Competitive Effects of Regional Airline Exit: Evidence from the COVID-19 Pandemic

Tingting Peng[1], Chun-Yu Ho[2], Patrick McCarthy[3], and Li Xu[4]

[1]Department of Economics, University at Albany, SUNY, tpeng2@albany.edu

[2]Department of Economics, University at Albany, SUNY, cho@albany.edu

[3]School of Economics, Georgia Institute of Technology, mccarthy@gatech.edu

[4]Antai College of Economics and Management, Shanghai Jiao Tong University, shirleyxu@sjtu.edu.cn

Abstract

We examine the competitive effects of regional airline exits in the U.S. from April 2019 through December 2020, leveraging the first wave of COVID-19 as a natural experiment. Using propensity score matching and difference-in-differences, we find consumers are worse off after exits, with a 16% decrease in flight availability and a 6% rise in fares. Longer-haul markets and those dominated by full-service carriers experience less impact. Exits also increase connecting flight prices by 2%. Incumbent airlines expand services and raise fares, while competing regional airlines and those with greater cash reserves seize market share, with less impact on on-time performance.

Keywords: Air Transportation, Exit, Market Structure, Competition, COVID-19

JEL Classification: L93, R40

1.0 Introduction

This paper analyzes the competitive effects of regional airline exits in the U.S. during the first year of COVID-19. Unique to this study is a focus on the regional airlines and how their exits affect incumbents' flight frequency, capacity, pricing, and quality provision. Regional air transport markets are an integral part of the domestic aviation market. Regional airlines play a pivotal role in connecting small communities to the air transportation network, significantly impacting one country's total accessibility and economy, providing more than one million jobs, generating $41 billion in local wages and tax revenues, and whose total economic impact exceeds $150 billion (Regional Airlines Association 2021, 2023). In 2020, 627 airports provided regional airline service, 439 of which provided only regional service. In contrast to major airlines that serve 34% of the domestic airports, regional airlines serve 94% (Regional Airlines Association 2021).

Similar to the major carriers, the COVID-19 pandemic and associated travel restrictions had a dramatic impact on regional airline service. Between 2019 and 2020, average daily departures decreased from 10,447 to 6,424, and enplaned passengers fell from 165.2 million to 73.3 million, average load factors, and average departures fell. Nonetheless, during the same period, as a proportion of total departures, regional airline departures increased from 40% to 42% which reflects market restructuring by the major carriers. More recently, between 2020 and 2024, United, Delta, and American Airlines collectively exited 62 markets and the low and ultra-low-cost carriers exited 52 markets (Regional Airlines Association 2024).

Although regional airlines have a cost advantage in operating small aircraft (Forbes and Lederman 2009), they are more vulnerable to bankruptcy (Budd et al. 2014). With the onset of the pandemic, the most vulnerable regional carriers ceased operations, starting with the bankruptcy announcement of Trans States Airlines in February 2020.[1] Consequently, many cities found themselves without regional airline services, prompting residents to resort to

[1] Trans States Airlines officially ceased operations in April 2020.

buses for transportation to hub airports. For instance, residents of Fort Collins now rely on bus services to reach Denver airport due to the absence of regional airline options, resulting in a longer travel time. Understanding how regional airline exits affect consumers in smaller communities is an important objective of this study.

In this paper, we exploit the exits of Trans State Airlines and Compass Airlines during the COVID-19 pandemic to identify and estimate the competitive effects of regional airline exits on flight frequency, capacity, pricing, and quality provision. Although our research focuses on the U.S. airline industry during the COVID-19 period, our approach and results can also be relevant and applied to other settings. First, due to the impact of COVID-19, global demand for air travel has sharply declined, causing many regional airlines to exit the market, not just in the United States but also in other markets. For example, SunExpress Germany owned by Lufthansa ceased operations in June 2020. Cathay Dragon owned by Cathay Pacific also ceased operations in October 2020. Also, their parent FSCs operate with a hub-and-spoke network at Frankfurt and Hong Kong. Therefore, our approach can also be used to analyze the European and Asian aviation markets, and the insights gained from our results are relevant for them.

Second, airline markets have been regularly hitting by public health shocks, such as the Severe Acute Respiratory Syndrome (SARS) in 2003, the Middle East respiratory syndrome (MERS) in 2012, and the Ebola epidemic in 2014. For example, Ferrell and Agarwal (2018) show that many countries banned flights during the Ebola epidemic, and commercial airlines were heavily impacted. Our study, which focuses on the U.S. airline industry during COVID-19, suggests that airlines with stronger financial ability can survive during a pandemic. Our findings provide insights into how airlines, especially regional carriers, might respond to future public health shocks.

The outline of the paper is as follows. We present the conceptual framework and relevant literature in Section 2. We introduce background and data in Section 3 and the empirical strategy in Section 4. Section 5 reports the results. Section 6 concludes.

2.0 Conceptual Framework and Literature Review

This section first discusses a conceptual framework that summarizes the causal relationships between regional airline exits, incumbent airline performances, and market outcomes. The section then reviews the literature and outlines our contributions to the existing body of research.

2.1 Conceptual Framework

There are multiple channels through which exits affect the price and quality of remaining airlines. First, exits reduce competition when they result in fewer airlines operating in a market. Since airlines employ price and/or quality to compete with each other, they may raise prices and compromise quality in response to reduced competition (Kim and Singal 1993; Prince and Simon 2017; Chen and Gayle 2019; Yimga 2020). This is the *market power channel*. Second, exits result in a loss of agglomeration of airlines in a market. Agglomeration benefits derive from labor pooling, i.e. several airlines operating in the same market that attracts a large skilled labor pool and a cluster of intermediate input suppliers (Duranton and Puga 2004). The loss of an airline may drive away some of the input resources in the market, which in turn raises input costs that generate incentives to increase prices and decrease quality (Ozturk et al. 2016). This is the *agglomeration channel*.

Third, exits may allow the remaining airlines to exploit scale economies to achieve cost savings. Previous studies find that U.S. airlines enjoy scale and scope economies. For example, larger airlines exploit scale economies from network size (Johnston and Ozment 2013) and scope economies by offering freight services (Hofer and Eroglu 2010). The cost savings can pass through to lower airfares (Hofer and Eroglu 2010; Johnston and Ozment 2013). Further, if airlines invest the realized cost savings in quality enhancement, the service quality of the incumbent airlines might improve. This is the *cost efficiency channel*.

The overall effect of exits on the price and quality of the incumbent airlines needs to be studied. A unique feature of regional airline exits relates to the markets they had served before ceasing operation. The regional markets serve smaller communities with lower populations and few operating airlines. Gillen and Hazledine (2015) report that regional airline markets resemble a market structure with a dominant airline with 90% market share, whereas the market structure of traditional/longer-haul markets resembles a symmetric duopoly. Regional airline exits have a substantial impact on the market structure. Thus, exits are likely to transform the regional market into a monopoly market structure, which substantially enhances the market power of incumbent airlines which outweighs the potential cost savings. Further, regional airlines are relatively small. These exits may have limited impacts on the agglomeration economies in the markets they serve. On the other hand, because entry by competitors is relatively easy, market power in regional airline markets is limited. Morrison and Winston (1987), for example, empirically demonstrate that domestic airline markets are imperfectly contestable, that is, actual relative to potential competitors have a larger impact on consumer welfare. Consistent with Gillen and Hazledine (2015), Morrison and Winston's results indicate that the net effect of an exiting airline, all else constant, from a contestable market enhances market power and reduces consumer welfare, but not to the same extent as exiting a non-contestable market.

Turning to the impacts on flight frequency and capacity, regional airline exits are a positive shock to the incumbent airlines. Incumbents expand their services to capture the consumers who would have taken the exiting airlines if no exit had occurred. However, the exploitation of market power through price increases may ultimately lead to decreased flight frequency and capacity at the market level.

The above analysis leads to our main hypotheses at the market level and market-airline level as follows:

H1: After the regional airlines exit, the market-level flight frequency and capacity decreases. Market-level average prices increase and service quality improves.

H2: After the regional airlines exit, the incumbent airlines increase their flight frequencies *and capacities. The incumbent airlines also raise their prices and improve their service quality.*

2.2 Literature Review

This paper contributes to three strands of literature. This study extends a growing empirical literature that examines the competitive effects of airline exits in the U.S.[2] Daraban and Fournier (2008) examines the exits of LCCs during 1993-2006 and find that the average market fare increases after LCC exits. Bachwich and Wittman (2017) examine the exits of LCCs during 2010-2015 and find that the incumbent airlines increased prices by about 10% after the exits. In a closer relationship to this work, Hüschelrath and Müller (2013) examine the exits of five airlines during 1995-2010 and find that the incumbent airlines increased prices by 12% and decreased passenger service by 15% after the exits.

Our work also examines the effects of airline exits but extends the previous work in several aspects. First, airline exits can be a response to incumbent strategies, such as price wars and capacity expansions, which potentially exaggerate the price increase and frequency decrease after airline exits. In contrast, we analyze the airline exits during the COVID-19 pandemic, which serves as an exogenous shock to airline exits and provides more credible inferences on the competitive effects of airline exit. Endogeneity concerns arise when studying the effects of exits in other periods, as these exits could be influenced by airlines' financial conditions or market shares. However, we address this concern by leveraging the COVID-19 pandemic. This period serves as an exogenous shock to airline exits, reducing reverse causality concerns and allowing for more accurate identification of the causal effects of airline exits. Second,

[2]There is also literature exploring the competitive effects of airline exits on European markets. Bilotkach et al. (2014) examine the exit of MALEV in 2012 and find mixed impacts on consumers because the replacing LCC, WizzAir, charges a lower price than MALEV but services with a lower flight frequency. Fageda et al. (2017) examine the exit of Spanair in 2011 and suggest that consumers benefit from it because the LCC entrants lower market prices and keep flight frequency about the same. Grosche et al. (2020) examine the exit of Air Berlin in 2017 and find that most markets become more concentrated. Eugenio-Martin and Parez-Granja (2022) examine the exits of charter airlines Monarch and Thomas Cook and find that the incumbent airlines did not pick up the lost passengers between the U.K. and the Canary Islands after the exit of Monarch but picked up a part of the lost passengers after the exit of Thomas Cook.

we investigate the redistribution of market shares from the exiting airlines to the incumbent airlines and explore the determinants, such as the similarity between exiting and incumbent airlines, driving the redistribution. Third, we not only focus on prices and passengers carried but also examine the competitive effect on service quality.

This study also contributes to the literature that examines the implications of airline competition during the COVID-19 pandemic. Abate et al. (2020) argue that governments across the world attempt to maintain air transport connectivity to protect economic activities. Larger airlines would benefit from supporting policies, while smaller airlines might exit the market. Indeed, there is country-level evidence showing large airlines benefit during the COVID-19 pandemic. Albers and Rundshagen (2020) suggest the bailout of Alitalia during the COVID-19 pandemic may distort competition and Ng et al. (2022) document the top two Japanese airlines secured a higher market share after the COVID-19 pandemic. In a closer relationship to our work, Mumbower (2022) finds that exit probability increases after the COVID-19 pandemic. Such increase is larger for LCCs than FSCs and is larger for airports with one operating airline than airports with multiple operating airlines. Although the previous works indicate that travelers face a more concentrated market after the COVID-19 pandemic, there is no discussion on how such a change in market structure affects consumers. Our work extends the literature by examining the competitive effects on flight frequency, fares and service quality of airline exits in the U.S. during the COVID-19 pandemic. Our results inform on how such airline exits adversely affect consumers.

This study further adds to the recent literature on the growing concentration in various industries in the U.S. that would potentially harm consumers (Council of Economic Advisers, 2016; Autor et al. 2020). The airline industry is not an exception to this increasing trend of concentration, especially after the recent merger wave including Delta-Northwest in 2008, United-Continental in 2010, Southwest-AirTran in 2011, and American-US Airways in 2014. In fact, the market concentration in the U.S. airline industry had surpassed that of the European airline industry despite their concentrations being similar in the 1990s (Gutiérrez and Philippon 2018). In contrast to examining the consolidation of the airline industry at the aggregate level, our work provides novel evidence on how small communities experience the adverse impacts of industry consolidation of the airline industry (Regional Airline Association 2019).

3.0 Background and Data

3.1 Regional Airline Model

A regional airline is either wholly owned by FSCs with which it partners or independently owned and contracts with one or more FSCs. The independently-owned regional model focuses on under-served markets, often providing essential connectivity for remote areas. Conversely, the contractor usually serves hub-and-spoke networks, providing capacity for FSCs through business arrangements such as code-share arrangements which include revenue-sharing agreements and capacity purchase agreements (CPAs). Revenue-sharing agreements focus on revenue sharing based on ticket sales between FSCs and regional airlines. In a CPA, FSCs outsource a portion of their capacity to regional airlines.

Table 1 shows that both Trans State and Compass Airlines are contractors and Ravn Air Group is independently owned. Trans State Airlines operates for American Airlines and United Airlines. Compass Airlines operates for American Airlines and Delta Airlines (Reynolds-Feighan 2018).

3.2 Exits during the COVID-19 Pandemic

In response to challenges caused by the COVID-19 pandemic, such as travel restrictions, reduced demand for flights, and concerns about passenger safety, several airlines took various measures, including route reductions, network reconfigurations, furloughs, and retirements of older aircraft. Some airlines also exited certain markets, either ceasing operations tem-

Table 1: Bankruptcy of U.S. regional airlines in 2020

Airline	IATA code	Date	Bankruptcy Type	Business Model
Trans State Airlines	AX	2020-4-1	Chapter 7	Contractor
Compass Airlines	CP	2020-4-5	Chapter 7	Contractor
Ravn Air Group (RavnAir Alaska/PenAir)	7H/KS	2020-4-5	Chapter 11	Independent

Source: We obtain the information on the U.S. airlines exit from Airlines for America (last access on September 27, 2023).

Note: We report the name of the exit airlines, the IATA code of the exit airlines, the exit date, and the type of bankruptcy. In Chapter 7, the airline ceases operations, and a trustee sells all of its assets and then distributes the proceeds to its creditors. Any residual amount is returned to the owners of the company. As we discussed in the previous sub-section, the two exit events terminate the revenue-sharing agreements and the CPAs between those two regional airlines and their cooperating FSCs. In Chapter 11, in most instances, the debtor remains in control of its business operations as a debtor in possession and is subject to the oversight and jurisdiction of the court. Miami Air International filed Chapter 11 bankruptcy on March 24 and Chapter 7 bankruptcy on May 8, but the OAG database does not include flight schedule information on Miami Air International, so we exclude this airline exit in our analysis.

porarily or exiting the market permanently. Table 1 documents the list of U.S. airlines filing for bankruptcy in 2020. The exiting airlines include Trans State Airlines, Compass Airlines, and Ravn Air Group, which are all regional airlines that ranked among the top 50 in the U.S. in 2018.[3] Trans State Airlines was the first to cease operations and declared bankruptcy on April 1, 2020. Subsequently, Compass Airlines exited, declaring bankruptcy and suspending operations on April 5, 2020. Although Ravn Air Group did not opt for a complete market exit, it opted to file for Chapter 11 bankruptcy to undertake debt restructuring.

In this paper, we focus on Chapter 7 bankruptcy.[4] The exit events we examine include those of Trans State Airlines and Compass Airlines. Coincidently, the two exit events we examine involve regional airlines with contractor business models. We do not examine the airlines that underwent Chapter 11 bankruptcy, since they continue to operate and restructure under the supervision of a court-appointed trustee, to emerge from bankruptcy as a viable business.

[3] See Regional Airline Association (RAA) at Page 28.

[4] Chapter 7 bankruptcy involves selling off an airline's assets to pay debts. It's like closing down the airline and liquidating everything. On the other hand, chapter 11 bankruptcy allows the airline to keep operating while it reorganizes and makes a plan to repay debts. It's about restructuring to stay in business.

3.3 Data and Variables

3.3.1 Market Definition and Selection

We define a market as a non-directional origin-destination airport pair.[5] Our final data is a unique airline-market-year-quarter combination. To analyze the competitive effects of regional airline exits on the respective markets, our research design applies four selection criteria to generate the estimation sample. First, following Mumbower (2022), we exclude the markets with destinations in Alaska, Hawaii, and U.S. territories as they were subject to government-imposed flight suspensions, inbound quarantine, and border closings during the COVID-19 pandemic. Second, we exclude markets only with the exiting airlines, Trans State or Compass Airlines, providing services because there are no incumbent airlines. Third, we exclude markets where the exiting airlines are inactive for at least one quarter before the exit. We also require that the markets have at least one incumbent airline per quarter. Fourth, we exclude flights with one-stop or more.

3.3.2 Treated Markets

Our treated markets include the origin-destination pairs that Trans State Airlines and Compass Airlines operated before 2020 Q2. There are 96 treated markets in our sample. All treated markets involve 5 hub airports, namely Chicago, Denver, Los Angeles, Seattle, and Las Vegas, which are shown in panel (a) of Figure 1. This sample of the treated market is consistent with the nature of our exiting regional airlines. They serve to connect smaller communities to the hub airports of American Airlines (Chicago and Los Angeles), Delta Airlines (Seattle), and United Airlines (Chicago, Denver and Los Angeles). Among 96 treated markets, 34 markets connect to Chicago, 33 markets connect to Denver, 13 markets connect to Los Angeles, 11 markets connect to Seattle, and 2 markets connect to Las Vegas.[6] Ac-

[5]For example, a flight that travels from Lehigh (ABE) to Chicago (ORD) is in the same market as another flight that travels from ORD to ABE.

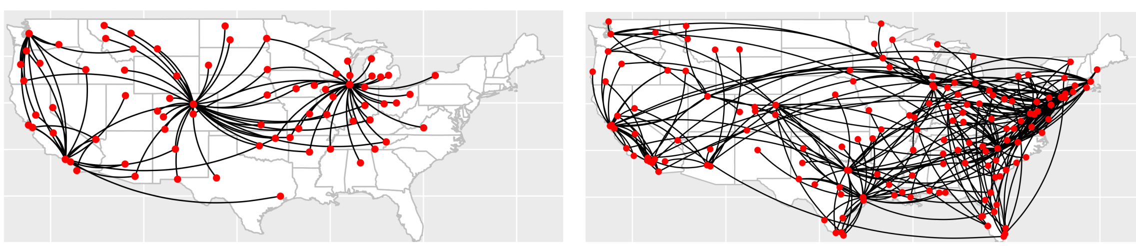
[6]The remaining 3 markets connect among these 5 hubs.

cording to the population information, Table 2 reports that except Las Vegas, the population in cities hosting the spoke airports at about 10% to 40% of that in cities hosting the hub airports.[7] This suggests that our markets mainly involve connecting smaller communities to hub airports.

Table 2: Hub Airport in Treated Markets

Hub Airport	Number of Markets	Hub Population	Spoke Population
Chicago city, IL	34	2,746,352	259,521
Denver city, CO	33	715,538	241,882
Los Angeles city, CA	13	3,898,767	748,967
Seattle city, WA	11	737,018	314,419
Las Vegas city, NV	2	644,866	1,200,091

Note: The table lists the hub airports in the treated markets, the number of treated markets, the population of the city where the hub airport is located, and the average market population. We obtained the city population data from the United States Census Bureau in 2020. We exclude the markets where both origin and destination are the listed 5 hub airports.



(a) Treated Group

(b) Control Group

Figure 1: Treated and Control Group

Notes: Red dots show the origin airports and destination airports. A black curve represents a non-directional origin-destination pair (a market). Panel (a) and (b) display the markets in the treated and control groups in our baseline model, respectively.

3.3.3 Flight Frequency and Seating Capacity

OAG Analyser provides data on flight frequency and seating capacity, which contains airline-level information on domestic daily flight schedules in the U.S. This database includes details

[7]Las Vegas connects with San Diego and San Jose which have a larger population.

such as the names of operating airlines, the departure and arrival airports, the duration of flights, the number of stops, the number of flights, and the seating capacity for the period between 2019 Q2 and 2020 Q4.[8]

We construct the market-level flight frequency by aggregating the number of non-stop flights of all airlines in each market per quarter, and the market-level capacity by multiplying the number of non-stop flights and the number of seats on each flight.[9] Although the capacity can not reflect the actual loading, it can indicate how airline exits impact capacity at the minimum level.

3.3.4 Fare and On-time Performance

The ticket fare data comes from the Airline Origin and Destination Survey (DB1B Market). This dataset contains a 10% quarterly sample of all tickets collected by U.S. airlines. It includes the origin airport code, destination airport code, operating carrier, number of passengers, market fare, and miles flown. Following Das (2019), we exclude the tickets with fares that are unreasonably high or low, in particular, we drop tickets with fares below \$50 or above \$2000.[10] The airline-market fare variable is computed by averaging the fares across tickets for each airline in each market and each quarter. The market-level average fare is computed by averaging the fares across tickets for all airlines in each market and each quarter.

BTS provides on-time performance data. This dataset includes information on scheduled and actual departure and arrival times, which enables us to track delays in both departure and arrival for each carrier in each airport in each month. To measure on-time performance, we use the minutes of departure delays, which is the difference in minutes between a scheduled

[8] Throughout the remainder of this paper, we will refer to seating capacity simply as "capacity" for the sake of convenience.

[9] Our study does not focus on aircraft cost efficiency, so we do not study the effect on available seat miles (ASM) as many previous literature such as Greer (2008), Adler et al.(2014), and Li et al.(2015).

[10] About 8% of the sample has a market fare below \$50, while less than 1% has a fare above \$2000. Without this exclusion, the mean value of market fare is \$191.4, which is smaller than the mean value of market fare in our sample data \$206.5.

and actual departure.[11] This measure is commonly used in previous studies (Mayer and Sinai 2003; Lange 2019). In particular, to compute airline-market level on-time performance, we take the average departure delay for each airline operating in each market quarterly. We compute the market-level average departure delays by averaging the departure delay across airlines in each market quarterly.

We combine the three datasets— flight data, ticket fare data, and on-time performance data —by matching them using airlines, markets, years and quarters.

3.3.5 Market Characteristics

We employ two market characteristics in our empirical analysis. First, we consider the distance between origin and destination airports. We obtain the distance variable from the BTS on-time performance dataset. We construct a distance dummy variable $Distance$ which takes 1 if the distance between the origin and destination airports is longer than 350 miles, and 0 otherwise.

Second, we consider the market share of exiting airlines, Trans State and Compass Airlines. We construct the market share $mktshare$ using the average share of frequency of Trans State and Compass Airlines in the treated markets over the four quarters before the exit.[12] For the untreated markets, $mktshare$ takes the value 0 as the exiting airlines, Trans State and Compass Airlines, did not operate in these untreated markets.

3.3.6 Airline Characteristics

We collect the LCC identifier from the International Civil Aviation Organization (ICAO) which provides information on LCCs all over the world based on ICAO definition. In the data, we observe countries, airline names, ICAO code, IATA code, start of operations, and whether they ceased operations. We collect the regional airline identifier from Regional

[11] A departure delay is 0 for early departures.

[12] We first calculate the total market shares of Trans State and Compass Airlines from 2019 Q2 to 2020 Q1 and then take the average of their total market shares.

Airline Association.

BTS also provides airline financial data, including quarterly financial data, such as cash, which comes from Air Carrier Financial Reports. The report contains operating balance sheet statements for large certificated U.S. air carriers with annual operating revenues of $20 million or more. We obtain the airline financial data in the period 2019 Q2 and merge it with our main dataset using the airlines' IATA code as an identifier.

3.4 Descriptive Statistics

Our data period is from 2019 Q2 to 2020 Q4. Table 3 presents the descriptive statistics of the main variables in our empirical analysis. At the market-quarter level, on average, the flight frequency is 1,026 flights per quarter, and capacity is 104,512 seats per quarter. In the treated group, the average frequency (capacity) is 1,273 (122,187), compared to 943.4 (98,600) in the control group. At the airline-market level, the average frequency and capacity are 358 flights and 37,433 seats respectively. In other words, in each market, there are about three airlines. Our sample airlines typically employ narrow-bodied jets to carry about 100 passengers per flight. For instance, our sample airlines frequently used the Airbus A220-100, which is equipped with 109 seats. Moreover, the market-level average fare charged in a quarter is $206.5 and average departure delay in a quarter is 10.82 minutes. In specific, the market average fare in the treated group is $201.2 compared to $208.3 in the control group.[13] And the market average departure delay is 10.78 minutes in the treated group, compared to 10.83 minutes in the control group.

Furthermore, the mean value of *Distance* is 0.637, which indicates that on average, 63.7% markets that are further than 350 miles, about the distance between Seattle and Medford, Oregon, and the distance between Las Vegas and Stockton, California. The average market share of Trans State and Compass Airlines before exit is 5.1%.

31.4% and 61.6% of our observations come from LCCs and regional airlines, respectively.

[13] The market fares are measured in nominal values. We report the results of market fares in real terms in the robustness checks in Table C.4.

In the treated group, 24.8% airlines are LCCs and 68.7% airlines are regional airlines, compared to 34.7% LCCs and 58% regional airlines in the control group. Moreover, on average, each incumbent airline holds approximately $528,444 in cash. Treated group has $451,535 in cash on average while control group has $566,975 in cash on average.

Table 3: Summary Statistics

	Full Sample		Treated Group	Control Group	
				Before Matching	After Matching
Variable	Mean	SD	Mean	Mean	Mean
Market Level Variables					
Frequency	1,026	963.6	1,273	648.4	943.4
Capacity	104,512	133,259	122,187	84,819	98,600
Fare (nominal dollars)	206.5	64.69	201.2	197.6	208.3
Delay (minutes)	10.82	7.458	10.78	9.850	10.83
Number of Observations	2,625	2,625	658	12,544	1,967
Airline-Market Level Variables					
frequency	358.3	384.7	320.0	329.9	376.5
capacity (passengers)	37,433	53,620	32,345	43,493	39,857
fare (nominal dollars)	200.5	67.52	193.2	197.4	203.9
delay (minutes)	11.92	13.57	11.76	10.59	12.00
Number of Observations	6,977	6,977	2,251	24,088	4,726
Market characteristics					
Distance	0.637	0.481	0.617	0.830	0.644
mktshare	0.051	0.118	0.202	0	0
Number of Observations	2,625	2,625	658	12,544	1,967
Airline characteristics					
LCC	0.314	0.464	0.248	0.470	0.347
Regional	0.616	0.486	0.687	0.364	0.580
Cash (nominal dollars)	528,444	925,565	451,535	565,370	566,975
Number of Observations	6,977	6,977	2,245	23,071	4,481

Note: For variables we use in regressions, we report the mean and the standard deviations for the full sample, as well as the mean value in the treated group and control group before and after matching. The variables *frequency*, *capacity*, *fare*, and *delay* are quarterly. The market characteristics, *Distance*, is a dummy variable. For the airline characteristics variables, both *LCC* and *Regional* are dummy variables. Regarding *cash*, we use the data from the second quarter of 2019.

4.0 Empirical Strategy: Difference-in-Differences

To estimate the causal effect of regional airlines' exit on market-level outcomes, we first conduct propensity score matching (PSM) to select control groups that are comparable to our treated group, and the results are presented in Appendix B.[14] Then, we employ the following Difference-in-Differences (DiD) model:

$$Outcome_{mt} = \beta post_t \times treat_m + \zeta_m + \zeta_t + e_{mt} \tag{1}$$

where $Outcome_{mt}$ represents frequency, capacity, fare, and delay in market m during time t.[15] The treatment variable $treat_m = 1$ if the market is in the treated group and 0 otherwise, and $post_t = 1$ if the time is 2020 Q2 and after and 0 otherwise. We also include market FEs, ζ_m, to control for unobserved market heterogeneity, and time FEs, ζ_t, to control for aggregate trends and temporal variations in those market outcomes, such as quarterly COVID case rates. e_{mt} is the error term. We cluster our standard errors at the market level to allow for serial correlation.

This model enables us to compare the changes in outcomes between the treated group and the control group, both of which are impacted by COVID-19, thereby alleviating concerns that our results might be driven by COVID-19 rather than the exits of the two regional airlines. The coefficient β is our coefficient of interest. According to Hypothesis 1, we expect that β is negative and significant for frequency, capacity, and average delay. For the average fares, we expect β_1 to be positive and significant.

To test for pre-trends and to understand the timing of exit effects, we estimate the event study version of equation 1 as:

[14] The selected markets in the control group are shown in panel (b) of Figure 1.

[15] t represents year-quarter. In our sample data, we have 3 quarters in 2019 and 4 quarters in 2020. So t is from 1 to 7.

$$Outcome_{m\tau} = \sum_{\tau=-4}^{2} \beta_\tau post_\tau \times treat_m + \zeta_m + \zeta_\tau + e_{m\tau} \qquad (2)$$

We designate the event period as period 0, which is the second quarter of 2020. The vector $post_\tau$ is composed of dummies for each quarter before and after the exit, ranging from 4 quarters before to 2 quarters after. We normalize the values for the preceding period leading up to the event to 0 (period -1). The other items are defined the same as above. If the coefficients are all insignificant in the pre-exit periods, then we can conclude that there is no pre-trend.[16]

5.0 Results

5.1 Market-level Results

In this section, we report the competitive effects of regional airline exits at the market level. We first report our baseline results at the market level in panel A of Table 4 and consider the dynamic effects of regional airline exits in Figure 2. We then conduct several robustness checks and present the results in Table C.4. Finally, we explore market heterogeneity, such as market distance and market share of the exiting regional airlines, and spillover effects on market fares. The results are reported in panels B and C of Table 4, respectively.

5.1.1 Baseline Results

Column (1) in Panel A of Table 4 reports that there is a 162 flight reduction (or 16% of the mean) in the markets experiencing the regional airlines' exit, compared to the control group. It highlights a significant shrinkage in flight availability after the exits of regional airlines. In other words, the exit of regional airlines does not trigger immediate supplies from

[16] Although our test fails to reject the null that there is no pre-trend, recent research cautions that tests of linear violations of parallel pre-trends have low power, which could bias treatment effect estimates. For this and related issues associated with treatment effect biases, see, for example, Roth (2022), Rambachan et al. (2023), and Borusyak et al. (2024).

other airlines to fill the void. Column (2) replaces the outcome variable with capacity. The coefficient β is negative, which is consistent with the results from flight frequency. However, the coefficient is insignificant.

Column (3) reports the results of market-level average fare. We find an approximate average fare increase of 13 dollars (or 6% of the mean) in the markets experiencing regional airline exits, compared to the control group. Regarding service quality, column (4) reports that the market-level average departure delay decreases by 1 minute (or 8% of the mean) in markets experiencing the regional airlines' exit, compared to the control markets. We conduct several robustness checks, including alternative sample selection criteria, control groups, and outcome measurements, and find that our baseline results are robust.[17]

In summary, our findings emphasize the multifaceted consequences of the regional airlines' exits. While leading to a reduced availability of flight services, the exits also lead to higher airfares. Nonetheless, service quality, measured by departure delay, improves, which may relate to a less crowded flight schedule after the exit.

5.1.2 Dynamic Effects

Figure 2 plots the dynamic effects of regional airline exits on the market-level frequency, capacity, average fare, and average delay. Encouragingly, there is no significant pre-trend in all outcome variables before the regional airlines exit.

Panel (a) depicts the coefficients of frequency and suggests that one quarter after the regional airlines exit the market, the number of flights in the treated markets decreases by 200. After that, the number of flights recovers to 110 flights below the level observed one quarter before the exits, but insignificantly different from 0, and stabilizes at that level. Panel (b) displays the coefficients of capacity and reveals a consistent pattern to panel (a) but the coefficients are insignificant.

Panel (c) depicts the coefficients of market-level average fare, which exhibit a significant

[17] The details and results of the robustness checks are presented in Appendix C.

Table 4: Market-Level Models

	(1) Frequency	(2) Capacity	(3) Fare	(4) Delay
Panel A: Baseline Results				
$post{\times}treat$	−162.007*	−10,500	12.512***	−0.915*
	(89.535)	(13,643.210)	(4.397)	(0.492)
R^2	0.850	0.849	0.807	0.702
N	2,625	2,625	2,625	2,625
Mean of Dependent Variables	1,026	104,512	206.5	10.82
Panel B: Market Heterogeneity				
$post{\times}treat$	−616.912***	−56,600*	13.943	−2.467***
	(183.063)	(32755.505)	(8.929)	(0.711)
$post{\times}treat \times Distance$	327.963*	23,069.452	−11.751	2.209***
	(169.596)	(28006.143)	(8.131)	(0.746)
$post{\times}treat \times mktshare$	1,315.212***	166,000***	30.307	0.983
	(360.721)	(54,441.058)	(22.368)	(3.038)
R^2	0.855	0.852	0.808	0.704
N	2,625	2,625	2,625	2,625
Mean of Dependent Variables	1,026	104,512	206.5	10.82
Panel C: Spillover Effects				
$post{\times}treat$			5.080***	
			(2.436)	
R^2			0.854	
N			6,139	
Mean of Dependent Variables			243.0	
Quarter FEs	Yes	Yes	Yes	Yes
Market FEs	Yes	Yes	Yes	Yes

Notes: The outcome variables are flight frequency in Column 1, capacity in Column 2, average fare in Column 3, and average delay in Column 4. Panel A reports the baseline results of Equation (3). Panel B interacts the $post \times treat$ variable with two market characteristics, $Distance$ and $mktshare$. These two terms do not enter the regression individually because they are absorbed by the market FEs. We demean $mktshare$. We report the mean values of outcome variables at the market level in the last row. We include market and quarter-fixed effects in all panels. The market fixed effects in panel C represent origin-transfer-destination fixed effects. The results in panel B are discussed in detail later in Section 5.1.3. The standard errors are clustered at the market level. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.

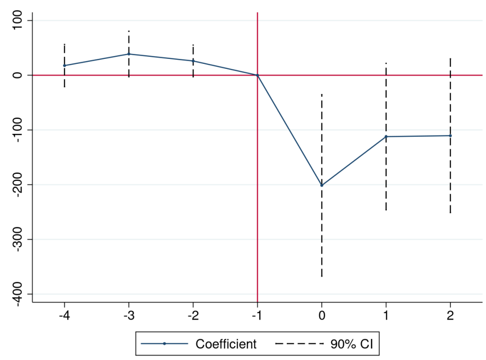
increase after the regional airlines' exits, stabilizing at 12 dollars above that in one quarter before the exits. Panel (d) presents the coefficients of market-level average delay, which shows a reduction of about 1 minute in delays following the exits of regional airlines, with a subsequent return to the level in one quarter before the exits.

Our findings from event studies are consistent with those from DiD models. Additionally, flight frequency, average fare, and average delay respond swiftly in the quarter of exit. The findings also suggest that the regional airline exits are the driving force behind our DiD results. The responses of flight frequency and average fare are persistent into the second quarter after the exit. These outcomes are consistent with reduced competition after the exit. Incumbent airlines capitalize on this by elevating their fares. Nonetheless, the positive impact on service quality is short-lived. Overall, our results suggest that consumers are worse off after the regional airlines' exit.

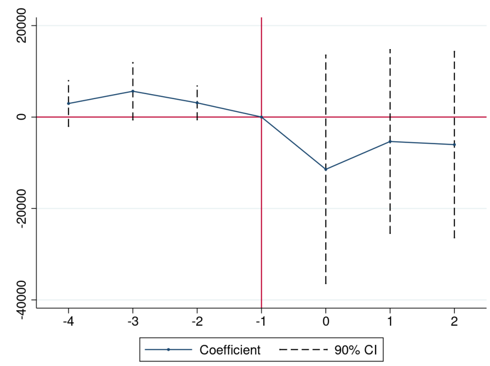
5.1.3 Market Heterogeneity

Here we consider two market heterogeneities, namely the distance between the origin and destination of a market as well as the average market share of the exiting regional airlines. On one hand, the market distance captures the availability of outside options, i.e. driving, bus, and train. A more distant market reduces the attractiveness of outside options, which enhances the market power of incumbent airlines after the exit. On the other hand, since our sample exiting airlines are contractors for American Airlines, Delta Airlines, and United Airlines, markets with a larger market share of exiting regional airlines relate to a stronger dominance of the largest three FSCs before the exits. Those FSCs can be more aggressive in protecting their markets if they had a larger market share through the exiting regional airlines before the exits. As a result, they may expand their service more after the exits and maintain their dominance in the market.

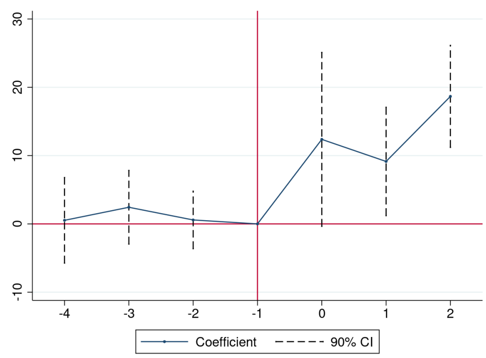
We present our results of market heterogeneity in panel B of Table 4. In particular, we interact the indicators $post \times treat$ with $Distance$ and with $mktshare$. The coefficient on



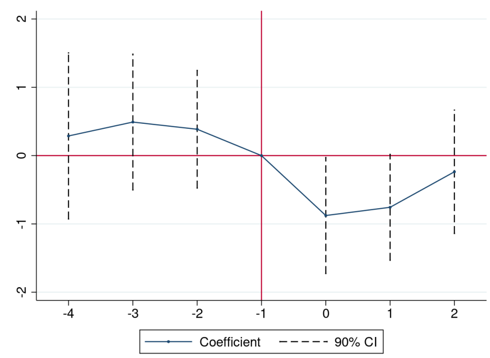
(a) Frequency



(b) Capacity



(c) Fare



(d) Delay

Figure 2: The Dynamic Effect of Airline Exit at the Market Level

Notes: Panels (a), (b), (c), and (d) plot the dynamic effects of regional airline exits on the flight frequency, capacity, average fare, and average delay, respectively. Each point (and 90% CI) represents estimates from a regression for each dependent variable. Market-specific and quarter-specific FEs are included. We cluster the standard errors at the market level.

the interaction term with *Distance* is positive and significant in columns (1) and (4) but insignificant in columns (2) and (3). Compared to closer markets, the negative effect of regional airlines' exits on flight frequency is smaller in distant markets, while the negative effect on on-time performance is larger in distant markets. These results indicate that the competitive effect is larger in closer markets not only among airlines but also between air and other transportation. Nonetheless, the exit in those distant markets result in a larger deterioration on on-time performance.

Further, the coefficients on the interaction term with *mktshare* are positive and significant in Columns (1) and (2), which indicate that there is a larger increase in the market-level frequency and capacity in the markets with a higher share of exiting regional airlines. In Table A.3, we look into the 6 markets in which the exiting airlines have more than 50% of market share before their exits. Trans States Airlines is present in 5 out of those 6 markets, while the remaining one has Compass Airlines. In those markets, there is another contractor airline, Skywest Airlines (OO), which is also a contractor for all three FSCs. Our results suggest that FSCs utilize the other contractor to preempt the market share of the exiting airlines.

5.1.4 Fare Effects on Connecting Flights

Our sample markets are part of hub-and-spoke networks. A passenger may transfer at the hub, but their final destinations are not the hub itself. In other words, the exits of regional airlines impact not only the markets between the sample spoke and the affected hub but also the markets between the sample spoke and another airport through the affected hub. As illustrated in Figure 3, passengers living in spoke city O transfer at hub H, where $O-H$ is our treated market. However, their final destinations could be $D1, D2, D3...D10$. If an airline exits the $O-H$ market, passengers whose destinations are $D1, D2, D3...D10$ can also be affected by these increased prices. However, our baseline results only indicate that the prices in the $O-H$ market increase due to the exit of regional airlines, with no evidence of price changes between O and $D1, D2, D3...D10$. In this section, we examine the spillover effects of regional airline exit on the market fare from a network perspective.[18] Specifically, we analyze these effects using the following specification:

$$Fare_{mdt} = \gamma post_t \times treat_m + \theta_{md} + \theta_t + \epsilon_{mdt} \tag{3}$$

where $Fare_{mdt}$ denotes the average fare between market m and destination d in time t.[19]

[18]We do not examine the spillover effects on market frequency, capacity, and departure delay because they are the same as the baseline results.

[19]We only consider one-stop fares. Itineraries with two or more stops are not examined here.

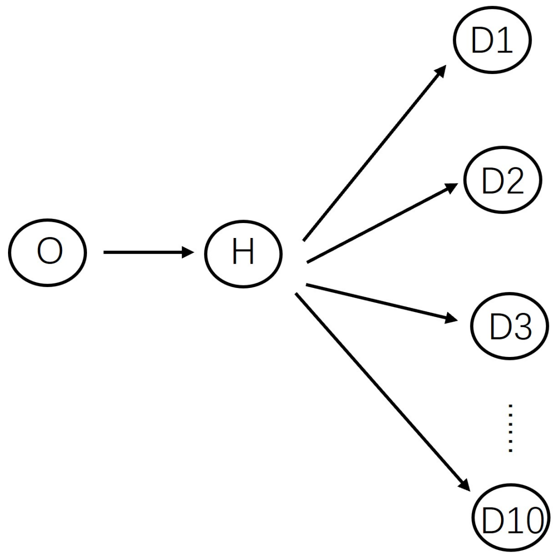


Figure 3: Toy Model of an Airline Network

To examine the spillover effects on markets connected to our five hubs, we select destinations d based on the top 10 destinations ranked by the number of non-stop flights connected to each hub. θ_{md} and θ_t are treated market-destination fixed effects and time-fixed effects, respectively. We cluster our standard errors at the market-destination level.

The result is presented in panel C of Table 4. We find that there is positive and significant effects of regional airline exits on prices of the connecting flights from the sample spokes to another airport through the affected hubs. Specifically, when a market experiences a regional airline exit, there is an increase of 5 dollars (or 2% of the mean) in those connecting flights.

5.2 Airline-Market Level Results

In this section, we study the competitive effects of regional airlines' exits at the airline-market level. Table 5 reports our results. In particular, we estimate the following DiD model:

$$Outcome_{imt} = \alpha post_t \times treat_m + \zeta_{im} + \zeta_t + e_{imt} \tag{4}$$

where $Outcome_{imt}$ represents frequency, capacity, fare, and delay of airlines i in market m in quarter t. We also include airline-market FEs, ζ_{im}, to control unobserved airline-market heterogeneity and quarter FEs, ζ_t, to control aggregate trends in the airline-market outcomes. e_{imt} is the error term. We cluster our standard errors at the airline-market level to allow for serial correlation. According to Hypothesis 2, we expect that α is positive and significant for frequency, capacity, and fare, while α is negative and significant for delay.

5.2.1 Baseline Results

Table 5 first shows our baseline results at the airline-market level in panel A. Columns (1) and (2) in panel A indicate that incumbent airlines expanded their flight operations in markets affected by the exits of regional airlines, showing an increase of approximately 105 flights (29% of the mean) and 9,901 capacity (26% of the mean). Columns (3) and (4) report that incumbent airlines increase their prices by 16 dollars (8% of the mean) in markets with the regional airlines exit relative to airlines in the control group, but there is no significant effect on departure delay.

We combine these findings with the results outlined in Section 5.1 and suggest that the incumbent airlines exhibit a preemptive stance in the markets experiencing regional airlines' exits. They augment their flight supplies to seize the market share previously held by the exiting airlines. Nonetheless, the increased supply from incumbent airlines does not completely offset the loss of service due to the exits. As a result, the more concentrated market structure results in a significantly higher fare, and a weak improvement in service quality if any.

5.2.2 Airline Heterogeneity

In this section, we examine the heterogeneous effects of regional airlines' exits on incumbent airlines' frequency, capacity, pricing, and quality provision. Specifically, we consider if the airline is a FSC, a LCC, and/or a regional airline.[20] Relative to LCCs and FSCs, a regional airline is a closer competitor of the exiting regional airlines because they offer more similar

[20]Sancho-Esper and Mas-Ruiz (2016) find that incumbents respond differently when facing various types of LCC entries. Similarly, we examine how incumbents respond differently in the face of exits.

Table 5: Airline-Market Level Models

	(1) Frequency	(2) Capacity	(3) Fare	(4) Delay
		Panel A		
post×treat	104.801***	9,901.462***	15.709***	−0.822
	(24.001)	(3,144.405)	(2.950)	(0.785)
R^2	0.795	0.837	0.796	0.459
N	6,977	6,977	6,977	6,977
		Panel B		
post×treat	−212.760***	−37,500***	12.056**	−1.314
	(52.281)	(8,228.473)	(5.696)	(1.666)
post×treat × Regional	391.524***	61,132.309***	−2.775	−0.498
	(53.433)	(7,687.691)	(6.239)	(1.163)
post×treat × LCC	190.308***	27,352.798***	14.670***	1.247
	(45.152)	(7,162.995)	(5.626)	(0.898)
post×*treat × Cash*	16.903***	1,100.083**	2.070**	0.584
	(5.545)	(461.036)	(0.825)	(0.362)
R^2	0.804	0.850	0.802	0.453
N	6,726	6,726	6,726	6,726
Airline-Market FEs	Yes	Yes	Yes	Yes
Quarter FEs	Yes	Yes	Yes	Yes
Mean of Dependent Variables	358.3	37,433	200.5	11.92

Note: In panel A, we report the baseline results at the carrier-market-year-quarter level. In panel B, we interact the *post × treat* variable with airlines' characteristics, *Regional*, *LCC*, and *Cash*. These three terms do not enter the regression individually because they are absorbed by the airline-market FEs. We take the log of cash and demean the log of cash. We report the mean values of frequency, capacity, fare, and delay at the airline-market level in the last row. We include airline-market and quarter-fixed effects in both panels A and B. We cluster the standard error at the airline market level. *** p<0.01, ** p<0.05, * p<0.1.

products and services. Further, we consider an airline's cash reserves. Financial resources are an important determinant for airlines surviving the COVID-19 pandemic (Standard & Poor Global Market Intelligence 2020). Airlines with more cash are more capable to cover operational expenses, invest in growth opportunities, and navigate unforeseen challenges. Those airlines are expected to have an advantage in expanding their services in the markets with regional airline exits.

Panel B reports the results of airline heterogeneity. The coefficients on the interaction term with *Regional* are positive and significant in columns (1) and (2), which also more than offset the negative coefficients of $post \times treat$. Incumbent regional airlines increase their frequency by 179 (50% of the mean) and increase their capacity by 23,632 (63% of the mean). The coefficient on the interaction term with *LCC* is positive and significant in columns (1) and (2), but they do not offset the negative coefficients of $post \times treat$. After the exits, the incumbent regional airlines increase their flight supplies to acquire passengers from the exiting regional airlines, while incumbent LCCs and FSCs are not keen to do so. At the same time, the incumbent regional airlines keep their fares closer to the pre-exit level to absorb more passengers, while incumbent LCCs and FSCs raise their fares. There are no significant results, however, on on-time performance.

Turning to the airlines with more cash reserves, columns (1), (2), and (3) report that the coefficients associated with the interaction term involving cash are positive and significant. Airlines with greater cash reserves expand their flight services and increase their fares in the markets experiencing regional airlines' exit. Specifically, if Alaska Airlines' cash reserves are 15% larger than that of Southwest Airlines, it might see a 0.7% (0.4%) increase in frequency (capacity). At the same time, Alaska Airlines charges 0.1% higher prices than Southwest Airlines.

In summary, our results suggest that regional airlines are closer competitors to the exiting regional airlines. As a result, the regional airlines' exits generate a more positive demand shift for them, which allows them to increase their services and capture the market share from exiting airlines. They also keep their fares about the same to accommodate the additional passengers. LCCs and FSCs reduce their flight services and raise their fares in response to the exits. Further, airlines with greater cash reserves are more able to increase their market shares and prices after the exits, which informs the importance of financial capabilities for airlines, such as having sufficient cash on hand or external funding like the CARES Act

(Mumbower 2022).[21]

6.0 Conclusion

Our paper examines the competitive effects of regional airline exits on frequency, capacity, pricing, and quality provision in the U.S. The identification of competitive effects comes from the exogenous shock to the survival of Trans States Airlines and Compass Airlines during the COVID-19 pandemic. Based on the combined PSM-DiD model, our empirical analysis leads to several conclusions. First, on average, consumers are worse off after the exits. When a market experiences the regional airlines' exits, there is a significant 16% decrease in flight availability without immediate replacements and a rise in average fares by roughly 6%, with a 2% increase in the connected markets. Second, the adverse supply outcome is mitigated for longer-haul markets and markets dominated by FSCs. Third, an analysis of the competition dynamics after the exits indicates that incumbent airlines expand their services and raise their fares. Lastly, competing regional airlines and airlines with greater cash reserves are more able to seize market shares after the exits. Fares rise but to a lesser extent for competing regional airlines. On-time performance is less impacted by the exits.

Overall, our findings suggest that regional airlines' exits have an important impact on the local economy. The back-of-envelope calculation shows that a 16% reduction in flight frequency may lead to a 0.128% point reduction ($0.128 = 16\% \times 0.008$) in the employment rate.[22] Such adverse economic consequences have implications for policymakers in designing effective regulatory and competitive policies for the airline industry in response to the growing concerns with regional airlines' exits. For example, regional airlines currently face an elevated risk of exiting due to pressures associated with pilot retention (Regional Airline Association 2023). Also, we find that closer markets are particularly vulnerable to the adverse effects of

[21] The Coronavirus Aid, Relief, and Economic Security (CARES) Act was signed into law on March 27, 2020, allocating $10 billion in economic relief funds to eligible U.S. airports impacted by the COVID-19 pandemic.

[22] The point estimate 0.008 is obtained from Table 8 in Sheard (2014).

regional airlines' exits, which can lead to a reduction in the availability of regional flights on smaller aircraft. Therefore, we suggest that regional airlines expand their service offerings to include a diverse range of destinations, thus reducing dependence on a narrow set of routes. Furthermore, regional air transport markets are likely to grow in importance with the emergence of urban air mobility and the regional transportation model that primarily uses small airports (McKinsey & Company 2023). Regional airlines are well-positioned to leverage these advancements to sustain and potentially expand air services in smaller communities.

From a competition policy perspective, our results also show market shares are more likely to move among regional airlines rather than between regional airlines and LCCs/FSCs, implying that regional airlines compete in a niche market segment rather than in a broader market with LCCs and FSCs. The results help policymakers gauge the competition level in markets involving regional airlines. Further, although there were a few de novo airline market entries over the last two decades, limited evidence is available to evaluate their competitive effects.[23] Our results suggest, however, a potential pro-competitive effect from deregulating entry for regional airlines.

From a managerial perspective, our results suggest that airline management may find additional value from holding cash reserves. Cash reserves provide airlines with a financial buffer to overcome economic downturns. To better respond to the exits of competitors, regional airlines can either enhance their internal financial stability or seek external support, such as through the CARES Act. Additionally, our results indicate that contracting with multiple regional airlines may be a competitive strategy for FSCs to hedge against the risk and maintain their market shares in smaller communities.

Our findings center on the impact of regional airlines that have exited the market, that is, undergone Chapter 7 bankruptcies. An area for future research is to analyze the market and competitive dynamic effects of airlines that have undergone Chapter 11 bankruptcies, having

[23]Exceptional cases are Virgin America in 2007, PEOPLExpress in 2014, Avelo and Breeze in 2021.

to significantly restructure without exiting the market. A second area for future research would focus on the long-term implications of regional airline exits. This study analyzes the first-year effects of the COVID-19 pandemic. As airlines and airline markets continue to adjust, analyzing the pandemic's overall effects and long-term implications will add to our understanding of regional airline markets.

References

Abate, Megersa, Panayotis Christidis, and Alloysius Joko Purwanto. "Government support to airlines in the aftermath of the COVID-19 pandemic." *Journal of air transport management* 89 (2020): 101931.

Adler, Nicole, Xiaowen Fu, Tae H. Oum, and Chunyan Yu. "Air transport liberalization and airport slot allocation: The case of the Northeast Asian transport market." *Transportation Research Part A: Policy and Practice* 62 (2014): 3-19.

Albers, Sascha, and Volker Rundshagen. "European airlines strategic responses to the COVID-19 pandemic (January-May, 2020)." *Journal of air transport management* 87 (2020): 101863.

Autor, David, David Dorn, Lawrence F. Katz, Christina Patterson, and John Van Reenen. "The fall of the labor share and the rise of superstar firms." *The Quarterly Journal of Economics* 135, no. 2 (2020): 645-709.

Bachwich, Alexander R., and Michael D. Wittman. "The emergence and effects of the ultra-low cost carrier (ULCC) business model in the US airline industry." *Journal of Air Transport Management* 62 (2017): 155-164.

Bilotkach, Volodymyr, Juergen Mueller, and Adél Németh. "Estimating the consumer welfare effects of de-hubbing: The case of Malév Hungarian Airlines." *Transportation Research Part E: Logistics and Transportation Review* 66 (2014): 51-65.

Borusyak, Kirill, Xavier Jaravel, and Jann Spiess. "Revisiting event study designs: Robust and efficient estimation." *Review of Economic Studies* (2024): rdae007.

Budd, Lucy, Graham Francis, Ian Humphreys, and Stephen Ison. "Grounded: Characterising the market exit of European low cost airlines." *Journal of Air Transport Management* 34 (2014): 78-85.

Chen, Yongmin, and Philip G. Gayle. "Mergers and product quality: Evidence from the airline industry." *International Journal of Industrial Organization* 62 (2019): 96-135.

Council of Economic Advisers. Benefits of Competition and Indicators of Market-Power. Issue Brief. May 2016.

Das, Somnath. “Effect of merger on market price and product quality: American and US airways.” *Review of Industrial Organization* 55, no. 3 (2019): 339-374.

Daraban, Bogdan, and Gary M. Fournier. “Incumbent responses to low-cost airline entry and exit: A spatial autoregressive panel data analysis.” *Research in Transportation Economics* 24, no. 1 (2008): 15-24.

Duranton, G. and Puga, D.. Micro-foundations of urban agglomeration economies. In *Handbook of regional and urban economics*, Vol. 4 (2004), pp. 2063-2117.

Eugenio-Martin, Juan Luis, and Ubay Perez-Granja. “Quantifying the net impact and redistribution effects of airlines’ exits on passenger traffic.” *Journal of Air Transport Management* 101 (2022): 102206.

Fageda, Xavier, Juan Luis Jiménez, Jordi Perdiguero, and Kevin Marrero. “Does market exit of a network airline affect airline prices and frequencies on tourist routes?.” *Tourism Management* 61 (2017): 465-471.

Ferrell, Chelsea, and Pulkit Agarwal. ”Flight Bans and the Ebola Crisis.” Harvard Public Health Review 14 (2018): 1-14.

Forbes, Silke Januszewski, and Mara Lederman. “Adaptation and vertical integration in the airline industry.” *American Economic Review* 99, no. 5 (2009): 1831-1849.

Gillen, David, and Tim Hazledine. ”The economics and geography of regional airline services in six countries.” *Journal of Transport Geography* 46 (2015): 129-136.

Gutiérrez, Germán, and Thomas Philippon. “How EU markets became more competitive than US markets: A study of institutional drift.” No. w24700. New York,: National Bureau of Economic Research, 2018.

Greer, Mark R. “Nothing focuses the mind on productivity quite like the fear of liquidation: Changes in airline productivity in the United States, 2000–2004.” *Transportation Research Part A: Policy and Practice* 42, no. 2 (2008): 414-426.

Grosche, Tobias, Richard Klophaus, and Adam Seredyński. "Market concentration in German air transport before and after the Air Berlin bankruptcy." *Transport Policy* 94 (2020): 78-88.

Hofer, C., Eroglu, C. (2010). "Investigating the effects of economies of scope on firms' pricing behavior: Empirical evidence from the US domestic airline industry." *Transportation Research Part E: Logistics and Transportation Review*, 46(1), 109-119.

Hüschelrath, Kai, and Kathrin Müller. "The competitive effects of firm exit: Evidence from the US airline industry." *Economics of Transportation* 2, no. 2-3 (2013): 72-85.

Johnston, Ahren, and John Ozment. "Economies of scale in the US airline industry." *Transportation Research Part E: Logistics and Transportation Review* 51 (2013): 95-108.

Kim, E. Han, and Vijay Singal. "Mergers and market power: Evidence from the airline industry." *The American Economic Review* (1993): 549-569.

Lange, Anne. "Does cargo matter? The impact of air cargo operations on departure on-time performance for combination carriers." *Transportation Research Part A: Policy and Practice* 119 (2019): 214-223.

Li, Ye, Yan-zhang Wang, and Qiang Cui. "Evaluating airline efficiency: an application of virtual frontier network SBM." *Transportation Research Part E: Logistics and Transportation Review* 81 (2015): 1-17.

Mayer, C and Sinai, T "Network Effects, Congestion Externalities, and Air Traffic Delays: or Why All Delays Are Not Evil", *American Economic Review* 93, no. 4 (2003): 1194-1215.

McKinesey & Company. "Short-haul flying redefined: The promise of regional air mobility." May 2023.

Morrison, Steven A., and Clifford Winston. "Empirical implications and tests of the contestability hypothesis." *The Journal of Law and Economics* 30, no. 1 (1987): 53-66.

Mumbower, Stacey. "Airline market exit after a shock event: Insights from the COVID-19 pandemic." *Transportation Research Interdisciplinary Perspectives* 14 (2022): 100621.

Ng, Kam To, Xiaowen Fu, Shinya Hanaoka, and Tae Hoon Oum. "Japanese aviation market performance during the COVID-19 pandemic-Analyzing airline yield and competition in the domestic market." *Transport Policy* 116 (2022): 237-247.

Ozturk, O. Cem, Sriram Venkataraman, and Pradeep K. Chintagunta. "Price reactions to rivals' local channel exits." *Marketing science* 35, no. 4 (2016): 588-604.

Prince, Jeffrey T., and Daniel H. Simon. "The impact of mergers on quality provision: Evidence from the airline industry." *The Journal of Industrial Economics* 65, no. 2 (2017): 336-362.

Rambachan, Ashesh, and Jonathan Roth. "A more credible approach to parallel trends." *Review of Economic Studies* 90, no. 5 (2023): 2555-2591.

Regional Airlines Association. "Valuable Service: Air Service to Small Communities Create Significant Economic Activities." Q1 (2019): 9.

Regional Airlines Association. "Small Community Air Service & the Pilot Shortage." February 6 (2023).

Regional Airline Association. "2021 The Year Of Community," *Annual Report* (2021).

Regional Airlines Association. "The Pilot Shortage & Small Community Air Service Trends." April 5 (2024).

Reynolds-Feighan, Aisling "The Evolution of Airline Partnerships in the U.S. Domestic Market," *Issues in Aviation Law and Policy* 18, no. 1 (2018): 7-32.

Roth, Jonathan. "Pretest with caution: Event-study estimates after testing for parallel trends." *American Economic Review: Insights* 4, no. 3 (2022): 305-322.

Sancho-Esper, Franco M., and Francisco J. Mas-Ruiz. "Spanish Domestic Airline Market Structure and Incumbent Cost Response to Market Entry: Direction and Magnitude of Response." *Journal of Transport Economics and Policy (JTEP)* 50, no. 3 (2016): 223-244.

Sheard, Nicholas. "Airports and urban sectoral employment." *Journal of Urban Economics* 80 (2014): 133-152.

Yimga, Jules. "The impact of airline code-sharing on product quality." *Journal of Transport Economics and Policy (JTEP)* 54, no. 1 (2020): 1-20.

A.0 Appendix Tables

A.1 List of Incumbent Airlines

The incumbent airlines are the airlines had competed with Trans State Airlines and Compass Airlines before they exited. Table A.1 documents a list of 20 incumbent airlines in the markets where the exits occurred. Among them, 7 airlines are LCCs and 11 are regional airlines.

Table A.1: List of Incumbent Airlines

IATA code	Airline Name	LCC	Regional Airline
AA	American Airlines	No	No
AS	Alaska Airlines	No	No
B6	JetBlue Airways	Yes	No
C5	CommuteAir	No	Yes
DL	Delta Air Lines	No	No
EV	ExpressJet	No	Yes
F9	Frontier Airlines	Yes	No
G4	Allegiant Air	Yes	No
G7	GoJet Airlines	No	Yes
MQ	Evory Air	No	Yes
NK	Spirit Airlines	Yes	No
OH	PSA Airlines	No	Yes
OO	SkyWest Airlines	No	Yes
PT	Piedmont Airlines	No	Yes
QX	HorizonAir	No	Yes
UA	United Air Lines	No	No
WN	Southwest Airlines	Yes	No
YV	Mesa Airlines	Yes	Yes
YX	Republic Airlines/Midwest Airlines	Yes	Yes
ZW	Air Wisconsin Airlines	No	Yes

Note: The table lists the IATA codes, names of incumbent airlines in the markets with exits, whether the airline is an LCC, as well as whether the airline is a regional airline. ExpressJet Airlines is not included in the list of regional airlines from Regional Airline Association. However, we still consider ExpressJet Airlines as a regional airline according to CAPA - Centre for Aviation.

A.2 Examples of Treated Markets

Based on Table 2, 5 cities serve as an airport hub in our treated sample. Table A.2 lists 13 treated markets connecting Log Angeles (LAX), 11 treated markets connecting Seattle (SEA), and 2 treated markets connecting Los Vegas (LAS) to illustrate our treated markets often connect smaller communities to a hub airport.

Table A.2: Treated Markets connecting to LAX, SEA and LAS

Los Angeles, CA-Albuquerque,NM	Las Vegas, NV-San Jose, CA
Los Angeles, CA-Boise, ID	Las Vegas, NV-San Diego, CA
Los Angeles, CA-Fresno, CA	Seattle, WA-Bozeman, MT
Los Angeles, CA-Houston, TX	Seattle, WA-Boise, ID
Los Angeles, CA-Portland, OR	Seattle, WA-Eugene, OR
Los Angeles, CA-Salt Lake, UT	Seattle, WA-Medford, MA
Los Angeles, CA-Sacramento, CA	Seattle, WA-Portland, OR
Los Angeles, CA-Reno, NV	Seattle, WA-Redmond, OR
Los Angeles, CA-Phoenix, AZ	Seattle, WA-Sacramento, CA
Los Angeles, CA-San Francisco, CA	Seattle, WA-San Jose, CA
Los Angeles, CA-Tulsa, OK	Seattle, WA-Spokane, WA
Los Angeles, CA-San Jose, CA	Seattle, WA-Pasco, WA
Los Angeles, CA-Tucson, AZ	Seattle, WA-Santa Ana, CA

Note: The table lists the treated markets in our data.

A.3 Markets dominated by the Exiting Regional Airlines

Table A.3: List of Airlines in the Markets dominated by the Exiting Regional Airlines

Market	Incumbent Airlines Before Exits	Incumbent Airlines After Exits
Denver city, CO-Springfield, MO	AX, OO	OO
Denver city, CO-Knoxville, TN	AX, G4, F9, OO	YX, OO, G4, F9
Denver city, CO-Great Falls, MT	AX, OO	OO
Denver city, CO-Hayden, CO	AX, OO, G7, UA	OO, WN
Denver city, CO-Minot, ND	AX, OO	OO
Los Angeles city, CA-Tulsa, OK	CP, G4, WN	G4, WN

Note: The table lists 6 treated markets, in which AX or CP holds a market share exceeding 50%. AX is Trans State Airlines and CP is Compass Airlines.

B.0 Propensity Score Matching (PSM)

To identify the competitive effects of regional airline exits, we need to control for confounding factors to ensure that the markets experiencing exits are comparable to the markets that do not experience exits. To select the control group of markets that are comparable to our treated markets, we proceed in two steps. First, we compile a list of incumbent airlines which competed with our two exiting airlines before they exit (see Table A.1). We only consider markets that contain those incumbent airlines as the set of potential control markets. Second, we employ a PSM methodology to construct the control group. PSM ensures comparability between the control group markets and the treated markets, thereby establishing a valid counterfactual scenario for comparison.[24] Without using PSM, our treated market resembles a hub-and-spoke structure. Randomly selecting a market connecting two spokes could introduce significant discrepancies in market population, hub prominence, and airport capacity compared to our treated market, leading to biased results. To estimate the propensity score, we construct a cross-section sample that consists of the treated markets and the potential control markets. We adopt a Logit specification to model a market's exit experience, that is, whether Trans State or Compass Airlines exited the market in 2020 Q2:

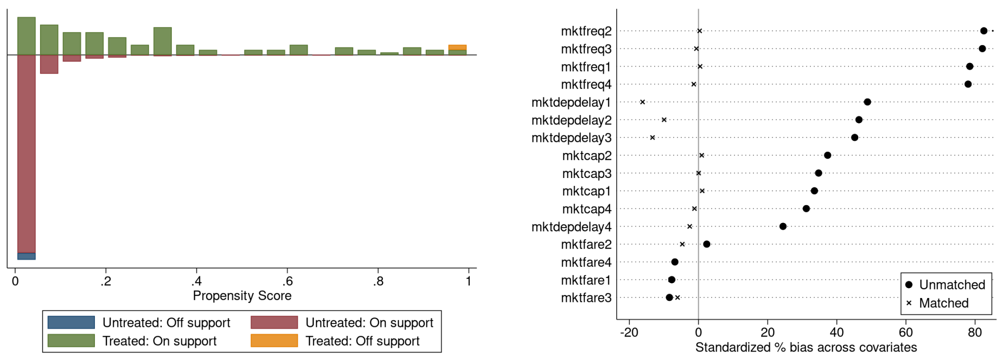
$$\frac{P_m}{1 - P_m} = X_m \alpha + \eta_m, \tag{B.1}$$

where P_m is the probability of a market m experiencing an exit. The set of explanatory variables X_m includes the market-level frequency, capacity, average fare, and average delay in all quarters before the exit 2020 Q2.[25]

[24] Our experimental design also aligns with the ignorability assumption in propensity score matching. We have chosen market frequency, capacity, prices, and departure delays before exits for each period as covariates, which contain the information of time-invariant factors driving the outcome variables. By including these covariates, the relationships between airline exits and outcome variables are independent. In other words, apart from the covariates we considered, we assume there are no other unobserved confounding factors influencing this relationship, which satisfies the ignorability assumption.

[25] We do not use GDP as a matching variable as the GDP information provided by the Bureau of Economic Analysis is at the county or MSA level, which is wider than our market definition.

Panel (a) in Figure B.1 shows the estimated propensity scores.[26] Most of the markets in the treated group and control group are on support while a small fraction of the markets are off support.[27] Overall, the assumption of common support is mostly verified. Further, to ensure the matched markets are useful and appropriate, we only keep the on-support markets without missing weights. Panel (b) shows the comparisons of the covariates before and after matching. The standardized bias is reduced and smaller than 20% for all the covariates.



(a) Propensity Scores (b) Propensity Score Test

Figure B.1: Propensity Score Matching Estimates

Notes: The figure depicts the propensity scores for treated and control observations. On-support means that we are able to find a matched market. Conversely, off-support means that we cannot find a matched market. We only keep the observations that are on support without missing weights in our estimation.

[26] We use 7-nearest neighbors matching and set the caliper at 0.05 level.

[27] On-support means that we can find a matched market, while off-support means that we cannot find a matched market.

C.0 Robustness Checks

In this section, we conduct robustness checks with alternative sample selection criteria, control groups, and measurements of outcome variables and present the results in Table C.4. Our baseline sample and results incorporate four sample selection restrictions, so we first relax the sample selection criteria to assess the robustness of our baseline findings. In panel A, we incorporate flights with one-stop, the results align closely with our baseline results because the regional airline-operated markets are predominantly non-stop flights.[28] In panel B, we exclude markets with fewer than one flight per week on average, leaving us with the markets most impacted by airline exits. The results are consistent with our baseline results, but with larger effects of airline exits on outcome variables.[29]

One concern is that the control group markets may be affected by the regional airlines' exits due to the hub-and-spoke model, where changes in service at a hub can significantly impact the connected spoke cities. To address this concern, we excluded control group markets connected to the five hubs listed in Table 2, ensuring that there is no interference from the treated markets to the control markets. The new control group is shown in panel (c) of Figure C.2, and we can observe that there are the five hubs are eliminated from the control group markets. The results using this new control group are presented in panel C of Table C.4. These results are consistent with our baseline findings but indicate larger effects of airline exits on the outcome variables.

Another concern is related to the Essential Air Service (EAS) program by subsidizing airlines to provide regular service.[30] To address this, we excluded control group markets

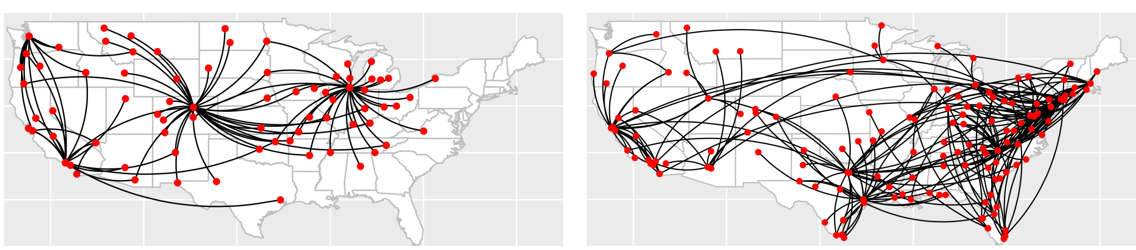
[28]We also test the impact of including inactive markets and find that the results are insignificant, suggesting that the exits of airlines have a stronger effect on active markets. We have excluded markets with destinations in Alaska, Hawaii, and U.S. territories, as well as those served solely by the exiting airlines, Trans State or Compass Airlines, in our first two restrictions. Since these are all inactive markets, we present results including inactive markets only in the robustness checks.

[29]We also test the results of excluding markets with less than two flights per week on average and find similar results.

[30]The Essential Air Service (EAS) program was implemented after the Airline Deregulation Act (ADA) of 1978 to ensure small communities previously served by certificated air carriers continue to receive minimal scheduled air service. A per-passenger subsidy rate is $1,000 or less if the community is farther than 210

eligible for the EAS program, with the results presented in panel D.[31] The effect on frequency (14%) is smaller than the baseline result (16%), which indicates that the EAS program assists remote communities in the control group to maintain air services. As a result, the treated markets experience a smaller decrease in frequency compared to the control group including markets that benefit from the EAS program. The findings on capacity, fare, and on-time performance remain consistent with the baseline results.

Moreover, we use alternative measurements for market capacity, fare, and on-time performance to test the robustness of our baseline results. We first replace the number of seats with passenger traffic and present the result in column (2) of panel E. We find an insignificantly negative effect, consistent with the baseline result (column (2) in panel A of Table 4). Second, we consider market fare in real terms, with the result shown in column (3). Specifically, after an airline exits, the market fare in terms of the real price increases by 5%, aligning with our baseline finding. Finally, we measure on-time performance using arrival delay instead of departure delay, and the results remain consistent. Overall, our results are robust to these alternative sample selection criteria, control groups, and measurements.



(a) Treated Group (b) Control Group

Figure C.2: Treated and Control Group

Notes: Red dots show the origin airports and destination airports. A black curve represents a non-directional origin-destination pair (a market). Panel (a) displays the markets in the treated group and panel (b) displays the markets in the control group after excluding the five hubs listed in Table 2.

miles from a hub, while the subsidy rate is $200 or less if the community is farther than 70 miles from a hub.

[31]None of our treated markets is eligible for the EAS program, so we still use the same treated group markets.

Table C.4: Robustness Checks

	(1) Frequency	(2) Capacity	(3) Fare	(4) Delay
Panel A: Flights with one stop				
post×treat	−195.138**	−15,800	14.120***	−1.093**
	(88.714)	(13,585.350)	(3.898)	(0.480)
R^2	0.848	0.855	0.811	0.707
N	2,814	2,814	2,814	2,814
Mean of Dependent Variables	1,039	107,009	206.0	10.68
Panel B: One flight per week				
post×treat	−199.865**	−17,800	11.805***	−1.693***
	(91.774)	(13,932.353)	(4.532)	(0.512)
R^2	0.847	0.849	0.802	0.688
N	2,492	2,492	2,492	2,492
Mean of Dependent Variables	1,024	102,387	204.9	10.56
Panel C: Only Isolated Markets in Control Group				
post×treat	−180.935**	−15,400	13.690***	−1.023**
	(89.475)	(13,539.075)	(4.491)	(0.518)
R^2	0.852	0.850	0.811	0.696
N	2,324	2,324	2,324	2,324
Mean of Dependent Variables	1,003	98,375	206.7	10.85
Panel D: Drop EAS Community in the Control Group				
post×treat	−147.996*	−9,015.422	12.850***	−0.872*
	(89.772)	(13,675.911)	(4.415)	(0.493)
R^2	0.850	0.849	0.808	0.708
N	2,583	2,583	2,583	2,583
Mean of Dependent Variables	1,038	105,971	206.9	10.79
Panel E: Alternative Measurements				
post×treat		−95.889	0.049***	−1.300**
		(784.229)	(0.017)	(0.519)
R^2		0.712	0.809	0.704
N		2625	2625	2625
Mean of Dependent Variables		3,095	0.801	11.28
Quarter FEs	Yes	Yes	Yes	Yes
Market FEs	Yes	Yes	Yes	Yes

Note: The outcome variables are flight frequency in Column 1, capacity in Column 2, average fare in Column 3, and average delay in Column 4. Panel A reports the results including both nonstop and one-stop flights. Panel B reports the results excluding the markets with less than one flight per week on average. Panel C reports the results using the market fare in terms of real price. Both Quarter and Market fixed effects are included in all panels. The standard errors are clustered at the market level. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.