E c o n o m i c s   B u l l e t i n

Price Cap Regulation of Airports: A New Approach

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Abstract

Airports are typically monopolistic providers of aeronautical services. Hence, the widespread privatization of airports within the last 20 years has in general been accompanied by some form of price regulation of aeronautical services. A great deal of attention has been given to the issue of whether the aeronautical price cap should be based upon revenues from both aeronautical and commercial services (the "single-till" approach) or revenues from aeronautical services only (the "dual-till" approach). However, each of these regulatory schemes will in general lead to regulated prices that are Pareto inefficient. This paper presents a price capping scheme that systematically exploits the potential Pareto improvements available under either the single-till or dual-till regimes.

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1. Introduction

Airports are typically monopolistic providers of aeronautical services. Hence, the widespread privatization of airports within the last 20 years has in general been accompanied by some form of price regulation of aeronautical services. Generally speaking, all airport charges may be classified as either aeronautical or commercial charges. Aeronautical charges include aircraft landing, parking, take-off, and maintenance fees as well as air traffic control fees ("landing charges"). Aeronautical charges also include fees for originating, departing, transfer, and transit passengers ("passenger charges"). Commercial charges include charges for leasing of terminal retail shopping concessions, banking, car parking and rental, etc.

One issue that has received a great deal of attention is that of whether it is preferable to adopt a "single-till" or "dual-till" approach to airport regulation. Under a single-till price cap regime, regulated aeronautical charges are determined using both aeronautical and commercial revenues and costs. In this case, revenues from commercial activities cover deficits incurred in the provision of aeronautical services. Under a dual-till price cap regime, the aeronautical and commercial components of the airport's operations are separated and regulated aeronautical charges are set such that costs incurred in the provision of aeronautical services are completely covered by aeronautical revenues. Oum, Zhang, and Zhang (2004) find empirical evidence of increased input efficiency under a dual-till regime. Applying a Hotelling-type location model, Czerny (2006) demonstrates that for a noncongested airport, the single-till price cap regime is welfare superior to the dual-till regime. Similarly, Lu and Pagliari (2004) perform a comprehensive welfare-based investigation of the issue. They conclude that the single-till approach yields higher social welfare for a noncongested airport, whereas the dual-till approach is welfare superior for a congested airport.

Both regulatory schemes, however, lead to regulated pricing policies that are Pareto inefficient. Indeed, it is straightforward to show that under both the single-till and the dual-till regimes, it is possible to increase consumer welfare, given the profit level earned by the airport. We are thus led to consider the design of alternative price cap schemes that permit the exploitation of the mutual gains available under the single-till and dual-till regimes.

In this paper, we first discuss the unique complementary nature of the demands for aeronautical and commercial services. We then present a price capping scheme that will simultaneously yield gains to both consumers and the regulated airport, thus exploiting potential Pareto improvements available at the status quo. Hence, regardless of whether the regulatory authority is currently employing a single-till or a dual-till regulatory scheme, (repeated) application of our proposed price capping scheme will result in a monotonically increasing sequence of consumer welfare levels and airport profits.

2. The model

As discussed previously, all airport charges may be classified as either aeronautical or commercial charges. Let x_1 and x_2 denote the quantities of aeronautical and commercial services consumed (per time period), respectively. We let p_1 denote the price of aeronautical services (i.e., the "price of a flight") and p_2 denote the price of commercial services. We shall assume that airlines and commercial service providers operate under conditions of perfect competition with constant marginal costs. Thus the prices charged by the airport to airlines and commercial service operators are identical to the prices paid by consumers for these services. Demands for aeronautical and commercial services are $x_1(p_1)$ and $x_2(p_1, p_2)$. Only passengers can purchase commercial services, in which case the demand for commercial services depends on the price of a flight but not the converse. Consumer surplus from flights is $V_1(p_1)$, which is assumed convex and twice continuously differentiable. By Roy's Identity, $\frac{\partial V_1(p_1)}{\partial p_1} = -x_1(p_1)$. The demand for commercial goods *per flight* is $x_2^f(p_2)$. Consumer surplus from commercial services is $V_2^f(p_2)$, which is convex, twice continuously differentiable, and satisfies $\frac{\partial V_2^f(p_2)}{\partial p_2} = -x_2^f(p_2)$. Total demand for commercial services is equal to the total number of flights times the demand for commercial services per flight: $x_2(p_1, p_2) \equiv x_1(p_1)x_2^f(p_2)$. Note that since flights and commercial services are complementary, $\frac{\partial x_2(p_1, p_2)}{\partial p_1} = x_2^f(p_2)\frac{dx_1}{dp_1} < 0$. In addition, total consumer surplus, which is assumed convex is

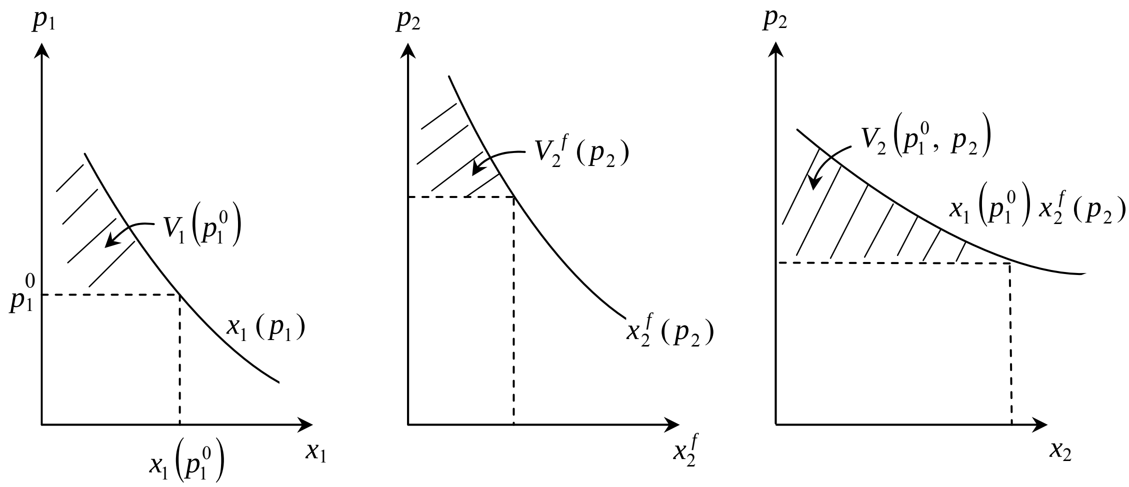
$$V(p_1, p_2) \equiv V_1(p_1) + x_1(p_1)V_2^f(p_2) \equiv V_1(p_1) + V_2(p_1, p_2)$$

and satisfies

$$\frac{\partial V(p_1, p_2)}{\partial p_1} = -x_1(p_1) + V_2^f(p_2)\frac{dx_1}{dp_1} < 0 \text{ and } \frac{\partial V(p_1, p_2)}{\partial p_2} = -x_1(p_1)x_2^f(p_2) = -x_2(p_1, p_2) < 0.$$

Convexity of $V(p_1, p_2)$ requires that $\frac{-dx_1(p_1)}{dp_1} + V_2^f(p_2)\frac{d^2x_1(p_1)}{dp_1^2} \geq 0$ for all p_1, p_2. This condition will be satisfied if $\frac{d^2x_1(p_1)}{dp_1^2} \geq 0$ for all p_1. It is therefore assumed that the demand for aeronautical services is convex. It should be noted that this includes both the linear and constant elasticity of demand cases. Figure 1 provides an illustration.

Figure 1



Observe that in this formulation, the demand for flights and the demand for commercial services *per flight* are independent. Passengers are therefore assumed to make two separate decisions in travel. First, airline tickets are purchased based on the price of a flight. Then, after arrival at the airport, passengers make purchasing decisions for commercial services based on the prices of these services. This two-part decision making may be justified by the fact that for the typical passenger, a substantial amount of time will typically elapse between the date of the ticket purchase and the date of the purchase of the commercial services (the date of travel) (Zhang and Zhang 1997).

3. An alternative price cap scheme

Under both the single-till and dual-till schemes, only the price of aeronautical services is capped. The airport thus selects prices to maximize $\pi(p_1, p_2)$ subject to $p_1 \le k$ where π denotes the airport's profit function (given the total existing capacity of aeronautical services), and k denotes the level of the price cap. Under single-till regulation, the level of k is selected so that overall airport profit is zero. Under the dual-till scheme, k is selected so that profits from aeronautical services are zero. Under a binding price cap constraint, profit maximization requires $\pi_{p_1} = \mu$ and $\pi_{p_2} = 0$, $\mu > 0$ where the subscripts denote the partial derivatives of π. However, a Pareto efficient price vector requires $\nabla V(p_1, p_2) = \lambda \nabla \pi(p_1, p_2)$, $\lambda < 0$ where ∇V and $\nabla \pi$ denote the gradients (vectors of partial derivatives) of V and π, respectively. Simultaneous satisfaction of these conditions, however, requires that $V_{p_2} = -x_1(p_1)\, x_2^f(p_2) = 0$, a contradiction. Hence, the single-till and dual-till price cap schemes can never result in efficient pricing.

To consider the possibility of improving upon such outcomes, suppose that the current (time period t) price vector is (p_1^t, p_2^t). Furthermore, suppose that the subsequent period's price vector will be (p_1^{t+1}, p_2^{t+1}). Since V is convex, consumer surplus will (weakly) increase if

$$dV = \left(p_1^{t+1} - p_1^t\right)\frac{\partial V}{\partial p_1}\left(p_1^t, p_2^t\right) + \left(p_2^{t+1} - p_2^t\right)\frac{\partial V}{\partial p_2}\left(p_1^t, p_2^t\right) \geq 0$$

or, equivalently

$$\left(p_1^{t+1} - p_1^t\right)\left(-x_1^t + V_2^f\left(p_2^t\right)\frac{dx_1}{dp_1}\left(p_1^t\right)\right) + \left(p_2^{t+1} - p_2^t\right)\left(-x_2^t\right) \geq 0 \quad (1)$$

where $x_1^t = x_1\left(p_1^t\right)$ and $x_2^t = x_2\left(p_1^t, p_2^t\right)$. Now define the Laspeyres price index

$$L^{t+1} = \frac{p_1^{t+1}x_1^t + p_2^{t+1}x_2^t}{p_1^t x_1^t + p_2^t x_2^t}.$$

Then (1) may be expressed as

$$L^{t+1} \leq 1 + \frac{V_2^f\left(p_2^t\right)\frac{dx_1}{dp_1}\left(p_1^t\right).\left(p_1^{t+1} - p_1^t\right)}{R^t} \quad (2)$$

where airport revenue $R^t = p_1^t x_1^t + p_2^t x_2^t$.

Observe now that if $p_1^{t+1} \leq p_1^t$, (2) will be satisfied if $L^{t+1} \leq 1$ since $\frac{dx_1}{dp_1}\left(p_1^t\right) < 0$. Furthermore, suppose that c_1 and c_2 denote the cost of providing each unit of aeronautical and commercial services during any time period under current aeronautical capacity. Since $p_1^t > c_1$ and $p_2^t > c_2$, we have $\frac{dx_1}{dp_1}\left(p_1^t\right) > \frac{dx_1}{dp_1}\left(c_1\right) \equiv s_1 < 0$ and $V_2^f\left(p_2^t\right) < V_2^f\left(c_2\right) \equiv s_2 > 0$ since the demand for aeronautical services is convex and consumer surplus is monotonically decreasing in prices. Now let $s = s_1 s_2$ and note that if $p_1^{t+1} > p_1^t$,

$$L^{t+1} \leq 1 + \frac{s\left(p_1^{t+1} - p_1^t\right)}{R^t}$$

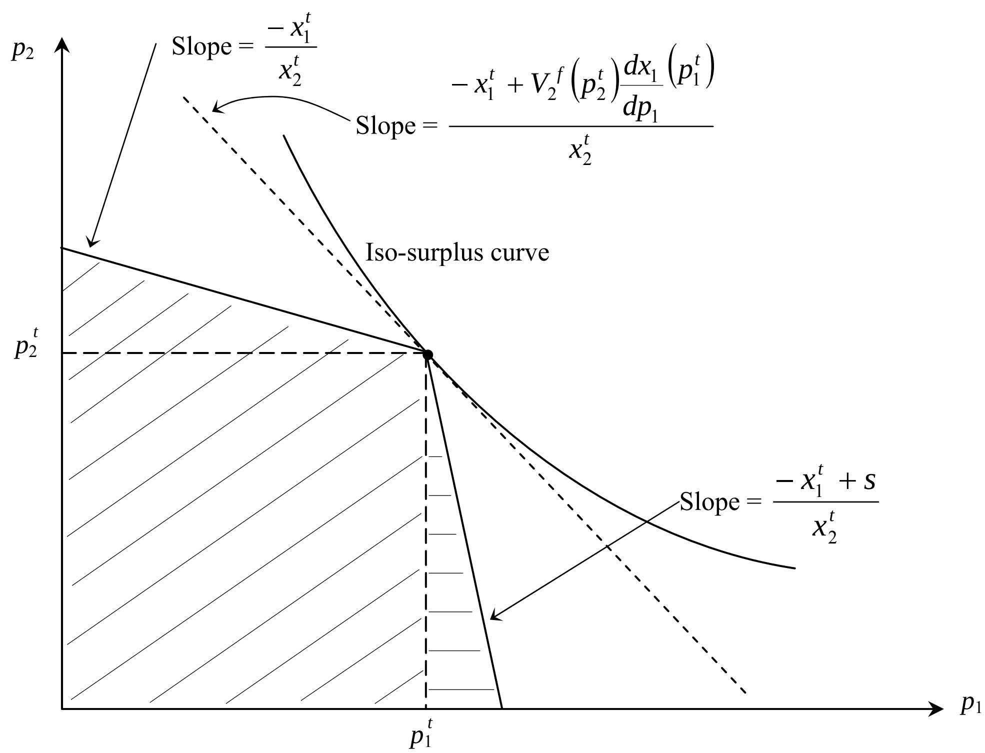
is sufficient to ensure that (2) is satisfied since $s < \frac{dx_1}{dp_1}\left(p_1^t\right)V_2^f\left(p_2^t\right)$. Thus, the price cap mechanism given by

$$L^{t+1} \leq 1 \text{ if } p_1^{t+1} \leq p_1^t \quad (3a)$$

$$\leq 1 + \frac{s\left(p_1^{t+1} - p_1^t\right)}{R^t} \text{ if } p_1^{t+1} > p_1^t \quad (3b)$$

is sufficient to ensure that $V\left(p_1^{t+1},\ p_2^{t+1}\right) \geq V\left(p_1^t,\ p_2^t\right)$. Moreover, since (3) permits the airport to select $p_1^{t+1} = p_1^t$ and $p_2^{t+1} = p_2^t$, by revealed preference it must be the case that $\pi\left(p_1^{t+1},\ p_2^{t+1}\right) \geq \pi\left(p_1^t,\ p_2^t\right)$. Therefore, application of (3) generates a Pareto improvement relative to the status quo. The price cap is illustrated in Figure 2. Constraint (3a) is satisfied in the diagonally shaded region. Constraint (3b) is satisfied in the horizontally shaded region. The entire shaded area lies below the iso-surplus curve passing through $\left(p_1^t,\ p_2^t\right)$, ensuring that consumer surplus cannot decrease when (3) is applied.

Figure 2



4. Discussion

The price cap scheme described by (3) generates Pareto improvements relative to the status quo by bringing the price of commercial services into the sphere of regulatory control. A conventional Laspeyres-based price cap cannot, however, be applied to airport regulation because of the asymmetric nature of the demands for aeronautical and commercial services, i.e., the demand for commercial services depends on the price of a flight but not vice versa. Our process works by exploiting bounds on the value of the derivative of the demand for aeronautical services and the value of consumer surplus for commercial services. Specifically, implementation requires the regulator to determine a lower bound on the slope of the demand for aeronautical services and an upper bound on the level of consumer surplus for commercial services. Bounds can be determined by estimating (i) the price elasticity of demand for aeronautical services and (ii) consumer surplus for commercial services when both aeronautical and commercial services are priced as marginal cost. While the process will in general result in simultaneous increases in consumer welfare and profit, a limit point of the procedure need not be a Pareto efficient price vector as is the case with conventional Laspeyres-based price cap regulation (e.g., Vogelsang and Finsinger 1979; Brennan 1989). This follows from the fact that the two-part price cap constraint in (3) is not differentiable. Thus, the process could terminate at a point for which additional Pareto improvements are possible. Of course, if the regulator has sufficient information to apply (2) directly in each time period, any limit point of the process will be Pareto efficient. In any case, as our results indicate that bringing the price of commercial services into the sphere of regulatory control in the manner described may generate substantial welfare improvements relative to the single-till and dual-till solutions.

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