



Department of Economics and Business

Chair of I.O. and Competition Theory

COMPETITION IN THE AIRLINE INDUSTRY: A  
COMPARISON BETWEEN HUB-AND-SPOKE AND POINT-  
TO-POINT NETWORKS.

THESIS SUPERVISOR

Gian Luigi Albano

CANDIDATE

Camilla Salvatori

ID Number 213771

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*To my dad, without whom this would not have been possible.*

*To my mom, thank you for supporting me in any choice.*

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## **Introduction**

The world of the airline industry is always been a big part of my life, but I didn't know anything about it, and that is the same for many people who constantly use their services but don't know what there is behind. The complex structure of a company working in this sector particularly fascinated me, and that is the reason why I decided to look into it more deeply and maybe understand something more.

Airline companies are present in everyone's life. People are able to choose between different airlines and different flights, depending on what are their needs. Passengers can be divided between time-conscious and cost-conscious meaning that a person that need to go somewhere for his job will probably choose a flight different from someone that is going on vacation. The choice that has to be made will depend on many factors starting from the price of the flight, time of the departure and arrival, additional costs, benefits included in the ticket and many more.

Other than the consumer's point of view, there is the company's point of view. As a matter of fact, airline firms must incur in some issues when deciding about which strategy to use. Airlines need to manage to lower costs in order to higher their profit. Companies certainly need to understand what the client will want, and in doing so, they will understand how to connect cities in their route map in the best way. The choice of companies is between two types of network structure, hub and spoke and point-to-point. In this case, the customer will have to analyze the critical factors of the two structures such as the waiting times at the intermediate hubs when the company has a transit in a specific city, and a discount cost factor for hub-to-hub and point-to-point travels.

In this essay, I decided to analyze how companies decide between these two available network structures to improve their profits after the deregulation of the market.

In the first chapter, there will be explained the airline industry in general, to let someone who doesn't know anything about this topic to be able to understand. It starts with the description of the background of the industry and some historical events that changed the market completely, such as the deregulation. Moreover, it explains how this industry sector affects the welfare of a country.

In the second chapter, there is a deeper analysis about all the competitors you can find in this type of market. It starts by separating the companies in the principal businesses in the market. The division is made by some main characteristics such as the size of the airplanes, the route of the flights, their profits and some others. Then there is the analysis of the two main carriers in the market: the full-service carriers and the low-cost carriers. Analyzing their pros and cons and what is their strategy to do business: pricing model, costs...

In the third chapter, there are described the two network structures used by the two different carriers, respectively the full-service carriers use the hub-and-spoke network while the low-cost carriers use the point-to-point network. The two configurations are analyzed and compared to understand the advantages and disadvantages of the two better.

All of this is needed to arrive at the fourth and principal chapter that outlines the principal topic of the thesis: the two network routes with their profits and costs in different situations. The study starts with a description of the total cost and profits of an airline company in general. Then, after that, there is the introduction of the two profits function of an hub-and-spoke system and of a point-to-point system. Afterwards, it is illustrated how the airlines can strategically use the two structures in response to a threat of entry from a competitor. At the beginning of the research, before the risk of a new entrance in the market, it is stated that a company will act as if it was in a monopolistic environment and thus using the point-to-point network. However, as soon as there is a threat for a new entrant to come into the business, the company will switch to the hub-and-spoke model.

Following this description there are two cases: if the firm already established in the market accommodate or deter the entrance of the competitor showing the two profits and which network structure will fit the best to improve its business.

Finally, in the last chapter there is a personal opinion on what the essay explained and how this situation arises nowadays, and also, I decided to analyze where the market will go by studying a research by IATA.

# **Ch.1 - Airline industry**

## **1.1 - Brief History**

The airline industry is today one of the most important economic sectors that offer its services in the world. It has been clear, since the birth of flight in 1903, the importance of its presence in the globalization of the world market: connecting people, cultures and businesses across the world. Even though until around 1930 flight was not seen as a way to ship people, technological development has changed this point of view. Particularly progresses in the speed and aircraft capacity produced a very much high request from people to fly.

Air travel provides the only rapid worldwide transportation network, so it is fundamental for global economic development. Over a third of all trade is sent by air (35 percent of world trade calculated by value, but only 0.5 percent by volume) which makes aviation a key component of business.

Nowadays, air transport is a fundamental enabler of global trade and e-commerce: 87 percent of e-commerce transactions are currently carried by air. The e-commerce shares of transported goods by air grew from 16 percent to 83 percent between 2010 - 2016 and is expected to reach 91 percent by 2025.

Aviation's advantage was the speed and reliability given to the market for delivery and transportation of compelling or time-sensitive products.

This industry sector generates economic growth, creates jobs, and facilitates international trade and tourism. According to most recent estimates by Air Transport Action Group (ATAG), the total economic impact of this business activity was 3.5 percent of world's gross domestic product (GDP) in 2014. Over 65 million jobs are supported internationally in aviation and related tourism and, of this, 10.2 million people work directly in the aviation industry.

The state of the airline industry is strong. It is expected that in 2019 there will be a new record in terms of the number of scheduled passengers with almost 4.6 billion. Despite all the power and prestige of the industry, there is the presence of numerous factors that could negatively affect the business. Indeed, the global nature of the industry makes it uniquely

vulnerable to a multitude of elements ranging from insufficient infrastructure to disease epidemics to politics. But somehow, although many crises, it had demonstrated long-term resilience, becoming an indispensable mean of transport.

## **1.2. - Main factors affecting the industry**

The aviation industry has become particularly important in the last decade of 1900, with some events that affected it positively such as deregulation, globalization, high economic growth, many technology developments, and more.

Air transport has always been managed by the State since it was considered to represent a social service and therefore was the government the one in charge of its operations.

It used to work this way because the states believed that they had the control of their national aerospace as much as their national territory. Each state was responsible for the creation of protectionist laws having the scope of giving the exclusivity of national traffic to the national airline and regulating international traffic with agreements with the other states. Indeed, airlines couldn't compete with others by lowering their prices or their fares, they competed by striving to offer the best quality service available on the market.

First, with the Airline Deregulation Act in 1978 in the U.S, and then with the European Union decision, on January 1, 1993, there has been the “liberalization” of the industry. Thus, meaning that the governments imposed on individual states the elimination of all protectionist norms and recognized all Community carriers the right to operate and determine the price freely.

This was the major turning point in this transport sector as it is able to expand the flight offers at lower prices and to increase competition. With the deregulation there was the introduction of a new protagonist, the low-cost company, also called LCCs, which focuses on charging lower prices, cutting all additional services related to the ticket. All of this was applied by LCCs to cope with the competition of other companies that instead offer a full service. With the entrance of low-cost airlines, air travel is no longer seen as something lustful but as a commodity and every extra service is now superfluous.

The period post deregulation was characterized by the creation of new carriers and new routes that connected cities. The available fares dropped. Thus, competition and customers both increased. Since competition was growing, companies already existing needed to guarantee to customers a better and suitable service for them.

Between the 80s and 90s, there has been an increase in the investments in the air transport industry, considered by all to be very capital-intensive and not very labor-intensive.

However, in the early 2000s, the air transport industry interrupted his growth process that was, until then, constant since the beginning, even though sometimes was volatile. This happened because big network carrier companies find it difficult to adapt to the new market with much more competition. The offer of lower and lower tariffs to counteract the excessive power of low-cost carriers produced an increase in passengers but not always an increase in revenues. Moreover, during those years, a global economic crisis has occurred, and the attack to the Twin Towers in New York (11th September 2001) and many more others air accidents slow down the growth process.

However, the “take off” of the air transport market could not take place if it was not accompanied by a very important component, globalization. If globalization means the elimination of all space-time barriers as a result of the invention of new technologies, it is inevitable the contribution that has been given to the growth of this sector.

Airline industries are renowned for being innovative because it is crucial for them to obtain competitive advantage over other companies. As a matter of fact, as already explained, competition in this sector has been increasing fast, especially when it comes to offering innovative products and services in both airports and aircraft.

This business profits are considered as the highest among other industries, that is why companies must employ new strategies. Actors in this industry need to be flexible to keep along with the constantly changing market and to differentiate from competitors to become market leaders. This demand of flexible business strategies is something totally recent, and it was necessary for companies to maximize their revenues.



Since 2005, airline companies continuously thinking of ways to be innovative in order to survive. In last decades, all companies have facilitated access to new technologies at hand that can be categorized as a very important factor for the economic growth.

## **Ch.2 - Competitors in the Airline Industry Market**

As previously exposed, due to the deregulation of the aviation market, there has been an increase in competition. Today we can count around 5000 airline companies all over the world but not everyone of them is officially operating and recognized.<sup>1</sup> Actually, some of them may operate in a really restricted zone of the market. Thus, they are not defined as competitors of the major companies in the world.

### **2.1 - Principal Airline Businesses**

The airline industry is similar to any other economic sector. Meaning that, there are different types of companies because there are different types of demands from customers. Every kind of business is addressed to a specific type of client. Below are listed the type of companies.

- Majors carriers: as the US definition says, a major airline is a company that generates operating revenues of more than \$1 billion annually. Generally, it is defined as this to distinguish it from every other type of business in the airline industry. Sometimes to be defined as a major company there are some standards that need to be respected. Some examples of this type of carriers can be: Delta Airlines, Emirates Airline, British Airways and all the other biggest companies around the world.

Nowadays, the leading major companies of the market are Qatar Airlines, Singapore Airlines and ANA - All Nippon Airways. Anyhow, this is based on customer's review of the services available from the company, since they are ranked according to Skytrax (an airline travel review website, <https://www.airlinequality.com>).

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<sup>1</sup> [https://en.wikipedia.org/wiki/Lists\\_of\\_airlines](https://en.wikipedia.org/wiki/Lists_of_airlines)

On the other hand, taking a look to the number of passengers that an airline can carry, the top three companies of the world are: Delta Air Lines, Southwest Airlines, and American Airlines.

([https://www.nationsonline.org/oneworld/major\\_airlines.htm](https://www.nationsonline.org/oneworld/major_airlines.htm))

- Flag carriers: a flag carrier is defined as an airline or ship-line registered under the laws of a country whose government gives it partial or total monopoly over international routes. These types of air carrier usually serve just specific regions but can also offer long distance flights. Similar to the major companies, they possess medium and large sized aircrafts. In the US, national airlines are considered as companies that can make annually operating revenues of a value between \$100 billion and \$1 billion. Examples of national carriers can be Alitalia, Air Canada, Lufthansa.
- Regional carriers: these airline companies are those who offer their services to passengers who need to travel around one region of a specific country. They can operate as an affiliated airline such as Alitalia City Liner (subsidiary airline of Alitalia), or they can be an airline with their own brand. This type of airline has been growing really fast and has been the most profitable one since deregulation, according to Air Transport Association of America (ATA). Other examples of regional airlines are Canadian North, American Eagle, City Jet. In the US, these are divided into three subgroups depending on their annual operating revenues: large regionals, medium regionals and small regionals. The first one generates revenues between \$20 and \$100 million; their aircraft can offer more than 60 seats. The second has revenues under \$20 million and has small aircrafts. The last represents the largest segment of this type of business. The thing that distinguishes them from the rest is the size of their aircraft that has less than 61 seats.

To explain it better: if you are traveling with your family and you need to go overseas, outside from your continent, you'd rather fly with a major airline because it has more options and destinations than a small company. On the other hand, you will choose a regional airline if you need to fly between small cities because you don't have to stop at a major airline's airport for a layover.

Last but not least, there is another category among airline companies, contained in the definition of major, national and regional, is the one that does not carry passengers, which is called cargo carriers.

There are two types of shipping used by the cargo carriers: the first one carries loadings inside the passengers' aircrafts and the other, that is the most used and called freighters, have their own jets and it ships nothing but merchandise.

## **2.2 – Low - Cost and Full Service**

The models formerly exposed used two business models: Full-Service Carriers (FSC), that is the most common, and the one that was introduced only after the deregulation, that is Low-Cost Carriers (LCC).

### **2.2.1 – Full - Service Carriers**

A *full - service carrier* or *legacy* is typically a national airline, or it is one between the main important in the country, which focuses on delivering a wide range of flights and connections that are characterized by their frequency. This type of airline provides any kind of benefits in the ticket price such as flight entertainment, checked baggage, meals, beverages, different service classes (e.g. economy, business, premium...) and so on and so forth. The pricing strategies of this type of company are: complex yield management which relies on the pricing strategies of competitors, customer demand and availability of seats (since the company tries to understand how many customers are willing to pay a higher amount to ensure themselves the spot on the aircraft) and dynamic pricing.

FSC usually use the hub-and-spoke model which merges most of the flights, as the name suggests, in a main hub. The hub-and-spoke structure will be explained more in details later. Another thing that characterize the full-service carriers is that it is likely to create strategic alliances with other companies in order to survive in the market where there is plenty of strong competition. The aim of this partnership is to offer passengers a full service from the beginning to the end of their trip, even if the airline concerned does not fly to their final destination. These coalitions are possible due to code sharing, meaning that each company can supply tickets on destinations that are operated by every other airline that is part of the contract.

The most important alliances today are: Star Alliance (27 members), Sky Team (19 members) and One world (13 members).

### **2.2.2 – Low - Cost Carriers**

*Low - cost carriers* or *no-frills carriers* is a type of company which relies on a cost reduction strategy, trying to minimize its operating costs in order to implement a price leadership strategy on the market they serve. This cost reduction is based on the idea of not delivering the conventional services offered from an FSC company which are instead comprehended in the higher fare. This results in lower prices charged for tickets since there are no more comforts. However, to fill in the losses due to reduced prices, the companies may sometimes charge supplementary fees (e.g. carry-on baggage).

This cost structure is also possible due to the usage of smaller aircrafts and so a decrease in the fuel utilized, maintenance costs, staff needed, and sometimes even capital costs. Moreover, the unit costs in which they incurred are burdening less on the company due to the high concentration of seats.

The pricing strategy used by LCC is typically very dynamic. They used to have really low-price tickets for people who booked their flight in advance. These are the low-wages passengers and people who want to “*catch the deal*”, those who are willing to pay less than others and who would not have flown otherwise.

Since low-cost companies use smaller planes than the others, they guarantee short-haul services with respect to FSC. The latter are concentrated in bigger airports and hubs. Instead, these low-cost airlines focused themselves in smaller airports. As a matter of fact, they are based on a point-to-point model which also allow to save on costs by removing the in-between stop at the hub.

Another thing characteristic of these carriers is that they are not part of any of the three principal alliances named before.

## **Chapter 3 – Hub - and - Spoke and Point - to - Point Systems**

Every transportation sector has production networks characterized by economies of networks, generally called economies of scale, that for definition are cost advantages reached when production becomes efficient. They can be achieved by companies by increasing production and lowering costs because expenses are spread over a larger number of goods.<sup>2</sup> Specifically, economies of networks are composed of all the routes available in which they can transport passengers or freight. The transportation industry was exposed to various changes after the deregulation that lead to no controls on price and entrances in the market. Thus, there was an increase in hub-and-spoke network (HS) that was caused by the increase in competition.

### **3.1 - Hub and Spoke**

Hub-and-spoke (HS) networks were created by the US airline, American Airline. They are used by those companies which allows to get customers altogether in one airport, called the hub, and then fly them to their final destination, called the spoke, in a smaller plane. To have an example British Airways' main hub is London Heathrow, Air France-KLM has Paris Charles-de-Gaulle. Simplified the airline wants to connect passengers from airport of origin (A) to final stop (B, D, ...) via the hub (H). This helped the airline firms to decrease their fares while increasing the number of passengers, destinations, and the number of flights departing from the single hub. Nonetheless, this system has its disadvantages, such

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<sup>2</sup> <https://www.investopedia.com/terms/e/economiesofscale.asp>

as the high costs in which companies must incur to sustain the complicated infrastructures required for a huge range of connections. Other problems could also be the longer travel times needed because passengers need to stop at the hub and the delays in the flights due to overcrowded hubs. Indeed, airlines need to manage a tight time schedule to provide connections. What is almost certain is that there are more advantages than disadvantages since more and more companies are starting to use this network system. The company saves money and time, and so do the passengers.

### **3.2 - Point-to-Point**

On the other hand, the point-to-point (PP) system, connects the travelers from the origin to destination with a non-stop flight, indeed also defined as O&D (origin and destination), which means that the passenger who wants to fly from a city (A) to another city (B), or vice versa, will be transported with a direct flight and there is no need to use a hub. As already said, this is the principal network used by low cost carriers' companies. In point of fact, this system helps companies to cut costs by removing the stop at the hub and also all the costs deriving from it, such as the development of the connections and the enormous airports. It also decreases the time that passengers need to travel, that is a first priority for them. Point-to-point model decreases aircraft turn times improving then the utilization of planes; they will need shorter "break times". The most significant problem of this system is that it cannot reach destination located very far away from the city of origin since not every place in the world can be economically reached with direct flights.

### **3.3 - Advantages and Disadvantages of the two systems**

Choosing between the two models is fundamental for airline companies, and it depends on different factors such as airport infrastructure, population in the city, geographical position, strategic partners. Both of them has some advantages and disadvantages that are best fitting for certain markets type, so there will be for certain a predominance of one system in respect to the other in specific cases.

The HS network system allows passengers to travel “from anywhere to everywhere” (Hansson, Ringbeck, & Franke, 2002, p. 1.). Since they have a wide range of connections, it is a necessity for the hub-and-spoke to have flights that are on time or the probability for passengers to lose their connections increases. Still with this system there are a bunch of efficiency improvements given the fact that is easier to link destinations since you need few routes. HS can connect four cities with only three routes, one hub and three spokes, but if they need to be connected with a point-to-point system, it will be necessary to have eight routes. This system indeed will also require lower usage of aircrafts. The economic benefits deriving from the use of a HS always increase with travelers’ concentration, and the network is becoming larger and larger. These two factors affect in an optimistic way both demand and supply. Moreover, a point-to-point model has no need to develop different functioning and efficient infrastructures for connections while for a HS is essential. Even though passengers prefer to use only one plane for their travel and don’t want to change at the hub, the HS’s capability to serve many more cities than a point-to-point is what grant them the competitive advantage.

As already said since passengers and networks grow for the hub-and-spoke system, also the flight frequency can and need to be increased. This can provide passengers with the possibility of choosing their preferred departure time-constrained to their needs. HS can also allow companies to save on costs for advertising since they can spread the marketing expenses among the huge number of locations reached and the high flight frequency.

As the number of travelers per destination increase, the cost of seat kilometer decline, since the availability of seats on aircraft grows faster than operating and capital cost. This happens because more passengers can fly between cities with fewer flights, allowing the company to reduce airport fees and employees’ costs. Thus, this will help increase economies of scope and the network will grow. This phenomenon of development of the connecting routes is due to the ease with which the company can add one destination in the system with just one additional route. Airline companies with a wide range of linkages between cities are the ones that impose their supremacy on a hub and thus gaining market power and imposing a fare to other companies passing through “their” hub.

Even though it may seem that HS is a mechanism that can help companies to save, it is the most expensive between the two. Indeed, the costs to let the system to work are elevated. As already explained, differently from the point-to-point, they need employees and establishment to match the necessities of customers that are passing through the hub to arrive at their final destination. Passengers who usually have the hub as their starting or arriving point are just the 40%, the rest need to transit.

HS system means higher costs as a consequence of the huge and complex network of routes available. Since the cities are connected one with the other with shorter flights, as a result of the hub, the costs will be more expensive per kilometer because they will weigh more on the company. Moreover, this happens because the more time spent by the aircraft at smaller height the more is the fuel burnt and thus the more will be the costs.

Furthermore, the HS incur in a severe time schedule reducing aircraft and crew availability in a precise moment since they can be somewhere else very far away from the hub. Since there is a high frequency of flights, arrivals and departures can be limited by the intense traffic in the airfield. Also, hub-and-spoke networks are not good at coping with unpredicted circumstances such as snowstorms or other extreme weather events.

The hub-and-spoke network delivers its services to a variety of cities with different sizes and demands. Thus, this means that it will need different types of aircraft, with different capacity and so fleet need to be assorted meaning that costs will increase in terms of mechanics, crew, and maintenance.

A last word on the HS system can be that they can be really complicated and costly to operate and so its planning and management network.



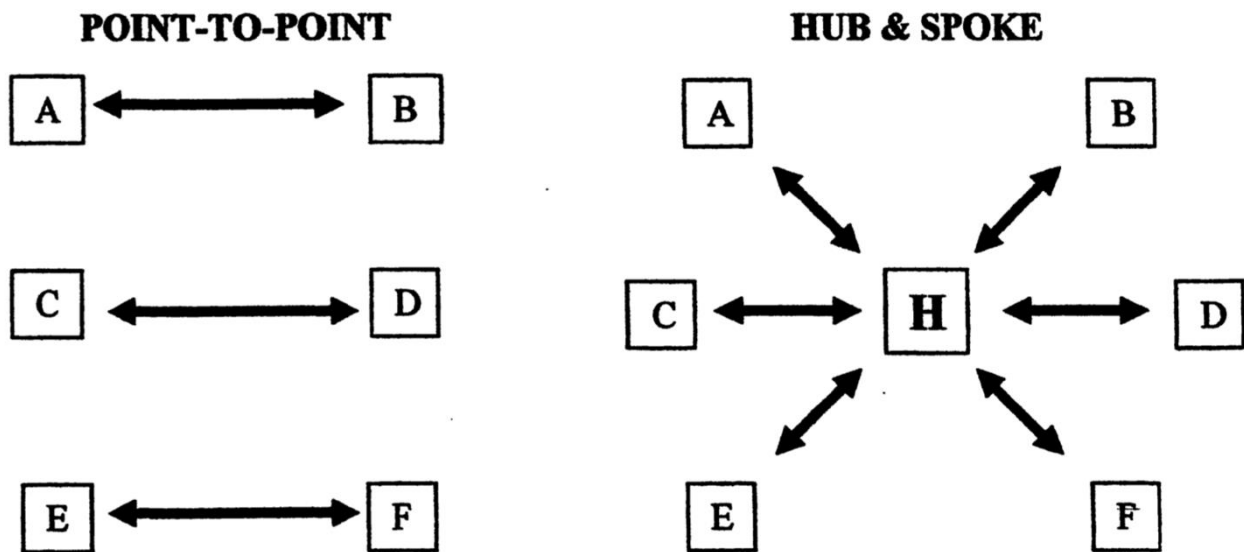


Figure 1: Cook, G. N., & Goodwin, J. (2008). *Airline Networks: A Comparison of Hub-and-Spoke and Point-to-Point Systems*. *Journal of Aviation/Aerospace Education and Research*

A point-to-point network has the scope of maximizing profits by providing customers a full service. Even though PP network is usually used by LCC's companies, people that usually fly with this systems are those who are willing to pay a higher fare for assure themselves a seat on the plane, even though they book in a day really close to the departure date, and for the flexible tickets. Airline companies try to exploit the different preferences of travelers and their willingness to pay for a flight to maximize their revenues, indeed in the late 1990s when costs increased, firm's fares roses.

The major difference between the two network systems is the complexity of an HS trying to connect many cities passing through a hub and the simplicity of a PP which, in contrast, link cities with just a direct flight. As a consequence, the use of this specific type of trajectories (non-stop) is made by companies who serves markets where the demand is enough to maintain the costs of huge aircraft. Although many small cities do not have this sufficient request to sustain non-stop flights to more destinations. Moreover, the elimination of the stop at the hub reduce costs even more. But even though a point-to-point system seems to help companies to save, it is known for the full-service, which ensures all the benefits that are available for customers, this is not completely true.

PP network's passengers are those who value their travel time. Indeed, this system allows to reduce sharply the time spent on the airplane first with the non-stop at the hub and second with the faster and bigger aircraft. With regard to airports, crew and some other assets they are all used to the maximum of their potential since everything is "bigger".

Still, the absence of connecting flights between destination in this PP network limit the companies that use it. This is a consequence of the impossibility to combine destinations on a single flight.

As already said, this type of network is especially used by LCCs. These carriers are struggling to enter unserved markets because they are dedicated to low-density markets where the request is for smaller aircraft. As a matter of fact, the operational costs that companies need to pay for the use of bigger planes are too high and do not encourage the expansion of a PP network. As a consequence, the use of these jets is an exclusivity of HS carriers.

In conclusion, it is noted that requests for flights varies by time of week, day and season (e.g. people want to travel during holidays or during the weekend) and this will make it challenging for companies to understand how to manage capacity and demand.

A major airline capability is to shift the fall of demand in one city with stronger demand in others, but a point-to-point network, since it doesn't have connections, does not have this ability to balance the variations in demand from customers. The efforts of the companies that use this network will be changes in the plane's sizes, the frequency of flights, or the creation of seasonal routes trying to overcome the losses.

## Chapter 4 – Comparison between HS and PP network routes

In defining a firm profit is important to declare first the costs in which a company can incur.

A total cost function is defined as a formula used to understand how the expenses that a company has to sustain will change at different output levels. It will estimate all the costs of production given a specific quantity to produce.

### 4.1 - Total cost function of airline companies

In the airline industry, the firms have the cost function that can be affected by the network structure they will choose, so between a hub-and-spoke model or a point-to-point model.

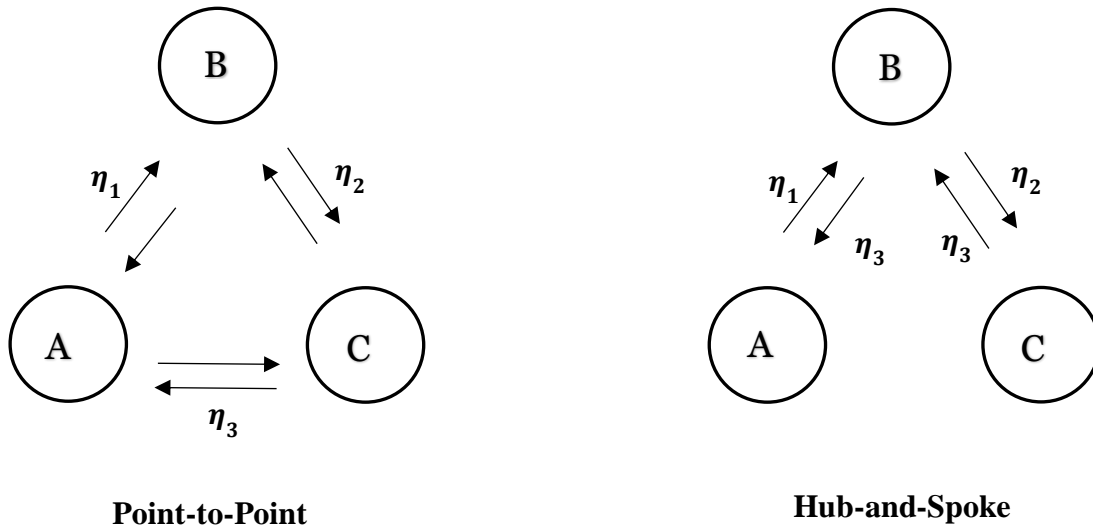


Figure 2

To understand this consider a one-way journey route in which  $\eta_1$  passengers want to travel from city A to city B,  $\eta_2$  passengers want to travel from city B to city C, and  $\eta_3$  passengers want to travel from city A to city C.

So the total cost function of a company, in this case, will be affected by the number of passengers transported on each route:  $TC(\eta_1, \eta_2, \eta_3)$ .

This function is defined as  $TC \stackrel{\text{def}}{=} c(\eta_1) + c(\eta_2) + c(\eta_3)$ , where  $c$  is the cost of operating on a specific route  $c(\eta) \stackrel{\text{def}}{=} \phi + \eta^2$  and it is the sum of some fixed costs,  $\phi$ , that could be

landing fees, renting fees for gates at the airport; a variable cost,  $\eta$ , that depends on the number of passengers and it this case rise quadratically due to aircraft capacity.

With the concept of total cost function, it comes, hand in hand, also the concept of the economies of network, which we already mentioned. The economies of network (or generally economies of scope) are gained from a company if its total cost of operating in all three routes are lower than the sum of the costs of operating in the three distinct routes by different and separate firms. Defined as:

$$TC(\eta_1, \eta_2, \eta_3) < TC(\eta_1, 0, 0) + TC(0, \eta_2, 0) + TC(0, 0, \eta_3) \quad (4.1)$$

Moving forward and defining the two total cost function of a HS and PP network, that are the two will be studied in this case, we have:

$$TC^{PP} = 3\phi + (\eta_1)^2 + (\eta_2)^2 + (\eta_3)^2$$

$$TC^{HS} = 2\phi + (\eta_1 + \eta_3)^2 + (\eta_2 + \eta_3)^2$$

Comparing the two functions  $TC^{HS} < TC^{PP} \text{ IFF } \phi > 5\eta^2$ , we can state that: if the fixed cost related with servicing even route 3 are large with respect to the number of passengers on each route, than HS is the convenient network to choose. On the contrary, if the costs of operating a route are small, then the PP network becomes the better one.

#### 4.2 - Hub and Spoke model and Point-to-point model profits

The period post deregulation saw a decline in the major airlines and an increase in the use of hub-and-spoke network by airlines. Thus, this period could have been defined as an oligopolistic market.

The reduction in the number of companies could have been justified by the entry accommodation and entry deterrence strategies used by the leading firms in the market.

The model studied here<sup>3</sup> is to show how companies can switch to a hub-and-spoke model from a point-to-point network and gain competitive advantage over a new entrant in the market, thus blocking or restricting his entry.

To start this study, consider figure 2 and a similar network. A passenger will want to fly between the city and, certainly, he can be transported or with a direct flight (PP model) or with a stop by a hub (HS model), which in this case will be city B. Suppose that there only three routes: from A to B, from B to C and from A to C.

First, it is necessary to consider the type of passengers that are traveling. In this case, there are two types of  $\eta$  passengers. The first type (T) are the ones for which time is worth very much and, if there is a transit in a hub city, will lose a utility of  $\delta$  with  $\delta < 0$ . The second type (N) are the passengers with a low value of time and they are indifferent between the two types of flight.

The utilities of the two types of passengers will be

$$U_i^T \stackrel{\text{def}}{=} \begin{cases} \beta - \rho_i & \text{flight is direct to destination} \\ \beta - \delta - \rho_i & \text{flight stop to a hub} \\ 0 & \text{does not fly} \end{cases} \quad (4.2)$$

$$U_i^N \stackrel{\text{def}}{=} \begin{cases} \beta - \rho_i & \text{flies directly or indirectly} \\ 0 & \text{does not fly} \end{cases}$$

Where  $\rho_i$  is the airfare imposed on a route  $I$ ,  $I = 1, 2, 3$ ; and  $\beta$ , with  $\beta > 0$ , is the value given by passengers to the service.

After all the calculations to find passengers utilities, next task is to find how the firms can make profits with the two network structures. To do so, consider an airline firm that is operating in a monopoly. Thus, just one company can provide flights to all cities and it will charge monopoly fares.

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<sup>3</sup> Shy, Oz, and Shy Oz. *The economics of network industries*. Cambridge university press, 2001.

- Point to point profit: the profit for a PP network denoted by  $\pi^{PP}$ , it is the sum of the profit on each route identified by  $\pi_i$ ,  $i = 1, 2, 3$ . The monopoly airline can set  $\rho_i = \beta$  and get maximum surplus since all passengers are served. The profit on each route  $\pi_i = 2\eta\beta - \mu$ , where  $\mu$  is the cost companies has to pay for any route (cost per flight) and 2 are the two types of passengers served. In the end, the profit under PP network will be

$$\pi^{PP} = 3\pi_i = 6\eta\beta - \mu. \quad (4.3)$$

- Hub and Spoke profit: with this model, the airfares here will be different since passengers need to pass through the hub in city B. So, assume that passengers who are starting or finishing their journey from the hub cannot purchase flight ticket for route 3 (from A to C). This means that if, for example, a person needs to go from New York to London. He is looking for tickets and he finds a company that has a convenient flight from New York to Madrid making a hub in London. He cannot purchase the ticket for Madrid and then get off in London. This happens because the monopoly can price discriminate between the passenger on the route that makes the stop at the hub and then go to final destination or the other passengers who don't need to go to the last same airport as the previous. As a consequence, airfares for route 1 and 2 will be for sure higher than the ones for route 3, thus  $\rho_1 > \rho_3$  and  $\rho_2 > \rho_3$ . Nevertheless, the monopolistic company need to ensure that  $\rho_3 \leq \rho_1 + \rho_2$  or the passengers will be better off by buying the two tickets, from city A to B and then from B to C.

In the HS model, the assumption that was made and the utility functions previously calculated (4.2) imply to set  $\rho_1 = \rho_2 = \beta$ , getting the maximum surplus from passengers on route 1 and 2. Instead for route 3 it is necessary to consider two levels of airfares: a higher one  $\rho_3 = \beta$ , but then they will lose the passengers in need to fly on route 3 but with a high value of time who doesn't want the stop at the hub, and a lower fare  $\rho_3 = \beta - \delta$ , and in doing so they will serve all the passengers. In the end the profits level will be two below:

$$\pi^{PP}|_{\rho_3=\beta} = 5\eta\beta - 2\mu \quad \text{or} \quad \pi^{PP}|_{\rho_3=\beta-\delta} = 6\eta\beta - 2\eta\delta - 2\mu. \quad (4.4)$$

If we compare the two profits level of a PP model and a HS model, we will obtain that

$$\pi^{PP} > \pi^{HS} \text{ if } \mu < \eta\beta \text{ and } \mu < 2\eta\delta \quad (4.5)$$

Thus, this means that for a sufficiently small cost per flight in which an airline can incur,  $\mu$ , the PP network is more profitable to use than the HS.<sup>4</sup>

### 4.3 - Entry Deterrence and Entry Accommodation

After analyzing the two profit when there is no competition, consider that there is a possibility where the firm is allowed to enter on one of the three routes (partial deregulation). Since on route 3 the HS is not operating a direct service, this route will be a great candidate for an entrant firm to start giving that service.

The incumbent firm will be denoted by I and the entrant firm by E. The entrant firm can work only in one of the tree routes. Assume that the two firms have the same costs and capacity structure. Otherwise, there will be asymmetry.

Two definitions are needed here: an airline industry is said to have an entry accommodation equilibrium if the entrant firm makes positive profits. On the other hand, an entry deterrence equilibrium is the case in which the entrant cannot make a positive profit, and thus, for sure, it will be negative.

First of all, it is necessary to declare that: on each route, the number of passengers is large enough relatively to the cost of operating a flight, thus  $\mu < 2\eta\delta$  and  $\mu < \eta\beta$ .

This presumption drives back to (4.5), hence meaning that a PP network is more beneficial than an HS network if there is no threat of entrants.

- Entry deterrence: in this case, the incumbent firm that is operating a PP network decides to restrain totally the competitor from entry, without thinking if this action would be profitable

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<sup>4</sup> Shy, Oz, and Shy Oz. *The economics of network industries*. Cambridge University press, 2001.

or not for itself. In order to realize this, the prevailing firm will lower the price until it reaches the costs paid per-passenger  $\rho_3^I = \mu/2\eta$ . Therefore, entrance will be blocked since in order to enter the firm E will have to set its price lower than the costs. Thus, he will earn no profits, actually he will have losses. Specifically, the price set by the company will be  $\rho_3^E < \mu/2\eta\beta$  and the profits will be  $\pi^E = 2\eta\beta\rho_3^E - \mu < 0$ , indeed it will obtain negative profits. In the end, since there is no competition, the firm I can set its price equal to the one as if he was a monopolist. Thus, it will be  $\rho_1^I = \rho_2^I = \beta$

Hence the incumbent firm will have the dominance on all the routes because there are no threat of entrants, leaving him with the profit that is

$$\pi^I = 4\eta\beta + 2\eta\rho_3^I - 3\mu = 4\eta\beta - 2\mu. \quad (4.6)$$

The other case is when the incumbent firm is using a hub-and-spoke network structure. Hence, he is not operating on route 3 with a direct flight. In order to hold back any new entrant firm, he will have to set the price equal to  $\rho_3^I = \mu/2\eta - \delta$ . This because it is the lowest price they can charge in order to keep away an entrant that will set the price equal to  $\rho_3^E = \mu/2\eta$ , and it is useful in order to balance the higher value of time for passengers for which time is worth since they are flying indirectly. Since with the HS model it holds the rule for passengers for whom destination or origin is the hub, they cannot purchase the ticket for route 3, thus the prices for the other two routes will be  $\rho_1^I = \rho_2^I = \beta$  and the incumbent will earn

$$\pi^I = 4\eta\beta + 2\eta\rho_3^I - 2\mu = 4\eta\beta - 2\eta\delta - 2\mu. \quad (4.7)$$

- Entry Accommodation: in this other situation, the PP network structure cannot be used since both the firm I and the firm E are providing a direct flight on route 3, thus they are providing an equal service. Therefore, this condition generates high competition and will leave the entrant firm with zero or negative profits. For this reason, suppose that the firm E is operating a HS network. Incumbent firm can permit entry in two different ways.

First, the firm I can cease to operate on route 3 and so the incumbent firm will earn a profit

$$\pi = \pi_1 + \pi_2 = 4\eta\beta - 2\mu \quad (4.8)$$



Second, the incumbent company can allow for a partial entry accommodation. Thus meaning that they will split passengers: incumbent firm will serve passengers with a low value of time and it will transport them via a hub since they will be happy anyway; while the entrant firm, that is operating a PP network, will serve the passengers with a high value of time since they won't travel via a hub.

Now, we are calculating an Undercut-proof equilibrium<sup>5</sup> (UPE), that is the pair of airfare prices ( $\rho_3^I, \rho_3^E$ ), where firm I can set the highest price without causing firm E equilibrium profit level to be smaller than E's profit level when it undercuts  $\rho_3^E$ . Thus, to prevent firm E from undercutting  $\rho_3^I$  and obtaining firm I's consumers. And this will also hold, vice versa, for firm E.

The two airfares on route 1 and route 2 will always be  $\rho_1^I = \rho_2^I = \beta$ . Therefore, under UPE, the entrant sets max  $\rho_3^E$  subject to

$$\pi^I = 4\eta\beta + \eta\rho_3^I - 2\mu \geq 4\eta\beta + 2(\rho_3^E - \delta) - 2\mu \quad (4.9)$$

Formally, the airfare for route 3 will be subject to the incumbent airline that is serving only  $(4 + 1)\eta$  passengers and it is not convenient for him to undercut the firm E's profits by lowering its price to  $\rho_i^{I'} = \rho_3^E - \delta$  to ensure himself all the  $6\eta$  passengers. On the other hand, the incumbent firm will maximize its airfare  $\rho_i^{I'}$  to

$$\pi^E = \eta\rho_3^E - \mu \geq 2\eta\rho_3^I - \mu \quad (4.10)$$

Specifically, the entrant firm will prefer to serve only  $\eta$  passengers for which time is worth instead of undercutting the incumbent price to get all the passengers by setting  $\rho_3^{E'} = \rho_3^I$ .

Solving (4.9) and (4.10) we obtain

$$\rho_3^I = \frac{2\delta}{3} \quad \text{and} \quad \rho_3^E = \frac{4\delta}{3} - \mu \quad (4.11)$$

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<sup>5</sup> Shy, Oz, and Shy Oz. *The economics of network industries*; pag. 309 -310. Cambridge University press, 2001.

From (4.11) is clear that  $\rho_3^E > \rho_3^I$  because the entrant operates with a PP network thus it provides a direct flight without the stop at the hub. Replacing the two prices into the functions in (4.9) and (4.10) produces

$$\pi^I = 4\eta\beta + \frac{2\eta\delta}{3} - 2\mu \quad \text{and} \quad \pi^E = \frac{4\eta\delta}{3} - \mu \quad (4.12)$$

So, in the end, comparing (4.8) and (4.12) it is evident that the incumbent firm will make a higher profit by not stopping to serve entirely the route 3 but dividing the passengers with the entrant firm.

Furthermore, making a comparison between (4.6) and (4.12) it is noticeable that, when there is a threat of entry, the incumbent firm finds entry accommodation under HS network to be better off for herself since it's gaining higher profits than entry deterrence through a PP network.

In the final analysis, comparing (4.7) and (4.12) proves that, if the passengers on each route exceeds a certain number, under partial deregulation, the incumbent company finds entry accommodation better than entry deterrence. In the final analysis, it is possible to state that the deregulation of the airline industry induces company to switch from PP network to HS network.

## **Ch. 5 - Conclusions**

Deciding between the two network is really personal and there is no right or wrong choice. Everything depends among many factors that can affect the decision.

### **5.1 - Final Word**

To conclude it is possible to say that the deregulation of the market of the airline companies has meant a big turning point in this sector: introducing the hub-and-spoke system. But when the LCC came into the market, they decided to operate a point-to-point network. These airlines had a great economic success and lead many FCC to add new routes and rethink their network.

So, while HB carriers are seeing mediocre profits, the PP carriers had a perspective of great profits. Therefore, it can be easily state that the future for short-haul travel is a shift to point-to-point networks, but in terms of long-haul the future is uncertain.

Air travel continues to grow at an astonishing rate, and it is becoming a cliché more than ever, but this growth hides the fact that we are in a period of significant changes. Last decade has been profitable due to a large variety of factors, including carrier consolidation. A global reduction in flights has been mismatch by a growth in available seat-kilometers deriving from a large number of seats in each plane and longer flight stages. Today, the hub-and-spoke routing, that has dominated the industry for decades, is under pressure.

Looking into papers and essays about this subject that I read, it could be state that there will be a development in the long-distance routes of the point-to-point structure. Nowadays, the hub-and-spoke airlines such as Lufthansa and British Airways, who fly with large aircraft, are those who dominate transcontinental travels. But, a new breed of regional jets added potential to the increase in the point-to-point system and they are focused on boosting passenger comfort while reducing environmental impact, a really important topic in our time. As a matter of fact, the ultra-large aircrafts produced by Airbus and Boeing are having trouble in the market, while smaller long-range jets are seeing a sharp rise in orders. The Boeing 787 Dreamliner has reduced the seat per kilometer costs, and this allowed the PP carriers to emerge. For example, when Norwegian Air Shuttle received the Dreamliner aircrafts has started serving further destinations than the closer ones, such as Oakland and

Las Vegas. This company is seeing a big boost in the number of passengers and they are establishing themselves in the market at an increasing pace. Moreover, in the end, it will not be astonishing if, in the near future, many new routes will open from secondary and smaller airports avoiding the bigger and capacity-constrained ones, like John Fitzgerald Kennedy Airport in New York or Heathrow in London.

## **5.2 - Future perspectives of the Airline Industry**

Last but not least, on the study demanded by IATA's Industry Affairs Committee and developed by the School of International Futures, there are outlined the pivotal risks and opportunities that the Airline Industry could deal with between now and 2035. It studies the external forces that can affect, directly or indirectly, aviation's future.

The conclusions extrapolated are based on the analysis of material from different sources: the study of the four scenarios, seminars held with over 50 companies, interviews, government, and more.

As already mentioned, in the study there are exposed four possible scenarios (new frontiers, sustainable future, resource wars, and platforms) making comparisons between 11 different themes that affect the airline industry (geopolitics, security and borders...) and they foresee different outcomes for the world. In order to create these, they needed to make assumptions on how the world may change between now and then. One explores the eastward shift of power, another sees the world prospering through successful sustainability, a third predicts a war over resources and the final assesses a world dominated by elite agendas. The research exasperates the four scenarios even though they are not predictions of what will happen for sure in the future, but they allow to consider a range of possible implications for the airline sector and to articulate some recommendations.

Some of these advices can be investments in alternative fuels to strengthen the companies' global public reputation that is important for a sustainable future. The study elaborated is needed to achieve a cleverer regulation framework to deliver greater harmonization, but this, undoubtedly, won't happen in a short term and it is necessary to encourage a dialogue with a plurality of government departments and institutions. The major effort should be

made when we talk about emerging countries and regions that are imposing their supremacy. It is essential to ensure a balanced dialogue in global discussions. Moreover, the important point is to share information with actors from outside the aviation sector that can be helpful to understand changes in social attitudes and economic factors. Another prediction is that airports could get smaller since resources' costs will rise. But what the study recommend is to ensure airline needs as a number one priority taking a more integrated approach to infrastructure development. Hence this happens because airports are no longer seen as a point for departure and arrival, but as passengers are waiting for their flight, they can have any kind of leisure. Thus, investments can improve the flight and airport experience, boost passenger flows and connection to airports in big cities. These trends will suggest then that airports will get bigger and not smaller. This would be helpful for the development of the hub-and-spoke network structure that indeed need good infrastructure to work at its best. Getting the air terminals to work better, companies will boost their customer relationship. Moreover, it is central for firms to take advantage of their strengths such as being a trustworthy airline company.

The only truth recognized in the study is that 2035 will be completely diverse from the present and that *"there is no last word on the future"* but the research can help airline strategies to be modified and adapted to alterations in the main drivers of change that can affect the companies. The advices given in this research, as the paper sets out, are not all relevant and fundamental for every airline company. It will be crucial for the companies to do their own thinking and build their own perspective.

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