Remedies in Airline Mergers: Analysis of the U.S. Domestic Airline Industry

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Abstract

In this study, I deliberate on the counterfactual merger simulations that have been carried out to establish the value of requiring slot divestiture at slot-controlled airports. I focus on two cases: the United Airlines–Continental Airlines merger and the American Airlines–US Airways merger. Slot divestment is done according to the requirements of antitrust enforcement agencies. The simulation results from three selected airports, Newark Liberty International Airport, Ronald Reagan Washington National Airport, and LaGuardia Airport, indicate that the average airfare reduced for all post-merger air travel products. As a result, the airlines attracted more passenger, creating consumer surplus at the airports. Nonetheless, the airlines are still struggling to alleviate anticompetitive risks resulting from overlapping non-stop routes. These problems occur when slot purchaser fail to enter the market for those routes. To address the structural limitations linked to slot divestiture, I tested other behavioral alternatives besides slot divestment: forcing the surrender of slots operating monopolistic routes, requiring code sharing between merged airlines and low-cost carriers, and opening frequent flyer programs to competitors and/or new entrants. Simulation results from these cases revealed that after merging

the operations, the alternative solutions would reduce the average airfare and the number of problematic routes. Therefore, the impact of price was dominant compared to only when slot divestment was needed. Also, requiring slot divestiture, combined with forcing slot purchasers to enter the market for overlapping nonstop routes and promoting code sharing would have lowered the average airfare for all products and the overlapping non-stop routes. However, requiring slot divesture combined with opening of the merged airlines' frequent flyer programs would not have addressed the problem of anti-competition on overlapping nonstop routes.

1 Introduction

In assessing the potential impacts of a proposed merger, antitrust enforcement agencies typically attempt to predict how the union will alter the level and balance of market power. If the proposed merger may significantly weaken market competitiveness, then the agencies decide whether to block the merger or to negotiate regulatory remedies for the merging companies. Instead of outright blocking proposed mergers, developing regulatory remedies has expanded as the preferred method of resolving anti-competition related to mergers. In fact, from 2009 to 2019, 412 mergers were challenged by Federal Trade Commission (FTC) or Department of Justice (DOJ), 242 of which (59%) were resolved and settled via remedies.[1]

Traditionally, the two major categories of remedies have been structural and behavioral. Although structural remedies focusing on asset divestiture to competitors or new market entrants have continued to dominate, some structural remedies have broadened their scope to overlap with behavioral remedies. As a result, some divestiture strategies are combined with negotiations about the operation behavior of the merging companies. Such remedies typically yield mergers that receive approval, al-

[1] Hart-Scott-Rodino Annual Report for fiscal years 2009-2019.
Available at https://www.ftc.gov/policy/reports/policy-reports/annual-competition-reports

beit at the expense of constraining merging firms with various prohibitive provisions and/or consent orders.

Since being deregulated in 1978, the U.S. airline industry has experienced more than 50 mergers or acquisitions. Nearly all have gone unchallenged, except the mergers of Northwest and Continental Airlines (2000) and of United Airlines and US Airways (2000). In two cases, antitrust enforcement agencies negotiated merger remedies as a means to proceed with the proposed mergers. First, in the United Airlines and Continental Airlines merger in 2010, to resolve its principal anti-competition concerns, the DOJ requested the airlines to transfer their takeoff and landing slots at Newark Liberty International Airport (EWR) to Southwest Airlines, a low-cost carrier with limited operations in the New York metropolitan area and no services to or from Newark. Later, in 2013, when the DOJ challenged the merger of American Airlines and US Airways, the airlines agreed to settle the charges by divesting slots and gates at key constrained airports across the country to low-cost carrier airlines in order to boost competition in the airline industry. Both cases also show that in the context of airport divestiture, merger remedies in the U.S. airline industry have often focused on slots and assets (e.g., gates and facilities).

While antitrust enforcement agencies tend to favor structural remedies due to the difficulties in monitoring behavioral remedies, evidence of their effectiveness in mergers remains limited and is potentially non-existent. In light of this, the current paper examines and compares the effectiveness of structural and behavioral remedies in resolving the anticompetitive effects of proposed mergers in the context of the U.S. airline industry. While structural remedies generally refer to antitrust enforcement agencies' demands for slot divestiture, behavioral remedies are potentially obligatory code-sharing, surrendering slots to allow flights to operate on overlapping nonstop routes, and opening frequent flyer programs to rivals and/or new entrants. However, anti-competitive practices are not necessarily resolved by demanding slot divestiture without forcing the slot purchasers to operate on specific routes. Also, divesting slots to low-cost carriers does not inevitably lead to the latter entering markets that show signs of antitrust risk because slots are not assigned to specific routes. Hence, the impact of slot divestiture may be weakened on routes that were served only by the merging carries prior to the merger – and thus represent a monopoly market post-merger. The theoretical framework by Brueckner (2001) confirms that code sharing leads to a reduction in the average interline airfare in city-pair markets. Using another perspective that examined the effects of frequent flyer programs on air travel product demand, Lederman (2005) highlights their attractiveness to consumers due to the added value. Based on this, the current study employs a structural model based on U.S. domestic airline data to simulate the impact of remedies on post-merger prices. This model is deployed to test the slot divestitures negotiated at Newark Liberty International Airport (EWR) as part of the United Airlines–Continental Airlines merger and at LaGuardia Airport (LGA) and Ronald Reagan Washington National Airport (DCA) for the American Airlines–US Airways merger. These airports are among the five "high-density traffic airports" for which the Federal Aviation Administration (FAA) has imposed capacity constraints via restricted runway slots with the aim of limiting air traffic. As slots at these airports are limited for both takeoff and landing, new entrants struggle to enter the market and compete on existing routes. And while incumbents may lease or sell their slots if with FAA approval, this is not commonplace. Hence, proposed mergers between two airlines with numerous overlapping routes at these slot-controlled airports give rise to significant antitrust concerns. In response to this, the US Department of Justice has mandated the divestiture of slots and assets at such airports to address the antitrust concerns and benefit consumers on overlapping routes.

The structural model used to evaluate the effect of remedies in airline mergers focuses on counterfactual analysis by using merger simulation. To simulate the effect of divestiture and behavioral remedies on the post-merger equilibrium price, I developed a structural model of the U.S. domestic airline industry that describes the demand and supply for air travel. In the spirit of McFadden (1981) and Berry, Levinsohn and Pakes (1995), the demand model was a random-coefficient discrete-choice model of air travel demand—that is, a discrete-type version of the random coefficient model, which accommodates finite types of consumers to capture heterogeneous preferences for airfare and product characteristics for each type. Berry, Carnall and Spiller (2006) and Berry and Jia (2010) have modeled two types of consumers—business travelers and tourists—whose preferences differ in their valuations of various product characteristics, including airfare, availability of direct flights, and FFP. Following that literature, I also used business travelers and tourists as types of passengers in the demand model. By running the estimated demand parameters, the model could compute the marginal costs and markups by using the first-order conditions of the differentiated products firm's profit function. After estimating the demand parameters and marginal costs, I simulated the post-merger equilibrium price under the post-merger ownership structure, which reflects the completion of slot divestiture with reference to post-merger data.

At the same time, because behavioral remedies have never been deployed by U.S. antitrust enforcement agencies in response to proposed airline mergers, I constructed data for such remedies with reference to assumptions from various behavioral remedy scenarios in order to simulate the effect of the remedies on post-merger price. For instance, I assumed that the agencies would request behavioral remedies such as obligatory code-sharing or opening the FFP to competitors and/or new entrants. Moreover, my model simulates post-merger equilibrium prices under the assumption that the agencies would require a combination of divestiture and behavioral remedies for the mergers between United Airlines and Continental Airlines and between American Airlines and US Airways. The model was estimated and simulated using various publicly available datasets representing the Department of Transportation's (DOT) Airline Origin & Destination Survey (DB1B) and T-100 domestic segment data.

The counterfactual merger simulation suggest that slot divestiture and alternative behavioral remedies can indeed decrease the average post-merger airfare of all air travel products and thus increase the number of passengers and consumer surplus at EWR, DCA and LGA. The reduced airfares, however, would not be significant for overlapping nonstop routes if the DOJ required only slot divestiture from the merged party, and that result thus indicates that slot divestiture presents limitations to resolving risks of anticompetitive behavior on problematic routes. Although slot divestiture's ineffectiveness on some routes can be predicted, the combination of slot divestiture and alternative behavioral remedies would have a pro-competitive effect in those markets.

This paper contributes to two streams of literature. On the one hand, it extends literature on mergers. Economists and antitrust practitioners have extensively studied the effect of horizontal mergers on price. In a review of eight studies on airline mergers in particular, Ashenfelter et al. (2014) found that most had examined how the mergers had impacted price and market share and, on that topic, revealed increases in price and market power that varied depending on the sample and econometric strategy. In a particular strand of studies (Borenstein, 1990; Kim & Singal, 1993; Morrison, 1996; Kwoka & Shumilkina, 2010; Luo, 2013), researchers have examined changes in price, quality, and consumer welfare by using comparative analysis or a reduced form model involving actual pre- and post-merger data. In another strand (Richard, 2003; Peter, 2006), researchers have adopted a structural approach to simulating post-merger output. Meanwhile, among research on how price affects horizontal mergers, simulation based on economic models has become an increasingly important approach. However, studies on airline mergers have also demonstrated significant limitations in their simulations of traditional mergers, usually by focusing solely on price changes while holding supply-side variables to be the same both pre- and post-merger. By contrast, Peters (2006) has examined the accuracy of simulations for five U.S. airline mergers completed in 1986 and 1987 by directly comparing the predicted and actual prices. Observing that standard methods of simulation did not generally provide accurate forecasts, Peters used counterfactual simulations, along with observed post-merger data, to measure the relative importance of other factors that also contributed to the price changes observed. The results indicated that the unexplained component of the price change was largely accounted for by supply-side effects, particularly cost-related factors. Peters (2006) also showed that a merged airline tends to reduce the frequency of flights in segments where the merging carriers once competed. By comparison, Bilotkach (2011), who investigated the implications of the America West–US Airways merger on multimarket contact (MMC), found that the merger affected the frequency of MMC. In the airline industry, frequency of flights is an important factor of the cost of airlines, and changes in frequency post-merger should prompt the merged airline to modify its operating costs. In overlooking that aspect, however, the standard merger simulation, which ignores such changes in cost-related factors, creates significant bias between predicted and observed post-merger prices. On the demand side, each consumer derives utility from price, observed product characteristics, and unobserved variables. Consequently, because mergers affect product characteristics, new post-merger product characteristics are liable to alter consumers' choices and their market shares in the product. On the supply side, changes in marginal costs and fixed costs result in new, optimal product characteristics for the merged firm. In response to that limitation, studies on endogenous product choice have emerged within the field of merger simulations. For example, Fan (2013) has provided some brilliant guidance for overcoming the limitation of the traditional merger simulation, namely by employing a structural model of newspaper markets to investigate the merger's effects. In the model, firms choose both price and quality, and the model can be estimated by using a new dataset of newspaper prices and characteristics. The simulated result of the effect in the Minneapolis newspaper market, for instance, that ignores adjustments in product characteristics will cause substantial differences in the estimated effects of mergers.

On the other hand, the paper also contributes to the rather limited literature on merger remedies. In such work, to examine the effectiveness of merger remedies ordered by antitrust enforcement agencies, the Federal Trade Commission (FTC) examined 50 of its merger orders from 2006 through 2012 in case studies and found that more than 80% of its orders resolved antitrust concerns. In a similar study conducted in another jurisdiction, the European Commission (EC) examined its 96 cases involving remedies and concluded that 85 of the 96 remedies analyzed has been effective or at least partially effective. That study particularly revealed that 77% of the EC's divestiture orders maintained or decreased the market share of the divested businesses. Whereas those studies were descriptive and addressed the result of merger remedy orders, Park (2019) performed an ex ante analysis of how merger remedies can affect market competition and consumer welfare, with particularly reference to the merger of American Airlines and US Airways. That study focused on the DCA market, where the DOJ ordered the divestiture of slots and a slot-controlled airport, and the estimation suggested that such divestiture increased aggregate consumer surplus even though the surplus of the subset of DCA passengers decreased. Other literature addressing merger remedies has focused on the effectiveness of structural remedies, primarily asset divestiture. However, this paper reports an ex ante analysis to examine the effectiveness of both structural and behavioral remedies in airline mergers.

The remainder of this paper is structured as follows. Section 2 provides institutional details on the mergers between United Airlines and Continental Airlines and between American Airlines and US Airways. Section 3 presents the structural model of the U.S. domestic airline industry, the estimation approach, and the merger simulation strategy, and Section 4 discusses the data. Section 5 reports the results of demand estimation, whereas Section 6 explains the counterfactual analysis of the merger simulation. Last, Section 7 concludes the paper by highlighting the implications of the findings and indicating directions for future research.

2 Institutional Details

This section presents the dilemmas with antitrust law posed by the merger and slot divestiture in two proposed mergers: United Airlines with Continental Airlines and American Airlines with US Airways.

2.1 The Merger of United Airlines and Continental Airlines

On May 3, 2010, when United Airlines and Continental Airlines publicly announced an agreement to merge, they proposed to create the world's largest airline, at least at the time. In evaluating the proposed merger, the DOJ considered the number of overlapping routes with flights operated by both airlines. According to data collected for this paper, counting all connecting flights for 8,332 air travel products with at least 500 passengers per year, the merger would have been expected to cause 935 products to lose a competitor. Although the DOJ anticipated the presence of a low-cost carrier to somewhat dampen the anticompetitive effect on airfares for those routes, the effect was more significant because the routes offered what airline passengers greatly prefer: nonstop service. All told, United Airlines and Continental Airlines offered overlapping services in eight markets—that is, on 16 origin–destination directional routes with nonstop service. Table 1 details the total passengers on those nonstop directional routes and each airline's market share. While examining the merger, the DOJ especially focused on overlapping routes with nonstop service offered only by

United and Continental, most of which—for more than a 50% market share—flew from O'Hare International Airport, United's hub, or Newark Liberty International Airport (EWR), Continental's hub, to slot-controlled airports barring other airlines from entering. In particular, for the routes EWR–SFO, EWR–DEN, and EWR–IAD, only United and Continental offered services and would have created a monopoly had the proposed merger been approved. In response to that anticompetitive concern, the DOJ ordered slot divestiture, and after United and Continental agreed to permanently transfer 36 slots and other assets at EWR to low-cost carrier Southwest Airlines, the merger was approved.[2]

2.2 The Merger of American Airlines and US Airways

Six months after American Airlines and US Airways announced their intention to merge on February 13, 2013, the DOJ, expressing concerns with violations of antitrust law, filed a lawsuit to challenge the merger. In reviewing the proposed union, the DOJ stressed its likely implications, including a significant increase in market concentration and the elimination of competition. Indeed, American Airlines and US Airways overlapped in 12 nonstop markets, or on 24 origin–destination routes with nonstop service, whose pre-merger total passenger counts appear in Table 2, along with each airline's market share. The DOJ especially highlighted Ronald Reagan Washington National Airport (DCA), where the proposed merger would not only own 69% of all takeoff and landing slots but also create a monopoly on 63% of all nonstop routes. Another dilemma concerned LaGuardia Airport (LGA), where the merger of the two airlines, as the second- and third-most popular ones there, would possess 33% of slots and 29.7% of all capacity. In view of those situations, the DOJ predicted that passengers in the areas served would face significant increases in airfare were the merger approved. After litigation, the DOJ thus announced a proposed set-

[2]Press Release, Department of Justice, United Airlines and Continental Transfer Assets to Southwest Airlines in Response to Department of Justice's Antitrust Concerns (Aug. 27, 2010)

tlement that mandated the divesture of slots and gates at a "key airport" to low-cost carriers. Ultimately, American Airlines and US Airways agreed to divest slots at two congested, slot-controlled airports: 104 at DCA and 34 at LGA. [3]

2.3 Slot Divestitures

DCA and LGA are two of the three slot-controlled airports in the United States today, along with John F. Kennedy International Airport (JFK). Although Newark Liberty International Airport (EWR) was a slot-controlled airport when United Airlines–US Airways merger was proposed, its slot restrictions have been eased since 2016.[4] To alleviate air traffic congestion and delays at those highly congested airports, the FAA began enforcing limits concerning the maximum number of flights per hour. EWR, for example, had an hourly limit of 81 flights during peak periods.[5] At LGA, airlines have been allowed to operate a maximum of 71 flights per hour, while DCA allows 60 flights per hour for specified airplane classes.

Because the FAA prohibits slot transactions between airlines, slots at slot-constrained airports are valuable assets, ones that airlines guard to block new entrants and reduce competition at those airports. As a consequence, concerns about anticompetitive conditions at slot-controlled airports have often been raised in evaluating airline mergers. As cases in point, the DOJ underscored that the United Airlines–Continental Airlines merger would eliminate competition at EWR, as would the American Airlines–US Airways merger at DCA and LGA. To allay those fears, the airlines agreed to divest their slots and assets at those slot-controlled airports to low-cost carriers. The new United Airlines completed its transfer of slots in June 2011, while the new American

[3]Press Release, Department of Justice, Justice Department Requires US Airways and American Airlines to Divest Facilities at Seven Key Airports to Enhance System-wide Competition and Settle Merger Challenge(Nov. 12, 2013)

[4]Press Release, Federal Aviation Administration, Change of Newark Liberty International Airport (EWR) Designation (Apr. 6, 2016)

[5]Federal Aviation Administration, Slot Management and Transparency for LaGuardia Airport, John F. Kennedy International Airport, and Newark Liberty International Airport (Jan. 8, 2015)

Airlines completed its transfer in February 2014.[6]

Orders for slot divestiture at slot-controlled airports significantly reduce barriers to entry faced by low-cost carriers and promote their expansion nationwide. Prior to their enforcement, legacy airlines had dominated those airports and made any effective competition from low-cost carriers notoriously difficult. Thus, if the mergers had been approved without structural remedies, they would have severely eroded competition. However, the DOJ anticipated that the low-cost carriers receiving the slots would create substantial market power in strategically important markets, including top business destinations such as New York City and Washington, DC. After all, increased access at slot-controlled airports allows low-cost carriers to offer more routes to more passengers at highly competitive rates, and the benefits for passengers as a result have been well documented. Bennett and Craun (1993), for instance, found that the entry of Southwest Airlines at such airports not only lowered airfares but also increased passenger traffic. In their research for the U.S. Department of Transportation's Office of Aviation Analysis, they dubbed the phenomenon "the Southwest Effect," given the airline's impact on several point-to-point, intra-state routes in California upon entering the market. In their investigation, the authors identified the Southwest Effect's especially significant impact on the Oakland–Burbank intra-California route in 1990, when Southwest's entry caused airfares to drop by 55% and passenger traffic to skyrocket by sixfold. Later, Windle and Dresner (1995), analyzing data from 1991 to 1994, found that airfares fell by 48% and that passenger traffic ballooned by 200% after Southwest had begun operating in the studied routes. Vowles (2000) also found that low-cost carriers have had a remarkably diminishing effect on airfares. Figure 1, Figure 2 and Figure 3 depict changes in market shares pre- and post-merger at EWR, DCA, and LGA, respectively. After the mentioned mergers and orders for slot divestiture, the market share of low-cost carriers expanded significantly at all three

[6] The Antitrust Division, United States, et al., v. US Airways Group, Inc., et al.; Public Comments and Response on Proposed Final Judgment (Mar. 13, 2014)

airports while that of the newly merged airlines narrowed.

Although the DOJ had expected slot divestiture at slot-controlled airports to exert a procompetitive effect, the structural remedies implemented to mitigate those concerns had certain structural limitations. For one, slot divestiture to low-cost carriers does not guarantee that low-cost carriers will enter markets showing signs of antitrust risks, precisely because slots are not constrained for operating on specific routes. For another, typically offering only basic services, low-cost carriers are not the most effective competitors for business passengers who want higher-quality services. To respond to the limitations of imposing structural remedies without mandating changes in operational patterns at slot-controlled airports, this study proposes to impose both structural and behavioral remedies in cases of airline mergers.

3 The Model

In this section, I describe a model of supply and demand in the air travel market, particularly with reference to an oligopolistic framework in which airlines supply differentiated products. The model differentiates air travel products according to a set of characteristics including airfare, frequency of departure, number of connections, and presence of a frequent flyer program (FFP). Whereas airlines and passengers are assumed to consider all of those characteristics of air travel products, economists cannot observe certain characteristics that airlines and passengers can—for instance, ticket restrictions and flight-level details. In the model, those latter characteristics are accounted for with an error term in the demand system. Otherwise, because airlines have information about those characteristics and consider them when setting airfares, ignoring the information can promote econometric endogeneity and substantially misleading results.

As part of that model, the demand for air travel is conceived in a discrete-choice model, hereafter called the "demand model," in which consumers select one of many options, ranging from choosing a product to not flying, as a way to maximize their utility. To capture the fact that each consumer's preference differs across various product characteristics, the demand model allows heterogeneity among consumers by estimating the distribution of that heterogeneity. It also captures endogeneity in pricing behavior and generates a realistic substitution pattern of the various air travel options on and outside the market.

On that topic, the model defines a market as a directional pair of airports—for example, DCA–EWR, which is distinct from the market EWR–DCA. That setup allows the characteristics of the origin airport to affect the consumer's demand. Beyond that, because airlines offer distinct sets of products in each market, I define a product as a possible combination of airline, airfare, and itinerary. For the DCA–EWR market, for instance, potential three products might be a nonstop flight on American Airlines for \$199, a nonstop flight on American Airlines for \$299, or a flight on American Airlines with a layover in Philadelphia for \$179. In any group of products, the price difference is mostly due to ticket restrictions that econometricians cannot observe. Such characteristics are taken into account with an error term indicating a difference in fares for the same airline's products on the same itinerary.

3.1 Demand

In the spirit of McFadden (1981) and Berry, Levinsohn, and Pakes (BLP, 1995), the demand model is a random-coefficient discrete-choice framework with heterogeneous consumer preferences. Resembling the setups of Berry, Carnall, and Spiller (BCS, 2006) and Berry and Jia (2010), the model extends the nested logit model by adopting heterogeneous preferences for both observable and unobservable characteristics of air travel products. Beyond that, because the preferences of business travelers and tourists differ significantly according to the characteristics of those products (e.g., number of connections and frequency of departure), the random coefficient model differentiates business travelers from tourists as types of consumers.

Following Berry and Jia (2010), the simple random coefficient discrete-choice model can be used to estimate the demand for air travel. Therein, based on personal preferences, the consumer chooses an air travel product on the market or the non-market option of not flying. For example, suppose r types of consumers and that each consumer i's utility for product j in market m can be identified by the utility:

$$u_{ijm} = x_{jm}\beta_r - \alpha_r p_{jm} + \xi_{jm} + \nu_{im}(\lambda) + \lambda\epsilon_{ijm}, \tag{1}$$

in which x_{jm} is a vector of observable product characteristics, p_{jm} is the price of the product, β_r is a vector of preferences for product characteristics, and α_r is the marginal disutility with an increase in price for type r consumers. Establishing random coefficients α_r and β_r for P_{jm} and x_{jm}, respectively, for each type of consumer captures heterogeneous preferences of business travelers versus tourists. Meanwhile, the unobserved characteristics of product j are captured by ξ_{jm}, whereas ν_{im}, the nested logit random preference constant across all air travel products, differentiates air travel from the non-market option of not flying. λ is the nested logit parameter, distributed from 0 to 1, specifying the degree of substitutability in the market. As $\lambda \to 1$, $\nu_{im}(\lambda)$ approaches 0, meaning that the correlation between air travel products becomes 0 and thus perfectly differentiated. In that case, the model does not consider non-market options and becomes a simple multinomial logit framework. By contrast, as $\lambda \to 0$, the correlation of on-the-market options increases, thereby implying the increased substitutability of air travel products and thus perfect substitutability. Beyond that, ε_{ijm} is a stochastic error with a mean of 0. Altogether, the error structure $\nu_{im}(\lambda)+\lambda\varepsilon_{ijt}$ follows an independent and identically distributed type I extreme value distribution with a mean of 0, as the nested logit form. Whereas the first nest includes the non-market option of not flying, the second includes the on-the-market options of all air travel products.

Using the model, I examine the effect of structural and behavioral remedies in airline mergers. To capture how behavioral remedies influence consumers' demands, the observed product characteristic x_{jm} has to contain the dataset of code-sharing status and FFPs to effectively indicate the enforcement of those remedies. The utility of the non-market option of not flying is given by:

$$u_{i0m} = \epsilon_{i0m} \tag{2}$$

in which product $j = 0$ is the non-market product and ε_{i0m} is normalized to be 0 for all consumers. Thus, the mean utility of the on-the-market product j is:

$$\delta_j = x_{jm}\beta_r - \alpha_r p_{jm} + \xi_{jm}, \tag{3}$$

Supposing that they choose to fly, all consumers purchase air travel products that provide the highest utility. In that light, the model assumes that consumers' preferences vary with demographic and product-specific shocks as well as follows multivariate normal distribution. Meanwhile, the random coefficients on price and product characteristics vary with discrete types of consumers and thus follow discrete distribution. As a result, the market share function is derived by estimating the percentage of type r consumers in the population and the weighted sum of the market share for each type. Altogether, assuming that consumers purchase air travel products, the percentage of type r passengers in the population who choose product j in market m is given by:

$$\frac{e^{(x_{jm}\beta_r - \alpha_r p_{jm} + \xi_{jm})/\lambda}}{\sum_{k=1}^{J} e^{(x_{km}\beta_r - \alpha_r p_{km} + \xi_{km})/\lambda}} \tag{4}$$

By extension, the share of type r consumers who choose to buy air travel products is:

$$s_m^r\left(x_m, p_m, \xi_m, \theta_d\right) \equiv \frac{\left[\sum e^{\left(x_{km}\beta_r - \alpha_r p_{km} + \xi_{km}\right)/\lambda}\right]^{\lambda}}{1 + \left[\sum_{k=1}^{J} e^{\left(x_{km}\beta_r - \alpha_r p_{km} + \xi_{km}\right)/\lambda}\right]^{\lambda}} \tag{5}$$

Let γ_r specify the percentage of type r consumers in the population, such that the overall market share of the jth product in market m is calculated by:

$$s_{jm}\left(x_m, p_m, \xi_m, \theta_d\right) = \sum_r \gamma_r \frac{e^{\left(x_{jm}\beta_r - \alpha_r p_{jm} + \xi_{jm}\right)/\lambda}}{\sum_{k=1}^{J} e^{\left(x_{km}\beta_r - \alpha_r p_{km} + \xi_{km}\right)/\lambda}} \cdot s_m^r\left(x_m, p_m, \xi_m, \theta_d\right) \tag{6}$$

in which θ_d is the vector of all demand-related parameters (i.e., β_r, α_r, λ, and γ_r) to be estimated. Thus defined by Equation (6), the internal and cross-price elasticity of air travel products for type r passenger yield:

$$\eta_{jkm}^r = \frac{\partial s_{jm} p_{km}}{\partial p_{km} s_{jm}} = \begin{cases} -\alpha_i p_{jt}(1 - s_{jt}^r) & \text{if } j = k \\ \alpha_i p_{kt} s_{kt}^r & \text{if} j \neq k \end{cases} \tag{7}$$

The demand model thus allows correlations between parameters of preference regarding price and product characteristics by adopting a random coefficient discrete-choice framework. For business travelers, airfare is not a primary factor when purchasing tickets, whereas they likely have different preferences for observed product characteristics such as frequency of departure and the option of a nonstop flight. For most potential passengers, however, airfare is the most important factor. Thus, preferences need to correlate across product characteristics and generate correlations between products that have similar product characteristics. Furthermore, because consumers with the same preferences will have the similar substitution patterns, each type of consumer exhibits different price elasticity and substitution patterns. As a result, the aggregate per-consumer price elasticity and cross-price elasticity in terms of heterogeneity among consumers are given by:

$$\eta_{jkm} = \frac{\partial s_{jm} p_{km}}{\partial p_{km} s_{jm}} = -\frac{p_{jm}}{s_{jm}} \frac{\partial}{\partial p_{km}} \left(\int \int \frac{e^{(x_{jm}\beta_r - \alpha_r p_{jm} + \xi_{jm})/\lambda}}{1 + \sum_{k=1}^{J} e^{(x_{km}\beta_r - \alpha_r p_{km} + \xi_{km})/\lambda}} \right) dF(\xi, \delta) \quad (8)$$

$$\approx \begin{cases} -\frac{p_{jm}}{s_{jm}} \sum_r \alpha_r s_{jm}^r (1 - s_{jm}^r) & \text{if } j = k \\ \frac{p_{km}}{s_{jm}} \sum_r \alpha_r s_{jm}^r s^r s_{km} & \text{if } j \neq k \end{cases} \quad (9)$$

3.2 Supply

To estimate competition in the airline industry, the model uses BLP's (1995) supply-side framework, such that each airline plays a static Bertrand–Nash price-setting game to maximize the expected profit. Researchers employ the static game assumption owing to its mathematical tractability and the fact that a firm's dynamic behavior is difficult to sustain when products are differentiated. Following BLP (1995), equilibrium markups can be computed by using the first-order conditions of airlines. For instance, suppose there are F airlines and that each airline offers subset J_f of the J different air travel products on the market. The profit function of an airline f is given by

$$\pi_f = \sum_{j \in J_f} (p_j - mc_j)\, s_j(x, p, \xi, \theta)\, M - fc_f \quad (10)$$

in which M is the overall market size demonstrated by the geometric mean of the populations of the Metropolitan Statistical Areas (MSA) of the origin and destination cities. In turn, mc_j represents the marginal cost, while fc_f represents total fixed cost for airline f. The corresponding first-order conditions for each airline's product are thus determined by:

$$\frac{\partial \pi_f}{\partial p_j} = s_j(x, p, \xi, \theta) + \sum_{h \in J_f} (p_h - mc_h) \frac{\partial s_h(x, p, \xi, \theta)}{\partial p_j} = 0 \quad (11)$$

Assume that the term of $(p_h - mc_h)$ generates the $J_f \times J_f$ matrix, and define the $J_f \times J_f$ matrix Δ_{s_f,p_f} such that

$$\Delta_{s_f,p_f} = \begin{pmatrix} \frac{\partial s_1}{\partial p_1} & \cdots & \frac{\partial s_{J_f}}{\partial p_1} \\ \vdots & \ddots & \vdots \\ \frac{\partial s_1}{\partial p_{J_f}} & \cdots & \frac{\partial s_{J_f}}{\partial p_{J_f}} \end{pmatrix} \tag{12}$$

and such that the $J_f \times J_f$ matrix of the pre-merger ownership matrix, Ω_{uv}, is defined by

$$\Omega_{uv} = \begin{cases} 1 & \text{, if airline offers product } : \{u, v\} \subset J_f \\ 0 & \text{, otherwise} \end{cases} \tag{13}$$

Next, let Ω_{uv}^{Pre} be the product of Δ and Ω, such that

$$\Omega_{uv} = \begin{cases} \frac{\partial s_v}{\partial p_u} & \text{, if airline offers product } : \{u, v\} \subset J_f \\ 0 & \text{, otherwise} \end{cases} \tag{14}$$

By extension, the first-order condition of the airline's profit function can be rewritten as

$$0 = s + \Omega^{pre} (p - mc) \tag{15}$$

in which $s = [s_1, \cdots, s_{J_f}]'$, $p = [p_1, \cdots, p_{J_f}]'$, and $mc = [mc_1, \cdots, mc_{J_f}]'$. As a result, the marginal cost function of airline f yields

$$mc = p - \Omega^{pre^{-1}} s \tag{16}$$

in which the second term constitutes the markups of the airlines. Assuming the law of demand, the airlines face a downward-sloping demand curve, and those markups should be positive. I presume that the marginal cost function is a linear function of the set of cost-related characteristics and given by:

$$mc_{jm} = v_{jm}\varphi + \omega_{jm} \tag{17}$$

in which v_{jm} is a vector of observed cost characteristics (i.e., frequency, hub, distance for short-haul market, and distance for long-haul market). In particular, frequency indicates the quantity of air travel products and directly affects the marginal cost, whereas the hub is a dummy variable indicating whether the flight's origin, destination, or connection involves the airline's hub airport. Flight operations at hub airports cause two counter-effects to the airline's marginal cost. On the one hand, the hub-and-spoke system allows an airline to offer various connecting flights for consumers at its hub airport and results in a higher load factor, which consequently lowers the per-passenger cost. On the other, however, the hub-and-spoke system increases the airline's marginal costs due to airport congestion caused by hub operations. The function distinguishes the cost parameter for short-haul and long-haul routes in order to capture differences in fuel efficiency by type of aircraft. I control carrier-specific cost effects by adding carrier dummies; φ is a vector of cost parameters, while ω_{jm} indicates unobserved marginal cost shocks.

4 Data

This section discusses the data used in the empirical work and sample selection, which come from the Department of Transportation's (DOT) Airline Origin & Destination Survey (DB1B) and T-100 Domestic Segment. I combine those two publicly available datasets to estimate supply and demand in the airline industry and perform counterfactual analysis for merger remedies in airline mergers. The entire dataset is used in the process of estimating demand and marginal cost parameters, while data subsets of the EWR, DCA, and LGA markets are employed for counterfactual analysis using merger simulation.

4.1 Data Sources

Administered by the DOT, the DB1B is a quarterly 10% sample of airline tickets sold for domestic routes in the U.S. air travel market. The DB1B provides detailed information about air travel products including airfare, origin and destination airports, connecting airports, ticketing and operating carriers, distance traveled, and number of passengers. By using information in the DB1B, the market share of each air travel product and carrier can be computed.

Although the DB1B provides rich information about air travel products, it does not contain capacity-related data such as frequency of departure, load factor, and aircraft fleet. The T-100 dataset, however, provides domestic segment data reported by U.S. air carriers, including carrier, aircraft fleet, number of available seats, frequency of departure, and load factor. Therefore, I merge and match DB1B and T-100 data to be able to estimate demand in the airline industry.

4.2 Sample Selection

Following BCS (2006) and Berry and Jia (2010), I use only four segments of round-trip itineraries at most, because passengers who buy tickets with two or more connections are rare. I eliminate itineraries with extremely low or high ticket prices (<$25 or >$1,250), which may be due to coding errors. Similar to Evans and Kessides (1994), I also exclude observations of air travel products that carry less than 1% of passengers on a route, because those products are not regular flights but chartered ones.

I define a market as a directional airport–pair and a product as a possible combination of airline, airfare, and itinerary. As in Borenstein (1990), market size is determined by the geometric mean of the populations of the metropolitan statistical areas (MSA) of the origin and destination cities.

In this paper, I consider only medium-to-large markets, defined as having passenger traffic at both the origin and destination airports of at least 1,000,000 passengers per quarter and located in a medium or large MSA with at least 850,000 residents in 2010. I exclude small markets for three reasons. First, according to Berry and Jia (2010), the substantial difference in patterns of demand and operating costs between small markets and medium-to-large ones complicates capturing those effects in a stylized model. Second, the DB1B dataset imposes the limitation that distorted data can occur in small markets, because it contains a random 10% sample of flight tickets issued for passenger air travel, adjusted by multiplying the dataset by a factor of 10 to estimate the entire market. Third and last, in order to overcome the computational burden, I restrict market size.

Following Peters (2006), I collect four quarters of data prior to the merger's announcement (i.e., pre-merger period) and four quarters of data following the merger's completion (i.e., post-merger period) to estimate demand in the airline industry and evaluate the effect of merger remedies in airline mergers. Because United Airlines and Continental Airlines publicly announced their agreement to merge in May 2010, I set the pre-merger period as 2009:Q2 through 2010:Q1. All flights operated by the merged airline began flying under the carrier code "UA" in November 2011, such that the post-merger period runs from 2012:Q1 through 2012:Q4. By contrast, the American Airlines–US Airways merger was announced in February 2013 and completed in October 2015. Therefore, its pre-merger period is defined as 2012:Q1 through 2012:Q4 and its post-merger period as 2016:Q1 through 2016:Q4.

4.3 Data Summary

For the United Airlines–Continental Airlines merger, the dataset contains 198,217 unique itinerary–airline–airfare products in 4,127 unique origin–destination directional markets. Table 3 summarizes the pre-merger statistics for in means with standard deviations. As noted, I use the entire pre-merger dataset to estimate the demand-related and marginal cost parameters and a subset of the dataset associated with EWR for the counterfactual analysis of the merger. The average airfare for all products in the dataset was $288, and each had an average of 2,012 passengers. Although 61.2% of passengers traveled on direct flights, only 17.2% of the air travel products offered nonstop service. Each product had 1.45 connections on average; 19% of flights departed from the carrier's hub, whereas 79% departed, arrived, or connected there. On average, 24% of flights passed through at least one slot-controlled airport during the operation. Among other statistics, 19% of passengers experienced a code-sharing flight, and 31% were rewarded the advantage of FFP. The bottom panel of Table 2 summarizes statistics for the market averages. The column "EWR Products" summarizes statistics for the subsample of EWR products in particular. Despite no significant differences in most variables between all products and EWR products, EWR products tended to award more FFP advantages than the average product in the domestic market.

For the American Airlines–US Airways merger, the dataset contains 211,002 unique itinerary– airline–airfare products in 4,309 unique origin–destination directional markets. Table 4 summarizes the pre-merger statistics in means and standard deviations. As with the other merger, the entire pre-merger dataset is used to estimate the model's parameters, while datasets of the refined LGA and DCA products are employed to simulate the effect of the merger remedies. The average airfare for all products was $303, and, on average, 2,091 passengers purchased the same air travel product. While 20.2% of all air travel products consisted of a direct flight, 70.4% of passengers took direct flights. Each product had 1.39 connections on average; 22% flew from the carrier's hub airport, whereas 80.2% departed, arrived, or connected there. On average, 29% of flights passed through at least on slot-controlled airport. Nearly a quarter

(24%) of flights were code-shared with partner airlines, and 35% of tickets sold gave passengers FFP rewards. Despite no significant difference in most variables between all products and both LGA and DCA products, the average price and number of departures related to DCA tended to be higher.

I thus use a dataset for the United Airlines–Continental Airlines merger from 2009:Q2 to 2010:Q1 and another for the American Airlines–US Airways merger from 2012:Q1 to 2012:Q4 merger. Relative to those two pre-merger periods, the average number of passengers traveling on direct flight increased by 8.2% from 2009 to 2012, and the number of connecting flights tended to decrease throughout the period sampled. Berry and Jia (2010) have asserted that the increase in direct flights but decrease in connecting flights relate to the trend of dehubbing among major airlines as a result of network restructuring after mergers.

5 Estimation

This section details of the paper's empirical strategy. I begin with estimating demand parameters for airline industry and compute the marginal costs of the airlines. I also describe the econometric problem of endogenous problem and introduce instrument to resolve that issue. The merger simulation method to simulate the post-merger equilibrium prices by using estimated demand parameter and marginal cost will be explained and finally how consumer surplus changes following mergers is discussed.

5.1 Demand

To estimate the demand-related parameters for the airline industry, I use the structural error—that is, unobserved product characteristics in the demand model—as a function of those parameters and data. I estimate the parameters by forming moments representing expectations of how the unobserved product characteristics interact with exogenous instruments. Following BLP (1995), the estimation techniques depend on an assumption that the unobserved product characteristics, ξ are independent of vector of the exogenous instruments, z_t:

$$E\left(\xi\left(p_m, x_m, s_m, \theta_d\right) \mid z_t\right) = 0, \tag{18}$$

which yields the vector of demand parameters, θ_d, that makes the covariance of the unobserved product characteristics and the instrument as close to 0 as possible. The method of moments requires solving for the unobservable product characteristics as a function of the data. Those characteristics as a function of the price, the observed product characteristics, and the observed market shares can be derived by inverting the market share in Equation (6):

$$\xi_m = s^{-1}\left(p_m, x_m, s_m, \theta_d\right). \tag{19}$$

As in Berry and Jia (2010), I estimate the demand-related parameters by using a slight modification of a contraction-mapping method adopted by BLP (1995) to solve for ξ_{jm} which equate the estimated market share to observed market share.

$$\xi_{jm}^{H} = \xi_{jm}^{H-1} + \lambda\left[\ln s_{jm} - \ln s_{jm}\left(x_m, p_m, \xi_m, \theta_d\right)\right], \tag{20}$$

in which H is the Hth iteration, $s_{jm}$is the observed market share, and $s_{jm}\left(x_m, p_m, \xi_m, \theta_d\right)$ is the estimated market share defined by Equation (5).

The demand model is affected by airfare, the number of connections, frequency of departure, presence of an FFP, code sharing, flight distance, distance squared, a dummy for carrier hub, a dummy for slot-controlled airport, carrier dummies, and a tour dummy for airports in Las Vegas, Orlando, or Miami. I treat prices and frequency as endogenous and instrumented.

The demand model allows two passenger types—business travelers and tourists—

in order to capture heterogeneity in consumers' preferences. Given the well-documented negative relationship between price sensitivity and a preference for convenience in relation to products, I allow two random coefficient parameters: the coefficient of airfare and the number of connections. I also allow random coefficient parameters for FFPs to capture differences in the preference for them between business traveler and tourist.

5.2 Supply

From the supply model presented in Section 3.2, the marginal cost can be estimated as the difference between prices and markups. Whereas the marginal cost function is a function of observed cost characteristics, markup is a function of demand-related parameters. The unobserved marginal cost can thus be derived as a function of the observed cost characteristics and demand-related parameters:

$$\omega_{jm} = p_{jm} - \Omega^{pre^{-1}} s_{jm}\left(x_m, p_m, \xi_m, \theta_d\right) - v_{jm}\varphi \tag{21}$$

As with demand, cost-related parameters can be estimated by forming moments, which represent expectations of the unobserved cost shock, in interaction with cost-side exogenous instruments. The supply model assumes that those two factors are independent:

$$E\left(\omega\left(p_m, x_m, s_m, \theta_d, \varphi\right) \mid z_t\right) = 0, \tag{22}$$

in which z_t is a vector for variables of exogenous instruments.

The marginal cost equation is regressed on the following shifters of cost: frequency, a dummy for carrier hub, a dummy for slot-controlled airport, distance, number of connections, and carrier dummies. Following Berry and Jia (2010), I also include long- and short-haul markets, separated by a threshold of 1,500 miles, to capture the fuel efficiency of differently sized aircraft.

5.3 Instruments

The estimation procedure requires employing exogenous instrumental variables. Because airfares are likely endogenous and correlated with unobserved product characteristics (e.g., ticket restrictions, date of purchase, and in-flight service), the instruments need to be orthogonal to the structural errors, including unobserved product characteristics (ξ_m) and marginal cost shock (ω_m), to identify the price coefficients.

The standard strategy to instrumenting for price is to exploit the characteristics of competing airlines and degree of market competition. According to Berry and Jia (2010), the average airfare is lower for markets with closer substitutes; thus, the number of air travel products within a market can represent the competitiveness of the market. The Herfindahl–Hirschman Index (HHI) represents measure of market concentration, which consequently affects prices. A similar concern extends to using the characteristics of competing airlines as instruments, including the number of competing airline routes that offer direct flights and the number of all airlines in the market.

A second identification strategy identifies variables that influence the cost of airline operations but do not affect demand. Following BCS (2006), for instruments I employ the airline's hub status at connecting and destination airports, which affect the marginal cost of flight operations. Briefly put, because flights that connect to or terminate at hubs tend to carry large volumes of passengers by using larger, more fuel-efficient aircraft, they create economies of density. However, hub status at origin airports likely affects the demand of air travel, because the benefit of FFPs and the airline's network size at the origin airport are important factors for certain types of passengers when they purchase airline tickets.

5.4 Merger Simulation

This paper's chief purpose is to simulate the effect of merger remedies on post-merger equilibrium prices. After estimating parameters of demand and marginal cost based on the pre-merger data, including the pre-merger ownership matrix, using structural model I can simulate a post-merger equilibrium output by modifying the ownership matrix and determining the post-merger equilibrium prices by using numerical methods. Assuming no merger remedies, the post-merger prices yield:

$$p^{post} = mc - {\Omega^{post}}^{-1} s(x, p, \hat{\xi}, \hat{\theta}_d) \tag{23}$$

in which p^{post} denotes the post-merger prices and Ω^{post} is the post merger ownership matrix reflecting new ownership matrix, Ω', and $\Delta(p')$.

The benefit of merger simulation method is to allow various counterfactual analysis assessing the effect of slot divestiture imposed by antitrust enforcement agencies and ex ante analysis of assumed behavioral remedies scenarios. I execute counterfactual merger simulation with different merger remedy scenarios. The details of the counterfactual analysis are discussed in the Section 7.

5.5 Consumer Welfare

After estimating demand parameters and post-merger prices, I can estimate expected changes in consumer welfare following the airline mergers. To measure changes in consumer welfare, I employ compensating variations, V_{rm}^{pre} and V_{rm}^{post}, defined by demand system of airline market using estimated parameters for demand and pre- and post-merger prices:

$$V_{rm}^{pre} = \ln \left[1 + \left(\sum_{j \in J} \exp \left(\left(x_{jm}\beta_r - \alpha_r p_{jm}^{pre} + \xi_{jm} \right) / \lambda \right) \right)^{\lambda} \right] \text{ and} \tag{24}$$

$$V_{rm}^{post} = \ln\left[1 + \left(\sum_{j \in J} \exp\left(\left(x_{jm}\beta_r - \alpha_r p_{jm}^{post} + \xi_{jm}\right)/\lambda\right)\right)^{\lambda}\right]. \tag{25}$$

Following McFadden (1981) and Small and Rosen (1985), the compensating variation of the equation for type r consumer in market m is:

$$CV_{rm} = \frac{V_{rm}^{pre} - V_{rm}^{post}}{\alpha_r} \tag{26}$$

in which α_r indicates the consumer's marginal disutility relative to the increase in airfare. Integrating CV_{rm} over the type of consumers and multiplying it by the market size yields the change in the total surplus of consumers due to airline merger.

6 Estimation Results

In this section, I report the estimated parameters of the supply and demand models, including marginal costs and markups.

6.1 Demand Parameters

Table 6 presents the estimated parameters of the demand model, in which all estimated coefficients were statistically significant, and the sign of the coefficient of each product characteristic was consistent with expectations. As mentioned in Section 5, several product characteristics influenced demand among consumers: airfare, number of connections, presence of an FFP, code sharing, flight distance, flight distance squared, a dummy for carrier hub, the dummy for slot-controlled airport, carrier dummies, and the tourist destination dummy for airports in Las Vegas, Orlando, or Miami.

The first column in Table 5 reports the estimated parameters of demand for United Airlines and Continental Airlines during the pre-merger period, whereas the second column reports corresponding parameters for American Airlines and US Airways. First, for the coefficient of airfare, representing consumers' sensitivity to changes in price, I included the random coefficient across two groups of consumers: business travelers and tourists. For the United Airlines–Continental Airlines pre-merger period, the airfare coefficients of business travelers and tourists were -0.099 and -1.003, respectively. For the American Airlines–US Airways pre-merger period, by comparison, the respective price coefficients were -0.112 and -1.058. Although both types of consumers sensed disutility in the increased prices, tourists were nearly 10 times more sensitive to price than business travelers. That result validates the heterogeneity of consumers' preferences in response to price increases and aligns with the estimated demand calculated by BCS (2006) and Berry and Jia (2010).

During the pre-merger periods in both cases, both business travelers and tourists experienced significant disutility by taking flights with connections. No significant difference emerged in the coefficients of the number of connections between the types of passengers, which indicates that both types preferred nonstop flights and, in turn, explains why most passengers traveled on direct flights: 61.2% in 2009 and 70.4% in 2013.

With FFPs, the airlines in the cases award consumers points for each flight purchased. Thus, FFPs create an incentive for both types of passengers to choose flights that award points, although business travelers are generally more willing to do so, arguably for the sake of status. Briefly explained, the FFPs of U.S. legacy airlines are structured with tiers based on accumulated points, and, each year, members need to accumulate a minimum number of points to achieve a certain tier status. In turn, airlines provide different levels of service and convenience according to the member's status. Although business travelers are generally less sensitive to price—their travel costs are covered by their companies—they do place positive weight on achieving status. Indeed, the estimated results for the pre-merger periods in both cases imply that business travelers' willingness to pay for FFP points is nearly 12 times higher than that of tourists.

Because passengers have more options to select a desired departure time if carriers offer multiple times, they value flight schedules with more frequent departures. For the pre-merger periods in both cases, the results for the coefficient of frequency validate that phenomenon. However, passengers derived less utility from code-sharing products; its estimated coefficients during the pre-merger period were -0.089 for United Airlines and Continental Airlines and -0.075 for American Airlines and US Airways. Because ticketing carriers and operating carriers differ on code-shared flights, the coordination involved with such flights may not be as convenient as purchasing from and flying on single airlines. In addition, code-shared flight tickets can entail restrictions to baggage services and access at the boarding gate.

Estimating flight distance and flight distance squared as parameters of demand captured the U-shaped demand for air travel in terms of distance—that is, air travel on short-haul flights rose bit eventually dropped as distance increased. Ivaldi and Vibes (2008) have posited that in the case of short-haul flights, substitution between air travel and outside-the-market options (e.g., driving, buses, and trains) is higher. As distance increases, however, air travel becomes a more effective way to travel, and the substitution of air travel with alternative options wanes. At the same time, traveling in general becomes less pleasant as distance increases, and the utility of flights thus also starts to wane.[7]. The coefficients of distance and distance squared thus confirm well-known characteristics of demand for air travel in the literature.

Meanwhile, the coefficients of hub airport dummy for the pre-merger periods in both cases—0.701 for United Airlines and Continental Airlines and 0.912 for American Airlines and US Airways—imply that passengers preferred to travel to or from a carrier's hub airport. Because carriers offer a wider range of destinations and flight

[7]See Berry and Jia (2010)

schedules to or from their hub airports, passengers are more likely to find convenient flight options there. The FFPs provided by the carriers with significant market share attract consumers to carriers' hubs as well. The positive parameter detected in analysis corroborates Borenstein's (1989) finding of so-called "airport dominance" by legacy airlines. The corresponding coefficients of the slot-controlled airport dummy were -0.188 and -0.355, which suggests that traveling via slot-controlled airports, as notoriously crowded, congested facilities, creates disutility for passengers. The airports in Las Vegas, Orlando, and Miami, all treated as offering access to tourist destinations, attracted more passengers than their slot-controlled counterparts. Thus, the tour dummy's coefficient was consistent with expectations.

The nested logit parameter λ, measuring all of the airline products' ability to be substituted, was 0.697 for United Airlines and Continental Airlines and 0.699 for American Airlines and US Airways during their pre-merger periods. Because all air travel products became perfect substitutes as λ approached 0, the coefficients 0.697 and 0.699 imply only slight substitutability among the air travel products. Last, the coefficient γ_{Business} represents the percentage of business travelers in the population. Along those lines, the coefficients for γ_{Business} in both cases, 0.054 and 0.059, indicate that an average 5.7% of potential travelers were business travelers. Despite the small percentage of business travelers in the population, business travelers have been shown to account for 43.1% of actual travelers based on a computation method suggested by BCS (2006).

6.2 Marginal Cost

Using the estimated parameters of demand, I computed the marginal cost by regressing the difference between observed prices and estimated markups on the characteristics of marginal cost, as shown in Equations (16) and (17). Table 6 details the parameters of marginal cost, all of which were statistically significant. As mentioned in Section 5, the following characteristics of marginal cost affected the marginal cost of carriers: number of connections, flight distance, the dummy for carrier hub, the dummy for slot-controlled airport, carrier dummies, and frequency. I included two sets of marginal cost parameters for distance and the number of connections, long- and short-haul markets, separated by a threshold of 1,500 miles.

The coefficient of frequency had a negative relationship with marginal cost in the pre-merger periods in both cases. In general, more frequent flights accelerate aircraft turnaround at gates and thus increase aircraft utilization, the latter of which distributes fixed costs over an increased number of flights, thereby decreasing costs per passenger and per flight. In their pre-merger periods, the coefficients of the hub dummy—that is, -0.087 for United Airlines and Continental Airlines and -0.137 for American Airlines and US Airways—imply that flights via a carrier's hub airport reduced the marginal cost. Two offsetting factors affecting that cost, as explained in Section 3.2, were flying to or from a carrier hub and using a slot-controlled airport. On the one hand, the hub coefficient reflected the net effect of those two countervailing factors, and the negative coefficient of the carrier hub dummy indicates that the reduced cost from higher load factors exceeded the increased cost due to airport congestion. On the other, the negative coefficient of the slot-controlled airport dummy implies that the marginal cost was higher for flights operating via slot-controlled airports. Most likely, congested traffic at slot-controlled airports had caused frequent flight delays and thus increased the operating costs of flights.

Although the marginal cost increased with distance in markets for both short- and long-haul flights, the coefficient of distance in the short-haul market exceeded that of the long-haul market. As to why, because aircraft consume massive amounts of fuel during takeoff and landing, and because large aircraft enjoy fuel efficiency due to economies of scale, carriers tend to use large aircraft on long-haul routes. The marginal cost also increased with connecting flights, albeit under the influence of two countervailing factors. For one, by transferring passengers from different origins to different destinations by using connecting flights, carriers can achieve higher load factors, spread the fixed cost, and reduce per-flight and per-passenger costs. As for the other, because aircraft consume massive amounts of fuel during takeoff and landing, an additional landing and additional takeoff substantially increase the fuel component of the marginal cost. The negative coefficient of connecting flight thus implies that increased cost due to an extra landing and takeoff outweighs the cost reduction achieved with economies of scale.

7 Counterfactual Merger Simulation

The purpose of merger remedies is to mitigate anticompetitive risks. To resolve those risks, antitrust enforcement agencies strive to tailor appropriate merger remedies while preserving the benefit of mergers. Although the agencies continue to prefer requesting structural remedies, those remedies are undesirable under certain market circumstances and have thus come to overlap with behavioral remedies as well.

In this section, I report upon various counterfactual merger simulations as a means to identify the implications of policies imposing remedies for airline mergers. I simulated the post-merger equilibrium prices such that antitrust enforcement agencies were assumed to have imposed both structural and behavioral remedies. Using standard merger simulation, I derived the post-merger equilibrium outcomes by using estimated parameters of demand and marginal cost along with a post-merger ownership matrix. To perform the simulations, I modified observations of several product characteristics in the pre-merger dataset and, in turn, computed the post-merger outcomes by using standard merger simulation. Because the DOJ requested slot divestiture at EWR for the United Airlines–Continental Airlines merger and at LGA and DCA for the American Airlines–US Airways merger, the counterfactual merger simulation used a subset of the dataset including products and markets representing EWR, DCA, and LGA.

7.1 Structural Remedies

In addressing airline mergers, antitrust enforcement agencies tend to employ structural remedies, including the divestiture of slots and airport facilities, to mitigate anticompetitive concerns. As mentioned in Section 2, the United Airlines–Continental Airlines and the American Airlines–US Airways mergers are two cases in which the DOJ mandated slot divestiture and approved the mergers only after the airlines agreed to permanently transfer slots to low-cost carriers.

The United Airlines−Continental Airlines Merger

In the case of the United Airlines–Continental Airlines merger, 36 daily takeoff and landing slots at EWR were divested to Southwest Airlines by June 2011. With 1,296 total slots available at EWR, those divested slots represented approximately 3.6% of the average daily flight at the airport. Following the divestiture, the new United Airlines discontinued nonstop services to five destinations—Columbus (CMH), Kansas City (MCI), Myrtle Beach (MYR), Ontario, California (ONT), and Sacramento (SMF)—from EWR. Once Southwest Airlines entered the EWR market, it inaugurated nonstop service to six new destinations—Baltimore (BWI), Chicago (MDW), Dallas (DAL), Denver (DEN), Houston (IAH), and St. Louis (STL)—as well as approximately 60 additional connecting services via those destinations. However, because Southwest Airlines entered the markets for only two of four problematic nonstop routes—EWR–DEN, EWR–IAD, EWR–ORD, and EWR–SFO—the DOJ voiced anticompetitive concerns. After all, in offering the other services, United Airlines–Continental Airlines would create a monopoly market if their merger were approved. That situation would have raised the structural limitations of structural remedies by exemplifying how slot divestiture to low-cost carriers cannot guarantee that low-cost carriers will enter problematic markets and thus mitigate anticompetitive concerns.

The American Airlines–US Airways Merger

When American Airlines and US Airways proposed merging, the DOJ mandated the divesture of 104 daily takeoff and landing slots at DCA and 34 daily at LGA, representing 7.2% and 2.9% of available daily slots at DCA and LGA, to low-cost carriers. Among them, Southwest Airlines permanently acquired 56 of the slots at DCA, JetBlue acquired 40, and Virgin America acquired eight. In response to divestiture, American Airlines ceased operating nonstop service to 17 destinations from DCA; the full list of American Airlines' network changes due to slot divestiture appears in the first column of Table 7. By contrast, Southwest Airlines added daily nonstop flights between DCA and 14 new destinations, JetBlue launched five new nonstop flights from DCA, and Virgin America added four flights to its one daily nonstop route to San Francisco. The summary of DCA-related market entries by low-cost carrier airlines resulting from divestiture due to the American Airlines–US Airways merger appears in the second and third column of Table 7.

In LGA's market, once 34 takeoff and landing slots were transferred to low-cost carriers, American Airlines ceased operating nonstop flights to Atlanta (ATL), Cleveland (CLE), and Minneapolis (MSP). Southwest Airlines and Virgin America each acquired 22 and 12 of the slots. Because Southwest already operated in six destinations: Akron–Canton (CAK), Chicago (MDW), Houston (HOU), and Nashville (BNA)—it used the divested slots to add round-trip flights between those destinations and LGA. With its 12 divested slots, by contrast, California-based airline Virgin America launched nonstop flights from LGA to Dallas (DAL) to provide connections to Los Angeles and San Francisco.

The proposed remedy for the American Airlines–US Airways merger mandated the divestiture of nearly four times as many slots as required for the United Airlines–Continental Airlines merger. The DOJ expected that low-cost carriers were in a position to be effective competitors and thus to benefit consumers. Although literature addressing the effect of slot divestiture in airline mergers has remained sparse, most literature reports retrospective studies based on the post-merger period. By extension, conducting counterfactual merger simulations to systematically examine the effect of slot divestiture ex ante stands to aid antitrust enforcement agencies in tailoring appropriate merger remedies.

Counterfactuals

To measure the effect of slot divestiture in airline mergers, I simulated post-merger equilibrium outcomes in cases in which slot divestiture occurred at EWR, DCA, and LGA during the merger procedure. I also executed a merger simulation assuming that no divestiture had occurred. Comparing the outcomes of those two merger simulations allowed measuring slot divestiture's effectiveness in airline mergers.

Available post-merger data informed the results for actual slot divestiture, while estimated parameters of demand and marginal cost allowed the simulation of counterfactuals. From the results of the simulations, the marginal effect of slot divestiture on post-merger equilibrium prices could be probed by comparing the counterfactual simulation's outcomes involving divestiture with those from the case not involving divestiture. Three simulated merger scenarios were examined. The first (i.e., baseline) entailed post-merger prices in the case that the DOJ did not order slot divestiture. The second (i.e., slot divestiture) reflected the DOJ's actual slot divestiture at EWR for United Airlines–Continental Airlines and at DCA and LGA for American Airlines–US Airways. For the third scenario, I simulated post-merger prices under the assumption that slot divestiture influenced consumer demand in the model.

The baseline scenario held observed and unobserved product characteristics as well as estimated marginal costs fixed at pre-merger levels. The ownership matrix of first-order conditions for profit maximization was changed to reflect post-merger changes in ownership. Simulated equilibrium outcomes under those conditions predicted post-merger outcomes changes due to the loss of competition following the merger. Next, to measure slot divestiture's impact on post-merger outcomes, I derived equilibrium outcomes from the ownership matrix that reflected the actual slot divestiture required for the merger to be approved. Similarly, to measure how changes in product characteristics affected demand among consumers following the merger, for the last scenario I employed a post-merger ownership matrix reflecting slot divestiture and post-merger observations of both observed and unobserved product characteristics in order to simulate post-merger equilibrium. Because slot divesture changed the values of product characteristics, including frequency, number of connections, presence of an FFP, code sharing, and airport's status as a carrier hub, estimating the parameters of demand and marginal cost by using pre-merger levels of product characteristics generated inaccurate post-merger predictions of slot divestiture's effect on air travel prices.

Table 8 presents the results of the simulated merger outcomes of the three scenarios. Using all air travel products to or from EWR, DCA, and LGA to derive post-merger outcomes, the simulations projected an increase in average airfare and a reduction in the number of passengers at all three airports had the DOJ not stipulated slot divestiture to low-cost carrier airlines prior to the mergers. The simulations also projected that mergers without slot divestiture would have disadvantaged consumers who travel via EWR, DCA, and LGA, because higher airfares generally deplete the surplus of consumers. However, the second scenario, assuming that the DOJ had mandated slot divestiture, indicated significantly different post-merger outcomes. Although the average airfares at EWR were projected to increase by approximately 1% following the United Airlines–Continental Airlines merger, the magnitude of the price increase was less than in the baseline scenario. Reductions in the number of passengers and consumer surplus would have also weakened had the merger proceeded with slot divestiture. Predicted post-merger airfare changes at DCA and LGA amid slot divestiture were both negative in the case of American Airlines and US Airways. However, slot divestiture's effect on post-merger prices would have been more substantial at DCA (-1.13%) than at LGA (-0.03%). The simulations thus predicted an increased number of passengers and consumer surplus at both airports, albeit to a greater degree at DCA than LGA. After all, the DOJ ordered the divesture of nearly three times as many slots at DCA, and, according to the results, the pro-competitive effect generally increased with the number of divested slots. As a case in point, the new American Airlines transferred 104 takeoff and landing slots at DCA but only 34 at LGA. The results accordingly suggest evidence of a positive relationship between the number of divested slots and slot divestiture's effect on the airline mergers.

Despite slot divestiture's pro-competitive effects after the mergers, they did not necessarily resolve risks of anticompetition in such a problematic market, at least as far as the DOJ was concerned. As mentioned, because antitrust enforcement agencies do not generally require slot purchasers to enter specific markets, slot divestiture to low-cost carriers cannot guarantee that low-cost carriers will enter markets with risks of anticompetitive tendencies. As a case in point, even though the overlapping nonstop routes to or from slot-controlled airports operated by the merged airlines were the DOJ's chief concerns, Southwest Airlines began serving only two of four of those routes also operated by new United Airlines at EWR, and no slot-purchasing airline entered the market for the corresponding routes served by the new American Airlines at DCA and LGW.

Table 9 reports the outcomes of simulated mergers for overlapping nonstop routes to or from EWR, DCA, and LGA. Among the results, the airline mergers without slot divesture would have substantially increased the airfare of overlapping nonstop routes relative to all other products at three airports. As a consequence, the mergers would have greatly reduced the number of passengers on those routes and their welfare as consumers. The simulated post-merger prices in the case of slot divestiture, by contrast, indicated that mergers increased airfare by 7.17% at EWR—that is, nearly 10% less than in the baseline scenario. That result implies that the entrance of Southwest Airlines into two overlapping nonstop routes partly eased anticompetitive effects. Beyond that, although the simulations in the case of slot divestiture predicted a drop in prices at DCA and LGA after the mergers, the magnitude of such drops was insignificant and not enough to counter the anticompetitive risks. Mergers entailing slot divestiture decreased airfare by 6.0% and 3.5% at DCA and LGA, respectively, relative to simulated ones without divestiture. Thus, although the mergers nevertheless significantly increased prices and harmed the welfare of consumers traveling on overlapping nonstop routes, following slot divestiture the emergence of low-cost carriers at those airports spawned various connecting flights with competitive prices, which partly served to decrease airfares on those same routes. However, slot divestiture did not prevent increases in the average airfare for those routes due to consumers' strong preferences for nonstop flights. Altogether, the results of the counterfactual merger simulations for overlapping nonstop routes revealed the structural limitations of imposing slot divestitures to low-cost carriers without forcing their entry into markets for overlapping nonstop routes.

7.2 Behavioral Remedies

The potential limitations of slot divestiture to low-cost carriers without forcing their entry into markets for nonstop overlapping routes urge alternative merger remedies. To that end, I developed three behavioral remedies ancillary to slot divestiture: (1) requiring the surrender of slots to operate flights for overlapping nonstop routes, (2) requiring code-sharing agreements between slot sellers and purchasers, and (3) opening FFPs to competitors and/or new entrants. To assess the effect of those behavioral remedies, I simulated the post-merger equilibrium outcomes under the assumption that antitrust enforcement agencies would mandate a combination of slot divestiture and each behavioral remedy before approving the proposed airline mergers.

Requiring the Surrender of Slots to Operate Flights for Overlapping Nonstop Routes

Mandating slot divestiture without forcing slot purchasers to enter the market for specific routes does not necessarily resolve risks of anticompetitive practices. The DOJ required slot divestiture to low-cost carriers airlines specifically, given their record as effective competitors against legacy carriers with significant market power. Therefore, the counterfactual merger simulation in the case of slot divestiture combined with the requirement to surrender slots to operate flights for overlapping nonstop routes assumed that low-cost carriers have purchased divested slots and have to enter the market for those routes. For the sake of simply constructing data under those assumptions, I assumed that Southwest Airlines began offering services on all of the merged airlines' overlapping nonstop routes to or from EWR, DCA, and LGA. That assumption was reasonable because Southwest acquired nearly 70% of all divested slots in the two merger cases.

Requiring Code-Sharing Agreements

Code-sharing agreements are contracts among airlines in which an operating carrier, acting as a ticketing carrier, is allowed to sell seats on its partner's flight for segments of an itinerary operated by its partner. In Section 6, the estimated parameters of demand suggest that consumers generally experience significant disutility by traveling on code-shared flights due to their inconvenience compared with flights whose ticketing and operating carriers are one and the same. However, studies have suggested that code sharing lowers airfares and has a pro-competitive effect in the market. According to Chen and Gayle (2007), code sharing can also prevent double marginalization, such as when two non-allied airlines set airfares for different segments of inter-line trips independently. That marginalization effect, which results in higher airfares, occurs when each airline determines its airfare with the goal of maximizing its profit on the segment that it operates in the absence of an alliance. If two airlines form a code-sharing agreement, however, they negotiate a pricing contract that can eliminate the marginalization effect by setting the airfare to maximize their joint profit. Code sharing also enables airlines to offer customers a broader range of networks and thus ensure better connection options.

In the counterfactual merger simulation, I assumed that code sharing allowed low-cost carriers to place their codes on the flights of overlapping nonstop routes operated by the merged airlines to or from EWR, DCA, and LGA. That assumption ensured that low-cost carrier airlines had access to connecting flights and that merged airlines could achieve higher load factors with connecting passengers, consequently increase their profitability on overlapping nonstop routes, and, in effect, reduce airfares. Using the DB1B, which contains information about ticketing and operating carriers, I constructed a dataset reflecting the assumption that antitrust enforcement agencies request obligatory code-sharing agreements between merged airlines and low-cost carrier airlines on overlapping nonstop routes to or from EWR, DCA, and LGA.

Opening the FFPs to Competitors and/or New Entrants

In assessing competition in cases of airline mergers, not only origins and destinations but also network effects need to be considered to determine the boundaries of the market. Network effects may be significant for corporate consumers and others who are members of FFPs, whose choice of airline can depend upon its network. The estimated parameters of demand in Section 6 suggest that business travelers receive greater utility from FFPs than tourists when purchasing air travel products, which exemplifies a phenomenon of network effects. Network effects arise for certain types of consumers because FFPs act as an entry barrier to new entrants in markets where merged airlines enjoy a significant market share. At EWR, DCA, and LGA, the merged airlines had an overwhelming market share. Although slot divestiture reduced the market power of the merged airlines at those airports, the existence of network effects due to FFPs nevertheless continued to interrupt the entry of effective competitors into the market. Therefore, the behavioral remedy of allowing the consumers of new entrants to receive FFP points for the merged airlines was expected to enhance the appeal of other airlines among loyal customers of the merged ones.

To simulate the effect of opening FFPs to competitors and/or new entrants, I assumed that United Airlines opened its FFP to the new routes served by Southwest Airlines to or from EWR and that American Airlines allowed rewarding FFP points to consumers traveling on the new routes of Southwest Airlines, JetBlue, and Virgin America to or from DCA and LGA following its merger with US Airways. I first estimated the average internal and cross-price elasticities of demand by using demand parameters for all air travel products at each of the three airports (i.e., EWR, DCA, and LGA). Table 10 presents those average elasticities for United Airlines and Southwest Airlines concerning all air travel products to or from EWR. The first two columns list the results regarding slot divestiture, whereas the last two columns list the average estimated internal and cross-price elasticities under the assumed mandatory opening of the FFPs to competitors and/or new entrants. The results suggest that internal price elasticity concerning demand for United Airlines rose by 0.1% and for Southwest Airlines dropped by 0.1%. Although those changes in were not significant, the results imply that the consumers of United Airlines were more sensitive to United's airfares after the airline opened its FFP to Southwest. The estimated cross-price elasticity of demand suggests that an increase of 1.0% in United's airfare would increase Southwest's demand by 0.54% without the FFP's opening and of 0.78% otherwise.

The own and cross-price elasticities of demand on all air travel products to or from DCA and LGA appear in Table 11 and Table 12, respectively. Although the magnitude of changes in the cross-price elasticities of demand differed, slot purchasers' cross-price elasticities tended to increase at all three airports under the assumption that the merged airlines' FFPs were opened to slot purchasers. Thus, though the FFPs of dominant airlines with hub-and-spoke systems are designed to deter the entry of effective competitors, slot divestiture with the mandatory opening of the FFPs to competitors and/or new entrants incentivized consumers to switch to those airlines.

Although the estimated own and cross-price elasticities under the assumed merger remedy offer valuable information about consumers' preferences and competition between the merged airlines, simple averages cannot support definitive interpretation. Therefore, I simulated the precise effect on competition of opening FFPs to competitors and/or new entrants by using counterfactual merger simulation.

Counterfactuals

To simulate the post-merger outcomes under the assumption that the DOJ would require slot purchasers to enter the market for overlapping nonstop routes operated by the merged airlines, I held observed and unobserved product characteristics as well as estimated marginal costs fixed at pre-merger levels. The ownership matrix of the first-order conditions for an airline's profit maximization was changed based on the actual change in ownership following the respective merger. In the second scenario, Southwest Airlines entered four markets for overlapping nonstop routes (i.e., EWR–SFO, EWR–DEN, EWR–ORD, and EWR–IAD) operated by United Airlines and, at DCA, commenced service for DCA–RDU and DCA–BNA. Last, Southwest was assumed to enter LGA–CLT and LGA–MIA. The post-merger ownership matrix needed to be modified to reflect those behavioral remedies ancillary to slot divestiture, after which the post-merger outcomes could be derived using the parameters of demand and marginal cost along with the modified post-merger ownership matrix.

Table 13 presents the results of the counterfactual simulation in the case that entering overlapping nonstop routes was required along with surrendering slots for all products at EWR, DCA, and LGA. Although the United Airlines–Continental Airlines merger increased airfares for all products to or from EWR by 0.05% under the assumption that slot purchasers would be required to enter the merged airlines' overlapping nonstop routes, the magnitude of the anticompetitive effect was less than in the merger case imposing slot divestiture only. That ancillary behavioral remedy to slot divestiture was also predicted as a more effective policy for reducing risks of anticompetitive practices at DCA and LGA following the American Airlines–US Airways merger. The effect of requiring entry into overlapping nonstop routes and surrendering slots was more significant when those routes were considered in relation to simulated post-merger outcomes. As shown, both merger cases substantially increased the airfare of such routes operated by the merged airlines, even with slot divestiture. However, the counterfactual merger simulation under that assumption predicted that the airfare of the overlapping nonstop flights via EWR operated by the new United Airlines would decrease by 0.71%, whereas the merger mandating slot divestiture only would cause an increase of 7.17% in those flights. The results in Table 14 suggest that requiring mandatory operation on overlapping nonstop routes to or from DCA and LGA more significantly decreased the average airfare on those routes. Because no slot purchaser entered the market for those routes at DCA and LGA according to actual post-merger data, the additional behavioral remedy's effect was far more significant when the DOJ was assumed to require Southwest Airlines to enter four overlapping nonstop routes operated by the new American Airlines via

DCA and LGA. Figure 4, Figure 5, and Figure 6 plot the simulated post-merger equilibrium airfare density for the baseline scenario, with slot divestiture, and with slot divestiture combined with forcing slot purchasers to enter the markets for the overlapping nonstop routes at EWR, DCA, and LGA, respectively.

The next alternative merger strategy assessed in counterfactual merger simulation was obligatory code-sharing agreements between merged airlines and low-cost carrier airlines on overlapping nonstop routes to or from EWR, DCA, and LGA. In that scenario, I assumed that the new United Airlines and Southwest Airlines were engaged in code-sharing agreements for EWR–SFO and EWR–IAD. In the American Airline–US Airways merger, the new American Airlines was assumed to agree to code sharing with Southwest Airlines, JetBlue, and Virgin America on DCA–RDU, DCA–BNA, LGA–CLT, and LGA–MIA. To simulate post-merger outcomes under that assumption, I modified the pre-merger data regarding the status of code sharing to reflect changes due to the additional behavioral remedy, and thus, parameters of demand and marginal cost were re-estimated.

Table 15 presents the results of the counterfactual simulations with obligatory code sharing for all products at EWR, DCA, and LGA. Although the magnitude of the effect of obligatory code sharing was insignificant compared with that of requiring slot purchasers to enter the overlapping nonstop routes, slot divestiture combined with obligatory code sharing decreased the airfares of all products at all three airports. As a result, the number of passengers and consumer surplus would have increased following the merger. The predicted changes in price after the merger combining slot divestiture and obligatory code sharing for overlapping nonstop routes are listed in Table 16. The results suggest that slot divestiture combined with obligatory code sharing substantially lowered the airfares for those routes compared with airfares when only slot divestiture was imposed. However, the post-merger prices of overlapping nonstop routes were nevertheless predicted to respectively increase and decrease the number of passengers and consumer surplus. Whereas obligatory code sharing on such routes decreased airfares by jointly maximizing profit among code-sharing partners based on true marginal costs, the pro-competitive effect was less than that of the alternative behavioral remedy that directly required slot purchasers to enter the markets for problematic routes. Figure 7, Figure 8, and Figure 9 plot the simulated post-merger equilibrium airfare density for the baseline scenario, with slot divestiture, and with slot divestiture combined with obligatory code-sharing agreements between merged airlines and low-cost carriers on overlapping nonstop routes at EWR, DCA, and LGA, respectively.

To examine how the combination of slot divestiture and requiring the merged airlines to open their FFPs to competitors and/or new entrants affected post-merger outcomes, I assume that United Airlines allowed awarding its FFP's points to Southwest's customers who travel to new destinations from Newark—that is, EWR–BWI, EWR–MDW, EWR–DAL, EWR–DEN, EWR–IAD, and EWR–STL. For the American Airlines–US Airways merger, I assumed that the new American Airlines would open its FFP to customers on Southwest's 17 new routes, JetBlue's five new routes, and Virgin's one new route to or from DCA, as well as Southwest's six new routes and Virgin's one new route to or from LGA. Those customers were assumed to be entitled FFP benefits identical to those enjoyed by customers who fly with the merged airlines' alliance partners.

The results in Table 17 suggest that slot divestiture combined with opening the FFPs of merged airlines would decrease the average airfare of all products by 0.03%, 1.39%, and 0.03% at EWR, DCA, and LGA, respectively, and thus boost the number of passengers and consumer surplus. However, the simulated post-merger outcomes under that scenario suggest that requiring opening the FFPs would not effectively resolve the risks of anticompetitive practices on the overlapping nonstop routes. Table 18 shows results suggesting that the average airfares of overlapping nonstop routes would increase by 6.8% at EWR, by 23.1% at DCA, and by 12.9% at LGA and thus substantially decrease the number of passengers and consumer surplus. Although the results suggest of simulations indicate that the average airfares of those routes would increase substantially, the predicted increase in airfares was less than when the DOJ mandate slot divestiture only. Figure 10, Figure 11, and Figure 12 depict the simulated post-merger equilibrium airfare density for the baseline scenario, with slot divestiture, and with the combination of slot divestiture and the opening of the merged airlines' FFPs to consumers of low-cost carriers' new destinations to or from EWR, DCA, and LGA, respectively.

The results of the counterfactual merger simulation with three alternative behavioral remedies suggest that, on average, slot divestiture combined with enforcing slot purchasers to enter the markets for overlapping routes would be the most effect remedy to reduce risks of anticompetitive practices at slot-constrained airports. All three behavioral remedies were predicted to have pro-competitive effects when considering all products following the merger. However, the results also show that slot divestiture combined with opening FFPs to competitors and/or new entrants would not significantly decrease the average airfares for overlapping nonstop routes operated by the merged airlines.

8 Conclusion

In brief, the objective of the study was to identify the structural limitations of merger remedies imposed in airline mergers and suggest alternative ones. To address those limitations and alternative merger remedies, I developed a random-coefficient discrete-choice model based on the characteristics of air travel products. The model accounts for the fact that airline consumers may have heterogeneous preferences concerning characteristics of air travel products. Focusing on the United Airlines–Continental

Airlines merger and the American Airlines–US Airways merger, in which the airlines were required to divest daily takeoff and landing slots at EWR, DCA, and LGA, I assessed the effectiveness of slot divestitures and various alternative behavioral remedies, namely involving an obligation to surrender slots operating monopolistic routes, mandatory code-sharing, and the required opening of FFPs to competitors and/or new entrants by using counterfactual merger simulation. EWR, DCA, and LGA are slot-controlled airports with strict entry barriers to effective competitors and thus provide ideal circumstances to study the effect of slot divestitures and alternative behavioral remedies in airline mergers. The analysis focused on the price effect of the slot divestitures and three alternative behavioral remedies, as well as the effects on demand among consumers and their welfare.

The results reported herein suggest that slot divestiture and alternative behavioral remedies can indeed decrease the average post-merger airfare of all air travel products and thus increase the number of passengers and consumer surplus. The reduced airfares, however, would not be significant for overlapping nonstop routes if the DOJ required only slot divestiture from the merged party, and that result thus indicates that slot divestiture presents limitations to resolving risks of anticompetitive behavior on problematic routes. Although slot divestiture's ineffectiveness on some routes can be predicted, the combination of slot divestiture and alternative behavioral remedies would have a pro-competitive effect in those markets. The counterfactual merger simulations in the case of slot divestiture combined with an obligation to surrender slots operating monopolistic routes predicted that reductions in average airfare would be greater in the model stipulating only slot divestiture than in the baseline model for all air travel products and overlapping nonstop routes. Obligatory code-sharing ancillary to slot divestiture also would decrease average airfares, even as the price effect would be less than that of forcing slot purchasers to enter markets for those routes. Last, opening merged airlines' FFPs would decrease the airfares of air travel products overall. The price effect, however, would be insignificant on overlapping nonstop routes. The counterfactual simulations additionally suggest that slot divestiture at slot-controlled airports would benefit consumers by lowering airfares and adding flight options. However, slot divestiture cannot guarantee benefits for every consumer. Therefore, the simulated outcomes of alternative merger policies examined in the study could aid policymakers in antitrust enforcement agencies.

Some limitations of the study indicate room for improvement in both modeling and estimations in future research. One remedy would be to improve the merger simulation model by adding flexibility in the supply system. Peters (2006) has suggested that standard merger simulations tend to overly predict the price effect of mergers due to ignoring supply-side effects, particularly the cost efficiency of the merged airlines. Second, my model does not incorporate the analysis on the changes in producer surplus caused by the merger remedies. Because the alternative behavioral remedies may create substantial costs for the merged airlines, the analysis on the profitability of the merged airlines was necessary to not intervene in effective competition. Last, I simulated post-merger outcomes by using only a subset of data associated with slot-controlled airports. Although the pro-competitive effects of slot divestiture combined with alternative behavioral remedies are apparent, those merger remedy schemes are unavailable at most airports whose capacity is not constrained.

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Table 1: Passengers on Nonstop Overlapping Routes between United Airlines and Continental Airlines (Q1 2010)

Routes	Passengers			Market Share		
	United	Continental	Others	United	Continental	Others
HNL−LAX	39,312	7,006	68,132	0.34	0.06	0.60
DEN−IAH	28,255	49,862	14,708	0.30	0.54	0.16
EWR−ORD	32,184	26,538	20,607	0.41	0.33	0.26
IAH−SFO	5,921	52,129	0	0.11	0.89	0
EWR−SFO	6,012	41,298	0	0.13	0.87	0
CLE−ORD	22,243	10,927	14,682	0.46	0.23	0.31
DEN−EWR	17,951	21,657	0	0.45	0.55	0
EWR−IAD	9,726	6,384	0	0.60	0.40	0
IAD−IAH	8,587	6,230	0	0.58	0.42	0
CLE−DEN	6,574	7,055	0	0.48	0.52	0
CLE−IAD	7,022	1,387	0	0.84	0.16	0
IAH−ORD	18,377	49,028	9,822	0.24	0.63	0.13

Source: DOT T-100 Domestic Segment

Table 2: Passengers on Nonstop Overlapping Routes between American Airlines and US Airways (Q4 2012)

Routes	Passengers			Market Share		
	American	US	Others	American	US	Others
BNA−DCA	4,315	3,943	0	0.52	0.48	0
CLT−DFW	16,557	38,299	0	0.30	0.70	0
CLT−LGA	4,795	49,208	0	0.09	0.91	0
CLT−MIA	5,816	20,408	0	0.22	0.78	0
CLT−ORD	5,681	38,256	9,184	0.11	0.72	0.17
DCA−RDU	4,851	7,247	0	0.40	0.60	0
DFW−PHL	19,470	18,404	0	0.51	0.49	0
LAX−PHX	29,039	21,175	0	0.58	0.42	0
MIA−PHL	11,503	6,922	0	0.62	0.38	0
ORD−PHL	11,230	30,122	18,038	0.19	0.51	0.30
ORD−PHX	17,191	28,176	12,081	0.30	0.49	0.21

Source: DOT T-100 Domestic Segment

Table 3: Summary Statistics for United Airlines and Continental Airlines Pre-merger Period

Product average				
Variable	All Products		EWR Products	
	Mean	SD	Mean	SD
Airfare ($100)	2.88	1.28	2.99	1.61
Passengers (1,000)	2.01	4.16	1.95	3.21
Nonstop	0.17	0.28	0.19	0.11
No. connection	1.52	0.63	1.28	0.54
No. daily departure	4.21	2.04	4.05	1.45
Hub	0.19	0.22	0.61	0.42
Code shared	0.21	0.49	0.19	0.75
Frequent-flyer program	0.38	0.12	0.72	0.39
Slot-control	0.32	0.84	1.00	1.00
Distance	2.74	1.32	2.56	0.58
Tourist place	0.24	0.42	0.11	0.58
American	0.15	0.32	0.11	0.71
Continental	0.09	0.28	0.35	0.29
Delta	0.20	0.41	0.08	0.51
United	0.14	0.28	0.24	0.40
US Airways	0.15	0.30	0.03	0.02
JetBlue	0.02	0.11	0	0
Southwest	0.08	0.28	0.02	0.54
Virgin Atlantic	0.01	0.18	0	0
Market average				
Variable	All Markets		EWR Markets	
	Mean	SD	Mean	SD
No. products	48.21	23.58	40.75	31.22
No. carriers	3.24	1.99	2.98	1.53
No.passengers (1,000)	28.06	22.35	25.20	23.49

Notes: The sample contains 198,217 unique itinerary–airline–airfare products in 4,127 unique origin–destination directional markets. Sample period is from 2009:Q2 to 2010:Q1

Table 4: Summary Statistics for American Airlines and US Airways Pre-merger Period

Product average						
Variable	All Products		DCA Products		LGA Products	
	Mean	SD	Mean	SD	Mean	SD
Airfare ($100)	3.03	1.51	3.30	1.94	3.08	1.88
Passengers (1,000)	2.09	3.02	2.55	1.81	2.15	1.91
Nonstop	0.20	0.18	0.22	0.41	0.19	0.24
No. connection	1.39	0.88	1.30	0.43	1.41	0.97
No. daily departure	4.54	1.94	4.85	2.05	4.29	3.21
Hub	0.22	0.20	0.45	0.72	0.38	0.87
Code shared	0.24	0.89	0.19	0.31	0.28	0.39
Frequent-flyer program	0.35	0.12	0.67	0.41	0.48	0.87
Slot-control	0.29	0.74	1.00	1.00	1.00	1.00
Distance	2.66	1.69	1.10	0.67	1.25	0.60
Tourist place	0.22	0.51	0.18	0.29	0.25	0.39
American	0.17	0.50	0.29	0.45	0.19	0.42
Delta	0.22	0.81	0.10	0.31	0.32	0.49
United	0.24	0.48	0.11	0.58	0.12	0.58
US Airways	0.11	0.47	0.39	0.57	0.15	0.44
JetBlue	0.06	0.31	0.02	0.05	0	0
Southwest	0.11	0.44	0.05	0.80	0.03	0.42
Virgin Atlantic	0.01	0.20	0	0	0.01	0.09
Market average						
Variable	All Markets		DCA Markets		LGA Markets	
	Mean	SD	Mean	SD	Mean	SD
No. products	45.11	19.44	38.99	24.93	39.08	23.46
No. carriers	3.20	2.04	2.81	1.62	2.98	1.25
No.passengers (1,000)	29.55	20.39	30.90	18.77	30.02	20.79

Notes: The sample contains 211,002 unique itinerary– airline–airfare products in 4,309 unique origin–destination directional markets. Pre-merger period is defined as 2012:Q1 through 2012:Q4

Table 5: Estimation Results on Demand Parameters

Demand variables	UA/CO Pre-Merger Periods	AA/US Pre-Merger Periods
$Airfare_{Business}$	-0.099** (0.003)	-0.112** (0.003)
$Airfare_{Tourist}$	-1.003** (0.014)	-1.058** (0.029)
$Connection_{Business}$	-0.562** (0.022)	-0.581** (0.021)
$Connection_{Tourist}$	-0.559** (0.028)	-0.580** (0.024)
$FFP_{Business}$	0.911** (0.018)	0.980** (0.021)
$FFP_{Tourist}$	0.718* (0.013)	0.882** (0.019)
Frequency	0.053** (0.009)	0.062* (0.010)
Code share	-0.089** (0.004)	-0.075** (0.006)
Distance	0.125** (0.003)	0.241** (0.007)
$Distance^2$	-0.097**(0.001)	-0.052** (0.001)
Hub	0.701** (0.043)	0.912** (0.053)
Slot-control	-0.188** (0.011)	-0.355**(0.019)
Tour	0.408** (0.024)	0.420** (0.035)
λ	0. 697** (0.002)	0.699** (0.003)
$\gamma_{Business}$	0.054** (0.003)	0.059** (0.004)
Carrier dummy		
Alaska	0.121** (0.020)	0.108** (0.012)
Continental	-0.125** (0.025)	
Delta	0.002** (0.016)	-0.008** (0.009)
United	0.133** (0.027)	0.102** (0.022)
US Airways	-0.001 (0.001)	0.009** (0.001)
Frontier	-0.757** (0.016))	-0.991**(0.018)
JetBlue	0.457** (0.043)	0.510**(0.026)
Southwest	-0.032	0.103** (0.049)
Observations	237,878	248,013

Notes: Standard errors are in parentheses. **Significant at the 5% level. *Significant at the 10% level.

Table 6: Estimate Results on Marginal Cost

Demand variables	UA/CO Pre-Merger Periods	AA/US Pre-Merger Periods
Frequency	-0.039** (0.003)	-0.012** (0.001)
Hub	-0.087** (0.007)	-0.137** (0.011)
Slot-control	0.098** (0.007)	0.043** (0.002)
$\text{Distance}_{\text{short}}$	0.281** (0.018)	0.250** (0.006)
$\text{Distance}_{\text{long}}$	0.153** (0.011)	0.178** (0.003)
$\text{Connection}_{\text{short}}$	0.072* (0.005)	0.082** (0.004)
$\text{Connection}_{\text{long}}$	0.053**(0.004)	0.071** (0.006)
Carrier dummy		
Alaska	-0.187** (0.015)	-0.205** (0.012)
Continental	-0.003** (0.025)	
Delta	-0.158** (0.015)	-0.199** (0.018)
United	-0.061 (0.009)	-0.089** (0.012)
US Airways	-0.092** (0.001)	0.118** (0.003)
Frontier	-0.357** (0.021)	-0.342**(0.018)
JetBlue	-0.357** (0.039)	-0.359**(0.028)
Southwest	–0.214** (0.018)	-0.292** (0.024)
Observations	237,878	248,013

Notes: Standard errors are in parentheses. **Significant at the 5% level. *Significant at the 10% level.

Table 7: Summary Statistics for American Airlines and US Airways Pre-merger Period

American	**Southwest**	**JetBlue**
Discontinue	Enter	Enter
Augusta	Chicago Midway	Charleston
Detroit	Nashville	Jacksonville
Fayetteville	New Orleans	Fort Myers
Fort Walton Beach	Tampa Bay	New York (JFK)
Islip	Akron-Canton	Windsor Locks
Jacksonville	Dallas Love Field	
Little Rock	Indianapolis	
Minneapolis	Houston	
Montreal	St. Louis	
Myrtle Beach	Kansas City	
Nassau	Orlando	
Omaha	Columbus	
Pensacola	Fort Lauderdale	
San Diego	Pensacola	
Savannah		
Tallahassee		
Wilmington		

Source: DOT T-100 Domestic Segment

Table 8: Simulated Post-merger Outcomes (All products)

	Pre-merger	Post-merger		
		Baseline	Slot Divestiture	Slot divestiture Changes Demand-Side
United/Continental Airlines				
EWR all products				
Price	\$299.12	+3.27%	+1.09%	+1.02%
Passengers	3,876,243	-1.47%	-0.02%	-0.04%
Consumer Surplus		-2.12%	-0.97%	-0.62%
American/US Airways				
DCA all products				
Price	\$330.21	+4.98%	-1.13%	-1.48%
Passengers	2,711,781	-2.87%	+0.81%	+0.97%
Consumer Surplus		-5.52%	+1.53%	+1.89%
LGA all products				
Price	\$308.12	+3.94%	-0.03%	-0.03%
Passengers	3,014,332	-1.95%	+0.57%	+0.61%
Consumer Surplus		-4.22%	+0.54%	+0.69%
No. all EWR products	4,310	4,310		
No. all DCA products	4,009	4,009		
No. all LGA products	3,967	3,967		

Notes: The units in simulated post-merger outcomes are all relative to observed pre-merger values.

Table 9: Simulated Post-merger Outcomes (Overlapping Nonstop routes)

	Pre-merger	Post-merger		
		Baseline	Slot Divestiture	Slot divestiture Changes Demand-Side
United/Continental Airlines				
EWR nonstop overlapped routes				
Price	$231.26	+17.29%	+7.17%	+6.02%
Passengers	321,760	-15.41%	-6.81%	-6.01%
Consumer Surplus		-16.53%	-6.13%	-5.96%
American/US Airways				
DCA nonstop overlapped routes				
Price	$340.35	+32.21%	+26.17%	+25.12%
Passengers	62,976	-21.14%	-19.02%	-18.14%
Consumer Surplus		-25.12%	-20.18%	-19.14.%
LGA nonstop overlapped routes				
Price	$319.77	+20.66%	+17.27%	+13.91%
Passengers	55,321	-18.20%	-16.68%	-11.97%
Consumer Surplus		-19.14%	-16.12%	-12.15%
No. EWR nonstop overlapped routes	4	4		
No. DCA nonstop overlapped routes	2	2		
No. LGA nonstop overlapped routes	2	2		

Notes: The units in simulated post-merger outcomes are all relative to observed pre-merger values. Overlapped routes from/to EWR are EWR−ORD, EWR−SFO, EWR−DEN and EWR−IAD. Overlapped routes from/to DCA are DCA−RDU and DCA−BNA. Overlapped routes from/to LAG include LGA−CLT and LGA−MIA.

Table 10: Average Estimated Own- and Cross-Price Elasticities (All EWR Products)

	Not Opening the FFP to Southwest			Opening the FFP to Southwest	
	United	**Southwest**		**United**	**Southwest**
United	-1.185	0.541	United	-1.289	0.781
Southwest	0.418	-2.703	Southwest	0.420	-2.611

Table 11: Average Estimated Own- and Cross-Price Elasticities (All DCA Products)

	Not Opening the FFP to New Entrants					Opening the FFP to New Entrants			
	American	**Southwest**	**JetBlue**	**Virgin**		**American**	**Southwest**	**JetBlue**	**Virgin**
American	-1.007	0.202	0.099	0.052	**American**	-1.351	0.402	0.157	0.054
Southwest	0.123	-1.886	0.011	0.008	**Southwest**	0.102	-1.951	0.010	0.011
JetBlue	0.021	0.005	-1.201	0.007	**JetBlue**	0.017	0.006	-1.102	0.005
Virgin	0.012	0.014	0.009	-1.001	**Virgin**	0.008	0.016	0.011	-1.127

Table 12: Average Estimated Own- and Cross-Price Elasticities (All LGA Products)

	Not Opening the FFP to New Entrants				Opening the FFP to New Entrants		
	American	**Southwest**	**Virgin**		**American**	**Southwest**	**Virgin**
American	-1.512	0.419	0.010	**American**	-1.894	0.621	0.013
Southwest	0.210	-2.802	0.009	**Southwest**	0.179	-2.706	0.008
Virgin	0.315	0.021	-2.981	**Virgin**	0.302	0.030	-2.811

Table 13: Simulated Post-merger Outcomes (All products)

	Pre-merger	Post-merger		
		Baseline	Slot Divestiture	Slot divestiture with Forced Entrance
United/Continental Airlines				
EWR nonstop overlapped routes				
Price	$299.12	+3.27%	+1.09%	+0.05%
Passengers	3,876,243	-1.47%	-0.02%	+0.01%
Consumer Surplus		-2.12%	-0.97%	-0.02%
American/US Airways				
DCA nonstop overlapped routes				
Price	$330.21	+4.98%	-1.13%	-1.48%
Passengers	2,711,781	-2.87%	+0.81%	+0.97%
Consumer Surplus		-5.52%	+1.53%	+1.89%
LGA nonstop overlapped routes				
Price	$308.12	+3.94%	-0.03%	-0.05%
Passengers	3,014,332	-1.95%	+0.57%	+0.61%
Consumer Surplus		-4.22%	+0.54%	+0.69%
No. all EWR products	4,310	4,310		
No. all DCA products	4,009	4,009		
No. all LGA products	3,967	3,967		

Notes: The units in simulated post-merger outcomes are all relative to observed pre-merger values. The counterfactual merger simulation assume that Southwest Airlines began offering services on all of the merged airlines' overlapping nonstop routes to or from EWR, DCA, and LGA.

Table 14: Simulated Post-merger Outcomes (Overlapping Nonstop routes)

	Pre-merger	Post-merger		
		Baseline	Slot Divestiture	Slot divestiture with Forced Entrance
United/Continental Airlines				
EWR nonstop overlapped routes				
Price	$313.06	+17.29%	+7.17%	-0.71%
Passengers	321,760	-15.41%	-6.81%	+1.29%
Consumer Surplus		-16.53%	-6.13%	+1.78%
American/US Airways				
DCA nonstop overlapped routes				
Price	$340.35	+32.21%	+26.17%	-3.27%
Passengers	62,976	-21.14%	-19.02%	+2.75%
Consumer Surplus		-25.12%	-20.18%	+1.07%
LGA nonstop overlapped routes				
Price	$319.77	+20.66%	+17.27%	-0.78%
Passengers	55,321	-18.20%	-16.68%	+0.07%
Consumer Surplus		-19.14%	-16.12%	+0.41%
No. EWR nonstop overlapped routes	4	4		
No. DCA nonstop overlapped routes	2	2		
No. LGA nonstop overlapped routes	2	2		

Notes: The units in simulated post-merger outcomes are all relative to observed pre-merger values. Overlapped routes from/to EWR are EWR−ORD, EWR−SFO, EWR−DEN and EWR−IAD. Overlapped routes from/to DCA are DCA−RDU and DCA−BNA. Overlapped routes from/to LAG include LGA−CLT and LGA−MIA. The simulation assumed that Southwest Airlines began offering services on all of the merged airlines' overlapping nonstop routes to or from EWR, DCA, and LGA.

Table 15: Simulated Post-merger Outcomes (All products)

	Pre-merger	Post-merger		
		Baseline	Slot Divestiture	Slot divestiture Obligatory Code-sharing Agreement
United/Continental Airlines				
EWR all products				
Price	$299.12	+3.27%	+1.09%	-0.08%
Passengers	3,876,243	-1.47%	-0.02%	+0.18%
Consumer Surplus		-2.12%	-0.97%	+0.24%
American/US Airways				
DCA all products				
Price	$330.21	+4.98%	-1.13%	-1.26%
Passengers	2,711,781	-2.87%	+0.81%	+1.39%
Consumer Surplus		-5.52%	+1.53%	+1.61%
LGA all products				
Price	$308.12	+3.94%	-0.03%	-0.05%
Passengers	3,014,332	-1.95%	+0.57%	+0.59%
Consumer Surplus		-4.22%	+0.54%	+0.68%
No. all EWR products	4,310	4,310		
No. all DCA products	4,009	4,009		
No. all LGA products	3,967	3,967		

Notes: The units in simulated post-merger outcomes are all relative to observed pre-merger values. The simulation assumed that code sharing allowed low-cost carriers to place their codes on the flights of overlapping nonstop routes operated by the merged airlines to or from EWR, DCA, and LGA.

Table 16: Simulated Post-merger Outcomes (Overlapping Nonstop routes)

	Pre-merger	Post-merger		
		Baseline	Slot Divestiture	Slot divestiture Obligatory Code-sharing Agreement
United/Continental Airlines				
EWR nonstop overlapped routes				
Price	$313.06	+17.29%	+7.17%	+0.27%
Passengers	321,760	-15.41%	-6.81%	-0.19%
Consumer Surplus		-16.53%	-6.13%	-0.36%
American/US Airways				
DCA nonstop overlapped routes				
Price	$340.35	+32.21%	+26.17%	+4.28%
Passengers	62,976	-21.14%	-19.02%	–2.89%
Consumer Surplus		-25.12%	-20.18%	-2.72%
LGA nonstop overlapped routes				
Price	$319.77	+20.66%	+17.27%	+2.91%
Passengers	55,321	-18.20%	-16.68%	-2.10%
Consumer Surplus		-19.14%	-16.12%	-3.27%
No. EWR nonstop overlapped routes	4	4		
No. DCA nonstop overlapped routes	2	2		
No. LGA nonstop overlapped routes	2	2		

Notes: The units in simulated post-merger outcomes are all relative to observed pre-merger values. Overlapped routes from/to EWR are EWR−ORD, EWR−SFO, EWR−DEN and EWR−IAD. Overlapped routes from/to DCA are DCA−RDU and DCA−BNA. Overlapped routes from/to LAG include LGA−CLT and LGA−MIA. The counterfactual merger simulation assumed that code sharing allowed low-cost carriers to place their codes on the flights of overlapping nonstop routes operated by the merged airlines to or from EWR, DCA, and LGA.

Table 17: Simulated Post-merger Outcomes (All products)

	Pre-merger	Post-merger		
		Baseline	Slot Divestiture	Slot divestiture with opening the FFP
United/Continental Airlines				
EWR nonstop overlapped routes				
Price	$299.12	+3.27%	+1.09%	-0.03%
Passengers	3,876,243	-1.47%	-0.02%	+0.05%
Consumer Surplus		-2.12%	-0.97%	+0.01%
American/US Airways				
DCA nonstop overlapped routes				
Price	$330.21	+4.98%	-1.13%	-1.39%
Passengers	2,711,781	-2.87%	+0.81%	+1.57%
Consumer Surplus		-5.52%	+1.53%	+1.68%
LGA nonstop overlapped routes				
Price	$308.12	+3.94%	-0.03%	-0.03%
Passengers	3,014,332	-1.95%	+0.57%	+0.11%
Consumer Surplus		-4.22%	+0.54%	+0.29%
No. all EWR products	4,310	4,310		
No. all DCA products	4,009	4,009		
No. all LGA products	3,967	3,967		

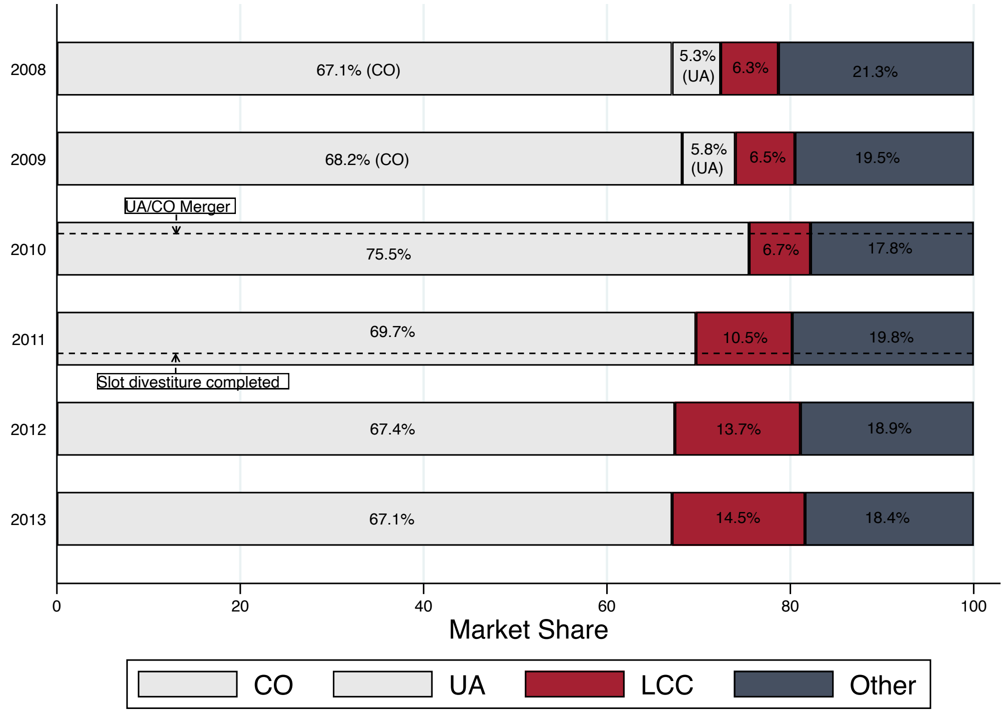
Notes: The units in simulated post-merger outcomes are all relative to observed pre-merger values. The simulation assumed that United Airlines opened its FFP to the new routes served by Southwest Airlines to or from EWR and that American Airlines allowed rewarding FFP points to consumers traveling on the new routes of Southwest Airlines, JetBlue, and Virgin America to or from DCA and LGA following its merger with US Airways.

Table 18: Simulated Post-merger Outcomes (Overlapping Nonstop routes)

	Pre-merger	Post-merger		
		Baseline	Slot Divestiture	Slot divestiture with opening the FFP
United/Continental Airlines				
EWR nonstop overlapped routes				
Price	$313.06	+17.29%	+7.17%	+6.81%
Passengers	321,760	-15.41%	-6.81%	-6.02%
Consumer Surplus		-16.53%	-6.13%	-6.99%
American/US Airways				
DCA nonstop overlapped routes				
Price	$340.35	+32.21%	+26.17%	+23.11%
Passengers	62,976	-21.14%	-19.02%	–22.79%
Consumer Surplus		-25.12%	-20.18%	-24.16%
LGA nonstop overlapped routes				
Price	$319.77	+20.66%	+17.27%	+12.98%
Passengers	55,321	-18.20%	-16.68%	-11.08%
Consumer Surplus		-19.14%	-16.12%	-13.20%
No. EWR nonstop overlapped routes	4	4		
No. DCA nonstop overlapped routes	2	2		
No. LGA nonstop overlapped routes	2	2		

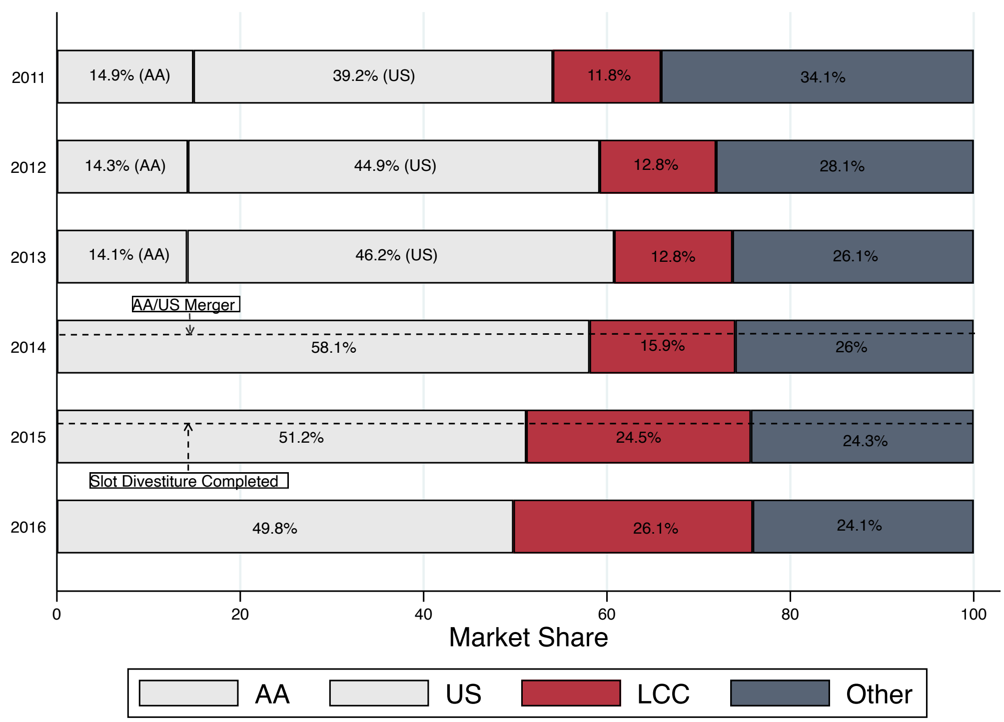
Notes: The units in simulated post-merger outcomes are all relative to observed pre-merger values. Overlapped routes from/to EWR are EWR−ORD, EWR−SFO, EWR−DEN and EWR−IAD. Overlapped routes from/to DCA are DCA−RDU and DCA−BNA. Overlapped routes from/to LAG include LGA−CLT and LGA−MIA. The simulation assumed that United Airlines opened its FFP to the new routes served by Southwest Airlines to or from EWR and that American Airlines allowed rewarding FFP points to consumers traveling on the new routes of Southwest Airlines, JetBlue, and Virgin America to or from DCA and LGA following its merger with US Airways.

Figure 1: Market Share Trends at Newark Liberty International Airport (EWR)



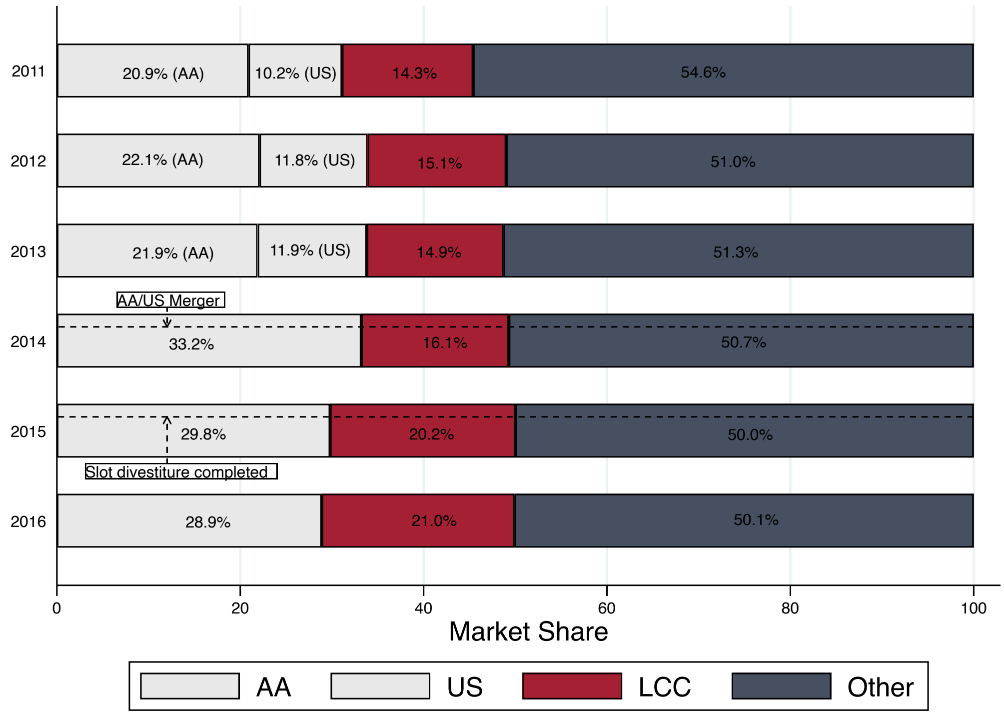
Source: DOT T-100 Domestic Segment

Figure 2: Market Share Trends at Ronald Reagan Washington National Airport (DCA)



Source: DOT T-100 Domestic Segment

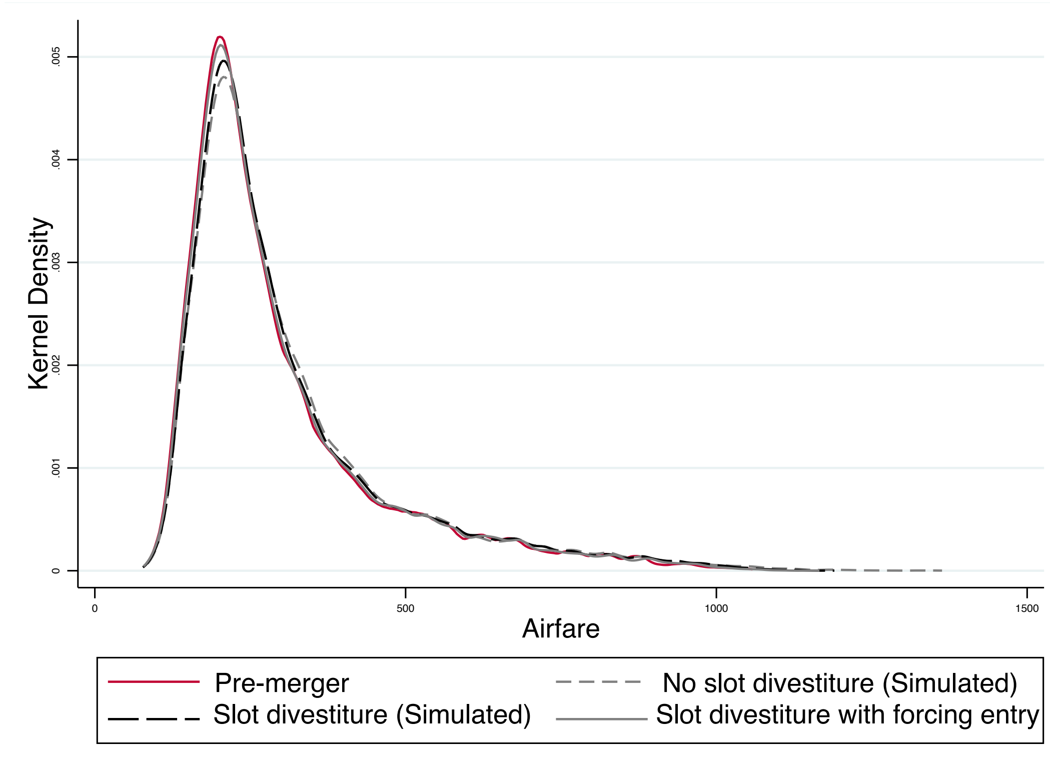
Figure 3: Market Share Trends at LaGuardia Airport (LGA)



Source: DOT T-100 Domestic Segment

Figure 4: Distribution of Airfare for United Airlines−Continental Airlines Merger (EWR): Pre-merger vs. No slot divestiture vs. Slot divestiture vs. Slot divestiture with forcing entry

(a) All EWR products



(b) Overlapped nonstop products

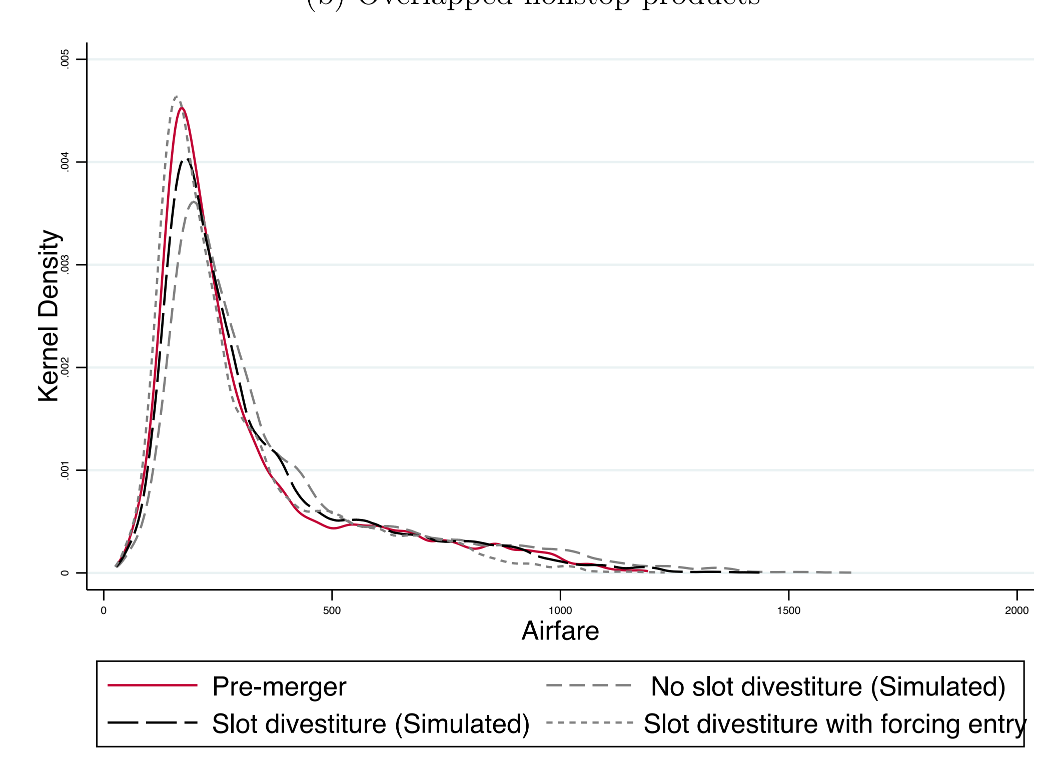
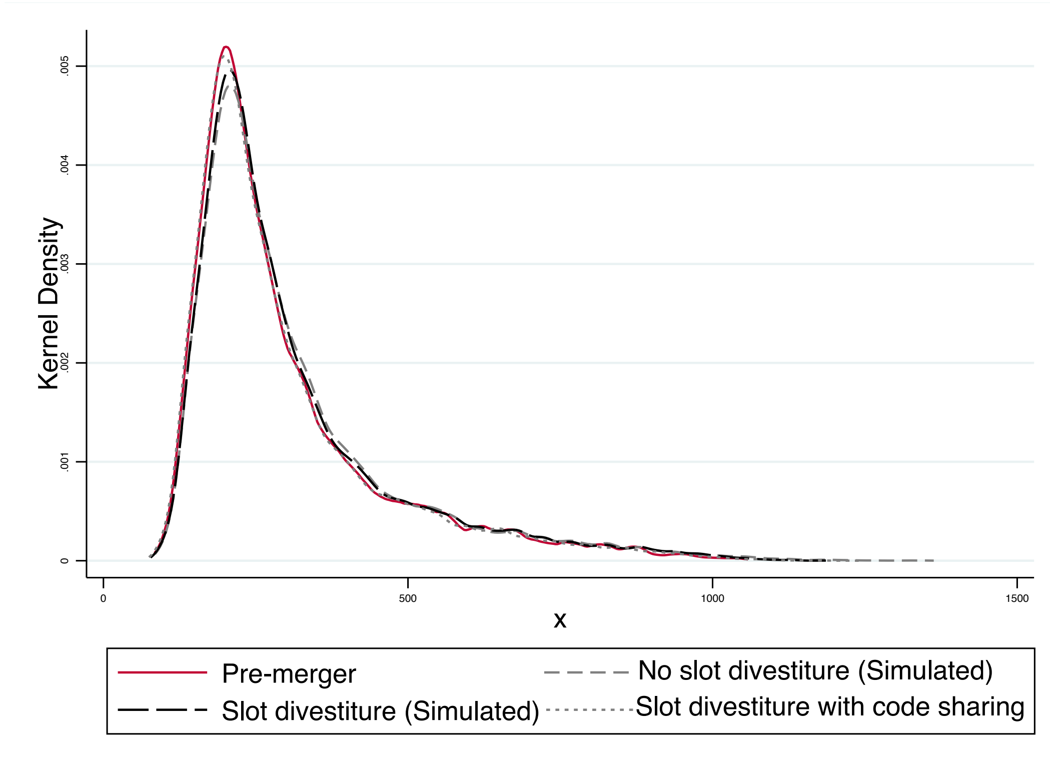


Figure 5: Distribution of Airfare for United Airlines−Continental Airlines Merger (EWR): Pre-merger vs. No slot divestiture vs. Slot divestiture vs. Slot divestiture with code sharing

(a) All EWR products



(b) Overlapped nonstop products

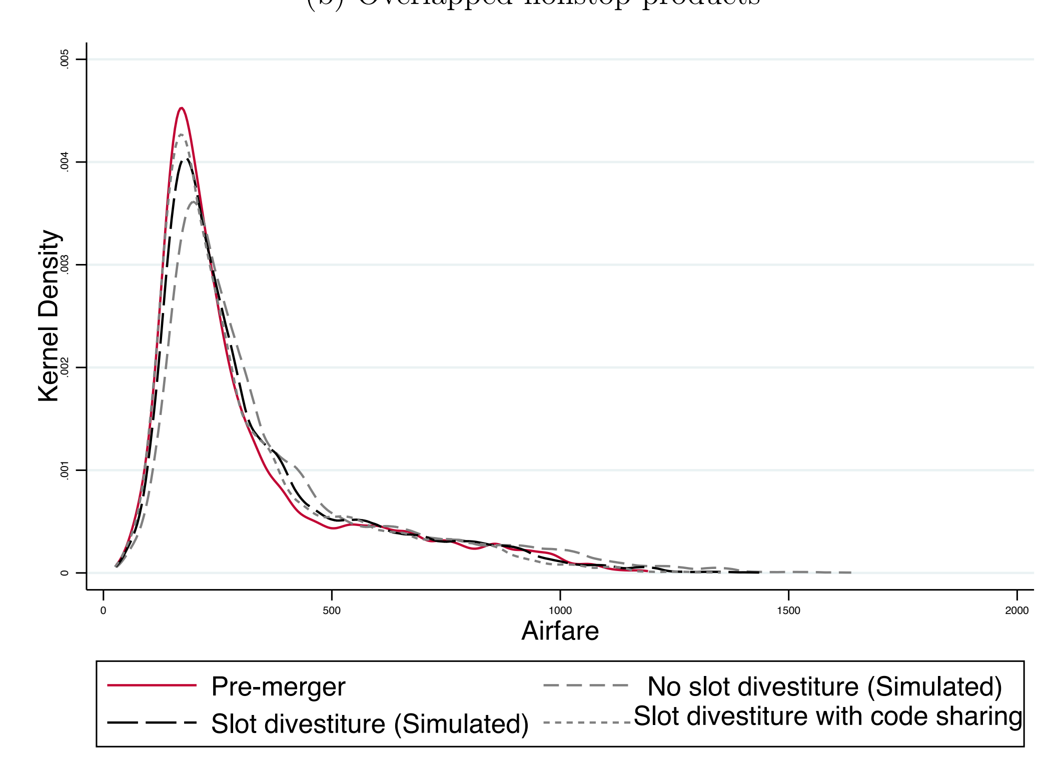
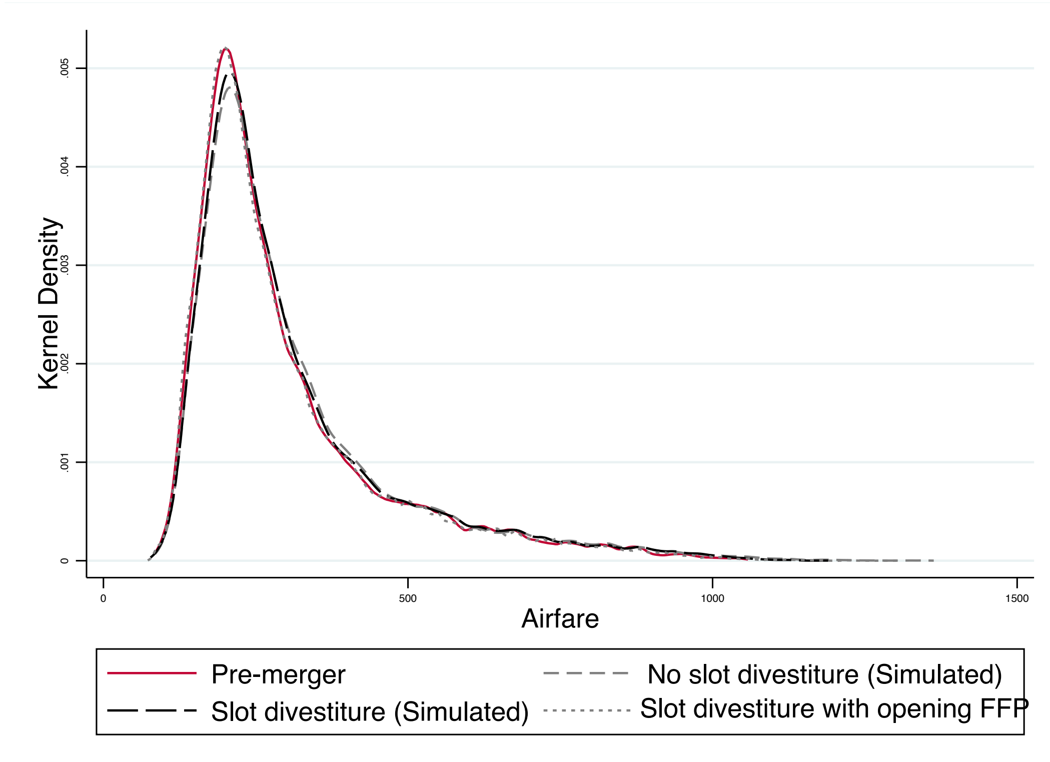


Figure 6: Distribution of Airfare for United Airlines−Continental Airlines Merger (EWR): Pre-merger vs. No slot divestiture vs. Slot divestiture vs. Slot divestiture with opening FFP

(a) All EWR products



(b) Overlapped nonstop products

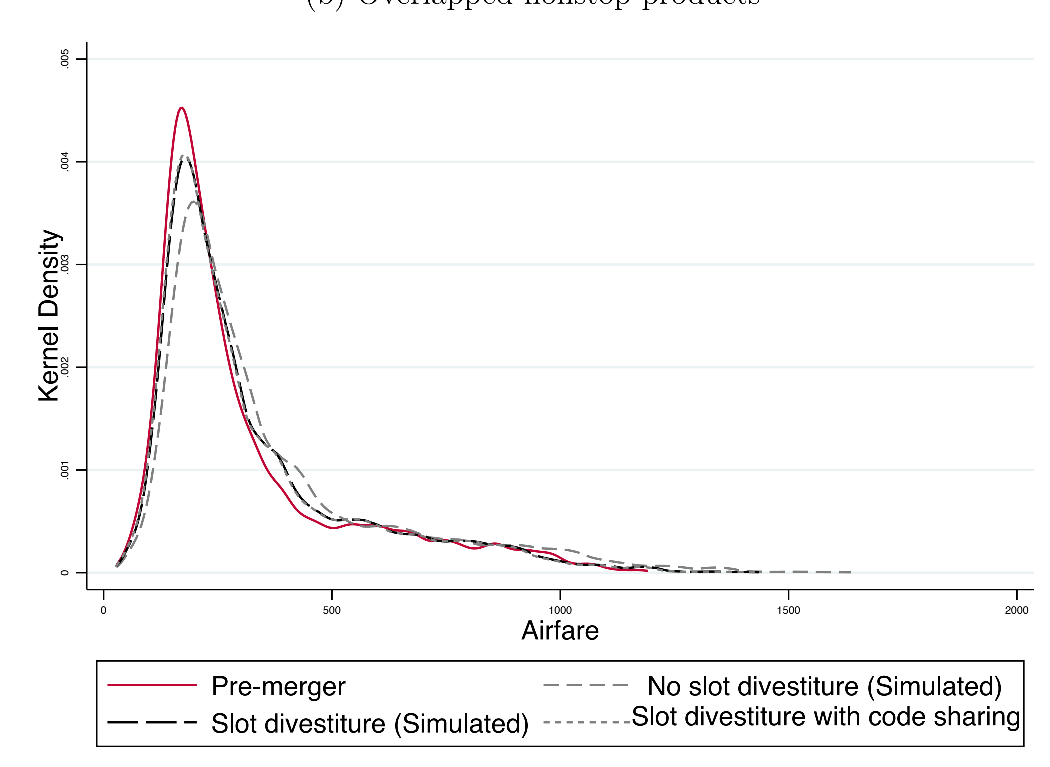
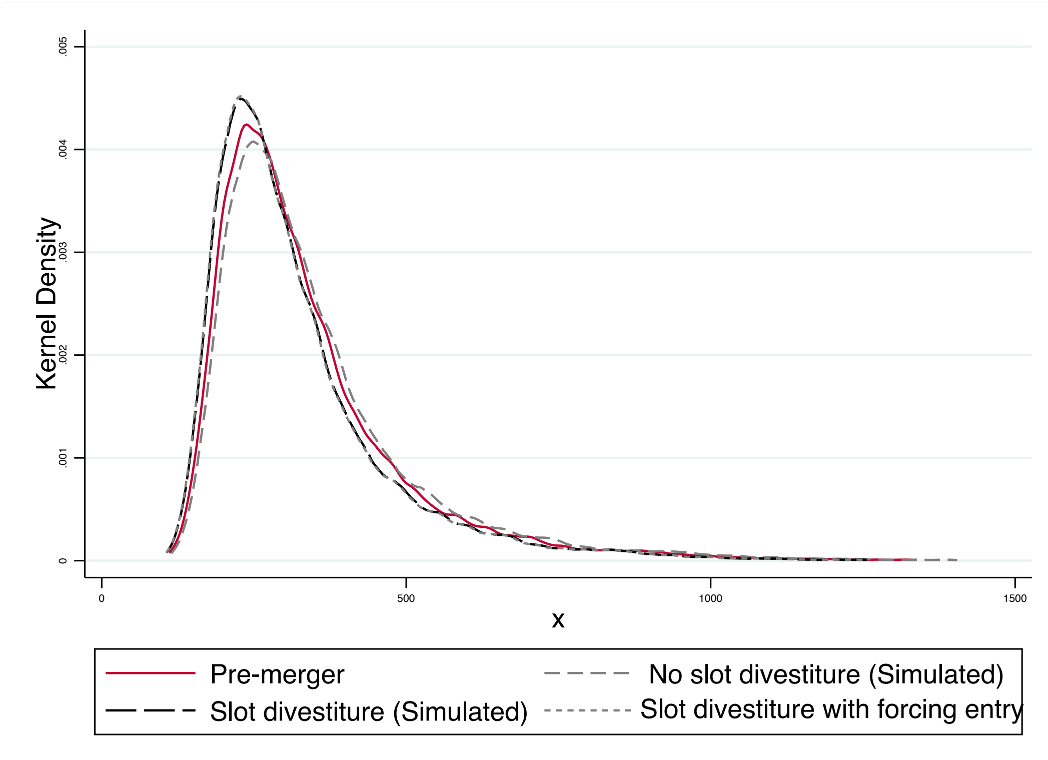


Figure 7: Distribution of Airfare for American Airlines−US Airways Merger (DCA): Pre-merger vs. No slot divestiture vs. Slot divestiture vs. Slot divestiture with enforcing entrance

(a) All DCA products



(b) Overlapped nonstop products

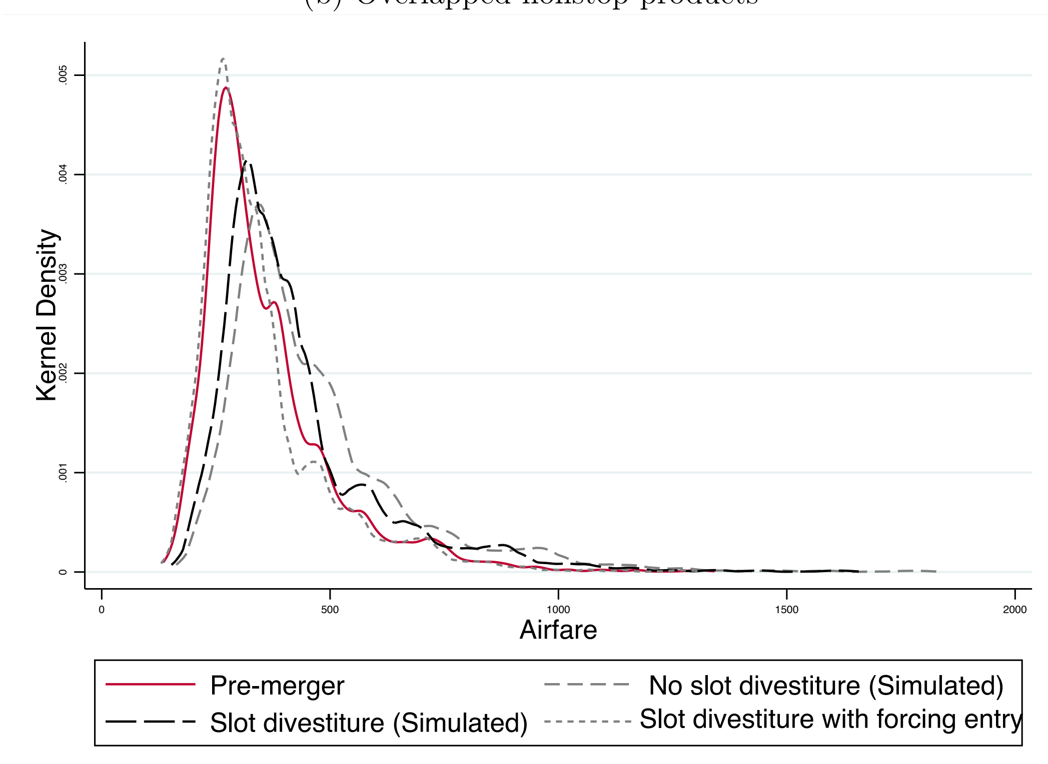
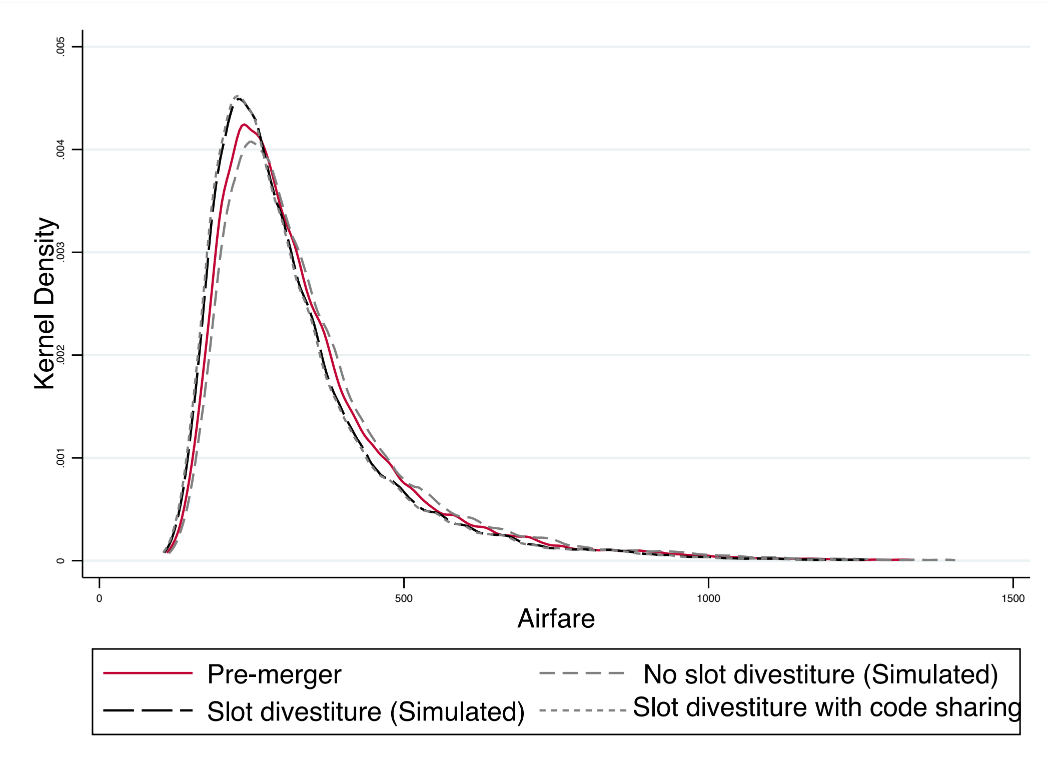


Figure 8: Distribution of Airfare for American Airlines−US Airways Merger (DCA): Pre-merger vs. No slot divestiture vs. Slot divestiture vs. Slot divestiture with code sharing

(a) All DCA products



(b) Overlapped nonstop products

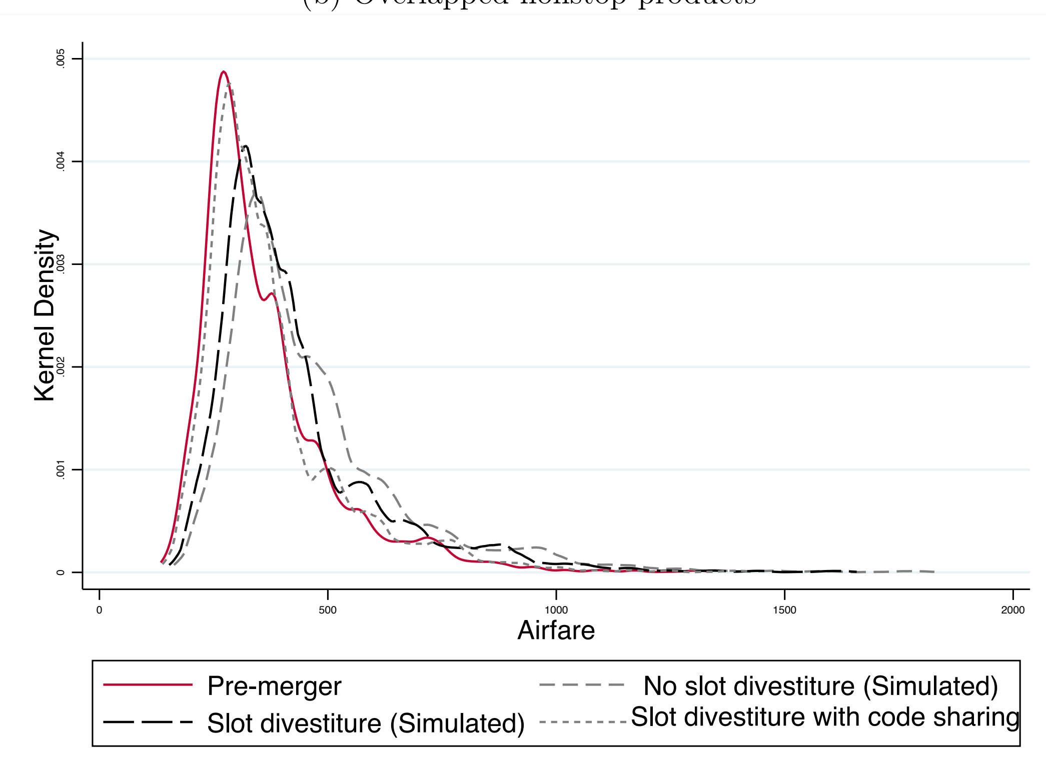
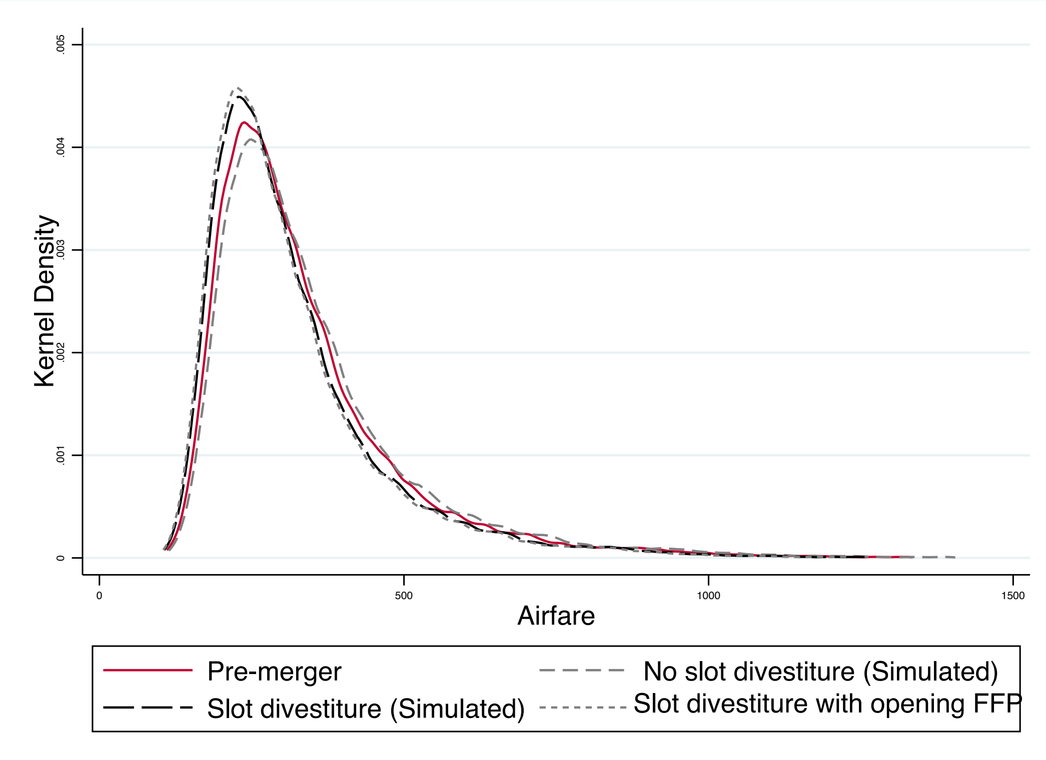


Figure 9: Distribution of Airfare for American Airlines−US Airways Merger (DCA): Pre-merger vs. No slot divestiture vs. Slot divestiture vs. Slot divestiture with opening FFP

(a) All DCA products



(b) Overlapped nonstop products

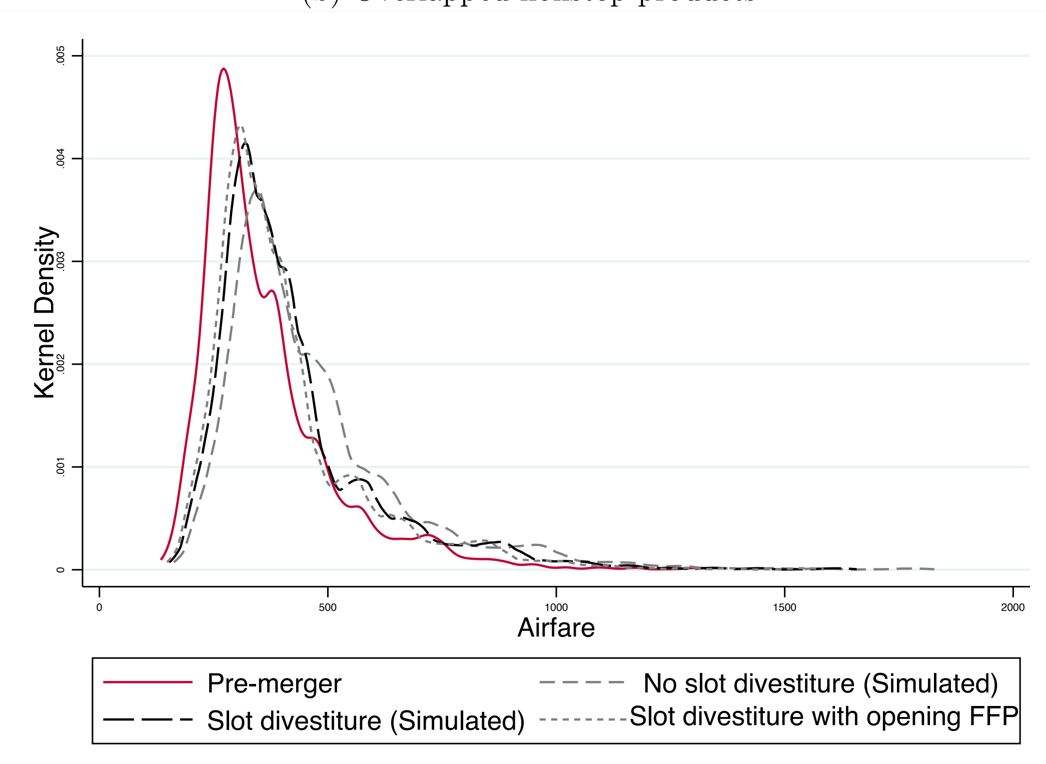
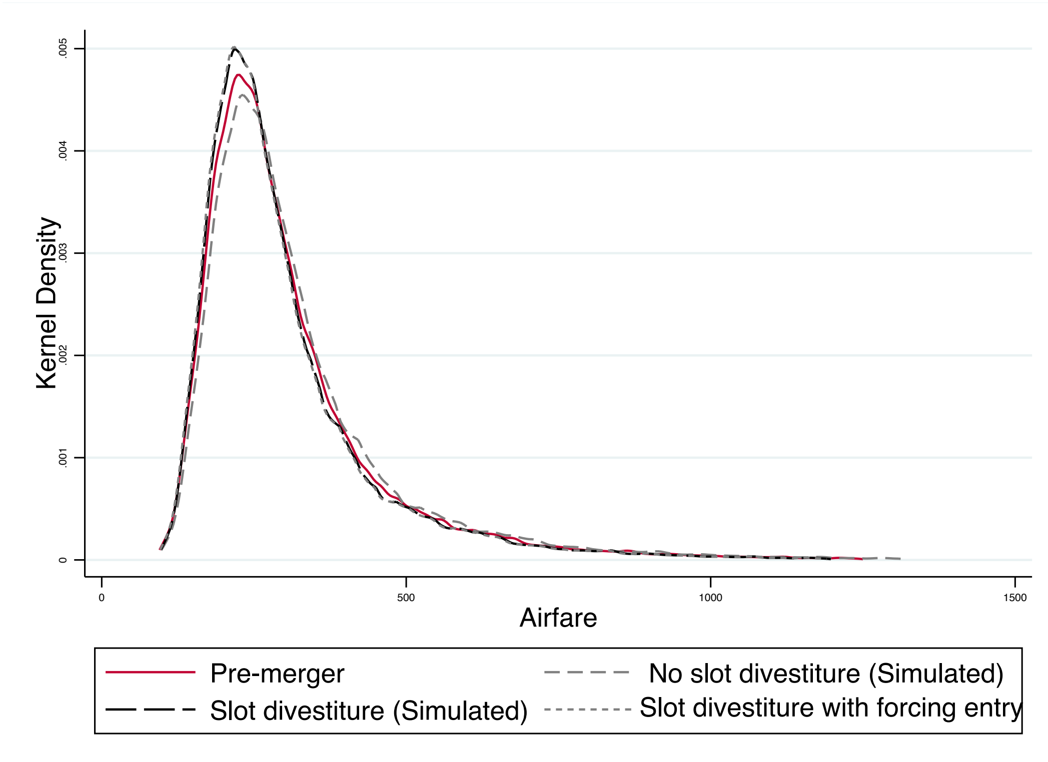


Figure 10: Distribution of Airfare for American Airlines−US Airways Merger (LGA): Pre-merger vs. No slot divestiture vs. Slot divestiture vs. Slot divestiture with enforcing entrance

(a) All LGA products



(b) Overlapped nonstop products

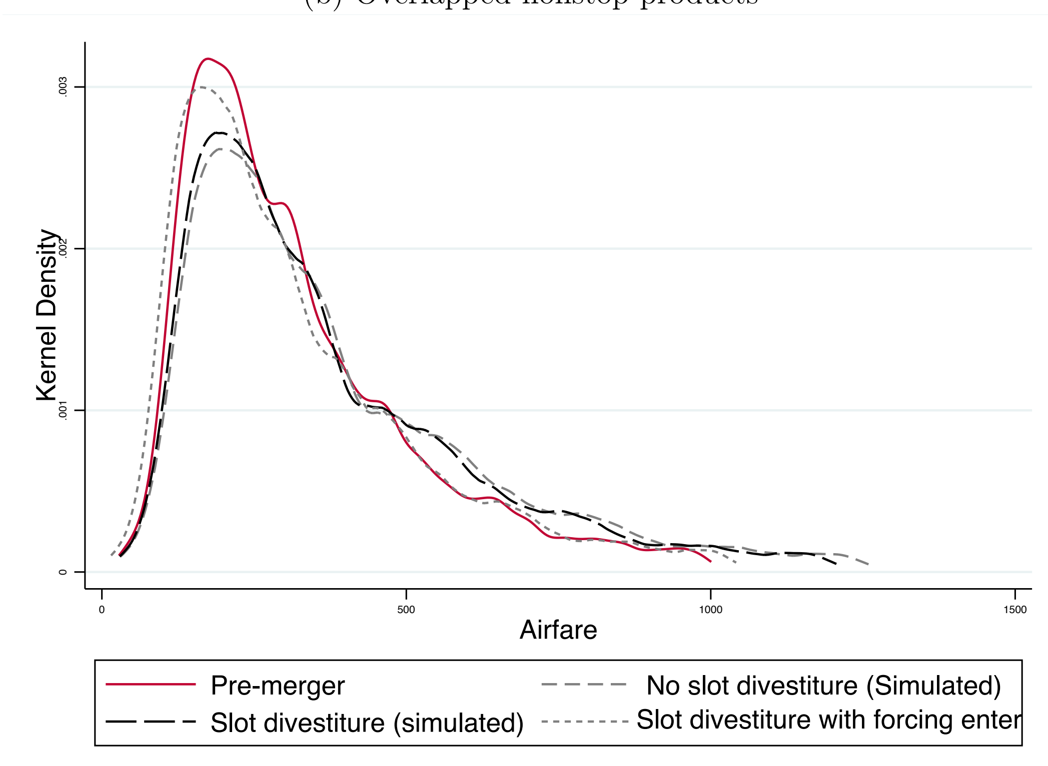
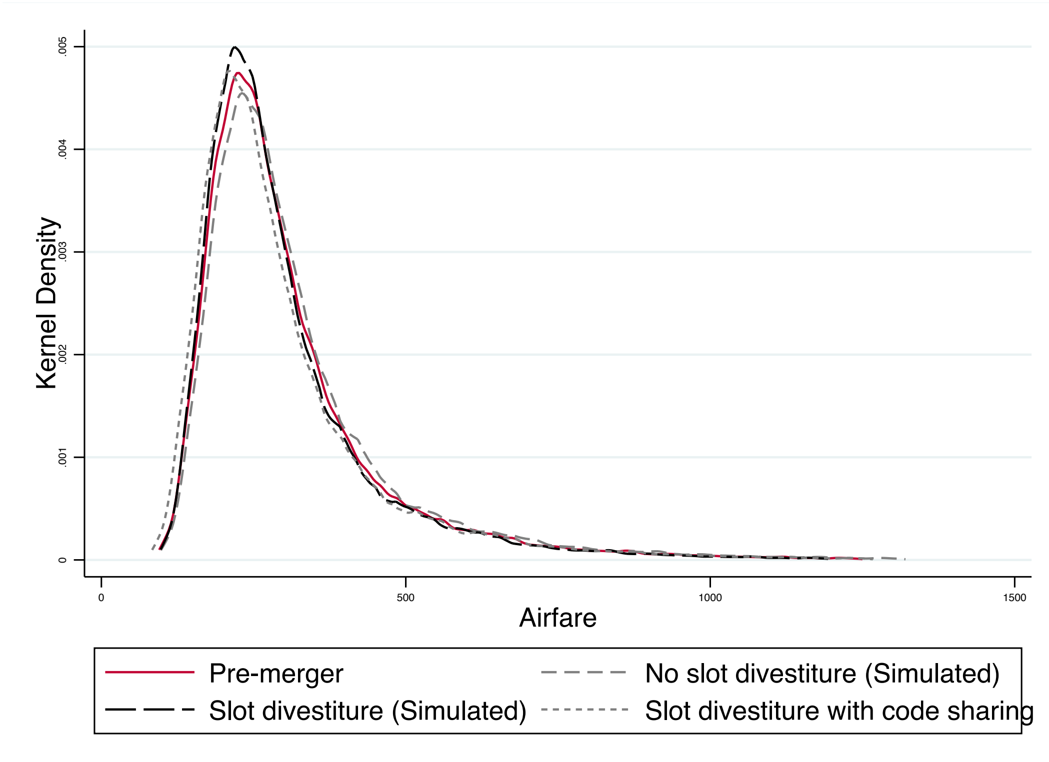


Figure 11: Distribution of Airfare for American Airlines−US Airways Merger (LGA): Pre-merger vs. No slot divestiture vs. Slot divestiture vs. Slot divestiture with code sharing

(a) All LGA products



(b) Overlapped nonstop products

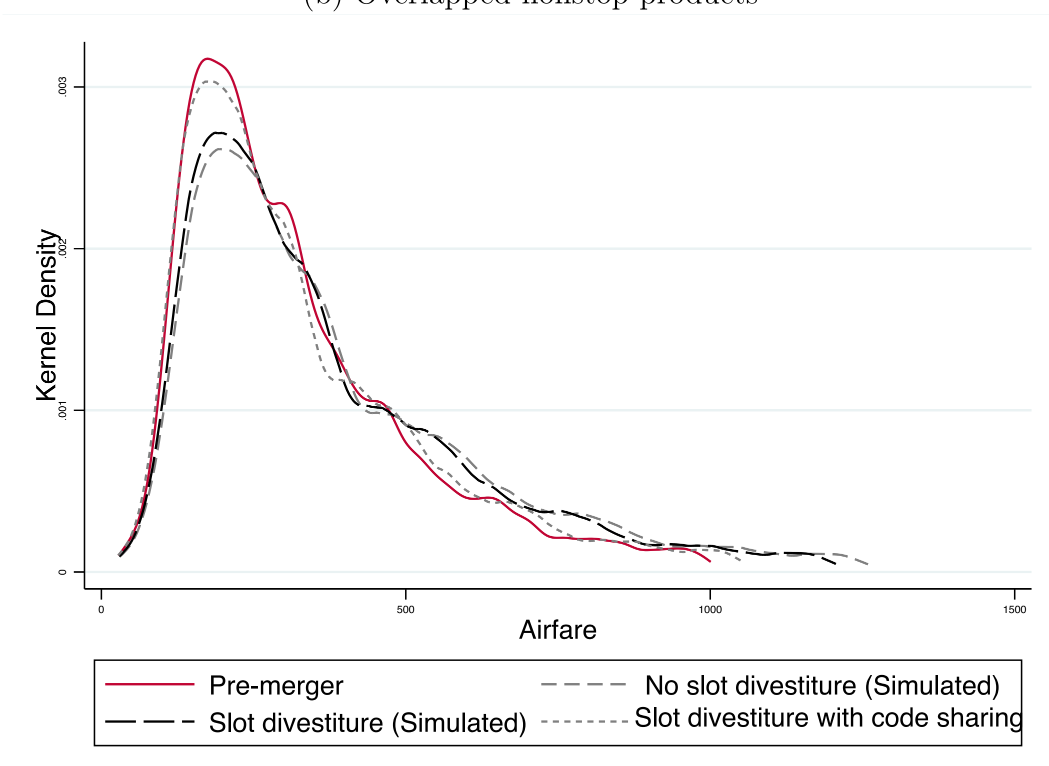
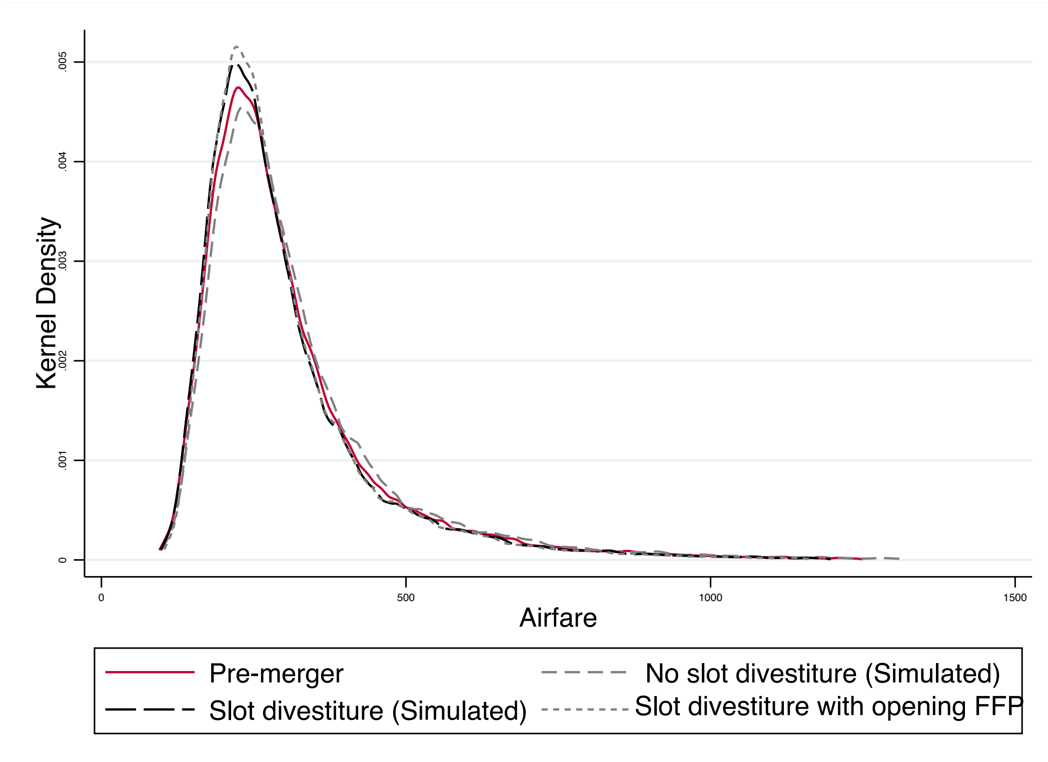


Figure 12: Distribution of Airfare for American Airlines−US Airways Merger (LGA): Pre-merger vs. No slot divestiture vs. Slot divestiture vs. Slot divestiture with opening FFP

(a) All LGA products



(b) Overlapped nonstop products