Access Pricing Regulation in the U.S. Domestic Aviation Industry

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Abstract

I examine how regulatory preferences in setting a federal price cap on passenger facility charges (PFCs), the variable portion of an access price in the U.S. domestic aviation industry, have evolved over time. PFCs are a per-passenger charge paid by airlines to airports. Despite the fact that the PFC cap has declined in real terms since 2001, I find that regulators have given greater importance to airports since the turn of the century. There are a number of recent proposals to increase the price cap and, at a minimum, restore the cap to 2001 real levels. I find that a price cap decrease would instead be necessary to maintain the preferences of regulators in 2001.

Keywords: Access Pricing, Airports, Regulation, Regulatory Preference

JEL Codes: L5, D43, L93, L13

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1 Introduction

In many industries, downstream firms require access to upstream infrastructure for the production of a final good. The fee that downstream firms pay for access to infrastructure, termed an access charge, is often regulated. In the aviation industry, airlines require access to airport facilities to provide passenger service. Airlines pay airports a per-passenger fee for the right to use the airport.[1]

When setting an access charge, a regulator implicitly places an importance on each component of social surplus.[2] Regulatory preferences determine observed regulation and are central to the analysis of a regulatory policy. A substantial empirical literature explores the preferences of regulators when the final price is regulated.[3] The present research contributes to the literature by examining regulatory preferences in the setting of access prices, not final prices. First, I develop a methodology for inferring regulatory preferences in the access pricing setting. Second, I apply this methodology to the U.S. domestic aviation industry, exploring the evolution of regulatory preference over time.[4]

In the U.S. domestic aviation industry, a per-passenger access charge is referred to as a passenger facility charge (PFC). PFCs were introduced in 1992 and are subject to price cap regulation. Despite protestation from airports, this price cap has not been raised since 2001, even to keep pace with inflation. Airports contend that an increase is necessary to build sufficient infrastructure capacity to meet growing air travel demand. Appeals to raise the cap face fierce opposition from passenger airlines and their lobbyists. An unchanged or reduced price cap does not imply regulators have placed less importance on airports. Changes in consumer preferences or downstream market structure can raise the incremental cost, in terms of airline profit and consumer surplus, of an existing price cap. To determine if current regulatory policy represents an increased preference for airports relative to airlines and/or consumers, it is necessary to uncover the relative importance placed on airports by the regulator.

I assume a regulator acts to maximize a weighted sum of consumer surplus, downstream firm profit, and airport surplus in both periods. I define airport surplus to be total airport access charge revenue because PFC

[1]Within a large theoretical literature on access pricing regulation, studies that allow for imperfect downstream competition are most relevant to the U.S. aviation industry. Laffont and Tirole (1994) and Armstrong et al. (1996) examine optimal access pricing regulation when an upstream monopolistic provider of access also competes downstream (i.e., the case of a vertically integrated upstream supplier). In Lewis and Sappington (1999), the upstream supplier of access competes downstream, but the regulator is uncertain about the production costs of the unregulated competitor. Valletti (1998) examines access pricing in a vertically separated industry with a monopoly upstream supplier. Downstream firms engage in Cournot competition. The U.S. domestic aviation industry is vertically separated, but downstream airlines compete in prices. Armstrong (2001) and Vogelsang (2003) provide more general reviews of the theoretical access pricing literature.

[2]This importance could be based on equity principles or the influence of interest groups as in Stigler (1971) and Peltzman (1976).

[3]See Naughton (1988) and Nelson and Roberts (1989) (electricity), Ahn and Sumner (2009) (milk), Klein and Sweeney (1999) (natural gas), Montes (2013) (telecommunications), and Resende (1997) (water utilities).

[4]Morrison (1987) examines an access charge, runway prices, in the aviation industry. However, this study treats runway access as a final good purchased by airlines. Unlike the present study, consumer welfare is not considered in the regulator's surplus function.

revenue helps airports achieve their stated goals of improving airport quality and safety.[5] Demand estimates and an assumption of Bertrand Nash competition allow for the estimation of consumer surplus, downstream profit, and airport PFC revenue. However, the weights that a regulator places on each component are unknown. I use observed access prices to infer the weight on airport revenue which rationalizes the observed regulatory decision. This weight represents the importance the regulator placed on airports at a given time.[6] The current study estimates this weight, in both 2000 and 2018, to determine whether regulatory preferences have shifted in favor of airlines or airports.[7]

My findings suggest that the weight regulators placed on airports increased between 2000 and 2018. In other words, regulatory decision-making in 2018 is consistent with the maximization of a social welfare function that places greater weight on airports than in 2000. This is despite the PFC cap declining in real terms. This result is caused by an increase in the price elasticity of passenger travel demand. More consumers are making purchases directly, rather than through travel agents, due to the introduction of online booking. Because consumers are more price-sensitive than travel agents, who tend to choose the shortest route rather than the cheapest, consumer demand is more elastic. Additionally, a greater portion of consumers travelled for leisure purposes in 2018 than in 2000. Leisure travelers are typically more price-sensitive than business travelers. Because demand is more elastic in 2018, the elevated downstream prices due to access charges caused more consumers to substitute away from air travel. This results in diminished consumer surplus and airline profits. Even though access charges have declined in real terms, the burden of those charges on both consumers and airlines has increased. The current regulatory policy represents a shift in preference towards airports and away from airlines and/or consumers.[8]

An understanding of how implied regulatory preference has evolved over time is helpful when evaluating recent proposals to increase the PFC cap.[9] For example, a recent RAND report commissioned by Congress (Miller et al., 2020) argues the price cap should be increased back to 2001 levels in real terms (recall that the PFC cap is not indexed for inflation and therefore has declined in real terms since 2001). If the decline in the PFC cap since 2001 (in real terms) is consistent with a reduction in regulatory preference for airports, this proposal would represent a return toward 2001 regulatory preferences. In contrast, if

[5] In Online Appendix D, I consider other sources of airport revenue such as non-aeronautical revenues (e.g., parking or concessions) or revenues from other aeronautical fees (e.g., landing fees). I find that my key qualitative findings are likely to continue to hold if these alternative sources of airport revenue are included in the airport surplus function.

[6] Even if the regulator did not explicitly act to maximize such a weighted welfare function, its policy choices may be consistent with such behavior (Ross, 1984).

[7] While the price cap increase went into effect in 2001, I use 2000 data for two reasons. First, the legislation that mandated the price cap increase was signed in 2000 so regulators likely used market conditions in 2000 when making the decision. Second, data from quarter 3 of 2001 may not be representative due to the September 11th attacks. Results are robust to instead using data from quarter 2 of 2001. See Online Appendix C.3 for details.

[8] I do not attempt to explain the cause of this shift in regulatory preference. One potential explanation is that a reduction in the price cap, which would be necessary to maintain regulatory preference, would be politically unpopular as it benefits airlines and potentially weakens public infrastructure.

[9] See Online Appendix B.1 for a review of proposed price cap changes.

regulatory preference for airports has increased since 2001, this proposal would represent a further reduction in preference for consumers and airlines relative to airports. The current study addresses this question and finds that regulatory preference for airports has increased over time. Thus, recent proposals to increase the cap would represent a further shift in preference towards airports.

Determining how implied regulatory preference has evolved over the past 20 years is also informative for regulators setting the cap. For example, suppose Congress wishes to maintain its regulatory preference for airports over time and give the same weight to airports, airlines and consumers as in 2001. To implement these preferences, one may believe that the price cap should be increased back to 2001 levels (in real terms) as the PFC has declined in real terms between 2001 and 2018.[10] However, the results of this study suggest that this is not the case. Due to changes in consumer demand, a reduction, rather than increase, in the price cap would be necessary to restore prior levels of regulatory preference. More generally, the results of this study stress the importance of accounting for changes in factors such as demand, cost, market structure when making regulatory decisions.

The next section provides background on passenger facility charges in the U.S. domestic aviation industry. Section 3 introduces the methodology, air travel demand, airline competition, airport pricing, and the regulator's problem. Section 4 discusses data and Section 5 discusses estimation of the demand model. Section 6 presents demand estimation results and presents estimates of regulatory preference. Section 7 contains counterfactual simulations that demonstrate the effects of regulatory preferences in detail. Section 8 concludes. Additional details and analyses are available in the Online Appendix.[11]

2 Passenger Facility Charges

Airports in the United States are publicly owned, usually by local governments, airport authorities, or port authorities. Airports obtain the funds necessary to operate and expand from two primary sources: government grants[12] and charges for airport access and services (both aeronautical and non-aeronautical). Unlike other aeronautical fees (e.g., landing fees) that are generally intended to cover operational and capital costs of existing airfield facilities and services, PFC revenue is designated for airport expansion and improvement. The revenue from PFCs can be used only for eligible projects. An eligible project must enhance or preserve safety, decrease noise from the airport or enhance carrier competition.[13] For example, PFC revenue was used to redevelop and improve the capacity of John F. Kennedy International Airport (JFK)'s Terminal

[10]The price cap would need to be increased from $4.50 to $6.26 in 2018 to return the price cap to 2001 levels (when the cap was last increased).

[11]The Online Appendix can be found at https://douglascturner.com/access-pricing-online-appendix/.

[12]For example, airport improvement grants (AIPs).

[13]Federal Code 14 C.F.R. §158.9 2007

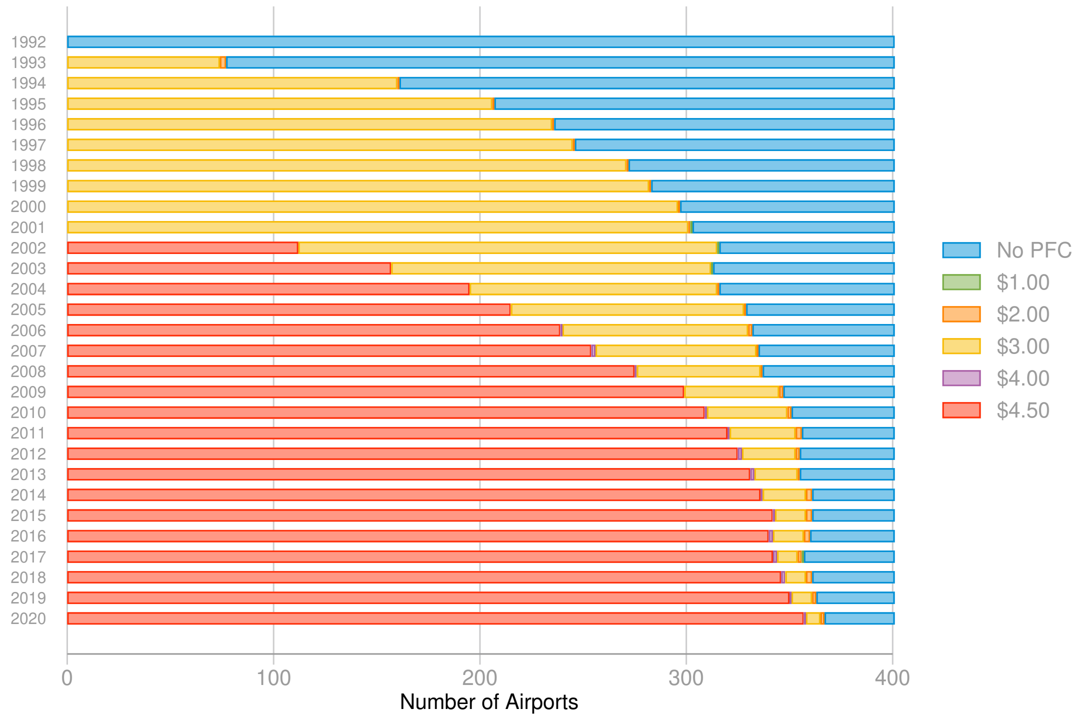

Figure 1: Passenger Facility Charge levels at U.S. Airports

3.[14] Portland International Airport (PDX) applied to use PFC revenue to rehabilitate a taxiway (preserving safety) while Key West International Airport (EYW) applied to use PFC revenue to finance a noise reduction plan.[15]

Since the introduction of the passenger facility charge program in 1992, PFCs have been subject to a price cap set by Congress. Previously, this cap was raised to keep pace with inflation and increased airport operations. Since 2001, when the price cap was raised in the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century, PFCs have remained capped at $4.50, despite requests for an increase from airport operators and some politicians. PFCs are not adjusted to account for inflation. Airports need the approval of the FAA before charging a PFC and are not necessarily approved to charge the maximum price. When the price cap was raised, airports quickly began acquiring approval to charge the new maximum. Passenger facility charges are restricted to take on values of 0, 1, 2, 3, 4, or 4.50 dollars per boarded passenger. Most airports charge no PFC, a PFC of $3, or a PFC of $4.50. Figure 1 shows the evolution of PFC levels over time at U.S. commercial airports. PFCs are collected each time a passenger boards a plane, but no more than 4 PFCs can be collected on any passenger trip.[16]

[14]Federal Register Vol. 79 No. 3. Notices. Monday, January 6, 2014.
[15]Federal Register Vol. 75 No. 53. Notices. Friday, March 19, 2010.
[16]See 49 U.S. Code § 40117.

Many proposals have been introduced during the past decade to increase the price cap or eliminate it entirely. These proposals are outlined in detail in Online Appendix B. Proposals to increase the price cap face strong opposition from airlines, airline trade associations, and their lobbyists. Airports allege that, by not increasing the price cap, regulators fail to value airport welfare sufficiently highly. Airlines argue the cap should not be increased as the current level already favors airports. To determine the relative valuations that regulators place on airports, airlines and consumers, it is necessary to infer the implicit weights a regulator places on each party's surplus. In the next section, I present a method to infer regulatory preference. By applying this method and comparing the preferences of regulators in both periods, it is possible to determine if regulatory preference has shifted in favor of airlines or airports.

3 Methodology and Model

3.1 Methodology

Ahmad and Stern (1984) and Ross (1984), building on the work of McFadden (1975), introduce a general method to infer the relative weight a regulator places on different components of social welfare when the final price of a good is regulated. The regulator chooses final prices to maximize a weighted sum of social surplus. The weights, which represent the relative preference a regulator places on each component of welfare, are unknown. Observed, regulated prices satisfy the first order conditions associated with this problem. By inverting these first order conditions, the relative weights which rationalize observed final prices can be recovered. Even if the regulator did not have the proposed objective and social welfare weights in mind when setting prices, they acted as if they did.[17]

The current study adapts the method of Ahmad and Stern (1984) and Ross (1984) to the access pricing regulation setting. There are two differences. First, when considering the optimal choice of access charge, the regulator now considers not only the welfare of consumers and the regulated entity but also downstream firms that engage in imperfect competition. Second, the regulator chooses an access charge (or an access charge cap) rather than a final price.

For simplicity, the methodology is introduced in a setting involving a monopoly upstream entity, two single product downstream firms and one access charge. The two downstream firms (denoted $i = 1, 2$) produce substitute products, are unregulated, and produce with marginal cost c_i^D. Consumer demand for product i (produced by firm i) is denoted $D_i(p_1, p_2)$. There exists a monopoly supplier, which may be

[17] The method of Ahmad and Stern (1984) and Ross (1984) has been applied extensively to analyze regulatory decision making in a variety of industries including electricity (Naughton, 1988; Nelson and Roberts, 1989), milk (Ahn and Sumner, 2009), natural gas (Klein and Sweeney, 1999), telecommunications (Montes, 2013), airport runway pricing (Morrison, 1987) and water utilities (Resende, 1997).

either public or private, of a necessary upstream input called access. The upstream entity provides access with constant marginal cost c^U. The price of access, the access charge, is denoted w. A price cap on the access charge, which is set by the regulator, is denoted $\overline{w}$. Let $p_i^*(w)$ denote the Nash equilibrium price of downstream firm i when the access charge is w:

$$p_i^*(w) = \text{argmax}_{p_i} D_i(p_i, p_{-i}^*(w))(p_i - c_i^D - w).$$

Let $\Pi_i^D(w) = D_i(p_1^*(w), p_2^*(w))(p_i^* - c_i^D - w)$ denote Nash equilibrium profits of downstream firm i when the access charge is w. A change in access price induces a change in downstream prices, affecting both downstream profit and consumer welfare. Let $\Pi^U(w)$ denote upstream surplus when the access price is w. Upstream entities choose an access charge to maximize their surplus subject to the price cap. In the case of a private firm, surplus is upstream firm profit $\sum_i D_i(p_1^*(w), p_2^*(w))(w - c^U)$. Let $w^*(\overline{w})$ denote this access charge:

$$w^*(\overline{w}) = \text{argmax}_{w \leq \overline{w}} \Pi^U(w).$$

In what follows, I assume the price cap is binding, $w^*(\overline{w}) = \overline{w}$.[18] $CS(w)$ denotes consumer surplus at the Nash equilibrium prices that result from an access charge of w.

Consider the problem of a regulator tasked with choosing a price cap $\overline{w}$ to maximize a weighted sum of three components: consumer surplus, upstream surplus, and downstream profit. The regulator's problem is[19]

$$\max_{\overline{w}} CS(\overline{w}) + \gamma\left(\Pi_1^D(\overline{w}) + \Pi_2^D(\overline{w})\right) + \alpha\Pi^U(\overline{w}) \tag{1}$$

where α denotes the regulatory preference for upstream surplus relative to consumer surplus and γ denotes regulatory preference for downstream profit relative to consumer surplus. The regulatory weight on consumer surplus is normalized to 1 without loss of generality. Thus, α and γ are interpreted as regulatory preference for airports and airlines relative to preference for consumers. When $\alpha = \gamma = 1$, the regulator cares equally about each of the three components above. $\frac{\alpha}{\gamma}$ denotes regulatory preference for upstream surplus relative to downstream profit. As $\alpha \to \infty$, the regulator cares solely about upstream surplus. As $\alpha \to 0$, she cares entirely about downstream profits and consumer welfare.

[18] If $\Pi^U(w)$ is strictly concave, this assumption holds if the cap is less than the monopoly access charge, $\overline{w} < w^M = \text{argmax}_w \Pi^U(w)$.

[19] For simplicity, I assume any relevant participation constraints are satisfied at the solution to the regulator's problem.

Assuming concavity of the objective, the solution is characterized by the first order condition,

$$\frac{\partial CS(\overline{w})}{\partial w} + \gamma \left(\frac{\partial \Pi_1^D(\overline{w})}{\partial w} + \frac{\partial \Pi_2^D(\overline{w})}{\partial w} \right) + \alpha \frac{\partial \Pi^U(\overline{w})}{\partial w} = 0. \tag{2}$$

To uncover the regulatory preference weight α which rationalizes an observed access charge/price cap of w^{obs}, equation (2) is solved for α:[20]

$$\alpha = -\frac{\frac{\partial CS(w^{obs})}{\partial w} + \gamma \left(\frac{\partial \Pi_1^D(w^{obs})}{\partial w} + \frac{\partial \Pi_2^D(w^{obs})}{\partial w} \right)}{\frac{\partial \Pi^U(w^{obs})}{\partial w}}. \tag{3}$$

α represents an "implicit preference" (Christiansen and Jansen, 1978) because even if the regulator did not set $\overline{w}$ by considering and solving the problem in equation (1), they acted as if they did solve the problem in equation (1) with an α value given in equation (3). I will consider a range of values for γ.[21]

3.2 Model

The methodology of Section 3.1 requires estimates of airline profit, consumer welfare, and airport surplus as a function of the access charge. To derive these estimates, it is necessary to specify a model of air travel demand, airline competition, and airport surplus. The model is presented suppressing time subscripts $t \in \{2000, 2018\}$. All components of the model will be estimated separately for both quarter 3 of 2000[22] and quarter 3 of 2018.[23] Section 3.2.1 presents the air travel demand model. Section 3.2.2 presents the model of airline competition. Section 3.2.3 presents the airport surplus function. Section 3.2.4 discusses the regulator's problem.

3.2.1 Air Travel Demand

Following prior literature,[24] consumer demand for air travel is modeled with a nested logit demand model.[25] All air travel products are placed in one nest and the outside good is placed in a second nest. The utility of

[20]As the price cap is binding by assumption, the observed price cap equals the observed access charge.

[21]As the regulator maximizes the objective over only one variable (the price cap), its not possible to infer regulatory weights for both airlines and airports simultaneously. However, one can examine the robustness of results by inferring α under a range of values for γ.

[22]While the price cap increase went into effect in 2001, I use 2000 data for two reasons. First, the legislation that mandated the price cap increase was signed in 2000 so regulators likely used market conditions in 2000 when making the decision. Second, data from quarter 3 of 2001 may not be representative due to the September 11th attacks. Results are robust to instead using data from quarter 2 of 2001. See Online Appendix C.3 for details.

[23]The most recently available data, when this project began, was from quarter 3 of 2018.

[24]See Doi (2019), Chen and Gayle (2019), Peters (2006), White III (2019) and Aguirregabiria and Ho (2012).

[25]A nested logit demand allows for correlations between choices that are within the same nest but requires independence of choices between nests.

individual i in market m from air travel product j is

$$u_{ijm} = -\beta_p p_{jm} + x'_{jm}\beta + \xi_{jm} + v_{im}(\rho) + (1-\rho)\epsilon_{ijm}$$

where x'_{jm} is a vector of product or market characteristics and p_{jm} is the price. $\theta_d = \{\beta_p, \beta, \rho\}$ are demand parameters to be estimated. ξ_{jm} is an unobserved portion of utility that results from unobserved product characteristics including in-flight amenities, departure time and flight frequency. ϵ_{ijm} is a standard type I extreme value error term and ρ is a nesting parameter. v_{im} has a distribution such that $v_{im}(\rho) + (1-\rho)\epsilon_{ijm}$ also follows an extreme value distribution. These assumptions generate a classic nested logit error structure. Let $\delta_{jm} = -\beta_p p_{jm} + x'_{jm}\beta + \xi_{jm}$ denote the portion of utility that is common to all individuals, the mean utility. I normalize the mean utility of the outside option to 0.

The unconditional probability of an individual choosing airline product j in market m is

$$s_{jm}(x_{jm}, p_{jm}, \xi_{jm}, \theta_d) = \frac{e^{\delta_{jm}/(1-\rho)}}{V_m} \frac{(V_m)^{1-\rho}}{1 + (V_m)^{1-\rho}},$$

where $V_m = \sum_{j \in \mathcal{J}_m} e^{\delta_{jm}/(1-\rho)}$ and $\mathcal{J}_m$ is the set of airline products in market m. The unconditional probability of an individual choosing airline product j in market m is also the market share of product j in market m.

Due to the endogeneity of prices and shares, additional restrictions are placed on the model in the form of moment conditions. Demand moments are formed from interactions between demand unobservables ξ_{jm} and a vector of demand instruments,

$$E[\xi_{jm}(\theta_d) Z^D_{jm}] = 0 \tag{4}$$

for all j and m. Airlines are assumed to make pricing decisions after the observation of ξ_{jm}. Thus, prices and shares are correlated with ξ_{jm}. All other product characteristics are assumed to be orthogonal to ξ_{jm}.

Let $\mathbf{p_m}$ denote the vector of equilibrium prices in market m. $\mathbf{p} = [\mathbf{p_1} \dots \mathbf{p_M}]'$ represents equilibrium prices in all markets where M is the number of markets. Consumer surplus, assuming away non-linear income effects, is

$$CS_m(\mathbf{p_m}; \theta_d) = \frac{ln\left(1 + e^{K_m(\mathbf{p_m}; \theta_d)}\right)}{\beta_p}$$

where

$$K_m(\mathbf{p_m}; \theta_d) = (1-\rho) ln\left(\sum_{j \in \mathcal{J}_m / \{0\}} exp\{\delta_{jm}(p_{jm}; \theta_d)/(1-\rho)\}\right).$$

$K_m(\mathbf{p_m}; \theta_d)$ is known as a nested logit inclusive value. $K_m(\mathbf{p_m}; \theta_d)$ is the expected utility from choice given the decision to purchase an air travel product. $CS_m(\mathbf{p_m};\theta_d)$ is the expected utility of choice between the outside option and a bundle of air travel products $\mathcal{J}_m$ at prices $\mathbf{p_m}$, which would yield a utility of $K_m(\mathbf{p_m};\theta_d)$. Aggregate consumer surplus can be written as

$$CS(\mathbf{p}) = \sum_m M_m CS_m(\mathbf{p_m}) \tag{5}$$

where M_m is the market size of market m. Market size is defined as the geometric mean of the population of the origin metropolitan statistical area and destination metropolitan statistical area.[26]

3.2.2 Airline Competition

Let w_a denote the PFC level at airport a and let $\mathbf{w}$ denote an $A \times 1$ vector of PFC levels where A is the total number of airports. The PFC associated with product j in market m is

$$pfc_{jm}(\mathbf{w}) = w_{a_1} + w_{a_2} + \dots w_{a_n} \tag{6}$$

where a_i is the airport where the ith departure occurs for product j and n is the number of departures for product j.[27]

Given airports' PFC choices, carriers simultaneously and independently set prices in each market to maximize[28]

$$\pi_{fm} = M_m \sum_{j \in \mathcal{J}_{fm}} s_{jm}(\mathbf{p_m})(p_{jm} - c_{jm} - pfc_{jm})$$

where p_{jm} is the price of product j and $\mathbf{p_m}$ is the vector of prices in market m. c_{jm} is the marginal cost of product j which is assumed to be constant. $\mathcal{J}_{fm}$ denotes the products offered by carrier f in market m. pfc_{jm} denotes the observed per passenger facility charge for this product.

The firms' profit-maximizing prices are determined by:

$$0 = s_{km}(\mathbf{p_m}) + \sum_{j \in \mathcal{J}_{fm}} \frac{\partial s_{jm}}{\partial p_{km}}(p_{jm} - c_{jm} - pfc_{jm}) \tag{7}$$

for each $k \in \mathcal{J}_{fm}$ and each market m. Equation (7) can be re-written in matrix notation as

$$c_m = \mathbf{p_m} + [O_m \cdot D_m]^{-1} s_m(\mathbf{p_m}) - pfc_m(\mathbf{w}) \tag{8}$$

[26] Population data is from the U.S. Census (https://www2.census.gov/programs-surveys/popest/datasets/).

[27] For a connecting product from LGA to MIA connecting through ATL in both directions, $a_1 = LGA$, $a_2 = ATL$, $a_3 = MIA$ and $a_4 = ATL$. Note that two PFCs are collected at ATL, one PFC is collected at LGA and one PFC is collected at MIA. See 49 U.S. Code § 40117.

[28] In Online Appendix C.4, I show that the main results are robust to relaxing this assumption and allowing airlines to coordinate pricing decisions.

where s_m is a vector of market shares and D_m is a matrix of partial derivatives where the (i, j) element is $\frac{\partial s_{jm}}{\partial p_{im}}$. c_m is a vector of marginal costs and pfc_m is a vector of passenger facility charges. O_m is an ownership matrix for market m where the (i, j) entry equals 1 if products i and j are owned by the same firm and 0 otherwise. Given demand estimates, observed prices, market shares and PFC levels, equation (8) can be solved for the vector of marginal costs c_m.[29] Airline profit is

$$\Pi_f(\mathbf{p}, \mathbf{w}) = \sum_m M_m \sum_{j \in \mathcal{J}_{fm}} s_{jm}(\mathbf{p_m})(p_{jm} - c_{jm} - pfc_{jm}(\mathbf{w})). \tag{9}$$

$\Pi^D(\mathbf{p}, \mathbf{w}) = \sum_f \Pi_f(\mathbf{p}, \mathbf{w})$ is total industry profit. Let $\mathbf{p}(\mathbf{w}; \theta_d)$ be the $N \times 1$ vector of equilibrium prices given a vector $\mathbf{w}$ of PFC levels and demand parameters θ_d where N denotes the number of products.

3.2.3 Airports

Airport executives and management consider their primary objectives to be providing efficient and safe facilities, stimulating growth in the local economy, and delivering a quality airport experience.[30] PFC proceeds help airports achieve each of these goals because PFCs can be used for projects that enhance safety, increase capacity (benefiting the local economy), or improve the consumer experience (such as terminal improvement).[31] Incentive structures such as performance-based pay (Advani and Borins, 2001) ensure that managers, who are responsible for submitting a PFC application, work to achieve these goals. Since additional PFC revenue helps managers meet airport goals and benefit personally, I assume airport surplus is equal to airport revenue from PFCs.[32]

The investment of PFC proceeds also benefits future consumers in two ways. First, once PFC projects are complete, consumers experience safer and higher quality airport facilitates. Second, the increased future downstream competition that results from PFC projects can also benefit future consumers through lower prices. As all PFC proceeds must be used for approved projects that benefit consumers after completion, airport revenue is a proxy for the increased future consumer surplus that PFC proceeds bring consumers plus the increase in the surplus of airport managers. When a regulator considers an increase in the PFC cap, the tradeoff is between short-run consumer welfare and airline profit, and the increased future surplus that additional airport funds will bring.

[29] I use pyblp (Conlon and Gortmaker, 2020) for demand and marginal cost estimation.

[30] The Houston Airport System states "The mission of the Houston Airport System (HAS) is to provide safe, efficient and appealing facilities to satisfy the air transportation needs of the Greater Houston Region at competitive prices while stimulating growth in its economy." (Source: http://www.houstontx.gov/budget/12budprop/IX_AIR.pdf).

[31] Although increased competition is a stated objective of the PFC program, only approximately 23% of PFC revenue (https://www.faa.gov/airports/pfc/monthly_reports/media/category-interest-lump-sum.pdf) since the inception of the program has been allocated to the construction of new terminals or terminal expansion. Terminal, or gate access, is the primary barrier to entry in the U.S. airline industry (Ciliberto and Williams, 2010).

[32] In Online Appendix D, I consider the impact of including other sources of airport revenue in the airport surplus function on implied regulatory preference.

Airports choose an access charge to maximize PFC revenue subject to the price cap. As can be seen in Figure 1, most airports (especially large airports considered in this study) increased their PFC to the new cap within a few years of the last increase. In light of this, I assume that any airport which currently offers the maximum PFC level would increase its PFC level to the new cap upon a price cap increase.[33] Indeed, counterfactual airport revenue from a greater access charge exceeds current airport revenue. This suggests that the existing price cap constrains airports into charging a PFC level below the revenue-maximizing level which would prevail without regulation. At the very few airports not currently charging the maximum PFC, I increase their hypothetical PFC level by the amount of the price cap increase in counterfactuals.[34] For a decrease in the price cap, I assume airports charge the minimum of their current PFC level and the new price cap.

I assume that downstream firms' and airports' participation constraints do not bind. Put differently, I assume the increases in PFCs considered in this study do not cause entry or exit by airlines, nor the closure of airports.[35]

3.2.4 The Regulator's Problem

The regulator's problem is

$$\text{argmax}_{\overline{w}} \quad CS(\mathbf{p}^*(\overline{w})) + \gamma \Pi^D(\mathbf{p}^*(\overline{w}), \mathbf{w}(\overline{w})) + \alpha R(\mathbf{p}^*(\overline{w}), \mathbf{w}(\overline{w})). \tag{10}$$

$\mathbf{w}(\overline{w})$ is a vector of PFC levels when the PFC cap is $\overline{w}$. $\mathbf{p}^*(\overline{w})$ are Nash equilibrium prices under a PFC cap of $\overline{w}$. Airport revenue is

$$R(\mathbf{p}, \mathbf{w}) = \sum_{a=1}^{A} R_a(\mathbf{p}, \mathbf{w})$$

where $R_a(\mathbf{p}, \mathbf{w}; \theta_d)$ is the revenue raised at airport a given equilibrium downstream prices $\mathbf{p}$ and PFC levels $\mathbf{w}$. The revenue at airport a is[36]

$$R_a(\mathbf{p}, \mathbf{w}) = w_a \sum_m M_m \sum_{j \in \mathcal{J}_m} 1\{j \in A^a_{m,od}\} s_{jm}(p_m) + 2 * 1\{j \in A^a_{m,c}\} s_{jm}(p_m)$$

[33] In Online Appendix C.2, I relax this assumption and instead assume some airports charging the maximum PFC level would not increase their cap to the new level upon a price cap increase. Results are qualitatively unchanged.

[34] For example, *CLT* airport charges an access charge of \$3. If the cap increases from \$4.50 to \$5.50, I assume the PFC level at *CLT* increases to \$4. Results are robust to instead assuming a corresponding percentage increase. Results are also robust to instead assuming airports which charge a PFC below the cap do not change their PFC after the cap is raised. See Online Appendix C.2 for additional details.

[35] With regards to airlines, this is potentially a strong assumption. Without a complete model of firm entry, exit and fixed costs, it would not be feasible to consider the participation constraints of airlines. With regards to airports, PFC revenue is not intended to cover operational costs so a lack of PFC revenue should not cause the closure of an airport.

[36] I restrict attention to roundtrip products and products consisting of no more than 1 connection in each direction (see Section 4).

where $A^a_{m,od}$ is the set of (round trip) products in market m where airport a is either the originating airport or the destination airport. $A^a_{m,c}$ is the set of products in market m where airport a is the connecting airport. w_a is the access charge at airport a. Let

$$W(\overline{w};\alpha) \equiv CS(\mathbf{p}^*(\overline{w})) + \gamma\Pi(\mathbf{p}^*(\overline{w}), \mathbf{w}(\overline{w})) + \alpha R(\mathbf{p}^*(\overline{w}), \mathbf{w}(\overline{w}))$$

denote the regulator's objective as a function of the price cap $\overline{w}$. I will consider a range of values for the parameter γ.

For robustness, I also consider an alternative specification of the regulator's problem:

$$\text{argmax}_{\overline{w}}\Pi(\mathbf{p}^*(\overline{w}), \mathbf{w}(\overline{w})) + \alpha R(\mathbf{p}^*(\overline{w}), \mathbf{w}(\overline{w})).$$

In this specification, regulators place no weight on consumer surplus.

4 Data

This paper uses three data sources. Data on airline ticket prices, ticket characteristics, and passenger numbers are from the airline origin and destination survey (DB1B).[37] The DB1B is a 10% random sample of U.S. domestic airline tickets collected by the Bureau of Transportation Statistics. The DB1B does not contain information on ticket restrictions (e.g., weekend stay over requirements or advance purchase requirements) which then constitute an unobserved element of utility. Data on passenger facility charges comes from the Federal Aviation Administration (FAA).[38] Population data is from the U.S. census metropolitan and micropolitan statistical area totals.[39]

I use DB1B data from quarter 3 of 2000 and 2018. Although passenger facility charges are assessed on international flights departing from the United States, I restrict attention to domestic markets.[40] For computational simplicity and tractability, I restrict to products involving only the top 100 U.S. airports as of 2018.[41] Following Berry et al. (2006) and Berry and Jia (2010), I drop any products involving airports in Alaska, Hawaii, or Puerto Rico. This results in a total of 94 airports in 79 metropolitan statistical areas.[42]

[37] https://www.transtats.bts.gov/DatabaseInfo.asp?DB_ID=125
[38] https://www.faa.gov/airports/pfc/monthly_reports/
[39] https://www.census.gov/data/tables/time-series/demo/popest/2010s-total-metro-and-micro-statistical-areas.html
[40] This is primarily due to data availability. PFCs have a smaller impact on international markets as they are a smaller percentage of the ticket price and are not collected on flight segments departing foreign airports.
[41] While over 300 U.S. airports charge PFCs, many constitute only a very small fraction of U.S. travel in terms of passengers and make up only a small portion of total PFC revenue.
[42] Aguirregabiria and Ho (2012) make a similar restriction and restrict to the top 75 cities. Ciliberto and Williams (2014) restrict to the top 200 airports. Ciliberto and Tamer (2009) use the top 100 metropolitan statistical areas. Berry (1992) uses the top 50 cities.

These airports serve approximately 78.3% of total departing domestic passengers in 2000 and 81.1% of total domestic departing passengers in 2018. I follow Berry and Jia (2010) and restrict the sample to roundtrip products. I also only consider products that connect through, at most, one airport as this constitutes the majority of itineraries.[43] Other sample restrictions are outlined in Online Appendix A. The final sample size is 23934 products in 2000 and 18649 products in 2018.

A market is defined as directional travel between two metropolitan statistical areas. Markets can contain products involving different airports. Products are defined by the sequence of airports involved in the itinerary and the ticketing carrier.

4.1 Control Variables

The demand specification includes a number of variables relevant to airline demand. Ticket price and an indicator for a product being nonstop are included. These are the two most important determinants of passenger utility. The nonstop distance between the origin and destination airport and the square of this distance are also included in the demand specification. These variables account for how differences in trip distance affect passenger utility. Connecting products involve flying some additional distance to travel between the origin and destination airport. Connections that are more conveniently located between origin and destination yield shorter travel times and distances. To account for this variation, I include the ratio of the distance flown to the nonstop distance between the two endpoint airports in the demand specification. The scope of a carrier's service from the origin airport is an important determinant of airline demand (Ciliberto and Tamer, 2009; Berry, 1992; Berry and Jia, 2010). Loyalty programs (such as frequent flyer programs) are more effective if accrued benefits can be used on a greater variety of routes. Additionally, carriers with a large presence at the origin airport can offer superior airport amenities (e.g., business lounges). I include dummy variables for Alaskan Airlines, American West, Continental, Delta, Northwest, Southwest, Transworld Airlines, US Airways, and United (American represents the baseline). For smaller low cost carriers (LCCs), I aggregate into a single group for simplicity. The group denoted *Other Low Cost Carriers* includes low cost carriers other than Southwest.[44]

[43] Among roundtrip itineraries, 64.2% of connecting products connect through at most one airport.

[44] Allegiant Airlines (G4), Spirit Airlines (NK), Frontier Airlines (F9), JetBlue Airlines (B6), Airtran Airways (FL), National Airlines (N7), Vanguard Airlines (NJ), ATA Airlines (TZ) and Sun Country Airlines (SY)

5 Estimation

5.1 Demand

Demand is estimated with the generalized method of moments (GMM), as in Berry and Jia (2010), Ciliberto and Williams (2014) and Gayle (2013). I estimate demand separately for each time period. GMM minimizes an objective function formed from sample analogs of the moments in equation (4).

For a given value of the parameters θ_d, I find for the value of $\xi_{jm}(\theta_d)$ that solves

$$s_{jm}(x_{jm}, p_{jm}, \xi_{jm}(\theta_d), \theta_d) = \bar{s}_{jm} \tag{11}$$

where s_{jm} denotes the market share implied by the model given this set of parameters and $\bar{s}_{jm}$ is the market share observed in the data. The GMM objective function is

$$G(\theta_d) = \xi(\theta_d) Z W Z^T \xi(\theta_d)$$

where $\xi(\theta_d)$ is a stacked vector of demand residuals, Z is a matrix of instruments and W is a weighting matrix. I employ two step optimal GMM with a first stage estimate of $(Z^T Z)^{-1}$. The GMM estimate is

$$\hat{\theta}_d = \text{argmin}_{\theta} G(\theta).$$

Demand instruments should be correlated with endogenous regressors such as price, but uncorrelated with unobserved product characteristics in ξ_{jm}. I assume that firms choose how many products to provide and those products' observed characteristics (e.g., nonstop versus connecting service) before the realization of demand unobservables. Price is chosen after the realization of ξ_{jm}, causing its endogeneity. All product characteristics are valid instruments as they are chosen before the realization of ξ_{jm}. In addition, I utilize three additional sets of instruments. The first set consists of BLP (Berry et al., 1995) instruments, as in Berry and Jia (2010) and Peters (2006). These instruments are averages or sums of rival product characteristics. Specifically, I use the average distance of rival products, the number of direct rival products, the average origin presence of rivals, the average destination presence of rivals and the number of carriers in the market. As firms choose price after observing rival product characteristics, these variables are likely correlated with price. Additionally, by the timing assumption, they are uncorrelated with ξ_{jm}.

The second set of instruments includes cost based instruments. I interact an indicator for LCC products with the above BLP instruments and exogenous product characteristics (provided they are not multicollinear). I also include a product's PFC as an instrument. Finally, I include the number of products in a market as an instrument, following Peters (2006). This variable has relevance for identifying the nesting parameter ρ. An instrument that properly identifies ρ is correlated with the inside market share of a product but not ξ_{jm}. The number of products in a market should affect inside market shares. The orthogonality between this instrument and ξ_{jm} follows from the assumption that decisions about product offerings are made before the realization of demand unobservables. Following a similar argument, and in order to identify both the price and nesting parameter, I include the percentage of rival products and the number of LCC products as instruments.

5.2 The Regulator's Problem

To characterize the solution to the regulator's problem (equation (1)) under a range of parameter values α, it is necessary to simulate the effects of a change in the PFC cap. I follow the following procedure.

First, I compute new access charges, $\mathbf{w}^{new} \equiv \mathbf{w}(\overline{w})$, for each airport. Next, I compute PFC levels for each product following equation (6). Next, I solve, for each market, the first order conditions in equation (8) for a new set of equilibrium prices $\mathbf{p}^{new} \equiv \mathbf{p}(\mathbf{w}^{new}; \hat{\theta}_d)$ and market shares, given demand estimates in Section 6.1. This involves computing new prices and shares by using the fixed point iteration of Morrow and Skerlos (2011). I hold fixed the firms in each market, their product offerings, observed product attributes and unobserved product attributes ξ_{jm}. Lastly, I compute airline profits $\Pi_f^D(\mathbf{p}^{new}, \mathbf{w}^{new}; \hat{\theta}_d)$, consumer surplus $CS(\mathbf{p}^{new}; \hat{\theta}_d)$ and airport revenue $R_a(\mathbf{p}^{new}, \mathbf{w}^{new}; \hat{\theta}_d)$.

The function

$$x(\alpha) \equiv \text{argmax}_{\overline{w}} W(\overline{w}; \alpha, \theta_d)$$

characterizes the optimal price cap as a function of α. $x^{-1}(\bar{w})$ is the weight a regulator must place on airport surplus for a price cap choice of $\bar{w}$ to be optimal. Substituting the parameter estimates from Section 6, $x(\alpha)$ can be estimated with

$$\hat{x}(\alpha) \equiv \text{argmax}_{\overline{w}} W(\overline{w}; \alpha, \hat{\theta}_d).$$

$\hat{x}(\alpha)$ is the solution to the nonlinear maximization of $W(\overline{w}; \alpha, \hat{\theta}_d)$ over $\overline{w}$. At each step in the non-linear search, I evaluate $W(\overline{w}; \alpha, \hat{\theta}_d)$ by recomputing access charges, prices and market shares, as above. $\hat{x}(\alpha)$ is not estimated statistically but inferred from demand estimates and an assumption that the regulator acts to maximize the objective $W(\overline{w}; \alpha, \theta_d)$ in each period.

Implied regulatory preference $\hat{\alpha}$ can be calculated in two ways. First, $\hat{\alpha}$ can be calculated by solving $\hat{\alpha} = \hat{x}^{-1}(\bar{w}_{obs})$ where $\bar{w}_{obs}$ is the observed price cap (i.e., 4.50 in both periods). Second, $\hat{\alpha}$ can be calculated using Equation (3) by estimating the relevant derivatives at the observed price cap. Both approaches yield identical results.

6 Estimation Results

6.1 Demand Results

Table 1: Demand Results

	2000 Nested Logit (NL)		2018 Nested Logit (NL)	
Variable	Mean	SE	Mean	SE
Intercept	-5.752***	(0.074)	-5.192***	(0.157)
Prices	-0.269***	(0.01)	-0.599***	(0.034)
Nonstop	1.141***	(0.019)	1.127***	(0.037)
Nonstop Distance	-0.255***	(0.037)	-0.069	(0.052)
Nonstop Distance Squared	0.059***	(0.012)	0.069***	(0.017)
Number of Dest. Origin	0.892***	(0.038)	0.795***	(0.043)
Distance Ratio	-0.413***	(0.03)	-0.178***	(0.038)
Continental	-0.224***	(0.02)		
Northwest	-0.164***	(0.019)		
US Airways	-0.344***	(0.02)		
American West	-0.015	(0.026)		
Transworld	-0.119***	(0.021)		
Delta	-0.105***	(0.017)	0.366***	(0.018)
United	0.162***	(0.02)	-0.009	(0.02)
Southwest	-0.153***	(0.023)	-0.29***	(0.028)
Other LCC	0.015	(0.026)	-1.45***	(0.087)
Alaskan	0.623***	(0.062)	0.261***	(0.043)
ρ	0.458***	(0.005)	0.457***	(0.009)
Own. elasticity	-2.107		-4.055	
Avg. Lerner	.545		.319	

Notes: This table presents nested logit demand estimates in 2000Q3 and 2018Q3. Standard errors are heteroskedasticity robust. *** p<.01, ** p<.05, *p<.1.

Table 1 presents demand estimation results. As expected, consumers prefer lower prices and nonstop service. The striking difference between estimates in 2000 and 2018 is the price sensitivity. Consumer demand for air travel has become more elastic between 2000 and 2018. Consumers in 2018 are less averse to inconvenient itineraries, as measured by the distance ratio variable. I present two potential explanations for these demand changes: changes in the way tickets are booked and changes in the proportion of business travelers.

In 2018, brick and mortar travel agents were far less common than in 2000. Instead, tickets are purchased online. Online ticketing websites primarily sort fares by price. Travel agent software previously ranked fares by their convenience, usually measured by duration (Ater and Orlov, 2015). Most tickets booked through travel agents appeared on the first page of search results in travel agent software, or even on the first line (Guerin-Calver, 1994). As tickets are sold primarily online in 2018, a higher price causes a product to fall lower in search results. Consumers purchase more expensive products less which presents as an increase in price sensitivity. A longer or less convenient product, in 2000, drops in travel agent software search results. These products suffer lower sales which presents as a high consumer sensitivity to products' distance ratio in 2000 demand results. The shift to online booking has changed consumer preferences, as expressed through purchasing power, such that consumers appear more sensitive to price and less sensitive to the inconvenience of products in 2018.

In 1997, the Airlines for America annual travel survey determined that 46 percent of U.S. air travel was for business purposes.[45] In 2018, the same survey determined that only 28% of air travel was for business purposes. Business travelers are less price-sensitive than other types of travelers. Business travelers prioritize convenience (as expressed through the distance ratio variable) instead of price. Leisure travelers are more price-sensitive because they can more easily change or cancel travel plans due to high prices but do not place as much importance on convenience. The changes in demand between 2000 and 2018 can thus be explained by a decrease in the proportion of business travelers and an increase in the proportion of leisure travelers.

The mean own-price elasticity is -2.107 in 2000 and -4.102 in 2018. These elasticities fall within a broad range of estimates from prior literature.[46] Previous elasticity estimates also support the finding that demand has become more price elastic over the past 2 decades. This increase in elasticity causes smaller markups. The model yields an average Lerner index of .545 in 2006 and 0.315 in 2018.[47]

[45]No 2000 data is available because the survey was not conducted between 1998 and 2014.

[46]Bontemps et al. (2020) find an elasticity of -4.69 in 2011 using a nested logit model. Ciliberto and Williams (2014) find an elasticity of -4.320 in 2006-2008, while Berry and Jia (2010) find a far lower elasticity of -2.10 in their main specification. This difference is likely driven by the way Berry and Jia (2010) define products in terms of fare bins (grouping tickets with similar fares into the same product). The approach of this paper, which does not utilize fare bins, is more comparable to Ciliberto and Williams (2014). Gayle (2013), using a random coefficients logit with continuous heterogeneity, found an elasticity of -4.72 with data from 2006. Using data from 1995 and both nested logit and generalized extreme value demand, Peters (2006) estimated elasticities ranging from -3.2 to -4, depending on the specification. Lastly, using more recent data from 2005 to 2013, Chen and Gayle (2019) found a value of -1.67 using a nested logit demand.

[47]This computation assumes Bertrand Nash competition. The 2000 Lerner index estimate is consistent with estimates of Berry et al. (2006) and Berry and Jia (2010), who report Lerner indexes around .6. Gayle (2013), using data from 2006, reports, for the subset of products he considers, a Lerner index of .39, which is closer to the result of this paper in 2018. Bontemps et al. (2020) find a Lerner index of .24 in 2011.

6.2 The Solution to the Regulator's Problem

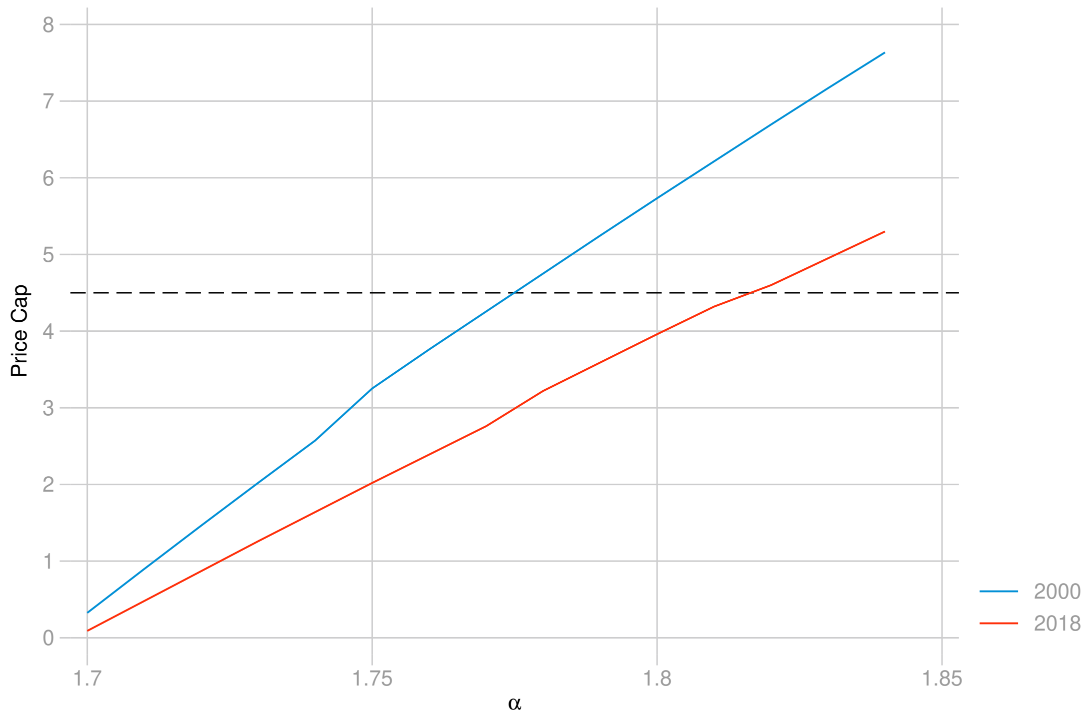

Figure 2: $\hat{x}(\alpha)$: The Solution to the Regulator's Problem in Equation (10)

Figure 2 presents $\hat{x}(\alpha)$, the solution to the regulator's problem in (10), for both 2000 and 2018 when $\gamma = 1$.[48] Thus, the regulator is assumed to place the same weight on airlines and consumers. The price cap, in this plot, is in nominal terms so the chosen price cap in each period corresponds to the dashed line at $y = 4.5$. Recall that $\gamma = 1$ which implies $\hat{\alpha} = \frac{\hat{\alpha}}{\gamma}$. Thus, the inferred regulatory preference parameter $\hat{\alpha}$ represents regulatory preference for airports relative to both consumers and airlines. A regulator who places equal weight on all components of the objective ($\alpha = 1$), would set a price cap of 0 and remove PFCs altogether, in both years. The existence of PFCs then implies that a greater weight is placed on the revenue of airports than on other components of the objective. As α increases, the regulator chooses a higher price cap, raising additional airport revenue. In 2000, the value of α that rationalizes the PFC cap choice of \$4.50 is approximately 1.775. A regulator with the same preferences, when faced with the market environment and consumer preferences of 2018, would choose to lower the price cap to approximately \$3, a reduction of one third. Conversely, a regulator choosing a price cap of \$4.50 in 2018 would have chosen a price cap of around \$6.50 in 2000. Assuming that prevailing regulations reflect the presumed preferences of regulators, implicit regulatory preferences have changed between 2000 and 2018 in favor of airports and against airline

[48]Figure graphic scheme source: Bischof (2017).

profit and short-run consumer welfare. This is despite the fact that the PFC price cap has declined in real terms over this time period.[49]

To explore the robustness of this result, I consider a range of alternative values for γ. Table 2 presents the solution to the regulator's problem in both 2000 and 2018 for each of $\gamma \in \{0, .125, .25, \ldots, 2\}$. Results from Figure 2 (when $\gamma = 1$) are qualitatively unchanged in all alternative parameterizations. A price cap of \$4.50 in both 2000 and 2018 is consistent with an increase in the implicit regulatory preference for airports relative to consumers (α) and relative to airlines ($\frac{\alpha}{\gamma}$) in all alternative specifications. If a regulator with the 2000 preferences were to choose a price cap in 2018, the price cap would be reduced. By leaving the price cap nominally unchanged over this period, the regulator has exhibited an increased concern with the relative welfare of airports. Table 2 also presents results from an alternative specification of the regulator's objective which does not consider consumer surplus. Results are qualitatively unchanged.

In Online Appendix C.1, I consider how my findings are affected by changes in regulatory preference for airlines (γ) between 2000 and 2018. I find that my primary qualitative conclusion is robust to moderate changes in γ. Specifically, regulatory preference for airports relative to both consumers and airlines increases between 2000 and 2018 for moderate changes in γ. When changes in γ are more drastic, a weaker result holds: Either regulatory preference for airports relative to consumers (α) has increased over this period or regulatory preference for airports relative to airlines ($\frac{\alpha}{\gamma}$) has increased over this period. There are no changes in γ for which the implied regulatory preference for airports relative to consumers (α) and regulatory preference for airports relative to airlines ($\frac{\alpha}{\gamma}$) both decline.

I conduct additional simulations in the next section to determine why a regulator with the same α parameter in both years, chooses a lower price cap in 2018.

7 Simulations

Despite the price cap declining in real terms between 2000 and 2018, regulatory preference for airports has increased. I argue this result is driven primarily by changes in air travel demand, particularly the price sensitivity of demand. In support of this explanation, I conduct two counterfactual simulations using 2000 data and two counterfactual simulations using 2018 data. I assume $\gamma = 1$ in all simulations for concreteness. Results are qualitatively unchanged under alternative γ values. For 2000, I compute the optimal price cap when regulators have 2000 regulatory preferences ($\alpha = 1.775$) and 2018 observable demand parameters (Simulation 1). Market structure, airline marginal costs, and unobservable demand residuals ξ

[49]One potential explanation for this shift in preference is a public and political perception that U.S. infrastructure is unsatisfactory. This sentiment could make a decrease in the cap (which is what would maintain regulatory preference) politically unpopular.

Table 2: Regulator's Problem-Robustness Checks

CS	γ	$\hat{\alpha}$ (2000)	$\hat{\alpha}$ (2018)	$\frac{\hat{\alpha}}{\gamma}$ (2000)	$\frac{\hat{\alpha}}{\gamma}$ (2018)
Yes	0	1.062	1.077	-	-
Yes	.125	1.151	1.170	9.210	9.360
Yes	.25	1.240	1.261	4.961	5.050
Yes	.375	1.329	1.355	3.545	3.613
Yes	.50	1.418	1.448	2.837	2.895
Yes	.625	1.508	1.540	2.412	2.464
Yes	.75	1.597	1.630	2.129	2.176
Yes	.875	1.686	1.725	1.927	1.971
Yes	1	1.775	1.816	1.775	1.816
Yes	1.125	1.864	1.909	1.657	1.697
Yes	1.25	1.953	2.002	1.562	1.602
Yes	1.375	2.042	2.094	1.485	1.523
Yes	1.5	2.131	2.185	1.421	1.458
Yes	1.625	2.220	2.279	1.366	1.403
Yes	1.75	2.309	2.372	1.32	1.355
Yes	1.875	2.399	2.464	1.279	1.314
Yes	2	2.488	2.557	1.244	1.278
No	1	-	-	0.712	0.739

Notes: This table presents inferred regulatory preference for airports relative to consumers ($\hat{\alpha}$) and airlines ($\frac{\hat{\alpha}}{\gamma}$) in 2000 and 2018 for a variety of γ values.

are unchanged from their 2000 values. Next, I compute the optimal price cap when regulators have 2000 regulatory preferences ($\alpha = 1.775$) and the price sensitivity of demand in 2018 (Simulation 2). Market structure, airline marginal costs, unobservable demand residuals ξ and all demand parameters except the price sensitivity are unchanged from their 2000 values. For 2018, I compute the optimal price cap if the regulator retained 2018 regulatory preferences ($\alpha = 1.816$) and faced 2000 observable demand parameters (Simulation 3). Market structure, airline marginal costs, and unobservable demand residuals ξ are unchanged from their 2018 values. Next, I compute the optimal price cap if the regulator retained 2018 regulatory preferences ($\alpha = 1.816$) and faced the price sensitivity of demand in 2000 (Simulation 4). Again, market structure, airline marginal costs, unobservable demand residuals ξ and all demand parameters except the price sensitivity are unchanged from their 2018 values. Results are shown in Table 3.

Simulations 1 and 2 show that regulatory preferences in 2000 would result in a far lower price cap if

Table 3: Counterfactual Solutions to the Regulator's Problem

Sim	Data	$\hat{\alpha}$	Demand Parameters	Observed Cap	Counterfactual Cap
1	2000	1.775	2018 Demand	4.50	1.89
2	2000	1.775	2000 Demand with 2018 β_p	4.50	1.44
3	2018	1.816	2000 Demand	4.50	9.31
4	2018	1.816	2018 Demand with 2000 β_p	4.50	8.18

Notes: This table presents counterfactual solutions to the regulator's problem in 2000 and 2018.

demand conditions were as in 2018. Consumers are more price-sensitive in 2018 and the burden of a price cap (on both consumers and airlines) is greater. In reaction to this, regulators choose a lower price cap. Simulations 3 and 4 show a comparable result in 2018. A regulator with 2018 preferences would increase the price cap above the observed level of \$4.50 if demand conditions, particularly the price sensitivity, were as in 2000. Consumers were less price-sensitive in 2000 and the cost, in terms of consumer welfare and airline profits, of a price cap increase is lower.

An access charge causes an increase in downstream prices. There are two effects. First, consumer surplus decreases because consumer surplus is decreasing in price. Second, airline profits decrease. This is the case because an increase in downstream prices causes consumers to substitute away from air travel. When consumers substitute away from air travel, airline profits are reduced. Both the loss in airline profit and the loss in consumer surplus are dependent on the price sensitivity of demand. Consumer surplus losses are greater when consumers are more price-sensitive because a price increase causes a greater loss in utility. Consequently, consumers are more likely to substitute away from air travel entirely when they are more price-sensitive. Airline profit losses are therefore more severe when consumers are more price-sensitive.

8 Conclusion

This paper adapts the methodology of Ross (1984) to the price cap regulation of access prices. This methodology is applied to the regulation of passenger facility charges in the U.S. aviation sector. I consider the problem of a regulator tasked with setting a price cap to maximize a weighted sum of airline profits, consumer welfare, and airport revenue. Access charges have a greater marginal cost, in terms of downstream firm profits and consumer welfare, and a smaller marginal benefit, in terms of airport revenue, in 2018 compared to 2000. This result can be explained by an increase in the price sensitivity of demand during this period. In response to an increase in the cap, more price-sensitive consumers in 2018 purchase fewer airline tickets which lowers airline profits. Consumer welfare losses are greater in 2018 as consumers experience a greater disutility from price increases. A regulator who places a weight on airport revenue such that the solution to her problem is the observed price cap of $4.50 in 2000 would decrease the price cap in 2018. These results suggest that by not lowering the nominal price cap, regulatory importance has shifted from airlines and/or short-run consumer welfare to airports. This paper stresses the importance of considering changes in consumer preferences when adjusting price caps over time.

The above results suffer from a few limitations. First, I do not consider the possibility of airline entry and exit. Airlines are assumed to neither enter nor exit markets due to changes in the passenger facility charge level. For small changes in the PFC, this is a reasonable assumption. For larger changes, it may be restrictive. Second, the random coefficients approach of Berry et al. (1995) would be a more realistic demand specification. Unfortunately, counterfactual equilibrium prices often suffer from a vast multiplicity of equilibria under this demand system, making counterfactual predictions difficult.[50]

In sum, this paper finds that the welfare burden of an increase in the federal cap on PFCs, on downstream firms and consumers, has increased since the last price cap increase. While airport trade organizations and politicians have suggested increasing the price cap, at least to keep pace with inflation, results suggest that regulators already place a greater weight on airport revenue in 2018 than in 2000.

Declarations The author has no competing interests to declare that are relevant to the content of this article.

[50] I originally estimated the above with both a continuous distribution of consumer heterogeneity and a discrete (2 types) distribution resembling Berry and Jia (2010) and Ciliberto and Williams (2014). Both models result in a large number of multiple equilibria in counterfactual simulations.

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