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# Airline competition and network structure

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ABSTRACT

This paper studies airline networks and their welfare implications in an unregulated environment. Competing airlines may adopt either fully-connected (FC) or hub-and-spoke (HS) network structures; and passengers exhibiting low brand loyalty to their preferred carrier choose an outside option to travel so that markets are partially served by airlines. In this context, carriers adopt *hubbing* strategies when costs are sufficiently low, and asymmetric equilibria where one carrier chooses a FC strategy and the other chooses a HS strategy may arise. Quite interestingly, flight frequency can become excessive under HS network configurations.

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## 1. Introduction

Before the deregulation of the airline sector (that took place during the 1980s in the US and during the 1990s in Europe), carriers faced constraints in fares and route structures and competition was concentrated in service quality (flight frequency). The deregulation introduced a new source of competition focused on airfares. In this new competitive environment with fares determined by market forces, carriers also became free to make strategic network choices. The success of hub-and-spoke structures in the years following the deregulation led to a concentration of traffic on the spoke routes producing an increase of flight frequency, as documented in Morrison and Winston (1995) and commented in Brueckner (2004).[1]

Brueckner and Flores-Fillol (2007) (hereafter BF) present a simple duopoly model of schedule competition in a single market, where airlines compete both in fares and scheduling decisions. This dual-competition pattern is studied in a setting that captures the most important elements characterizing the airline sector after its deregulation. Nevertheless, the analysis needs to be completed to allow for network choices in a multi-market framework. The wide-ranging network reorganization observed after the deregulation with the adoption of *hubbing* strategies, supports the idea of introducing this element into the analysis.

Thus, in an unregulated context where carriers may organize their networks either fully-connected (FC) or hub-and-spoke (HS), this paper aims at applying the simple duopoly model of schedule competition introduced by BF to capture optimal network choices and analyze their welfare implications. The comparison between the two network categories is studied in Brueckner (2004) for the monopoly case and we extend this analysis to a duopoly setting.

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[1] Morrison and Whinston showed that a route-weighted measure of flight frequency rose by 9.2% between 1977 and 1983, generating passenger benefits in excess of $10 billion per year.

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In its modeling, this paper includes both demand and supply *network effects* because each network configuration will affect differently passengers' utility and airlines' cost structure. We try to capture the important elements characterizing the airline sector after its deregulation. Airlines compete in airfares and scheduling decisions, travelers exhibit *brand loyalty* (i.e., they have a utility gain from using a particular airline) and markets can be partially served by airlines. In addition, cost per seat realistically falls with aircraft size, capturing the presence of *economies of traffic density* (i.e., economies from operating a larger aircraft) that are unequivocal in the airline industry.

In fact, brand loyalty is an important element of the airline industry, especially since the proliferation of frequent-flyer-programs and worldwide alliances (although brand loyalty may also reflect idiosyncratic consumer preferences for particular aspects of airline service that may differ across carriers). In this framework, the possibility of having partially-served markets by airlines (or uncovered markets by airlines) is achieved by introducing in the analysis an outside option that can be interpreted as an alternative transport mode such as automobile, train or ship. In this way, passengers with low brand loyalty do not undertake air travel and make use of the outside option. Differently from BF, there is single group of passengers and the relevant margin of choice (either airline/airline; or airline/outside option) is determined endogenously depending on the cost of the outside option relative to the frequency–airfare pair offered by each carrier.[2]

Thus, the originality of the present paper lies in putting together the elements in BF and Brueckner (2004) that constitute the building blocks of the unregulated airline sector, in a way that carriers are free to make strategic network choices in a competitive context where city-pair markets may be uncovered by airlines. Under this specification, the aim of the paper is twofold. On the one hand, it attempts to gain some insight about the possible equilibria in airline networks when carriers decide between FC and HS network strategies. In this vein, the paper links fare-and-frequency choices and uncovered markets with the network structures arising in equilibrium. On the other hand, the paper provides a welfare analysis so as to assess the possible equilibrium results obtained under the different network specifications.

Our main findings can be summarized as follows. In a framework where transport costs are sufficiently low, carriers adopt hubbing strategies, as happened following the deregulation of the industry. As costs increase, economies of traffic density weaken and airlines' incentives to pool passengers from several markets into the same plane vanish. Consequently, FC structures occur in equilibrium when costs are sufficiently high. In addition, asymmetric configurations where one carrier chooses a FC strategy and the other chooses a HS strategy may arise without introducing any explicit asymmetry (neither in costs nor in demand parameters). This result captures the actual coexistence of alternative network strategies in the airline industry.

The analysis of the social optimum reveals that frequencies characterizing FC network structures are suboptimal, confirming the results in BF and Brueckner (2004). This finding seems to be accurate in a single-market setting but not in the current unregulated environment where most carriers organize their networks in a HS manner.

Quite interestingly, flight frequency can become excessive under HS network configurations when markets are partially served. This outcome differs from the monopoly results in Brueckner (2004)[3] and constitutes an explanation to the apparent overprovision of frequencies in the current airline unregulated environment, which is closely related to the adoption of hubbing strategies (that caused an increase in flight frequencies). As suggested before, although the deregulation might have been expected to cut frequencies, exactly the opposite occurred leading to a concentration of traffic on the spoke routes and to an increase of flight frequency (which were widely viewed as excessive).[4] We find out that this process could generate an overprovision of frequencies, a result that is in line with Brueckner and Zhang (2001). Thus, when airlines adopt HS configurations and there is an outside option, frequencies may become excessive due to their strategic interaction in the market (this result is like a prisoner's dilemma).

A couple of interesting related papers are Berechman and Shy (1996) and Kawasaki (2008). These two papers consider a monopoly carrier choosing network structure, flight frequency and fares and assume that passengers gain an extra benefit when flying FC because of time reduction. Equivalently, Brueckner (2004) adds a disutility parameter into the travelers' utility when trips are HS. We do not incorporate this realistic assumption into our model because the results would remain qualitatively equivalent with the exception that the equilibrium areas where carriers operate HS become smaller, at the cost of introducing a new parameter that complicates the analysis. In a different setting to the one we assume, these papers conclude that airlines adopt HS networks when operating costs are small, whereas they adopt FC networks when operating costs are high. These findings about network structure are in line with the results we obtain in this paper. Furthermore, Kawasaki (2008) differentiates between leisure and business passengers depending on their respective time value.

There are some other previous contributions to the analysis of airline networks that mostly focus on the phenomenon of hubbing, that became an issue in the airline sector after the deregulation when airlines started to pool passengers from several markets into the same plane. In this vein, Oum et al. (1995) find out that hubbing reduces costs and is typically a dominant strategy for carriers. From a more general approach, Hendricks et al. (1999) show that HS networks are likely to arise when carriers do not compete aggressively. Barla and Constantatos (2005), in a setting where each airline decides on its capacity under demand uncertainty, observe that HS networks help the firm to lower its cost of excess capacity in the case of low demand and to improve its capacity allocation in the case of high demand. Finally, with a numerical example, Alderighi et al. (2005) suggest the possibility of asymmetric equilibria when the size of the internal markets is large.

[2] In BF there is an exogenous proportion of high and low-type passengers depending on their valuation of travel. High types choose between the two carriers and low types choose between their preferred airline and an outside option.

[3] In Brueckner (2004), frequencies are suboptimal both under FC and HS networks.

[4] See Douglas and Miller (1974).

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