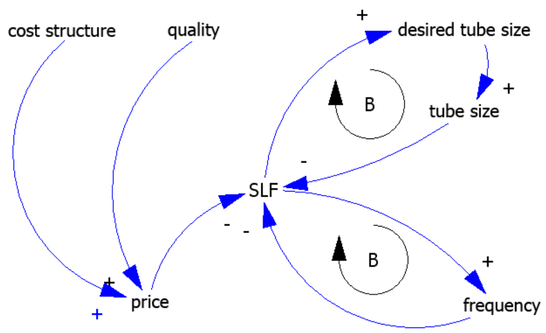

Figure 2: CLD module airline config

Running the simulation requires exogenously setting a monthly *reference frequency* as well as initial values for *tube size* and *reference price*.

Quality improvements (decreases) are indirectly able to push (reduce) seat load factors with pricing. Cost reduction (increase) can also lead to higher (lower) seat load factors through pricing. Rising (falling) seat load factors determine the use of bigger (smaller) aircrafts, which in turn leads to balanced seat load factors. Only if equipment changing measures do not provide the adequate seat load factors, frequencies will be altered to produce the targeted seat load factor. We will look at the consequences of airline policies on all of these parameters in the following.

3.2 Airline Policy

The parameters that constitute the airline policies represent the decision rules of an airline. The seat load factor serves yield management as the central tool of operative business. As key performance indicator, the seat load factor is available nearly in real-time and with precision.

The model uses a simplified revenue parameter as difference between price and unit cost. Adding a possible *monopoly rent* results in the *desired revenue*. By setting the *desired revenue* negative, predatory pricing as a strategic movement can be enabled. Tickets will therefore be sold under *unit costs*.

Changes in price and frequency are controlled by the *difference between desired and actual revenue* per passenger and by the actual *seat load factor*. Changes in price are realized without delay. This is generally the case for competitive actions, which the model highlights, while price changes because of product development or new products undergo a delay. This is not to be shown with the model.

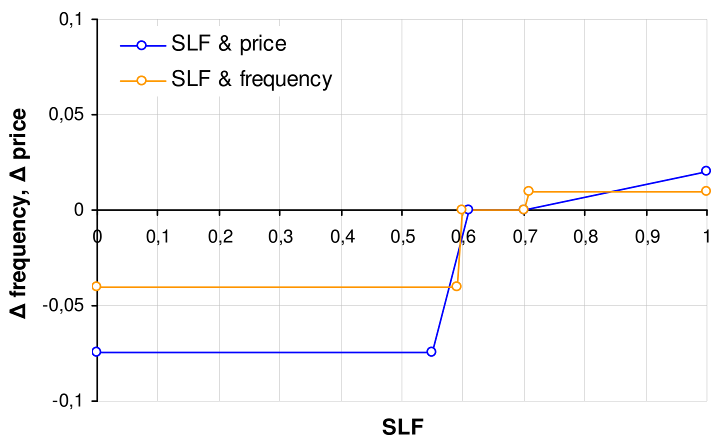

Figure 3: lookup revenue & frequency as well as price (reference mode, Lufthansa parameters)

Changes of the supplied frequency in reality are only possible at a change of season. Grandfather rights and slot distribution process determine this fact. The model uses a first order smooth function with six periods delay to simulate adjustments in frequencies. Negative deviations of the *difference of desired revenue and actual revenue* (more revenues than targeted) lead to higher *frequencies* and lower *prices* and vice versa.

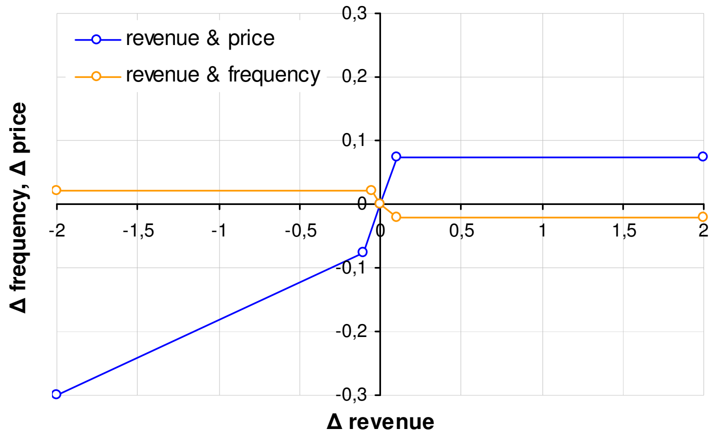

Figure 4: lookup SLF & frequency as well as price (reference mode, Lufthansa)

Price and *frequency* control by *seat load factor* is demonstrated in figure 4, showing the Lufthansa reference case example. On European routes Lufthansa has an average seat load factor of about 65%. Yet small deviations are countered with price adjustments. Changes in frequency are based mainly on seat load factors. Unlike full service carriers, low cost airlines are used to fly with higher seat load factors of around 80%. Thresholds and effects have to be determined separately for each business model in order to correctly set up the simulation. *Seat load factors* are also used to control the *tube size*. Changing the *tube size* enables an airline to adjust their offered *capacities* short term. Therefore, no delay is applied to changing the tube sizes in the model.

The parameters *price*, *tube size*, *frequency*, quality and cost structure are the basic triggers for strategic movements. As an expansion of figure 2, the following causal loop diagram in figure 5 shows the multiple interdependencies and effects of this sector of the model.

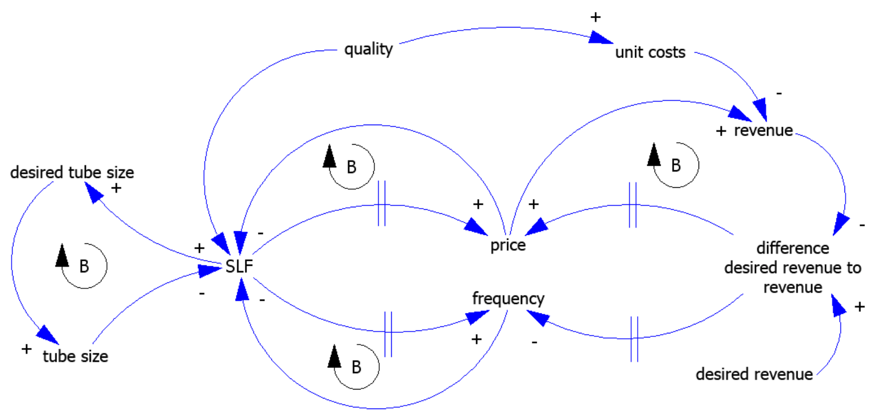

Figure 5: CLD module airline policy

3.3 Airline Attractiveness

Attractiveness as one of the inputs for modeling demand or the probability of buying an airline's ticket instead of another one's, consists on the one hand of an *aggregated utility* of supplied quality characteristics and on the other hand of the *price*. Both components are related as a price/performance ratio by division.

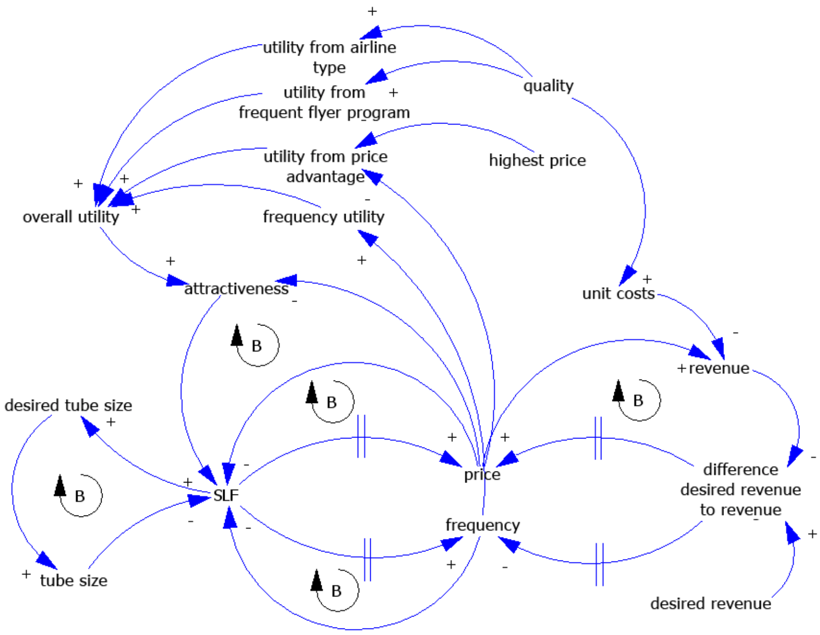

Figure 6: CLD module airline attractiveness

As extension of the airline policy module, the consequences of different utilities and eventually attractiveness as well as effects of changes in price and frequency on utility parameters are visible in the causal loop diagram in figure 6. The particular utility components are built of parameter values of frequency, airline type, frequent flyer programs and a monetary advantage depending on the difference of a price to the highest price available.

Like in the Fishbein-Model (Fishbein 1963) quality features are weighted with a customer preference and partial results summed up. Multipliers of airline characteristics as well as price utility range from 0 to 1, i.e. they are scaled homogeneously, while the way to compute these parameters varies. The quality multiplier of airline type results directly out of the variable airline type. The same way of calculation applies to the multiplier for customer relationship management which is based on the variable frequent flyer program, while price utility equals 1 - (airline price / maximum price). In case of a supplied price equal maximum price, the additional utility is 0 while in all other cases price utility will be $0 < U_P < 1$.

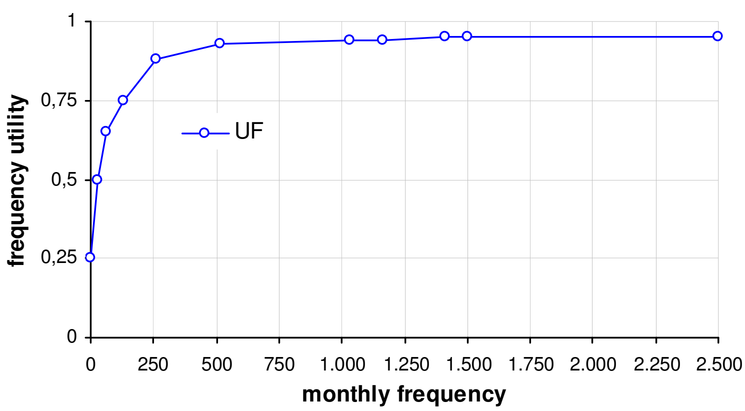

Figure 7: lookup monthly frequency and utility

Frequency utility U_F derives from an estimated function. Applying real flight frequencies between two airports and a mean of 17 hours daily for take-offs and landings at major

German airports, we will produce a comparable frequency in hours. The shortest time difference found between two flights is 44 minutes, i.e. 1.400 flights per month. We rank this value with a 0.95 utility on a scale from 0 to 1. The higher the frequency, the shorter the time difference between desired and possible start of a flight. *Frequency utility* decreases rapidly as shown in figure 6 at more than 8 hours time difference between two flights (this reflects a typical one-day business round trip with a single airline) (Consumers' Association 1997).

Aggregation of overall utility of an offer per customer type results of the above mentioned Fishbein-Model. Preference weights are taken from a study of Northern Illinois University to predict customer loyalty of airline passengers (Ostrowski et al. 1991). They correspond to results of other studies.

criteria	leisure passengers	business passengers
price	3,9	2,1
frequency	3,2	4,5
frequent flyer programs	1,5	2,0
airline reputation	1,5	1,5

Table 1: Comparing main criteria of leisure and business passengers

Using a utility function for different alternatives deducted from Mandel (Mandel et al. 1997, Mandel 1998), attractiveness is computed as the above described price/performance-ratio as exponent of the basis e.

$$A_{i,j} = \left[e^{\left(\frac{U_{O,i,j}}{P_j} \right)} \right]$$

with $A_{i,j}$ = attractiveness, $U_{O,i,j}$ = overall utility, i = customer type, j = airline and P_j = price.

3.4 Demand

The demand module is designed to distribute the relevant demand among the airline companies in a market. This is achieved in two steps: First, the overall demand per customer segment based on the mean price of all available offers is computed. Then, this demand is redistributed to the corresponding airlines, depending on their offer's attractiveness.

The determination of the overall demand is founded on a *base market* that is divided in business and leisure customers. The correct relation between both segments on a route can be observed easily by the equipment used by the airlines. The demand function is calculated by *base price*, the corresponding *base demand* and *price elasticities of demand* that depend on route characteristics, customer segment and airline type (Ernst&Young 2007, Jorge-Calderón 1997, Brons et al. 2001, Pompl 2002, Dresner 2006):

airline type	business	long-haul leisure	short-haul leisure
network carrier	-0,8	-1,0	-1,5
low cost carrier	-1,5	-1,5	-1,5

Table 2: Comparing price elasticities of demand

The emerging price/consumption function is connected dynamically to the market growth. Additionally to demand variations at different mean prices, an exogenous change in market size leads to right-hand or left-hand shifts.

Each customer segment's demand is reallocated to active airlines relying on a probability function. According to Mandel, the probability consists of the share of *attractiveness of an airline* to a certain customer segment on the *overall attractiveness* of all disposable alternatives (Mandel 1998, Mandel 1999):

$$P_{i,j} = \left(\frac{A_{i,j}}{\sum A_{i,j}} \right)$$

with $P_{i,j}$ = probability, $A_{i,j}$ = attractiveness,

i = customer segment and j = airline

In addition it is possible to assign fixed *contingents* to an airline, e.g. to simulate corporate flight contracts. The demand allocated to the airline companies is delayed by a Smooth function of first order with two periods delay before entering the demand variables of each airline. The reason is the delayed customers' perception of quality or price changes, eventually variation in attractiveness. In reality these changes will be perceived not immediately but through marketing, word of mouth or one's own research.

Depending on capacities either all of an airline's demand will be taken or partly rejected, as the case may be. Unsatisfied demand will not cumulate, because of other available alternative transport modes like train, car etc. in the German transport market. Each airline's part of market share can be determined by the share of passengers transported on total passengers transported.

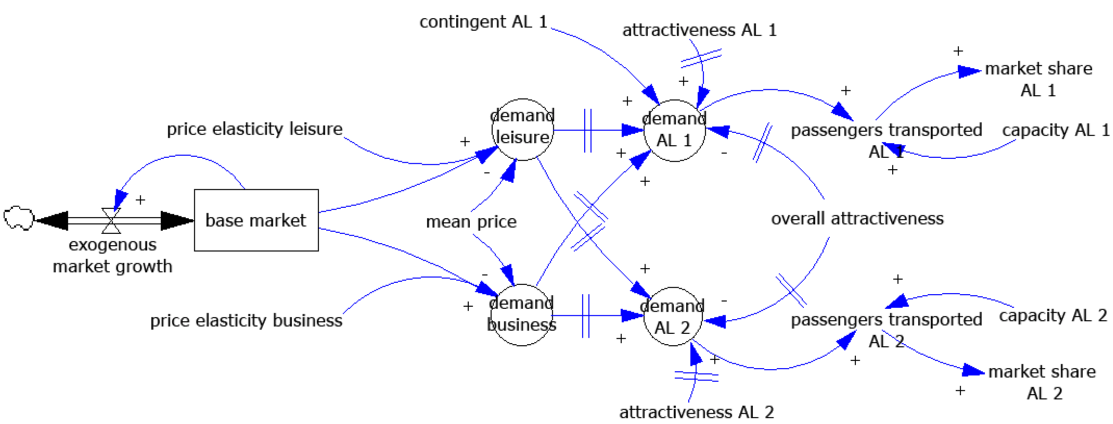

Figure 8: SFD module demand

Figure 8 demonstrates the strongly abstracted demand module. The price/consumption function is found implicitly in the variables *base market*, *mean price* and *leisure demand* as well as *business demand*. The probability function to distribute the overall demand among the airlines is implicit in *demand airline 1* and *demand airline 2*. In the course of the stylized presentation *Attractiveness airline 1* and *attractiveness airline 2* as well as *overall attractiveness* aggregate the individual customer segment-related attractivenesses.

4. Reference Case and Model Calibration

Because of the non-availability of monetary information on airline markets, we used the predatory pricing events of Lufthansa (LH) and Germania (ST) on Frankfurt/Main - Berlin/Tegel route from 2001 until 2005 as reference case. The precise and transparent documentation and the information accessible only because of the law suit between these companies concerning pricing and effectiveness of product features on demand make this case an ideal reference scenario.

Lufthansa, that had flown until November 2001 on the route Frankfurt/Main and Berlin/Tegel in a monopoly situation, cut its price for a round-trip ticket from 485€ to 200€ just before entry of Germania on this city pair. Germania, that originally had announced a round-trip price of 198€ for entry, reacted by lowering its price to 110€ on November 12th to compensate for lower service and reputation compared to its competitor. Lufthansa at that time yet offered free on-board service, airport lounges, a frequent flyer program as well as a three times higher frequency between the airports of Frankfurt/Main and Berlin/Tegel. On January 1st of 2002 Germania raised its price from 110€ to 198€ to reach the necessary break-even point which led to a reduction in demand by 39% for Germania. Because of abuse of their market dominating position (German Law §19 GWB), Lufthansa was prohibited by the German Antitrust authorities to offer a ticket price that does not exceed the price of Germania by 35€ (70€ round-trip) at minimum in the relevant market. This obligation lasted two years (Bundeskartellamt 2002).

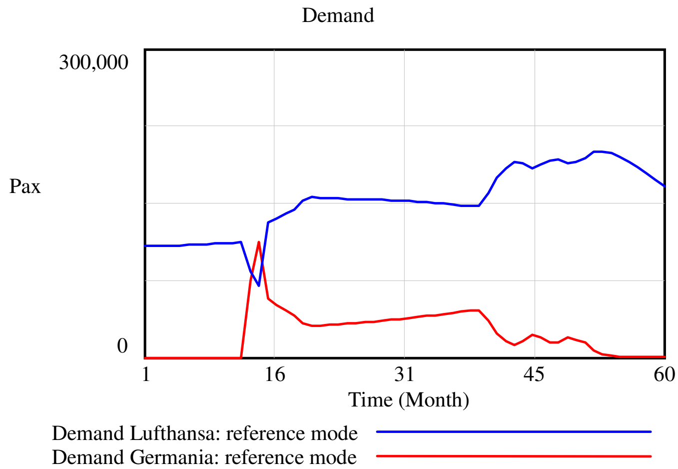

Figure 9: Demand (Pax = Passengers)

After Germania's route entry, set off by the now more favourable mean price the demand-effective business potential increases by 50% while leisure demand doubles. Figure 9 demonstrates this development. Lufthansa loses demand post-entry while on the long run overall Lufthansa demand rises from about 100.000 passengers to 150.000 and later on up to nearly 200.000 passengers. The temporary fall of Lufthansa's demand curve has to be assessed critically. Although intensive sensitivity analysis and a smooth function to soften changes in demand 25% of Lufthansa's demand is lost in the short term. This post-entry demand reaction despite the fact of Lufthansa's halved price would be unlikely in a realistic situation. The model does not produce a smooth transition for missing a detailed fare class system. Apart from this point, the further development can be considered plausible.

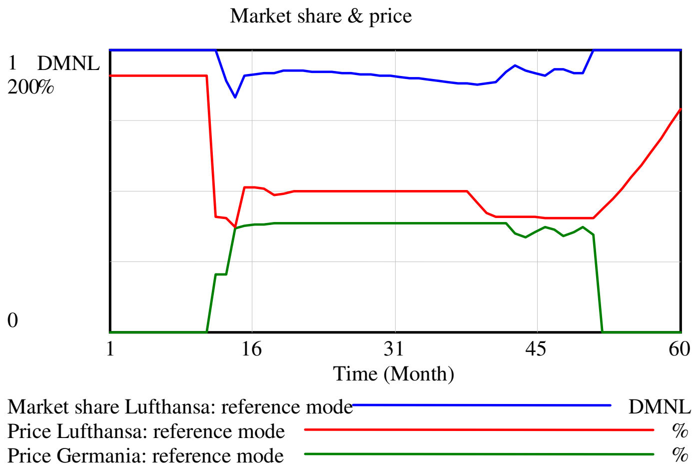

Figure 10: Market share & price

With the beginning price regulation Lufthansa's market share decreases by some 7-12%. After the 2 year regulation phase, Lufthansa is free to lower its price, adapting Germania's price. As a result, lost market shares can be regained. Germania reacts with a minor price cut without significant effect on their demand. Post-exit Lufthansa endogenously raises its price corresponding to their regained monopoly situation.

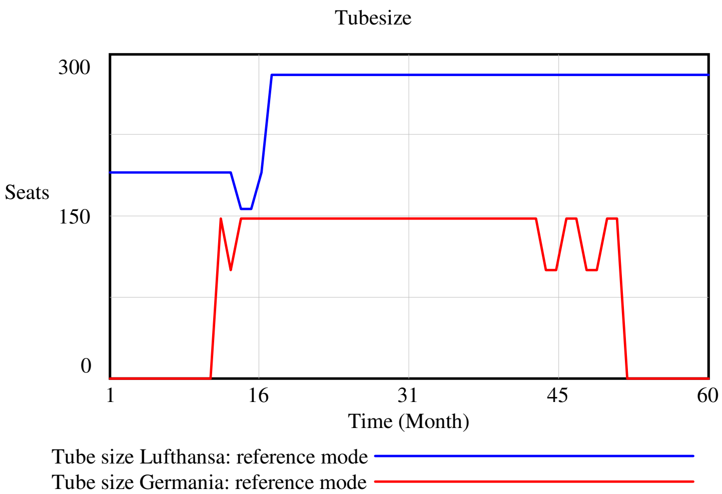

Figure 11: Tube size

Lufthansa's seat load factors, apart from a post-entry downturn, mainly range between 65-68% during price regulation. Having a look on the deployed equipment after regulation's beginning is interesting: Lufthansa turns to maximizing their capacity by using bigger aircrafts with more seats than before. Meanwhile Germania flies Boeing 737 with 148 seats only during price regulation and changes to smaller aircraft size afterwards.

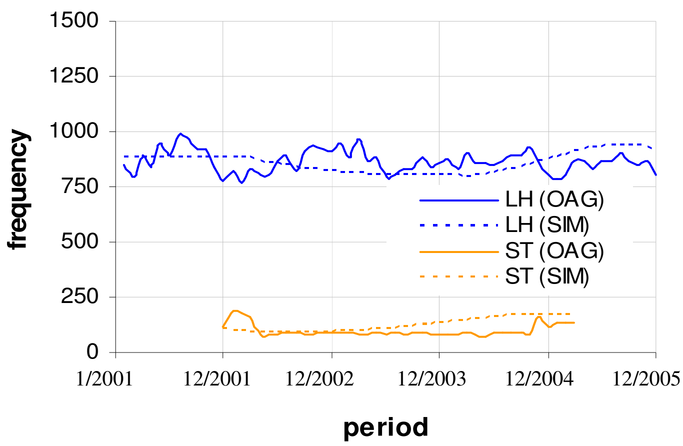

Figure 12: Frequency real (OAG)/simulated (SIM)

Comparing both airlines' simulated frequencies with reality data shows the capability of the model to produce similar developments as in reality.

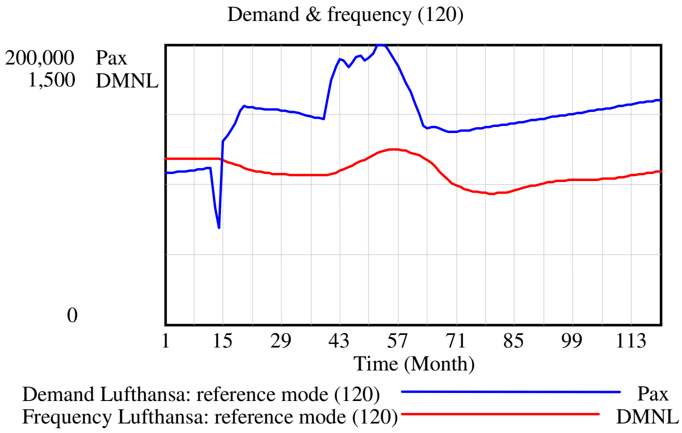

Figure 13: Demand & frequency (120)

The stability of the system's behavior is documented in figure 13 that illustrates Lufthansa's demand and frequency during a 120 period simulation run. The demand peak around period 40, based on the second predatory pricing action by Lufthansa, decreases post-exit down to the original demand level after Germania has left the city pair. The curve shows the exogenous market growth of 2% and the delayed frequency adjustment.

We found that the model set up with the Reference case data is capable of producing the historical events as well as some more detailed aspects like Lufthansa's capacity maximizing. Comprehension of the underlying dynamics is therefore possible and enables the use of the model for a more wide-ranging scenario analysis.

5. Scenario Analysis

Setting up scenarios depends on four basic definitions as seen in table 3. Concerning the market the model allows a monopoly and duopoly situation. The airline profile can be set to network carrier as well as low cost airline. Competitive behavior ranges from pricing to capacity variation as well as quality changes to predatory actions. The route characteristics can be set to national-type, continental or intercontinental depending on the price elasticities from demand. In the following scenario analysis we will deal with duopoly markets, that contain network airlines and low cost carriers. Competition to be shown is based on capacity, price and predatory action while we focus on national route-types.

market	business model	competition depending on policy	scale
monopoly duopoly	network carrier low cost carrier	capacity quality price predatory actions	national continental intercontinental

Table 3: Scenario analysis components

5.1 Duopoly with network carrier incumbent and new low cost airline

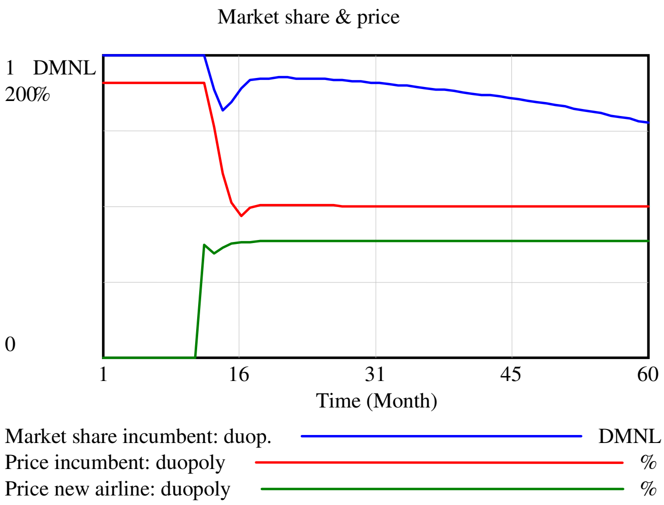

Figure 14: Market share & price

At the time of entry of the low cost carrier, the incumbent cuts its price by the monopoly element. Still airline 2 has a price 20% lower than the former monopolist. Figure 14 pictures this price difference besides the incumbent's decreasing market share. At the end of the run the incumbent has lost about 25% of the market without being able to break this trend.

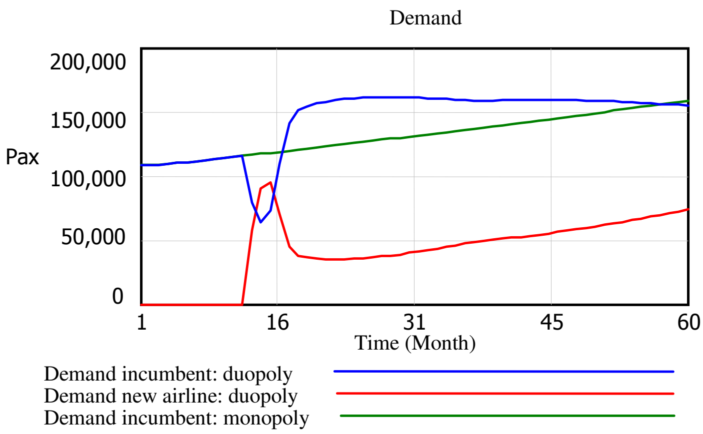

Figure 15: Demand

At the same time we observe post-entry overall demand growth and the incumbent, in spite of losing demand to its new competitor, facing higher demand than in the monopoly market. Moreover figure 15 depicts the fact that the complete exogenous market growth accrues to the new airline. Airline 1's demand even starts to decrease by period 28.

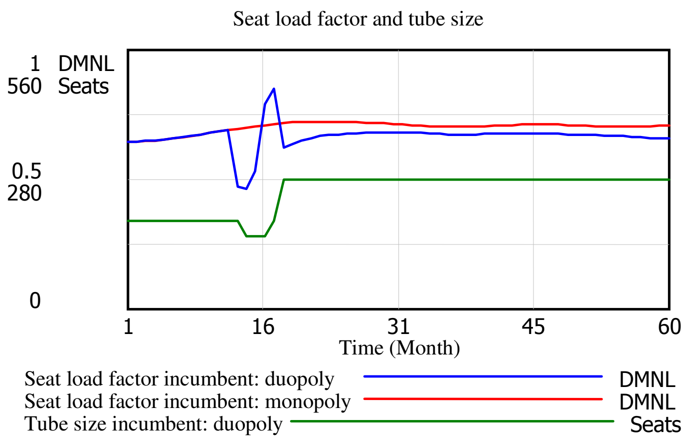

Figure 16: SLF & tube size

The incumbent's seat load factors run on a reduced level compared to a monopoly market. Post-entry demand decline yet criticized in the reference mode result, here as well causes a fall of seat load factor. As figure 16 shows tube size is scaled down to 156 seats. In combination with strong demand growth this leads to heavily increased seat load factors in the next period. Permanently increased demand creates seat load factors that encourage the deployment of bigger tube sizes.

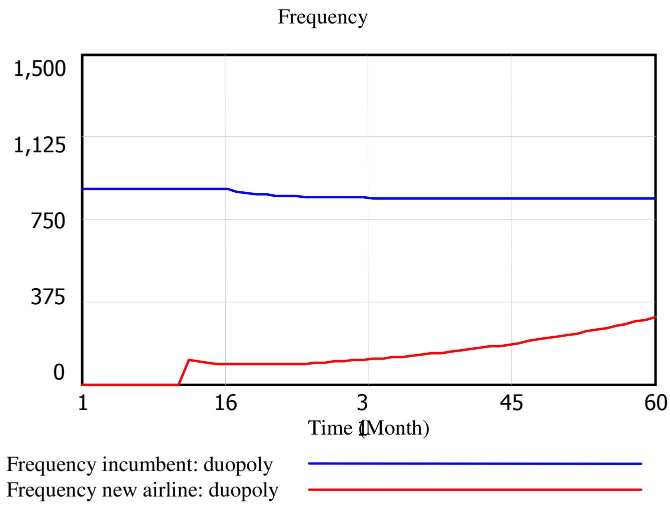

Figure 17: Frequency

The incumbent's frequency course nearly develops steadily. The post-entry erratically increased demand is absorbed by stepping-up tube sizes. Therefore initially there is no need to boost frequency. This observation complies with real decisions to cover demand growth primarily by using bigger tube sizes and later increase frequency.

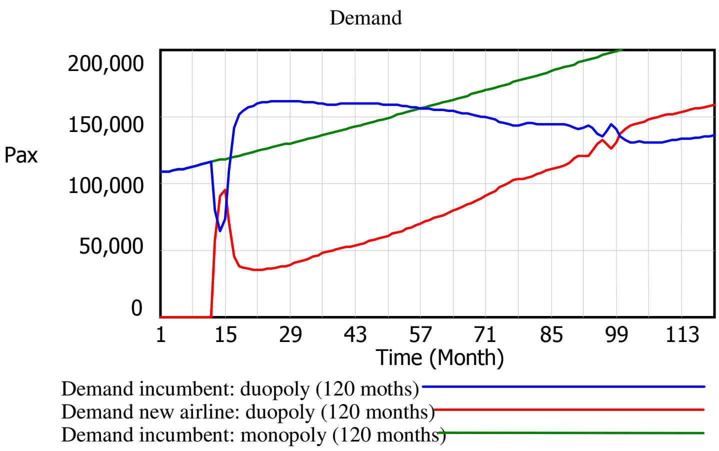

Figure 18: Demand

Taking a look on a prolonged simulation run of 120 periods shows a constantly sinking demand for the incumbent. Though the loss rates are minor, the market share decreases heavily because of the incumbent not participating in the exogenous market growth. Structurally there is no change in the steady state system behavior. The new competitor's expansion runs undamped. The chosen growth rates for frequencies (dependent on revenues and seat load factors) account for the slow growth of the new company without performing any strategic movements. Only after 8 years the incumbent's market share is exceeded by the new company.

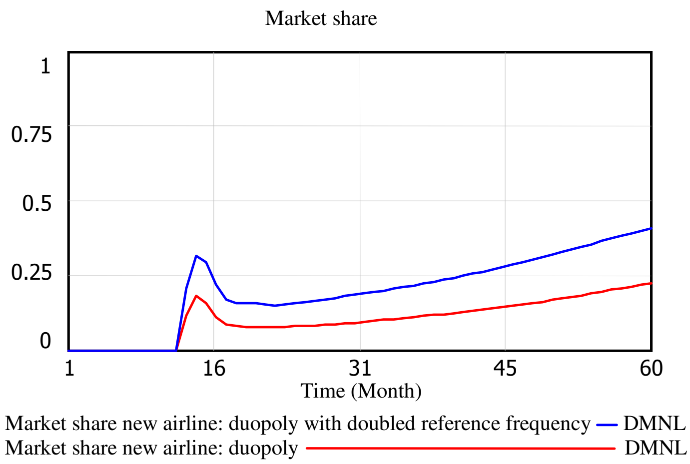

Figure 19: Market share

Doubling the new airline's reference frequency to 2.580 flights per year in every period causes double the quantity of frequencies, compared to the scenario's basis run. I.e. only 107 additional flights offered in the starting phase are capable of producing a frequency difference at the end of the run of 300 frequencies more per month on the average. Examining the market shares leads to similar results, unsurprisingly as market share is measured as share of the number of total passengers transported. C.p. this means the higher the frequency and capacity of an entry in the beginning, the higher the probability of success.

5.2 Predatory pricing by incumbent network carrier against new low cost airline

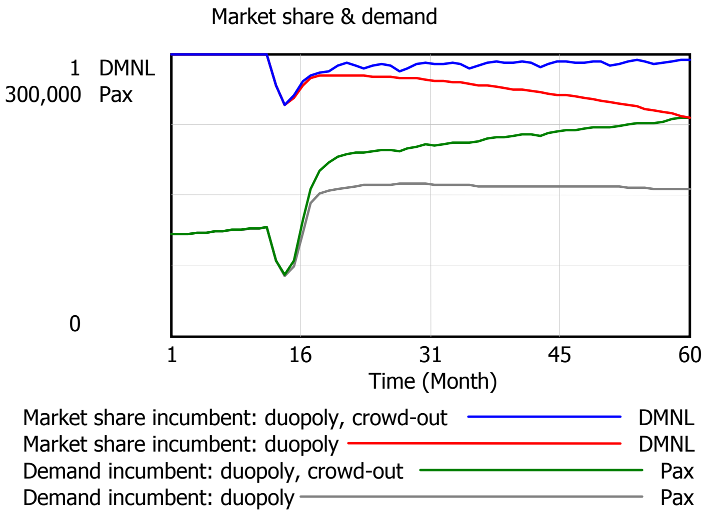

Figure 20: Market share & demand

By setting a price below unit costs, the incumbent starts predatory pricing to crowd out its new competitor. As aggregated result the incumbent regains yet after few periods nearly all of the lost market shares. The low cost carrier is impeded to establish in the market. Indeed the incumbent's price still is higher than the low coster's, however a better frequency supply, a more favorable frequent flyer program and substantial service provided by the former monopolist airline present a higher overall utility to passengers. Frequencies therefore evolve positively.

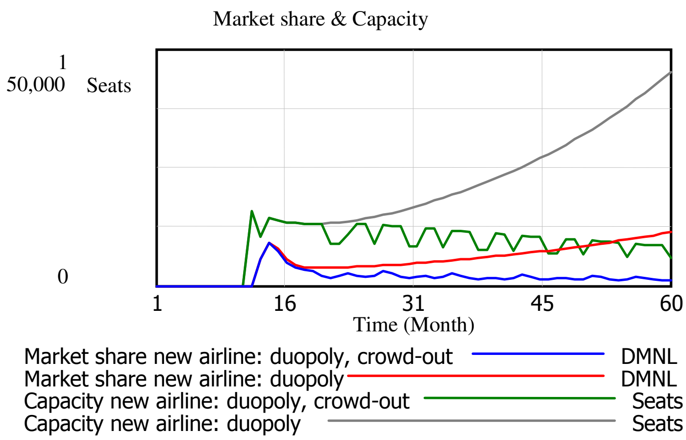

Figure 21: Market share & capacity

Figure 21 recapitulates the consequences of entry with and without incumbent's predatory pricing. The unfavorable development of frequency and tube size (shown as capacity by multiplying) prevent the new airline from taking in an appropriate market position. Hence the incumbent's crowding-out strategy turns out successfully. The dominance of predatory action appears even stronger if entry takes place with doubled reference frequency. Although in the first runs (without predatory pricing) an entry with higher frequency takes a course more successful, under the circumstance of predatory pricing it does not prove to be an effective mechanism against the consequences of crowding-out. The new airline's market share drops below 10% after only a couple of periods, medium term below 5%.

We also did a post-entry scenario simulating the reengineering of the low cost carrier's business model by improving quality and thereby increased unit costs. To be successful, the simulation has shown the necessity of flanking these measures with a heavily enlarged frequency supply.

We simulated as well an entry of a full service carrier into a monopoly market of another network airline. Results vary mainly with price and quality parameter setting. The dominance of these variables can clearly be observed in those runs.

6. Conclusions

The airline industry is characterized by strong dynamic developments. Our aim was to analyze the effects of entry and exit on routes between two airports with our System Dynamics model. The model has been calibrated using information of the German Antitrust law suit between Lufthansa and Germania. Other market types, like for example European or Intercontinental city pairs, are also possible to analyze.

We have simulated strategic movements of airline companies under varying the preconditions. Especially, the effectiveness of predatory pricing against market entry under different conditions has been researched. Our results were compared to hypotheses deducted from a literature review:

- Latent demand does not necessarily benefit a new company in a market. The detailed scenario analysis above has shown that both incumbent and newcomer in a market are able to skim the demand. Our tests with two similar full service carriers resulted in showing a clear dependency of demand on pricing.
- Sinking revenues with entry of a low cost carrier could be observed in all tested scenarios. This is because of the incumbent's necessity to cut prices at least by renouncing monopoly revenues to attract demand medium-term. Pursuing a predatory price strategy will lead to even stronger revenue losses short-term.
- Post-entry price decreases and rises in output can be shown as well. The examined scenarios present in a short- to medium-term perspective post-entry and indifferent the business model of the new entrant overall increased values for frequency, passengers transported or capacity.
- Several years can be necessary to outperform an incumbent when entering an airline market in terms of market share or capacity. Especially in the situation of an entry slot-restraints prevent a company to establish in a market on a broad basis.
- The meta-hypothesis that dynamics in airline markets are driven partially by developments caused by entry and exit on a city pair was confirmed by the scenario analysis. The observed strategic movements in form of changes of frequency, capacity or price as well as applied policy changes like predatory pricing or business model restructuring have provided growth for the overall market and sometimes undesirable developments for single airlines.

We made several findings from the perspective of the airlines.

Low cost airline entering a market dominated by an incumbent

- Optimized cost structure mandatory
- Big scale entries pay off
- Endurance, i.e. liquidity necessary to cover early losses

Incumbent network carrier perspective with low cost entry:

- Demand/market share corrode if market behavior stays fair
- Predatory pricing will override any other strategic movement, just don‘t let yourself get caught

Incumbent network carrier vs. network carrier entry:

- Not shown in the scenario analysis above, but from the scenario network carrier vs. network carrier entry, we clearly observe the dominance of pricing and quality parameters

7. Future Research

One aspect to enhance the model would be modeling a parameter to represent unsatisfied demand because of capacity restrictions. In the actual version there is only one decision point per period towards one airline or the other. A second loop to another decision step could contain the choice between not flying at all or to revise the first decision and opt for flying with a competitor's airline if no places are available with the first choice company.

A second possibility to expand the model would be a more detailed design of cost and revenue parameters. Effects of changes in cost or output would be gratifying. Likewise a subsystem to realize yield management with different fare classes would be useful. Changes in tube size then had real consequences on costs and revenues, if e.g. scale effects could be considered. Another improvement could focus on the model's slot distribution system. A more realistic process would back-up some of the findings we made.

In-depth research can be done, according to the insights won by the simulation, e.g. in terms of strategic movements of airlines in multi market competition. For deeper understanding of two airlines' behaviors on a city pair, the model with its possibilities of scenario analysis can be an adequate basis in its actual layout.

References

Ashby, W.R., An Introduction to Cybernetics, London 1956

Bailey, E.E. and Baumol, W.J., Deregulation and the theory of contestable markets, in: Yale Journal on Regulation, 1, 1984, 1, p. 111 - 137

Baumol, W.J., Contestable markets: an uprising in the theory of industry structure, in: American Economic Review, 72, 1982, 1, p. 1 - 15

Bish, E.K., Suwandechochai, R. and Bish, D.R., Strategies for Managing the Flexible Capacity in the Airline Industry, in: Naval Research Logistics, Vol. 51, 2004, 5, p. 654 - 685

Bundeskartellamt, Beschluss in dem Verwaltungsverfahren gegen Deutsche Lufthansa AG, Köln, Bundeskartellamt, 9. Beschlussabteilung, B 9 - 144/01, o.O. 2002

Brons, M, Pels, E., Nijkamp, P. and Rietveld. P., Price Elasticities of Demand for Passenger Air Travel: A Meta-Analyses, Arbeitspapier TI 2001-047/3 des Tinbergen Institute der Erasmus Universität Rotterdam, Universität Amsterdam und Freien Universität Amsterdam, Amsterdam 2001

Chandler, A.D., Organizational capabilities and the economic history of the industrial enterprise, in: Journal of Economic Perspectives, 6, 1992, p. 79 - 100

Consumers' Association, London, Airline competition - a long haul for the consumer, o.O. 1997

Dresner, M., Leisure versus business passengers: Similarities, differences, and implications, in: Journal of Air Transport Management, 12, 2006, p. 28 - 32

Edwards, C.D., Conglomerate bigness as a source of power, in: Princeton University Press, Business Concentration and Price Policy - A conference of the Universities-National Bureau Committee for Economic Research, Princeton, 1955, p. 331 - 352

Ernst & Young und York Aviation, Analysis of the EC Proposal to include Aviation Activities in the Emissions Trading Scheme, o.O. 2007

Fishbein, M., An Investigation of the Relationships between Beliefs about an Object and the Attitude toward that Object, in: Human Relations, 1963, Vol. 16, p. 233 - 239

Geroski, P.A., What do we know about Entry?, in: International Journal of Industrial Organization, 13, 1995, p. 421 – 440

Geroski, P.A. and Hall, S.G., Price and Quantity Responses to Cost and Demand Shocks, in: Oxford Bulletin of Economics and Statistics, 57, 1995, 2, p. 185 - 204

Greig, D., When does Airline Competition become Predation?, in: Forsyth, Gillen, Mayer and Niemeier, Competition versus Predation in Aviation Markets - A Survey of Experience in North America, Europe and Australia, Aldershot and Burlington 2005, p. 95 - 102

Hüschelrath, K., Strategic Behaviour of Incumbents - Rationality, Welfare and Antitrust Policy, in: Forsyth, Gillen, Mayer and Niemeier, Competition versus Predation in Aviation Markets - A Survey of Experience in North America, Europe and Australia, Aldershot and Burlington 2005, p. 3 - 36

Jorge-Calderón, J.D., A demand model for scheduled airline services on international European routes, in: Journal of Air Transport Management, Vol. 3, 1997, No. 1, p. 23 - 35

Joskow, A.S., Werden, G.J. and Johnson, R.L., Entry, Exit, and Performance in Airline Markets, in: International Journal of Industrial Organization, 12, 1994, p. 457 - 471

Klingenberg, C., The future of continental traffic program: How Lufthansa is countering competition from no-frills airlines, in: Delfmann, W., Baum, H., Auerbach, S., Albers, Strategic Management in the Aviation Industry, Aldershot and Burlington 2005, p. 165 - 184

Mandel, B.N., Airport Choice & Competition - a Strategic Approach, Komferenzbeitrag zur 3rd Air Transport Research Group (ATRG) Conference, Hong Kong 1999

Mandel, B.N., Measuring competition in Air Transport, Konferenzbeitrag zur Conference: Airport and Air Traffic - Regulation, Privatisation and Competition, Hamburg 1998

Mandel, B.N., Gaudry, M. and Rothengatter, W., A disaggregate Box-Cox Logit mode choice model of intercity passenger travel in Germany and its implications for high-speed rail demand forecasts, in: The Annals of Regional Science, 1997, 31, p. 99 - 120

Maurer, P., Luftverkehrsmanagement - Basiswissen, 3. Auflage, München 2003

Miller, D. and Chen, M.-J., The simplicity of competitive repertoires: An empirical analysis, in: Strategic Management Journal, Vol. 17, 1996, p. 419 - 439

Morrison, S., Actual, Adjacent, and Potential Competition, Estimating the Full Effect of Southwest Airlines, in: Journal of Transport Economics and Policy, 35, 2001, p. 239 - 256

Ostrowski, P and O'Brien, T.V., Predicting Customer Loyalty for Airline Passengers, Arbeitspapier des Department of Marketing, Northern Illinois University, o.O. 1991

Pitelis, C. and Schnell, M.C.A, Barriers to Mobility in Europe's Civil Aviation Markets: Theory and New Evidence, in: Review of Industrial Organization, 20, 2002, p. 127 - 150

Pompl, W., Luftverkehr - Eine ökonomische und politische Einführung, 4. Auflage, Berlin, Heidelberg u.a. 2002

Prahalad, C.K. and Hamel, G., The Core Competence of the Corporation, in: Harvard Business Review, 68, 1990, 3, p. 79 - 91

Schnell, M.C.A., Investigating Airline Managers' Perception of Route Entry Barriers: A Questionnaire-Based Approach, in: Forsyth, Gillen, Mayer and Niemeier, Competition versus Predation in Aviation Markets - A Survey of Experience in North America, Europe and Australia, Aldershot and Burlington 2005, p. 249 - 267

Simon, D., Incumbent pricing responses to entry, in: Strategic Management Journal, 26, 2005, 1229 - 1248