An Analysis of Airport Pricing and Regulation in the Presence of Competition Between Full Service Airlines and Low Cost Carriers*

Xiaowen Fu**, Mark Lijesen,*** and Tae H. Oum**

*Corresponding Author: Tae H. Oum
E-mail: tae.oum@sauder.ubc.ca; 1-604-822-8320
cc. Xiaowen Fu, xiaowen.fu@sauder.ubc.ca

* This paper was presented at the 2005 Annual Conference of the American Economics Association’s Transportation and Public Utilities Group in Philadelphia (7-9 January, 2005). The authors would like to thank the participants at the AEA-TPUG session, Tokyo University, Kyoto University and National University of Singapore for their helpful Comments and suggestions for improvement. Tae Oum acknowledges gratefully the pleasant research environment provided by the Graduate School of Economics, Tokyo University while he was a visiting professor during the time he was working on this paper, and the research grant support of the Natural Science and Engineering Council of Canada.

** Sauder School of Business, The University of British Columbia, Vancouver, Canada

*** CPB Netherlands Bureau for Economic Policy Analysis; M.G.Lijesen@cpb.nl
An Analysis of Airport Pricing and Regulation in the Presence of Competition Between Full Service Airlines and Low Cost Carriers

Xiaowen Fu*, Mark Lijesen,** and Tae H. Oum***

Abstract

Despite the airport privatization and deregulation trend in recent years, whether or not the privatized or commercialized airports should be left unregulated is still an open question. Related to this issue, one question that has received little attention to date is if and how pricing behavior of unregulated airports affect downstream airline competition, especially the competition between airlines offering differentiated services such as the case of full service airlines (FSA) vis-à-vis low cost carriers (LCC). If the upstream monopoly (airport) hinders downstream (airline) competition, the welfare effects of the upstream unregulated monopoly may be much larger than initially suspected. This aspect of airport pricing has not been formally incorporated in the debate on airport price regulation.

In this paper, we study a duopoly model to capture the differential competitive effects of changing airport user charges on FSAs and LCCs. By making reasonable assumptions on differential price elasticities, unit costs and competitive behavior as manifested by firm-specific conduct parameters, we perform numerical simulations to measure differential effects on an FSA and an LCC of increasing airside user charge by an unregulated upstream monopolist airport.

Our analytical and numerical results suggest existence of the asymmetric effects of an airport’s monopoly pricing on LCC and FSA. That is, LCCs suffer more from an identical cost increase than FSAs and are, therefore, more vulnerable to monopolistic pricing practices of an unregulated airport. This implies that unregulated airport pricing would reduce the extent of competition in downstream airline markets, and thus, cause a further detrimental effect on welfare over and above the first-order dead weight loss of airport’s monopolistic pricing. Considering that LCCs have brought considerable reduction of average fares and the associated welfare gains, it is important for the governments to take into account of these asymmetric effects of increasing airport user charges on FSAs and LCCs when they consider the form and extent of regulation or deregulation.

Although our model and simulation work deal specifically with the effect of airport pricing on downstream airline markets, our framework of analysis may be applicable to analysis of any policy affecting costs of FSAs and LCCs including security levies as well as potentially adaptable to other upstream-downstream industry cases.

* Sauder School of Business, The University of British Columbia, Vancouver, Canada
  xiaowen.fu@sauder.ubc.ca
** CPB Netherlands Bureau for Economic Policy Analysis; M.G.Lijesen@cpb.nl
*** University of Tokyo, Japan, and The University of British Columbia, Vancouver, Canada
  tae.oum@sauder.ubc.ca and
An Analysis of Airport Pricing and Regulation in the Presence of Competition Between Full Service Airlines and Low Cost Carriers

Xiaowen Fu, Mark Lijesen, and Tae H. Oum

1. Introduction

The competitive effects of input price increases form an important research and policy topic for two reasons. First, lacking upstream competition may influence downstream competitiveness and reduce welfare. Secondly, markets with volatile input prices may be prone to effects on downstream competitiveness as well. Both features are clearly present in aviation, where airports with market power provide indispensable inputs to airlines.

This subject is primarily important for the regulation of privatized airports. Starting with the privatization of the three airports in the London area (Heathrow, Gatwick, and Stansted) and four other airports in the UK to BAA plc. in 1987, many airports around the world have already been or are in the process of being privatized. The majority stakes of Copenhagen Kastrup International Airport, Vienna International Airport and Rome’s Leonardo Da Vinci Airport have been sold to private owners. Many other European airports are in the process of being privatized. Auckland International Airport and Wellington International Airport in New Zealand and a large number of major Australian airports have been privatized as well. South Africa, Argentina, Mexico and many Asian countries including Japan are also considering privatizing their airports.\(^1\) Canada is currently reviewing the regulatory oversight issues on its local airport authorities which were set up as not-for-profit corporations to manage major airports.

Since the late 1990s economists have been arguing whether privatized airports need to be regulated in the first place. Studies on country-specific options and experiences on this issue include Forsyth (1997, 2002a, b), Beesley (1999), Starkie and Yarrow (2000), and Starkie (2001). In particular, Beesley (1999) argues that the price-cap regulation is inappropriate, particularly in the case of London’s Heathrow. Starkie (2001) further concludes that ex-ante regulation for airports might be unnecessary because the airports are unlikely to abuse their monopoly power due to the existence of complementarity between the demand for aviation services and the demand for concession and other commercial services (concession).\(^2\)

Indeed, some countries have moved towards a situation in which there is no formal price regulation but only monitoring of privatized airports (Forsyth, 2002b). For example, New Zealand and Australia do not formally impose any price regulation on their privatized airports. Instead, since 1988, Auckland, Christchurch and Wellington airports have been required to disclose contractual terms, financial reports and some performance measures. In Australia, primarily based on the recommendation of the Productivity Commission (2001), on 1 July, 2002 the government ended the price-cap regulation on all privatized airports for a period of

---

1 See Hooper (2002) for the list of Asian airports that are being considered for privatization.
2 Besides ex-ante regulation (ROR, price-cap), there is also ex-post regulation (conduct regulation). It is important to point out that those economists who argue for deregulation usually have the former in mind and are not proposing that conduct regulation be abolished also.
Towards the end of the five-year test period an independent review will be conducted in order to decide whether or not some sort of price regulation on the airports need to be re-established.

There are some evidences to suggest that the airports attempted to raise prices after deregulation, and interested parties have had considerable concerns that airports may abuse their market power. Three regulatory reviews were conducted in New Zealand after the 1988 deregulation, the last of which started in May 1998 and took five years to finish. In Australia, Virgin Blue applied to the Australian Competition Tribunal to declare airside services at the Sydney Airport as commercial services to be treated according to the Trade Practices Act of Australia (TPA). The Declaration of the airside services at the Sydney Airport under the TPA would force the Sydney Airport’s management to negotiate with the airlines before setting new fees or changing existing levels of airside service fees including aircraft landing charges. In case there is a major disagreement between the airport and the airlines, then the matter is referred to a binding arbitration by the Australian Competition and Consumer Commission (ACCC). Virgin Blue, a major LCC in Australia, believes that Sydney Airport under the current system has the ability and incentive to increase airside service charges substantially, and thus harm Virgin Blue’s ability to compete. Interestingly, Virgin Blue’s major competitor, Qantas Airlines, supported the Declaration Application.

The subject of the research treated in this paper has been motivated by our involvement in the Virgin Blue vs. Sydney Airport case before the Australian Competition Tribunal. This paper reports some analytical results we obtained during our investigation for the case. In particular, we analyze how an increase in airport charges would affect the downstream airline competition, especially when competing airlines offer differentiated products (services) in the market place such as the case of competition between low cost carriers and full service airlines. A duopoly model with differentiated products is used to obtain analytical results. Due to strict confidentiality restrictions on the rich data to which we had access, however, we are not able to report empirical results obtained from using real market data. Instead, a numerical simulations and sensitivity tests on key parameters of our model are used to validate our analytical results on the differential effects of an identical increase in airside service charges on FSAs and LCCs.

Although we focus our analysis on air transport industry, our approach to analysis is likely to have a wider application to other industries and markets where a monopolist provide an essential input to competing firms in downstream markets. Other network-oriented industries such as railroads, seaports, electric power, and telecom (last one-mile to homes and offices) industries have limited competition in upstream markets due to the natural monopoly nature of these networks. The third party access pricing issue has been an important research topic in some of such network sectors, notably in telecommunication and energy networks. The third party access to the network is an important condition for effective competition in network sectors. The third party access refers to both the possibility of access and the conditions under

---

3 At the same time, the Parliamentary Secretary to the Treasurer directed the Australian Competition and Consumer Commission (ACCC) to undertake formal monitoring of prices, costs and profits (Price Monitoring) related to the supply of aeronautical services and related services at seven major airports: Adelaide, Brisbane, Canberra, Darwin, Melbourne, Perth and Sydney airports.

4 See, for instance Laffont et al. (1998), Lewis and Sappington (1999) and Granderson (2000)
which the access can take place. One important condition is the price under which access is granted, i.e., the access fee.

The remainder of this paper is organized as follows. Section 2 discusses theoretical derivation of the impact of an identical increase in input cost (e.g., airport’s airside service fees) on competition in the downstream airline markets. A numerical simulation and results are presented in section 3. The final section concludes and discusses the results.

2. Effects of Increase in Airport Charges on Competition in Downstream Airline Markets

As airports provide essential inputs to airlines, it follows immediately that when the airport charge is increased above socially optimal level (competitive level), air travel volume will be reduced below socially optimal level, leading to a welfare loss. This issue has been extensively studied in the literature of double marginalization and natural monopoly regulation. However, so far the impact of airport charges on downstream airline competition has received little attention. Even less attention has been given to the impacts of changing airport charges on the competition between Full Service Airlines (FSAs) and Low Cost Carriers (LCCs).

This problem is worth a scrutiny since LCCs’ activities have been more sensitive to airport charges. Many LCCs around the world actually started their business by using secondary airports taking advantage of their lower airport charges and less congestion. For example, Ryanair could not have achieved such a successful service in the Dublin-London route if they had to use Heathrow airport. Also, it is well known that Southwest typically starts their operations at secondary airports in U.S. European LCCs, especially Ryanair, drive a hard bargain with airports and local business interests in order to extract best charges and service conditions. Some LCCs are apparently successful in gaining even a subsidy from the airport for an initial period of their service initiation. The agreement between Brussel’s Charleroi Airport and Ryanair was under investigation by the European Commission as the commercial assistance to Ryanair by the airport was regarded as constituting an illegal state subsidy (Piling, 2003). Ryanair paid, in average, $1 or less per passenger to eight provincial UK airports during the 1998 – 2000 period while the average aeronautical revenue at major airports in Europe were above $8 per passenger (Barrett, 2004). LCCs’ high sensitivity to airport charges is also evidenced by the fact that some LCCs chose to abandon an airport if they didn’t succeed in negotiating for a deep discount on airport charges, especially when an airport seeks to recover their investments made during its “promotional” periods. For example, Dublin, London’s Luton airport and Manchester have experienced a reduction in LCC services after revising low airport charges they offered initially (see Francis, Fidato and Humphreys (2003) and Barrett (2000)). All of these suggest that LCCs are more sensitive to the terms of airport access than FSAs. Meanwhile, LCCs have been credited as a major contributor to airline competition and air fare reduction, as documented, for example, in Dresner, Lin and Windle (1996), Windle and Dresner (1999), Lin, Dresner and Windle (2001) and Hofer, Dresner, and Windle, (2004). In particular, Morrison (2001) estimated that in 1998, the estimated savings due to actual, adjacent, and potential competition from Southwest were $12.9 billion. These savings amount to 20 percent of the U.S. airline industry’s 1998 domestic scheduled passenger
revenue and slightly more than half the fare reductions attributed to the U.S. airline
deregulation. Understanding the possible differential impacts of airport charge on LCCs and
FSAs is, therefore, of a great importance to airport regulators and airline competition policy
makers. Below, we begin our analysis by constructing a duopoly model between an LCC and
an FSA.

2.1 A Duopoly Competition Model with Differentiated Products
Most previous studies have analyzed the effect of LCC entry and competition in airline
markets without explicitly treating product differentiation between FSA and LCC. The
implicit assumption that the competitors produce a homogenous product is embedded in many
of such models and also in the reduced-form price equations often estimated by researchers.
However, the assumption of homogeneous product is not realistic for modeling the competition
between FSA and LCC. Both FSA and LCC offer multiple products in the market. FSAs
typically offer a combination of first class and business class, full fare economy, shallow
discount, and a fair amount of deep discount services. Although LCCs are well known for
selling cheap deep discount tickets, they also offer increasingly flexible services comparable to
full fare economy and shallow discount tickets being sold by FSA. As such, FSAs and LCCs
may be regarded as offering homogenous products in the lower end of the market segments,
but overall FSAs offer a superior product compared to LCC with higher costs. Previous
studies such as Richards (1996) and Windle and Dresner (1999) confirm that LCCs in general
target more price sensitive travelers with inferior services. In addition, LCC and FSA may
behave differently in market competition, as evidenced by their different strategies found in
many previous pricing studies. Therefore, explicitly considering product differentiation and
firm conduct are crucial for the evaluation of any change in external conditions such as
changes in input prices, taxes, security charges, etc.

To analyze the competition between an FSA and an LCC taking into account of the product
differentiation formally, we construct a differentiated duopoly model similar to those used by
Dixit (1979) and Singh and Vives (1984). Throughout this section, we designate the FSA as
firm 1 and the LCC as firm 2. These two firms face the following respective inverse demand
functions.

$$\begin{cases}
    p_1 = a_1 - b_1 q_1 - k q_2 \\
    p_2 = a_2 - k q_1 - b_2 q_2 
\end{cases}$$

(1)

which correspond to a representative consumer maximizing a quadratic and strictly concave
utility function $U(q_1, q_2) = a_1 q_1 + a_2 q_2 - \frac{1}{2}(b_1 q_1^2 + 2kq_1q_2 + b_2 q_2^2)$. The concavity condition
implies $b_1 b_2 - k^2 > 0$. The demand function can be rewritten as:

$$\begin{cases}
    q_1 = \frac{1}{b_1 b_2 - k^2}[(a_1 b_2 - a_2 k) - b_2 p_1 + k p_2] \\
    q_2 = \frac{1}{b_1 b_2 - k^2}[(a_2 b_1 - a_1 k) + k p_1 - b_1 p_2] 
\end{cases}$$

(2)
The condition of positive output quantities for both firms implies:

(3) \((a_1b_2 - a_2k) > 0\) and \((a_2b_1 - a_1k) > 0\)

The stylized demand functions can be depicted as in figure 1, based on our empirical knowledge on FSA and LCC markets:

**Figure 1. Stylized Demand System**

Since LCCs focus on price-sensitive customers, they face more price-elastic demand. Utilizing the fact that, in general, a change in a firm’s price impacts more on quantity of its own product than on quantity of the substitutes (competitor’s output), the following additional constraints can be imposed:

\[
\begin{align*}
(4)\quad & a_i > a_2 > c_i \\
& b_1 > b_2 > k > 0
\end{align*}
\]

Where \(c_i\) are firms’ constant marginal costs. We restrict to the case where two firms produce substitutes to compete, which implies \(k > 0\) and \(a_2 > c_i\) used in (4).\(^5\) Although mathematically, our duopoly model doesn’t need condition \(c_i > c_2\), this condition is likely to hold in airline markets.

With these demand functions, the two firms maximize their profits \(\pi_i = (p_i - c_i)q_i\). Assuming that both firms maximize profits by setting output quantities, then the FOC for firm \(i\) may be written as:

---

\(^5\) If \(k = 0\), then the two firms offer totally independent products (no substitutability). As \(k\) approaches 1, two firms offer increasingly homogenous products. When \(k = 1\), the two firms produce 100% homogeneous products.
where we can denote firm $i$'s conduct parameter as $v_i = \frac{\partial q_j}{\partial q_i}$. These conduct parameters measure how aggressively firms compete. The larger the negative conduct parameter, the more aggressive is the firm’s competition strategy. Firm 1 and 2’s FOCs define their respective reaction functions, which constitute the following system of equations:

\begin{align}
0)2( 121111 & = \quad - \\
0)2( 222212 & = \quad - \\
\end{align}

When the two firms do not collude in the market, we have $-1 \leq v_i \leq 0$, which implies:

\begin{align}
m = (2b_1 + kv_1) > b_1 > k > 0 \\
n = (2b_2 + kv_2) > b_2 > k > 0
\end{align}

Note that our earlier restriction that $b_1 > b_2$ implies that $m > n$ for all $v_1 \geq v_2$. Solving the system of First Order Conditions leads to firms’ equilibrium outputs given each firm’s conduct parameter:

\begin{align}
q_1 &= \frac{n(a_i - c_i) - k(a_2 - c_2)}{mn - k^2} \\
q_2 &= \frac{m(a_2 - c_2) - k(a_1 - c_1)}{mn - k^2}
\end{align}

Since $(mn - k^2) \geq (b_1 + (b_1 - k))[b_2 + (b_2 - k)] - k^2 > 0$, positive output implies that

\begin{align}
m(a_i - c_i) - k(a_2 - c_2) > 0 \\
m(a_2 - c_2) - k(a_1 - c_1) > 0
\end{align}

Restrictions in equation (9) ensure that two firms’ reaction functions intersect each other so that a unique Nash Equilibrium exists. This is depicted in the following stylized figure 2.

---

6 In particular, a zero conduct parameter corresponds to Cournot competition, while the value of -1 corresponds to Bertrand competition.

7 This refers to the cases when firms engage in competition more aggressively than Cournot.
Figure 2. Two Firms’ Reaction Functions Intersect

\[ q_2 = \frac{na_1 - ka_2}{mn - k^2} - \frac{n}{mn - k^2}c_1 + \frac{k}{mn - k^2}c_2 \]
\[ q_2 = \frac{ma_2 - ka_1}{mn - k^2} + \frac{k}{mn - k^2}c_1 - \frac{m}{mn - k^2}c_2 \]

Where \( r_1 \) and \( r_2 \) are firm 1 and 2’s reaction functions respectively, and \( A = \frac{a_1 - c_1}{k} \), \( B = \frac{a_2 - c_2}{n} \), \( C = \frac{a_1 - c_1}{m} \), \( D = \frac{a_2 - c_2}{k} \) are the points where these reaction functions intersect with each firm’s output axis.

For clarity of interpretation, solution (8) can be rewritten as follows:

\[ q_1 = \frac{na_1 - ka_2}{mn - k^2} - \frac{n}{mn - k^2}c_1 + \frac{k}{mn - k^2}c_2 \]
\[ q_2 = \frac{ma_2 - ka_1}{mn - k^2} + \frac{k}{mn - k^2}c_1 - \frac{m}{mn - k^2}c_2 \]

That is, each firm’s output depends on the degree of product differentiation (as measured by \( k^2 \)), firms’ costs and conduct.

2.2 Analytical Results on Firms’ Outputs

As in the previous section, let us look at the effect of an identical increase in marginal costs (i.e. \( dc_1 = dc_2 = dc \)) on both firms’ outputs. By applying such an identical marginal cost increase to the system of equations in (10), we obtain:

\[ k^2 \]

In fact, \( \frac{k^2}{b_1b_2} \) may be regarded as a more appropriate measure of product differentiation.

---

\( ^8 \) More precisely, the degree of product differentiation depends on the relative values of \( k, b_1, \) and \( b_2 \) in equation (1).
\begin{align}
\begin{aligned}
dq_1 &= \left( \frac{\partial q_1}{\partial c_1} + \frac{\partial q_1}{\partial c_2} \right) dc = -\frac{n-k}{mn-k^2} dc \\
dq_2 &= \left( \frac{\partial q_2}{\partial c_1} + \frac{\partial q_2}{\partial c_2} \right) dc = -\frac{m-k}{mn-k^2} dc
\end{aligned}
\end{align}
(11)

It can be seen that when two firms engage in equally aggressive competition \((v_1 = v_2 = v)\), \(k < (n = 2b_2 + kv) < (m = 2b_1 + kv)\), which implies that \(|dq_1| < |dq_2|\). This result means that when duopoly firms adopt a similar strategy in setting quantity (same conduct parameter), then the firm facing less price-elastic demand will end up reducing its output less than its competitor (the firm facing higher price-elastic demand). In our case, when an FSA and an LCC engage in equally aggressive competition, the equilibrium passenger volume of LCC will be reduced more than that of FSA when an identical increase in marginal cost occurs to both firms. It is important to note that this finding is strengthened if we assume that the LCC competes more aggressively than the FSA, implying \(0 \geq v_1 > v_2 \geq -1\).

Then, what can we say about the relative reduction in outputs of the two firms from equations (11)? To answer this question, we express equation (11) in relative terms as below:

\begin{align}
\begin{aligned}
\frac{dq_1}{q_1} &= -\frac{n-k}{n(a_1-c_1) - k(a_2-c_2)} dc \\
\frac{dq_2}{q_2} &= -\frac{m-k}{m(a_2-c_2) - k(a_1-c_1)} dc
\end{aligned}
\end{align}
(12)

It can easily be shown that \((a_1-c_1) > (a_2-c_2)\) is a sufficient condition to ensure that the LCC’s output is affected proportionally more than the FSA’s output.

As \(c_i\) denotes the constant marginal costs of carrying one additional passenger, whereas \(a_i\) is the highest evaluation (for the first unit of consumption) for the service, we should have \(a_i >> c_i\), which in general leads to \((a_1 - a_2) > (c_1 - c_2)\) when two firms’ services are fairly differentiated. However, if firm 1 and firm 2 offer almost homogenous product (implying \(a_1 \approx a_2\)), then one can see that the firm with higher marginal cost will lose proportionally more output.
2.3 Analytical Results on Firms’ Prices

Let us now turn our attention to the effects of the identical cost increase on air fares. With each firm’s outputs at the equilibrium, the prices of each product can be obtained by substituting the equilibrium outputs in equation (10) into the respective demand functions:

\[
\begin{align*}
    p_1 &= \left(\frac{a_n - a^*_2 k(m-b_1)}{mn-k^2} + \frac{b_n - k^2}{mn-k^2} c_1 + \frac{k(m-b_1)}{mn-k^2} c_2 \right) \\
    p_2 &= \left(\frac{a^*_2 m - a^*_1 k(n-b_2)}{mn-k^2} + \frac{k(n-b_2)}{mn-k^2} c_1 + \frac{mb_2 - k^2}{mn-k^2} c_2 \right)
\end{align*}
\]  

Each firm’s equilibrium price increase caused by the cost increase \(dc\) can be written as:

\[
\begin{align*}
    dp_1 &= (\frac{\partial p_1}{\partial c_1} + \frac{\partial p_1}{\partial c_2}) dc = \left(\frac{b_n - k^2 + mk - kb_1}{mn-k^2}\right) dc < dc \\
    dp_2 &= (\frac{\partial p_2}{\partial c_1} + \frac{\partial p_2}{\partial c_2}) dc = \left(\frac{kn - k^2 + mb_2 - kb_2}{mn-k^2}\right) dc < dc
\end{align*}
\]

This means when the two firms’ marginal costs increase by an identical amount, neither firm will fully pass the cost increase to passengers. This result is consistent with the fact that both firms face negatively sloped demand curves as depicted in Figure 1.

2.4 Analytical Results on Firms’ Profits

Thus far, as we have shown, an identical marginal cost increase is likely to harm an LCC more than it will harm an FSA. Similarly, it can be shown that in general, the FSA’s profit will be proportionally less harmed by an identical marginal cost increase. To show this, the two firms’ profit functions can be written as:

\[
\begin{align*}
    \pi_1 &= (p_1 - c_1)q_1 = \frac{m - b_1}{(mn-k^2)^2} [n(a_1 - c_1) - k(a_2 - c_2)]^2 \\
    \pi_2 &= (p_2 - c_2)q_2 = \frac{n - b_2}{(mn-k^2)^2} [m(a_2 - c_2) - k(a_1 - c_1)]^2
\end{align*}
\]

Therefore, an identical marginal cost increase \(dc\) will change firms’ profit by:

\[
\begin{align*}
    d\pi_1 &= (\frac{\partial \pi_1}{\partial c_1} + \frac{\partial \pi_1}{\partial c_2}) dc = -2 \frac{m - b_1}{(mn-k^2)^2} [n(a_1 - c_1) - k(a_2 - c_2)](n-k) dc \\
    d\pi_2 &= (\frac{\partial \pi_2}{\partial c_1} + \frac{\partial \pi_2}{\partial c_2}) dc = -2 \frac{n - b_2}{(mn-k^2)^2} [m(a_2 - c_2) - k(a_1 - c_1)](m-k) dc
\end{align*}
\]
Like before, \((a_1 - c_1) > (a_2 - c_2)\) is a sufficient condition to ensure that the full service airline is proportionally less affected. However, as we have shown that firms’ positive outputs imply the following:

\[
\begin{align*}
&n(a_1 - c_1) - k(a_2 - c_2) > 0 \\
&m(a_2 - c_2) - k(a_1 - c_1) > 0
\end{align*}
\]

From these, it immediately follows that \(d\pi_1 < 0\) and \(d\pi_2 < 0\) whenever \(dc > 0\). That is, although FSA will be proportionally less harmed by such an identical cost increase, its profitability will always be reduced. As such, unless the FSA is sure that such identical cost increase will drive the LCC out of the market, it is not in the FSA’s interest to adopt the strategy of “Raising Rival’s Cost”, at least not in the form of encouraging an airport to raise the user charges it imposed on airlines (in such a way to increase marginal costs of both airlines by an identical amount). This may explain why Qantas joined Virgin Blue’s declaration application. Although a price increase by Sydney airport would harm Virgin Blue more than it does to Qantas (thus creating some competitive advantage for Qantas), it is unlikely that Virgin Blue will be forced to abandon all markets to/from Sydney airport.

Although these results are derived from the assumption that firms have constant marginal costs, our general conclusions are likely to hold even if fixed costs are also considered. When airlines have fixed costs, their profits will be smaller given the same amount of output and price. Each firm’s reaction function will have the same shape as before, but optimal outputs below a certain point now correspond to loss minimization instead of profit maximization. As LCCs typically operate on a route by route case while FSAs often consider the overall network effects when they make a decision to operate on or exit from a route, it is likely that LCCs will be the first to exit the market because its equilibrium outputs and profits are more sensitive to an identical increase in airport charge. Of course, empirically this depends on each airline’s existing profitability, cost, and competition strategy.

2.5 Summary of Analytical Results:
From the duopoly model of FSA vs. LCC competition with product differentiation, we find that:

- An identical increase in marginal cost will harm an LCC more than an FSA as the former suffers proportionally more reduction of its output and profit than the latter;
- Neither the FSA nor the LCC can fully pass on such an external cost increase to consumers. Therefore, both firms suffer loss in their profits.
- If the LCC competes at least as aggressively as the FSA, an identical marginal cost increase would lead the LCC to reduce its output quantity by a larger amount than the FSA, implying a more seriously harm to LCC.

That is, an identical cost increase will proportionally harm the LCC more. Although such an identical marginal cost increase, such as per-passenger airport service charge, or government imposed per-passenger security charge is likely to only constitute a small proportion of the
total unit costs, its impacts may be non-trivial. As most airlines are currently operating at barely breakeven level, such cost increase will further reduce these airlines’ profitability, possibly forcing them to reduce service levels or cease operations on some routes altogether.

We have shown that in theory, although an FSA’s outputs and profits will be less impacted negatively by an external factor leading to an identical increase in per-passenger marginal cost to both FSAs and LCCs (and thus, creating a competitive advantage over an LCC), an FSA will not adopt the “Raising Rival’s Cost” strategy by encouraging airports raise airside user charges unless it is sure that such cost increase will drive the LCC totally out of the market.

3. Numerical Simulation and Sensitivity Test

Many empirical cases involving the competition between LCC and FSA pose special challenges for empirical analysis because of the often disequilibrium nature of market data. For example, an LCC enters the market with significantly lower prices than FSAs. In this situation, FSAs often respond to the challenge by allocating more seats to deep discount fare category and thereby lowering their average price. At the same time, FSAs lose their market shares (and often traffic volumes) as they reduce their average air fares progressively while the LCC keeps their initial low prices at the similar level for some time. The market data on Qantas and Virgin Blue revealed such disequilibrium nature of the market. In other words, Qantas was losing market shares while it reduced air fares, but Virgin Blue was gaining market share although it maintained similar (low) prices introduced at the time of entry. Therefore, it is impossible to estimate a sensible econometric model from such a short term data set. Therefore, we had to rely on numerical simulations in order to measure the differential effects of increasing airside service charges on Qantas and Virgin Blue as well as validating our analytical results.9

The parameter values used in this section mimic a realistic air transport market, but they don’t represent any particular city pair market we studied because of the confidential nature of the route-specific data we received from Qantas and Virgin Blue. All parameters used in our model met the assumptions and constraints described in section 2, and reflect our best estimate based on our understanding of the air transport markets, in particular in the markets where an FSA and an LCC compete.

**Assumptions:**
We start with the likely values for some of the parameters so that the differentiated duopoly model described in section 2 can be calibrated. This base case provides some numerical results which enable one to appreciate the differential impacts of an identical marginal cost increase on an LCC and an FSA. Sensitivity tests are used so that we are sure these results hold for any reasonable ranges of the parameter values. The assumptions we made for the base case are:

---

9 Even though FSAs and LCCs have been competing in U.S. airline markets for a long time, to our knowledge, few empirical industrial organization studies have been carried out on the differentiated product competition between LCCs and FSAs probably because of the fact that detailed airline and route specific cost data are often not accessible by researchers.
• Conduct Parameters: We limit our analysis to non-collusive games, thus limiting ourselves to non-positive values for $v_1$ and $v_2$. The base values we choose are $v_1 = v_2 = -0.5$.

• $b_1$, $b_2$ and $k$: constraint (4) requires $b_1 > b_2 > k$. Parameter $k$ measures how different the services provided by the two firms are. Let $k = t \cdot b_1$ ($0 < t < 1$), then if $t = 0$ the two firms’ services are not substitutes at all, while $t = 1$ indicates that the FSA and LCC produce perfectly homogenous services. Our base case assumes $t = 0.7$. We also assume $b_2 = \frac{b_1+k}{2}$ so that constraint (4) is always satisfied.

• Market price elasticity for air travel: -1.4.

• Each firm’s equilibrium price: we assume FSA’s price at $p_1 = $100 while the LCC’s price is assumed to be 25% lower, i.e., $p_2 = $75.

• Each firm’s equilibrium output: We assume that at equilibrium the FSA has a 60% market share carrying 60,000 passengers each month.

**Base Case Model Results:**
With the above assumptions, other parameters of the model can be derived as follows:

• Market output $Q = q_1 + q_2 = 100,000$ passengers per month.

• Market price $P = \frac{P_1 q_1 + P_2 q_2}{Q} = $90

• $b_1$: When both firms experience an identical price change $dp_1 = dp_2 = dp$, or an equivalent market price change of $dP = dp$, from the demand equation in (1) the total change in market output can be obtained as $dQ = dq_1 + dq_2 = \frac{2k - b_1 - b_2}{b_1 b_2 - k^2} dp$. As market elasticity $e = \frac{dQ_P}{dP}Q$ is known, one can derive $b_1 = -\frac{3P}{e(2t+1)Q} = 0.0008$.

• Table 1 reports the base case values of other parameters that we derived:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>$b_2$</th>
<th>$c_1$</th>
<th>$c_2$</th>
<th>$a_1$</th>
<th>$a_2$</th>
<th>$e_{11}$</th>
<th>$e_{22}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>0.00068</td>
<td>68.7</td>
<td>58.9</td>
<td>170.7</td>
<td>136.1</td>
<td>-4.9</td>
<td>-6.48</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>$k$</th>
<th>$m$</th>
<th>$n$</th>
<th>$\pi_1$</th>
<th>$\pi_2$</th>
<th>$e_{12}$</th>
<th>$e_{21}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>0.00056</td>
<td>0.00133</td>
<td>0.00108</td>
<td>1,880,357</td>
<td>642,857</td>
<td>3.02</td>
<td>6.05</td>
</tr>
</tbody>
</table>

Note $e_i$ are firm’s own price elasticity, while $e_{ij}$ measures firm $i$’s cross elasticity with respect to firm $j$’s price. They have the correct signs and are within a reasonable range\(^{10}\). With all of

\(^{10}\) Few studies have empirically estimated firm specific elasticity for airlines. Oum, Zhang and Zhang (1993) reported that UA and AA’s firm specific elasticities are significantly above market elasticity. In many leisure routes the two firms’ firm specific elasticity were as high as around -10.
the parameter values, it is straightforward to calculate the impact of an identical increase in marginal cost. The results are summarized in Table 2.

Table 2. Changes in Market Equilibrium Caused by Different Airport Charge Increase

<table>
<thead>
<tr>
<th>Airport Charge Increase</th>
<th>$1</th>
<th>$2</th>
<th>$3</th>
<th>$5</th>
<th>$6</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1</td>
<td>-0.8%</td>
<td>-1.6%</td>
<td>-2.3%</td>
<td>-3.9%</td>
<td>-4.7%</td>
</tr>
<tr>
<td>$2</td>
<td>-1.7%</td>
<td>-5.1%</td>
<td>-6.0%</td>
<td>-8.5%</td>
<td>-10.2%</td>
</tr>
<tr>
<td>$3</td>
<td>0.8%</td>
<td>1.5%</td>
<td>2.3%</td>
<td>3.8%</td>
<td>4.5%</td>
</tr>
<tr>
<td>$4</td>
<td>1.0%</td>
<td>1.9%</td>
<td>2.9%</td>
<td>4.8%</td>
<td>5.8%</td>
</tr>
<tr>
<td>$5</td>
<td>-1.5%</td>
<td>-3.1%</td>
<td>-4.6%</td>
<td>-7.6%</td>
<td>-9.1%</td>
</tr>
<tr>
<td>$6</td>
<td>-3.4%</td>
<td>-6.7%</td>
<td>-9.9%</td>
<td>-16.3%</td>
<td>-19.4%</td>
</tr>
<tr>
<td>$7</td>
<td>0.9%</td>
<td>1.8%</td>
<td>2.7%</td>
<td>4.5%</td>
<td>5.4%</td>
</tr>
<tr>
<td>$8</td>
<td>-1.1%</td>
<td>-2.3%</td>
<td>-3.4%</td>
<td>-5.7%</td>
<td>-6.9%</td>
</tr>
</tbody>
</table>

As expected, Table 2 shows that the reductions in LCC’s outputs and profits are larger than those of the FSA for all levels of increases in airport charges simulated, implying proportionally larger negative effects on the LCC. Although the market price elasticity in the base case is only assumed to be -1.4, the corresponding LCC’s firm-specific price elasticity is much larger in absolute value ($e_{22} = -6.48$). Together with its low cost, it is not surprising that even a moderate increase in airport charge will reduce its profitability significantly. One should note that the LCC’s price for the base case was assumed to be $75. The reduction in airline’s profitability will be more moderate for longer distance (more costly) routes. In the base case, the FSA loses fewer passengers and passes on a greater proportion of the cost (airport charge) increase to passengers. These are, of course, entirely consist with our analytical results.

There are two major assumptions in our simulation: value of firms’ conduct parameters, and parameter $t \ (k)$ which measures the extent of product differentiation between LCC and FSA. Few studies estimated differential conduct parameters empirically using airline data on LCCs and FSAs. Haugh and Hazledine (1999) and Hazledine, Green and Haugh (2001) are exceptions that we are aware. Although their studies found that the LCC does behave more aggressively in the trans-Tasman market (as evidenced by LCC’s lower conduct parameter), they obtained this result based on calibration of their models instead of estimating the model parameters empirically from the real data. Although their finding supports our view that LCCs use more aggressive strategies (equivalent to a lower value of conduct parameter) than FSAs, it is necessary for us to conduct a sensitivity test on a plausible range of conduct parameter values in order to study sensitivity of our results.

First, we set firm 1’s conduct parameter to -0.5 ($v_1 = -0.5$) and simulate market equilibrium as we change firm 2’s conduct parameter $v_2$ from 0 to -1, with an interval of 0.1. We calculate all of the model parameters corresponding to each pair of the conduct parameters, and then
simulate the effects of increasing marginal costs for both carriers by a $1. Such tests are repeated for the \( t \) values of 0.5, 0.6, 0.7, 0.8 and 0.9 so that \( k \) takes values in the range of \([0.5b_1, 0.9b_1]\), respectively.

We plot curves for ratio of the two firms’ passenger reduction percentage
\[
y = \left( \frac{dq_2}{q_2} \right) / \left( \frac{dq_1}{q_1} \right) = \frac{\% \Delta q_2}{\% \Delta q_1}
\]
in figure 3. All of the curves showing the ratio of percentages of the LCC-FSA output reduction are upward sloping, implying that the more aggressively the LCC behaves, the higher will be its relative output reduction from an identical marginal cost increase. Figure 3 shows also that the curve for a higher value of \( t \) is steeper than the ones for lower \( t \) values. This indicates that competition becomes more important as products become closer substitutes. Let us consider the extreme case (not in the figure) where the goods are no longer substitutes (i.e. \( t=0 \)). In this case, the output reduction ratio curve in the figure would become a horizontal line, implying the absence of any effect of changing conduct parameter for LCC (\( v_2 \)). This makes sense, since \( t=0 \) implies that both firms are monopolists in their respective markets.

**Figure 3. Output reduction ratio* (de=$1)**

(*The ratio is defined as \( y = \frac{\% \Delta q_2}{\% \Delta q_1} \), firm 2’s conduct parameter \( v_2 \) changes while \( v_1 \) fixed as -0.5)

The corresponding differential changes in two firms’ profits, \( |\% \Delta \pi_2| - |\% \Delta \pi_1| \) are plotted as in figure 4. Note that since \( \Delta \pi_i \) is negative for both firms, a positive differential number indicates that the LCC suffers more profit reduction proportionally.
The profit reduction ratio curves are upward sloping, suggesting that the LCC’s profit will be reduced more from an identical marginal cost increase as it behaves increasingly more aggressively. Note that the curve for a high value of $t$ is steeper than the ones for lower $t$ values. This reflects again that competition becomes more important as products become closer substitutes. It can be seen from the graph that only in the unlikely case when two firms offer fairly close services ($t = 0.9$) while the FSA competes much more aggressively than the LCC ($v_1 = -0.5$, $v_2 = 0$), it is possible that the FSA loses profits proportionally more than the LCC.

In sum, our numerical simulation and sensitivity tests on key parameters of our duopoly model demonstrate the reliability of our analytical results within reasonable ranges of the key parameter values. More importantly, the numerical simulations also give the estimated values of the differential effects of an identical marginal cost increase (e.g., due to increase in airport’s airside service charges including landing fees) on an FSA and an LCC, and thus on the competition in downstream airline markets an airport serves.

4. Discussion and Conclusion
With the worldwide trend of airport privatization and commercialization, the extent and form of airport regulation are becoming an important issue for policy makers and regulators. The level of an airport’s user charge affects not only air travel demand and social welfare, but also competition in the downstream airline markets to/from that airport. This latter aspect of the effect of airport user charges have been overlooked and thus, have not been incorporated in the analysis of airport pricing and regulation. This paper attempt to fill this void in the literature by showing that the level of competition in downstream airline markets will be reduced when an airport increases its airside service charges (e.g., aircraft landing fees) by same amount to all airlines because such increase would reduce equilibrium outputs and profits of LCCs proportionally more than those of FSAs.

In section 2, using duopoly models we have derived the following analytical results:

- When two airlines compete with differentiated products such as the case where an FSA and an LCC compete with each other, the LCC will lose its output and profits proportionally more than its FSA competitor. As a result, such increase in airport user charge would harm competition in the downstream airline markets to and from that airport.
- We have analyzed influences of the extent of product differentiation (substitutability), the extent of difference in unit cost levels and the difference in the two firms’ conduct parameters on the equilibrium outcomes. In addition, although an increase in airport’s airside fee can increase competitive advantage of FSA vis-à-vis LCC, it is still not in the FSA’s best interest to encourage airports to increase airside user charge in order to take advantage of its increasing competitive advantage.

Our numerical simulation and sensitivity tests on key parameters confirmed all of our analytical findings. The simulation experiments further indicated the following empirical results:

- The ratio of LCC’s output reduction percentage relative to FSA’s increases as LCC’s conduct parameter \( v_2 \) moves from zero towards -1. This implies that the more aggressively LCC behaves, the higher will be the reduction of its output relative to FSA caused by an identical marginal cost increase;
- Competition becomes more important as the two firms (FSA and LCC) compete with closer substitutes;
- The differential in the percentage of profit reduction between LCC and FSA increases as the LCC’s conduct parameter \( v_2 \) moves from 0 towards -1.0. This implies that the LCC’s profit reduction relative to FSA’s profit reduction will increase as LCC behaves progressively more aggressive.

Although in this paper we can not compare our simulation results explicitly with those of our work on the Virgin Blue vs. Sydney Airport case before the Australian Competition Tribunal because of the confidential nature of the data and results, we are satisfied that our simulation results in this paper are consistent overall with the aggregate results we obtained using the real airline and airport data. In the Australian work, we obtained the results on the duopoly routes to and from Sydney. Our simulation results in this paper and our Australian work indicate clearly that an increase in an airport’s user charge will harm LCCs significantly more than FSAs by reducing LCC’s outputs and profits significantly more than those of FSAs.
Therefore, unregulated airside service pricing by a monopoly airport is likely to impact negatively on the competition in the downstream air transport markets to and from that airport. This implies that future analysis on airport pricing and price regulation should consider this aspect of additional welfare loss a monopolistic airport pricing may cause. This is especially important when there is no alternative airport in the airport’s catchment area.

Some economists argue that since the incentives for generating non-aviation revenues including concession and car parking revenues would constrain airport management from charging monopolistic airside service charges, there is no need to impose any price regulation on privatized airports. However, recently Oum, Zhang and Zhang (2004) have shown that the airside service charges of an unregulated profit-maximizing airport are higher than those of a public airport under a breakeven budget constraint, even after the effect of concession profits is taken into account. In addition, because of the extremely low price elasticity of air travel demand with respect to airports’ user charges11 any profit-maximizing airport management will have incentives to raise airside user charges at least several hundred percentage points beyond the current levels even after considering effect of the demand complementarity between aircraft landing and concession activities. Therefore, the governments should consider carefully whether or not they need to impose some sort of price regulation on privatized airports.

Finally, although further research is needed our results suggest that economic welfare may be improved by applying lower markups on the airside service charges to low cost carriers than full service airlines.

While we have argued the need for some sort of price regulation on privatized airports, we have not evaluated the types and extent of regulation. Instead, we pointed out that policy makers and regulators need to take into account of the effect of airport pricing on competition in the downstream airline market when decisions on price regulation or deregulation of privatized airports are considered. Obviously, further research, especially empirical research on this subject is needed.

---

11 Gillen, Oum and Tretheway (1998) report the elasticity ranging between -0.01 and -0.1 depending on the aircraft size.
References


