Bridging Retrospective and Prospective Merger Analyses: The Case of US Airline Mergers*

Gaurab Aryal† Anirban Chattopadhyaya‡ Federico Ciliberto§

March 17, 2025

Abstract

We begin with a retrospective analysis of three major U.S. airline mergers and document the sensitivity of the findings, particularly questioning whether market conditions evolve similarly for treated and control markets. We then develop a structural model that clarifies this and other assumptions implicit in retrospective analyses and separates efficiency gains from increases in firms' conduct. Using only pre-merger data, we propose a reduced-form approach that leverages exogenous changes in market structure to forecast merger effects. Finally, we use structural prospective merger simulations with our other estimates for a comprehensive evaluation. This bridging of approaches uncovers a fundamental tension: either efficiency gains were limited or, if they were significant, they were accompanied and offset by coordinated effects.

JEL: L40, L41, D43

Keywords: Merger Analysis, Airline Competition, Antitrust Policy.

*We thank Dennis Carlton, Mark Israel, Ian MacSwain, and Eugene Orlov for generously sharing their replication files. We also thank Charlie Murry for the early discussions about mergers that helped us frame this paper. Additionally, we appreciate the valuable feedback from seminar participants at the International Industrial Organization Conference in Boston in 2024, especially our discussant Chun-Yu Ho.

†Department of Economics, Boston University, aryalg@bu.edu

‡Department of Economics, University of Virginia, ac8pj@virginia.edu

§Department of Economics, University of Virginia, DIW and CEPR, ciliberto@virginia.edu

1 Introduction

Merger evaluation remains one of the most challenging problems in antitrust policy because of the difficulties separating efficiency gains from increased market power. This literature has developed two distinct methodologies: reduced form retrospective analyses that examine actual post-merger outcomes by applying event study methods like difference-in-differences (DiD) to pre- and post-merger data (e.g., Kim and Singal, 1993; Focarelli and Panetta, 2003; Hastings, 2004; Ashenfelter and Hosken, 2010; Ashenfelter et al., 2015; Carlton et al., 2019), and structural prospective analyses that predict merger effects using only pre-merger data (e.g., Nevo, 2000; Nevo and Whinston, 2010). There are a few important exceptions to this classification (Baker, 1999; Pesendorfer, 2003; Davis, 2005; Miller and Weinberg, 2017; Igami and Sugaya, 2022; Bruegge et al., 2024), which underpin our work here. For a more comprehensive overview of mergers see Whinston (2006) Chapter 3, Kwoka, Jr. (2014) and Asker and Nocke (2021).

The disconnect between these approaches has left critical questions unanswered. For instance, when retrospective analysis shows stable post-merger prices, it is unclear if this price stability is masking offsetting efficiency gains and market power changes. Such disconnect highlights the need for methodological integration that can reveal the underlying mechanisms driving observed outcomes and provide more nuanced insights than either approach alone.

We aim to fill this gap by developing a unified approach that bridges these methodologies, demonstrating its value through an analysis of three major airline mergers: Delta-Northwest (2008), United-Continental (2010), and American-US Airways (2013). Our empirical framework operates along two distinct methodological dimensions, assuming that mergers and market structures are exogenous. The first dimension distinguishes between analyses using pre- and post-merger data versus those using only pre-merger data. The second separates reduced-form from the structural approach, creating four complementary analyses (see the four quadrants in Table 1) that provide a comprehensive understanding of merger effects. In the process, we show how insights from one approach can inform and strengthen the other.

Table 1: Roadmap of Empirical Strategy

	Data Used	
Method Used	**Pre- and Post-merger**	**Pre-merger Only**
Reduced Form	Retrospective Analysis (Section 3)	Market Structure Analysis (Section 5)
Structural Form	Interpretation of Results in Section 3 (Section 4)	Merger Simulation (Section 6)

Notes: This table outlines our empirical framework. The columns indicate whether the analysis uses pre- and post-merger data or only pre-merger data, and the rows indicate whether the method is reduced-form or structural.

Our paper follows a systematic analysis that sequentially integrates reduced-form and structural approaches. We begin with a reduced-form retrospective analysis of pre- and post-merger data (Section 3). We then evaluate the robustness of this approach concerning the time trends to capture possibly declining demand. Next, we develop a structural interpretation of these reduced-form estimates, explicitly delineating the economic assumptions underlying the DiD strategy (Section 4), and find that the structural estimates suggest mergers generate cost efficiency and lead to a decline in competitiveness. Then, we develop a reduced-form approach that relies on the exogenous variation in market structure in only the pre-merger data to forecast merger effects (Section 5). We conclude by implementing a structural merger simulation that employs only the pre-merger data and uses estimated effects of mergers on prices from our Sections 3 and 5 to determine the post-merger marginal costs and use it to evaluate the reduced form estimates under different post-merger strategic conduct based on the findings in Section 4 (Section 6).

The US airline industry provides an ideal setting for our analysis. It offers rich, comprehensive data spanning ticket prices, passenger numbers, seat capacity, and flight schedules from multiple authoritative sources: the Department of Transportation's Origin and Destination Survey for ticket prices and passenger numbers, the Bureau of Transportation Statistics' T100 database for seat capacity, and the Official Airline Guide (OAG) data for flight sched-

ules. Moreover, the industry's extensive scrutiny in both academic research (e.g., Borenstein, 1990; Kim and Singal, 1993; Olley and Town, 2018; Carlton et al., 2019; Das, 2019; Li et al., 2022; Eizenberg and Zvuluni, 2024; Olsen et al., 2024; Remer and Orchinik, 2024) and legal proceedings (e.g., U.S. District Court, MA, 2023) provides crucial institutional context and validation points for our methodology

In the following, our analysis begins in Section 3 by replicating the DiD estimates of the effects of mergers in Carlton et al. (2019), whose clear and transparent methodology for analyzing airline mergers has been influential in court proceedings. This analysis supports the claim that the three mergers were pro-competitive: post-merger airfare decreased by 4% to 7.5%, and capacity expanded significantly by 16% to 29%. However, these results are sensitive to assumptions about time trends. Using first differences reveals almost no price effects and significantly smaller capacity effects, suggesting violations of the assumption of parallel trends. Our pre-trend analysis confirms this concern about parallel trends.[1]

Next, to explore these findings and make explicit the economic assumptions underlying the DiD framework, we develop a structural framework in Section 4 such that the implied reduced form price equation corresponds to the one used in retrospective analysis. DiD is a program evaluation that requires a set of assumptions about airline pricing to determine the effect of a merger, and our structural model clarifies those hypotheses. To this end, we build on Bresnahan (1982) and propose a structural model that allows merger-specific coordinated effects (Porter, 2020), treating air travel as a homogeneous product with market-level quantity-weighted average prices.

Our structural model reveals three critical insights about the model implicitly assumed in a typical retrospective analysis. First, consistent DiD estimation requires that mergers not alter firm conduct and that time-varying unobservable "demand shocks" evolve similarly across treated and control markets. Second, the error term in the DiD specification contains unobservable demand and supply shocks. While the cost shocks may reasonably be uncorre-

[1]These findings are further supported by the synthetic DiD (Arkhangelsky et al., 2021) estimates, where we find limited evidence of merger effects on prices and passenger volumes.

lated with merger decisions, demand shocks could systematically differ between treated and control markets—for instance, if firms are more likely to merge in markets with declining demand—and biasing the DiD estimates. Third, our estimates suggest that mergers affect firm conduct differently across market structures, indicating both unilateral and coordinated effects that the retrospective analysis might miss.

Next, we consider the scenario typically faced by the antitrust authorities and the courts: evaluating mergers using only pre-merger data. In Section 5, we develop a reduced-form approach that leverages exogenous variations in market structure pre-merger to predict post-merger effects using only pre-merger data. Building on methodology pioneered by Baker (1999), this approach analyzes how prices vary with different market structures in the pre-merger period to forecast merger-induced changes. Using the first differences method, we find that transitions from duopoly to monopoly are associated with modest but consistent fare increases (ranging from 2.9% to 6.2%) and substantial capacity reductions (15.7% to 27.6%). Conversely, markets transitioning from monopoly to duopoly show symmetric effects: fare decreases of 3.0% to 7.7%, and large capacity increases of 31.5% to 38.5%.

Finally, in Section 6, we implement a structural merger simulation (Nevo, 2000) that considers different scenarios for post-merger cost efficiencies and conduct. In particular, we consider a random utility discrete choice model of demand with differentiated products and Bertrand competition where firms choose prices. Following Verboven (1996), we employ a nested logit demand model to distinguish between nonstop and connecting services, allowing for rich substitution patterns across products and carriers. Our merger simulation analysis reveals that predicted price effects depend critically on assumptions about post-merger cost efficiencies and firms' conduct. In particular, we explore how post-merger prices depend on efficiency gains and changes in competitive conduct. Under standard competition assumptions and maximum efficiency gains (where merged entities adopt the lower costs of merging firms), the model predicts price decreases ranging from 2.9% to 5.1%. However, this finding presents a puzzle when compared to our earlier findings of stable post-merger

prices: either efficiency gains were limited or significant efficiencies were offset by an increase in coordinated effects.

Thus, our bridging framework reveals a crucial tension in evaluating airline mergers that traditional approaches miss. As post-merger prices remain stable, there are two possible interpretations: either the merger generated substantial efficiency gains but also increased market power significantly, or both efficiency gains and competitive effects were modest. This tradeoff creates a strategic dilemma for merging airlines - they can either claim large efficiency gains but must also accept the evidence of increased market power or argue for modest competitive effects. However, then it weakens the case for the merger based on efficiency. By iterating between reduced-form and structural approaches, our framework makes this tradeoff explicit, providing authorities with a more complete toolkit for merger evaluation. Moreover, our finding that market structure changes primarily affect capacity rather than prices suggests that antitrust authorities should broaden their focus beyond price effects alone.

Our paper's contributions to the literature are both methodological and empirical. Building on the extensive merger analysis literature cited throughout this introduction and the rest of the paper, we integrate existing reduced-form retrospective and structural prospective analyses, drawing insights from each while addressing their limitations. Specifically, we demonstrate how retrospective studies that use post-merger data to measure price effects (e.g., Ashenfelter and Hosken, 2010) and prospective approaches that use pre-merger data and focus on structural estimation of efficiency gains (e.g., Farrell and Shapiro, 1990), can be integrated to provide more robust merger analysis, under the assumption of exogenous mergers and market structure.[2]

[2]This assumption is nearly universal in the empirical merger literature, underlying both retrospective analyses and structural merger simulations, with notable exceptions being Dafny (2009); Aguirregabiria and Ho (2012); Ciliberto et al. (2021); Li et al. (2022), and Bontemps et al. (2023) among others.

2 Data and Descriptive Analysis

Our analysis relies on three data sources. We use the US Department of Transportation's Origin and Destination Survey (DB1B), a quarterly 10% sample of all tickets sold, which contains information on ticket prices and passenger numbers for each carrier and route. Second, we use the Bureau of Transportation Statistics' T100 (Form 41) database for the number of seats (capacity) allocated by each airline across all routes every quarter. Finally, we use the Official Airline Guide (OAG) database that provides information on all nonstop flight schedules.

We focus on three major mergers in the airline industry. Delta and Northwest Airlines announced their merger plan on April 14, 2008; the shareholders approved it on September 26, 2008, and the US Department of Justice (DOJ) approved it on October 29, 2008. United and Continental announced their merger plan on May 2, 2010, gaining shareholder approval on September 17, 2010. The merger was completed on October 1, 2010, forming United Continental Holdings, although the full operational integration was completed only in mid-2012. The merger between American Airlines and US Airways was announced on February 14, 2013. This merger faced initial opposition from the DOJ, which filed a lawsuit on August 13, 2013, to block the proposed merger. However, a settlement was reached on November 12, 2013, allowing the merger to be completed on December 9, 2013.[3]

We adopt the methodologically rigorous framework established by Carlton et al. (2019) to define our analytical parameters, including time, control and treatment groups, and other methodological elements.

Specifically, for each merger, the *pre-* and *post-merger* periods are, respectively, defined as the eight quarters before and after the merger approval. Specifically, for DL-NW, these are Q4 2006-Q3 2008 (pre) and Q1 2009-Q4 2010 (post); for UA-CO, these are Q3 2008-Q2

[3]While (Kim and Singal, 1993) examine price effects at both merger announcement and implementation (approval) dates, our analysis focuses exclusively on the pre- and post-approval periods. This approach allows us to focus on the real market effects following regulatory clearance rather than the anticipatory effects, providing a more focused examination of realized competitive outcomes.

2010 (pre) and Q4 2010-Q3 2012 (post); and for AA-US, these are Q4 2011-Q3 2013 (pre) and Q1 2014-Q4 2015 (post).

Next, we discuss the selection of "treated" and "control" markets, an approach the US court system accepts when evaluating merger cases.[4] For each merger, we classify a city pair market as a "treated" market if both merging parties provided nonstop service before the merger.[5] Furthermore, we separately focus on 2-to-1 markets, the duopoly markets, where only the merging parties provide nonstop service, and 3-to-2 markets, the triopoly markets, where one other carrier provides nonstop service besides the two merging parties.

To minimize any indirect effects of the merger from these selected markets, we exclude markets where either of the two merging parties had a substantial connecting presence. A carrier is deemed to have a connecting presence in a market if it handles at least 10% of total passenger traffic through connections. Specifically, we remove all "connecting overlap" markets, where (i) neither of the two merging parties offered nonstop service, and (ii) pre-merger, each party served at least 10% of passengers and jointly served at least 40% of passengers. We refer to the remaining markets as the treated markets.

Likewise, we classify a market as a "control" market if the merger does not affect its market structure. In other words, in such a market, only at most one carrier can be the merging party, so if it is a duopoly or a triopoly pre-merger, it remains the same post-merger. Thus, the control markets have the same number of nonstop carriers as the overlap routes in the pre-merger period. As with the treated market, we also restrict our attention to control markets where, whenever applicable, the merging party does not have a substantial connecting presence.

In Table 2, we present comprehensive summary statistics revealing distinct patterns across market segments before and after the merger. Despite maintaining higher average

[4]In our analysis, we also consider the sample of markets connecting the top 50 Metropolitan Statistical Areas (MSAs), a standard approach widely used in the literature. For example, Berry and Jia (2010) examine airports located in medium to large metropolitan areas with at least 850,000 people in the year 2006, which roughly corresponds to the top 50 MSAs.

[5]A carrier is considered 'nonstop' in a city route if it conducts 10 nonstop operations (five round-trips).

Table 2: Summary Statistics

	Pre-Merger			Post-Merger		
	Mean	Median	SD	Mean	Median	SD
Average Price						
Treated	228.25	229.52	52.24	226.33	231.52	48.32
Control	185.65	179.05	52.70	195.75	189.65	51.93
Treated & Control	186.22	179.63	52.92	196.16	190.19	51.99
Top 50 MSAs	190.37	183.93	51.99	199.99	193.51	51.35
Passengers						
Treated	37,546.17	29,755	25,643.97	39,261.17	30,420	27,690.30
Control	34,330.75	25,760	32,748.04	33,884.38	25,130	32,655.25
Treated & Control	34,374.05	25,850	32,664.22	33,956.57	25,190	32,598.85
Top 50 MSAs	41,753.65	32,110	34,851.46	41,760.55	32,620	34,710.27
Offered Seats						
Treated	132,391.60	155,774.50	70,204.90	148,652.90	170,601.50	81,357.05
Control	103,468.40	76,187.50	88,269.59	100,320.80	74,366.00	86,191.09
Treated & Control	103,858.20	76,558.50	88,112.42	100,970.10	74,749.50	86,305.49
Top 50 MSAs	120,719.80	94,867.00	95,021.14	118,584.60	93,900.00	92,958.21

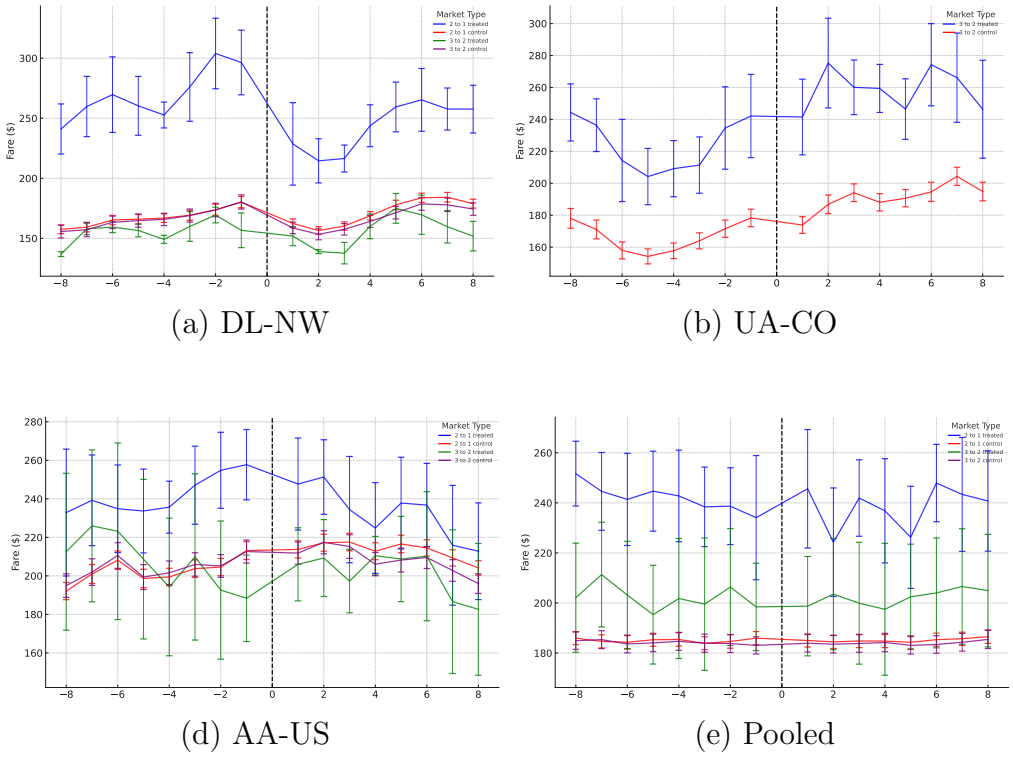
Notes: This table shows the mean, median, and standard deviation for our main variables, broken out by different market definitions (all markets, treated and control markets, and top 50 and 150 MSA markets) and merger status.

fares, treated (i.e., overlap), markets showed a slight decrease from $228.25 to $226.33. Notably, control markets experienced a price increase from $185.65 to $195.75. The average one-way fare in the combined sample of treated and control markets and in the sample of markets between the top 50 MSAs increased, respectively, from $186.22 to $196.16 and from $190.37 to $193.51, suggesting differentiated price effects across market segments.

Passenger volumes exhibited mixed trends: while the combined sample of treated and control saw a slight decline from 34,374 to 33,957 passengers, treated markets experienced growth from 37,546 to 39,261 passengers, representing approximately a 4.6% increase. The Top 50 MSA markets consistently maintained a constant passenger volume, remaining remarkably stable at approximately 41,750 passengers.

The most striking changes occurred in seat capacity, particularly in treated markets, which grew substantially from 132,392 to 148,653 seats (a 12.3% increase), while the overall market average decreased from 103,858 to 100,970 seats. This pattern suggests strategic capacity expansion in overlap markets alongside modest capacity rationalization in other

Figure 1: Time Series of Airfares



(a) DL-NW (b) UA-CO

(d) AA-US (e) Pooled

Note: This figure plots quarterly average airfares for different mergers for eight quarters before and after a merger with their point-wise 95% confidence intervals computed using standard deviations clustered at the market level. The 3-to-2 Markets (green lines) refer to routes where the merger reduced the number of carriers from three to two, with their corresponding control markets shown in purple. The 2-to-1 Markets (blue lines) denote routes transitioning from two carriers to one, with their control markets shown in red. The vertical line at "0" indicates the merger completion date. Average fares are computed as passenger-weighted means across markets within each category. Subfigures (a) to (c) show the time series for the three merger samples separately, and subfigure (d) shows the time series for the pooled samples.

markets. The significant capacity increase in treated markets, coupled with only modest passenger growth, suggests that the merged entities prioritized service frequency and aircraft size in markets where they previously competed, potentially as a strategy to strengthen market position.

Our summary statistics indicate a slight decrease of 0.8% in treated markets (from $228.25 to $226.33) and a 5.4% increase in control markets (from $185.65 to $195.75), but these aggregates may obscure temporal patterns. We examine the quarterly price trends for the eight quarters before and after each merger to further explore these nuanced price changes.

Figure 1 presents the evolution of average airfares across different market structures before and after the merger, accompanied by their 95% confidence intervals. We plot separate

time series for control markets, markets transitioning from three to two carriers (3-to-2 markets), and markets that consolidate from two to one carrier (2-to-1 markets). The vertical line denotes the merger completion date. Examining these price trajectories, we find no apparent discontinuities or substantial price-level shifts following the merger across any market category. The price paths in treated markets (3-to-2 and 2-to-1) largely parallel those in control markets throughout the sample period, with their confidence intervals frequently overlapping. The relative stability of prices across all market structures is particularly noteworthy given the significant changes in market concentration implied by these consolidations.

To analyze these price, capacity, and seat changes in greater detail, we now move to a replication of the Carlton et al. (2019) analysis, which provides a more rigorous econometric framework for evaluating the causal impact of these mergers.

3 Retrospective Analysis

We use the event study approach to separately assess the impact of three legacy airline mergers (Delta-Northwest, United-Continental, and American-US Airways) on three key economic variables: average fares, passenger volume, and seat availability.

The analysis compares the mean of each variable in control markets before and after a merger and compares that difference with the difference in means in treated markets. In particular, we estimate the following regression specification to determine the average treatment on the treated under the DiD assumptions:

$$Y_{mt} = \beta_0 + \beta^{\texttt{DiD}} \times (\text{Treated}_{mt} \times \text{Post-Merger}_{mt}) + X_{mt}^{\top}\gamma + \delta_m + \theta_t + \varkappa_{mt}, \tag{1}$$

where Y_{it} is the outcome variable (logarithm of average nominal fares or passenger volume or seat availability) for market m in year-quarter t, $\text{Treated}_{mt} \in \{0, 1\}$ is a binary variable equal to one if m is a treated market and zero otherwise, $\text{Post-Merger}_{mt} \in \{0, 1\}$ is also a binary variable that is equal to one post-merger and zero otherwise. The model includes

Table 3: Estimated Effects of Mergers

	Merger Cases			
Outcomes	DL-NW	UA-CO	AA-US	Pooled
Panel A: Fixed Effects				
Log (Price)	-0.041^{***}	-0.036^{***}	-0.078^{***}	-0.056^{***}
Log (Passengers)	0.028	0.057^{***}	0.088^{***}	0.064^{***}
Log (Offered Seats)	0.216^{***}	0.258^{***}	0.153^{***}	0.204^{***}
Panel B: First Differences				
Log (Price)	0.025	0.044^{***}	0.038	0.027
Log (Passengers)	-0.218^{***}	-0.045^{***}	0.275^{***}	0.011
Log (Offered Seats)	0.133^{***}	0.037^{***}	0.160^{***}	0.122^{***}

Notes: This table reports DiD estimates from Equation (1) for airfare, passenger volume and offered seats. The analysis is structured such that the first three columns show the estimates for the three mergers separately, and the last column shows the estimates for the "pooled" sample. Panel A presents results using mean-deviation fixed effects, and Panel B presents results using the first differences method.
$^{***}: p < 0.01$.

city-route fixed effects (δ_m), time fixed effects (θ_t), and additional controls (X_{mt}), e.g., the percentage of nonstop passengers per city-route.

3.1 Estimation Results

Our parameter of interest is $\beta^{\texttt{DiD}}$, which, under the parallel trends assumptions, is the effect of a merger on the outcome variables in the treated markets. The estimation results from (1) are shown in Table 3. Panel A presents estimates using the fixed effects method (mean deviation). We estimate that the average prices decreased by 4.02% (DL-NW), 3.54% (UA-CO), and 7.50% (AA-US). The passenger volume increased by 2.84% (DL-NW), 5.87% (UA-CO), and 9.19% (AA-US).[6] Almost all of these estimates are statistically significant at 1%-level, except that the estimated effect on passenger volume following the DL-NW merger is noisy. Most notably, the number of offered seats, i.e., the allocated capacities, expanded by

[6]This estimate is a weighted average of the parameter estimates across markets and time (de Chaisemartin and D'Haultfœuille, 2020) and should be interpreted as a percentage change in the outcome variable. The percentage changes for $\beta^{\texttt{DiD}}$ is given by $(\exp(\beta^{\texttt{DiD}}) - 1) \times 100$ (Halvorsen and Palmquist, 1980).

24.11% (DL-NW), 29.44% (UA-CO), and 16.53% (AA-US) - all statistically significant.

Overall, our findings align with those of Carlton et al. (2019), demonstrating that all three airline mergers enhanced consumer welfare through a combination of lower prices and expanded service offerings. This consistency is further supported by the pooled estimates presented in the final column of Table 3, which confirm these welfare-improving effects across the consolidated analysis.[7]

3.2 Robustness Analysis

These results merit scrutiny, particularly regarding the substantial capacity effects across mergers. For instance, the UA-CO merger shows a 29.4% increase in allocated seats, a striking change in market capacity.

The most natural and simple way to check the robustness is to run first differences instead of fixed effects, as done in Kim and Singal (1993). The first difference and fixed effect methods should yield similar estimates.[8] However, they differ in their identifying assumptions, which in the presence of time trends may result in different estimates (Wooldridge, 2010). In particular, the fixed effects method requires *strict exogeneity,* i.e., $\text{Treated}_{mt} \times \text{Post-Merger}_{mt}$ is uncorrelated with ε_{mt} *across all periods.* In contrast, first differences only require that the variable is uncorrelated with the change in ε_{mt} immediately before and after the merger. The variable $\text{Treated}_{mt} \times \text{Post-Merger}_{mt}$, changes value *only in a single quarter,* suggesting that the first differences assumption is less demanding than the fixed effect method. Furthermore, in a DiD framework, the first differences have an additional advantage: the constant term captures any differential linear trends between treatment and control markets, slightly relaxing the parallel trends assumption.

The results from using the first differences to estimate (1) are shown in Table 3 Panel B. The contrast with our fixed effects estimates is striking in three key dimensions.

[7] These results are robust regardless of the semi-log specification and control market selection. Specifically, the findings remain consistent even when we use levels and limit control markets to routes between the 50 largest Metropolitan Statistical Areas (MSAs) by population. See Appendix B for detailed analyses.

[8] They yield the same estimates if there is only one period before and one period after the mergers.

First, while fixed effects estimation suggests that mergers lead to a 5.6% *decrease* in prices, the first differences approach suggests prices *increase* slightly. However, they are measured with noise, except for the UA-CO merger, for which the price increases by 4.5%. Second, the effects of the merger on passenger volume are significantly different. The DL-NW merger shows a substantial 21.8% decrease in passengers using first differences, compared to a small positive effect using the fixed effects method. Only AA-US maintains a positive passenger effect (27.5% increase) in first differences. Third, while capacity effects remain positive and significant across both specifications, their magnitude is notably smaller under the first differences approach. For example, the UA-CO capacity effect drops from 25.8% to 3.7%.

The first differences method implicitly allows for different time trends between treatment and control groups through the constant term. In the airline context, such differential trends could reflect market-specific changes in local economic conditions or evolving travel patterns. The differences in the estimates using the two methods highlight the importance of capturing time trends for merger analysis.

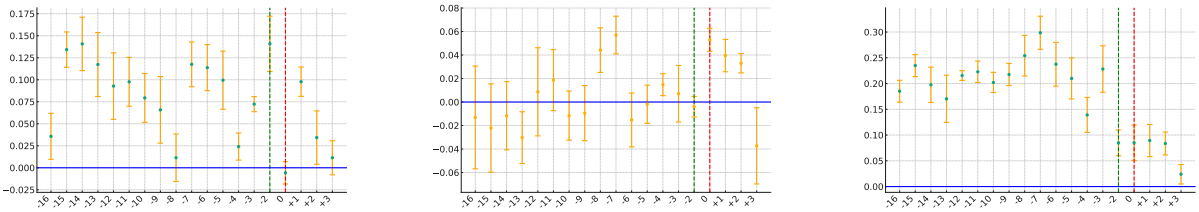
The stark differences between fixed effects and first differences estimates raise concerns about whether the parallel trends assumption—fundamental to DiD analysis—holds in our setting. To investigate this issue more rigorously, we conduct pre-trend analyses using the event study approach.

This approach allows us to assess the validity of the parallel trends assumption and trace merger effects over time.[9] The pre-trend analysis reveals significant differences in market trends pre- and post-mergers, suggesting that the parallel trends assumption fails and that the findings that mergers are pro-competitive (Table 3, Panel A) may not hold.

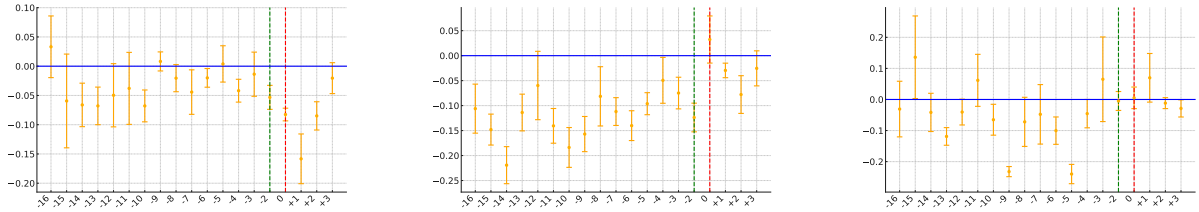
Our pre-trend analysis in Figure 2 indicates that the parallel trends assumption critical to DiD methodology is violated in this context. One approach to address this violation is

[9]For ease of presentation, we show only the estimation results in Figure 2, and that too for only the 3 to 2 markets, and leave the complete econometric specifications and estimation procedure and results for 2 to 1 markets in Appendix B.5.

Figure 2: Pre-Trends Analysis



Airfares: (a) DL-NW (b) UA-CO (c) AA-US



Passenger (d) DL-NW (e) UA-CO (f) AA-US

Note: This figure presents event study estimates examining pre-merger trends in airfares (in subfigures (a), (b), and (c)) and passenger volumes (in subfigures (d), (e), and (f)) across the three mergers, for 3 to 2 markets. Each panel plots quarterly coefficients from a regression of log(price) or log(passengers) on merger-market interaction terms, with quarter 0 marking the merger's completion date. The y-axis represents the estimated differential between merger-affected and control markets, while the x-axis measures quarters relative to the merger. Vertical bars denote 95% confidence intervals constructed using standard errors clustered at the market level.

including market-specific time trends in our model. In airline markets, such trends reflect gradual changes in local economic conditions or evolving travel patterns, specifically on the demand side. However, incorporating these trends presents methodological challenges, particularly in choosing the appropriate functional form.

Following Friedberg (1998), we begin with the most parsimonious approach by adding linear trends to our baseline (1) specification:

$$Y_{mt} = \pi_0 + \pi^{\texttt{DiD}} \times (\text{Treated}_{mt} \times \text{Post-Merger}_{mt}) + X_{mt}^{\top}\tau + \eta_m + \iota_t + \kappa_m \times t + \omega_{mt}, \qquad (2)$$

where $\kappa_m \times t$ captures market-specific time trends. This approach allows post-merger data to influence the estimated trends.

This specification requires a methodological decision regarding trend estimation: whether to use the full sample or restrict estimation to pre-merger data only. We implement both

Table 4: Estimated Effects of Mergers, with Time Trends

	Method 1				Method 2			
	DL-NW	UA-CO	AA-US	Pooled	DL-NW	UA-CO	AA-US	Pooled
Panel A: Treatment-Control Specific Trends								
Log (Price)	−0.022	0.074***	0.032	0.027	0.041***	0.052***	0.063**	0.055***
	(0.023)	(0.020)	(0.057)	(0.028)	(0.015)	(0.08)	(0.025)	(0.013)
Log (Passengers)	−0.162***	−0.105***	0.080	−0.033	−0.105***	−0.010	0.148***	0.038
	(0.027)	(0.012)	(0.063)	(0.040)	(0.018)	(0.010)	(0.030)	(0.025)
Log (Offered Seats)	0.156***	0.063***	0.123**	0.119***	0.354***	0.160***	0.193***	0.235***
	(0.037)	(0.014)	(0.050)	(0.026)	(0.047)	(0.009)	(0.031)	(0.025)
Panel B: Market-Specific Trends								
Log (Price)	−0.023	0.073***	0.031	0.027	−0.045**	0.112***	0.121**	0.074**
	(0.023)	(0.020)	(0.057)	(0.028)	(0.019)	(0.046)	(0.061)	(0.037)
Log (Passengers)	−0.161***	−0.104***	0.082	−0.034	−0.101*	−0.120**	0.243***	0.055
	(0.028)	(0.012)	(0.063)	(0.040)	(0.052)	(0.048)	(0.106)	(0.073)
Log (Offered Seats)	0.151***	0.062***	0.124**	0.119***	0.306***	0.124***	0.287***	0.243***
	(0.038)	(0.014)	(0.048)	(0.026)	(0.045)	(0.035)	(0.103)	(0.060)

Notes: This table presents DiD estimates of merger effects under alternative trend specifications. Panel A controls for differential trends between treatment and control groups, while Panel B allows for market-specific trends. Method 1 incorporates trends directly in the difference-in-differences framework. Method 2 employs a two-step approach: first estimating trends using pre-merger data and extrapolating them to the post-merger period, then implementing the DiD estimation on the detrended data. The analysis examines three mergers (DL-NW, UA-CO, and AA-US) separately and in a pooled specification. Standard errors, clustered at the market level, are reported in parentheses.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

approaches. Method 1 uses the entire sample period to estimate market-specific linear trends by estimating (2). Method 2 employs a two-step procedure: first estimating trends using only pre-merger data, then extrapolating these trends forward and estimating the merger effects on detrended outcomes. In particular, in Method 2, we estimate κ_m from (2) using only the pre-merger data and then estimate (1) using the $\tilde{Y}_{mt} \equiv Y_{mt} - \hat{\kappa}_m \times t$ for all periods as the dependent variable. We consider two variants for each method: one that allows different trends between treated and control markets and another that permits market-specific trends.

Table 4 presents these results. Notably, incorporating time trends substantially alters the main findings Table 3 Panel A: price decreases, and passenger volume increases either reverse

or become statistically insignificant. This pattern holds across different trend specifications, suggesting the initial findings may have been driven by pre-existing market trajectories rather than merger effects.

Interestingly, the positive effect on seat capacity remains robust across all specifications, though with varying magnitudes. While the baseline estimates indicated a 20.4% capacity increase, the trend-adjusted estimates range from 11.9% to 24.3% in the pooled sample. This persistent capacity expansion, coupled with the reversal in price and passenger effects, may indicate changes in airline conduct rather than straightforward efficiency gains.

While our linear trend specification imposes strong assumptions about market evolution, specifically that trends are linear and homogeneous within groups, we validate our findings using more flexible methods. In Appendix B.6, we demonstrate that the synthetic DiD approach, which better captures the complex dynamics of airline markets, produces qualitatively similar results. This consistency across methodologies strengthens our confidence in the robustness of our findings.[10]

4 Structural Interpretation of Retrospective Analysis

Market power and efficiency gains are two key competing effects of mergers, but isolating their impact in data presents significant challenges. While the retrospective analysis in Section 3 that employs the DiD method is commonly used in merger evaluations, its economic foundations deserve closer scrutiny. In this section, we demonstrate how the price equation (1) in DiD analysis emerges from a structural model of demand and supply, building on the now-classic framework by Bresnahan (1982). This approach allows us to clarify the assumptions embedded in typical DiD strategies and evaluate their validity.

We begin with a demand function $Q = D(P, Z; \boldsymbol{\alpha}) + \varphi$, where Q is the quantity demanded

[10]Specifically, The estimates from synthetic DiD are in Appendix B.6 Table B.5 Panel B and are similar to the first-difference results reported in Table 3 Panel B for prices and passenger volume. Our findings are similar to Remer and Orchinik (2024), who uses the synthetic DiD method and find that mergers lead to higher prices.

of the homogenous good, P is its price, Z is a random variable that captures stochastic factor that shifts demand and is not affected by P or φ, and $\boldsymbol{\alpha}$ is the vector of demand parameter(s). To be consistent with the reduced form (1), we maintain the assumption of homogeneous demand. The corresponding marginal revenue, augmented to allow for the conduct, is given by $MR = P + \lambda \times h(\cdot)$, where $h(Q) = P'(Q) \times Q \leq 0$ and $\lambda \in [0, 1]$ is the strategic conduct parameter. The conduct parameter λ measures the degree of competition in the market, where $\lambda = 0$ represents perfect competition, and $\lambda = 1$ represents monopolistic behavior.

Let $c(Q, W, I; \boldsymbol{\theta})$ denote the marginal cost of production, where Q is the quantity supplied of the homogenous good, W is a random variable that captures stochastic factor that shifts cost and is not affected by P or φ, $I \in \{0, 1\}$ is an indicator variable that is equal to one post-merger and zero otherwise, and $\boldsymbol{\theta}$ is the vector of cost parameter(s).

The supply relationship – we deliberately avoid using the term "supply function" as we are operating in an oligopolistic setting except when $\lambda = 0$ – is derived from the optimality condition that the marginal revenue at Q must be equal to marginal cost for all firms, i.e., $P = c(Q, W, I; \boldsymbol{\theta}) - \lambda \times h(Q, Y, \boldsymbol{\alpha}) + \vartheta$, where ϑ is supply error.

Further, suppose that the conduct post-merger can be different from pre-merger, which we capture using an unknown function $\lambda(I)$ in the optimality condition:

$$P = c(Q, W, I; \boldsymbol{\theta}) - \lambda(I) \times h(Q, Y, \boldsymbol{\alpha}) + \vartheta. \tag{3}$$

A key feature of our specification is that the merger affects only the supply relationship—specifically, the cost and conduct parameters—rather than the demand function itself. However, this feature does not mean the merger will not affect demand-side outcomes such as prices. Rather, it assumes that preference parameters (like consumer price sensitivity) remain unchanged by the merger. There is no reason why consumers' preferences should change just because fewer firms now offer a homogeneous product; consumers only respond to the resulting price changes.

Furthermore, our specification also allows for various post-merger scenarios, from maintained competition, i.e., when $\lambda(1) \approx \lambda(0)$, to enhanced market power, i.e., $\lambda(1) > \lambda(0)$, and merger induced efficiency gain, i.e., $c(\cdot,\cdot,1;\cdot) \leq c(\cdot,\cdot,0;\cdot)$.

To align with the DiD specification (1), we assume linear demand and cost functions:

$$\begin{aligned} Q &= D(P,Z;\boldsymbol{\alpha}) + \varphi = \alpha_0 + \alpha_1 \times P + \alpha_2 \times Z + \varphi \\ c &= c(Q,W,I;\boldsymbol{\theta}) = \theta_0 + \theta_1 \times Q + \theta_2 \times W + \theta_3 \times I. \end{aligned}$$

Using the optimality condition (3) and $h(Q) = Q/\alpha_1$, we obtain the following system of simultaneous equations indexed by market m and time t:

$$\begin{aligned} Q_{mt} &= \alpha_0 + \alpha_1 \times P_{mt} + \alpha_2 \times Z_{mt} + \varphi_{mt}, \\ P_{mt} &= \theta_0 + (\theta_1 - \lambda(I_{mt})/\alpha_1) \times Q_{mt} + \theta_2 \times W_{mt} + \theta_3 \times I_{mt} + \vartheta_{mt}. \end{aligned} \tag{4}$$

Letting $\tilde{\gamma}_{mt} = (\theta_1 - \lambda(I_{mt})/\alpha_1)$ and substituting the quantity equation into the price equation and simplifying yields the reduced form

$$\begin{aligned} P_{mt} = \frac{\theta_0 + \tilde{\gamma}_{mt}\alpha_0}{(1-\tilde{\gamma}_{mt}\alpha_1)} + \frac{\theta_3}{(1-\tilde{\gamma}_{mt}\alpha_1)} \times I_{mt} + \frac{\tilde{\gamma}_{mt}\alpha_2}{(1-\tilde{\gamma}_{mt}\alpha_1)} \times Z_{mt} \\ + \frac{\theta_2}{(1-\tilde{\gamma}_{mt}\alpha_1)} \times W_{mt} + \frac{\tilde{\gamma}_{mt}\varphi_{mt} + \vartheta_{mt}}{(1-\tilde{\gamma}_{mt}\alpha_1)}, \end{aligned} \tag{5}$$

where the variable I_{mt} equals 0 for control markets across all periods t and equals 1 for the treated markets in periods after the merger. Therefore, we can interpret $I_{mt} = \text{Treatment}_{mt} \times \text{Post-Merger}_{mt}$ as the main variable of interest and its coefficient $\beta^{\dagger} := \frac{\theta_3}{(1-\tilde{\gamma}_{mt}\alpha_1)}$ as the effect of merger on prices.

The intercept in (5) corresponds to the combined effect of the constant term plus market and time-fixed effects in Equation (1). Additionally, the exogenous variable X_{mt} in (1) represents the vector of demand and cost shifters (Z_{mt}, W_{mt}). Now, we can compare (5) with the DiD specification (1) to understand the structural interpretation of the reduced

form regressions.[11]

Our structural model reveals three key insights about DiD-based merger analysis. First, the DiD coefficient combines demand (α_1) and supply-side (θ_1 and θ_3) parameters.

Second, the composite error ($\varkappa_{mt}$) in Equation (1) contains both demand (φ) and supply (ϑ) shocks. So, even if merger decisions are independent of market conditions and firms conduct does not change (i.e., $\lambda(1) = \lambda(0)$), consistent estimation requires that mergers neither alter firm conduct nor experience differential evolution of unobservables across treatment and control markets, i.e., $\mathbb{E}(I_{mt} \mid \varkappa_{mt}) = 0$.

Third, while cost shocks (ϑ_{mt}) may plausibly be uncorrelated with merger decisions, demand shocks (φ_{mt}) could systematically differ between merging and non-merging markets —particularly if firms with declining demand are more likely to merge.[12]

If mergers affect firms' conduct, the DiD estimates may be biased because the DiD specification fails to account for an indirect effect. This effects operates through the composite error $\varkappa_{mt}$ via the relationship $\tilde{\gamma}_{mt} = \theta_1 - \lambda(I_{mt})/\alpha_1$. Specifically, if a merger changes firms' conduct, it alters $\varkappa_{mt}$, creating a correlation between the merger indicator I_{mt} and the error term ε_{mt}. This correlation, i.e., $\mathbb{E}(I_{mt} \mid \varkappa_{mt}) \neq 0$, violates a key assumption of DiD estimation, resulting in biased estimates.

Crucially, even when these identification assumptions fail, and the reduced-form DiD estimates become biased, *our structural framework maintains its identification.* This key advantage underscores the importance of complementing DiD analysis with structural approaches when evaluating mergers.

Specifically, our identification strategy relies on the exogeneity of the instruments Z and W, an approach that traces back to Wright (1928), Appendix A. Under appropriate

[11] The dependent variables in Equation (1) are log prices, while they are in levels in Equation (5). We refer the reader to Appendix Table B.1 Panel B for proper comparison. The marginal effects are analogous whether we use levels or logs. For a streamlined presentation, we present the log specification in the main text and the level specification in the appendix.

[12] Interestingly, both the AA-TWA merger involved TWA's hub in St. Louis, a city that had been declining in economic importance, and the UA-CO merger involved Cleveland, another city facing economic challenges. While we do not establish a causal relationship, these examples suggest the possibility of such patterns on the demand side.

assumptions about these instruments being centered, uncorrelated, and having non-zero correlations with the endogenous variables ($\mathbb{E}(PW) \neq 0$ and $\mathbb{E}(QZ) \neq 0$), we can identify:

$$\alpha_1 = \frac{\mathbb{E}(QW)}{\mathbb{E}(PW)}; \quad \text{and} \quad \tilde{\gamma} = \frac{\mathbb{E}(PZ)}{\mathbb{E}(QZ)}.$$

Remarkably, without further assumptions, we cannot identify the conduct $\lambda(\cdot)$ and cost parameter θ_1 from $\tilde{\gamma} = \theta_1 - \lambda(I)/\alpha_1$. However, we can identify the change in conduct by comparing pre-merger $\tilde{\gamma}_0 := \theta_1 - \lambda(0)/\alpha_1$ with post-merger $\tilde{\gamma}_1 := \theta_1 - \lambda(1)/\alpha_1$, which gives

$$\Delta\lambda = \lambda(1) - \lambda(0) = -\alpha_1 \times (\tilde{\gamma}_1 - \tilde{\gamma}_0). \tag{6}$$

Building on the discussion of conduct parameter identification, we can draw a meaningful parallel to Miller and Weinberg (2017) who consider differentiated products. Despite differences in our models, they also estimate mergers' effect on conduct using pre- *and* post-merger data. Such before-and-after comparison is essential for identifying the coordinated effect (Berry and Haile, 2014), or we can use simulation like in Igami and Sugaya (2022).

For estimation, we use several exogenous variables, not just one. On the demand side, we use market size (defined as the geometric mean of endpoint populations) and demographic characteristics at both origin and destination cities: per capita income, net migration, population size, and births and deaths. On the supply side, we use the nonstop flight ratio and year-quarter dummies to control for seasonality. These variables are listed with their summary statistics Appendix Table A.1[13]

Table 5 presents estimates from our structural model across three specifications and the implied elasticities and reduced-form merger price effects. Panel A reports key structural parameters: the price coefficient (α_1) capturing consumer price sensitivity, the merger's effect on costs (θ_3), and changes in the conduct parameter ($\Delta\lambda$). For market structure-specific

[13]We use the generalized method of moments estimator (Hansen, 1982). For inference, we estimate the Eicker-White-Huber heteroskedasticity-consistent standard errors (Wooldridge, 2010).

Table 5: Conduct Parameter Estimates and Implied Elasticities

Conduct Specifications	(1) Perfectly Competitive ($\lambda = 0$)			(2) Homogeneous			(3) Market Structure Specific		
Mergers	DL-NW	UA-CO	AA-US	DL-NW	UA-CO	AA-US	DL-NW	UA-CO	AA-US
Panel A: Structural Parameters									
Price Coefficient (α_1)	-0.188***	-0.027***	-0.092	-0.188***	-0.03***	-0.092***	-0.188***	-0.03***	-0.085***
	(1.66e-05)	(8.59e-06)	(0.1366)	(1.05e-05)	(9.2e-11)	(1.2e-08)	(1.5e-09)	(1.03e-10)	(1.8e-08)
Merger's effects on Cost (θ_3)	0.362***	-0.667***	0.251***	-0.134***	0.069***	-0.059***	-0.134***	0.069***	0.059***
	(0.0001)	(0.0001)	(0.0075)	(9.878e-05)	(3.2e-13)	(2.7e-08)	(3.4e-08)	(7.1e-14)	(4.05e-08)
Changes in Conduct									
—Uniform ($\Delta\lambda$)				0.188***	0.03***	0.065***			
				(0.0001)	(2.03e-10)	(2.3e-08)			
— "2 to 1" markets ($\Delta\lambda_2$)							0.161***	0.023***	0.076***
							(7.2e-09)	(6.3e-11)	(2.5e-08)
— "3 to 2" markets ($\Delta\lambda_3$)							0.187***	0.027***	0.084***
							(1.07e-08)	(1.3e-10)	(3.6e-09)
Panel B: Implied Elasticities									
Mean Elasticity	-0.671	-0.095	-0.253	-0.670	-.0103	-0.252	-0.670	-0.103	-0.235
Median Elasticity	-0.128	-0.020	-0.075	-0.128	-0.021	-0.074	-0.128	-0.021	-0.069
Panel C: Implied Estimate of Price Effects of Merger ($\beta^\dagger$)									
— Perfect Competiton	0.364***	0.670***	0.246***						
	(0.0001)	(0.0004)	(0.0027)						
— Uniform				0.122***	0.068***	-0.057***			
				(0.0001)	(6.5e-12)	(2.6e-08)			
— "2 to 1" markets							-0.125***	0.068***	0.057***
							(3.1e-08)	(3.9e-12)	(3.9e-08)
— "3 to 2" markets							-0.122***	0.068***	0.057***
							(3.1e-08)	(3.5e-12)	(3.8e-08)

Notes: Panel A presents GMM estimates of price coefficient (α_1) and merger coefficient in costs (θ_3) in the structural parameters from Equation (4). Column (1) imposes competitive conduct ($\lambda = 0$), Column (2) allows for a homogeneous conduct parameter that differs only between pre- and post-merger periods, and Column (3) allows conduct to vary by market structure. The changes in conduct are the estimates of the parameter defined in Equation (6). Panel B presents the implied mean and median elasticities, and Panel C presents the implied effect of the merger on prices in Equation (5). Eicker-White-Huber heteroskedasticity-consistent standard errors are reported in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

conduct in column (3), we distinguish between the 3 to 2 markets ($\Delta\lambda_3$) and 2 to 1 markets ($\Delta\lambda_2$), measuring changes in competitive behavior following the mergers.

Our baseline specification in Column (1) assumes perfect competition ($\lambda = 0$), mirroring assumptions in standard reduced-form analyses. We find significant negative price sensitivity for DL-NW (-0.188) and UA-CO (-0.027) mergers, while for AA-US, it is imprecise. The mergers' cost effect varies: increasing for DL-NW and AA-US while decreasing for UA-CO.

Panel B reports the implied price elasticities. Under the competitive specification, mean price elasticities range from -0.095 (UA-CO) to -0.671 (DL-NW), with AA-US at -0.253. The median elasticities are substantially smaller, revealing considerable right-skewness in the distribution of price sensitivities across markets. These unusually small magnitudes suggest that assuming perfect competition may understate the role of market power in determining airline prices.

Column (2) relaxes the perfect competition assumption by allowing firms' conduct to change post-merger, though still imposing homogeneity of the change across all markets. This specification reveals significant increases in market power following all three mergers, with conduct parameter changes ($\Delta\lambda$) ranging from 0.030 for UA-CO to 0.188 for DL-NW. These statistically significant increases indicate substantial reductions in competition in merger-affected markets, with DL-NW markets experiencing the most pronounced competitive deterioration.

Our preferred specification in Column (3) provides a more nuanced analysis by allowing differential conduct changes in "2 to 1" markets ($\Delta\lambda_2$) versus "3 to 2" markets ($\Delta\lambda_3$). This market structure-specific approach reveals that both types of markets experienced statistically significant increases in market power post-merger. Interestingly, we find that "3 to 2" markets generally saw larger increases in the conduct parameter than "2 to 1" markets across all three mergers. For instance, in the DL-NW merger, $\Delta\lambda_3$ (0.187) exceeds $\Delta\lambda_2$ (0.161), suggesting that markets with remaining competition still experienced substantial competitive harm.

Statistical tests strongly reject the null hypothesis of no change in conduct for all three mergers, confirming significant increases in market power. The magnitudes of the conduct parameter changes (ranging from 0.023 to 0.188) are smaller than the 0.37 estimate reported by Miller and Weinberg (2017) for the beer industry after a joint venture. This difference likely reflects the airline industry's network structure, where the presence of connecting routes and alternative carriers maintains some competitive pressure even after consolidation. However, mergers need not always increase coordinated effects. Igami and Sugaya (2022) demonstrate that mergers can simultaneously reduce competitiveness (unilateral effects) while decreasing collusion (coordinated effects). These findings suggest that coordinated effects depend on specific industry characteristics, firm asymmetries, and the merger itself.

With the estimated structural parameters, we can compute the implied price effects of mergers through the coefficient $\beta^{\dagger}$ of the merger indicator variable I_{mt} in Equation (5), which captures merger-induced price changes and is not subject to the endogeneity concerns (discussed above) present in the DiD estimates in Equation (1). Panel C of Table 5 presents these estimates across different conduct specifications.

Using our estimated structural parameters, we compute the implied price effects of mergers through the coefficient $\beta^{\dagger}$ of the merger indicator variable I_{mt} in Equation (5). This measure captures merger-induced price changes and is not subject to the endogeneity concerns in the DiD estimates discussed earlier. Panel C of Table 5 presents these estimates across all conduct specifications.

Focusing on our preferred specification in Column (3), the implied reduced-form estimates reveal heterogeneous price effects across the three mergers. The DL-NW merger led to price reductions ($\beta^{\dagger} \approx -0.12$), suggesting that efficiency gains outweighed increased market power. In contrast, the UA-CO and AA-US mergers led to a modest price increase ($\beta^{\dagger} \approx 0.068$ and 0.057, respectively).

While these results provide valuable insights into the relationship between market structure and firm conduct, they rest on assumptions of homogeneous products, linear demand,

and linear costs. To assess the robustness of our findings, Section 6 extends our analysis using discrete choice models that relax both the homogeneity and linear demand assumptions, allowing for a more flexible characterization of consumer preferences and market competition. Before that, we show how to use only pre-merger data to run reduced form analysis.

5 A Reduced-Form Approach to Merger Prediction

We present a reduced-form approach that we can use to understand merger effects when *only the pre-merger data are available.* Specifically, we propose a method that fully leverages the assumption that market structures are exogenous. If market structure changes are exogenous, pre-merger transitions—from duopoly to monopoly or triopoly to duopoly—should inform us about post-merger outcomes in 2 to 1 and 3 to 2 markets. This methodology builds on Baker (1999)'s analysis of the Staples-Office Depot merger, later expanded by Davis (2005) to study movie theaters, and recently employed by Bruegge et al. (2024) using entry events to simulate the impact of the merger on prices.

To validate our assumption that changes in market structure provide identifying variation, we first examine how simulated changes in market concentration (measured by HHI) affect key outcomes. We estimate the following first-difference model:

$$Y_{mt} = \Psi \Delta HHI_{mt} + \Gamma X_{mt} + F_m + F_t + \chi_{mt}, \tag{7}$$

where ΔHHI represents simulated changes in the Herfindahl-Hirschman Index. Following Dafny et al. (2012) and Miller and Weinberg (2017), we construct these simulated concentration changes by redistributing exiting firms' market shares proportionally among the remaining competitors in each market.

Panel A of Table 6 presents the estimated coefficients (Ψ) for the effect of ΔHHI on prices, passenger volume, and offered seats. The results show a consistent relationship between increased market concentration and higher prices across all three mergers. A one-unit

Table 6: Market Structure Effects

	DL-NW			UA-CO			AA-US		
	Price	Pas.	Seats	Price	Pas.	Seats	Price	Pas.	Seats
Panel A:									
ΔHHI	0.102***	-0.082	-0.422***	0.021**	-0.097	0.008	0.067***	-0.290***	-0.472***
	(0.012)	(0.069)	(0.047)	(0.010)	(0.063)	(0.044)	(0.014)	(0.086)	(0.060)
Panel B:									
$2 \to 1$	0.059***	0.039	-0.323***	0.032***	-0.300**	-0.275***	0.029***	0.056	-0.170***
	(0.005)	(0.149)	(0.011)	(0.005)	(0.143)	(0.010)	(0.004)	(0.122)	(0.008)
$1 \to 2$	-0.080***	0.092	0.289***	-0.077***	0.090	0.325***	-0.030***	0.151	0.274***
	(0.005)	(0.143)	(0.010)	(0.006)	(0.168)	(0.012)	(0.005)	(0.154)	(0.011)
$3 \to 2$	0.015**	0.073	-0.145***	0.017***	0.288*	-0.163***	0.007	0.061	-0.134***
	(0.006)	(0.170)	(0.012)	(0.006)	(0.163)	(0.011)	(0.005)	(0.149)	(0.010)
$2 \to 3$	-0.057***	-0.230	0.168***	-0.052***	-0.144	0.202***	-0.042***	0.102	0.168***
	(0.006)	(0.168)	(0.012)	(0.007)	(0.178)	(0.012)	(0.005)	(0.163)	(0.011)

Notes: This table presents the coefficients from Equations (7) and (8), for each of the three mergers, estimated using first difference method. Panel A reports coefficients on simulated changes in HHI in Equation (7). Panel B shows coefficients for market structure transitions, where $2 \to 1$ indicates transition from duopoly to monopoly, $1 \to 2$ from monopoly to duopoly, and anologously for other variables as defined in Equation (8). All dependent variables (price, passengers, seats) are in logarithms using the Top 50 markets by population. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

increase in HHI (measured on a 0-1 scale) is associated with price increases ranging from 2.1% (UA-CO) to 10.2% (DL-NW). The DL-NW and AA-US mergers also significantly negatively affect capacity (seats), suggesting that concentrated markets experience higher prices and reduced service. These findings validate our approach of using natural transitions in market structure to forecast merger effects.

Building on our concentration analysis, we next examine specific market structure transitions using a more detailed fixed-effect model:

$$\begin{aligned} Y_{mt} =& \Psi_1 \times \mathbb{1}\{\text{Duopoly} \to \text{Monopoly}\}_{mt} + \Psi_2 \times \mathbb{1}\{\text{Monopoly} \to \text{Duopoly}\}_{mt} \\ &+ \Psi_3 \times \mathbb{1}\{\text{Duopoly} \to \text{Triopoly}\}_{mt} + \Psi_4 \times \mathbb{1}\{\text{Triopoly} \to \text{Duopoly}\}_{mt} \\ &+ \Gamma^* X_{mt} + F^*_m + F^*_t + \chi^*_{mt}, \end{aligned} \tag{8}$$

where the indicator variables capture market structure transitions. For example, $\mathbb{1}\{\text{Duopoly} \to \text{Monopoly}\}_{mt}$ equals 1 if market m transitioned from duopoly to monopoly at time t.

Panel B of Table 6 presents these transition effects across all three mergers. Several important patterns emerge: First, transitions from duopoly to monopoly ("2 to 1") lead to significant price increases across all mergers: approximately 6.1% for DL-NW ($\exp(0.059) - 1 \approx 0.061$), 3.3% for UA-CO, and 2.9% for AA-US. These consolidations also result in substantial capacity reductions, with offered seats decreasing by approximately 27.6% for DL-NW, 24.0% for UA-CO, and 15.6% for AA-US.

Second, we observe *symmetric effects* in the opposite direction. When markets transition from monopoly to duopoly ("1 to 2"), prices decrease by approximately 7.7% for DL-NW, 7.4% for UA-CO, and 3.0% for AA-US. At the same time, capacity expands considerably—ranging from 33.5% to 38.4% increases in offered seats across the three mergers.

Third, similar but less pronounced patterns appear in transitions between triopoly and duopoly. "3 to 2" transitions show modest price increases (approximately 0.7% to 1.7%) and significant seat reductions (13.5% to 15.0%), while "2 to 3" transitions result in price decreases (4.1% to 5.5%) and seat expansions (18.3% to 22.4%).

Our reduced-form analysis of natural market structure transitions reveals consistent patterns across all three airline mergers. Consolidation leads to moderate price increases but substantial capacity reductions, while market entry produces symmetric effects in the opposite direction. In the next section, we consider a structural approach to prospective merger analysis that incorporates the lessons from these natural experiments and the efficiency considerations from our retrospective evaluation. Our findings differ from Bruegge et al. (2024) in their investigation of the Jet Blue and Spirit Air merger, where they observed that "entries with larger capacity tend to have greater fare effects, and that the difference in fare effects between carriers varies with the capacity level." In contrast, our analysis shows significant capacity changes but relatively modest price effects across the mergers we studied.

6 Structural Pre-merger Analysis

In this section, we present a merger simulation framework that incorporates empirical insights from our difference-in-differences estimations in Sections 3 and 5. This approach connects our reduced-form findings with structural modeling to better understand the price and welfare implications when two airlines merge. Combining these complementary methodologies, we aim to address some of the limitations inherent in either approach used in isolation.

We begin by estimating a discrete choice model of airline demand and costs using pre-merger data and then use the estimates to determine post-merger prices. Then we use DiD estimated price effects (Table 3 Panel B) to calibrate efficiency gains and incorporate estimated changes in competitive conduct (as implied by our analysis in Section 4), we create a more comprehensive framework for merger evaluation. We note that the DiD analysis examines average market prices, but the structural approach considers firm-specific pricing decisions. We will return to this later when discussing the counterfactual analysis.

6.1 Demand Specification

Our demand specification considers an environment with differentiated products. While our earlier analysis focused on aggregate (homogeneous) demand for airline travel—primarily examining the binary choice between flying and not flying—using quantity-weighted average prices under the assumption of linear demand, the current model examines the demand for differentiated airline offerings.

We employ a nested logit model, standard in antitrust analysis, where consumers choose between various airline offerings and a "no-fly" option. Our approach follows the nested logit framework established in Verboven (1996), Ciliberto and Williams (2014), Björnerstedt and Verboven (2016), and Duch-Brown et al. (2023).

We divide the choice set in each market $m \times t$ into two primary groups: the outside option ($g = 0$), which corresponds to not flying, and inside options ($g = 1$), which corresponds to

flying using one of the flight services offered by the airlines. We further divide the inside options into nonstop services ($h = 1$) and connecting services ($h = 2$). Let J_{hgmt} represent the set of airline offerings in subgroup h of a group g in market $m \times t$.

Then, let the utility that a consumer i gets from choosing an option $j \in J_{hgmt}$ be

$$u_{ijmt} = X_{jmt}\boldsymbol{\phi} + \varrho p_{jmt} + \xi_j + \xi_t + \xi_{jmt} + \nu_{ijmt} := \delta_{jmt} + \nu_{ijmt},$$

where X_{jmt} represents a vector of product characteristics, p_{jmt} denotes price, and $(\boldsymbol{\phi}, \varrho)$ are preference parameters, ξ_j are carrier specific indicator variables, ξ_t are year-quarter indicator variables, and ξ_{jmt} captures product characteristics unobserved by the econometrician. Crucially, we maintain that ν_{ijmt} is the unobserved utility component corresponding to flying with one airline and is given by $\nu_{ijmt} = \varepsilon_{igmt} + (1 - \sigma_2)\varepsilon_{ihgmt} + (1 - \sigma_1)\varepsilon_{ijmt}$, where ε_{igm}, ε_{ihgm}, and ε_{ijm} are independent random variables that follow extreme value distribution, consistent with Berry (1994) and Verboven (1996).

The model includes two key correlation parameters: σ_1 and σ_2. These parameters capture the relationship between unobservable components at different levels of the nesting structure and reveal important insights about traveler preferences. Specifically, σ_1 measures correlation within subgroups (connecting or nonstop), with a high value indicating a strong correlation in traveler preferences for products within the same type of airline service. For instance, a high σ_1 suggests that travelers who prefer one nonstop flight are likely to prefer other nonstop flights to connecting flights. Meanwhile, σ_2 measures correlation within the broader group of all options, where a high value indicates a strong correlation across all airline traveling choices, suggesting that travelers view different air travel options as closer substitutes. For the model to be consistent with random-utility maximization, these parameters must satisfy $0 \leq \sigma_2 \leq \sigma_1 < 1$, with this ordering reflecting the intuition that products within the same service type (nonstop or connecting) are closer substitutes than products across different service types.

Following Björnerstedt and Verboven (2014, 2016), we can write the market share (choice probability) for an airline service $j \in J_{hgmt}$ as:

$$s_{jm} = \frac{\exp(\delta_{jmt}/(1-\sigma_1))}{\exp(\mathcal{I}_{hgmt}/(1-\sigma_1))} \times \frac{\exp(\mathcal{I}_{hgmt}/(1-\sigma_2))}{\exp(\mathcal{I}_{gmt}/(1-\sigma_2))} \times \frac{\exp(\mathcal{I}_{gmt})}{\exp(\mathcal{I}_m t)}, \tag{9}$$

where $\mathcal{I}_{hgm}$, $\mathcal{I}_{gm}$, and $\mathcal{I}_m$ are the inclusive values defined as

$$\begin{aligned} \mathcal{I}_{hgm} &= (1-\sigma_1) \ln \sum_{k \in J_{hgm}} \exp(\delta_{km}/(1-\sigma_1)); \quad \mathcal{I}_{gm} = (1-\sigma_2) \ln \sum_{h \in \{1,2\}} \exp(\mathcal{I}_{hgm}/(1-\sigma_2)); \\ \mathcal{I}_m &= \ln(1+\exp(\mathcal{I}_{gm})). \end{aligned}$$

Then, we can use these shares (9) to estimate the demand parameters, as in Berry (1994).

6.2 Estimation Results

While establishing identification and estimating demand parameters are essential steps in merger analysis, our approach follows standard methods in the literature (Björnerstedt and Verboven, 2014, 2016). To maintain focus on our novel contribution, we present these technical components, including the summary statistics of the variables in Appendix Table A.2, identification strategy, and robustness checks, in Appendix Section C. Next, we proceed directly to our merger simulation analysis.

Table 7 presents the estimated own- and cross-price elasticities and nesting parameters across the three major airline mergers. Our sample includes all pairwise combinations of the top 50 populated origin and destination markets, restricted to three years leading up to the merger. Our estimated elasticities reveal significant market power and clear substitution patterns. Own-price elasticities (M_{ejj}) range from -4.07 to -4.57, indicating that a 1% increase in price leads to approximately a $4-4.5\%$ decrease in demand. The Delta-Northwest merger period exhibits the highest own-price elasticity (-4.57). These estimates align with previous studies: Berry and Jia (2010) find the own price elasticity for leisure passengers

Table 7: Own- and Cross-Price Elasticities: Unweighted Market Averages

Panel A: DL-NW Merger

	Mean	SD	Min	Max
M_{ejj}	-4.569	1.399	-9.479	-2.696
M_{ejk}	0.974	1.056	0.119	4.901
M_{ejl}	0.011	0.015	0.000	0.068
M_{ejm}	0.002	0.003	0.000	0.010
σ_1	0.581	σ_2	0.024	
	(0.0064)		(0.0063)	

Panel B: UA-CO Merger

	Mean	SD	Min	Max
M_{ejj}	-4.068	0.935	-6.535	-2.896
M_{ejk}	0.417	0.416	0.020	1.748
M_{ejl}	0.023	0.037	0.000	0.145
M_{ejm}	0.002	0.004	0.000	0.017
σ_1	0.481	σ_2	0.081	
	(0.0064)		(0.0066)	

Panel C: AA-US Merger

	Mean	SD	Min	Max
M_{ejj}	-4.326	0.959	-8.860	-2.956
M_{ejk}	0.266	0.229	0.007	0.895
M_{ejl}	0.112	0.129	0.001	0.457
M_{ejm}	0.005	0.006	0.000	0.019
σ_1	0.257	σ_2	0.167	
	(0.0091)		(0.0097)	

Notes: Table shows pre-merger own- and cross-price elasticities. M_{ejj} represents own-price elasticities. M_{ejk}, M_{ejl}, and M_{ejm} are the cross-price elasticities for products in the same nest (e.g., both nonstop), different nest (nonstop vs. connecting), and outside market (flying vs. not-flying), respectively. Statistics computed across markets where merging carriers competed. Elasticities are calculated at observed prices and market shares. For each merger, σ_1 and σ_2 are the nesting parameters with their standard errors in parentheses.

is -5.01, Ciliberto et al. (2021) estimate the median price elasticity to be $[-4.03, -3.86]$, Bontemps et al. (2023) estimate it at -3.78, and Aryal et al. (2024) estimate it to be -3.90. The nested structure shows the strongest substitution between similar service types (elasticities 0.26-0.97), weaker substitution across service types (0.01-0.11), and minimal substitution with the outside option (0.002-0.005).

The estimated cross-price elasticities reveal a clear hierarchical substitution pattern consistent with our nesting structure. Cross-price elasticities are strongest between products of the same service type (M_{ejk}: 0.26–0.97), substantially weaker across service types (M_{ejl}: 0.01-0.11), and minimal with the outside option (M_{ejm}: 0.002–0.005). This pattern aligns with the estimated nesting parameters, where within-service-type correlation (σ_1: 0.26–0.58) consistently exceeds between-service-type correlation (σ_2: 0.02-0.17). The DL-NW merger exhibits notably stronger within-type substitution (M_{ejk}: 0.97) compared to UA-CO (0.42) and AA-US (0.27). The substitution with the outside option for any individual product (M_{ejm}) is minimal across all mergers. Notably, this measure alone does not capture consumers' overall response to industry-wide price changes.

6.3 Merger Simulations

We conduct merger simulations with the estimated demand and cost parameters by removing one airline and analyzing the resulting price effects. While such simulations would be straightforward for homogeneous goods with symmetric firms, the airline industry presents additional complexity due to product differentiation and heterogeneous costs that may change post-merger through efficiency gains.

Even maintaining our assumptions of exogenous market structure and merger decisions, simulating post-merger outcomes requires careful consideration of demand characteristics and cost structures. We address this challenge through multiple counterfactual scenarios. For product offerings, we begin with a baseline case where the merged entity maintains both pre-merger product lines, then examine scenarios where it retains only one brand. For

Table 8: Counterfactual Merger Analysis: Price Effects

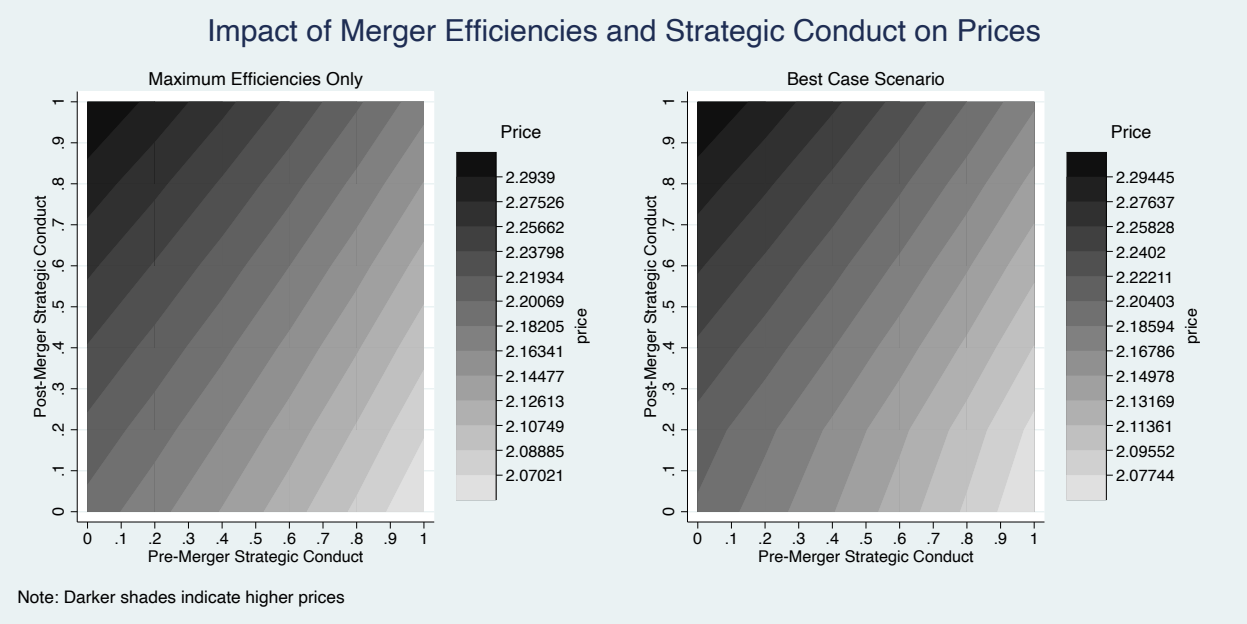
	Pre-merger		**Post-merger**								
			Pre-merger Costs			**Smallest Cost**			**Average Cost**		
	Price	MC	Both In	Only Firm 1	Only Firm 2	Both In	Only Firm 1	Only Firm 2	Both In	Only Firm 1	Only Firm 2
Panel A: (All markets, no change in conduct)											
DL-NW	2.293	1.742	2.376	2.292	2.279	2.177	2.131	2.122	2.378	2.294	2.278
UA-CO	2.234	1.672	2.266	2.232	2.153	2.128	2.100	2.101	2.260	2.192	2.191
AA-US	2.285	1.749	2.318	2.287	2.236	2.219	2.193	2.195	2.316	2.263	2.263
Panel B: (conduct = 1)											
DL-NW	2.293	1.742	2.725	2.666	2.664	2.505	2.500	2.502	2.724	2.667	2.662
UA-CO	2.234	1.672	2.643	2.618	2.543	2.500	2.489	2.491	2.642	2.579	2.581
AA-US	2.285	1.749	2.422	2.407	2.356	2.321	2.312	2.315	2.421	2.383	2.384

Notes: This table presents counterfactual merger analysis based on estimated discrete choice demand parameters and recovered pre-merger marginal costs. We simulate post-merger equilibrium prices (in hundreds of USD) for each merger under various cost and market structure scenarios. The cost scenarios consider three possibilities: the merging entities keep their pre-merger costs, which is relevant only when both merging firms remain in the market; the merged firm adopts the smallest of the merging firms' costs; or the merged firm operates with the average of the merging firms' pre-merger costs.

costs, following Ciliberto et al. (2021), we explore three scenarios: maintaining pre-merger costs, adopting the minimum costs between merging carriers (i.e., the maximum efficiency), and using the average of pre-merger costs. Additionally, we leverage our DiD estimates to discipline the implied efficiency gains, allowing us to trace price effects across various levels of market competition by varying conduct parameters.

Table 8 presents these results, with the first two columns showing pre-merger equilibrium prices and corresponding marginal costs for each merger pair. Under standard competition assumptions (Panel A), a merger's price effects vary substantially with efficiency gains. More importantly, we find that price reductions materialize only under the most optimistic efficiency scenario, where merged entities adopt the minimum costs of the merging firms. In particular, this maximum efficiency scenario generates market-wide price decreases ranging from 2.9% (AA-US) to 4.7% (UA-CO) to 5.1% (DL-NW). However, maintaining original costs leads to modest price increases of 1.4% to 3.6% across markets.

Figure 3: Strategic Conduct Analysis



Note: These contour plots show predicted post-merger prices (in hundreds of USD) as a function of pre- and post-merger conduct parameters. The left panel assumes merged firms achieve maximum cost efficiency by adopting the lower marginal costs of the merging parties. The right panel additionally allows the merged firm to inherit the more favorable demand characteristics. The darkness of the shades indicates price levels. Conduct ranges from perfect competition (0) to full collusion (1), where pre-merger conduct is on the x-axis, and post-merger conduct is on the y-axis.

Suppose the airlines can reach the most optimistic efficiency scenario. In that case, it presents a puzzle: How do we reconcile the prediction of lower prices here with the earlier findings of stable post-merger prices? As suggested earlier, one possible explanation is that the firm's strategic conduct changed after the merger.

This contrast between simulation predictions and our earlier findings that mergers do not lower prices suggests potential changes in competitive conduct. Indeed, when allowing for full post-merger collusion (Panel B, conduct parameter = 1), we find substantial price increases even under maximum efficiency: 9.2% for DL-NW, 11.9% for UA-CO, and 1.6% for AA-US. These effects amplify further under the original cost scenario, with increases ranging from 6.0% for AA-US to 18.3% for UA-CO to 18.8% for DL-NW.

Figure 3 illustrates this tradeoff through contour plots of predicted price (in hundreds of US dollars) effects. We compare two scenarios: one where firms achieve maximum cost efficiency (left panel) and another where, in addition to the maximum efficiency, the merged

firm inherits the superior demand characteristics of the two merging firms (right panel). While cost efficiencies can drive price reductions, changes in post-merger conduct often dominate these benefits. Demand-side improvements are relatively minor compared to cost efficiencies and conduct changes. Lastly, we note that the simulated maximum prices of approximately $229 in Figure 3 align closely with the observed average prices in treated markets (see Table 2), suggesting the model generates economically meaningful predictions. The contour plots consistently indicate higher post-merger conduct across both efficiency scenarios, though the magnitude of price effects varies with the assumed efficiency gains.

This empirical exercise reveals a fundamental tension in evaluating the three airline mergers. The estimated price stability could reflect either large efficiency gains offset by increased market power or modest but opposing efficiency and competitive conduct changes. This aspect creates a dilemma for merging airlines - claiming significant efficiencies implies accepting evidence of increased market power while arguing for minimal competitive effects undermines the efficiency justification for the merger. A unified approach makes this tradeoff explicit.

7 Conclusion

We have shown how bridging structural and reduced-form approaches enhances our understanding of merger effects in the airline industry. Mergers can affect prices and capacity differently, and these effects vary systematically with market structure. The magnitude of capacity changes, particularly, is difficult to explain with standard models of differentiated product competition. Indeed, when we allow for changes in strategic conduct parameters post-merger, we find evidence of increased market power that reduced-form analyses miss.

Our framework makes explicit the tradeoff between efficiency and market power, complementing the long line of research on merger evaluations (e.g., Farrell and Shapiro, 1990; Nocke and Whinston, 2010). Our empirical analysis suggests that post-merger industry competitiveness may decline, consistent with the airline industry exhibiting characteristics

that facilitate increased strategic conduct. This finding aligns with previous findings by Ciliberto and Williams (2014) and the discussion in Aryal et al. (2022) on factors that facilitate coordination in the airline industry. Further evidence on these mergers comes from Remer and Orchinik (2024), who independently developed an analysis using synthetic DiD methodology. Their research finds that merger-induced increases in multi-market contact led to higher prices, especially in the UA-CO and AA-US mergers, suggesting these mergers facilitated coordinated price effects through increased multi-market contact.

More broadly, this paper contributes to the literature examining how mergers affect market outcomes and welfare (see Nocke and Whinston, 2022). Our bridging framework demonstrates that conclusions about merger effects can differ substantially depending on whether one considers only price effects or incorporates changes in conduct and capacity. While our results support the need for joint consideration of structural and reduced-form approaches, they also emphasize that prospective analyses of mergers should be grounded in industry-specific details. Although we focus on airlines, this bridging approach can be valuable for analyzing mergers in other concentrated industries, such as beer, carbonated beverages, or breakfast cereals. See Asker and Nocke (2021) for other concentrated industries.

Looking ahead, promising directions for future research include extending our framework to incorporate endogenous market structure (e.g., Ciliberto et al., 2021), product characteristics and allowing these to change with mergers (e.g., Sweeting, 2010; Fan, 2013; Wollmann, 2018; Li et al., 2022; Bontemps et al., 2023). The challenge will be maintaining our current approach's transparency while adding these additional features. Our methodology of connecting reduced-form and structural approaches provides a valuable template for such extensions.

References

Abadie, Alberto and Javier Gardeazabal, "The Economic Costs of Conflict: A Case

Study of the Basque Country," *American Economic Review*, 2003, *93* (1), 113–132.

Aguirregabiria, Victor and C. Y. Ho, "A Dynamic Oligopoly Game of the US Airline Industry: Estimation and Policy Experiments," *Journal of Econometrics*, 2012, *168*, 156–173.

Arkhangelsky, Dimitry, Susan Athey, David A. Hirshberg, Guido W. Imbens, and Stefan Wager, "Synthetic Difference-in-Differences," *American Economic Review*, 2021, *111* (12), 4088–4118.

Aryal, Gaurab, Charles Murry, and Jonathan W. Williams, "Price Discrimination in International Airline Markets," *Review of Economic Studies*, 2024, *91* (2), 641–689.

_ , Federico Ciliberto, and Benjamin T. Leyden, "Coordinated Capacity Reductions and Public Communication in the Airline Industry," *Review of Economic Studies*, 2022, *89* (6), 3055–3084.

Ashenfelter, Orley C. and Daniel Hosken, "The Effects of Mergers on Consumer Prices: Evidence from Five Mergers on the Enforcement Margin," *Journal of Law and Economics*, 2010, *53* (3), 417–466.

_ , _ , and Matthew Weinberg, "Generating Evidence to Guide Merger Enforcement," *Competition Policy International*, 2009, *5* (1).

_ , Daniel S. Hosken, and Matthew C. Weinberg, "Efficiencies Brewed: Pricing and Consolidation in the US Beer Industry," *RAND Journal of Economics*, 2015, *46* (2), 328–361.

Asker, John and Volker Nocke, "Collusion, Mergers, and Releated Antitrust Issues," in Kate Ho, Ali Hortaçsu, and Alessandro Lizzeri, eds., *Handbook of Industrial Organization*, Vol. 5, Elsevier, 2021, chapter 12, pp. 177–279.

Baker, Jonathan B., "Econometric Analysis in FTC v. Staples," *Journal of Public Policy & Marketing*, 1999, *18* (1), 11–21.

Berry, Steven, James Levinsohn, and Ariel Pakes, "Automobile Prices in Market Equilibrium," *Econometrica*, 1995, *63* (4), 841–890.

Berry, Steven T., "Estimating Discrete-Choice Models of Product Differentiation," *RAND Journal of Economics*, 1994, *25* (2), 242–262.

_ **and Panle Jia**, "Tracing the Woes: An Empirical Analysis of the Airline Industry," *American Economic Journal: Microeconomics*, 2010, *2* (3), 1–43.

_ **and Philip A. Haile**, "Identification in Differentiated Products Markets Using Market Level Data," *Econometrica*, 2014, *82* (5), 1749–1797.

Björnerstedt, Jonas and Frank Verboven, "Merger simulation with Nested Logit Demand: Implementation using Stata," *Stata Journal*, 2014, *14* (3), 511–540.

_ **and** _ , "Does Merger Simulation Work? Evidence from the Swedish Analgesics Market," *American Economic Journal: Applied Economics*, 2016, *8* (3), 125–164.

Bontemps, Christian, Cristina Gualdani, and Kevin Remmy, "Price Competition and Endogenous Product Choice in Networks: Evidence from the US Airline Industry," *Mimeo*, 2023.

Borenstein, Severin, "Airline Mergers, Airport Dominance, and Market Power," *American Economic Review P&P*, 1990, *80* (2), 400–404.

Bresnahan, Timothy F., "The Oligopoly Solution Concept is Identified," *Economics Letters*, 1982, *10* (1-2), 87–92.

_ , "Empirical Studies of Industries with Market Power," in Richard Schmalensee and Robert Willig, eds., *Handbook of Industrial Organization*, Vol. 2, Elsevier, 1989, chapter 17, pp. 1011–1057.

Bruegge, Chris, Gautam Gowrisankaran, and Alex Gross, "A Policy Function Approach to Price Effects: an Application to the JetBlue-Spirit Merger," *Working Paper*, November 2024. Working Paper.

Carlton, Dennis, Mark Israel, Ian MacSwain, and Eugene Orlov, "Are Legacy Airline Mergers Pro- or Anti-competitive? Evidence From Recent U.S. Airline Mergers," *International Journal of Industrial Organization*, 2019, *62*, 58–95.

Ciliberto, Federico and Jonathan W. Williams, "Does Multimarket Contact Facilitate Tacit Collusion? Inference on Conduct Parameters in the Airline Industry," *RAND Journal of Economics*, 2014, *45* (4), 764–791.

_ , Charles Murry, and Elie Tamer, "Market Structure and Competition in Airline Markets," *Journal of Political Economy*, 2021, *129* (11), 2995–3038.

Clarke, Damian, Daniel Pailañir, Susan Athey, and Guido Imbens, "Synthetic Difference In Differences Estimation," *Mimeo*, 2023.

Dafny, Leemore, "Estimation and Identification of Merger Effects: An Application to Hospital Mergers," *Journal of Law and Economics*, 2009, *52* (3), 523–550.

_ , Mark Duggan, and Subramaniam Ramanarayanan, "Paying a Premium on Your Premium? Consolidation in the US Health Insurance Industry," *American Economic Review*, 2012, *102* (2), 1161–1185.

Das, Somnath, "Effect of Merger on Market Price and Product Quality: American and US Airways," *Review of Industrial Organization*, 2019, *55* (3), 339–374.

Davis, Peter, "The Effect of Local Competition on Admission Prices in the U.S. Motion Picture Exhibition Market," *Journal of Law & Economics*, 2005, *48* (2), 677–707.

de Chaisemartin, Clément and Xavier D'Haultfœuille, "Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects," *American Economic Review*, 2020, *110* (9), 2964–2996.

Duch-Brown, Nestor, Lukasz Grzybowski, André Romahn, and Frank Verboven, "Evaluating the Impact of Online Market Integration - Evidence from the EU Portable PC Market," *American Economic Journal: Microeconomics*, 2023, *15* (4), 268–305.

Eizenberg, Alon and Omri Zvuluni, "An Empirical Analysis of Merger Efficiencies," *Mimeo*, 2024.

Fan, Ying, "Ownership Consolidation and Product Characteristics: A Study of the US Daily Newspaper Market," *American Economic Review*, 2013, *103* (5), 1598–1628.

Farrell, Joseph and Carl Shapiro, "Horizontal Mergers: An Equilibrium Analysis," *American Economic Review*, 1990, *80* (1), 107–126.

Focarelli, Dario and Fabio Panetta, "Are Mergers Beneficial to Consumers? Evidence from the Market for Bank Deposits," *American Economic Review*, 2003, *93* (4), 1152–1172.

Friedberg, Leora, "Did Unilateral Divorce Raise Divorce Rates? Evidence from Panel Data," *American Economic Review*, 1998, *88* (3), 608–627.

Halvorsen, Robert and Raymind Palmquist, "The Interpretation of Dummy Variables in Semilogarithmic Equations," *American Economic Review*, 1980, *70* (3), 474–475.

Hansen, Lars P., "Large Sample Properties of Generalized Method of Moments Estimators," *Econometrica*, 1982, *50* (4), 1029–1054.

Hastings, Justine S., "Vertical Relationships and Competition in Retail Gasoline Markets: Empirical Evidence from Contract Changes in Southern California," *American Economic Review*, 2004, *94* (1), 317–328.

Igami, Mitsuru and Takuo Sugaya, "Measuring the Incentive to Collude: The Vitamin Cartels, 1990–99," *Review of Economic Studies*, 2022, *89*, 1460–1494.

Kim, E. Han and Vijay Singal, "Mergers and Market Power: Evidence from the Airline Industry," *American Economic Review*, 1993, *83* (3).

Kwoka, Jr., John E., *Mergers, Merger Control, and Remedies: A Retrospective Analysus of U.S. Policy*, MIT Press, December 2014.

Li, Sophia, Joe Mazur, Yongjoon Park, James Roberts, Andrew Sweeting, and Jun Zhang, "Repositioning and Market Power After Airline Mergers," *RAND Journal of Economics*, 2022, *53* (1), 166–199.

Miller, Nathan H. and Matthew C. Weinberg, "Understanding the Price Effects of the MillerCoors Joint Venture," *Econometrica*, 2017, *85* (6), 1763–1791.

Nevo, Aviv, "Mergers with Differentiated Products: The Case of the Ready-to-eat Cereal Industry," *RAND Journal of Economics*, 2000, *31* (3), 395–421.

_ **and Michael D. Whinston**, "Taking the Dogma out of Econometrics: Structural Modeling and Credible Inference," *Journal of Economic Perspectives*, 2010, *24* (2), 69–82.

Nocke, Volker and Michael D. Whinston, "Dynamic Merger Review," *Journal of Political Economy*, 2010, *118* (6), 1201–1251.

_ **and** _ , "Concentration Thresholds for Horizontal Mergers," *American Economic Review*, 2022, *112* (6), 1915–1948.

Olley, G. Steven and Robert Town, "End of an Era: The American Airlines- US Airways Merger (2014)," in John E. Kwoka, Jr. and Lawrence J. White, eds., *The Antitrust Revolution: Economics, Competition, and Policy*, seventh ed., Oxford University Press, 2018, chapter 19, pp. 448–470.

Olsen, Andrew, Reed Orchinik, and Marc Remer, "Price Effects in U.S. Merger Retrospectives: A Meta-Analytic Approach," *Mimeo*, 2024.

Pesendorfer, Martin, "Horizontal Mergers in the Paper Industry," *RAND Journal of Economics*, 2003, *34* (3), 495–515.

Porter, Robert H., "Merger and Coordinated Effects," *International Journal of Industrial Organization*, 2020, *93*, 102583.

Remer, Marc and Reed Orchinik, "Multimarket Contact and Prices: Evidence From an Airline Merger Wave," *Mimeo*, 2024.

Roth, Jonathan and Pedro H.C. Sant'Anna, "When is Parallel Trends Sensitive to Functional Form?," *Econometrica*, 2023, *91* (2), 737–747.

Sweeting, Andrew, "The Effects of Mergers on Product Positioning: Evidence From The Music Radio Industry," *RAND Journal of Economics*, 2010, *41* (2), 372–397.

U.S. District Court, MA, "U.S. vs. American Airlines Group Inc. and JetBlue Airways Corporation," Civil No. 21-11558-LTS May 2023.

Verboven, Frank, "International Price Discrimination in the European Car Market," *RAND Journal of Economics*, 1996, *27* (2), 240–268.

Whinston, Michael D., *Lectures on Antitrust*, MIT Press, 2006.

Wollmann, Thomas G., "Trucks without Bailouts: Equilibrium Product Characteristics for Commercial Vehicles," *American Economic Review*, 2018, *108* (6), 1364–1406.

Wooldridge, Jeffrey M., *Econometric Analysis of Cross Section and Panel Data*, 2 ed., MIT Press, 2010.

Wright, Philip G., *The Tariff on Animal and Vegetable Oils*, The Macmillan Company, 1928.

Appendix

A Data Construction

A.1 Origin and Destination Survey (DB1B)

Our main data source is the domestic Origin and Destination Survey (DB1B), a 10% sample of airline tickets from all reporting carriers. This dataset is available from the U.S. DOT's National Transportation Library. We clean the data by removing the following:

- Tickets with more than six coupons or more than three coupons in either direction.
- Tickets sold by foreign carriers flying between two U.S. airports.
- Tickets that are part of international travel.
- Tickets involving non-contiguous domestic travel (Hawaii, Alaska, and Territories).
- Tickets with questionable fare credibility or bulk fare indicators.
- Tickets that are neither one-way nor roundtrip.
- Interline tickets (travel on more than one airline in a directional trip).

We treat roundtrip tickets as two separate directional trips, with the price for each direction being half of the roundtrip price. A passenger flying on a roundtrip ticket is counted as a single passenger in both directions. We exclude tickets cheaper than $25, those in the top and bottom 1% of the year-quarter fare distribution, and airlines serving fewer than 90 passengers per quarter.

A.2 T-100 Domestic Market (U.S. Carriers)

This dataset contains domestic nonstop segment data reported by U.S. air carriers, including carrier, origin, destination, and available capacity. We use this dataset to obtain information on carriers' capacity on their nonstop routes.

A.3 Additional Data Tables

Tables A.1 and A.2 present summary statistics for the key variables employed in our empirical analysis. Table A.1 displays the descriptive statistics for variables used in estimating the linear structural model described in Section 4, including market concentration, pricing, and service quality measures. Table A.2 summarizes the variables incorporated in our nested logit discrete choice framework in Section 6. These variables capture various product characteristics, including price, service type, and carrier attributes that influence consumer choices in the airline industry. For each merger, the sample for these tables includes all pairwise combinations of the top 50 populated origin and destination markets, restricted to three years before the merger. This sampling approach ensures sufficient market coverage while maintaining a manageable dataset focused on the pre-merger competitive landscape.

Table A.1: Summary Statistics –I

Variable	Mean	Median	SD
DL-NW			
Quantity (10,000s)	3.4041	2.5625	3.1592
Price ($100)	1.8717	1.8349	0.5074
Market size (1,000,000s)	3.6211	3.1279	1.9928
Per-Capita Income at Origin ($10,000)	42.0451	41.0382	6.5522
Per-Capita Income at Destination ($10,000)	42.0489	41.0564	6.5502
Net Migration at Origin (100)	0.0979	0.0515	0.3162
Net Migration at Destination (100)	0.0975	0.0515	0.3157
Population at Origin (1,000,000)	4.8210	3.1827	4.6315
Population at Destination (1,000,000)	4.8094	3.1032	4.6361
Births in Market (100,000)	22,242.79	19,689.00	16,731.96
Deaths in Market (100,000)	10,694.55	8,820.00	8,073.81
Ratio of Nonstop passengers	0.8409	0.8937	0.1779
UA-CO			
Quantity (10,000s)	3.4753	2.5430	3.4403
Price ($100)	1.9410	1.8765	0.5183
Market size (1,000,000)	3.7576	3.2795	2.0466
Per-Capita Income at Origin ($10,000)	43.7443	42.9350	7.1511
Per-Capita Income at Destination ($10,000)	43.7459	42.9350	7.1509
Net Migration at Origin (100)	0.1432	0.0596	0.2420
Net Migration at Destination (100)	0.1432	0.0596	0.2416
Population at Origin (1,000,000)	5.0334	3.3734	4.7191
Population at Destination(1,000,000)	5.0202	3.3400	4.7316
Births in Market (100,000)	23,283.55	20,683.20	15,904.49
Deaths in Market (100,000)	11,701.28	10,380.60	8,047.72
Ratio of Nonstop passengers	0.8484	0.8878	0.1518
AA-US			
Quantity (10,000s)	3.3443	2.5250	3.1662
Price (100)	2.0874	2.0239	0.5027
Market size (1,000,000)	3.8320	3.4570	1.8798
Per-Capita Income at Origin ($10,000)	48.6923	47.5981	7.9698
Per-Capita Income at Destination ($10,000)	48.6793	47.5981	7.9674
Net Migration at Origin (100)	0.1941	0.1378	0.3408
Net Migration at Destination (100)	0.1935	0.1378	0.3400
Population at Origin (1,000,000)	5.2040	3.4762	4.8102
Population at Destination (1,000,000)	5.1877	3.4762	4.8144
Births in Market (100,000)	26,604.41	24,094.80	13,557.27
Deaths in Market (100,000)	14,331.84	12,780.80	7,384.71
Ratio of Nonstop passengers	0.8248	0.8688	0.1704

Notes: Summary statistics table of the variables (and their units of measurement) used to estimate the structural model in Section 4. For each merger, the sample includes all pairwise combination of the top 50 populated origin and destination markets, restricted to three years leading up to the said merger.

Table A.2: Summary Statistics –II

Variable	Mean	Median	SD
DL-NW			
Log (Share of product / Share outside good)	-8.0909	-8.2547	1.4772
Price	2.1486	2.1003	0.5731
Log (Share of product j in subgroup h)	-1.8762	-1.8101	1.0944
Log (Share of subgroup h in group g)	-0.8807	-0.5281	1.0340
Nonstop	0.1985	0.0000	0.3988
Ticketing Carrier	0.6203	0.6200	0.2606
Distance	1.2402	1.0809	0.6542
UA-CO			
Log (Share of product / Share outside good)	-8.0888	-8.2361	1.4730
Price	2.1029	2.0458	0.5684
Log (Share of product j in subgroup h)	-1.8276	-1.7571	1.0905
Log (Share of subgroup h in group g)	-0.8825	-0.5226	1.0464
Nonstop	0.2065	0.0000	0.4048
Ticketing Carrier	0.6123	0.5800	0.2643
Distance	1.2482	1.0947	0.6525
AA-US			
Log (Share of product / Share outside good)	-7.9341	-8.0130	1.4397
Price	2.2286	2.1880	0.5541
Log (share of product j in subgroup h)	-1.6707	-1.5548	1.0525
Log (share of subgroup h in group g)	-0.8306	-0.4725	0.9989
Nonstop	0.2223	0.0000	0.4158
Ticketing Carrier	0.6989	0.6800	0.2964
Distance	1.2229	1.0628	0.6528

Notes: Summary statistics table of the variables used to estimate the nested-logit discrete choice model in Section 6, separated by the merger. For each merger, the sample includes all pairwise combination of the top 50 populated origin and destination markets, restricted to three years leading up to the said merger.

B Retrospective Analysis: Robustness

B.1 DiD Estimation with Levels

We now re-estimate Equation (1) using levels instead of logs (presented in Table 3). This exercise serves two immediate purposes. First, it provides a robustness check of our DiD estimates, as economic theory does not specify whether parallel trends should hold in logs or levels. Finding consistent results across both specifications would strengthen our conclusions (see Roth and Sant'Anna (2023) for a discussion of the sensitivity of DiD to functional form). Second, since our structural model in Section 4 is specified in levels, these estimates enable direct comparison with our structural analysis.

Table B.1: Estimated Effects of Mergers (levels)

	Merger Cases			
Outcomes	DL-NW	UA-CO	AA-US	Pooled
Panel A: Fixed Effects				
Airfare	-6.685**	1.762	-16.136***	-8.680***
Passengers	3.728***	0.815	4.389***	3.256***
Offered Seats	33.968***	32.898***	24.585***	29.130***
Panel B: First Differences				
Airfare	-0.765	-1.662***	-1.302	-1.335**
Passengers	0.335**	-0.226	2.229***	1.043**
Offered Seats	4.756***	3.121***	5.995***	4.915***

Notes: This table reports DiD estimates from Equation (1) for airfare, passenger volume and offered seats. These variables are measured in levels, where seats are in 1,000. The analysis is structured such that the first three columns show the estimates for the three mergers separately, and the last column shows the estimates for the "pooled" sample. Panel A presents results using mean-deviation fixed effects, and Panel B presents results using the first differences method. $^{***}: p < 0.01$; $^{**}: p < 0.05$.

The estimates are displayed in Table B.1. Panel A shows substantial merger effects when using the fixed effects approach. The DL-NW merger reduced fares by \$6.69 ($\approx 3\% = (6.69/225.39)\%$ relative to pre-merger fares) while increasing passengers by 3,728 and capacity by 34,000 seats per market. These effects are both economically and statistically significant. The UA-CO merger showed minimal price effects (\$1.76 increase, statistically insignificant) but similar capacity expansion. The AA-US merger generated the largest fare reduction of \$16.14 (6.8%) with a significant increase in passenger volume and offered seats.

However, these effects largely disappear under the first differences (Panel B) method. The DL-NW fare effect drops to an insignificant -\$0.77, while UA-CO shows a modest -\$1.66 decrease. The AA-US fare effect shrinks to an insignificant -\$1.30 (from a substantial increase of \$32.9 under fixed effects). Similarly, passenger and capacity effects attenuate by 80-85%, though remaining statistically significant.

These findings provide evidence of stable post-merger prices and align with our main findings in Section 3 Table 3, indicating more modest merger effects than traditional fixed effects approaches might suggest.

B.2 Analysis at the Airline-Market Level

For our main analysis presented in Table 3, we estimated Equation (1) at the market level, where each observation represents a unique market-time pair (e.g., the logarithm of average flight prices for Atlanta to St. Louis market at a given time). As a robustness check, we consider the fixed effects (mean deviation) estimator to examine whether the competitive merger effects documented in Table 3 Panel A might have been driven by market-level aggregation. In particular, we extend our analysis by estimating merger effects at the more granular market-airline level. In this specification, each observation corresponds to a unique market-airline-time combination—for instance, the logarithm of average prices for flights operated by Delta in the ATL-STL market at a specific period.

Our primary variable of interest remains ($\text{Treated}_{mt} \times \text{Post-Merger}_{mt}$) as defined in Equation (1). However, instead of incorporating market fixed effects, we include "market-airline" fixed effects while retaining the time fixed effects. Similarly, the % nonstop now measures the percentage of nonstop passengers for a specific airline in a given market.

Table B.2: Estimated Effects of Mergers (Airline-Market Level)

	DL/NW merger	UA/CO merger	AA/US merger	Pooled
Log (Prices)	-0.102***	-0.036	-0.127***	-0.088***
	(0.026)	(0.025)	(0.023)	(0.015)
Log (Passengers)	0.098	0.370**	-0.035	0.139
	(0.075)	(0.164)	(0.173)	(0.090)
Log (Offered Seats)	0.598***	0.920***	0.685***	0.733***
	(0.221)	(0.354)	(0.231)	(0.161)

Note: This table reports DiD (fixed effect) estimates from Equation (1) for airfare, passenger volume and offered seats, defined at the airline-market-time level. The analysis is structured such that the first three columns show the estimates for the three mergers separately, and the last column shows the estimates for the "pooled" sample. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$

The results from this estimation exercise are presented in Table B.2. The estimates broadly corroborate the main findings in Table 3 Panel A. Merger effects, when estimated at the airline level, continue to appear pro-competitive—prices decrease while output and capacity increase in overlap markets relative to control markets.

B.3 Pre- and Post-Merger Windows

In our baseline specifications, we defined the pre- and post-merger periods as 8 quarters before and after the quarter in which the merger was approved. However, there is no consensus in the literature regarding the optimal window length for measuring merger effects. While shorter windows may provide cleaner identification of immediate merger impacts by reducing

confounding factors, they also result in smaller sample sizes and potentially less statistical power. To assess the sensitivity of the results in Table 3 Panel A to the chosen time window, we re-estimate Equation (1) using substantially narrower windows—specifically, one month and two months before and after merger approval.

Table B.3: Estimated Effects of Mergers (Different Time Windows)

	Merger Cases			
Outcomes	DL-NW	UA-CO	AA-US	Pooled
Panel A: 1 month before/after merger				
Log (Price)	0.032	0.005	0.011	0.016
Log (Passengers)	-0.203***	-0.051	0.167*	0.027
Log (Offered Seats)	0.103**	0.049***	0.166***	0.129***
Panel B: 2 months before/after merger				
Log (Price)	0.015	0.019	-0.014	-0.001
Log (Passengers)	-0.126***	0.004	0.164***	0.075*
Log (Offered Seats)	0.130***	0.134***	0.175***	0.163***

Notes: This table reports DiD estimates from Equation (1) for airfare, passenger volume and offered seats. Panel A presents results using one month before/after as relevant period to estimate merger effects across, and Panel B presents results using two month before/after as relevant period. $^{***}: p < 0.01$; $^{**}: p < 0.05$.

We present the results in Table B.3. Panel A shows that when using only one month before/after as the relevant period, the merger effects on airfares are imprecisely estimated across all merger cases. The effects on passenger volume appear mixed, with significant negative effects for DL-NW, insignificant effects for UA-CO, and marginally significant positive effects for AA-US. However, capacity (offered seats) consistently shows significant increases in overlap routes across all mergers. Panel B presents results using a two-month window. The pattern is similar—airfare effects remain statistically insignificant, passenger volume effects vary across merger cases, and capacity effects maintain positive significance across all mergers. These findings suggest that the immediate effects of mergers differ from longer-term impacts, with capacity adjustments occurring more rapidly than price and demand responses. The consistent positive effect on offered seats across both time windows indicates that merged airlines quickly increased capacity in overlapping markets. However, the corresponding price adjustments and passenger volumes may require more time to materialize or stabilize.

B.4 Alternative Control Market Definition

Our main analysis excludes overlap routes from all mergers when selecting control markets. So, the overlap routes of subsequent mergers are not included in the control group for preceding mergers—specifically, UA-CO and AA-US overlaps are excluded from the DL-NW control selection, and AA-US overlaps are excluded from the UA-CO control selection. To

test the robustness of our findings to this methodological choice, we conduct an alternative analysis where we relax this restriction and allow overlap routes from subsequent mergers to potentially serve as controls for preceding mergers.

Table B.4: Estimated Effects of Merger (Alternative Control Markets)

Outcome	DL-NW	UA-CO	AA-US	Pooled
Log (Price)	-0.102***	-0.036	-0.127***	-0.088***
	(0.026)	(0.025)	(0.023)	(0.015)
Log (Passengers)	0.098	0.370**	-0.035	0.139
	(0.075)	(0.164)	(0.173)	(0.090)
Log (Offered Seats)	0.598***	0.920***	0.685***	0.733***
	(0.221)	(0.354)	(0.231)	(0.161)

Note: This table reports DiD estimates from Equation (1) for airfare, passenger volume and offered seats, using a different definition of control markets, using the fixed effect (mean deviation) approach. We allow for overlapping markets of succeeding mergers to be selected as control for preceding mergers.

We present the results from this modified approach in Table B.4. The findings remain consistent with our main results, indicating that mergers led to a price fall and increased capacity in overlap routes. Specifically, we observe statistically significant price decreases for the DL-NW and AA-US mergers and the pooled analysis. Passenger volume effects are positive but generally less precisely estimated, with only the UA-CO merger showing a statistically significant increase. Most notably, offered seats show large, positive, and highly significant increases across all merger cases and in the pooled analysis.

B.5 Pre-trend Analysis

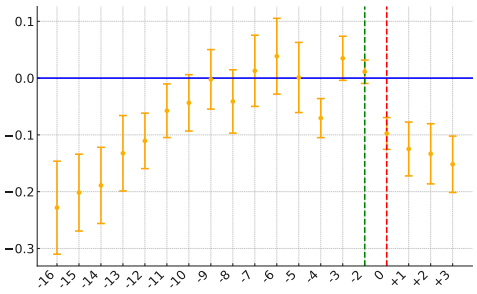
In Figure B.1, we present the estimates from pre-trend analysis for 2 to 1 markets, mirroring the methodology employed in Figure 2 for 3 to 2 markets, except for UA-CO merger, there are not any 2 to 1 treated markets. The results reveal that the merger coefficients for price and passenger volume exhibit substantial instability in pre-merger periods across the two mergers. This instability suggests a violation of the parallel trends assumption.

B.6 Synthetic DiD

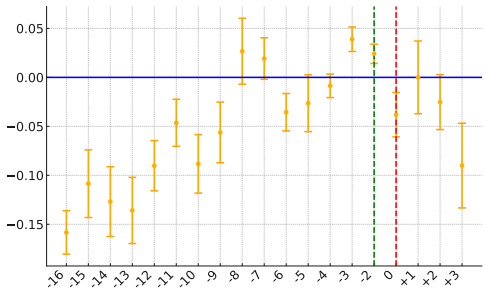
The identification of appropriate control markets presents a fundamental challenge in merger analysis. The ideal control group should closely mirror the counterfactual evolution of treated markets in the absence of the merger, satisfying the parallel trends assumption crucial for DiD estimation. As Ashenfelter et al. (2009) observe, researchers face an inherent trade-off: control markets must be geographically distant enough to avoid merger spillovers yet similar enough to face comparable demand and cost conditions. This presents what Ashenfelter et al. (2009) term the "similarity-independence tension" in control market selection.

Recent methodological innovations offer a promising avenue to address this issue. The synthetic control method (Abadie and Gardeazabal, 2003) extended to the DiD framework

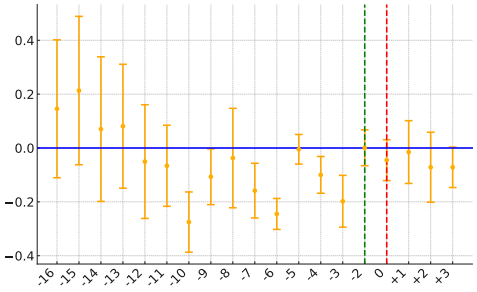
Figure B.1: Pre-Trends Analysis



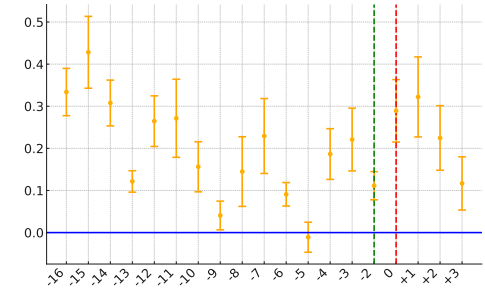
Airfares: (a) DL-NW



(b) AA-US



Passenger (c) DL-NW



(d) AA-US

Note: This figure presents event study estimates examining pre-merger trends in airfares (in subfigures (a) and (b)) and passenger volumes (in subfigures (d) and (e)) across Dl-NW and AA-US mergers for 2 to 1 markets. Each panel plots quarterly coefficients from a regression of log(price) or log(passengers) on merger-market interaction terms, with quarter 0 marking the merger's completion date. The y-axis represents the estimated differential between merger-affected and control markets, while the x-axis measures quarters relative to the merger. Vertical bars denote 95% confidence intervals constructed using standard errors clustered at the market level.

by Arkhangelsky et al. (2021) provides a data-driven approach to constructing control markets. This method systematically combines potential control markets to create a synthetic comparison group that better approximates the counterfactual of the treated markets. Providing a systematic method to construct control groups reduces researcher discretion in market selection and relaxes the rigid assumptions about trend specifications inherent in our previous analysis. For instance, when analyzing the DL-NW merger, a treated market with pre-merger characteristics similar to DL-NW overlap markets would receive a higher weight than a dissimilar market without parametric assumptions about the evolution of market outcomes.

We apply this approach using the implementation package developed by Clarke et al. (2023) to reassess the findings in Table 3. The estimates are presented in Table B.5. These effects suggest three key results. First, we find limited evidence of merger effects on prices and passenger volumes. For instance, the UA-CO merger shows a minimal fare effect of -0.4% in levels and -0.8% in first differences (the latter being marginally significant). The passenger volume effects are similarly modest, approximately 1% in both specifications, and

Table B.5: Estimated Effects of Mergers (Synthetic DiD)

	Merger Cases		
Outcomes	DL-NW	UA-CO	AA-US
Panel A: Levels			
Log (Price)	-0.015	-0.004	-0.035
	(0.022)	(0.012)	(0.032)
Log (Passengers)	0.048	0.011	0.178
	(0.034)	(0.026)	(0.052)
Log (Offered Seats)	0.130	0.213***	0.130**
	(0.099)	(0.015)	(0.030)
Panel B: First Differences			
Log (Price)	-0.003	-0.008*	-0.000
	(0.007)	(0.004)	(0.0006)
Log (Passengers)	0.005	0.005	0.018
	(0.034)	(0.013)	(0.011)
Log (Offered Seats)	0.020	0.053***	0.020**
	(0.017)	(0.013)	(0.009)

Notes: This table presents synthetic DiD estimates of merger effects for three airline mergers. The synthetic control approach constructs comparison groups that better approximate the counterfactual evolution of treated markets. Panel A reports estimates using outcome levels, while Panel B presents results using first differences. Standard errors are reported in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

statistically indistinguishable from zero. These estimates suggest economically negligible price impacts from the merger.

Second, our capacity analysis reveals an intriguing contrast between level and first-difference specifications. The levels estimation in Panel A indicates substantial capacity expansion, with effects ranging from 13.9% to 23.7% across mergers (UA-CO exhibiting the largest increase). However, these effects attenuate considerably in the first-difference specification (Panel B), declining to a range of 2.0% to 5.4%. This marked disparity between specifications warrants careful interpretation of the capacity effects.

Third, these findings broadly align with the estimates reported in Table 3 Panel B, particularly for prices and passenger volume. However, the synthetic control approach yields notably smaller capacity effects than our baseline estimates.

C Demand Estimation

Recall that we partition the choice set in market $m \times t$ into two primary groups: the outside option ($g = 0$) for not flying and inside goods ($g = 1$) for available flights. Inside goods are subdivided into nonstop ($h = 1$) and connecting services ($h = 2$). Following Verboven (1996); Björnerstedt and Verboven (2014); Ciliberto and Williams (2014) and Björnerstedt and Verboven (2016), under the extreme value distribution (Berry, 1994; Verboven, 1996), we derive the estimating equation for the two-level nested logit model:

$$\begin{aligned} \ln(s_{jmt}/s_{0mt}) = X_{jmt}\boldsymbol{\phi} + \varrho p_{jmt} + \sigma_1 \ln(s_{jmt}/S_{h1mt}) \\ +\sigma_2 \ln(S_{h1mt}/S_{1mt}) + \xi_j + \xi_t + \xi_{jmt}, \end{aligned} \tag{C.1}$$

where $S_{h1mt} = \sum_{j \in J_{h1mt}} s_{jmt}$ the total market share of products in subgroup h (connecting vs nonstop), and $S_{1mt} = S_{11mt} + S_{21mt}$ is the combined market share of all airline service, and the shares s_{jmt} are defined in Equation (9).

The model captures market structure through two key ratios: s_{jmt}/S_{h1mt} represents product j's share within its subgroup (connecting or nonstop), while S_{h1mt}/S_{1mt} represents the subgroup's share among all airline products. The share of the outside option (not fly) is $s_{0mt} = 1 - S_{1mt}$.

Identifying demand parameters requires addressing the endogeneity of prices and nonstop service indicators in Equation (C.1). Building on Ciliberto et al. (2021), we employ two exclusion restrictions. First, we exclude destination networks from demand, assuming they affect utility only through prices and costs. Second, we use competitor networks as instruments for price variation while keeping the origin network as a demand shifter, exploiting the fact that destination networks primarily affect costs and competition but not utility.

We use the `mergersim` program (Björnerstedt and Verboven, 2014, 2016) for estimation and present the results for three mergers in Table C.1. The results show remarkable consistency, particularly in own-price elasticities (averaging -4.3, with -4.57 for DL-NW, -4.07 for UA-CO, and -4.33 for AA-US). This stability in price responsiveness across different mergers suggests fundamental similarities in consumer behavior in airline markets. The nested logit structure reveals clear hierarchical choice patterns, with the nesting parameters (σ_1 and σ_2) satisfying theoretical restrictions across all cases. The within-subgroup correlation (σ_1) ranges from 0.26 to 0.58, while the within-group correlation (σ_2) ranges from 0.02 to 0.17. A similar pattern is reflected in the cross-price elasticities, which show the strongest substitution within subgroups (0.27 to 0.97), weaker substitution across groups (0.01 to 0.11), and minimal substitution to not flying (0.002 to 0.005). All coefficients are statistically significant at the 1% level across all mergers.

Other market characteristics show significant effects: carrier presence at origin airports (city-origin-ticketing carrier: 0.63-0.72) indicates the value of frequent flyer programs, route distance effects (city-market-distance: 0.66-0.87) suggest network advantages on longer routes, and substantial nonstop premiums (nonstop: 2.50-3.03) demonstrate a strong preference for direct flights.

We conduct extensive robustness checks using various instrument combinations and model specifications to validate our identification strategy and assess result sensitivity. These tests serve to (1) evaluate our exclusion restrictions' validity, (2) examine demand parame-

Table C.1: Demand estimation, by Merger

Variables\Merger	DL-NW	UA-CO	AA-US
Airfare	-1.0219***	-1.0373***	-1.4985***
	(0.0136)	(0.0153)	(0.0256)
M_{lsjh}	0.5814***	0.4818***	0.2572***
	(0.0064)	(0.0064)	(0.0092)
M_{lshg}	0.0246***	0.0817***	0.1676***
	(0.0064)	(0.0066)	(0.0098)
Nonstop	2.4955***	2.6256***	3.0311***
	(0.0167)	(0.0170)	(0.0225)
Ticketing Carrier	0.6289***	0.7185***	0.6426***
	(0.0143)	(0.0147)	(0.0176)
Distance	0.6659***	0.6591***	0.8713***
	(0.0064)	(0.0071)	(0.0118)

Notes: This table presents estimates of demand parameters, by merger cases. For each merger, the sample includes all pairwise combination of the top 50 populated origin and destination markets, restricted to three years leading up to the said merger. Nonstop is the indicator variable for nonstop services, from the OAG data, and the ticketing carrier is the carrier that sells ticket at the origin city. Standard errors are reported in parentheses.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

ter stability across different identifying assumptions, and (3) address potential weak instrument concerns. The alternative specifications confirm our main identification approach and highlight the inherent challenges in identifying airline demand parameters, revealing which structural features remain consistent across specifications and which are more sensitive to identification choices.

The estimates from this exercise for only the AA-US sample are displayed in Table C.2. The comparison between OLS and various IV specifications reveals clear evidence of price endogeneity. The OLS price coefficient (-0.640) is substantially smaller than most IV estimates, consistent with the expected upward bias due to the correlation between prices and unobserved quality. This finding underscores the importance of proper identification in our demand estimation.

Before discussing each set of IVs, we present our identification strategy. Our approach builds on a key insight from the literature that the airlines' decisions to establish a presence in some markets are long-term strategic choices that are unlikely to depend on short-term demand or cost shocks. If so, we can construct IVs based on carriers' network structures. In particular, for each market, we create a vector of IVs that measure the number of markets each major airline serves from the origin and destination airports. This approach captures the scope of carriers' networks, which are largely fixed in the short run but affect pricing decisions and the provision of nonstop service.

Importantly, these network measures also help identify the nesting parameters (σ_1 and σ_2) by explaining variation in market shares at different levels of the nesting structure.

The level of airlines' networks affects their market presence and service offerings, affecting the relative shares of products within service-type nests (nonstop vs. connecting) and the overall share of air travel relative to the outside option of not flying. The effectiveness of these IVs is reflected in the precision of our estimates of the nesting parameters, with small standard errors across our preferred specifications. This result stands in marked contrast to earlier work with nested logit models in other industries, such as Verboven (1996)'s study of automobile markets, where identifying the nesting parameters proved more challenging.

IV Set 1 establishes our base approach with two key innovations. First, we treat nonstop service as endogenous alongside prices, addressing the concern that airlines' decisions to offer nonstop service correlate with unobserved market characteristics that affect demand. Second, we exclude the destination networks of merging parties from our instrument set, as these networks will change due to the merger itself. Including them would implicitly assume that post-merger network structures remain unchanged, potentially biasing merger predictions.

IV Set 2, our baseline specification (as shown in Table C.1) further restricts the instrument set by excluding competitors' nonstop destination networks. This specification explores whether the presence of nonstop service by competitors at destinations might be correlated with unobserved market characteristics that affect demand. Despite this more restrictive approach, the results remain stable: the price coefficient changes only slightly (from -1.477 to -1.498), while the nesting parameters continue to satisfy theoretical restrictions with σ_1 = 0.257 and σ_2 = 0.168.

IV Set 3 follows the original Ciliberto et al. (2021) approach by including the networks of merging firms among the instruments. This less restrictive specification lets us compare our results directly with the established literature. The results maintain stability with this different approach to instrumentation: while the price coefficient decreases somewhat (-1.043), it remains in a plausible range, and the nesting parameters ($\sigma_1 = 0.191$, $\sigma_2 = 0.188$) continue to satisfy theoretical restrictions. The robustness checks reveal that proper identification is crucial for obtaining reasonable price coefficients and maintaining the nested logit model's theoretical coherence.

IV Set 4, which excludes the destination networks of the carrier corresponding to each observation, produces theoretically inconsistent results: the nesting parameters violate the required restrictions with σ_1 = -0.363 and σ_2 = 0.952, and the own-price elasticity becomes implausibly large (-12.731).

IV Set 6 returns to the Ciliberto et al. (2021) instrument set but treats nonstop service as exogenous rather than endogenous. The results strongly support our choice to treat nonstop as endogenous: when we fail to do so, we obtain theoretically inconsistent nesting parameters (σ_1 = -0.370, σ_2 = 0.163), an implausibly small price coefficient (-0.514), and an unreasonably low own-price elasticity (-0.988).

Finally, **IV Sets 6 and 7** adopt the traditional approach to instruments in the spirit of Bresnahan (1989) and Berry et al. (1995), using the sum of competitors' origin networks as instruments. Set 6 treats nonstop service as exogenous, while Set 7 treats it as endogenous. Remarkably, both specifications produce results that are broadly consistent with our main findings. Set 6 yields a price coefficient of -1.189 and an elasticity of -3.069, while Set 7 generates similar estimates with a price coefficient of -1.176 and an elasticity of -3.123. The nesting parameters in both specifications satisfy theoretical restrictions (Set 6: $\sigma_1 = 0.153$, $\sigma_2 = 0.067$; Set 7: $\sigma_1 = 0.191$, $\sigma_2 = 0.034$) and remain in plausible ranges.

Table C.2: Demand Estimates: Robustness

	OLS	IV Set 1	IV Set 2	IV Set 3	IV Set 4	IV Set 5	IV Set 6	IV Set 7
Panel A: Demand Estimates								
Airfare	-0.640	-1.477	-1.498	-1.043	-1.415	-0.514	-1.189	-1.176
	(0.004)	(0.017)	(0.026)	(0.021)	(0.034)	(0.031)	(0.021)	(0.021)
σ_1	0.583	0.229	0.257	0.191	-0.363	-0.370	0.153	0.191
	(0.002)	(0.008)	(0.009)	(0.008)	(0.024)	(0.014)	(0.006)	(0.007)
σ_2	0.329	0.247	0.168	0.188	0.952	0.163	0.067	0.034
	(0.002)	(0.008)	(0.010)	(0.009)	(0.026)	(0.008)	(0.004)	(0.005)
Nonstop	1.394	2.978	3.031	2.891	5.456	2.395	2.005	1.942
	(0.006)	(0.021)	(0.022)	(0.020)	(0.084)	(0.013)	(0.009)	(0.010)
City-Ticketing Carrier-Markets	1.337	0.742	0.643	0.763	0.419	1.338	1.132	1.116
	(0.011)	(0.017)	(0.018)	(0.016)	(0.035)	(0.020)	(0.014)	(0.014)
Distance	0.327	0.821	0.871	0.649	0.749	0.246	0.617	0.624
	(0.004)	(0.009)	(0.012)	(0.010)	(0.017)	(0.015)	(0.009)	(0.009)
Panel B: Elasticity Estimates								
Own-Price Elasticity	-2.971	-4.217	-4.326	-2.844	-12.731	-0.988	-3.069	-3.123
Observations	158,892	158,892	158,892	158,892	158,892	158,892	158,892	158,892
Nonstop Treated as Endogenous	✗	✓	✓	✓	✓	✗	✗	✓

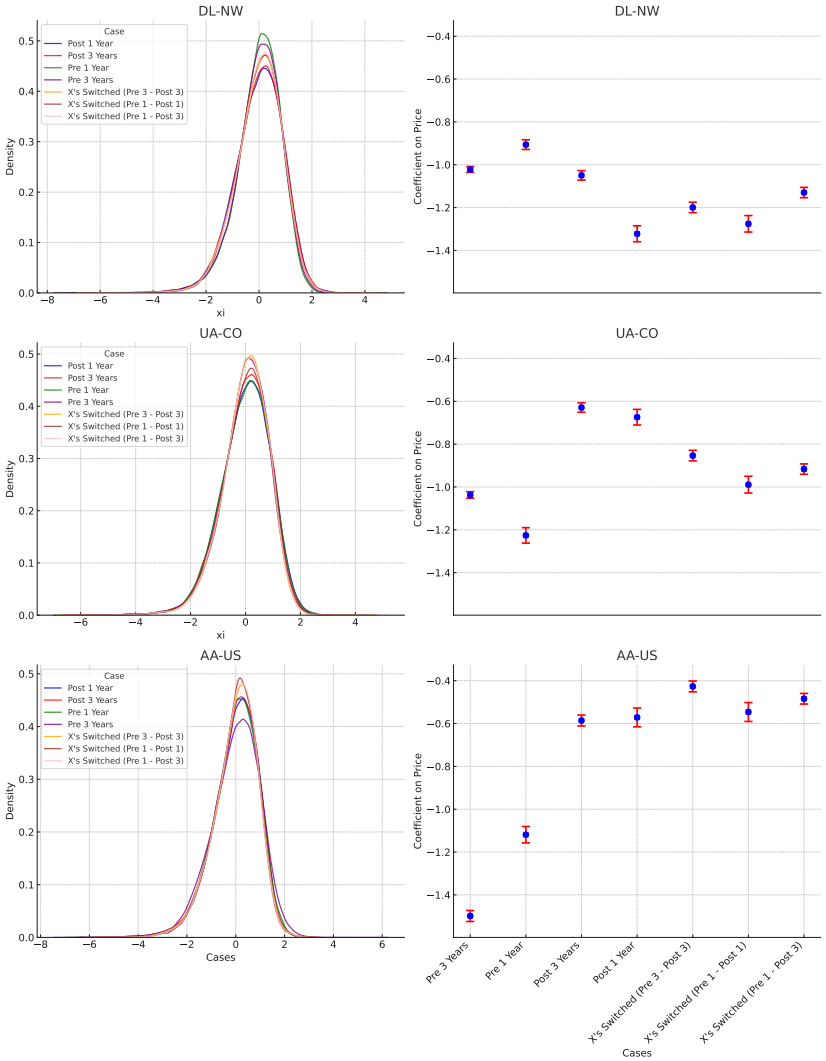
Notes: Each column presents estimates from a separate regression for the sample of all pairwise combination of the top 50 populated origin and destination markets, restricted to three years leading up to the AA-US merger. Standard errors are shown in parentheses. City-Ticketing Carrier-Markets refers to city-origin ticketing carrier markets. Distance refers to city-market distance. All IV specifications use Nonstop variable as the endogenous variable with different sets of instruments.

The stability of other market characteristics across all specifications further validates the model. The nonstop premium remains positive and substantial, though its magnitude varies. Similarly, the effects of carrier presence at origin airports and route distance consistently show expected signs despite some variation in magnitude. The consistency between our network-based identification strategy and more traditional BLP instruments supports our findings, suggesting that key features of airline demand are robustly identified across different instrumental variable approaches.

We conduct additional robustness exercises estimating demand with alternative samples for all three mergers. The Left Panel in Figure C.1 illustrates how price coefficients differ between pre-merger and post-merger samples, suggesting potential changes in market con-

duct following consolidation. Importantly, when we replace post-merger exogenous variables (i.e., the X's) with pre-merger values while maintaining the post-merger sample structure, we obtain estimates similar to those from post-merger data alone. This consistency provides confidence in the exogeneity of our instruments. The Right Panel in Figure C.1 displays the kernel density of the "structural error" or the unobserved product characteristics (i.e., the ξ_j's) across different sample specifications. The similar distribution of these errors further validates our demand estimation approach. The observed differences in price coefficients between pre- and post-merger periods may implicitly capture changes in market conduct, highlighting the importance of accounting for such changes in merger analysis.

Figure C.1: Price Coefficients under Different Samples



Note: The left panel shows price coefficients and the right panel displays the kernel density estimates of implied unobserved product characteristics ξ_j from demand estimation for all three mergers (DL-NW, UA-CO, and AA-US). For each merger, we estimate demand using seven specifications: (1-2) markets connecting top 50 MSAs three years pre-merger; (3) markets connecting top 50 MSAs three years post-merger; (4) markets connecting top 50 MSAs one-year post-merger; (5) three-year post-merger sample with exogenous variables from three years pre-merger; (6) one-year post-merger sample with exogenous variables from one-year pre-merger; and (7) three-year post-merger sample with exogenous variables from one-year pre-merger. These specifications allow us to examine the stability of demand parameters across different time horizons and test the exogeneity of our instruments.