The Price Effects of the Alaska Airline and Virgin America Merger

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Abstract

I examines the price effects of the merger between Alaska Airlines and Virgin America, focusing on non-stop routes where the two airlines were in direct or potential competition prior to the merger. Using a Difference-in-Differences (DID) approach, I find that the merger led to an increase in prices on affected routes, particularly on routes where the airlines were potential competitors. The price increase is more pronounced in routes where Alaska Airlines had a higher pre-merger market share. Weighted regression, accounting for passenger volumes, highlights that price effects are stronger in high-volume markets, suggesting that these routes primarily drive the overall price increase. The study finds that price effects remain consistent across various model specifications.

1 Introduction

Mergers and acquisitions are common strategic decisions made by companies to achieve growth and gain competitive advantages. Mergers can have a significant impact on competition, market power, and pricing. The U.S. airline industry has experienced drastic consolidation from a series of mergers and acquisitions after the airline deregulation of 1978. There are certainly advantages of a merger: it creates synergy to reduce cost and creates opportunities for firms to expand their network to serve a broader range of consumers. However, there are several reasons why mergers in general, and in the airline industry in particular, are worth regulators' attention. First, a merger can reduce the number of competitors in a market. The merged firm can potentially create a dominant market position, which can lead less competition and higher prices for consumers. In the airline industry this can have a significant impact on the price of air travels. Second, mergers can impact the quality and availability of products and services for consumers as the quality of service tends to decline after a merger due to cost-cutting measures and personnel reductions. This usually results in flight cancels and delays. Third, mergers can create significant changes in industries and sectors, leading to job losses, changes in supply chains, and other ripple effects.

A retrospective study of a merger can provide empirical evidence on the price effects of mergers, offering guidance for future merger analyses. This paper examines the 2018 merger between Alaska Airlines and Virgin America, focusing on its impact on airfares. Specifically, this study explores the price effects by pre-merger competition status. The findings contribute to a deeper understanding of airline mergers' implications for market competition and consumer welfare, offering valuable evidence for policymakers as they assess the consequences of mergers and make regulatory decisions to maintain competitive markets and protect consumer interests.

To assess the price changes in the airline market resulting from the merger, I first categorize airline routes into different treatment groups based on their pre-merger competition type. I then employ the Difference-in-Differences (DID) method for causal analysis, which allows me to estimate the impact of the merger on prices across these groups. To ensure the robustness of my estimates and address potential violations of the parallel trends assumption, I also apply the Synthetic Difference-in-Differences (SDID) method. The results consistently indicate a price increase on routes where the merging parties previously competed, with a larger price increase observed on routes where Alaska Airlines held a high market share before the merger.

The remainder of the paper is organized as follows: Section 2 provides a brief background on the airline mergers under consideration. Section 3 reviews existing theoretical and empirical studies on airline mergers and their effects on prices and consumer welfare, highlighting gaps in the literature and identifying the research questions that motivate this study. Section 4 describes the data sources and variables used in the analysis. Section 5 presents the causal analysis methods used to estimate the effects of mergers on prices and addresses potential endogeneity and omitted variable bias. Section 6 concludes by summarizing the main findings and contributions of the paper, discussing its limitations, and suggesting avenues for future research.

2 Background

US Airline Industry

Air travel, once a rigorous adventure well into the 1940s, has become a convenient and integral part of modern life. The U.S. airline industry has seen remarkable growth, expanding from carrying just 6,000 passengers in 1929 to 1.2 million by 1938. By 1972, air travel is relatively common and a small percentage of passengers were classified as "frequent flyers." To accommodate the rapid increase in air travel,the Federal Aviation Administration was created in 1958 to manage aviation safety. One of the most significant acts leading to the airline market as it exists today was the Airline Deregulation Act adopted in 1978, which removed federal control over areas such as fares, routes, and the market entry of new airlines.

This move was designed to foster free-market competition, leading to the creation of numerous new airlines and encouraging smaller, regional carriers like Air Florida and Frontier to expand nationally. To enhance operational efficiency in this newly competitive environment, airlines widely adopted the hub-and-spoke system, which used major airports as central connecting points. While this strategy increased passenger loads and airline profitability, it also introduced significant negative externalities, such as increased air traffic congestion and, importantly, higher fares due to the concentration of market power at hub airports. Airline mergers are also common: from the year of deregulation until 2022, more than 30 airline merger cases were completed, with large airlines such as American Airlines undergoing five mergers and Delta Air Lines completing four mergers.

Merger Parties

Virgin America (VX), a low-cost U.S. based carrier that operated since 2007. It was headquartered in the San Francisco Bay Area and operated domestic flights to major metropolitan areas, with major hubs in San Francisco and Los Angeles. Despite its strong brand identity and customer loyalty, Virgin America faced challenges in scaling its operations and competing with larger, more established airlines. This ultimately led to its acquisition by Alaska Airlines in 2016, with the merger completed in 2018, marking the end of Virgin America's operations as a standalone carrier.

Alaska Airlines (AS) is a major American airline that has its roots in Alaska, where it began as a small regional carrier in 1932. Headquartered in Seattle, Washington, Alaska Airlines has grown to become one of the largest carriers in the United States, known for its extensive network across the West Coast and beyond. It operates out of five hubs with its primary hub being at Seattle-Tacoma International Airport.

The Alaska Airlines-Virgin America merger was announced in April 4, 2016, when Alaska Air Group signed an agreement to acquire Virgin America for $2.6 billion. The Department of Justice approved the merger with the requirement for Alaska Air Group to significantly reduce the scope of its code-share agreement with American Airline to ensure that Alaska will compete vigorously with American as Virgin did. The merger officially closed on December 14, 2016, and the two airlines began operating as a single carrier in April 2018. During the integration process, Alaska Airlines announced a number of changes, including the retirement of the Virgin America brand, the adoption of Alaska Airlines' name and logo, and the addition of new routes and destinations. The two airlines also worked to integrate their frequent flyer programs. Overall, the Alaska Airlines-Virgin America merger was completed relatively quickly, with the two airlines fully integrated within two years of the merger announcement.

The Alaska Airlines and Virgin America merger was unique in several ways compared to other recent airline mergers. First, from the company's establish history and pricing behavior, Alaska Airline was a legacy carrier which was established for more than 80 years before the merger. Where Virgin America was a low-cost carrier last less than 10 years at the time of merger. Second, the two airlines serve very different demographic areas. Alaska Airline had a focus on short-haul routes on the US west coast, while Virgin America had a focus on longer, transcontinental flights. The merger expanded Alaska Airline's reach into new markets, especially on the US East Coast where Virgin America had a strong presence.

3 Literature

There is a considerable body of research examining mergers across various industries, such as in Kim & Kim (2021) [8] and Craig et al. (2021)[4]. Rhoades et al. (1998)[16] studied the efficiency effects of bank mergers, finding that while four of the nine banks improved efficiency, the other five did not. Prager et al. (2021)[15] studied hospital mergers, discovering that wage growth for industry-specific workers declined when hospital mergers significantly increased industry concentration.

In particular, the airline industry has experienced a significant number of mergers in recent decades, with many of the largest airlines worldwide resulting from industry consolidation. As a result, there is a large body of academic studies exploring the impact of these mergers on various welfare measures, including works by Kim & Kim (2021)[8], Ryerson & Kim (2014)[17], and Park (2014)[13].

One of the primary areas of focus in the literature on airline mergers is the impact on prices. Kim & Singal (1993)[7] studied price changes associated with airline mergers during periods when mergers were not contested by the government. They found that airline mergers can reduce competition and increase market power, leading to higher prices for consumers. Luo (2014)[11] examined the Delta-Northwest merger, finding significant price increases on directly competing connecting routes but no significant changes on nonstop routes. Kwoka & Shumilkina (2010)[9] investigated the USAir-Piedmont merger, providing the first direct evidence of incumbent pricing effects due to the elimination of potential competition using a fixed-effect model. They found a 9% price increase on directly competing routes and a 5% increase on potentially competing routes.

In contrast, some studies have found that the impact of mergers on prices varies depending on market conditions. Das (2019)[5] used a difference-in-differences approach and found an overall price decrease following the American Airlines and US Airways merger. Although prices increased in smaller markets, the price reduction in markets with over 10,000 consumers was significantly larger than the price increases. Le (2016)[10] found a pro-competitive effect on routes that the merging carrier entered after the merger.

Another key area of focus in the literature is the impact of mergers on consumers, particularly regarding the quality and availability of products and services. Das (2019) provided evidence of delays in both departures and arrivals following the AA-US merger, with significant delays in all but the smallest markets with fewer than 5,000 passengers. However, a positive outcome of the merger was a reduction in flight cancellations. Le (2016) found a 13% decrease in output resulting from the merger of two low-cost carriers, Southwest and AirTran.

In addition, structural estimation has been widely used to analyze airline market. Peters

(2006)[14] applied a generalized extreme value (GEV) model to simulate post-merger prices for five airlines, finding that the empirical relationship between price and market concentration is strongly influenced by increased unilateral pricing power. This study underscores the role of supply-side effects in post-merger price increases. Berry and Jia (2010)[9] utilized a discrete choice oligopoly supply and demand model to examine changes in the airline industry over the last decade, discovering that profit reductions for legacy carriers stemmed not only from more price-sensitive demand for air travel but also from rising marginal costs for nonstop flights and the expansion of low-cost carriers. Armantier & Richard (2008)[2] employed a random coefficient model and found that code-sharing arrangements increased consumer surplus on connecting flights while decreasing it on nonstop flights. These studies provide various perspectives on the impact of mergers on consumer experiences.

Compared to the difference-in-differences (DID) method used in many of the aforementioned merger analyses, I also apply a novel approach called the synthetic difference-in-differences (SDID) method, introduced by Arkhangelsky in 2021 [1]. This method integrates the ideas from both synthetic control and difference-in-differences methods. A growing body of recent literature has begun adopting this method, including Bernhardt et al. (2023) [3] in their study of tax reductions, and Wu et al. (2024) [18].

This study makes several unique contributions to the literature on airline mergers and competition. First, it examines one of the most recent and significant mergers in the U.S. airline industry, the acquisition of Virgin America by Alaska Airlines. This merger is notable because it involves a legacy carrier merging with a low-cost carrier, presenting distinct market dynamics compared to prior mergers between similar carriers. Second, this research expands beyond the traditional focus on direct competition by also considering potential competition routes, an aspect often neglected in merger studies. This highlights how mergers can influence routes where only one airline previously operated, broadening the scope of market impact. Lastly, the study introduces and tests the SDID method as a robustness check, finding results that align with the traditional DID approach. This methodological contribution enhances the empirical evidence on the merger's price effects while addressing potential violations of the parallel trends assumption.

4 Data and Variables

4.1 Data

The data come from the Department of Transportation's Airline Origin and Destination Survey (DB1B), which is a 10% quarterly sample of all airline tickets. DB1B dataset includes origin, destination and intermediate stops of a given flight itinerary, number of passengers, fares, marketing carrier, operating carrier, market distance and so on.

Several filters were implemented in order to maintain consistency in the analysis and to eliminate any extreme values that could potentially interfere with the results. Travel outside the 48 mainland U.S. states is excluded. Itineraries with more than one stop in either direction were omitted. Direct flights that include a stop with no change in flight number are categorized as connecting flights. Itineraries with ticket carrier change and bulk fare are excluded, and the ticket price is adjusted using transportation CPI. The airfare was bounded between $50 and $1000. All routes are non-direction, meaning a ticket from A to B is treated the same as a ticket from B to A. In accordance with Luo (2014), a market size restriction requires 1800 passengers per quarter for nonstop routes and 900 passengers per quarter for connecting routes. Any carriers with less than the specified number of passengers are excluded.

For the base model, the pre-merger periods were defined as 2014Q1 to 2015Q4, while the post-merger periods were defined as 2018Q2 to 2019Q3. The choice of 2018Q2 as the start of the post-merger period was appropriate, given the International Air Transport Association's (IATA) retirement of the "VX" code in that quarter. Additionally, routes operated by non-merging parties that solely operated pre- or post-merger were excluded. Nonstop services were solely used for price analysis. At the time of the Alaska and Virgin merger announcement, legacy carriers were American (AA), Alaska (AS), Delta (DL), United (UA), and Hawaiian (HA).

4.2 Types of Competition

Following Le's (2016) approach, I define four types of competition between Alaska Airline and Virgin America's routes. Figure 1 illustrates these competition types, showing the relationships between destination cities, the serving carriers, and the defined competition categories. In the figure, each circle represents an airport destination, with airline abbreviations indicating the carrier that served the route before the merger. Airline abbreviations with a prime notation (e.g. AS') indicate service by the airline after the merger was completed.

First, *direct competition* routes refer to routes that are served by both Alaska Airline and Virgin America. In Figure 1, the route (1) from Los Angeles to Boston (LAX-BOS) is labelled as direction competition routes, as both AS and VX served this route pre-merger. Second, *potential competition* routes are those served by only one of the two carriers, with the other carrier serving at least one endpoint of the route. An example is the route from San Francisco to Boston (SFO-BOS) as (2), where VX served the route pre-merger, AS did not, but AS served Boston, one of the destinations. Similarly, the route Boston to Seattle (BOS-SEA) as (3) is another example of potential competition. Research by Kwoka and Shumilkina (2010) found that the price effect of eliminating potential competition is both economically and statistically significant. *Non-overlap* served by one of the merging firms where the other firm serves neither destination, such as route (4) in Figure 1. *New service routes (enter)* are those that were not served by VX before the merger but were started by AS only after the merger, as shown by route (5). I define new service routes to test the pro-competitive effect that arises when Alaska is able to expand its network after the merger. Lastly, remaining routes served by other carriers are used as control in my analysis.

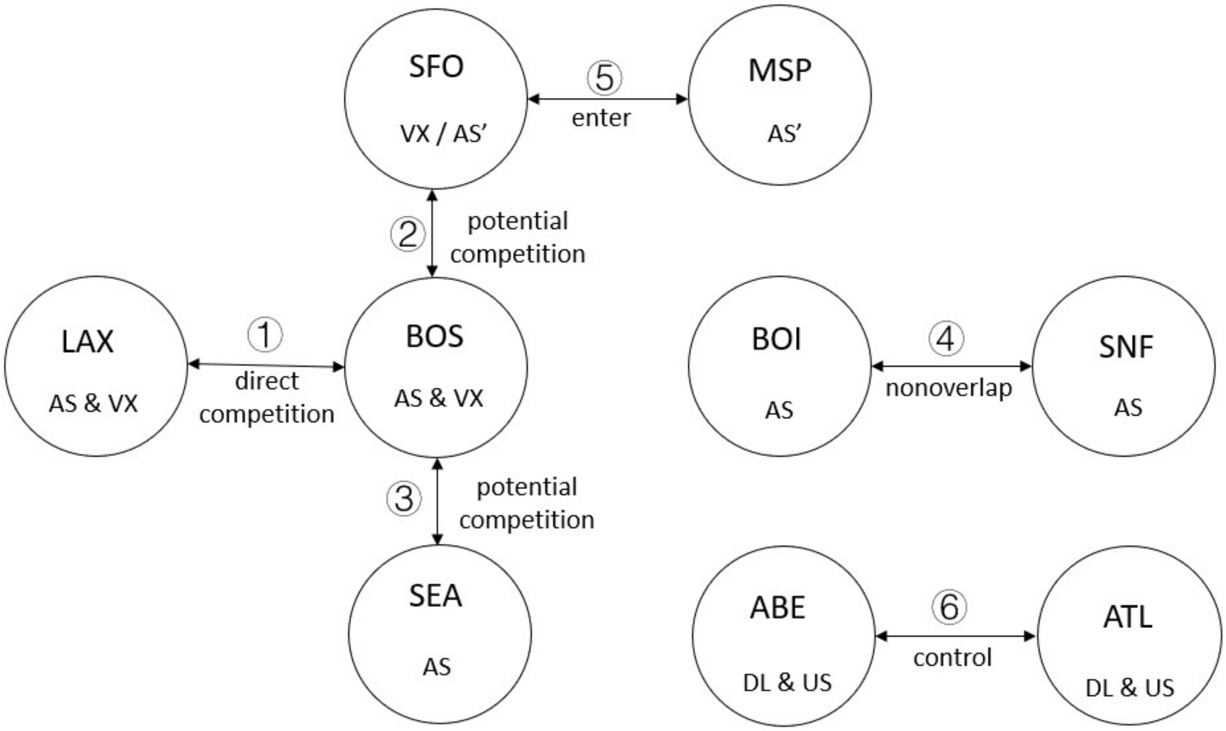


Figure 1: Competition Type Illustration

4.3 Summary Statistics

I present the summary statistics of the airline market below. Tables 1 and 2 show the number of routes that meet the data cleaning criteria for each competition category. Table 1 uses the full sample, which includes both nonstop and connecting flights. The purpose of showing the full sample is to provide a general overview of the number of routes each firm actually serves, reflecting the overall size and network reach of the airlines.

Although I have the full sample of airline routes, my analysis focuses specifically on the price effects on nonstop routes. There are several reasons for this selection. First, nonstop routes are generally more convenient for passengers, offering shorter travel times and avoiding the need for connections. This makes them more attractive to both leisure and business travelers, resulting in higher demand. Second, because of their convenience, demand on nonstop routes tends to be more sensitive to price changes. Travelers on these routes are more likely to consider price fluctuations when making travel decisions, as the option of flying direct often comes with a premium. Finally, nonstop routes typically involve less variation in travel time and layovers, making it easier to isolate the price effects of the merger without the added complexity of analyzing multi-stop itineraries, which might introduce additional factors such as layover duration or flight frequency. Table 2 narrows the scope to show the route counts for the nonstop sample only. This allows for a more targeted examination of the price effects.

Table 3 presents the summary statistics of key variables by competition group. As indicated in Table 1, the non-overlap category has very few observations, making its statistics more sensitive to extreme values. Consequently, its summary data differs somewhat from the other groups, and I exclude this category from further analysis due to the low number of observations. Apart from the non-overlap group, the price distribution is generally similar across the remaining competition groups. The market concentration, as measured by the Herfindahl-Hirschman Index (HHI), is similar for both control routes and those affected by the merger, with direct competition routes being slightly more competitive, as indicated by a lower HHI. However, other variables show variation across groups. For example, routes in the direct competition group are primarily tourist destinations, leading to higher passenger volumes on those routes. In contrast, tourist destinations account for a smaller proportion of the routes in the control group.

5 Empirical Analysis

5.1 Identification Strategy

I use difference-in-differences (DID), a quasi-experimental approach to answer the research question how does the merger affect airline ticket prices. Routes that served by AS or VX are further grouped into one of the four route types that I defined in section 4.2 are in treatment group. Routes that are not served by AS or VX and their destinations are overlapped with AS or VX routes are defined as my control group. DID can help solve the endogeneity problem by controlling for unobserved time-invariant heterogeneity between treatment and control groups by comparing the changes in outcomes between two groups. When the parallel trends assumption is satisfied, which means that in the absence of the treatment, the outcome variable would have followed the same trend for both groups, DID can isolate the effect of the treatment from other factors that may be driving changes in the outcome variable and produces unbiased estimates.

I calculate the price difference on treatment group routes between premerger periods (2014Q1 to 2015Q4) and postmerger periods (2018Q2 to 2019Q3). I also calculate the price difference on control routes during the same time periods. The difference between the two calculation is my point estimate. My estimating equation is

$$ln(Fare_{ikt}) = \alpha + \gamma \text{ competition}_{ik} + \lambda \text{post}_t + \delta \text{ competition}_{ik} * \text{post}_t + \epsilon_{ikt} \tag{1}$$

Where route is indexed by i, carrier is indexed by k, time is indexed by t, and ϵ_{ikt} is the error term. δ is the DID estimator of focus. It can be shown that

$$\hat{\delta} = \frac{1}{M}\sum_{m=1}^{M}(Y_{t2} - Y_{t1}) - \frac{1}{N}\sum_{n=1}^{N}(Y_{c2} - Y_{c1}) \tag{2}$$

Where t and c stands for treatment and control groups. 1 and 2 denote pre- and post-merger periods.

Parallel Trend Assumption

The parallel trends assumption is a key requirement for the DID method. Satisfying this assumption means that, in the absence of the treatment, the outcome variable would have evolved similarly for both the treatment and control groups. When this condition is met, the DID method can provide reliable estimates of the treatment effect. I present the pre-merger outcome trends for each treatment group alongside the control group's outcome.

For the two treatment groups, direct competition and potential competition, the parallel trends assumption is satisfied, as shown in Figure 3, panels (a) and (b). However, the pre-merger trend for the non-overlap group differs from that of the control group at several time points. This is likely due to the small number of observations in this group, making its trend more sensitive to volatility and extreme values. Alaska's new service routes show a price trend that generally aligns with the control group, with the exception of a few time points. The slight differences may also be due to the small number of observations. I will use the aforementioned control variables to account for factors contributing to the divergence between the two trends. And I will introduce the novel Synthetic Difference in Differences method as a robustness check for my estimates in later sections.

Control Group and Control Variables

The baseline regression uses a difference-in-differences approach with the following control variables:

Distance is the nonstop miles between origins and destinations.

Tourist, a dummy variable equal to one for a tourist destination, usually associated with lower price due to elastic demand to those destination.

Slot, a dummy variable equal to one for a slot-controlled airport. The FAA uses runway slots to limit schedule air traffic at certain capacity constrained airport. Flighting to a slot controlled destination is usually associated with a higher price.

Hub, a dummy variable equal to one for a route whose end point is a hub airport. Flying to an airport that is a hub of an airline usually associate with higher price given the airline is likely to have market power over this route.

HHI, the Herfindahl–Hirschman index measure the market concentration, which is used as control for market concentration for routes.

However, it is possible that HHI is endogenous. To address this, I follow the approach of Kwoka and Shumilkina (2010) and report results both with and without HHI. While the

Difference-in-Differences method already accounts for time-invariant heterogeneity, including control variables in the baseline regression serves two main purposes. First, it reduces omitted variable bias by further controlling for confounding factors that may influence prices. Second, it reduces residual variance, as these covariates are important determinants of price. Including them increases the precision of the model's parameter estimates. In alternative model specifications, I include fixed effects to control for time-invariant characteristics of carriers, routes, quarters, and their interactions.

To ensure that the control routes share more characteristics with the treated routes, I selected control routes whose destinations overlap with those served by routes in the treatment group. Additionally, to make the control group more comparable to the treatment group, the market share distribution of the control group was carefully matched to that of the treatment group. As shown in Figure 3, the graphs on the left display the market share distribution of carriers for routes by competition categories before filtering the control group. Treated routes tend to be more competitive, with most carriers holding a low market share. However, some control group routes were solely served by a single carrier. To improve the suitability of the control group, I excluded routes with a single carrier. The three graphs on the right in Figure 3 show that, after this selection process, the market share distribution of the treated and control groups aligns more closely. This matching procedure minimizes potential bias arising from differences in market competition characteristics, resulting in a more accurate analysis of the merger's causal effect.

5.2 Empirical Results

The Difference-in-Differences estimation results are presented in Table 4 without HHI as a control and in Table 5 with HHI as a control. In the first column, all control routes in the sample are used, and instead of applying fixed effects, I include carrier- and route-specific covariates to examine the relationship between these characteristics and prices. The results for these characteristics align with expectations: flying to an airport that serves as a hub for a carrier increases travel fares by 24%. Similarly, flying to a slot-controlled airport is, on average, 6.7% more expensive due to capacity constraints and limited supply. On the other hand, flying to tourist destinations is associated with a 5.7% decrease in price.

In the remaining columns of Table 4, instead of listing flight characteristics, I applied fixed effects to capture time-invariant characteristics of routes and carriers, such as route distance and the type of aircraft owned by the carrier. I also included quarter fixed effects to account for factors that remain constant across observations but vary over time, such as seasonal travel patterns. Columns 2 through 4 use the same estimation specification but with different sets of control groups. First, control routes that do not overlap with the treated routes' destinations were eliminated. In column 4, control routes were further refined by excluding those served by only a single carrier, as discussed earlier in Figure 2. The results show that the merger led to a 6.3% price increase on direct competition routes served by Alaska Airlines and Virgin America . On potentially competing routes, the price effect was even higher, with a 7.5% increase. However, there was no significant price change on routes where AS entered as a new competitor post-merger.

The last column presents the empirical results with additional fixed effects, specifically the interactions between routes, carriers, and quarters. Notably, when these interaction effects are included, the price effect on direct competition routes decreases in magnitude and loses statistical significance. This is likely due to the reduced number of observations within each fixed-effect group, direct competition routes in the route-quarter interaction group typically have fewer than five observations. With this reduced within-group variation, detecting statistically significant effects becomes more difficult. However, this specification still confirms the price increase for potential competition routes.

The results in Table 5 are similar to those in Table 4, with the inclusion of the additional HHI variable. The conclusions remain consistent, showing the same price effects across competition types, with only minor differences in effect magnitude. The HHI variable enters the estimation with the expected sign: an increase in HHI indicates a more concentrated market, leading to higher prices. Since the HHI variable behaves as expected and slightly adjusts the price effects, I will include it in subsequent analyses.

The price effect is likely influenced by the firm's market power. It is well-established in the literature that firms exercise their market power when they dominate the market [6] [12]. To explore this further, I split my sample based on Alaska Airlines' pre-merger market share to study how market share impacts the price effect of the merger. The mean and median market share of Alaska Airlines is approximately 0.43, which I use as the threshold to divide the sample into low and high market share groups. Table 6 presents the results: the first two columns compare the price effects when the treated routes are grouped by low and high market share. For the low market share group, the price effect on direct competition routes disappears. However, the merger still leads to a significant price increase of 3.4% on potential competition routes. In the high market share group, the merger results in a 7.85% price increase on direct competition routes and nearly a 10% increase on potential competition routes. Columns 3 and 4 include additional fixed effects and show similar results, indicating that the conclusion of a price increase is robust and consistent across specifications.

I used a weighted regression to account for the varying passenger volumes on each flight, which allows the price effects to be more accurately reflected for routes serving larger populations. This approach ensures that price changes in highly populated areas have a greater influence on the overall estimates, providing a clearer picture of the merger's impact on consumers. Table 7 presents the regression results weighted by passenger volume. The key findings are consistent with previous analyses: prices increased after the merger, with a larger magnitude on potential competition routes and a stronger effect on routes where Alaska Airlines had a high market share pre-merger. Notably, after applying the passenger weight, the effect on direct competition routes also becomes significant, showing a 6.3% increase in price across the sample, regardless of market share. This result suggests that the price effect is more pronounced on routes with higher passenger volumes and that the unweighted analysis may have diluted these effects. The significance observed in the full sample after weighting indicates that high-volume markets are primarily driving the overall price effect.

5.3 Robustness Check

Synthetic Difference in Differences

Synthetic Difference in Differences (SDID) is an estimation strategy that adopts the idea from both the Synthetic Control method and the Difference in Differences method. The method is proposed by Arkhangelsky and others in 2021 (Arkhangelsky et al., 2021). The traditional DID methods are applied in cases where a group of observations are exposed to the policy, and econometrician are willing to make the "parallel trend" assumption that implies that we are able to control for for selection effects by accounting for unit- and time-specific fixed effects. The synthetic control method is usually applied when a small set of observations are treated. The method seeks to compensate for the lack of parallel trends by reweighting units to match their pre-exposure trends. The SDID method takes advantage of both approaches by including the additive unit-specific shifts and reweights to match pre-exposure trends to relax the parallel trend assumption.

The DID estimator solves the two-way fixed effects regression problem:

$$\hat{\tau}^{did}, \hat{\mu}, \hat{\alpha}, \hat{\beta} = \underset{\tau,\mu,\alpha,\beta}{\operatorname{argmin}} \Big\{ \sum_{i=1}^{N} \sum_{t=1}^{T} (Y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau)^2 \Big\} \tag{3}$$

with τ being the DID estimator, α and β are the individual and time fixed effects, μ being the error term, and $W_{it} \in 0, 1$ representing the exposure to treatment. On the other hand, the synthetic control estimator omit the unit-specific effect but includes the optimal weights $\hat{\omega_i}^{sc}$ that align pre-exposure trends in the outcome of unexposed units with those for the exposed units:

$$\hat{\tau}^{sc}, \hat{\mu}, \hat{\beta} = \underset{\tau,\mu,\beta}{\operatorname{argmin}} \Big\{ \sum_{i=1}^{N} \sum_{t=1}^{T} (Y_{it} - \mu - \beta_t - W_{it}\tau)^2 \hat{\omega_i}^{sc} \Big\} \tag{4}$$

The SDID includes the two-way fixed effects from DID and the weights from synthetic control. In addition, the DID estimator it also include a time weights $\hat{\lambda}_t^{did}$ that balance pre-exposeure time periods with post-exposure ones.

$$\hat{\tau}^{sdid}, \hat{\mu}, \hat{\alpha}, \hat{\beta} = \underset{\tau,\mu,\alpha,\beta}{\operatorname{argmin}} \left\{ \sum_{i=1}^{N} \sum_{t=1}^{T} (Y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau)^2 \hat{\omega}_i^{sdid} \hat{\lambda}_t^{sdid} \right\} \tag{5}$$

By incorporating the weighting approach from the synthetic control method, the Synthetic Difference-in-Differences (SDID) model improves accuracy and offers greater flexibility, especially when the parallel trend assumption is not fully satisfied. When implementing the SDID method, only the outcome, treatment, group, and time variables are included, unlike the DID estimation, which allows for additional control variables and interacted fixed effects. Table 8 presents the post-merger price effects for affected routes, aligning with the DID estimation that includes Route-Carrier interacted fixed effects.

For direct competition routes, the SDID method, similar to the DID approach, does not indicate a significant price increase—likely due to the limited number of observations within the fixed effect groups. Consistent with the DID results, potential competition routes show a significant price increase, with an effect as high as 8.9%. The SDID model also suggests a 2.75% decrease in price on routes where Alaska Airlines entered post-merger, which aligns closely with the DID result without HHI controls. In summary, the SDID method, while applying weighting and omitting covariates, produces results consistent with the DID findings: no significant price increase on direct competition routes, a 7%–9% price increase on potential competition routes, and a 2.5%–2.75% price decrease on new entry routes by Alaska Airlines.

6 Conclusion and Future Steps

The merger between Alaska Airlines and Virgin America significantly reshaped the competitive landscape of the U.S. airline industry. This study investigates the price effects of the merger on different types of airline routes, focusing on routes where Alaska Airlines and Virgin America were either direct competitors, potential competitors, or where Alaska entered new markets. Overall, the results indicate a general increase in prices on routes affected by the merger, particularly on routes where the two airlines were potential competitors, with smaller but still notable price increases on routes where they directly competed.

The analysis highlights that routes with higher passenger volumes and where Alaska Airlines had a higher pre-merger market share saw the most substantial price effects. These findings suggest that the merger not only reduced competition on overlapping routes but also allowed Alaska Airlines to leverage its increased market power to raise prices on other routes it serves. The results are robust across different model specifications, including those with and without the Herfindahl-Hirschman Index (HHI), further confirming the price increases post-merger.

One limitation of this study is the small number of observations in certain fixed effect groups, particularly when route-carrier-quarter interactions are introduced. This can lead to a loss of statistical significance due to reduced within-group variation, especially on direct competition routes where the number of observations is often less than five. Another limitation is that, while the analysis focuses on non-stop routes to ensure consistency in price effects, it does not account for potential spillover effects on connecting routes or broader network dynamics, which could provide additional insight into the overall impact of the merger. Additionally, while control variables and fixed effects were applied to capture time-invariant characteristics and minimize omitted variable bias, there is still a possibility that some unobserved factors—such as local economic conditions or regional regulations—might influence pricing decisions but were not fully accounted for in the model.

Future studies could expand the analysis to include connecting routes, providing a more comprehensive view of the merger's impact on airline networks. Since connecting routes form a significant portion of air travel, examining their price dynamics and competitive behavior could yield valuable insights. Another important area for future research is to analyze the long-term effects of the merger. This study focuses primarily on the immediate aftermath of the merger, but a longer time horizon could help to assess how pricing strategies and competition evolve as airlines fully integrate their operations. Additionally, more attention could be given to the synergy effects of market entry, particularly when Alaska Airlines expanded its network post-merger. A causal analysis of this entry could reveal important market dynamics, while extending the analysis to structural modeling would allow for the estimation of consumer welfare, offering deeper insight into how the merger affects consumer choices and well-being.

Figures and Tables

Pre			Post		
carrier	type	count	carrier	type	count
	direct	104		direct	104
	potential	706		potential	728
AS	nonoverlap	887	AS	nonoverlap	887
	enter	0		enter	394
	exit	245		exit	0
	total	1942		total	2113
	direct	104		direct	0
	potential	22		potential	0
VX	nonoverlap	0	VX	nonoverlap	0
	enter	0		enter	0
	exit	8		exit	0
	total 126	134		total	0
Other	control	24182	Other	control	24182

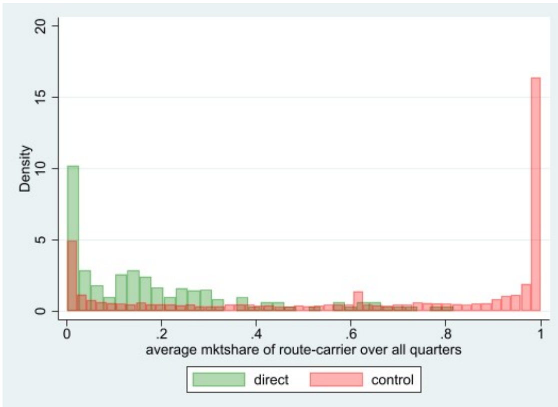
Table 1: Route count by competition type, full sample

Pre			Post		
carrier	type	count	carrier	type	count
	direct	23		direct	23
	potential	142		potential	166
AS	nonoverlap	9	AS	nonoverlap	9
	enter	0		enter	72
	exit	55		exit	0
	total	229		total	270
	direct	23		direct	0
	potential	24		potential	0
VX	nonoverlap	0	VX	nonoverlap	0
	enter	0		enter	0
	exit	16		exit	0
	total	63		total	0
Other	control	4112	Other	control	4112

Table 2: Route count by competition type, nonstop sample

prices	count	mean	sd	min	max
control	36313	216.41	77.82	50	935.81
direct	1685	225.34	76.61	57.15	531.38
nonoverlap	171	183.68	68.53	83.82	440.45
potential	6658	222.67	77.65	50.39	770.00
enter	2042	227.14	67.59	51.53	616.78
passengers	count	mean	sd	min	max
control	36313	14671.19	25342.17	10	282800
direct	1685	46763.71	54282.87	10	269360
nonoverlap	171	13175.50	19830	10	85660
potential	6658	22308.34	32273.96	10	380250
enter	2042	22973.24	35041.65	10	255110
market share	count	mean	sd	min	max
control	36313	0.35	0.35	0.00	1
direct	1685	0.19	0.21	0.00	0.99
nonoverlap	171	0.57	0.42	0.00	1
potential	6658	0.34	0.36	0.00	1
enter	2042	0.43	0.36	0.00	1
HHI	count	mean	sd	min	max
control	36313	6904.42	2225.45	2415.67	10000
direct	1685	4005.20	1582.42	1938.81	9767.73
potential	6658	6218.65	2365.37	2243.15	10000
enter	2042	6541.40	2163.73	2832.72	10000
nonoverlap	171	8579.25	1770.78	5000.25	10000
tourist	count	mean	sd	min	max
control	36313	0.68	0.47	0	1
direct	1685	0.93	0.26	0	1
enter	2042	0.62	0.48	0	1
nonoverlap	171	0.27	0.44	0	1
potential	6658	0.82	0.38	0	1
hub	count	mean	sd	min	max
control	36313	0.37	0.48	0	1
direct	1685	0.64	0.48	0	1
enter	2042	0.50	0.50	0	1
nonoverlap	171	0.16	0.37	0	1
potential	6658	0.60	0.49	0	1
slot control	count	mean	sd	min	max
control	36313	0.25	0.43	0	1
direct	1685	0.81	0.39	0	1
enter	2042	0.46	0.50	0	1
nonoverlap	171	0	0	0	0
potential	6658	0.46	0.50	0	1

Table 3: Summary Statistics of Variables in Interest



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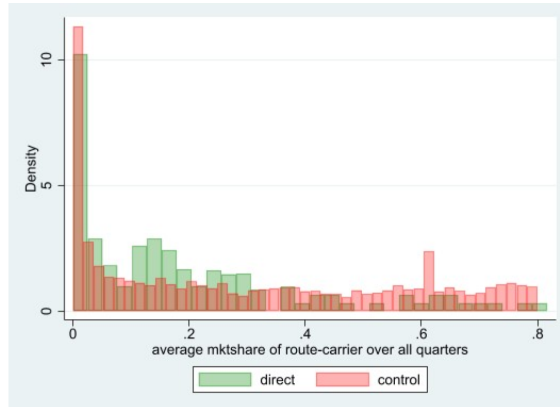

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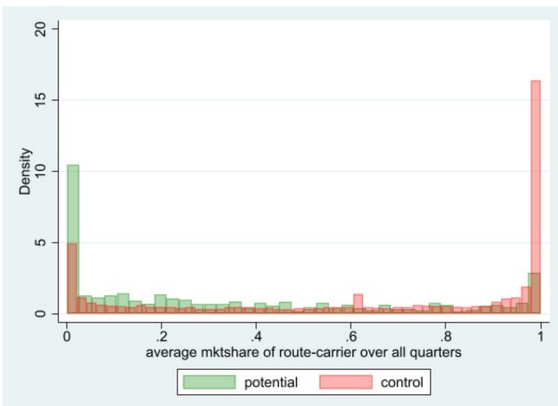

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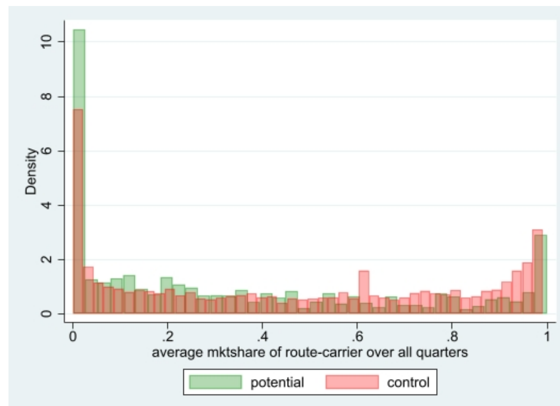

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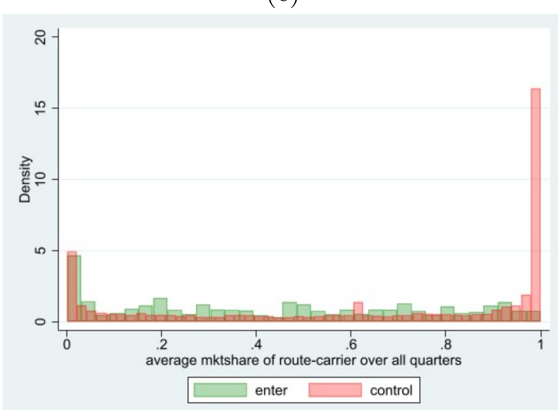

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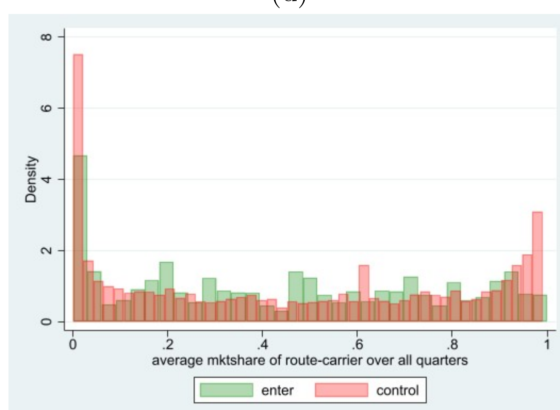
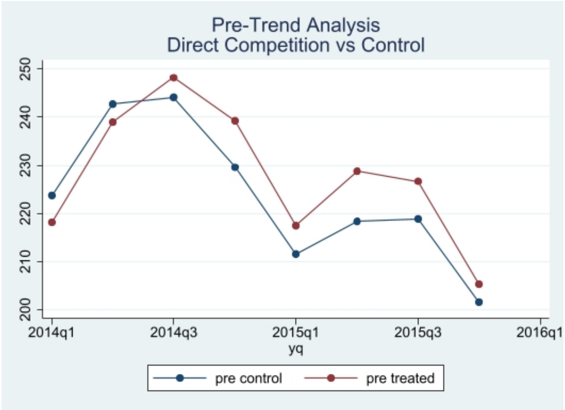


(f)

Figure 2: Market share distributions before and after control group adjustment



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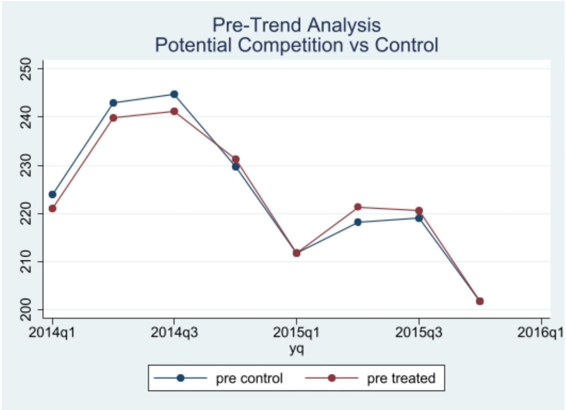

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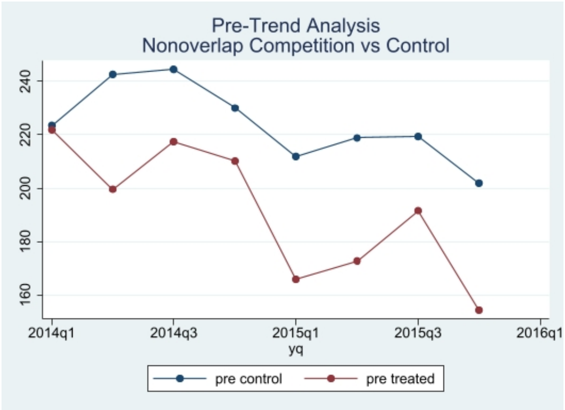

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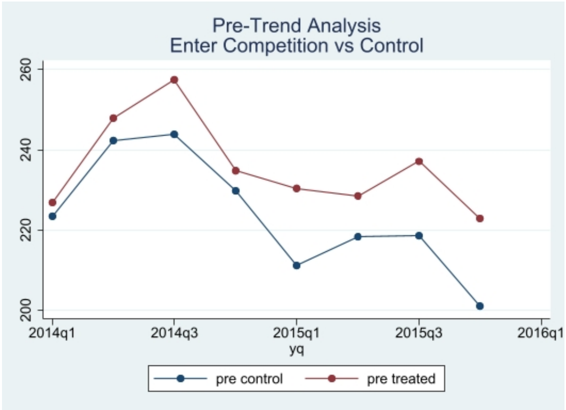


(d)

Figure 3: Parallel Trend Analysis for each Treatment Groups

Table 4: Baseline Model Control Group Comparison without HHI

	All Control Routes	All Controls Routes	Destination Overlapped Controls	Matched Market Share Distribution	More Fixed Effects
did_direct	-0.0211	0.0640***	0.0658***	0.0624***	0.0294
	(0.0363)	(0.0235)	(0.0237)	(0.0242)	(0.0219)
did_potential	0.141***	0.0755***	0.0774***	0.0733***	0.0677***
	(0.0155)	(0.00977)	(0.00987)	(0.0102)	(0.00925)
did_enter	-0.000374	-0.0148	-0.0129	-0.0131	-0.0258**
	(0.0154)	(0.0105)	(0.0106)	(0.0109)	(0.0102)
hub	0.241***	0.166***	0.170***	0.151***	0
	(0.00252)	(0.00303)	(0.00316)	(0.00379)	(.)
slot	0.0676***				
	(0.00314)				
tourist	-0.0568***				
	(0.00254)				
Route FE		X	X	X	X
Carrier FE		X	X	X	X
Quarter FE		X	X	X	X
Route x Carrier FE					X
Route x Quarter FE					X
Carrier x Quarter FE					X
N	91774	91771	74156	52084	50201
adj. R^2	0.413	0.680	0.657	0.658	0.764

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Baseline Model Control Group Comparison with HHI

	All Control Routes	All Controls Routes	Destination Overlapped Controls	Matched Market Share Distribution	More Fixed Effects
did_direct	-0.0188	0.0652***	0.0671***	0.0630***	0.0295
	(0.0362)	(0.0235)	(0.0237)	(0.0242)	(0.0219)
did_potential	0.150***	0.0778***	0.0802***	0.0753***	0.0700***
	(0.0154)	(0.00978)	(0.00987)	(0.0102)	(0.00925)
did_enter	0.0154	-0.00856	-0.00504	-0.00681	-0.0188*
	(0.0153)	(0.0105)	(0.0106)	(0.0109)	(0.0103)
hub	0.236***	0.166***	0.170***	0.152***	0
	(0.00251)	(0.00303)	(0.00316)	(0.00378)	(.)
hhi	0.0000157***	0.00000538***	0.00000689***	0.00000619***	0.00000640***
	(0.000000582)	(0.000000696)	(0.000000752)	(0.000000841)	(0.000000885)
slot	0.0851***				
	(0.00319)				
tourist	-0.0392***				
	(0.00261)				
Route FE		X	X	X	X
Carrier FE		X	X	X	X
Quarter FE		X	X	X	X
Route x Carrier FE					X
Route x Quarter FE					X
Carrier x Quarter FE					X
N	91774	91771	74156	52084	50201
adj. R^2	0.417	0.681	0.657	0.658	0.765

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Effect by Median AS Pre-merger Market Share

	low Share<0.43	high Share>0.43	low Share>0.43	high Share<0.43
did_direct	-0.0121	0.0785**	-0.0137	0.0720**
	(0.0342)	(0.0376)	(0.0311)	(0.0316)
did_potential	0.0336*	0.0997***	0.0184	0.0942***
	(0.0175)	(0.0134)	(0.0161)	(0.0114)
hhi	0.00000647***	0.00000682***	0.00000719***	0.00000755***
	(0.000000886)	(0.000000910)	(0.000000930)	(0.000000954)
Route FE	X	X	X	X
Carrier FE	X	X	X	X
Quarter FE	X	X	X	X
Route x Carrier FE			X	X
Route x Quarter FE			X	X
Carrier x Quarter FE			X	X
N	39310	37573	37458	35780
adj. R^2	0.648	0.651	0.754	0.756

Standard errors in parentheses

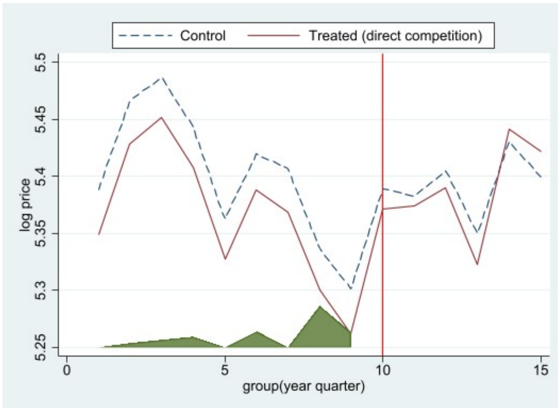
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Baseline Model Weighted by Passengers

	(1) low share	(2) high share	(3) full sample
did_direct	0.00444***	0.0655***	0.0626***
	(0.000226)	(0.0000506)	(0.0000488)
did_potential	0.0491***	0.0768***	0.0726***
	(0.0000738)	(0.0000335)	(0.0000303)
did_enter			0.00879***
			(0.0000300)
hhi	0.0000210***	0.0000199***	0.0000212***
	(4.25e-09)	(4.33e-09)	(4.11e-09)
Route FE	X	X	X
Carrier FE	X	X	X
Quarter FE	X	X	X
Route x Carrier FE	X	X	X
Route x Quarter FE	X	X	X
Carrier x Quarter FE	X	X	X
N	948738350	921362760	994168380
adj. R^2	0.934	0.934	0.935

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$



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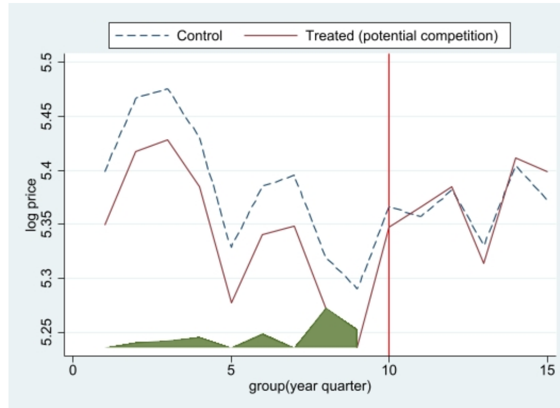

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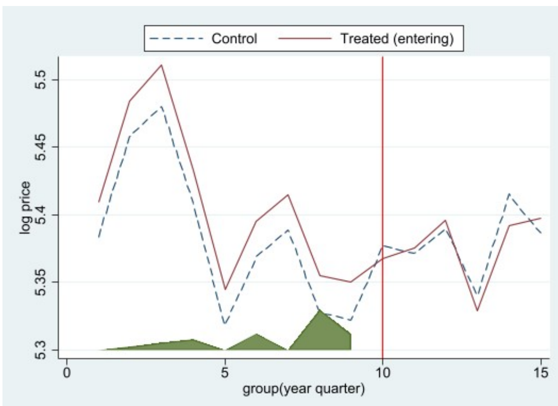

(c)

Figure 4: Synthetic Difference in Difference Illustration

	(1)	(2)	(3)
did_direct	0.0515		
	(0.0334)		
did_potential		0.0890***	
		(0.0138)	
did_enter			-0.0275**
			(0.0135)
Route-Carrier	X	X	X
Quarter FE	X	X	X
N	42120	42120	42120

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Synthetic Difference in Differences Estimation

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