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Slot Divestitures and Price Competition at Reagan National and LaGuardia

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Abstract

The American Airlines/US Airways merger was initially challenged by US antitrust authorities partly because of the airlines' significant takeoff/landing slot concentration and direct (overlap) competition at slot-controlled airports, Reagan National and LaGuardia. The approval of their merger required that they divest slots to other carriers. This paper examines whether these divestitures have preserved price competition in markets in which the merging airlines directly competed. We find that in the case of Reagan National, they have not, as prices increased in these markets. Instead, most of the procompetitive price effects have been in nonoverlap markets. In the case of LaGuardia, however, the divestitures preserved price competition in both overlap and nonoverlap markets. Several factors that affect the estimates include route direction, degree of overlap, distinction between nonstop and connecting routes, and carrier identity.

Keywords Slot divestitures · Merger · Price competition · US airlines

JEL Classification L43 · L50 · L93

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1 Introduction

Airports in the US are classified depending on the level of congestion. At the highest level, Level 3[1] airports have flight demand during peak hours that greatly exceed their runway capacity and without control would result in excessive congestion. To manage this congestion, these airports limit the number of flights with the use of time slots during these hours: Airlines must have a specific time slot for each departure and landing. Although slots help manage congestion, they have implications for market competition. Since the number of slots is capped, competitive pressure is also reduced if slots are not distributed among competitors.

How is price competition affected if the existing holders are required to divest some of their slots to other competitors? This question is relevant because the merger between American Airlines (AA) and US Airways (US) in 2013 was initially blocked by the US Department of Justice (DOJ)[2]–in part because the two airlines had dominant slot positions at Reagan National (DCA) in Washington, DC, and to lesser extent at LaGuardia (LGA) in New York: two of the most capacity-constrained airports in the US. Consequently, a major requirement for the DOJ to approve their merger was the divestiture of some of their slots at these two airports to low-cost competitors (LCCs).[3]

Although these divestitures had the potential to preserve price competition at these airports, it is unclear whether this potential was realized–particularly in merger-related markets (overlap markets): While these divestitures reduced the slot concentration of the merging airlines and gave these LCCs greater access to these airports, the divestitures did not ensure that the competition that was lost in overlap city-pair route markets would be replaced or maintained.

This paper considers how these divestitures affected price competition in city-pair markets at DCA and LGA–particularly in overlap markets.

We use a difference-in-differences approach to isolate these price effects. While several factors affect the magnitude of these estimates–including the direction of the routes, nonstop versus connecting routes, and the extent of overlap–on balance these divestitures have not preserved price competition in overlap markets at DCA, but they have done so at LGA: The largest increases in price at DCA have been on those nonstop one-way routes for which DCA is the departing airport. Much of the pro-competitive effect at DCA came instead from markets in which the merging airlines did not directly compete (nonoverlap markets): particularly those markets where US provided service prior to the divestitures. In the case of LGA, even though price competition in overlap markets has essentially been preserved, there is evidence of higher prices in nonoverlap markets: particularly for round-trip nonstop routes where US provided service.

[1] Level 1 airports have enough capacity to meet demand, and Level 2 airports have demand that approaches capacity at certain time periods.

[2] See DOJ (2013a).

[3] In addition to slots at DCA and LGA, the airlines were also required to divest gates at other key airports across the country. These airports however are not slot-controlled (DOJ 2013b, 2014a).

These findings suggest that the effectiveness of these divestitures in preserving price competition in these markets was limited. In particular, price competition in overlap markets that were connected to DCA was not preserved even though the size of the divestitures at DCA was three times larger than at LGA. This finding raises the question of the appropriate size of the divestitures and the effectiveness of using LCCs alone to discipline these markets.

The next section summarizes the regulatory framework of airport slots and slot distribution before and after the divestitures. A brief literature review follows in Sect. 3. Section 4 describes the data and specifies the empirical model. Results are presented in Sect. 5. Section 6 concludes.

2 Background

2.1 Slot Administration and Regulatory Framework

The market with respect to slots dates to 1968 when the Federal Aviation Administration (FAA) issued the High Density Traffic Airports Rule (HDR)[4] to decrease flight delays at five congested airports: New York Kennedy, LaGuardia, Chicago O'Hare, Reagan National, and Newark Liberty.[5] The rule restricts the number of operations by giving airlines the right to operate at an airport at particular times.

In 1985, the FAA issued an ancillary directive (Buy/Sell Rule)[6] that granted the purchase, sale, and leasing of slots. From its inception, new entrants have shown strong disagreement towards the HDR. They claimed that they were at a disadvantage since the HDR did not facilitate new entry, and they lobbied the U.S. Congress to grant exceptions to the HDR in 1994. Subsequently, Congress enacted the AIR-21 Act[7] which phased out slot restrictions completely after July 1, 2002 at Chicago O'Hare (Fukui, 2010). In October 2016, the FAA changed Newark Liberty Airport (EWR)'s designation from a Level 3 airport to a Level 2 to allow more efficient use of terminal and runway capacity (Fukui, 2019). This change came as a result of significant improvements in on-time performance and reductions in delays at EWR.[8]

Currently in the U.S., there are three Level 3 airports: New York Kennedy (JFK); LaGuardia (LGA); and Reagan National (DCA). The FAA plays a significant role in determining the necessity for restrictions on airline operations, and slot allocations are predicated on historic slots, a two-month minimum usage requirement, and other provisions in the FAA order and rules (Federal Aviation Administration, 2020). Independently, airports also have the ability to review airline operations based on terminal capacity.

4 14 CFR part 93 subpart K. https://www.federalregister.gov/d/2012-7742/p-6.

5 33 FR 17,896 (Dec. 3, 1968).

6 Part 93 subpart S, 50 FR 52,195 (Dec. 20, 1985).

7 Wendell H. Ford Aviation Investment and Reform Act of the 21st Century.

8 Federal Aviation Administration (2016). FAA Announces Slot Changes at Newark Liberty International. https://www.faa.gov/newsroom/faa-announces-slot-changes-newark-liberty-international.

Table 1 Slot distribution and divestitures

Airport	Slots divested (%)	BEFORE		AFTER		CHANGE	
		US + AA (%)	LCCs (%)	US + AA (%)	LCCs (%)	US + AA (%)	LCCs (%)
DCA	11.8	69	6.4	57.2	18.2	− 17	+ 184
LGA	3	31.6	8	28.6	11	− 9.5	+ 37.5

This table is calculated using the 881 weekday slots for DCA and 1,141 for LGA in conjunction with the slot-holder data from the FAA.

Level 1 and 2 airports differ from Level 3 airports in the sense that they do not possess traditional slots. Instead, at Level 1 and 2 airports, cooperation between airlines and the airport is essential in managing arrivals and departures. For instance, if there are multiple airlines that plan to depart at roughly the same time from a given Level 1 or 2 airport, the departure time for each flight is determined by the number of flights that will be arriving at a specific destination airport. In order to know at what time each of, say, five flights would depart from a particular airport, we would need to know the identity of the destination airport for each of the five flights and how many other flights are arriving at that destination airport at the scheduled arrival time. This is accomplished by a metering process: "time-based flow management" (TBFM). This is an air traffic management tool that aims to schedule airplanes to an active runway with the least amount of delay (Diana, 2015).

2.2 Slot Distribution and Divestitures at DCA and LGA

In response to its merger with US Airways, American Airlines was forced to sell 104 takeoff and landing slots at Reagan National and 34 slots at LaGuardia, for more than $425 million (Kendall, 2014). The transaction allowed LCCs to obtain otherwise inaccessible slots and gates at Reagan National (Southwest Airlines, JetBlue Airways and Virgin America) and LaGuardia (Southwest and Virgin America). In its press release of November 12, 2013, the DOJ announced that:

> … it is requiring US Airways Group Inc. and American Airlines' parent corporation, AMR Corp. to divest slots and gates… to low cost carrier airlines (LCCs) in order to enhance system-wide competition in the airline industry resulting in more choices and more competitive airfares for consumers.[9]

In a typical week, there are on average 5,966[10] departures and landings that require slots at DCA and 6,425 at LGA. The number of these slots differs between weekdays and weekends. A typical weekday at DCA has about 881 slots available, but on the weekend the number is less–729 on Saturday and 832 on Sunday–because

[9] DOJ (2013b).

[10] Federal Aviation Administration (2021). Slot Administration–Data https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/perf_analysis/slot_administration/data.

of lower demand. At LGA, typical weekday and Sunday availabilities are 1,141 and 720, respectively. Slots are not required until noon on Sunday. It is not slot-controlled on Saturday.

Table 1 shows the approximate slot-distribution percentages at each airport before and after the divestitures for the merging airlines and for the LCCs. Before their merger, US had a majority share of slots at DCA–about 55 percent–and AA had 14 percent. Without divestitures, their combined share would have been 69 percent. There were 104 slots (52 round trips per day) that were divested at this airport: 11.8 percent of the total. These divestitures reduced the holdings of the airlines by about 17 percent[11] and increased the LCCs' share from 6.4 to 18.2 percent: an increase of 184 percent. Although the number of slots divested was sizable, it was modest in percentage terms since the airlines still held the dominant share at 57.2 percent after divestitures.

At LGA, the number of slots divested (34 slots, or 17 round trips) was much smaller at 3 percent.[12] These divestitures reduced the airlines' share by 9.5 percent and increased the LCCs' share by 37.5 percent. In contrast to DCA, at this airport neither US nor AA was the dominant slot holder (it was Delta), nor would the merged airline have been the dominant slot holder without these divestitures.

3 Related Literature

In recent years, the list of retrospective studies on airline mergers—including Carlton et al. (2017), Le (2016), Jain (2015), Hüschelrath and Müller (2015), and Luo (2014)—has grown. However, because the DOJ has imposed slot divestitures only on the United/Continental and American Airlines/US Airways mergers, there is still little theoretical or empirical research that has examined such a policy's effectiveness–particularly in overlap markets.

Reitzes et al. (2015) finds that under certain conditions, increases in the concentration of slot holdings as a result of a merger can decrease total welfare and consumer surplus even though total output is unchanged. Empirically, Clark (2015) finds that price decreased and consumer welfare increased in markets in which Southwest entered following the United/Continental slot divestitures. Zhang et al. (2017) find that these recent divestitures are associated with lower prices at the affected airports.

While slot divestitures can be procompetitive on average, it is unclear whether this is the case in overlap markets in which the merger eliminated a direct competitor. This paper adds to the literature by distinguishing the competitive impact between overlap and nonoverlap markets.

[11] This percentage is calculated as (57.2/69) – 1.

[12] Although a total of 138 slots were divested, 26 were already in use by the LCCs through leasing. These divestitures made permanent the usage of these slots.

4 Data and Empirical Model

4.1 Data

The unit of analysis is at the level of airline route, market, and quarter-year, where a *route* is defined as a combination of origin airport, destination airport, and any connections. An airline *market* is defined unidirectionally as a combination of origin airport and destination airport. Using airport-pairs to define the market is appropriate for this application because these divestitures are at specific airports DCA and LGA. Using city-pairs to define the market would not be as appropriate because a city can have multiple airports that are not subjected to divestitures.

In a given market, an airline can offer nonstop routes, connecting routes, or both. An example of a ticket is AA: DCA-CMH-DFW, where the passenger flies with American Airlines from DCA to Dallas (DFW) with a connection in Columbus (CMH). The route in this case is a connecting route DCA-CMH-DFW, but the market is DCA-DFW.

The data come from the Airline Origin and Destination Survey, which contains a 10 percent sample of domestic airline tickets. Each ticket has information on the airline identity, the route and market, and ticket prices.[13] This information helps identify markets and the airlines that were affected by the divestitures. The predivestiture periods are the first and second quarters of 2012, and the postdivestiture periods are the first and second quarters of 2016. Before arriving at the final sample, the following standard exclusions were applied: tickets outside the 48 mainland states; tickets with real prices less than \$25 or greater than \$1,700; tickets with more than one connection; business-class tickets; and bulk-fare tickets. Separate analyses are conducted for round-trip and one-way tickets.[14]

4.2 Econometric Model

The reduced-form price regressions are estimated separately for DCA and LGA and are given compactly as follows:

$$\begin{aligned}\ln(price_{irmt}) = {} & \beta_0 + \beta_1 post_t * DCA_m/LGA_m * overlap_m \\ & + \beta_2 post_t * DCA_m/LGA_m + \beta_3 post_t * overlap_m \\ & + \beta_4 post_t * nonoverlap_m + \beta_5 DCA_m/LGA_m * overlap_m \\ & + \beta_6 DCA_m/LGA_m + \beta_7 overlap_m + \beta_8 nonoverlap_m + \beta_9 post_t \\ & + X_{imt}\beta_{controls} + \varepsilon_{irmt}\end{aligned} \tag{1}$$

where $price_{irmt}$ is the ticket price that is charged by carrier i, on route r, in market m, at time (quarter) t. Since the data are at the ticket level, and because tickets that

[13] Ticket prices in the DB1B data include taxes and fees but not ancillary fees such as checked baggage.

[14] The prices for one-way tickets are directly observable in the data. Since we analyze one-way and round-trip tickets separately, there is no need to use half of round-trip prices in any analyses.

are bought by different passengers who are traveling on the same route in a given time period (a calendar quarter) may differ in price, the price variable is passenger-weighted and is adjusted by the transportation price index.[15] DCA_m is a dummy variable that equals one if the origin or destination airport is DCA, and zero otherwise. In the price regression for LGA, this dummy variable is LGA_m, which indicates LGA as the origin or destination airport.

The variable $overlap_m$ indicates markets (including non DCA or LGA markets) in which American Airlines and US Airways had overlap competition prior to their merger. If both airlines offered nonstop or connecting service in a market prior to their merger, this market is considered an overlap market. The variable $nonoverlap_m$ indicates markets that were served by either American Airlines or US Airways, but not by both. Because only one of the merging airlines offered nonstop or connecting service in these markets prior to their merger, they are considered nonoverlap markets. The control observations are markets that were unrelated to the divestitures and the merger. The variable $post_t$ is a time dummy variable that equals one for the postdivestiture periods.

The estimate of interest is β_1: the price effect of the divestitures in DCA or LGA markets in which the merging airlines had pre-merger overlap competition. The estimate β_2 is also of interest because it captures the effects in those DCA/LGA markets in which the two airlines did not directly compete. In the estimations, the DCA regressions exclude LGA routes, and the LGA regressions exclude DCA routes. This allows us properly to isolate the price effects and avoid potential confounding factors.

The vector X_{imt} includes the following route and market characteristics that are common to airline studies: *HHI* is the Herfindahl–Hirschman Index for market concentration. We acknowledge that HHI is endogenous since it is computed as a function of airlines' market shares, which vary with airlines' decisions. However, in calculating the postdivestiture market shares of the merging airlines, we follow Bamberger et al. (2004) and Kwoka and Shumilkina (2010) by holding them fixed at the predivestiture level.[16] Therefore, any changes in *HHI* in the postdivestiture periods are due to changes in the passenger shares of the non-merging rather than the merging airlines.

The variable *mktsize* measures market size and is computed as the geometric mean of the market origin- and destination-city populations. The variable *income* is the geometric mean of the market origin- and destination-city per capita income.[17] The variable *orig hubsize* is a proxy for hub size at the origin airport that counts the number of airports to which the market origin airport connects with nonstop flights. The variable *dest hubsize* is a proxy for hub size at the destination airport that counts the number of airports to which the market destination airport connects with nonstop flights. The variable *distance* measures the nonstop distance between the

[15] Bureau of Labor Statistics CPI, all-urban-consumer series CUUR0000SAT with base year 2012.

[16] For example, if American and US Airways carry 5000 and 3000 passengers in a particular market predivestiture, these same numbers of passengers in that market are kept for the postdivestiture period.

[17] Population and income statistics are from the US Bureau of Economic Analysis.

Table 2 Summary statistics

	Round-trip				One-way			
Variable	Mean	SD	Min	Max	Mean	SD	Min	Max
price	280.35	112.25	25.11	1602	301.37	145.32	25.07	1,688.6
DCA	0.022	0.146	0	1	0.024	0.154	0	1
LGA	0.021	0.142	0	1	0.031	0.173	0	1
overlap	0.356	0.479	0	1	0.419	0.493	0	1
nonoverlap	0.324	0.468	0	1	0.293	0.455	0	1
post	0.451	0.498	0	1	0.510	0.499	0	1
HHI	6,840.1	2,394.4	1655.2	10,000	6,735.2	2,402.9	1,716.9	10,000
mktsize	475,282.7	488,444.8	3087.1	5,775,837	576,374.2	606,978.3	3,099.8	5,775,837
income	46,340.5	7,146.2	26,245.1	158,354.5	47,017.1	7,069.5	25,248.2	143,289.8
orig hub-size	21.22	25.68	0	136	24.59	26.10	0	136
dest hub-size	20.50	24.96	0	135	24.18	25.35	0	135
distance	1,108.97	604.64	43	2783	1,161.35	642.65	43	2783
vacation	0.192	0.394	0	1	0.218	0.413	0	1
N	363,025				124,480			

market origin and destination airports. The variable *vacation* signifies a vacation-oriented city: an indicator variable for an origin or destination airport that is located in Florida or Nevada.[18] The composite error of the model is $\varepsilon_{irmt} = \eta_{ir} + \nu_t + \mu_{irmt}$, where: η_{ir} is the route-carrier fixed effects; ν_t is the time fixed effects; and μ_{irmt} is the remaining unobserved factors that vary over time.

Summary statistics of these variables for round-trip and one-way tickets are shown in Table 2.

These regressions are estimated by OLS and fixed-effects (FE)—the within estimator. FE exploits the pre- and postdivestiture time variation within a route-carrier combination while controlling for unobserved time-invariant route-specific factors. To account for the potential presence of heteroskedasticity and serial correlation, standard errors are clustered at the route-carrier level. In addition, a test of the parallel-trend assumption suggests that prices in the DCA/LGA markets and in those markets that were unaffected by the divestitures followed similar trends in the predivestiture periods.

[18] This definition follows Hofer et al. (2008).

Table 3 Baseline results for DCA. Dependent variable is *ln(price)*

	Round-trip		One-way	
	OLS	FE	OLS	FE
*post*DCA*overlap*	0.060*** (3.53)	0.052** (2.17)	0.10*** (2.64)	0.192*** (2.60)
*post*DCA*	−0.110*** (8.58)	−0.083*** (4.29)	−0.148*** (5.32)	−0.210*** (3.29)
*post*overlap*	0.019*** (6.47)	0.018*** (4.9)	0.002 (0.40)	0.013 (1.3)
*post*nonoverlap*	0.026*** (6.47)	0.030*** (8.03)	0.016** (2.77)	0.040*** (3.72)
*DCA*overlap*	−0.019 (1.48)		−0.02 (0.68)	
DCA	0.047* (1.66)		0.003 (0.05)	
overlap	−0.067*** (21.24)		−0.059*** (9.57)	
nonoverlap	−0.059*** (22.99)		−0.064*** (12.51)	
post	0.129*** (32.50)	0.106*** (21.02)	0.135*** (16.12)	0.099*** (6.39)
ln(HHI)	0.010*** (4.59)	0.038*** (8.67)	0.013*** (3.56)	0.046*** (3.61)
ln(mktsize)	−0.045 (1.43)	0.066* (1.81)	0.023 (0.33)	0.115 (0.94)
ln(income)	0.194** (2.16)	0.660*** (5.86)	0.108 (0.57)	0.300 (0.88)
orig hubsize	0.002*** (46.30)	0.0015*** (10.08)	0.002*** (25.93)	0.002*** (3.64)
dest hubsize	0.002*** (49.93)	0.002*** (10.50)	0.003*** (28.05)	0.002*** (4.31)
ln(distance)	0.242*** (148.60)		0.255*** (81.86)	
vacation	−0.136*** (15.82)		−0.107*** (7.94)	
constant	2.22** (2.15)	−2.81** (2.17)	2.302 (1.05)	0.359 (0.09)
Chow Test, H_o: Round-trip and one-way regressions are indistinguishable F (2, 232,263) = 503.52 $p = 0.000$***				
R^2	0.3064	0.0814	0.3078	0.0488
N	355,521	355,521	120,645	120,645

*$p<0.10$, **$p<0.05$, ***$p<0.01$. OLS estimation includes dummy variables for carrier, origin airport, destination airport, and quarter. Absolute t-values appear in parentheses. Standard errors are clustered at the route-carrier level. *Within* R^2 are reported for FE regressions

5 Baseline Results

5.1 Baseline Results for DCA and LGA

For DCA, Table 3 reports OLS and FE estimates and absolute t-values for round-trip and one-way tickets. In addition, to get a sense of the overall effect, these regressions include both nonstop and connecting routes. Route distinctions, however, will be made in Sect. 5.3. Since the FE model exploits the time variation within a route-carrier combination, time-invariant variables are differenced out. Consistent with the literature, price increases with market concentration (*HHI*), per capita income (*income*), hub size (*hubsize*), and distance (*distance*), while price decreases with vacation routes (*vacation*).

We now turn to the price effects in DCA markets in which the merging airlines had pre-merger overlap competition. OLS and FE estimates for round-trip and one-way tickets on the triple interaction variable *post*DCA*overlap* are positive and statistically significant at the 5 percent significance level, which suggests that prices increased in these markets. The magnitude of the FE price increase is more than three times larger for one-way than for round-trip tickets. The FE estimates suggest that one-way prices increased about 21 percent, while round-trip prices increased about 5.3 percent.[19] These results suggest that the divestitures at DCA did not keep prices competitive in these overlap markets.

In contrast, prices in the other DCA markets (except the overlap markets) decreased. The estimates on the variable *post*DCA* are negative and statistically significant at the 1 percent level across the board. Round-trip and one-way prices decreased on average 8 and 19 percent, respectively. These results suggest that the divestitures at DCA were procompetitive for the other DCA markets – but (perhaps ironically) not for the pre-merger overlap markets.

Table 4 reports the results for LGA. With respect to overlap markets, we have a result that contrasts with DCA: The FE estimate on the variable *post*LGA*overlap* is negative (a 4.3 percent decrease) and statistically significant at the 10 percent level for round-trip prices; but for one-way prices the estimate, while positive, is not statistically significant. These results suggest that prices in both of these markets have essentially been kept competitive.

For the remainder of the LGA markets, the effects differ between round-trip and one-way prices. For round-trip prices, the FE estimate is not statistically significant; but for one-way prices, the estimate is negative (8.8 percent decrease) and statistically significant at the 5 percent level.

Overall, these results suggest that in contrast to the divestitures at DCA, the divestitures at LGA have on balance prevented prices from increasing in both overlap and the remaining markets.

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[19] There are differences in the magnitudes between OLS and FE, but we will rely on the FE estimates to discuss the magnitude since it is the preferred model. Since the dependent variable is *ln(price)*, the percent change for a right-hand-side indicator variables is obtained by using $e^{\beta}-1$, where β is the parameter of interest.

Table 4 Baseline results for LGA. Dependent variable is *ln(price)*

	Round-trip		One-way	
	OLS	FE	OLS	FE
*post*LGA*overlap*	−0.061*** (3.43)	−0.044* (1.76)	−0.020 (0.56)	0.039 (0.78)
*post*LGA*	0.030** (2.14)	0.022 (1.10)	0.002 (0.07)	−0.093** (2.12)
*post*overlap*	0.020*** (6.73)	0.018*** (5.13)	0.003 (0.46)	0.013 (1.34)
*post*nonoverlap*	0.028*** (9.67)	0.032*** (8.47)	0.018** (3.08)	0.04*** (3.79)
*LGA*overlap*	0.055*** (4.36)		0.047* (1.96)	
LGA	−0.040 (0.61)		−0.150 (1.14)	
overlap	−0.066*** (20.98)		−0.060*** (9.30)	
nonoverlap	−0.060*** (23.02)		−0.064*** (12.45)	
post	0.129*** (32.21)	0.107*** (21.09)	0.134*** (16.06)	0.099*** (6.43)
ln(HHI)	0.007*** (3.92)	0.036*** (8.16)	0.010*** (2.91)	0.043*** (3.37)
ln(mktsize)	−0.046 (1.47)	0.063* (1.71)	0.025 (0.38)	0.096 (0.78)
ln(income)	0.183** (2.02)	0.619*** (5.48)	0.098 (0.51)	0.301 (0.89)
orig hubsize	0.002*** (46.91)	0.001*** (9.65)	0.002*** (26.91)	0.001*** (3.64)
dest hubsize	0.002*** (50.29)	0.001*** (9.93)	0.003*** (28.49)	0.002*** (3.79)
ln(distance)	0.240*** (147.15)		0.253*** (81.49)	
vacation	−0.133 (15.48)		−0.104*** (7.74)	
constant	2.40** (2.30)	−2.306* (1.77)	2.41 (1.11)	0.630 (0.16)
Chow Test, H_o: Round-trip and one-way regressions are indistinguishable F(2, 232,142) = 504.71 $p = 0.000$***				
R^2	0.3076	0.0819	0.3076	0.0478
N	355,140	355,140	121,446	121,446

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. OLS estimation includes dummy variables for carrier, origin airport, destination airport, and quarter. Absolute t-values appear in parentheses. Standard errors are clustered at the route-carrier level. *Within* R^2 are reported for FE regressions

Table 5 Change in consumer welfare from slot divestitures ($US per carrier-route per quarter)

		DCA (1)	LGA (2)
Overlap routes	Round-trip	– $2,680	$1,893
	One-way	– $13,573	0^{+}
Remaining routes	Round-trip	$2,878	0^{*}
	One-way	$14,068	$1,503
Net Change in Welfare		$693	$3,396

Estimates are quarterly carrier-route averages

$^{+}\beta_1$ is not statistically significant

$^{*}\beta_2$ is not statistically significant

For both Tables 3 and 4, we perform a Chow test to check whether the round-trip regressions are significantly different from the one-way regressions. We report the test results at the bottom of the tables. The p-value suggests that the null hypothesis–that the round-trip and one-way regressions are statistically indistinguishable–is rejected, which reinforces the justification to estimate them separately.

Since we find fare increases at DCA on overlap routes and fare decreases on the remaining routes, we conduct a "back-of-the-envelope" net welfare analysis in Table 5. To calculate the change in consumer welfare on overlap routes for DCA, we multiply the percent change obtained from the coefficient estimate on the triple interaction variable *post*DCA*overlap* in Table 3 ($e^{\beta_1} - 1$) by the average route-level price and by the route-level average number of passengers.[20] β_1 is the coefficient estimate on the triple interaction variable *post*DCA*overlap* in Eq. 1. For the remaining DCA routes, we multiply the expression $e^{\beta_2} - 1$ by the average route-level price and by the route-level average number of passengers. β_2 *is* the coefficient estimate on *post*DCA* in Eq. 1. We perform analogous calculations for LGA and report the findings in column 2 of Table 5. The net effect in Table 5 is the sum of the effects across overlap and the remaining routes

We find that consumer welfare increased following the slot divestitures for both DCA and LGA – although the effect appears to be larger at LGA. This suggests that at DCA, the procompetitive effects in the remaining markets dominate the anticompetitive effects in the overlap markets.

With the consumer welfare estimates in Table 5, we are able to provide more aggregate welfare calculation. In our post-merger sample (Q1 and Q2 of 2016), there are 353 DCA routes and 316 LGA routes per quarter, respectively. Therefore, the overall consumer welfare gain on DCA routes amounts to roughly $0.5 million ($693 × 353 routes × 2 quarters). On LGA routes, the corresponding welfare gain is $2.1 million ($3396 × 316 routes × 2 quarters). Ceteris paribus, on a yearly basis, that is equivalent to $1 million on DCA routes and $4.2 million on LGA routes.

[20] $\left(e^{\beta_1} - 1\right) \times$ *mean price* $\times$ *mean number of passengers*.

Table 6 Origin versus destination DCA and LGA. Dependent variable is *ln(price)*

	DCA		LGA	
	Round-trip	One-way	Round-trip	One-way
*post*DCA_origin*overlap*	0.068**	0.22***		
	(2.05)	(2.74)		
*post*DCA_dest*overlap*	0.037	0.156		
	(1.10)	(1.27)		
*post*DCA_origin*	−0.075***	−0.210***		
	(2.80)	(3.40)		
*post*DCA_dest*	−0.093***	−0.210*		
	(3.36)	(1.88)		
*post*LGA_origin*overlap*			−0.035	0.020
			(1.05)	(0.25)
*post*LGA_dest*overlap*			−0.055	0.061
			(1.45)	(0.91)
*post*LGA_origin*			0.013	−0.090
			(0.47)	(1.37)
*post*LGA_dest*			0.033	−0.10
			(1.07)	(1.72)
*post*overlap*	0.018***	0.013	0.018***	0.013
	(4.90)	(1.30)	(5.13)	(1.34)
*post*nonoverlap*	0.030***	0.040***	0.032***	0.040***
	(8.03)	(3.72)	(8.48)	(3.79)
post	0.106***	0.099***	0.107***	0.099***
	(21.02)	(6.38)	(21.09)	(6.44)
ln(HHI)	0.038***	0.046***	0.036***	0.043***
	(8.66)	(3.59)	(8.16)	(3.37)
ln(mktsize)	0.066*	0.115	0.063*	0.096
	(1.80)	(0.93)	(1.71)	(0.79)
ln(income)	0.660***	0.304	0.619***	0.299
	(5.86)	(0.89)	(5.48)	(0.88)
orig hubsize	0.001***	0.001***	0.001***	0.001***
	(10.04)	(3.61)	(9.66)	(3.64)
dest hubsize	0.002***	0.002***	0.001***	0.002***
	(10.51)	(4.34)	(9.92)	(3.76)
constant	−2.8**	0.34	−2.31*	0.76
	(2.16)	(0.09)	(1.77)	(0.17)
Within R^2	0.0814	0.0488	0.0819	0.0479
N	355,521	120,645	355,140	121,446

$*p<0.10$, $**p<0.05$, $***p<0.01$. Coefficients are fixed-effects estimates. Absolute t-values appear in parentheses. Standard errors are clustered at the route-carrier level

Table 7 Nonstop versus connecting routes. Dependent variable is *ln(price)*

	DCA				LGA			
	Round-trip		One-way		Round-trip		One-way	
	Nonstop	Connect	Nonstop	Connect	Nonstop	Connect	Nonstop	Connect
*post*DCA*overlap*	0.080*	0.045	0.290***	0.185**				
	(1.88)	(1.52)	(2.60)	(2.12)				
*post*DCA*	−0.058**	−0.085***	−0.226***	−0.210***				
	(2.13)	(3.37)	(4.34)	(2.63)				
*post*LGA*overlap*					−0.083*	−0.022	−0.080	0.073
					(1.87)	(0.71)	(0.87)	(1.15)
*post*LGA*					0.062*	0.013	−0.052	−0.116**
					(1.70)	(0.54)	(0.77)	(2.02)
*post*overlap*	−0.013	0.025***	0.050**	0.002	−0.012	0.026***	0.051**	0.002
	(1.47)	(6.46)	(2.07)	(0.18)	(1.42)	(6.68)	(2.12)	(0.19)
*post*nonoverlap*	0.038***	0.030***	0.081***	0.028**	0.039***	0.031***	0.086***	0.028**
	(4.10)	(7.22)	(2.93)	(2.42)	(4.16)	(7.65)	(3.10)	(2.41)
post	0.049***	0.114***	0.076**	0.10***	0.052***	0.114***	0.077**	0.10***
	(3.67)	(20.95)	(1.98)	(5.89)	(3.88)	(20.98)	(1.99)	(5.95)
ln(HHI)	0.006	0.040***	0.004	0.052***	0.004	0.040***	−0.011	0.050***
	(0.61)	(8.66)	(0.10)	(3.73)	(0.40)	(8.22)	(0.33)	(3.64)
ln(mktsize)	0.073	0.07*	0.467**	0.072	0.057	0.066	0.442**	0.053
	(1.11)	(1.68)	(2.36)	(0.52)	(0.86)	(1.63)	(2.32)	(0.38)
ln(income)	1.715***	0.541***	−0.261	0.624	1.635***	0.502***	−0.29	0.619
	(5.86)	(4.46)	(0.34)	(1.64)	(5.59)	(4.12)	(0.38)	(1.64)
orig hubsize	0.001**	0.002***	0.001	0.002***	0.001**	0.002***	0.001	0.002***
	(2.41)	(10.33)	(0.51)	(3.79)	(2.35)	(9.88)	(0.75)	(3.71)
dest hubsize	0.001**	0.002***	0.002*	0.002***	0.001*	0.002***	0.002*	0.001***
	(2.29)	(10.97)	(1.90)	(3.81)	(1.94)	(10.53)	(1.92)	(3.26)
constant	−14.15***	−1.57	1.921	−2.552	−13.06***	−1.11	2.641	−2.234
	(4.27)	(1.12)	(0.22)	(0.59)	(3.94)	(0.79)	(0.30)	(0.52)
Chow test, H_o: Nonstop and connecting routes are indistinguishable								
	$F(1, 4665) = 0.07$ $p = 0.792$		$F(1, 2423) = 1.21$ $p = 0.271$		$F(1, 4452) = 6.37$ $p = 0.012$***		$F(1, 2793) = 1.52$ $p = 0.218$	
Within R^2	0.0910	0.0821	0.0515	0.0493	0.0917	0.0826	0.0496	0.0486
N	47,521	308,000	15,017	105,628	47,850	307,290	15,298	106,148

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Coefficients are fixed-effects estimates. Absolute t-values appear in parentheses. Standard errors are clustered at the route-carrier level

5.2 Origin versus Destination DCA and LGA

The variables *DCA* and *LGA* previously defined do not distinguish between whether DCA/LGA is the origin or destination airport. Making this distinction, however, can be important because the direction of the route can matter. Table 6 reports FE estimates in which the distinction between origin and destination airport is made.

In the case of overlap markets, the price increase is larger when DCA is the origin airport than when it is the destination airport; the effect of the latter is not statistically significant. These results suggest that much of the price increase is from routes that originated from DCA rather than routes that arrived at DCA. For the remaining DCA markets, price decreases were quite similar for round-trip tickets and almost identical for one-way tickets, which suggests that price reductions were more symmetric in this case.

For LGA, none of the estimates of the effect of origin or destination are statistically significant, which suggests that distinguishing between origin and destination airport matters less in this case.

5.3 Nonstop versus Connecting Routes

This section considers the effects in nonstop versus connecting routes. The distinction between these routes is particularly important because one of the concerns of this merger was that in the absence of any divestitures, the airlines would monopolize a majority of nonstop routes into and out of DCA, which suggested that the adverse effects on these routes might be larger. By construction, a nonstop itinerary requires a single flight between origin and destination airports regardless of whether the itinerary is one-way or a roundtrip.

The results in Table 7 suggest that the extent of the price increase for DCA overlaps is larger for nonstop than for connecting routes. The coefficients for *post*DCA*overlap* are larger for nonstop routes versus connecting routes. This suggests that the merger caused nonstop tickets to increase in price more than was true for connecting tickets to and/or from DCA. Business travelers have a preference for nonstop flights as they are able to save time and avoid potential travel bottlenecks at connections. Non-business travelers are more willing to take connecting flights as they do not value time as much as business passengers do.[21]

For this reason, the demand for air travel by business passengers tends to be less price-elastic compared to the demand by non-business passengers. The difference in price elasticities of demand between the two types of products (nonstop versus connecting) may be further exacerbated in a post-merger environment where there is less competition, which would allow carriers to raise prices more on nonstop flights.

In contrast, the price decreases in the remaining routes are quite similar for nonstop and connecting routes, which suggests that the route distinction for the remaining routes is not as important as for overlap routes. We test for route distinction for DCA using a Chow test. The test results reported at the bottom of Table 7 confirms that there is no statistical difference between nonstop and connecting routes.

In the case of LGA overlaps, prices decreased more for nonstop than for connecting routes – particularly for round-trip prices (an 8 percent decrease); the price effects on connecting routes are not statistically different from zero. For the remaining routes, prices decreased for one-way connecting routes (an 11 percent decrease)

[21] Connecting flights are also more abundant than nonstop ones.

but increased for round-trip nonstop routes (a 6.4 percent increase). Even though the statistical significance of the latter estimate is weaker, this evidence suggests that prices on these round-trip nonstop routes in particular have not been competitive. A Chow test suggests that nonstop and connecting routes are statistically different for round-trips that involved LGA.

5.4 Extent of Overlap at DCA and LGA

Since much of the price increase at DCA and price reduction at LGA is from overlap markets, the extent of the merging airlines' market shares at these airports before divestitures may affect the size of these estimates. Three cases are examined, based on their predivestiture market shares: (i) predivestiture the US market share was greater than the AA market share; (ii) predivestiture the AA market share was greater than the US market share; and (iii) predivestiture the AA plus US combined shares were at various levels.

Table 8 shows only the estimates of the triple interaction variable from the various DCA and LGA fixed-effects regressions. Columns 1 and 2 of panel A show the results for case (i); columns 3 and 4 of Panel A show case (ii); and panels B and C show case (iii).

For the DCA markets in which US had a larger market share (first row, first column) before divestitures, prices increased about 8.5 percent for round-trip tickets but

Table 8 Price effects conditional on the extent of pre-merger market shares of AA and US at DCA and LGA. Dependent variable is *ln(price)*

	Round-trip (1)	One-way (2)	Round-trip (3)	One-way (4)
Panel A	US share > AA share		AA share > US share	
*post*DCA*overlap*	0.082*	−0.050	0.066**	0.315***
	(1.78)	(0.31)	(2.20)	(4.25)
*post*LGA*overlap*	0.022	−0.086	−0.100***	0.102
	(0.43)	(1.00)	(2.94)	(1.57)
Panel B	AA share + US share ≤ 25%		AA share + US share > 25% and ≤ 50%	
*post*DCA*overlap*	0.054*	0.360***	0.021	−0.243*
	(1.78)	(4.01)	(0.28)	(1.93)
*post*LGA*overlap*	−0.053	0.042	0.100	0.232
	(1.54)	(0.53)	(0.37)	(1.53)
Panel C	AA share + US share > 50% and ≤ 75%		AA share + US share > 75%	
*post*DCA*overlap*	0.268**	0.374***	0.034	−0.211
	(2.47)	(2.68)	(0.63)	(1.05)
*post*LGA*overlap*	−0.052	0.094	−0.052	−0.018
	(0.43)	(0.72)	(0.97)	(0.17)

$^*p < .10$, $^{**}p < .05$, $^{***}p < .01$. Coefficients are fixed-effects estimates. Absolute t-values appear in parentheses. Standard errors are clustered at the route-carrier level.

the effect is not statistically significant for one-way tickets. However, if AA had the larger market share (first row, columns 3 and 4), prices increased for both round-trip and one-way tickets, but the increase was much larger for one-way tickets (37.0 percent versus 6.8 percent). These latter results are revealing because they suggest that the strongest price effect at DCA was for those one-way routes in which AA had the larger pre-merger market share despite US having the majority slot share overall at this airport.

For LGA, the round-trip prices decreased 9.5 percent in markets in which AA had the larger pre-merger share. However, the other estimates are not statistically significant, which suggests that prices were essentially unchanged.

The last four rows show the effects of the two carriers' combined pre-merger market shares at various levels. For DCA, we see substantial price increases for round-trip and one-way tickets where the airlines' combined pre-merger market shares were less than 25 percent or between 50 and 75 percent. In Sect. 2.2 and the Table 1 notes, we mentioned that DCA was relatively more slot-constrained than was LGA. In fact, DCA had only 881 weekday slots compared to 1,141 for LGA. Less capacity suggests a more limited supply of air travel services, which would likely result in higher prices. This initial effect was exacerbated by the merger – the elimination of a competitor – which increased market power (larger combined market shares) post-merger at DCA.

At 25 to 50 percent combined market share, one-way prices decreased about 21.6 percent and at greater than 75 percent the price changes were not statistically different from zero. These results suggest that prices increased at DCA only at certain levels of combined market share, not across all levels. For LGA, all of the estimates are statistically insignificant, which suggests that prices remained unchanged regardless of combined market share.

5.5 AA versus US Nonoverlaps at DCA and LGA

Since much of the procompetitive effect is from the markets that did not have pre-merger overlaps – particularly at DCA – it may be important to distinguish between those nonoverlap DCA markets that AA served predivestitures and those that US served predivestitures, so as to determine it mattered whether AA or US (but not both) served the pre-merger market. The estimates on the interaction variables *post*DCA*AA* and *post*DCA*US* capture respectively the post-merger price effects in nonoverlap DCA markets in which AA and US served before the divestitures.

As Table 9 indicates, estimates on the variable *post*DCA*US* are statistically significant for roundtrips, but estimates on *post*DCA*AA* are not; this suggests that much of the price decrease at DCA is from roundtrips in nonoverlap markets that were served by US rather than AA prior to their divestitures (a 16 percent decrease).

This result suggests that post-divestiture at DCA, the available slots at the airport increase leads to a decrease in roundtrip ticket prices. One-way ticket prices, on the other hand, may not experience a drop in price because they are often used by business travelers who need to travel quickly and are less price-sensitive than

Table 9 AA versus US nonoverlap markets at DCA and LGA. Dependent variable is *ln(price)*

	DCA		LGA	
	Round-trip	One-way	Round-trip	One-way
*post*DCA*AA*	−0.082	0.013		
	(1.23)	(0.09)		
*post*DCA*US*	−0.174***	−0.167		
	(3.15)	(1.40)		
*post*DCA*overlap*	0.185**	0.236		
	(2.58)	(1.38)		
*post*LGA*AA*			−0.021	−0.014
			(0.57)	(0.23)
*post*LGA*US*			0.086***	−0.115*
			(2.87)	(1.67)
*post*LGA*overlap*			−0.088*	0.065
			(1.74)	(0.67)
*post*overlap*	0.006	−0.012	0.006*	−0.010
	(1.61)	(1.23)	(1.72)	(1.03)
*post*nonoverlap*	0.021***	0.025**	0.021***	0.026**
	(5.52)	(2.36)	(5.62)	(2.49)
post	0.110***	0.107***	0.111***	0.108***
	(21.66)	(6.99)	(21.83)	(7.06)
ln(HHI)	0.039***	0.049***	0.038***	0.046***
	(9.01)	(3.83)	(8.57)	(3.58)
ln(mktsize)	0.051	0.098	0.050	0.079
	(1.39)	(0.79)	(1.36)	(0.65)
ln(income)	0.531***	0.106	0.497***	0.079
	(4.72)	(0.32)	(4.40)	(0.24)
orig hubsize	0.001***	0.001*	0.001***	0.001*
	(6.68)	(1.76)	(6.45)	(1.95)
dest hubsize	0.001***	0.001**	0.001***	0.001**
	(7.56)	(2.47)	(7.11)	(2.07)
constant	−1.231	2.688	−0.843	3.237
	(0.95)	(0.70)	(0.65)	(0.85)
Within R^2	0.0835	0.0539	0.0839	0.0525
N	355,521	120,645	355,140	121,446

$^*p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$. Coefficients are fixed-effects estimates. Absolute t-values appear in parentheses. Standard errors are clustered at the route-carrier level

leisure travelers who typically book roundtrip tickets. Therefore, we would expect more roundtrip price responsiveness relative to one-way prices.

For LGA, again AA nonoverlap markets are not statistically significant. However, we have mixed results for the US nonoverlap routes: price increases for round-trip tickets (a 9 percent increase), and price decreases for one-way tickets (a 12.2 percent decrease). The finding of higher round-trip prices in nonoverlap markets that were served by US before the divestitures suggests that not all nonoverlap markets' price competition was preserved and is consistent with the previous findings on nonstop/connecting routes. The distinction between AA and US nonoverlap markets makes clear that much of the price increase at LGA is on round-trip nonstop routes that were previously served by US.

6 Conclusion

The AA/US merger was initially blocked by antitrust authorities in part because the airlines had significant overlap competition and high levels of slot concentration at two of most constrained airports in the US: DCA and LGA. Their merger was ultimately approved, however, on the condition that they divest a number of takeoff-and-landing slots at the two airports to LCCs.

This paper studies the price effect of these divestitures, with a focus on markets in which the merging airlines had overlap competition on routes that were associated with these airports. The results suggest that, on balance, these divestitures kept prices competitive at LGA but not at DCA. Our back-of-the-envelope welfare calculations suggest that on net, consumers experienced a modest welfare gain on DCA routes and four times that amount on LGA routes.

In requiring these divestitures, the DOJ has acknowledged the difficulty in preserving price competition in markets in which competition was lost because of the merger and has indicated that these divestitures might not address anticompetitive concerns in these markets. Rather, they are intended to give LCCs greater access to these airports and to help strengthen their networks to benefit consumers system-wide–not necessarily in specific markets (DOJ, 2014b).

A potential area for future research would be the investigation of the price effects across less concentrated versus highly concentrated markets.

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