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Price competition of airports and its effect on the airline network

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ABSTRACT

This paper deals with the price competition between airports and its effect on airline (carrier) networks. We construct a model that includes the following two features: (i) the carrier can choose its network configuration (point-to-point or hub-spoke) and (ii) airport operators can compete for airport charges by considering the carrier's choice. By utilizing this model, we address the question of how airport competition affects the carrier's network choice. The results show that the price competition of airports forces the carrier to choose an airport at a relatively small city as the network hub. Furthermore, the private operation of airports disturbs the formation of a hub-spoke network.

1. Introduction

In recent decades, liberalization of the aviation industry has been practiced through airport privatization, airline deregulation, and “Open Skies” agreements. Airport privatization has caused airport operators to focus on the profits from their airports more significantly than before such privatization, while airline deregulation and Open Skies agreements have loosened constraints on carriers' network choice. Observing these several changes in the aviation industry, Graham (2008) claims that carriers consider low airport charges as a key factor in their decisions regarding the airports to which they will provide flight services. This indicates that airport operators may have incentives to discount their airport charges in order to be selected as a flight destination or a hub airport. In fact, Kuala Lumpur International Airport (KUL) introduced a discount program in which landing fees for new routes and increased frequencies are discounted 100% for three years. This KUL program has a significant effect on the carriers' network choices[2]: for example, in 2013, Turkish Airlines launched direct flight service between KUL and Istanbul instead of the former one-stop service via Bangkok. This shows that operators can induce the carrier to form a favorable network for them by discounting their charges.[3] In this paper, we focus on the following issues: (i) whether airport operators discount their airport charges; (ii) if so, when does price competition between airports occur? By dealing with these questions, we investigate the problem of how such discounts and competition affect network structures.

After the seminal works of Starr and Stinchcombe (1992) and Hendricks et al. (1995), several studies have focused on the carrier's network choice (for example, Brueckner, 2004; Kawasaki, 2008; Flores-Fillol, 2009).[4] More specifically, these papers focused on the carrier's tradeoff between the hub-spoke and point-to-point networks, namely the scale economy of the hub-spoke network (density and distance economies) and the additional operating costs for providing connecting flights. Although Graham (2008) claims that the airport operators' choices are additional key determinants in the network choice of carriers, these papers ignore the behavior of operators.

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[2] Indeed, as a result of this program, KUL has experienced a significant increase in the number of passengers (from 21 million in 2004 to 40 million in 2012), which is much faster than Singapore Changi Airport and New Bangkok International Airport.

[3] Consequently, the price competition among airports is observed in several regions. In East Asia, for example, Narita International Airport (NRT) cut its charges in 2013 to enforce competitive power against Incheon International Airport, which offers lower airport charges to carriers than NRT.

[4] Brueckner (2004) analyzes the topic using three airports and a monopolistic carrier model. The carrier chooses a hub-spoke network when the fixed cost for a flight is high relative to the marginal cost for a seat and when passengers place a high value on flight frequency. Kawasaki (2008) extends the model of Brueckner (2004) by introducing the heterogeneity in value of time among passengers, leisure, and business demands. Flores-Fillol (2009) extends the model by considering the duopoly case and shows that asymmetric equilibria may arise, namely one carrier chooses a point-to-point network while the other chooses a hub-spoke network.

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In addition, the pricing policy at airports itself is another topic that is drawing attention (Oum et al., 1996; Brueckner, 2002; Pels and Verhoef, 2004; Zhang and Zhang, 2006; Morimoto and Teraji, 2013). These studies that deal with the pricing policy presume the carrier's network is fixed, and focus on its direct effect on the hinterland's welfare. The airport pricing policy, however, may indirectly affect the welfare of its hinterland through the change in the carrier's network.[5] To capture this effect, it is important to focus on competition among airports, and this type of competition has also been studied. Most of studies in this strand (Pels et al., 2000; De Borger and Van Dender, 2006; Basso and Zhang, 2007; Mun and Teraji, 2012) focus on competition between airports in a relatively small region (for example, airports in a metropolitan area). Therefore, the carrier's network choice, point-to-point or hub-spoke, is not considered. Competition in a relatively large region (for example, airports in multiple countries) is studied in Matsumura and Matsushima (2012) and Czerny et al. (2013). These studies deal with competition between countries for the infrastructure operation, but the carrier is not allowed to choose its network configuration.

We establish a model that enables us to investigate the interaction between airport competition and the carrier's network choice. Specifically, we focus on multiple airports that are competing in a specific region: for example, the airport competition between Narita International Airport and Incheon International Airport in the East Asian region. The monopoly carrier provides international flight services from a continent, for example, East Asia, to another continent such as the United States or Europe. When providing the service, the carrier chooses one of two networks: (i) it directly connects all airports in a region with the final destination (point-to-point) or (ii) it directly connects one of the airports in a region (the hub) to the final destination and provides connecting flights between the hub and the other airports (hub-spoke). In the model, the airport operators first set their airport charges and second, the carrier decides its network configuration. Therefore, each operator considers the carrier's network choice in setting the charges. By employing this model, we deal with the question of how the price competition among airports distorts the carrier's network choice. In addition, through the analysis, we also show the distortion by the private operation of the airports.

The remainder of the paper is organized as follows. Section 2 describes the model while Section 3 focuses on the optimal network, which is the reference for the comparison with the equilibrium network. Section 4 derives the equilibrium network in which airport operators compete via airport charges, and Section 5 evaluates the welfare effect of airport competition by comparing the equilibrium network with the optimal one. Finally, Section 6 provides some concluding remarks.

2. The model

2.1. The basic setting

Suppose that an economy consists of two cities: Cities 1 and 2. Residents in each city travel to the foreign country in another continent using the airport at their residence. We assume that each airport is operated by a private firm, and we call operator i the one who manages Airport i. A monopoly carrier provides the intercontinental air service from these two airports to the foreign country. When providing the intercontinental air service, the carrier makes a network choice (point-to-point or hub-spoke). The carrier also determines which airport would be the hub if it chooses the hub-spoke network. Fig. 1 summarizes the three possible network configurations. In Fig. 1, network P is the point-to-point while network H_i corresponds to the hub-spoke case in which Airport i ($i=1, 2$) is the hub. Moreover, note that l_{12} and l_{iF} in Fig. 1 represent the distance between Airports 1 and 2, and the distance from Airport i to the foreign country, respectively. In addition, we assume that $l_{12} < l_{iF}$, and we normalize the distance between Airport 1 and the foreign country to unity, $l_{1F}=1$.

Our model has three types of economic agents, the two airport operators, the monopoly carrier, and households. These three types of agents determine their choices in the following sequence. First, two airport operators simultaneously set their respective airport charges. At the second stage, given the choices of airport operators, the monopoly carrier determines its network configuration, N, and airfares for users at the two airports, p_i. Finally, the households in each city decide whether to travel to the foreign country from the airport near their residence.

We assume that intercontinental air service demand is inelastic. That is, households in each city travel to the foreign country once unless the airfare, p_i, exceeds the reservation price. In addition, all households have a common value of the reservation price, and it is normalized to unity. Therefore, the aggregate demand for the international air service at City i is

$$d_i(p_i) = \begin{cases} n_i & \text{if } p_i \le 1, \\ 0 & \text{otherwise}, \end{cases} \tag{1}$$

where n_i is the population of City i. To simplify the analysis, we normalize the total population of the economy n_1+n_2 to one. In addition, n denotes the population of City 1, and, without loss of generality, we limit our focus on the case where $1 > n > 1/2$. In the following subsections, we describe the carrier's network choice and the behavior of airport operators.

2.2. The carrier

When providing the air service, the carrier must incur three types of costs: the operating cost, the airport charge payment, and the fixed cost for handling the direct flight. We assume that the operating cost is proportional to passenger kilometers and that airport charges are paid on a per-passenger basis. In addition, we assume that the fixed cost is solely generated from the direct flights to the foreign country. This fixed cost can be interpreted as the airport charge at the foreign country or as the cost related to the long haul flights.[6] In summary, the carrier's total cost, $C(N; \mathbf{a})$, under network N ($N=P, H_1, H_2$) is given by

$$C(P; \mathbf{a}) = \sum_{i=1}^{2} c l_{iF} n_i + \sum_{i=1}^{2} a_i n_i + 2F, \tag{2.1}$$

$$C(H_i; \mathbf{a}) = (c l_{iF} + c l_{12} n_j) + [a_i(1+n_j) + a_j n_j] + F, \quad \text{for } i = 1, 2, j \ne i, \tag{2.2}$$

where c, a_i, and F represent the operating cost per passenger kilometer, the airport charge per passenger at i, and the fixed cost for handling the direct intercontinental flights. In equations (2), the first term of the RHS is the operating cost, the second term is the airport charge payments, and the third term is the fixed cost. Also note that these equations show that the carrier can save the

[5] Congestion and the carrier's network choice are studied in Fageda and Flores-Fillol (2013). However, they deal with the effect of the carrier's network choice on congestion.

[6] This fixed cost includes the cost for additional crews (pilots and flight attendants) in order to provide a daily flight to each of the long haul routes. For example, Japanese airlines allocate at least two sets of crews for each intercontinental route, such as Tokyo to London and Tokyo to New York City.