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Network Evolution with Changes in Market Structure and Competition: Linking Network Structure and Business Models

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Abstract
In this paper I examine the relationship between changes in market structure and the evolution of airline networks as hub and spoke, fully connected or partially connected. An important element is how new business models may lead legacy carriers to choose a new network structure. I also examine how the demand and supply side forces which favour one network structure over another may interact in a way that may lead to a socially inefficient network structure. I also examine how demand uncertainty may affect the choice of network structure. Finally, I examine the consolidation versus the fragmentation theories of route development and assess them in terms of historical data.

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Introduction

The evolution of aviation networks took a significant turn when deregulation took place in domestic aviation markets. The US was first to deregulate but was followed by many other countries in Europe, Canada, Australia and New Zealand to name a few. What was observed was a shift from the loose point to point networks developed under regulation to hub and spoke networks which allowed market forces to determine the most profitable, not least cost, network. Other forces can also lead to a change in network configuration including changes in market structure such as mergers or entry by new firms, changes in business models and exogenous events such as macroeconomic downturns, SARS, war and events such as September 11th.

Taking a snapshot of the North American and European commercial passenger aviation industry in the fall of 2005, the signals on firm survivability and industry equilibrium are mixed; some firms are under severe stress while others are succeeding in spite of the current environment.[1] In the US, we find United Airlines continuing in Chapter 11 and Delta and Northwest Airlines have been placed in Chapter 11 with some positing that the two carriers should merge; two wrongs making a right. USAirways, while still in Chapter 11, has merged with America West. We also find Continental Airlines surviving after having been in and out of Chapter 11 in recent years, while Southwest Airlines, Jet Blue and AirTran continue to be profitable. In Canada, we find Air Canada seemingly successfully out of CCAA bankruptcy protection (the Canadian varient of chapter 11), after reporting losses of over $500 million for the year 2002 and in March 2003.[2] Meanwhile Jetsco has failed and WestJet, like Southwest continues to show profitability albeit at a much lower margin and with a loss in one quarter. Two new carriers Harmony and CanJet (reborn) have entered the market.

In observing these carriers we note they have altered their networks in the face of evolving market conditions and competition. Air Canada has, for example, shifted its focus on long haul international and developing feed using new Embraer 175 RJs. Westjet has shifted into the US market and has recently announced flights to Hawaii. In the US American Airlines in de-hubbing and carriers are offering somewhat more point to point service. In North America full service or legacy carriers have been reducing their capacity while LCCs and regional carriers have been increasing capacity.

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1 This scenario is true in most other countries as well.
2 CCAA refers to the Companies Creditors Arrangement Act.

Looking at Europe, the picture is much the same, with large full-service airlines (FSAs hereafter) such as British Airways and Lufthansa sustaining losses and suffering financial difficulties, while value-based airlines (VBA's) like Ryanair and EasyJet continue to grow and prosper. The big story of course is the merger of Air France and KLM (AF-KLM) and the question of what will the new network look like; a giga-hub at Charles de Gaulle or multiple-hubs with specialized roles? In either case choice of aircraft is critical.[3]

Asian air travel markets were performing better than in North America, having overcome their bought with SARS and are riding a wave of double digit economic growth in China and other parts of Asia.

In this paper the focus is on the evolution of air transport networks after economic deregulation, and the connection between networks and business models, in an environment where regulatory changes continue to alter the rules of the game. The paper also examines the underlying economics of aviation networks, what demand and supply side features will underlie a decision to choose a hub versus point to point network and what factors lead to changes; why do hubs work for example? Additional questions to be addressed include:

- to identify the drivers for network development of airlines with multiple hubs
- apply this knowledge to the new Air France-KLM company
- consider the consequences for the stakeholders in the industry
- identify implications for French and Dutch aviation policy

This introductory section continues with a descriptive account and analysis of developments in the aviation sector and how we have observed differing networks emerge. Section 2 describes and contrasts distinguishing elements of the two dominant but divergent business models: the traditional FSA business model, which is tied to the use of hub-and-spoke networks and the VBA business model, which utilizes a point-to-point network structure. In section 3 we review and develop some insights from the economics of networks applied to airline competition and in section 4, we discuss the underlying drivers including uncertainty as to the impact on network design. Section 5 contains a summary and conclusions while in section 6 we specifically address the above questions in light of what has been developed in the paper.

3 With the choice of the A380 AF would seem to favor a giga-hub.

The airline network is a dynamic environment that has numerous variants including point-to-point (P2P), hub to hub (H2H) and hub and spoke (H2S). Hubs can also have differing characteristics, for example,

- *International hubs driven by long-haul*
  - Gateway cities
  - Many European hubs: CDG, LHR, AMS, FRA
  - Some evolving interior hubs, such as Chicago
  - Typically one bank of connections per day
- *Regional hubs connecting smaller cities*
  - Most US hubs, with at least 3 banks per day
  - Some European hubs, with 1 or 2 banks per day
- *High-Density hubs without banking*
  - Continuous connections from continuous arrivals and departures
  - American Airlines at Chicago and Dallas
  - Southwest at many of its focus cities

Even P2P networks differ among LCCs. Ryanair has few origins and many destinations, Air Berlin has many origins and few destinations and Easyjet has a number of origins and destinations many involving major cities; something the other two mentioned carriers avoid.

As the business models of participating airlines change, so will the airline network. The market environment facing the network carriers, those with substantial hub-to-hub and hub-to-spoke operations in selected airports, has become increasingly competitive. A complex web linking declining average yields with a narrowing margin between premium and walkup versus competitive fares is forcing network carriers to undertake painful cost-cutting measures.

2 Survival of the fittest?

The trend worldwide thus far indicates two quite divergent business strategies. The entrenched FSA carriers' focuses on developing hub and spoke networks while new entrants seem intent on creating low-cost, point-to-point structures. The hub and spoke system places a very high value on the feed traffic brought to the hub by the spokes, especially the business traffic therein, thereby creating a complex, marketing intense business where revenue is the key and where production costs are high. Inventory (of seats) is also kept high in order to meet the service demands of business travellers. The FSA strategy is a high cost strategy

because the hub-and-spoke network structure means both reduced productivity for capital (aircraft) and labour (pilots, cabin crew, airport personnel) and increased costs due to self-induced congestion from closely spaced banks of aircraft.[4]

The FSA business strategy is sustainable as long as no subgroup of passengers can defect from the coalition of all passenger groups, and recognizing this, competition between FSAs included loyalty programs designed to protect each airline's coalition of passenger groups – frequent travelers in particular. The resulting market structure of competition between FSAs was thus a cozy oligopoly in which airlines competed on prices for some economy fares, but practiced complex price discrimination that allowed high yields on business travel. However, the vulnerability of the FSA business model was eventually revealed through the VBA strategy which (a) picked and chose only those origin-destination links that were profitable and (b) targeted price sensitive consumers.[5] The potential therefore was not for business travelers to defect from FSAs (loyalty programs helped to maintain this segment of demand) but for leisure travelers and other infrequent flyers to be lured away by lower fares.[6]

Figure 1and Figure 3 present schemata that helps to summarize the contributory factors that propagated the FSA hub-and-spoke system and made it dominant, followed by the growth of the VBA strategy along with the events and factors that now threaten the FSA model.

3. The economics of networks and airline competition

In this section we set out a simple framework to explain the evolution of network equilibrium and show how it is tied to the business model. The linkage will depend on how the business models differ with respect to the integration of demand conditions, fixed and variable cost and network organization.

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4 Airlines were able to reduce their costs to some degree by purchasing ground services from third parties. Unfortunately they could not do this with other processes of the business.

5 VBAs will also not hesitate to exit a market if it is not profitable (e.g. WestJet's decision to leave Sault St. Marie and Sudbury) while FSAs are reluctant to exit for fear of missing feed traffic and beyond revenue.

6 LCCs first obtain passengers who are unhappy with the FSA, next they obtain highly price elastic passengers, people attracted from other modes and activities and to some degree from the FSA, only after this does the growth in market share depend upon taking traffic from competitors.

Figure 1

The Rise of the FSA Hub-and-Spoke System

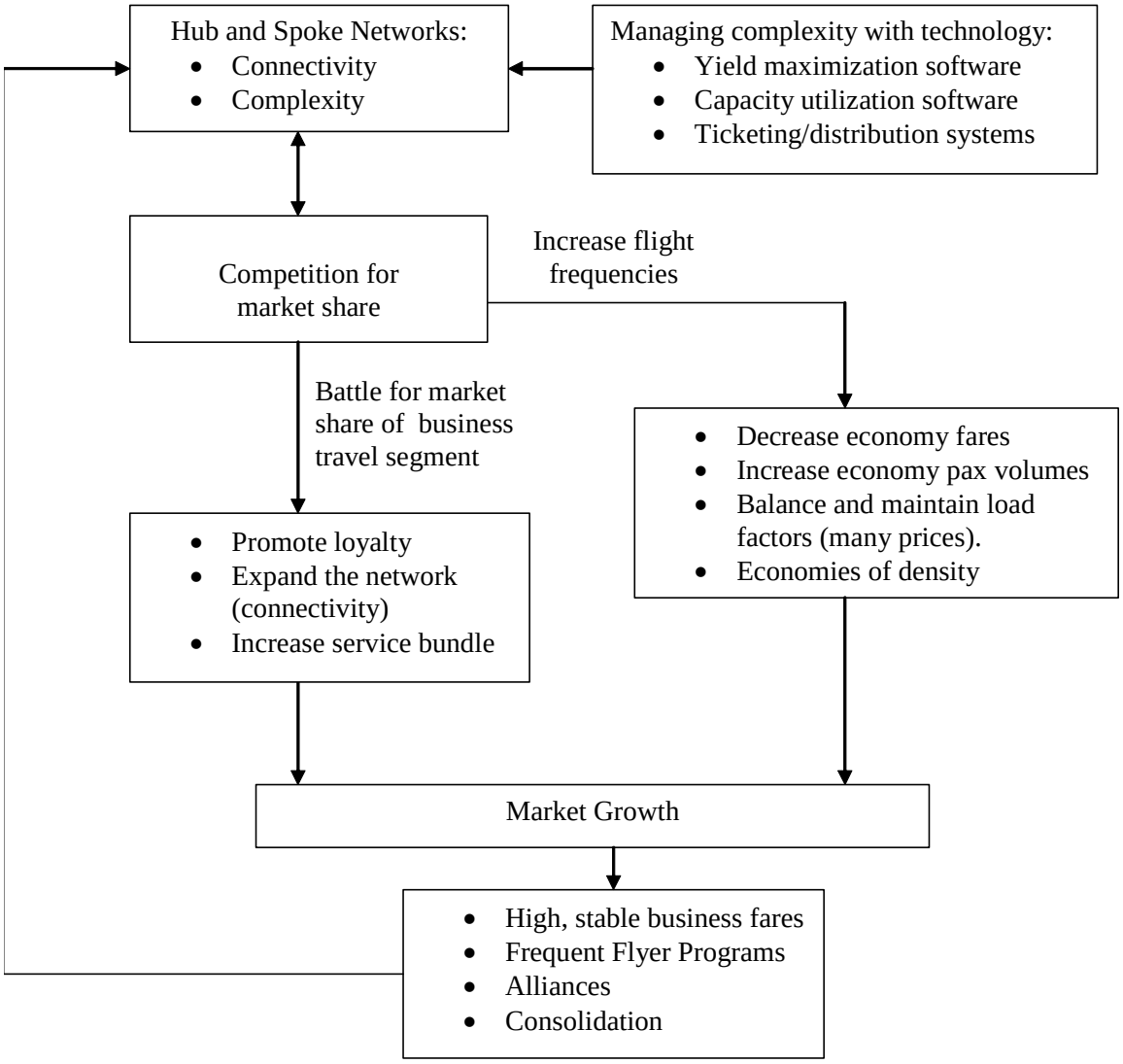
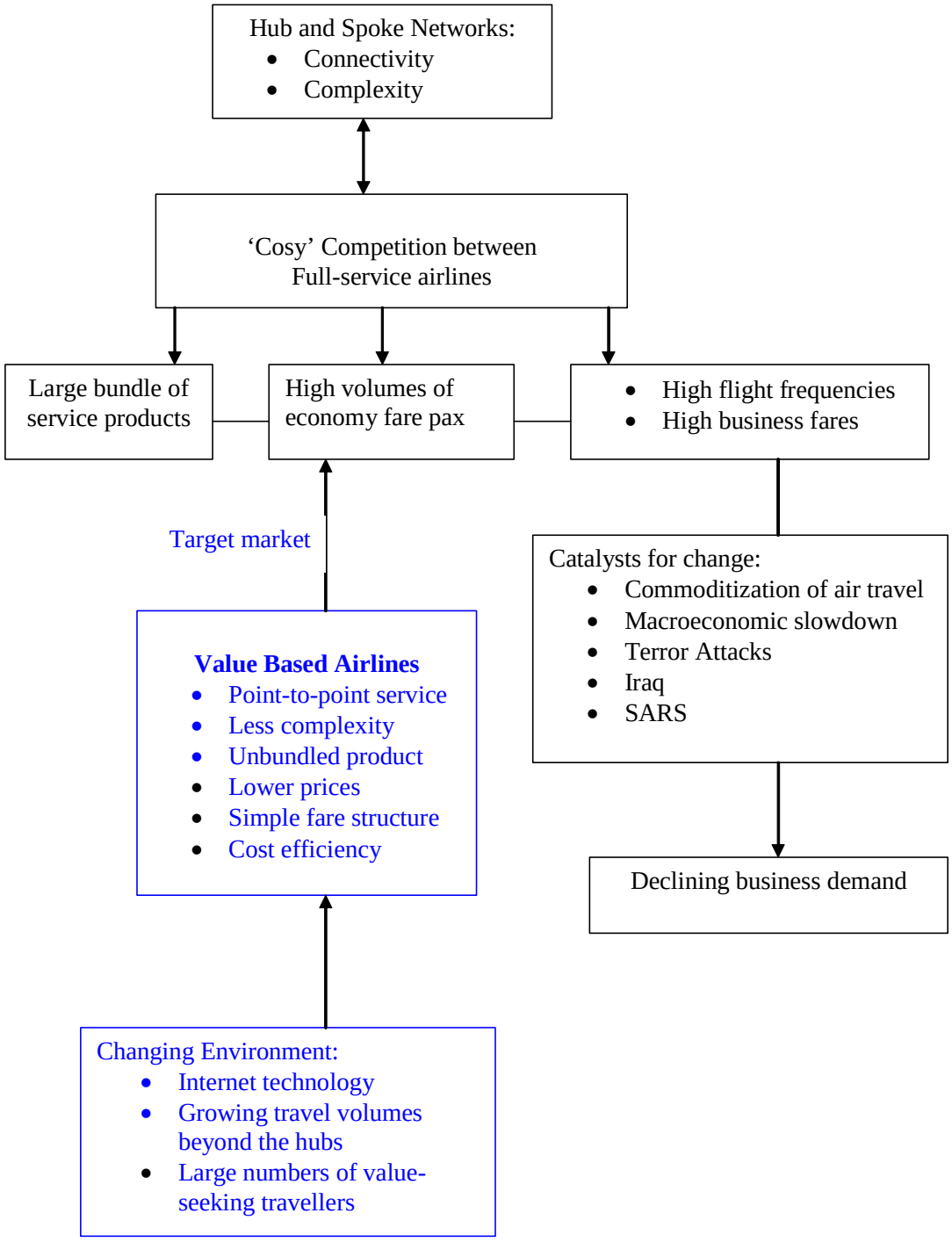


Figure 2

Hub-and-Spoke Networks Under Threat: The Growth Of VBA Point-to-Point Networks



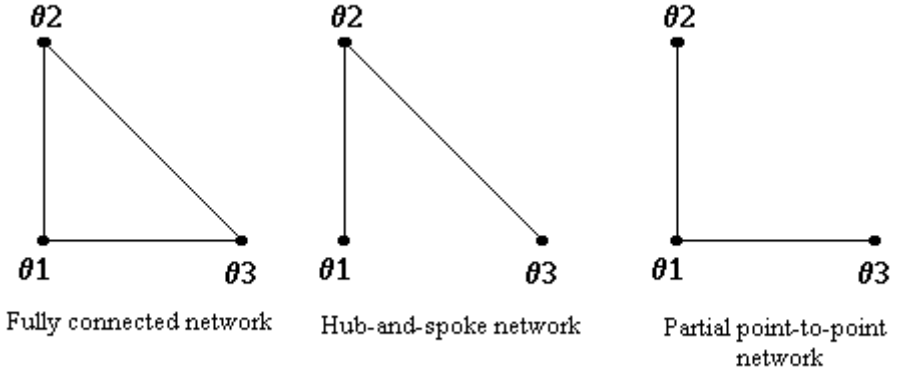
Let three nodes $\{\theta_1, \theta_2, \theta_3; (0, 0), (0, 1), (1, 0)\}$, form the corner coordinates of an isosceles right triangle. The nodes and the sides of the triangle may thus represent a simple linear travel network that defines two 'short-haul' travel links $[(\theta_1, \theta_2) (\theta_1, \theta_3)]$ and one 'long-haul' link (θ_2, θ_3).

In this travel network, the nodes represent points of entry and exit to/from the network, thus if the network is assumed to be an air travel market, the nodes represent airports rather than cities. This may be important when considering congestion or other factors affecting passenger throughput at airports.

This simple network structure allows us to compare three possible structures for the supply of travel services: a complete (fully connected) point-to-point network (all travel constitutes a direct link between two nodes); a hub-and-spoke network (travel between θ_1 and θ_2 requires a connection through θ_2) and limited (or partial) point-to-point network (Selective direct links between nodes). These are illustrated in Figure 3 below.

Figure 3

Alternative network structures



In the network structures featuring point-to-point travel, the utility of consumers who travel depends only on a single measure of the time duration of travel and a single measure of convenience. However in the hub-and spoke network, travel between θ_1 and θ_3 requires a connection at θ_2, consequently the time duration of travel depends upon the summed distance $d_{1c3} = d_{12} + d_{23} = 1+\sqrt{2}$. Furthermore, in a hub-and spoke network, there is interdependence between the levels of convenience experienced by travellers. If there are frequent flights

between θ_1 and θ_2 but infrequent flights between θ_2 and θ_3, then travellers will experience delays at θ_2.

There has been an evolving literature on the economics of networks or more properly the economics of network configuration. Hendricks et al. (1995) show that economies of density can explain the hub-and-spoke system as the optimal system in the airline networks. The key to the explanation lies in the level of density economies. However, when comparing a point-to-point network they find the hub-and-spoke network is preferred when marginal costs are high and demand is low but given some fixed costs and intermediate values of variable costs a point-to-point network may be preferred. Shy (2001) shows that profit levels on a fully connected (FC) network are higher than on a hub-and-spoke network when variable flight costs are relatively low and passenger disutility with connections at hubs is high. What had not been explained well, until Pels (2000) is the relative value of market size to achieve lower costs per ASM versus economies of density.[7]

Pels et al. (2000) explore the optimality of airline networks using linear marginal cost functions and linear, symmetric demand functions; MC=1-βQ and P=α-Q/2 where β is a returns to density parameter and α is a measure of market size. The Pels model demonstrates the importance of fixed costs in determining the dominance of one network structure over another in terms of optimal profitability. In particular, the robustness of the hub-and-spoke network configuration claimed by earlier authors (e.g. Hendricks et al., 1995) comes into question.

As we know in a P2P network the number of direct connections is n(n-1) while in a hub and spoke network it is 2(n-1) direct connections. Density of Q passenger sin the two networks would be Q/[n(n-1)] and Q/[2(n-1)] respectively; clearly the hub and spoke achieves higher density economies.

In our three-node network, the Pels model generates two direct markets and one transfer market in the hub-and-spoke network, compared with three direct markets in the fully connected network. Defining aggregate demand as $Q = Q_D + Q_T$, the profits from a hub-and-spoke network, are:

$$\prod_{HS} = 2\left(P_D Q_D + \frac{1}{2} P_T Q_T \right) - 2\left(Q_D + Q_T - \frac{\beta}{2}(Q_D + Q_T)^2 + f \right) \qquad (1)$$

7 ASM – available seat mile.

while the profits of a FC network are:

$$\Pi_{FC} = 3\left(P_{FC}Q_{FC} - \left(Q_{FC} - \frac{\beta}{2}Q_{FC}^2 + f \right) \right) \quad (2)$$

More generally, for a network of size n, hub-and-spoke optimal profits are:

$$\Pi_{HS} = (n-1)\left(P_D Q_D + \frac{(n-2)}{2} P_T Q_T \right) - (n-1)\left(Q_D + (n-2)Q_T - \frac{\beta}{2}(Q_D + (n-2)Q_T)^2 + f \right) \quad (3)$$

and FC profits are:

$$\Pi_{FC} = \frac{n(n-1)}{2}\left(P_{FC}Q_{FC} - \left(Q_{FC} - \frac{\beta}{2}Q_{FC}^2 + f \right) \right) \quad (4)$$

Under what conditions would an airline be indifferent between network structures? The market size at which profit maximizing prices and quantities equate the profits in each network structure is:

$$\alpha^* = \frac{\beta(2n-1)+1 \pm \sqrt{X}}{\beta(2n-1+\beta)} \quad (5)$$

where, $X = [1-\beta(2n-3)](\beta-1)[2f\beta(2n-1+\beta)+\beta-1]$ (6)

The two possible values of α^* implied by (5) represent upper and lower boundaries on the market size for which the hub-and-spoke network and the fully connected network generate the same level of optimal profits. These boundary values are of course conditional on given values of the density economies parameter (θ) fixed costs (f), and the size of the network (n). These parameters can provide a partial explanation for the transition from FC to hub-and-spoke network structures after deregulation but they do not provide an explanation for a reversion to a more point to point structure from hub and spoke.

With relatively low returns to density, and low fixed costs per link, even in a growing market, the hub-and-spoke structure generates inferior profits compared with the FC network, except when the market size (α) is extremely high. However with high fixed costs per network link, the hub-and-spoke structure begins to dominate at a relatively small market size and this advantage is amplified as the size of the network grows. Importantly in this model, dominance does not mean that the inferior network structure is unprofitable. In (α,β) space, the feasible area (defining profitability) of the FC structure encompasses that of the hub-and-spoke structure. This accommodates the

observation that not all airlines adopted the hub-and-spoke network model following deregulation.

Where the model runs into difficulties is in explaining the emergence of limited point-to-point networks and the VBA model. It is the symmetric structure of the model that renders it unable to capture some important elements of the environment in which VBAs have been able to thrive. In particular, three important elements of asymmetry are missing. First, the model does not allow for asymmetric demand growth between nodes in the network. With market growth, returns to density can increase on a subset of links that would have been feeder spokes in the hub-and-spoke system when the market was less developed. These links may still be infeasible for FSAs but become feasible and profitable as independent point-to-point operations, providing an airline has low enough costs.

Second, the model does not distinguish between market demand segments and therefore cannot capture the gradual commoditization of air travel, as more consumers become frequent flyers. To many consumers today, air travel is no longer an exotic product with an air of mystery and an association with wealth and luxury. There has been an evolution of preferences that reflects the perception that air travel is just another means of getting from A to B. As the perceived nature of the product becomes more commodity-like, consumers become more price-sensitive and are willing to trade off elements of service for lower prices.[8] VBAs use their low fares to grow the market by competing with other activities. Their low cost structure permits such a strategy. FSAs cannot do this to any degree because of their choice of bundled product and higher costs.

Third, the model does not capture important asymmetries in the costs of FSAs and VBAs, such that VBAs have significantly lower marginal and fixed costs. Notice that the dominance of the hub-and-spoke structure over the FC network relies in part on the cost disadvantage of a fixed cost per link, which becomes prohibitive in the FC network

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8 To model a such a demand system we need a consumer utility function of the form: $U = U(Y, T, V) = \gamma V(Y - P)$; where Y represents dollar income per period and $T \in [0,1]$ represents travel trips per period. V is an index of travel convenience, related to flight frequency and P is the delivered price of travel. This reduces each consumer's choice problem to consumption of a composite commodity priced at $1, and the possibility of taking at most one trip per period. Utility is increasing in V and decreasing in P, thus travellers are willing to trade-off convenience for a lower delivered price. Diversity in the willingness to trade off convenience for would be represented by distribution for Y, γ, and V over some range of parameter values. Thus the growth of value-based demand for air travel would be represented by an increase in the density of consumers with relatively low value of these parameters.

as the number of nodes (n) gets large. VBAs do not suffer from this disadvantage because they can pick and choose only those nodes that are profitable. Furthermore, FSAs variable costs are higher because of the higher fixed costs associated with their choice of hub-and-spoke network.

A fourth and fifth factor relate to congestion and vulnerability. Hub and spoke systems create their own congestion due to the use of banks of aircraft to create the 'hubbing effect. This can be costly in terms of inflicting costs on yourself in terms of waste but also in terms of lower productivity from capital and labour at hub airports.[9] Furthermore, there may be a high degree of vulnerability due to concentration at a hub since any disruption may result in particularly high costs regardless of the source of the disruption; e.g. weather at YYZ with Air Canada, labour disputes (BA and Air France in 2005). Disruption at large hubs carry large costs and hub rebuilding strategies shift the cost onto spokes in the network.

4. Why do hubs work or do they?

In the earlier section we illustrated the key factors driving network choice are economies of density, fixed costs per node and incremental costs of adding nodes and market size. To refine our understanding it is useful to ask what do hubs do to the demand side to make them valuable and what costs do they create them makes them less valuable.

Success in any business requires that a product offer value and at a price where profits can be made. Hubs make valuable trip options, a person at a small market feeder city can get almost anywhere with one connection. This access means feeder cities can participate in trade and commerce. Hubs can be cost effective for passengers in terms of lowering overall trip costs, yet passengers prefer point to point connections. Unfortunately may destinations attract as few as 10 passengers per day so connecting loads can use cost-effective airplanes.

Hubs provide competitive advantages to carriers as they can average out peaking in different markets. Hub carriers can also dominate frequency resulting in greater market share, hub premiums (to some degree) and cost economies from density economies. They could also

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[9] C. Mayer and T Sinai (2002) *Network Effects, Congestion Externalities and Airport Delays: Why not all Delays are Evil* (NBER Working paper 2002) argue hub carriers already internalize most of the costs of hubbing and a tax that did not take the network benefits of hubbing into account could reduce social welfare.

control sales channels but this has diminished with greater use of the Internet. Finally, having access to beyond (or before) traffic makes the carrier's value higher to an alliance partner.

Hubs also compete with other hubs, including your own. Value is created with quality of connections in the air and on the ground. A hub to add customer value must have short connecting times, reasonable walking distances, reliable baggage handling, few delayed flights and sufficient frequency to 'insure' against late flights.[10]

Hubs can enhance revenue by creating opportunities for pricing mixes. This includes higher fare sin captive feeder markets, low discount fares in selected connecting markets to fill seats; low connecting fares to compete against non-stops, selected low fares against competition. Discounting and filling means owning not just high fare markets.

However hubs are expensive in many ways and are vulnerable to the competitive threat of the different business model of the LCCs. In the US after deregulation all major carriers shifted to a hub and spoke system. They also tended to concentrate their traffic at one major hub while some had regional hubs. Yet with the increasing competitive threat from LCC some have moved in a different direction. American Airlines is using a 'rolling hub' concept, which does exactly as its name implies. The purpose is to reduce costs through both fewer factors such as aircraft and labour and to increase productivity. The first step is to 'de-peak' the hub, which means not having banks as tightly integrated. This reduces the amount of own congestion created at hubs by the hubbing carrier and reduces aircraft needed. It also reduces service quality but it has become clear that the traditionally high yield business passenger who valued such time-savings is no longer willing to pay the very high costs that are incurred in producing them.

As an example, American Airlines has reduced daily flights at Chicago so with the new schedules it has increased the total elapsed time of flights by an average of 10 min. Elapsed time is a competitive issue for airlines as they vie for high-yield passengers who, as a group, have abandoned the airlines and caused revenues to slump. But that 10-min. average lengthening of elapsed time appears to be a negative American is willing to accept in exchange for the benefits.

[10] A business passenger wants assurance that if his/her flight is late there will be sufficient subsequent capacity to complete the trip in a timely manner.

At Chicago, where the new spread-out schedule was introduced, American has been able to operate 330 daily flights with five fewer aircraft and four fewer gates and a manpower reduction of 4-5%.[11] The change has cleared the way for a smoother flow of aircraft departures and has saved taxi time.[12] It's likely that American will try to keep to the schedule and be disinclined to hold aircraft to accommodate late arriving connection passengers. While this may appear to be a service reduction it in fact may not, since on-time performance has improved.[13] Thus American has substituted travel time for reliability; research has shown the latter is valued more than the former.

The shift to hub and spoke in the US and the increasing concentration of traffic at major hubs was affected by he way the US was regulated; a failure to regulate capacity. It was also affected by the fact the US never had a public or flag carrier. In Europe, capacity was regulated and thus the shift to hub and spoke with EU deregulation was less pronounced. Also the existence of the major flag carrier in each country meant there was already a tendency to hubbing.

The literature shows that profit maximizing airlines with market power (in many cases monopoly airlines are modelled) will choose either a single hub or a point to point network if demand and cost are symmetric. The hub and spoke network is profit maximizing if passengers' value travel time is low and their value of flight frequency is high. The forces behind hubbing are moderately strong economies of aircraft size, a high valuation of flight frequency, low variable cost per passenger and low value of travel time.

Why might multi-hub networks emerge? First congestion at a hub may drive an airline to open a second hub (e.g. Frankfurt and Munich,

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[11] American has also reduced its turn around at spoke cities from 2.5 hours previously to approximately 42 minutes.

[12] As a result of smoother traffic flows, American has been operating at Dallas/Fort Worth International Airport with nine fewer mainline aircraft and two fewer regional aircraft. At Chicago, the improved efficiency has allowed American to take five aircraft off the schedule, three large jets and two American Eagle aircraft. American estimates savings of $100 million a year from reduced costs for fuel, facilities and personnel, part of the $2 billion in permanent costs it has trimmed from its expense sheet. The new flight schedule has brought unexpected cost relief at the hubs but also at the many "spoke" cities served from these major airports. *Aviation Week and Space Technology*, Sept 2, 2002 and February 18, 2003.

[13] Interestingly, from an airport perspective the passenger may not spend more total elapsed time but simply more time in the terminal and less time in the airplane. This may provide opportunities for non-aviation revenue strategies.

Heathrow and Gatwick, Charles de Gaulle and Orly), second differing geographic traffic flows may lead to a second hub (e.g. EU to North America and EU to Asia), third asymmetric demand where some cities generate more traffic than others may lead to multiple hubs (e.g. Alaska and SAS). A fourth reason may lie in strategic positioning for both airline competitors and airport bargaining. Lufthansa's reaction to Easyjet at Hamburg is a clear example of strategic reaction to LCC entry. Similarly it may be that opening a hub at Munich reduces the bargaining power that Frankfurt would have over Lufthansa.

What might happen in the case of demand uncertainty? In oligopoly models in which airlines make decisions on capacity, network structure and quantities the literature shows that in a model where network design and capacities have to be decided before the demand conditions are perfectly known, hubbing dominates. In this setting, hubbing provides airlines with the flexibility to change the allocation of capacity across markets after the demand is revealed. Hence hubbing is always chosen by a monopolist even in the absence of economies of traffic densities.

However, despite this advantage, it can be show that a duopolist may choose to adopt a linear structure. This perhaps surprising result is due to the fact that opting for a linear structure and thus renouncing the flexibility provided by hubbing corresponds from a firm's point of view to a commitment to use a specific amount of capacity on a market. On the one hand, this provides an airline company with the advantage of acting "tough", thereby affecting its rival's choice of capacity. On the other hand, this commitment prevents airlines from feeding competition on a market where demand turns out to be high by rationing passengers on other markets. In other words, a hub and spoke network structure may lead to a transfer of competition from one market to others. Hence, a network configuration where both firms adopt a linear structure may, besides providing a Nash equilibrium, also be optimal in terms of airline profits.

The literature also shows that when firms have different capacity costs, asymmetric network configurations may emerge with the low cost carrier adopting a linear structure and the high cost carrier a hub and spoke network. It would interesting to examine how demand uncertainty, capacity cost and the structure of the competitive environment affect the probability of an airline offering a direct or indirect connection between two cities. Where the literature is weak is in extending multiple choices (3-stage games) to price competition. It would certainly be worthwhile studying network choice in more complex competitive environments. For example, what happens if airlines do not have monopoly positions on their hub markets?

A Look at History

It is useful to look at history and observe trends and ask why these trends should not change. What we observe in most regions of the world when looking at the data is:

A. market growth is served by more airplanes not bigger airplanes

B. Why does growth add frequency?

    a. Deregulation causes one-time move to smaller airplanes (Competition drives airlines to more routes and frequencies)

    b. Economic savings of larger airplanes diminish with size (For new airplanes of similar missions)

    c. Cost savings come from avoiding intermediate stops (Connecting passengers pay a time and cost penalty)

    d. Natural network development (Route networks move from skeletal to highly-connected)

    e. Travelers' priorities change as economies get richer (Higher value for timely services, less emphasis on lowest cost)

C. Frequency is Added as Population Gains Wealth (History of route developments reflect growing value of schedules)

    a. Early route networks developed to serve lower values of time:

        i. Design minimizes per seat expenses

        ii. Frequencies are daily or less

        iii. Trips can require slow connections

    b. As nations grew in per-capita income, value of time rose:

        i. Route network design refocused on saving time

        ii. Saved time created value, especially for business travel

        iii. Value worth extra expense

        iv. Added frequencies, added nonstop markets

        v. Competitors spurred incumbent airlines to add service

Perhaps the most important factor that now affects network evolution is the growth of LCCs in domestic markets. Hub carriers now face erosion of their domestic market as well as fractioning of their markets. LCCs in most every circumstance extend their market share to about 30 percent and this appears to be a ceiling. The explanation may well be that LCCs first attract passengers disenchanted with the legacy carrier, then attract passengers from other modes and activities (growing the market) and only then do they capture market share by 'stealing' passengers. It is at this point the legacy carrier reacts in a more aggressive manner.

The strategic impact of LCCs may overshadow the traditional reason for choosing one network type over another such as cost and density economies. If legacy carriers shift to long haul international markets with feed through alliances and higher frequency RJs, the outcome may well be concentration at a single [gateway] hub.

Hubbing	
Positive	Negative
Economies of density	Congestion costs
Hub premiums	Low productivity/high costs
Price mixing	Requires high frequency-costly
Capture feeder rents	Loss of bargaining power at hub
Value in alliance	vulnerability
Increase connections	

5. Summary and Conclusions

There seems to be two competing theories of the evolution of airline routes and networks, a Consolidation theory and a Fragmentation theory. The Consolidation theory is put forward by those who argue airlines will "grow" the large markets by the growth rate of the industry as a whole, say 5% a year. However, the evidence is that the

larger markets did not grow quite as fast as the industry in general. However, there are people who advocate the opposite—that large markets are not only growing fast, but they are (a) using large airplanes today, and (b) going to use even more tomorrow. Thus the argument is:

- Large markets will need larger airplanes
- Industry consolidation increases this trend
- Alliances increase this trend
- This trend is happening

On the other hand the Fragmentation theory says that networks develop a small number of markets early, and the rest of the history of network development is the story of these initial markets being bypassed in various ways. The story is that all future network development bleeds traffic off the original "minimum spanning tree" network. In summary;

- Large markets peak early
- Bypass flying bleeds traffic off early markets
  - Some connecting travelers get non-stops
  - Others get competitive connections
  - Secondary airports divert local traffic
- New airlines attack large traffic flows
- Frequency competition continues

The Consolidation theory is one of dominant hubs while the fragmentation theory is one of more point to point networks.

What does all this mean for route and network strategies? Route strategies should respect history and what the data are telling us. In particular:

- **Plan for growth:**

  70%-100% of it in added frequencies
- **Plan for flexibility:**

  Long-term commitments should not hang on one specific future
- **Plan to have more routes:**

  Growth will include new nonstop markets
- **Plan to have more frequencies:**

  Growth will include more flights at more times of day

- **Plan to face competition:**

  Competitors will by-pass your hub

- **Plan to discuss history:**

  Leaders may imagine growth patterns different from history

6. Questions for discussion

The objectives set out for this workshop include:

A. to identify the drivers for network development of airlines with multiple hubs
B. apply this knowledge to the new Air France-KLM company
C. consider the consequences for the stakeholders in the industry
D. identify implications for French and Dutch aviation policy

Point A has been dealt with in the preceding section, particularly section 3 and 4, the remaining three points are considered in turn below.

What is the future for AF-KLM?

The focus is on what type of network will emerge and will it be a multiple hub or single giga-hub? In the paper I addressed the issue of network evolution and business models but did not address an important issue for Air France-KLM and that is the growing competitive threat of Emirates. The natural evolution of Emirates network is to spoke to major but also secondary cities in Europe to feed traffic through Dubai. This competitive threat would lead me in the direction of AF-KLM having multiple hubs which are specializing in traffic flows. My arguments are:

- the fragmentation theory is more persuasive than the consolidation theory (this does not contradict the expected consolidation in the airline industry)
- frequency outweighs density economies
- strategic positioning to specialize traffic flows (EU-NA and EU-Asia)
- strategic positioning to reduce the possibility of Singapore or Cathy Pacific entering and establishing a hub at Schiphol
- a giga-hub is vulnerable to high cost disruption and congestion

Implications for industry stakeholders (airports, airframe manufacturers, labour)?

A single giga-hub would favour one airport (Charles de Gaulle) and large aircraft (A380) while multiple hubs favour many airports (Charles de Gaulle and Schiphol) and smaller aircraft (Boeing 787, Airbus 350 and Boeing 777 combination together with feed).

Labour would gain more with a giga hub to the extent rents were created and they, labour, were able to extract the rents. Under multiple hubs, even with a degree of specialization in traffic flows and hence complementarity, there would be greater competition and a greater proportion of rents, to the extent they were generated, would remain with the carrier.

It would appear Boeing would have a relative advantage over Airbus until the A350 was brought on stream. However given the current fleet configurations and placements, Airbus may not lose.

Airports would be relatively worse off with a multiple hub strategy in that rents and bargaining power would be lower. However, Schiphol would be clearly better off than under a giga-hub strategy.

Implications for French and Dutch Aviation Policy?

A multiple hub strategy with specialized traffic flows would be complimentary with aggressive liberalization focused on 5th and particularly 6th freedoms. Given a specialization in traffic flows these freedoms would be targeted at different countries.

A giga hub strategy would seem to be complimentary with greater liberalization for both France and the Netherlands but for differing reasons. A giga hub at Charles de Gaulle would provide excellent connections between EU and North America but Asian access would need to be enhanced; a strong effort to liberalize across many Asian countries is needed. For Schiphol, the value is to create opportunities for non-EU carriers most likely Asian carriers to establish a second hub. I have mentioned either Singapore or Cathay Pacific as short to medium term candidates.

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