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This thesis is dedicated to my parents for their unconditional support, tremendous amount of encouragement, and everlasting confidence in my ability.

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TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Table Page

Table Page

Table Page

Table Page

LIST OF FIGURES

Figure Page

Figure Page

ABBREVIATIONS

AA	American Airlines
CAB	Civil Aeronautics Board
CAR	Cumulative Abnormal Return
CPI	Consumers Price Index
CRSP	Center for Research in Security Prices
CSM	Competitive Strategy Measure
DB1B	Database 1B of DOT
DID	Difference-in-Differences Analysis
DOJ	Department of Justice
DOT	Department of Transportation
FAA	Federal Aviation Administration
Fsize	Size of the acquirer firm which is defined as logarithm of total assets of the firm
GAO	Government Accounting Office
HHI	Hirschman Herfindahl Index
HML	High Minus Low book to market ratio
LCC	Low Cost Carrier
Lev	The leverage ratio of the firm which is defined as (DLTT+DLC)/SEQ where dltt=Long-Term Debt–Total, dlc= Debt in Current Liabilities–Total, and SEQ= Stockholders Equity (Parent)
MMC	Multi-market contact
NB	Nash Bertrand
NOC	Number of Competitors

NOEQHHI	Number equivalent to HHI
Rdin	R&D intensity of the the acquiring firm which is defined as R&D/sales
R&D	Research and Development
Roa	The rate of return on assets which is defined as net income over total assets
Share	Percentage of share of the target firm acquired
SML	Small Minus Large Capitalization
TC	Tacit Collusion
TQ	Tobin's Q ratio which is defined as market value of the firm over book value of the firm
TRB	Transportation Research Board
US	US Airways
Value	The amount of $ (in million) paid to target firm

ABSTRACT

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My dissertation consists of three chapters. In the first chapter, I analyze the effect of the merger between American Airlines (AA) & US Airways (US) on market price and product quality. I use two complementary methodologies: difference-in-differences (DID) and merger simulation. Contrary to other results in the airline literature, the DID analysis shows that, overall, price has decreased as a result of the merger. While divestitures required as part of the merger had a strong price-reducing effect, the overall decrease involves non-divestiture markets as well. Interestingly, the decrease appears only in large airport-pair markets, whereas prices rose considerably in smaller ones. Effects on quality are mixed. The DID analysis shows that the merger reduced flight cancellations, increased flight delays, and had no effect on flight frequency or capacity overall. Using merger simulation, I find that the change in ownership leads to a 3% increase in price. The structural model performs better in predicting the post-merger price if I allow the model to deviate from the Bertrand-Nash conduct. A 10% cost reduction due to the merger is able to predict the post-merger price quite well. When I incorporate a conduct parameter into the model, the required percentage of cost savings is lower. Given the divestiture and the subsequent entry of low-cost carriers (LCCs), tacit collusion may break down. Thus both cost savings and reduced cooperation could explain a reduction in the price in the post-merger period.

In my second chapter, I analyze possible reasons why airline prices are higher in the smaller markets compared to larger markets. In the literature, most of the studies ignore the fact that the smaller markets are different compared to larger markets in

terms of the nature of competition. I find that a combination of lower competition, and lack of entry from low cost carriers (LCCs) are the reasons behind higher prices in the smaller city-pair markets. I show that price is substantially higher in a market with a fewer number of firms controlling for several other factors. My paper estimates the modified critical number of firms to be 5 and the critical value of the HHI to be .6.

In my third chapter, I study the effect of announcement of investment in research & development (R&D) on the value of a firm in the pharmaceutical industry. Three types of R&D by the pharmaceutical firms are considered for the analysis: acquisition of other smaller firms, internal investment in R&D, and collaborative investment in R&D. This chapter finds that few target specific characteristics and financial characteristics of the acquiring firm are important drivers of the abnormal returns around the announcement period.

1. EFFECT OF MERGER ON MARKET PRICE AND PRODUCT QUALITY: AMERICAN AIRLINES AND US AIRWAYS

In this chapter, I analyze the effect of the merger between American Airlines (AA) & US Airways (US) on market price and product quality. I use two complementary methodologies: difference-in-differences (DID) and merger simulation. Contrary to other results in the airline literature, the DID analysis shows that, overall, price has decreased as a result of the merger. While divestitures required as part of the merger had a strong price-reducing effect, the overall decrease involves non-divestiture markets as well. Interestingly, the decrease appears only in large airport-pair markets, whereas prices rose considerably in smaller ones. Effects on quality are mixed. The DID analysis shows that the merger reduced flight cancellations, increased flight delays, and had no effect on flight frequency or capacity overall. Using merger simulation, I find that the change in ownership leads to a 3% increase in price. The structural model performs better in predicting the post-merger price if I allow the model to deviate from the Bertrand-Nash conduct. A 10% cost reduction due to the merger is able to predict the post-merger price quite well. When I incorporate a conduct parameter into the model, the required percentage of cost savings is lower. Given the divestiture and the subsequent entry of low-cost carriers (LCCs), tacit collusion may break down. Thus both cost savings and reduced cooperation could explain a reduction in the price in the post-merger period.

1.1 Introduction

According to the United States Department of Justice's (DOJ) updated 2010 merger guidelines, "mergers should not be permitted to create, enhance or entrench market power or to facilitate its exercise"[1]. A merger can decrease competition by reducing the number of firms in the market. In the case of the 2013 merger between AA and US, the DOJ along with seven states and the District of Columbia decided to challenge the merger because of anti-competitive concerns. AA and US argued that the merger would generate substantial efficiency in terms of cost savings and consumer network benefits. The following quote is from the chief executive officer (CEO) of US Airways defending the merger:

> This merger will greatly enhance competition and provide immense benefits to the traveling public. Combined, US Airways and American Airlines will offer more and better travel options for passengers through an improved domestic and international network, something that neither carrier could provide on its own. Millions more passengers each year will fly on this new network than would fly on US Airways and American, should they be forced to remain separate. Conservative estimates place the net benefits to consumers at more than $500 million annually. Simply put, from the perspective of consumers, the new American will be much greater than the sum of its parts. This merger will be pro-competitive and lawful. Plaintiffs' request for this Court to enjoin the merger should be summarily denied.[2]

Since the U.S. airline industry has only a few large competitors, this merger raises the issue of increasing market power for the existing airlines. But an increase in market power may not be always welfare-reducing for society as a whole. Even though an increase in market power and the resulting increase in price is not desirable from

[1]https://www. justice. gov/atr/horizontal-merger-guidelines-08192010#5c
[2]https://www.dallasnews.com/business/airlines/2013/09/10/heres-us-airways-defense-of-its-merger-with-american-airlines

the point of view of consumers' welfare, Williamson (1968) shows that there is a trade-off between efficiency gain and market power effect as in Figure 1.1.

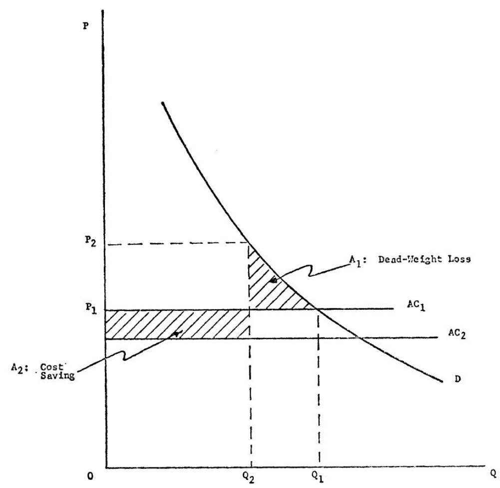

Figure 1.1.: Cost Savings vs Market Power

According to Williamson (1968), a market power effect is necessary but not sufficient for a merger to reduce welfare. Accordingly in Figure 1.1, AC_1 is the average cost and P_1 is the price in the pre-merger period. Average cost goes down to AC_2 in the post-merger period but price goes up to P_2. The area A_1 represents the dead-weight loss while the area A_2 represents the cost savings. If the area of A_2 is larger than the area of A_1 then the merger will be welfare-improving even though there is an increase in price. Farrell and Shapiro (2001) provides more detailed discussion about consumer-welfare standard vs total-welfare standard for the evaluation of mergers.

There is a debate about efficiency gain and market power effects of mergers involving airlines. The efficiency gain may be generated from cost savings in airport operations, information technology, and supply chain management. Synergy is the concept that the performance of two companies combined will be greater than the sum of the performances of the separate individual companies. It can occur due to cost reductions, economies of scale, combined human resources, or technology.

Market power may be generated due to a reduction in the number of competitors in the market. As a result of the removal of a competitor, a firm might be able to profitably raise the market price of a good or service.

There is anecdotal evidence, for example, in media reports, that service quality goes down after a merger. Similar to price, there are two opposite effects on product quality: a positive effect due to a larger resource pool[3] and negative effects due to problems in integration. Service quality can improve because of the combined resource pool of the merged airline. The merged airline can improve quality by efficiently managing a larger resource pool[4]. For example, if there is a technical problem in the aircraft, a firm with a larger number of aircrafts can deploy a substitute aircraft and reduce delays in departure. A larger airline can also internalize congestion externalities.[5] The merged airline can upgrade quality by adopting the best practices of the two airlines.

Quality of service can decrease due to problem in integrating important resources. Problems can occur in combining the labor and merging the reservation systems of the two airlines. Reduced competition in the post-merger period may also decrease quality.

A post-merger empirical analysis can help determine whether efficiency or market power dominates by analyzing the price before and after the merger (Hosken et al. (2017)). Also, change in quality of service can be analyzed by looking at the change in flight frequency and other observable data, such as delays and cancellation of flights.

While there are many studies that analyze the effect of mergers on market price, there are few studies that analyze the effect on product quality. This paper analyzes the effect of the merger on product quality in addition to analyzing the effect on price.

[3]See Robinson (1958) for a more detailed discussion of sources of economies of scale.

[4]However, the same improvement in quality or cost savings can be achieved by the internal growth of a airline, and this improvement is not merger specific as described in the Horizontal Merger Guidelines by DOJ.

[5]Congestion externalities are created when airlines do not consider that adding flights may lead to increased delays for other air carriers. See Mayer and Sinai (2003) for more details.

The merger between AA and US is quite special in many respects. First, these two airlines together were going to create the largest airline in the world when the merger was proposed in 2012. Second, AA was undergoing bankruptcy during that time. Last, these two airlines had 30% overlapping[6] routes among their city-pair markets. It is an important merger to study because of these three unique factors.

There are very few studies that have analyzed the aspect of "mutual forbearance" or co-operation among the major airlines[7]. Peters (2006) uses merger simulation to predict the post-merger prices of the five mergers that took place in the 1980s and makes a comparison between the predicted post-merger prices and the actual post-merger prices. According to Peters:

> While the model does not allow me to distinguish empirically between the effects of cost and conduct, I find it implausible that the results were driven largely by cost changes.

Peters (2006) concludes that deviations from the assumed model of firm conduct play an important role in understanding the observed difference between the predicted and the actual post-merger prices[8]. He finds that the unexplained component of the price change is largely accounted for by supply-side effects and suggests use of more flexible models of firm conduct.

Ciliberto and Williams (2014) provides empirical evidence that multimarket contact (MMC) facilitates tacit collusion among airlines, when conduct parameters are modeled as functions of multimarket contact. The paper finds that carriers with little multimarket contact do not cooperate in setting fares, whereas carriers serving many markets simultaneously sustain almost perfect co-ordination. Miller and Weinberg (2017) finds that price increased after a merger between Miller and Coors in the beer industry because of tacit collusion.

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[6]The route networks of AA, US, and the overlapping markets are shown in the Appendix.

[7]Nevo (2001) analyzes the possibility of tacit collusion in the ready-to-eat cereal industry and concludes that the observed high price-cost margin is not due to collusive behavior among the firms.

[8]Peters (2006) did not find any significant role of other factors such as flight frequency or airport presence in explaining the observed difference between the predicted price and the actual post-merger price.

I use two complementary methodologies: difference-in-differences analysis and merger simulation. I find that the merger has a significant negative effect on price and that the effect is larger for bigger markets. The effect on price in smaller markets is opposite to that in bigger markets implying, that smaller city-pair markets have not benefited from the merger. I also find that the merger had no significant impact on the frequency of flights and the number of seats. Delays in departure and delays in arrival have increased in the post-merger period. But the merger has reduced the number of canceled flights.

This is the first paper that takes into account the role of conduct into the supply-side while studying an airline merger. This paper uses the estimated conduct parameters from MMC in the modeling framework to predict the post-merger price. In this paper, I consider the possibility that the existing cooperation level among the legacy carriers may go down due to competition from LCCs after entry. This paper fills a gap in the literature by using both the cost savings and the conduct parameter in counterfactual simulations to explain the observed post-merger price.

Section 2 of the paper briefly describes the related literature. Section 3 covers the history of the U.S. airline industry. Section 4 provides a brief background of the merger. Section 5 describes the data and the variables. Section 6 outlines the identification strategy. Section 7 describes the merger simulation. Section 8 discusses the estimation. Section 9 reports the results. Section 10 provides a brief analysis of cost data reported by the airlines to Department of Transportation (DOT). Finally, section 11 concludes.

1.2 Literature Review

There may be a trade-off between efficiency gain and market power in the case of a merger between two firms. Williamson (1968) analyzed this trade-off and concluded that antitrust authorities should consider both sides before deciding to approve or reject a merger. If the efficiency gain dominates the market power effect then the price will decrease, otherwise, the price will increase.[9]

After the airline industry deregulation in 1978 many mergers took place. Carlton et al. (1980) studied the merger between North Central Airlines and Southern Airways and did not find any significant increase in price. Borenstein (1990) analyzed two mergers: the Northwest (NW) merger with Republic Airlines (RP) and Trans World Airlines' (TWA) purchase of Ozark (OZ). He showed that the combined airlines gained airport dominance, which resulted in substantial market power. Werden et al. (1991) examined the same two mergers and found a considerable increase in price and a reduction in service. Morrison (1996) studied NW-RP, TWA-OZ and Piedmont (PI)-US Airways (US). He found that the price increases were 2.5% for NW-RP, 15.3% for TWA-OZ, and 23% for PI-US.

Kim and Singal (1993) studied airline mergers between 1985-1988 and showed that the effect of efficiency gain on costs was more than offset by the exercise of increased market power. Evans and Kessides (1993) found a positive correlation between route concentration and price. They also found a positive correlation between airport concentration and price.[10]

There are a few studies that have used merger simulation techniques to predict the post-merger price. Peters (2006) used merger simulation to predict the post-merger prices for five mergers that took place in the 1980s and then made a comparison between predicted post-merger prices and actual post-merger prices. He concluded that deviations from the assumed model of firm conduct play an important role in understanding the observed difference between the predicted and the actual post-merger prices.

Kwoka and Shumilkina (2010) analyzed the US-Air and Piedmont merger and showed that the combined firm achieved pricing power in many routes after merging

[9] Farrell and Shapiro (1990) analyzed the general conditions under which horizontal mergers raise prices.

[10] Other studies that analyzed the relationship between concentration and market power in the airline industry include Borenstein (1989) and Abramowitz and Brown (1993).

with a potential competitor. Bilotkach (2011) analyzed the relationship between multi-market contact (MMC) and intensity of competition. The paper showed that high MMC (due to a merger) resulted in a reduction of the frequency of flights. Many papers have analyzed the effects of mergers on market price (Carlton et al. (1980), Kim and Singal (1993), Focarelli and Panetta (2003), Luo (2014)). The results from the empirical literature are mixed.

In case of bank mergers, Sapienza (2002) found that for small target firms the lending rate decreased but for large target firms the rate increased. Prager and Hannan (1998) found that banks reduce their deposit rates after merger. Kahn et al. (2005) found that the lending rate for individual loans increased but for automobile loans the rate did not increase much.

For hospital mergers Dafny (2009), Krishnan (2001), and Capps and Dranove (2004) found that the prices increased after a merger.

Even though there are many studies that analyze the effect of merger on price there are very few studies that look into the effect of the merger on product quality. Mazzeo (2003), Rupp and Holmes (2006), Rupp et al. (2006), and Prince and Simon (2009) found that there is a positive relationship between quality and competition. In the case of the hospital industry, Vogt and Town (2006) found mixed evidence of quality change in different mergers. Ho and Hamilton (2000) found that mergers affected the quality negatively in many cases. In the case of the airline industry, Chen and Gayle (2018) measured quality as the ratio of nonstop flight distance to itinerary flight distance and found that quality improved after merger.

This paper fills the gap in the literature by using both the cost savings and the conduct parameter in counterfactual simulation to explain the observed post-merger price. I also analyze the effect of merger on product quality. Since there are very few empirical studies that analyze this aspect of product quality this paper contributes to understanding the effects on both price and product quality due to the AA-US merger.

1.3 US Airline Industry

The Civil Aeronautics Board (CAB) was established in 1938[11]. It directly regulated the airline industry by controlling prices, entry, exit, and merger. In 1958, Federal Aviation Administration (FAA) was created to provide for the safe and efficient use of national airspace.[12]

In the 1970s the CAB was discredited for not being able to deliver a good market performance. The Airline Deregulation Act of 1978 was aimed at bringing competitiveness in the commercial aviation industry and removing government regulation without reducing the powers of FAA over all aspects of air safety. After deregulation[13], prices were reduced by 30% in inflation-adjusted terms. The airline industry faced many challenges during the 80s and a large number of mergers took place in the industry.

After the attack on 11th September 2001, the airline industry faced additional challenges, including weak demand and fuel price volatility. Both the legacy airlines and the LCCs have responded to these challenges by bankruptcies, reorganizations, spin-offs, and new pricing strategies. There have been seven major mergers in recent years: US Airways and America West Airlines (2005), Delta Air Lines and Northwest Airlines (2008), Republic Airlines and Midwest Airlines (2009), Republic Airlines and Frontier Airlines (2009), United Airlines and Continental Airlines (2010), Southwest Airlines and AirTran Airways (2011), and American Airlines and US Airways (2013).

1.4 The AA-US Merger Background

On November 29, 2011, American Airlines filed for bankruptcy. In April 2012 US airways announced it would take over American Airlines. In February 2013, American Airlines and US Airways announced plans to merge, creating the largest airline in the world.

[11] Borenstein and Rose (2014) gave a very detailed overview of the U.S. passenger airline industry.
[12] https://www.faa.gov/about/history/brief_history/
[13] For a detailed review of deregulation in the U.S. see Winston (1993) and Winston (1998).

On August 13, 2013, the United States Department of Justice, along with Attorneys General from the District of Columbia, Arizona (Headquarters of US Airways), Florida, Pennsylvania, Tennessee, Texas (Headquarters of American Airlines), and Virginia filed a lawsuit to block the merger, arguing that it would result in less competition and higher prices. American Airlines and US Airways both announced their intention to fight the lawsuit and defend their merger.

The Department of Justice reached a settlement of its lawsuit on November 12, 2013. The settlement required the merged airline to give up landing slots or gates at 7 major airports. Under the deal, the new American was required to sell 104 slots at Ronald Reagan Washington National Airport and 34 slots at LaGuardia Airport. Additionally, AA had to sell two gates at O'Hare International Airport, Los Angeles International Airport, Logan International Airport, Dallas Love Field and Miami International Airport. Some of the slots were sold to low-cost carriers such as JetBlue and Southwest Airlines[14].

An appeal filed in the US Supreme Court against the merger complaining about price increases was declined by the Supreme Court on December 8, 2013[15]. On this day American Airlines emerged from bankruptcy as AMR Group. On April 8, 2015, the Federal Aviation Administration awarded American Airlines and US Airways a single operating certificate. Reservation systems of the two airlines were integrated on October 17th, 2015.

1.5 Identification Strategy

Two different methodologies are used to answer the main research questions of this paper. These are difference-in-differences analysis and merger simulation using discrete choice structural demand estimation. To overcome the omitted variable bias, difference-in-differences analysis (DID) is particularly useful. While taking the second

[14]https://www.justice.gov/opa/pr/justice-department-requires-us-airways-and-american-airlines-divest-facilities-seven-key

[15]http://www.frequentbusinesstraveler.com/2013/12/supreme-court-declines-to-block-american-us-air-merger/

difference the confounding factors are dropped from both treatment and control. For DID analysis the design of the treatment and the control is very important. I have done several robustness checks to make sure the design of the treatment and the control does not bias the results. Even though DID analysis is a good method for identification of the treatment effect, it can not be used for counterfactual analysis. Since one of the objectives of the paper is to disentangle the conduct and cost savings by counterfactual simulation, I use merger simulation as the second identification strategy.

1.6 Difference-in-Differences Analysis (DID):

I calculate the difference in prices on routes operated by AA or US (treatment) between post- (2016: Q1 to Q4) and the pre-merger period (2010: Q2 to 2012: Q2) and I also calculate the difference in prices in routes not operated by AA or US (control). I take the difference of those two. This will eliminate the effect of changes in cost and other general economic changes between the pre- and post-merger period and will give us the effect of the merger on price[16]. My estimating equation is:

$$P_{jmt} = \gamma_m * Treatment + \lambda_t * Time + \delta * D_{mt} + \epsilon_{jmt} \tag{1.1}$$

In equation (1.1), P_{jmt} is the price of product j in market m at time t. γ_m is the coefficient of the treatment variable, λ_t is the coefficient of the time variable, D_{mt} is time variable multiplied by the treatment variable and ϵ_{jmt} is the error term. Under a strict exogeneity assumption of the treatment variable D_{mt}, it can be shown that

[16]See Ashenfelter and Card (1985), Card and Krueger (2000) for more details about DID analysis.

the DID estimator is the following:

$$\hat{\delta} = \frac{1}{M}\sum_{m=1}^{M}\left(\bar{P_{m1}} - \bar{P_{m2}}\right) - \frac{1}{N}\sum_{n=1}^{N}\left(\bar{P_{n1}} - \bar{P_{n2}}\right),$$

$$where,$$

$$\bar{P_{mt}} = \sum_{j=1}^{J_m} P_{jmt} w_j \qquad \forall t = 1, 2 \tag{1.2}$$

$$\bar{P_{nt}} = \sum_{j=1}^{J_n} P_{jnt} w_j \qquad \forall t = 1, 2.$$

In equation (1.2), M is the number of markets used as treatment and N is the number of markets used as a control. J_m is the number of products in market m. w_j is the proportion of passengers used as a weight to calculate the average fare in a particular market.

1.6.1 Data for DID Analysis

For the purpose of this study, I restrict the data to 48 U.S. contiguous states only. The main source of data for this project is the DB1B database of the Department of Transportation. The database is a 10% quarterly sample of airline origins and destinations. The database has three different parts: DB1B Coupon, DB1B Market, and DB1B Ticket.

The DB1B Ticket dataset contains information about each itinerary: the sequence of airports visited, including the origin and the final destination, the number of connections each way, the ticket prices, the number of passengers, information about the ticketing carrier and operating carrier, and distance traveled. I adjust all prices using the CPI using 2009 as the base. I drop itineraries with fares which are unreasonably high or low (itineraries with fares above $2000 or below $50 are dropped)[17]. I also exclude round-trip itineraries with more than one connection each way. Itineraries with multiple destinations are also excluded. These are standard steps in the literature to clean and simplify the data.

For the analysis, I combine smaller airline with the parent company. For example, American Eagle is a subsidiary of parent company American Airlines. I treat codeshare agreements in a similar way. For simplicity, I assign the ownership of the codeshare flights to the ticketing carrier that actually sells the ticket to the consumer. I drop itineraries with multiple ticketing carriers.

For DID analysis, I define a market as a unique year-quarter-origin-destination combination. A market is defined as a directional airport-to-airport trip in a particular year and a particular quarter, for example, in 2016 quarter 1, Indianapolis (IND) to Chicago (ORD). "Directional market" implies that air travel from Indianapolis to Chicago is a distinct market from air travel from Chicago to Indianapolis. This implies also that the characteristics of the origin airport are important factors affecting air travel demand.

The T-100 Domestic Segment database is used for flight frequency. I use the number of departures from a particular city-pair market to calculate the frequency of flights. The frequency of the data is monthly, so I aggregate the monthly number of departures to calculate the quarterly frequency. I then match this data with the DB1B database. I utilize the On-Time Performance database for quality-related variables such as delay and cancellation of flights.

I define the pre-merger period as the eight quarters before the merger was announced, from 2010Q2 to 2012Q1.[18] I specify the post-merger period as four quarters after the merger is completed, from 2016Q1 to 2016Q4. The selection of 2016Q1

[17] Extremely low fares indicates that those tickets were purchased using frequent flier miles or some kind of promotion by the airlines. I also dropped the itineraries with "not credible" fares.

[18] I have conducted various robustness checks regarding the selection of the pre-merger period. The United and Continental merger was completed in 2010 and the Southwest and AirTran merger was completed in 2011. I have done the analysis with various different pre-merger periods and the results are qualitatively the same.

as the starting of the post-merger period is reasonable since the International Air Transport Association (IATA) retired the "US" code from 2016Q1.

The summary statistics of the number of passengers and price for the pre-merger and the post-merger period is given in Table 1.1 and Table 1.2. Summary statistics of the frequency of flights and the number of seats for the pre-merger period and the post-merger period are given in Table 1.3 and in Table 1.4. I have also reported the summary statistics of the delay and the cancellation of flights for the pre-merger period and the post-merger period in Table 1.5 and in Table 1.6[19].

Table 1.1 lists the summary statistics of the pre-merger data including the variables such as the number of passengers (in a quarter) and the passenger weighted average price (in a quarter). There are 15552 observations in the control group and 11100 observations in the treatment group. The average number of passengers traveled in the treatment group is 10700 compared to 6826 in the control group. The average price is $394 in the treatment group compared to $355 in the control group.

The summary statistics of the post-merger period is given in Table 1.2 for variables such as the number of passengers and the passenger weighted average price. There are 6409 observations in the control group and 5195 observations in the treatment group. The average number of passengers traveled in the treatment group is 11812 compared to 7965 in the control group. The average price is $397 in the treatment group compared to $353 in the control group.

Table 1.3 provides the summary statistics of the pre-merger data including the variables such as the flight frequency (total number of departures in a quarter) and the number of seats (total number of seats in a quarter) for the non-stop markets. There are 6447 observations in the control group and 8883 observations in the treatment group. The average flight frequency (number of departures in a quarter) in the treatment group is 603 compared to 500 in the control group. The average number

[19]Please keep in mind that the total number of observations for passengers, flight frequency, and delay are different because the data sources are different for these three types of data. Price and number of passengers data is from DB1B, and flight frequency and number of seats data is from T100 Database. The data regarding delay and cancellations comes from On Time Performance Database.

Table 1.1.: Summary Statistics Pre-merger Period

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Control Group								
Number of Passengers (per quarter)	15552	6826.15	7781.99	490	101710	2340	4000	8090
Passenger Weighted Average Price	15552	355.27	110.42	77.89	820.85	273.82	344.28	423.4
Treatment Group								
Number of Passengers (per quarter)	11100	10699.77	12978.22	510	107360	2960	5890	12890
Passenger Weighted Average Price	11100	393.64	94.55	128.27	953.64	325.43	391.05	454.66

Table 1.2.: Summary Statistics Post-merger Period

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Control Group								
Number of Passengers (per quarter)	6409	7964.58	9103.8	580	100750	2590	4640	9720
Passenger Weighted Average Price	6409	353.81	106.61	85.08	816.73	279.69	336.9	421.74
Treatment Group								
Number of Passengers (per quarter)	5195	11811.68	14484.01	690	110320	3080	6270	14120
Passenger Weighted Average Price	5195	397.42	99.04	145.81	817.65	320.33	399.82	468.83

Table 1.3.: Summary Statistics Pre-merger Period

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Control Group								
Flight Frequency (per quarter)	6447	500.51	442.52	1	2620	168	377	732
Number of Seats (per quarter)	6447	61017.65	61030.93	0	386687	16859	40091	86775
Treatment Group								
Flight Frequency (per quarter)	8883	603.15	556.47	1	4876	215	449	829
Number of Seats (per quarter)	8883	72822.22	75474.01	0	588567	20954	47810	101582

Table 1.4.: Summary Statistics Post-merger Period

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Control Group								
Flight Frequency (per quarter)	2852	449.25	438.29	1	3256	131.5	310	631
Number of Seats (per quarter)	2852	61154.01	66003.23	0	451669	15550	38194	85774
Treatment Group								
Flight Frequency (per quarter)	4096	553.87	539.12	1	5712	181	412	765
Number of Seats (per quarter)	4096	72772.32	78066.11	0	682724	19633	45946	99231.5

of seats available is 72822 in the treatment group compared to 61031 in the control group.

The summary statistics of the post-merger period is given in Table 1.4 for variables such as the flight frequency and the number of seats for the non-stop markets. There are 2852 observations in the control group and 4096 observations in the treatment group. The average flight frequency (number of departures in a quarter) in the treatment group is 553 compared to 449 in the control group. The average number of seats available is 72772 in the treatment group compared to 61154 in the control group.

Table 1.5 records the summary statistics of the pre-merger data including the variables such as the delay in arrival, delay in departure, and number of cancellations. There are 12081 observations in the control group and 9080 observations in the treatment group. The average delay in arrival (number of minutes in a quarter) in the treatment group is 3690 compared to 2608 in the control group. The average delay in departure (number of minutes in a quarter) in the treatment group is 3044 compared to 2378 in the control group. The average number of cancellations in the treatment group is 4 compared to 2 in the control group.

The summary statistics of the post-merger period is given in Table 1.6 for variables such as the delay in arrival, delay in departure, and number of cancellations. There are 5344 observations in the control group and 4128 observations in the treatment group. The average delay in arrival (number of minutes in a quarter) in the treatment group is 4151 compared to 2640 in the control group. The average delay in departure (number of minutes in a quarter) in the treatment group is 3681 compared to 2477 in the control group. The average number of cancellations in the treatment group is 2 compared to 1 in the control group.

Table 1.5.: Summary Statistics Pre-merger Period

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Control Group								
Delay in Arrival (minutes per quarter)	12081	2608.73	2605.38	0	23144	794	1804	3542
Delay in Departure (minutes per quarter)	12081	2378.28	2415.97	-1508	22357	690	1661	3282
Cancellation of Flights (per quarter)	12081	1.75	3.61	0	62	0	0	2
Treatment Group								
Delay in Arrival (minutes per quarter)	9080	3690.3	3931.46	0	48601	1145	2470.5	4856
Delay in Departure (minutes per quarter)	9080	3044.3	3401.3	-1384	46449	853.5	1999	4053
Cancellation of Flights (per quarter)	9080	3.64	6.66	0	107	0	1	4

Table 1.6.: Summary Statistics Post-merger Period

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Control Group								
Delay in Arrival (minutes per quarter)	5344	2639.57	2865.1	0	27504	837	1738.5	3405
Delay in Departure (minutes per quarter)	5344	2477.12	2713.03	-896	27142	764	1634.5	3249
Cancellation of Flights (per quarter)	5344	1.28	3	0	70	0	0	1
Treatment Group								
Delay in Arrival (minutes per quarter)	4128	4150.94	4970.52	0	56999	1129.5	2535.5	5392
Delay in Departure (minutes per quarter)	4128	3680.69	4437.8	-792	47028	944.5	2240.5	4818.5
Cancellation of Flights (per quarter)	4128	1.99	4.26	0	82	0	1	2

Pre-trend Analysis

For DID analysis to be an appropriate methodology, it is important to check if there is a parallel price trend for the treatment and the control groups.

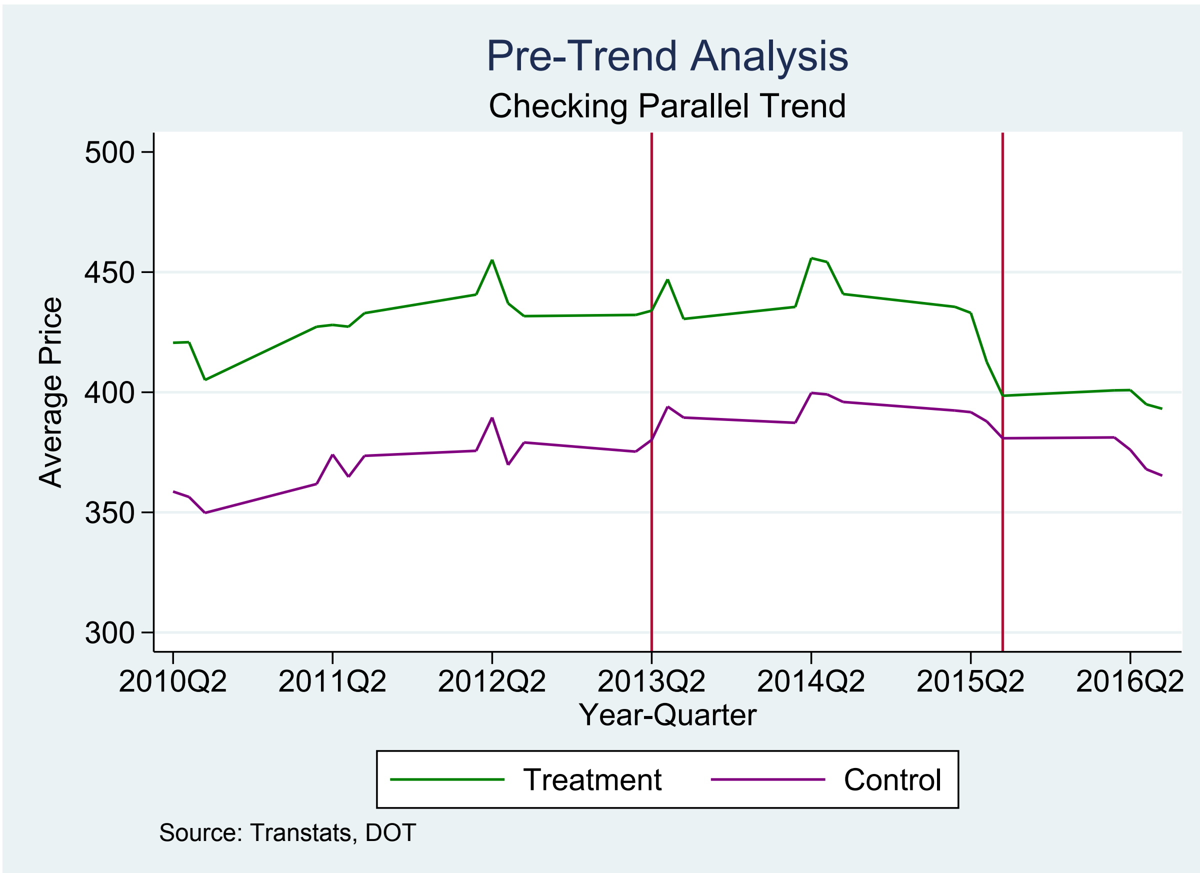


Figure 1.2.: Pre-Trend Analysis

From Figure 1.2, we can see that the pre-merger prices among the treatment and the control group are parallel, which means that the use of DID analysis to identify the effect of the merger is justified.

I have also provided the pre-trend analysis for frequency of flights and number of seats, in Figure 1.10 in the Appendix. Figure 1.11 illustrates the pre-trends for variables related to delay and Figure 1.12 shows the pre-merger trends for cancellation of flights.

1.6.2 DID Analysis Results

I provide here the results from the DID analysis. In Table 1.7, I list the DID statistics for price for different types of markets, which are defined according to the number of passengers traveled[20]. The first column of Table 1.7 considers all the markets where the number of passengers traveled is less than five thousand in a particular year and quarter. The second column considers all the markets where the number of passengers traveled is less than ten thousand and more than or equal to five thousand in a particular year and quarter. The third column considers all the markets where the number of passengers traveled is less than twenty-five thousand and more than or equal to ten thousand in a particular year and quarter. The fourth column considers all the markets where the number of passengers traveled is more than or equal to twenty-five thousand in a particular year and quarter. Finally, the fifth column consists of all the markets together for the analysis. The overall difference is around -9 (Table 1.7 column 5) while the difference is larger for bigger markets (-23 in column 4). On the other hand, the difference is positive for smaller markets (21 in column 1) which means that the price has increased in smaller markets due to the merger

[20] I have not defined market size in terms of population of the origin and destination because it is well known that people from nearby cities may drive and fly from another city. In that case, population might not be a good indicator to define market size (Li et al. (2018)). Nonetheless, I have provided the results in Table 1.37 in the Appendix using population as market size, and the results are qualitatively similar. Also, I have not divided the markets by the number of competitors because number of competitors is highly endogenous, and in one of my companion paper, Das (2018b), I show that entry and exit can happen even within a span of 2 years, so even in the short run, number of competitors is highly endogenous. Again, I have provided the results in Table 1.36 in the Appendix using number of competitors in the pre-merger period as the criteria to divide the markets, and the results are qualitatively similar.

Table 1.7.: Diff-in-diff Analysis: Price

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	2.948	-4.842	-1.955	-0.335	-6.787***
	(1.26)	(-1.57)	(-0.67)	(-0.06)	(-3.37)
Treated	38.84***	57.95***	66.36***	67.99***	45.60***
	(21.17)	(21.67)	(24.90)	(16.55)	(25.35)
DID	21.46***	8.736*	-15.20***	-23.75***	-9.044***
	(6.50)	(1.88)	(-3.31)	(-3.27)	(-2.75)
Constant	372.7***	340.3***	304.5***	274.1***	322.8***
	(294.08)	(184.43)	(182.37)	(94.25)	(302.44)
N	19628	8609	7356	2663	38256
adj. R^2	0.048	0.084	0.106	0.102	0.047

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.8 provides the DID analysis results for price with markets with only non-stop product competition. The results are different compared to the results in Table 1.7. In Table 1.8, even though the DID statistic for all markets together is negative and statistically significant, the DID statistics for other columns are not statistically significant. In spite of the difference in statistical significance, the sign and the magnitude of the DID statistics are in line with Table 1.7. In Table 1.8 the DID statistics for the larger markets are negative which is similar to Table 1.7.

Table 1.8.: Diff-in-Diff Analysis: Price (Markets with only Nonstop Product Competition)

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	-7.485	0.664	-3.315	0.536	-8.962*
	(-0.88)	(0.09)	(-0.60)	(0.08)	(-1.94)
Treated	30.60**	-7.555	-22.07*	5.286	-10.79
	(2.16)	(-0.57)	(-1.97)	(0.67)	(-1.41)
DID	1.925	-11.79	-15.55	-28.08	-17.02*
	(0.18)	(-0.85)	(-1.06)	(-1.35)	(-1.76)
Constant	431.5***	204.1***	324.8***	118.9***	524.0***
	(19.77)	(10.19)	(10.93)	(7.10)	(61.68)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	5050	1956	1630	429	9065
adj. R^2	0.680	0.700	0.626	0.740	0.568

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.9 provides the DID analysis results for price for markets having both nonstop and connecting products. The results are different compared to the DID results for price in Table 1.7 and Table 1.8. In Table 1.9, the DID statistics for the smaller markets are positive and statistically significant as Table 1.7, but for the larger markets the DID statistic is not statistically significant.

Table 1.9.: Diff-in-Diff Analysis: Price (Markets with both Connecting and Nonstop product competition)

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	-3.774	-3.670	-12.88*	-16.26	-22.33***
	(-0.70)	(-0.74)	(-1.87)	(-1.40)	(-4.22)
Treated	7.962*	18.88***	16.98***	15.06	17.35**
	(1.92)	(3.18)	(3.24)	(1.42)	(2.42)
DID	20.78***	16.90**	3.170	-8.038	1.633
	(3.42)	(2.31)	(0.33)	(-0.80)	(0.23)
Constant	432.6***	-25.66*	23.44**	284.5***	589.8***
	(7.09)	(-1.71)	(2.23)	(18.11)	(8.93)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	10374	6548	5724	2234	24880
adj. R^2	0.583	0.586	0.562	0.479	0.346

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.10 provides the DID analysis results for price for markets with only connecting product competition. The smallest markets have only connecting products and no nonstop products. As a result, in Table 1.10, I have only reported the statistics for the first column. The sample size is too small to calculate the coefficients for the other markets. The results in Table 1.10 for the smaller markets are similar to Table 1.7 and Table 1.9. The DID statistic for the smaller markets is positive and significant. By breaking down the results from Table 1.7 into only nonstop, both connecting and nonstop, and only connecting product markets it is evident that the increase in price in the smaller markets is mostly coming from the connecting product competition and on the other hand, the negative effect on price in the larger city pair markets is coming mostly from competition in nonstop products.

Table 1.10.: Diff-in-Diff Analysis: Price (Markets with only Connecting Product Competition)

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	47.48***				
	(8.74)				
Treated	-4.894				
	(-1.32)				
DID	20.70***				
	(3.50)				
Constant	613.9***				
	(63.06)				
Year-quarter FE	Y				
Origin FE	Y				
Destination FE	Y				
Cluster	Y				
N	4204				
adj. R^2	0.578				

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.11 enumerates the DID statistics for price for different types of markets with divestiture as another control variable. Divestiture is defined as a dummy variable taking the value of one if both of the cities in a city-pair market involve the divestiture of any gates or slots to LCCs[21]. The overall difference is around -9.23 while the difference is larger for bigger markets. On the other hand, the difference is positive for the smaller markets which means that the price did not go down in the smaller markets due to the merger, unlike in the bigger markets. We can also see that the divestiture has a negative significant impact on the price in both the smaller and the larger markets. Thus, divestiture of assets to LCCs has played an effective role

[21] As a robustness check I have also defined divestiture as the number of gates sold to LCCs and I find similar results as shown in Table 1.39.

in reducing the price across all types of city-pair markets[22]. One important thing to notice is that the DID results are similar even after controlling for divestiture.

Table 1.11.: Diff-in-diff Analysis: Divestiture

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	2.917	-4.849	-1.911	-0.264	-6.497***
	(1.25)	(-1.58)	(-0.65)	(-0.05)	(-3.23)
Treated	38.87***	57.85***	66.41***	69.37***	47.61***
	(21.19)	(21.54)	(24.78)	(16.29)	(26.15)
DID	21.45***	8.815*	-15.24***	-23.90***	-9.227***
	(6.49)	(1.89)	(-3.32)	(-3.30)	(-2.83)
Divest	-24.11***	8.465	-2.187	-10.60**	-33.20***
	(-3.48)	(1.01)	(-0.33)	(-2.22)	(-8.73)
Constant	372.7***	340.3***	304.5***	274.1***	322.9***
	(293.82)	(184.42)	(182.36)	(94.24)	(302.42)
N	19628	8609	7356	2663	38256
adj. R^2	0.048	0.084	0.106	0.103	0.051

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table 1.44 in the Appendix, I record the DID statistics for frequency of flights for different types of markets. The overall difference is around 9, which implies more frequent flights, but the coefficient is not statistically significant. On the other hand, the difference is positive for medium and small markets and negative for large markets, but none of the coefficients are statistically significant. The negative significant effect of the time variable in Table 1.44 implies that over time the frequency of flights has gone down for the control group of markets.

[22] I have done several robustness checks such as including the year-quarter fixed effects, origin and destination fixed effects and clustering with respect to destination to control for hub effects. I have included the results in Table 1.35 and Table 1.38 in the Appendix. The results are qualitatively the same and quantitatively very similar to Table 1.7 and Table 1.11.

Table 1.45 in the Appendix provides the DID statistics for number of seats available for different types of markets. The overall difference is around 886.2, but it is not statistically significant. Although, the difference is positive for the small and the medium sized markets and negative for large markets, neither of those coefficients are statistically significant.

In Table 1.12, I list the DID statistics for delay in departure (total minutes delay in a quarter in a city-pair market) for different types of markets. The overall difference is around 1333, and it is statistically significant. The result implies that the number of minutes delay has gone up as a result of the merger by approximately 1333 minutes per quarter, or by 15 minutes per day. The difference is positive for small, medium, and large markets and statistically significant for all types of markets except small markets. Delay in markets where the number of passengers traveled is between five to ten thousand in a quarter has gone up by approximately 471 minutes per quarter or 5 minutes per day. On the other hand, delay in markets where the number of passengers traveled is more than twenty five thousand in a quarter has gone up by approximately 1532 minutes per quarter or 17 minutes per day.

Table 1.12.: Diff-in-diff Analysis: Delay in Departure

	(1)	(2)	(3)	(4)	(5)
	DD	DD	DD	DD	DD
	<5K	<10K&>=5K	<25K&>=10K	>=25K	All
	(1)	(2)	(3)	(4)	(5)
	d_d	d_d	d_d	d_d	d_d
Time	-329.2***	-571.6***	-228.8	369.7	-346.0*
	(-4.00)	(-4.67)	(-1.15)	(0.73)	(-1.80)
Treated	-314.3**	-347.8**	-942.4***	-992.5	-1349.5***
	(-2.30)	(-2.07)	(-4.58)	(-1.07)	(-4.48)
DID	95.73	471.8***	687.2***	1532.7**	1333.2***
	(0.73)	(2.72)	(3.28)	(2.44)	(4.81)
Constant	4182.6***	2155.0***	6548.3***	1287.9	-2301.3***
	(5.94)	(5.96)	(8.25)	(1.22)	(-4.41)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	12556	8154	7376	2547	30633
adj. R^2	0.366	0.427	0.432	0.504	0.464

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table 1.13, I record the DID statistics for delay in arrival (Total minutes delay in a quarter in a city-pair market) for different types of markets. The overall difference is around 1272, and it is statistically significant. The result implies that the minutes delay has gone up as a result of the merger by approximately 1272 minutes per quarter or by 14 minutes per day. The difference is positive for small, medium, and large markets and statistically significant for all types of markets except the small markets. Delay in markets where the number of passenger traveled is between five to ten thousand in a quarter has gone up by approximately 365 minutes per quarter or 4 minutes per day. On the other hand, delay in markets where the number of passenger traveled is more than twenty five thousand in a quarter has gone up by approximately 1417 minutes per quarter or 16 minutes per day.

Table 1.13.: Diff-in-diff Analysis: Delay in Arrival

	(1) DA <5K	(2) DA <10K&>=5K	(3) DA <25K&>=10K	(4) DA >=25K	(5) DA All
Time	-479.0***	-748.0***	-472.7**	411.2	-498.6**
	(-5.88)	(-5.88)	(-2.49)	(0.63)	(-2.30)
Treated	-264.1*	-346.1*	-1065.8***	-983.2	-1406.8***
	(-1.77)	(-1.95)	(-4.72)	(-0.90)	(-4.38)
DID	18.49	365.1*	627.1***	1417.4*	1272.9***
	(0.13)	(1.83)	(3.56)	(1.91)	(3.82)
Constant	4806.0***	2640.4***	6759.3***	800.3	-3449.6***
	(5.15)	(6.83)	(8.53)	(0.72)	(-3.64)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	12556	8154	7376	2547	30633
adj. R^2	0.392	0.445	0.459	0.508	0.493

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.14 lists the DID statistics for number of cancellations per quarter for different types of markets. The overall difference is around -2, and it is statistically significant. On the other hand, the difference is bigger for the larger markets. The difference is statistically significant for all types of markets. Thus the merger has reduced cancellations in affected markets.

Table 1.14.: Diff-in-diff Analysis: Cancellation of Flights

	(1)	(2)	(3)	(4)	(5)
	NoC	NoC	NoC	NoC	NoC
	<5K	<10K&>=5K	<25K&>=10K	>=25K	All
	(1)	(2)	(3)	(4)	(5)
	c	c	c	c	c
Time	-1.082***	-1.165***	-1.751***	-4.172***	-2.495***
	(-6.00)	(-4.19)	(-5.17)	(-3.30)	(-5.56)
Treated	0.454**	0.0576	-0.408	1.385	-0.602*
	(2.17)	(0.33)	(-0.63)	(0.83)	(-1.70)
DID	-0.614**	-0.423*	-0.881***	-4.963***	-2.427***
	(-2.22)	(-1.81)	(-2.78)	(-3.21)	(-3.41)
Constant	7.331***	2.552***	0.465	2.795*	-2.247
	(4.21)	(3.85)	(0.18)	(1.81)	(-1.04)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	12556	8154	7376	2547	30633
adj. R^2	0.230	0.252	0.309	0.387	0.321

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

1.6.3 Role of Entry

In this section, I have documented the summary statistics of the entry and the role of entry in explaining the observed heterogeneous effect of merger on different types of markets. In Table 1.15, I have recorded the pre-merger HHI, change in HHI, whether the particular market went through divestiture, whether there was any entry in that market, and finally the percentage price change for a select few markets[23]. It is evident from Table 1.15 that if the increase in HHI is higher then the percentage price reduction is lower. If there is divestiture or entry in a market then the percentage

[23]HOU-CHI represents Houston to Chicago, CHI-NYC represents Chicago to New York City, TUS-CHI represents Tuscon to Chicago, and SAN-CLT represents San Diego to Charlotte.

price reduction is higher. The summary statistics in Table 1.15 shows the importance of divestiture and entry in explaining observed price reduction in different markets. This raises the question whether entry is driving the results shown in Table 1.7. I am going to report few more summary statistics on entry in Table 1.16 before looking into the issue of entry driving the observed prices. In Table 1.16, I have documented the

Table 1.15.: Summary Statistics: HHI, Divestiture, Entry, and Price Change

	Pre-merger HHI	Change_HHI	Divestiture	Entry	Price Change
HOU-CHI	6229	130	yes	yes	-40%
CHI-NYC	3548	75	yes	yes	-15%
TUS-CHI	7235	2765	yes	no	-5%
SAN-CLT	3676	1946	no	no	+6%

average number of entry in different types of markets. The first column represents the market size. $< 5K$ is the smallest market size with number of passenger travelling is less than five thousands in a particular quarter. *All* represents all markets together. The second column shows the average LCC entry in the treated group of markets. The third column records the average LCC entry in the non-treated group of markets. The fourth column shows the average LCC entry in the non-treated markets which did not go through any divestiture of gates. The fifth column represents the average LCC entry among those treated markets which went from 0 LCC to a positive number of LCC in the post-merger period. Finally, the sixth column shows the average number of LCCs entry in the non-treated group of markets which went from 0 LCC in the pre-merger period to a positive number of LCCs in the post-merger period. From the last row in Table 1.16 it is evident that the average entry is higher in the treated group of markets compared to the non-treated group of markets which raises the possibility that entry might be contributing to the observed post-merger prices. To verify this concern, I run the price regression in Table 1.17 after excluding all the markets that went through divestiture. This should control for entry.

Table 1.16.: Summary of Entry

Mkt Size	#LCC Entry (T)	#LCC Entry (NT)	#LCC Entry (NTWD)	#LCC Entry (T)(0→1)	#LCC Entry (NT)(0→1)
$<= 5K$	.17	0.08	0.06	0.17	0.17
$> 5K \& <= 10K$	0.47	0.19	0.13	0.47	0.60
$> 10K \& <= 25K$	0.60	0.22	0.18	0.65	0.83
$> 25K$	0.48	0.52	0.50	1.00	0.80
ALL	0.47	0.16	0.13	0.50	0.30

From Table 1.17, I find that the merger still has a significant negative effect on the price in the larger markets. This shows that the divestiture and resulting entry is not driving the price results although divestiture has significant negative effect on price as shown in Table 1.11. Table 1.18 shows the effect of merger on entry. The

Table 1.17.: Effect of Merger on Price (Excluding Divestiture Markets)

	(1)	(2)	(3)	(4)	(5)
	Price	Price	Price	Price	Price
	<5K	<10K&=>5K	<25K&=>10K	=>25K	All
time	-12.04***	-20.40***	-17.54***	-22.14***	-19.70***
	(-5.73)	(-7.83)	(-5.58)	(-6.14)	(-8.60)
treated	13.06	34.00***	16.94**	54.72***	35.01***
	(1.45)	(2.88)	(2.35)	(3.98)	(3.25)
did	2.872	-4.029	-27.01***	-20.55***	-26.90***
	(0.17)	(-0.29)	(-2.71)	(-3.61)	(-4.70)
cons	396.3***	48.76***	-32.94	163.9***	571.1***
	(6.16)	(2.78)	(-1.63)	(7.36)	(27.01)
N	32816	12789	11483	5352	62440
adj. R^2	0.644	0.659	0.598	0.399	0.310

dependent variable for this regression is the number of entries. The DID statistics are all positive and significant and it is evident that entry is present in both smaller and larger markets. So it is evident that entry pattern alone could not explain the observed price results. I show the effect of merger on LCC entry in Table 1.19. The dependent variable is the number of LCC entry. The results show that LCC entry is higher in the medium sized markets compared to large and small markets but again the DID statistics for both the largest and the smallest group of markets are not statistically significant which hinges on the fact that the entry pattern could not explain the results alone.

Table 1.18.: Effect of Merger on Entry

	(1) Entry <5K	(2) Entry <10K&=>5K	(3) Entry <25K&=>10K	(4) Entry =>25K	(5) Entry All
time	-0.0328**	-0.0544**	-0.0114	0.165**	0.0498
	(-2.28)	(-2.37)	(-0.43)	(2.25)	(1.35)
treated	0.509***	0.516***	0.516***	0.323*	0.580***
	(3.40)	(3.56)	(7.16)	(1.90)	(5.53)
did	0.382***	0.528***	0.552***	0.360***	0.500***
	(4.31)	(3.90)	(9.16)	(3.46)	(7.32)
_cons	0.0289	0.399***	0.749***	3.125***	-1.114**
	(0.10)	(2.65)	(5.04)	(6.59)	(-2.11)
N	35129	15776	13447	6056	70408
adj. R^2	0.388	0.477	0.567	0.608	0.690

Table 1.19.: Effect of Merger on LCC Entry

	(1) Entry <5K	(2) Entry <10K&=>5K	(3) Entry <25K&=>10K	(4) Entry =>25K	(5) Entry All
time	0.0167**	0.0388***	0.0509**	0.158***	0.0751**
	(2.09)	(3.36)	(2.22)	(2.92)	(2.37)
treated	-0.149***	-0.265***	-0.0250	-0.0830	0.0392
	(-2.63)	(-5.08)	(-0.51)	(-0.90)	(0.69)
did	0.0580	0.187*	0.151*	-0.0496	0.152***
	(1.06)	(1.69)	(1.76)	(-0.86)	(3.23)
cons	0.407***	1.329***	0.693***	0.998***	-0.749***
	(8.86)	(18.41)	(6.33)	(3.16)	(-3.47)
N	32816	12789	11483	5352	62440
adj. R^2	0.627	0.578	0.521	0.531	0.562

1.7 Merger Simulation

Following the discrete choice random utility maximization framework of Hausman and McFadden (1984), the own-price and cross-price elasticities can be estimated structurally using the pre-merger data. Using the demand parameter estimates, I recover the marginal cost assuming a specific model of firm conduct. Then using the estimated marginal cost and appropriately changing the ownership matrix, I simulate the post-merger price and compare the simulated post-merger price with the pre-merger price.

Model

Following Peters (2006), I consider a discrete choice nested logit model for consumer demand in the airline industry. I follow closely the framework of Berry (1994) and Berry et al. (1995). This class of models assumes an interior, static price setting equilibrium to back out marginal cost and markup. I first compute the parameters of the demand model using the pre-merger data. I calculate the marginal cost assuming that all the firms are playing a static Bertrand-Nash game. Then, I use the computed marginal cost to numerically solve for a new equilibrium in the post-merger period by changing the ownership matrix appropriately to reflect the merger. Then I perform some counterfactuals by assuming different values for the cost savings and conduct parameter.

Demand

Suppose consumer i chooses from J different products offered in market m by different competing airlines. The person also has the option of choosing an outside good, without choosing any of the products offered by the airlines. The consumer maximizes her utility function while choosing among different products.

$$\max_{j \in (0,\dots,J_m)} U_{ijm} = x_{jm}\beta - \alpha ln(p_{jm}) + \xi_{jm} + v_{it}(\lambda) + \lambda\epsilon_{ijm} \tag{1.3}$$

In equation (1.3), U_{ijm} is the total utility that consumer i derives from choosing product j in market m. x_{jm} is a vector of observed product characteristics such as itinerary convenience (distance), whether the itinerary is nonstop or not, and whether the origin airport is a hub for the carrier. β is the vector of parameters for the observed product characteristics. p_{jm} is the price of product j in market m. α represents the marginal utility of the log of the price. ξ_{jm} represents the unobserved (by the econometrician) product characteristics. ϵ_{ijm} is the random noise that is assumed to be identically and independently distributed across consumers, markets and products.

Following Berry (1994), I assume that the error term ϵ_{ijm} follows an extreme value Type I distribution. The term $v_{it}(\lambda)$ follows the distribution described by Cardell (1997). This distribution implies the nested logit form. The first nest contains the option of not flying or choosing between an outside good and an inside good. The second nest is among different products within a particular market. This type of setup assumes that some consumers are driven out of the market if the price is too high. The parameter λ determines the degree of within-market substitutability. If $\lambda \to 0$, it implies that products are perfectly substitutable. On the other hand, if $\lambda \to 1$, it implies that products are independent and the nested logit model becomes the standard multinomial logit model. Following Berry (1994), I normalize the mean utility level of the outside good to be zero. One of the limitations of the nested logit model is that I have to assume that consumers in all markets have the same values of α, β, and λ, i.e., I have to assume that consumers in Chicago have the same demand parameters as consumers in Miami.

Each consumer picks one variety from the available products in every market. The mean utility of product j of a consumer is the following

$$\delta_j = x_j\beta + \xi_j - \alpha ln(p_j) \tag{1.4}$$

where $j = 0$ is the outside good and $\delta_0 = 0$. The proportion of consumers choosing product j is equal to the probability of a consumer choosing product j among the set of products 1,2,...,J in the nest g. This probability is given by

$$s_{j|g} = \frac{exp(\frac{\delta_j}{\lambda})}{\sum_{k=1}^{J} exp(\frac{\delta_k}{\lambda})} \tag{1.5}$$

By similar logic, the probability of a consumer flying is equal to the share of consumers purchasing flights. Thus, the probability of flying and the probability of choosing the outside good are

$$\begin{aligned} s_g &= \frac{D^\lambda}{1+D^\lambda}, \\ &and \\ s_0 = 1 - s_g &= \frac{1}{1+D^\lambda} \end{aligned} \tag{1.6}$$

respectively, where $D = \sum_{k=1}^{J} exp(\frac{\delta_k}{\lambda})$. The overall share of product j is given by

$$s_j = s_{j|g} * s_g = \frac{exp(\frac{\delta_j}{\lambda})D^{\lambda-1}}{1+D^\lambda} \tag{1.7}$$

Following Berry (1994), I derive the estimating equation

$$\begin{aligned}\frac{s_j}{s_0} = \frac{s_g * s_{j|g}}{s_0} &= \left(\frac{D^\lambda}{D^\lambda+1}\right)\left(\frac{D^\lambda+1}{1}\right)\left(\frac{exp(\frac{\delta_j}{\lambda})}{D}\right)\\ &= D^{\lambda-1}exp(\frac{\delta_j}{\lambda})\\ &= D^{\lambda-1}\left(exp(\frac{\delta_j}{\lambda})\right)^{1-\lambda}\left(exp(\frac{\delta_j}{\lambda})\right)^{\lambda}\\ &= \left(s_{j|g}\right)^{1-\lambda}\left(exp(\frac{\delta_j}{\lambda})\right)^{\lambda}\end{aligned} \tag{1.8}$$

Then taking log on both sides gives

$$ln(s_j) - ln(s_0) = x_j\beta - \alpha ln(p_j) + \xi_j + (1-\lambda)ln(s_{j|g}), \tag{1.9}$$

The term ξ_j is the random error term. This term, which represents the unobservable characteristics of product j, will be endogenous. Unobservable aspects of the product such as time of purchase, refund policy, and leg room will all be correlated with price as well as the share of the product within its nest. Hence, I will need to instrument for price and inside share.

Instruments

Even though there is so much data available from the DB1B, many characteristics about flights are not observed, such as time of purchase, flight restrictions, and in-flight service, which are very likely to be correlated with the price and within group share. Following Berry (1994), I control for this endogeneity by instrumenting price and within group share with several different instruments.

In the literature, it is common to use input cost variables to instrument for price and within group share, since they are correlated with the price but not correlated with the unobserved product characteristics. I include a fourth order polynomial in distance because of the direct relation of distance to the operating cost of a flight.

Following Berry and Jia (2010), I also include the hub status of the connecting airport as an instrument. The hub status of the connecting airport will affect cost through traffic density at the connecting airport while it will not be correlated with unobserved product characteristics.

According to Berry (1994), demand side variables that affect markups also can be used as instruments. Characteristics of competing firm products can be used as instruments since they affect markup. I use the number of other carriers in the market, the number of products offered by other carriers in the market, the average number of connections of products offered by other carriers in the market, the average inconvenience of products offered by other carriers in the market, and market level HHI as demand-side instruments for price.

Supply

Following Berry and Jia (2010), I assume that firms play a static Bertrand-Nash price setting game. I use the first-order conditions and the estimated demand parameters to back out the marginal cost of each product as in Berry et al. (1995). Suppose the total number of firms is $\mathcal{F}$ and that firm f is producing a subset $\mathcal{F}_f$ of J different products. The payoff function and first-order condition is given below

$$\pi_f = \sum_{j \in \mathcal{F}_f} (p_j - mc_j) s_j(x, \xi, p, \theta_d) M - C_f \tag{1.10}$$

$$\frac{\partial \pi_f}{\partial p_j} = s_j(p) + \sum_{r \in \mathcal{F}_f} (p_r - mc_r) \frac{\partial s_r(p)}{\partial p_j} = 0, \tag{1.11}$$

where C_f is the fixed cost of firm f, mc_j is the marginal cost of product j produced by firm f, and M is the overall market size[24]. I define the matrix of the partial derivatives of share with respect to price as $E(p)$ where $E_{jr}(p) = -\frac{\partial s_r(p)}{\partial p_j}$. I also define the pre-merger ownership matrix Ω as follows:

$$\Omega_{jr} = \begin{cases} 1 & , \text{ if } \exists f : \{j, r\} \subset \mathcal{F}_f \\ 0 & , \text{ otherwise.} \end{cases} \tag{1.12}$$

If product j and product r offered by the same firm f, then the element corresponding to product j and product r in the ownership matrix will be 1, otherwise it will be zero. Let Ω^{pre} be the element-by-element product of $E(p)$ and Ω, so that

$$\Omega^{pre}_{jr}(p) = \begin{cases} -\frac{\partial s_r(p)}{\partial p_j} & , \text{if } \exists f : \{j, r\} \subset \mathcal{F}_f \\ 0 & , \text{otherwise} \end{cases} \tag{1.13}$$

where $\frac{\partial s_r(p)}{\partial p_j}$ is given by

$$\frac{\partial s_r(p)}{\partial p_j} = \begin{cases} s_j s_{r|g} \left(\frac{\alpha}{p_j}\right)(1 - s_g - \frac{1}{\lambda}) & , \text{if } r \neq j \\ s_j \left(\frac{\alpha}{p_j}\right)\left(\frac{1}{\lambda}(1 - s_{j|g}) + s_{j|g}(1 - s_g)\right) & , \text{if } r = j. \end{cases} \tag{1.14}$$

Following this notation, I can write the first order condition as follows:

$$s(p) - \Omega^{pre}(p)(p - mc) = 0. \tag{1.15}$$

Marginal cost is estimated by

$$\hat{mc} = p - (\hat{\Omega}^{pre})^{-1} s^{observed}. \tag{1.16}$$

[24]For calculating the market size, I estimate the inbound and outbound traffic from origin and destination airports and then calculate the market size using an idea similar to the gravity model in trade literature (see Silva and Tenreyro (2006) and Li et al. (2018) for more details).

Simulation

For the simulation, I use the overlapping markets[25] following Peters (2006). One reason is that the entry of LCCs occurs mostly in overlapping markets, due to divestiture and other reasons such as market size and profit opportunity. After estimating the marginal cost, I simulate the post-merger price by appropriately changing the ownership matrix and by solving for optimal prices in an interior price setting equilibrium.

$$\hat{mc} = p' - \left(\Omega^{post}(p')\right)^{-1} s(p') \tag{1.17}$$

In equation (1.17), $\hat{mc}$ is the estimated marginal cost from pre-merger data. $\Omega^{post}(p')$ is the post-merger matrix defined by element-by-element multiplication of the new ownership matrix Ω' and $E(p')$, where p' is the vector of post-merger equilibrium prices. I use numerical methods to solve for the post-merger equilibrium price.

I first assume that there are no cost savings and there is no tacit collusion among the firms. I run counterfactual merger simulations with different levels of cost savings. I calculate the pair-wise conduct parameter between two airlines and then incorporate that in the merger simulation process. I find that part of the decrease in the price can be explained by reductions in cooperation among firms in the post-merger period, and the other part can be explained by cost savings from the merger.

[25] The overlapping markets, where both AA and US used to operate in the pre-merger period, are most likely to be affected from the merger.

1.7.1 Data for Merger Simulation

Similar to DID analysis, I define a market as a unique year-quarter-origin-destination combination. A market is defined as a directional airport-to-airport trip in a particular year and a particular quarter, for example, in 2016 quarter 1, Indianapolis (IND) to Chicago (ORD). "Directional market" implies that air travel from Indianapolis to Chicago is a distinct market from air travel from Chicago to Indianapolis. This implies also that the characteristics of the origin airport are an important factor affecting air travel demand. I define a product as a unique combination of carrier and number of connections, for example, in Table 1.20 a non-stop flight on American Airlines from Chicago to Houston is a different product compared to flying to Houston via Dallas-Forth Worth. I drop very small markets, following the literature. Markets with less than 200 passengers in a quarter are dropped.

Table 1.20.: Examples of Different Products

Origin	**Connection1**	**Destination**	**Carrier**	**Product**
ORD	DFW	HOU	AA	1
ORD	NON STOP	HOU	AA	2
ORD	DEN	HOU	UA	3
ORD	NON STOP	HOU	UA	4
ORD	NON STOP	HOU	NK	5

Source:DB1B

In the airline industry the price for different flights varies across different unobservable characteristics such as time of purchase, in-flight services, and leg room. Following standard procedure, see Peters (2006), I aggregate observations at the product level. I define the price of a particular product as the passenger-weighted average fare of all of its observed fares in the data and the quantity as the sum of the passengers. For calculating the market size, I estimate the inbound and outbound traffic from origin and destination airports and then calculate the market size using an idea similar to the gravity model in trade literature (see Li et al. (2018)).

1.7.2 Sample Range

I define the pre-merger period as eight quarters before the merger is announced, from 2010Q2 to 2012Q1. I define the post-merger period as four quarters after the merger is completed, from 2016Q1 to 2016Q4. The selection of 2016Q1 as the starting of the post-merger period is reasonable since International Air Transport Association (IATA) retired the "US" code from 2016Q1 which serves as official recognition of the completion of the merger at that time. The summary statistics of the pre-merger and the post-merger period is given in Table 1.21 and Table 1.22. In Table 1.21, price is defined as the passenger weighted average airfare. Number of connections is defined as the number of stops made in an itinerary excluding the origin and destination airport. Market distance is defined as the minimum distance between a city-pair. Inconvenience of a particular product is defined as the distance of the product over the market distance.

1.7.3 Estimation

Demand

I use the following equation to estimate the demand parameters.

$$ln(s_j) - ln(s_0) = x_j\beta - \alpha ln(p_j) + \xi_j + (1-\lambda)ln(s_{j|g}) + \epsilon_j \tag{1.18}$$

In equation (1.18), s_j is the share of product j, and s_0 is the share of the outside good. x_j is the vector of exogenous product characteristics such as number of connections, the level of inconvenience (distance of the product over the market distance), and hub status of the origin and destination airports. I put the outside good in one nest, and all flights in another nest. The term ξ_j represents unobservable product qualities which are almost certain to be correlated with price and within group market shares.

Table 1.21.: Summary Statistics Pre-merger Period

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Price	73142	395.14	107.82	84.09	1340.4	317.88	382.04	455.81
Number of connections	73142	.97	.84	0	2	0	1	2
Inconvenience	73142	1.07	.1	1	2.05	1	1.03	1.09
Market distance	73142	2571.07	1218.51	694.6	5442.58	1623.02	2238.12	3469.27
Hub status of origin airport	73142	.19	.32	0	1	0	0	.5
Hub status of destination airport	73142	.19	.31	0	1	0	0	.5
Distance	73142	2720.97	1264.37	692	6566.83	1724	2391.73	3650
Number of products by other carriers	73142	2.86	2.37	0	17	1	2	4
Total number of connections of products by other carriers	73142	3.04	2.92	0	20	0	2	5
Total inconvenience of products by other carriers	73142	3.05	2.51	0	17.56	1.02	2.38	4.31
Number of other carriers in the market	73142	1.75	1.27	0	7	1	2	2
Average number of connections of products by other carriers	61902	1.05	.65	0	2	.5	1	1.5
Average inconvenience of products by other carriers	61902	1.07	.08	1	1.99	1.02	1.05	1.09
Herfindahl Index	73142	.59	.23	.17	1	.42	.54	.73
Hub status of connecting airport	73142	.31	.34	0	1	0	.21	.5

Table 1.22.: Summary Statistics Post-merger Period

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Price	40848	380.71	121.05	65.31	1108.16	300.29	377.48	456.79
Number of connections	40848	.88	.84	0	2	0	1	2
Inconvenience	40848	1.07	.11	1	2.17	1	1.03	1.09
Market distance	40848	2428.66	1234.41	502.27	5442.58	1457.02	2132.19	3334.04
Hub status of origin airport	40848	.19	.32	0	1	0	0	.5
Hub status of destination airport	40848	.19	.31	0	1	0	0	.5
Distance	40848	2578.28	1284.5	502	7092	1599.1	2289.41	3488
Number of products by other carriers	40848	2.79	2.43	0	15	1	2	4
Total number of connections of products by other carriers	40848	2.73	2.77	0	15	0	2	4
Total inconvenience of products by other carriers	40848	2.98	2.58	0	15.82	1	2.28	4.32
Number of other carriers in the market	40848	1.7	1.3	0	6	1	2	3
Average number of connections of products by other carriers	33344	.98	.65	0	2	.5	1	1.4
Average inconvenience of products by other carriers	33344	1.07	.08	1	2.05	1.02	1.05	1.09
Herfindahl Index	40848	.59	.24	.18	1	.41	.53	.74
Hub status of connecting airport	40848	.28	.32	0	1	0	.13	.5

I use several instruments such as distance, hub status of the connecting airport, and product characteristics of the competitors to instrument for these endogenous variables.

Marginal Cost

After estimating the demand parameters, I use the following equation to calculate the marginal cost. Table 1.23 summarizes the estimated marginal costs and prices in the pre-merger period. Figure 1.3 plots marginal costs and prices in the pre-merger period. While most of the points are just below the 45-degree line, still there is some variation in the estimated cost data.

$$\hat{mc} = p - (\hat{\Omega}^{pre})^{-1} s^{observed} \tag{1.19}$$

Table 1.23.: Summary Statistics of Marginal Cost and Price (Pre-merger Period)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Marginal Cost	7452	248.85	85.58	4.65	783.14	193.26	242.66	296.98
Price in the Pre-merger Period	7452	435.61	109.39	110.35	1043.6	361.97	424.76	498.69

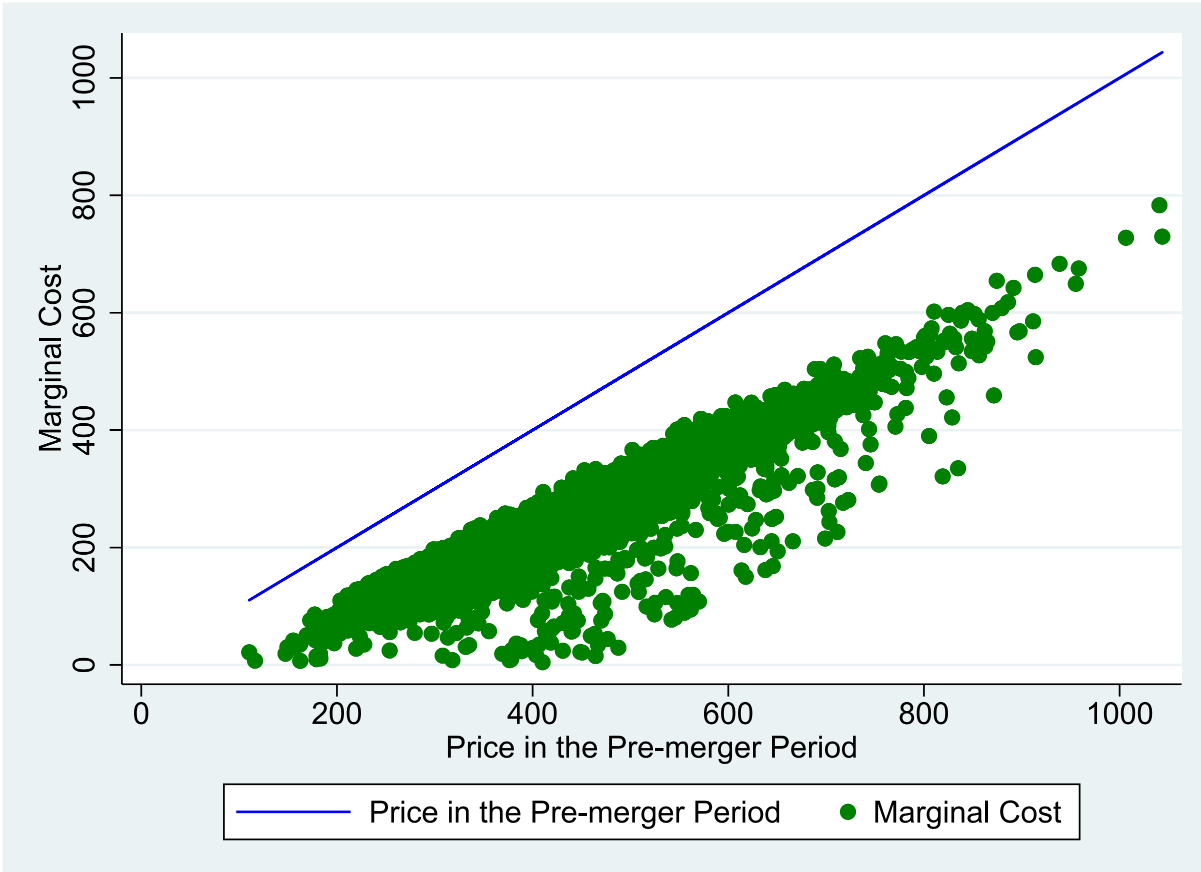


Figure 1.3.: Price and Marginal Cost

Finally, I use the different levels of cost savings and the conduct to run the counterfactual simulations to match the actual post-merger price with the simulated price.

Demand

In Table 1.24, I list the results of the demand estimation. Almost all the coefficients are statistically significant and have the expected sign. The coefficient of the log of fare is -2.92, and it is significant at the 1% level. Similarly, the log of within-group share is also significant at the 1% level. The estimated value of λ is .345 which indicates that the products are substitutable with each other. This invalidates the standard multinomial logit model which assumes that products are independent.

Consumers also prefer fewer connections as the coefficient on connections is negative and significant. The hub variables are significant, and the coefficients have positive sign. Consumers prefer shorter rather than longer routes as the coefficient of inconvenience is negative. Demand for flights increases as the market distance increases since the coefficient of market distance is positive. The coefficient of the interaction of hub status and market distance is also positive. The interactions of market distance and hub status are also positive and significant.

I calculate the elasticity of demand for different markets using the estimated value of parameters α and λ. The average own-price elasticity in overlapping markets is -7.14, and average cross-price elasticity is 1.39. Table 1.25 shows the elasticity measure in a particular market[26]. The elasticities of nonstop products are lower in absolute value than elasticities of connecting products, implying that nonstop products are less elastic compared to the connecting products. The elasticities also are higher for products with a higher average price.

[26]The estimated elasticity are similar to the past literature in the airline industry (see Ciliberto and Williams (2014)).

Table 1.24.: Demand Estimation:2SLS

log of fare	-2.920***
	(0.0898)
log of within group share	0.655***
	(0.00813)
connections	-0.209***
	(0.00699)
inconvenience	-0.386***
	(0.0411)
market distance	0.0437***
	(0.00128)
origin is a hub	0.896***
	(0.0341)
origin is a hub*market distance	0.00179**
	(0.000866)
destination is a hub	0.413***
	(0.0276)
destination is a hub*market distance	0.00296***
	(0.000853)
constant	14.95***
	(0.481)
N	61902
adj. R^2	0.784

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.25.: Elasticity Matrix of Chicago-Phoenix Market, 2012 Q2

Carrier	**Passengers**	**Fare**	**Connections**	**Elasticity**					
American	610	454.49	One	-8.3	2.5	1.3	.2	.03	1.7
American	18310	423.75	Non stop	0.1	-5.7	1.4	.2	.03	1.9
United	9520	422.63	Non stop	0.1	2.7	-7.0	.2	.03	1.8
United	950	510.43	One	0.1	2.3	1.2	-8.3	.03	1.5
US Airways	160	595.37	One	0.1	1.9	1.0	.12	-8.4	1.3
US Airways	13570	388.21	Non stop	.1	2.9	1.5	.18	.04	-6.5

Marginal Cost

I use equation (1.19) to calculate the marginal cost. Then I use the calculated marginal cost and equation (1.17) to solve numerically for the post-merger price. I compare the simulated price with the pre-merger price to measure the extent of the price change. I also compare actual post-merger price with pre-merger price. Next I run counterfactual simulations with different values of cost reduction both common across all firms and specific to the merged firm.

Conduct

In equation (1.20), κ is the conduct parameter which is between zero and one. When κ is 0, the cooperation level is zero. $\kappa = 1$ implies perfect collusion, and $0 < \kappa < 1$ implies some degree of tacit collusion. When tacit collusion is present in the market, the firm not only cares about its own profit but also takes into account some fraction of the other firms' profit into the maximization problem. π_f is the own profit of firm f, and π_{others} is the profit of other firms in the market. In the second line, I have written the profit functions in explicit form where p_j is price of product j, mc_j is the marginal cost, and s_j is the share of product j which is a function of observable (x) and unobservable (ξ) product characteristics, price (p), and elasticity of demand (θ_d). M is the market size, and C_f is the fixed cost.

$$\begin{aligned} \pi_f &= \pi_{own} + (\kappa) * \pi_{others} \\ \pi_f &= \sum_{j \in \mathcal{F}_f} (p_j - mc_j) s_j(x, \xi, p, \theta_d) M \\ &\quad + (\kappa) \left(\sum_{j \notin \mathcal{F}_f} (p_j - mc_j) s_j(x, \xi, p, \theta_d) M - C_f \right) \end{aligned} \tag{1.20}$$

In equation (1.21), I have provided an example considering only two firms A and B. I have written the two first order conditions of firms A and B jointly in line 5 and in a more compact way in line 6. The diagonal elements of the ownership matrix O_{jr}

are 1, and the off-diagonal elements are κ. E_{jr} is the matrix of partial derivatives of market share with respect to price.

$$
\begin{aligned}
\pi_A &= (p_a - mc_a)s_a M + \kappa(p_b - mc_b)s_b M - (C_a + \kappa C_b) \\
\pi_B &= (p_b - mc_b)s_b M + \kappa(p_a - mc_a)s_a M - (C_b + \kappa C_a) \\
\frac{\partial \pi_A}{\partial p_a} &= s_a M + (p_a - mc_a)M\frac{\partial s_a}{\partial p_a} + \kappa(p_b - mc_b)M\frac{\partial s_b}{\partial p_a} = 0 \\
\frac{\partial \pi_B}{\partial p_b} &= s_b M + (p_b - mc_b)M\frac{\partial s_b}{\partial p_b} + \kappa(p_a - mc_a)M\frac{\partial s_a}{\partial p_b} = 0
\end{aligned}
\tag{1.21}
$$

$$
\begin{pmatrix} s_a \\ s_b \end{pmatrix} + \begin{pmatrix} 1 & \kappa \\ \kappa & 1 \end{pmatrix} .* \begin{pmatrix} \frac{\partial s_a}{\partial p_a} & \frac{\partial s_b}{\partial p_a} \\ \frac{\partial s_a}{\partial p_b} & \frac{\partial s_b}{\partial p_b} \end{pmatrix} \begin{pmatrix} p_a - mc_a \\ p_b - mc_b \end{pmatrix} = 0
$$

$$
s(p) + \Omega_{jr}^{pre}(p)(p - mc) = 0, where
$$

$$
\begin{aligned}
\Omega_{jr}^{pre}(p) &= \left(O_{jr} + \kappa O_{jr}^c\right) \odot E_{jr}, \\
O_{jr}^c &= \begin{cases} 0 & , \text{ if } \exists f : \{j, r\} \subset \mathcal{F}_f \\ 1 & , \text{ otherwise,} \end{cases} \\
\kappa = f(mmc_{kh}^t) &= \frac{\exp(\phi_1 + \phi_2 mmc_{kh}^t)}{1 + \exp(\phi_1 + \phi_2 mmc_{kh}^t)}.
\end{aligned}
$$

I calculate the conduct parameter[27] pairwise from the multimarket contact between the carriers following Ciliberto and Williams (2014). The numbers of overlapping markets between pairs of carriers are given in Table 1.26 and Table 1.27. The following equation (1.22) is used to estimate the conduct between two carriers as in Ciliberto and Williams (2014).

$$
f(mmc_{kh}^t) = \frac{\exp(\phi_1 + \phi_2 mmc_{kh}^t)}{1 + \exp(\phi_1 + \phi_2 mmc_{kh}^t)} \tag{1.22}
$$

In equation (1.22), mmc_{kh}^t is the number of overlapping markets between carrier k and carrier h at time period t. ϕ_1 and ϕ_2 are constants. The estimated pairwise conduct parameters are shown in Tables 1.28 and 1.29. The conduct parameter value is higher for the carriers having a higher number of overlapping markets. I use this estimated

[27] More detailed definition of conduct parameter is given in the Appendix.

conduct parameter to simulate the post-merger price. The results are shown in Table 1.30.

Table 1.26.: Number of Overlapping Markets: 2012 Q2

	DL	US	AA	UA	AS	B6	F9	G4	NK	SY	VX	WN
DL	1194	446	302	369	32	112	109	7	56	27	18	720
US	446	754	195	333	19	59	57	0	26	9	23	372
AA	302	195	598	355	31	42	26	1	40	5	30	245
UA	369	333	355	873	59	57	130	9	37	4	46	426
AS	32	19	31	59	126	11	7	7	5	1	21	71
B6	112	59	42	57	11	162	0	0	13	0	13	64
F9	109	57	26	130	7	0	219	2	9	5	0	149
G4	7	0	1	9	7	0	2	23	2	0	0	0
NK	56	26	40	37	5	13	9	2	82	1	4	29
SY	27	9	5	4	1	0	5	0	1	27	0	15
VX	18	23	30	46	21	13	0	0	4	0	49	25
WN	720	372	245	426	71	64	149	0	29	15	25	1151

Table 1.27.: Number of Overlapping Markets: 2016 Q2

	DL	AA	UA	AS	B6	F9	G4	NK	SY	VX	WN
DL	1348	821	385	120	152	170	1	159	32	29	791
AA	821	1201	453	50	114	147	0	155	19	33	599
UA	385	453	746	57	50	156	1	131	12	44	346
AS	120	50	57	188	8	13	1	14	4	10	121
B6	152	114	50	8	224	3	0	34	0	16	82
F9	170	147	156	13	3	263	1	45	6	13	148
G4	1	0	1	1	0	1	3	0	0	0	1
NK	159	155	131	14	34	45	0	253	14	7	124
SY	32	19	12	4	0	6	0	14	32	0	16
VX	29	33	44	10	16	13	0	7	0	64	30
WN	791	599	346	121	82	148	1	124	16	30	1153

Table 1.28.: Estimated Conduct: 2012 Q2

	DL	US	AA	UA	AS	B6	F9	G4	NK	SY	VX	WN
DL	1.00	0.60	0.32	0.44	0.05	0.09	0.09	0.04	0.06	0.05	0.05	0.93
US	0.60	1.00	0.17	0.37	0.05	0.06	0.06	0.04	0.05	0.04	0.05	0.45
AA	0.32	0.17	1.00	0.42	0.05	0.06	0.05	0.04	0.05	0.04	0.05	0.23
UA	0.44	0.37	0.42	1.00	0.06	0.06	0.11	0.04	0.05	0.04	0.06	0.56
AS	0.05	0.05	0.05	0.06	1.00	0.04	0.04	0.04	0.04	0.04	0.05	0.07
B6	0.09	0.06	0.06	0.06	0.04	1.00	0.04	0.04	0.04	0.04	0.04	0.06
F9	0.09	0.06	0.05	0.11	0.04	0.04	1.00	0.04	0.04	0.04	0.04	0.12
G4	0.04	0.04	0.04	0.04	0.04	0.04	0.04	1.00	0.04	0.04	0.04	0.04
NK	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.04	1.00	0.04	0.04	0.05
SY	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	1.00	0.04	0.04
VX	0.05	0.05	0.05	0.06	0.05	0.04	0.04	0.04	0.04	0.04	1.00	0.05
WN	0.93	0.45	0.23	0.56	0.07	0.06	0.12	0.04	0.05	0.04	0.05	1.00

Table 1.29.: Estimated Conduct: 2016 Q2

	DL	AA	UA	AS	B6	F9	G4	NK	SY	VX	WN
DL	1.00	0.97	0.48	0.10	0.12	0.14	0.04	0.13	0.05	0.05	0.96
AA	0.97	1.00	0.61	0.06	0.09	0.12	0.04	0.13	0.05	0.05	0.83
UA	0.48	0.61	1.00	0.06	0.06	0.13	0.04	0.11	0.04	0.06	0.40
AS	0.10	0.06	0.06	1.00	0.04	0.04	0.04	0.04	0.04	0.04	0.10
B6	0.12	0.09	0.06	0.04	1.00	0.04	0.04	0.05	0.04	0.05	0.07
F9	0.14	0.12	0.13	0.04	0.04	1.00	0.04	0.06	0.04	0.04	0.12
G4	0.04	0.04	0.04	0.04	0.04	0.04	1.00	0.04	0.04	0.04	0.04
NK	0.13	0.13	0.11	0.04	0.05	0.06	0.04	1.00	0.04	0.04	0.10
SY	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	1.00	0.04	0.05
VX	0.05	0.05	0.06	0.04	0.05	0.04	0.04	0.04	0.04	1.00	0.05
WN	0.96	0.83	0.40	0.10	0.07	0.12	0.04	0.10	0.05	0.05	1.00

The actual decrease in price is approximately 8% when I compare the pre-merger and the post-merger prices in the overlapping city-pair markets. From Table 1.30, we can see that an industry-wide cost reduction of 10%[28] is required to match the actual decrease in price if we assume that there is no cost reduction due to the merger. A

[28]The price of jet fuel decreased almost 25% in the post-merger period as shown in Figure 1.6. Jet fuel is one of the primary input for commercial air travel. It is difficult to estimate the percentage cost reduction per seat mile due to the reduction in jet fuel cost but it will definitely have a significant effect across the industry.

Table 1.30.: With Tacit Collusion in Pre-merger and Post-merger Period

Cost Saving	**Industry**					
Merger	**0%**	**2.5%**	**5%**	**7.5%**	**10%**	**12.5%**
0%	2.9	-0.2	-2.4	-4.8	-7.2	-9.7
2.5%	1.5	-0.7	-3.3	-5.8	-8.2	-10.7
5%	0.5	-1.3	-3.9	-6.3	-8.7	-11.2
7.5%	-0.1	-2.5	-4.7	-7.1	-9.5	-11.9
10%	-1.0	-3.4	-5.4	-7.6	-10.4	-12.5
12.5%	-1.8	-3.9	-6.5	-8.6	-11.1	-13.4

cost reduction of 7.5% across all firms and a reduction of 10% specific to the merged firm are able to match the actual post-merger price quite closely. In Table 1.31, firms are acting as Nash-Bertrand players both in the pre-merger and the post-merger period. We can see that the reduction in price with the same level of cost savings is approximately 1% higher compared to Table 1.30.

In Table 1.32, there is tacit collusion among firms in the pre-merger period but not in the post-merger period. We can see that with tacit collusion only in the pre-merger period, the reduction in price with the same level of cost savings is 2% higher compared to Table 1.30. In Table 1.33, I show that with average conduct level of .5 among the legacy carriers[29], the reduction in price will be even higher compared to the reduction in price in case of pairwise conduct parameter. This shows the existence of another channel through which price reduction is possible apart from cost savings. This result suggests that the possibility is strong that the firms were operating with some level of tacit cooperation, and they might not be acting as Nash-Bertrand competitors in the pre-merger period.

Table 1.31.: With Nash-Bertrand in Pre-merger and Post-merger Period

Cost Saving	**Industry**					
Merger	**0%**	**2.5%**	**5%**	**7.5%**	**10%**	**12.5%**
0%	2.5	-0.5	-2.5	-5.0	-7.5	-9.9
2.5%	1.5	-0.8	-3.6	-5.9	-8.5	-10.9
5%	0.6	-1.4	-4.4	-6.5	-9	-11.5
7.5%	-0.4	-2.6	-4.8	-7.3	-9.7	-12.2
10%	-1.1	-3.5	-5.6	-7.9	-10.5	-12.7
12.5%	-1.9	-4.2	-6.6	-8.7	-11.2	-13.6

[29] I include American, Delta, United, and Southwest in this group.

Table 1.32.: With Tacit Collusion only in Pre-merger Period (pairwise)

Cost Saving	**Industry**					
Merger	**0%**	**2.5%**	**5%**	**7.5%**	**10%**	**12.5%**
0%	1.8	-0.8	-3.3	-5.6	-8.2	-10.5
2.5%	1.1	-1.2	-3.9	-6.7	-8.7	-11.1
5%	0.3	-2.2	-4.9	-7.1	-9.4	-11.9
7.5%	-0.6	-2.9	-5.2	-7.6	-10.1	-12.7
10%	-1.5	-3.8	-6.1	-8.6	-10.9	-13.1
12.5%	-2.1	-4.8	-6.7	-9.4	-11.2	-14.1

In Table 1.34, I have summarized the results of Tables 1.30, 1.31, 1.32, and 1.33. The row header represents the industry-wise percentage cost savings and the merger-specific cost savings respectively. The column header represents the pre- and post-merger nature of competition. NB implies the firms are competing in a Nash-Bertrand environment whereas TC represents that the firms are tacitly colluding. Price reduction is lowest with NB in the pre-merger period and TC in the post-merger period. Price reduction is highest with breakdown in tacit collusion in the post-merger period which helps to explain some part of the observed reduction in price in the data besides cost savings. The entry of low cost carriers due to divestiture is one way to justify why reduction in tacit collusion is a possibility.

Table 1.33.: With Tacit Collusion only in Pre-merger Period (average level)

Cost Saving	**Industry**			
Merger	**0%**	**2.5%**	**5%**	**7.5%**
0%	-4.5	-6.8	-9.4	-11.5
2.5%	-5.5	-7.6	-10.4	-12.5
5%	-6.5	-8.4	-10.7	-13.1
7.5%	-7.2	-9.3	-11.7	-13.7

Table 1.34.: Simulated percentage reduction in price with industry-wide cost reduction, merger-specific cost reduction (row) and nature of competition in the pre- , post-merger period (column)

	(0,0)	**(2.5,2.5)**	**(5,5)**	**(7.5,7.5)**
(NB,NB)	2.5	-0.8	-4.4	-7.3
(TC,NB)	1.8	-1.2	-4.9	-7.6
(NB,TC)	3.7	-0.2	-3.4	-6.7
(TC,TC)	2.9	-0.7	-3.9	-7.1
(TC,NB)[30]	-4.5	-7.6	-10.7	-13.7

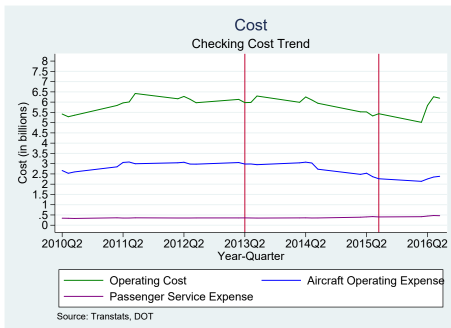
[30] $\rightarrow \kappa = conduct \quad parameter = .5 \quad (among \quad the \quad major \quad carriers)$

1.7.4 Cost

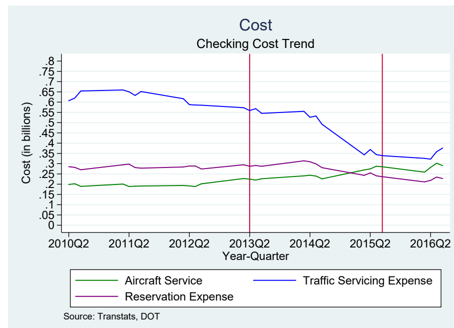
This section analyzes the operating cost of the airlines. If there is any efficiency gain due to the merger it might be reflected in the accounting cost. This cost data is taken from the schedule P-7 of Air Carrier Financial Statistics reported to the DOT. In general there are always concerns regarding the validity of accounting cost data for economic analysis[31]. To see if the accounting cost data is reliable, I compare the estimated total variable cost from the simulation to the actual cost reported by the airlines, and I find that the figures are similar.

I plot the different types of costs against the year-quarter combination for AA-US combined and for the other airlines separately. It is clear from Figures 1.4(a) and 1.4(b) that there is some downward trend for operating cost and traffic servicing expense for the merging airlines. On the other hand the downward trend is missing from the the cost data of the other airlines. This downward trend in cost might be due to cost reductions due to the merger.

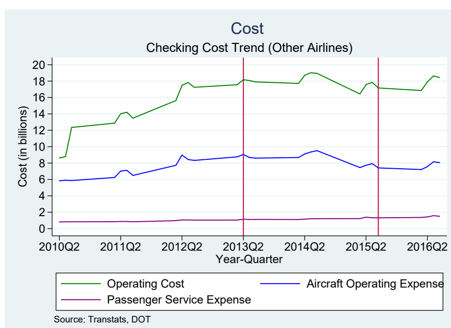
[31] Accounting measures of operating cost are problematic (see, for example, Nevo (2001)). Here, I use these accounting measures of cost to have a crude estimate of cost in the pre- and post-merger period.



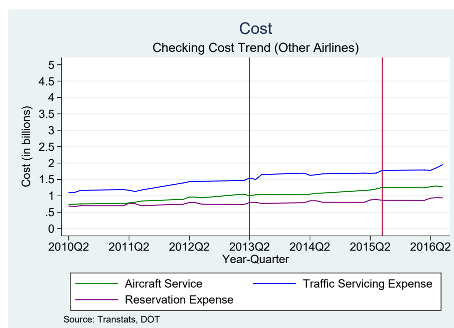
(a) Figure A



(b) Figure B

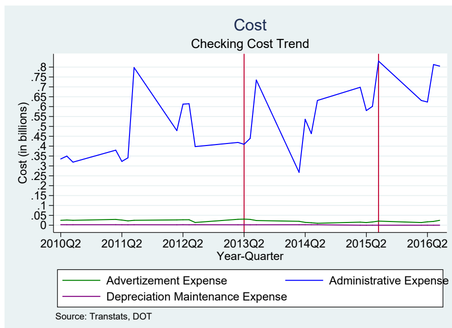


(c) Figure C

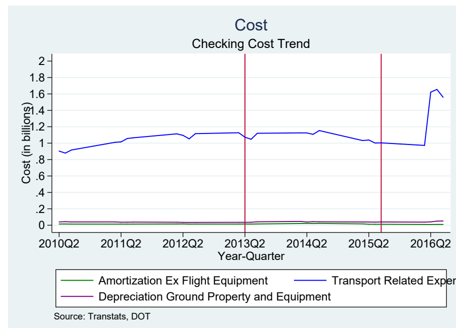


(d) Figure D

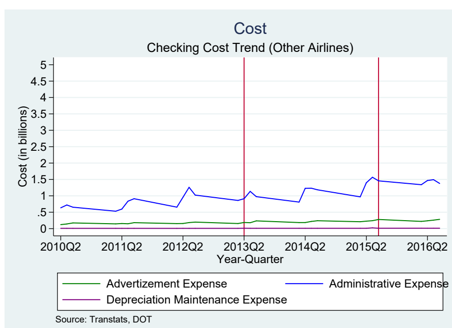
Figure 1.4.: Comparing Cost Data for Merging and Other Airlines



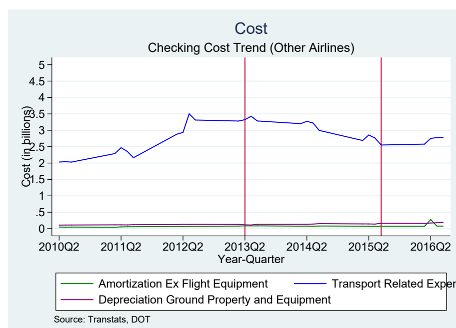
(a) Figure A



(b) Figure B



(c) Figure C



(d) Figure D

Figure 1.5.: Comparing Cost Data for Merging and Other Airlines

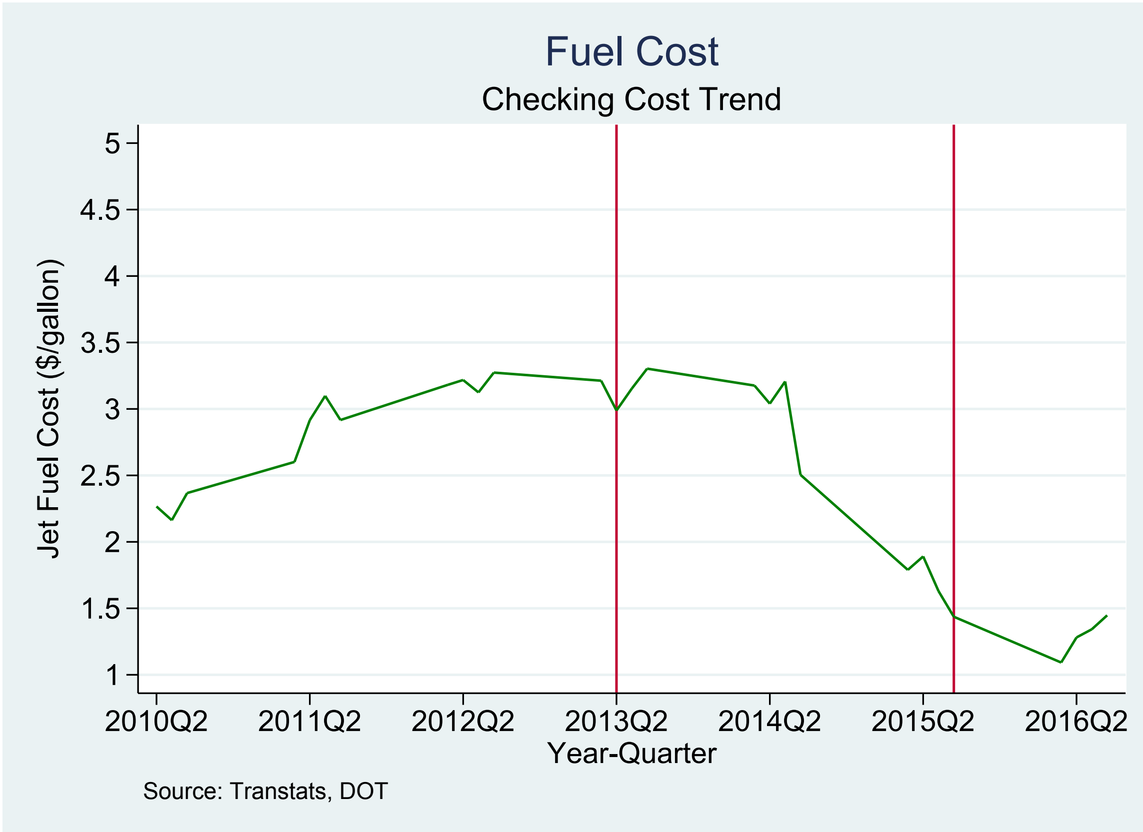


Figure 1.6.: Jet fuel price

1.8 Conclusion

This paper analyzes the impact of the AA-US merger on market price and product quality. From the difference-in-differences analysis I find that the merger has a significant negative effect on the price in the larger markets. Smaller markets have not benefited from the merger in terms of lower price. Price has increased in the smaller markets due to the merger. Slot divestiture has helped to reduce the price in both larger and smaller markets. However the negative effect of slot divestiture on price in smaller markets is greater which is consistent with the idea that competition is lower in many smaller markets. Slot divestiture helps in increasing the level of competition, resulting in lower price.

I also find that the merger has no significant effect on the frequency of flights or capacity (number of seats) in the nonstop markets. Delay in departure and arrival have increased as a result of the merger, but the merger does have significant effects in reducing the number of cancellations in the post-merger period.

From the difference-in-differences analysis, I can claim that the merger between American and US Airways has been beneficial to consumers in terms of lower average prices and fewer number of canceled flights in the larger markets while the smaller markets have not benefited from lower prices. The fact that divestiture has a significant impact in reducing the price in smaller markets has important policy implications. To keep smaller markets more competitive and prices at the competitive level, divestiture is a important policy tool.

From the merger simulation, I find that the change in the market structure, assuming no cost reduction, leads to a 3% increase in price. Given that the actual post-merger price has decreased after the merger, either there must be cost reduction from the merger or cost must have gone down at the industry level for all firms. The other possibility is the breakdown of tacit collusion among the firms in the post-merger period due to entry of LCCs. I find that a combination of 7% cost reduction for all firms, 10% cost savings due to the merger, and a reduction in cooperation among the airlines is able to predict the post-merger price quite accurately.

A breakdown of price cooperation in the post-merger period due to the entry of the LCCs[32] might contribute to the observed reduction in price (see (Farrell and Shapiro, 2001, p. 699)) apart from the cost savings due to the merger and the reduction in jet fuel cost.

Some limitations need to be acknowledged. First, even though my paper attempts to analyze the conduct parameter, the analysis is still under the framework of Nash-Bertrand competition. It will be interesting to build a model to capture cooperation among firms in a more direct way. Second, my analysis does not incorporate the inter-temporal pricing decisions of the airlines. Third, the data provided by DOT is quarterly data which might raise the issue of aggregation bias. Fourth, my paper does not take into account the network effects directly into the model. It will be interesting to look at the network effects separately and I leave that for future research (Ciliberto et al. (2017)). I also do not endogenize the product choice offered in the market which is a growing research area (Li et al. (2018)). Finally, I do not model the dynamics of airline competition which will be very interesting but more structurally demanding (Aguirregabiria and Ho (2012)).

[32] Ciliberto et al. (2016) model entry and find that entry has been effective in reducing the price

1.9 Appendix

DID Analysis

Overlapping Markets

Figure 1.7 shows the route network of American Airlines in the pre-merger period. American Airlines had 6 hub airports which were Chicago Ohare, New York LaGuardia, Washington DC, Miami International, Dallas Forth Worth, and Los Angles International.

Figure 1.7.: Route Network of American Airlines in the Pre-merger Period

Figure 1.8 shows the route network of US Airways in the pre-merger period. US Airways had 4 hub airports which were Boston Logan, Philadelphia, Charlotte, and Phoenix. Figure 1.9 shows the overlapping route network of US Airways and American Airline in the pre-merger period.

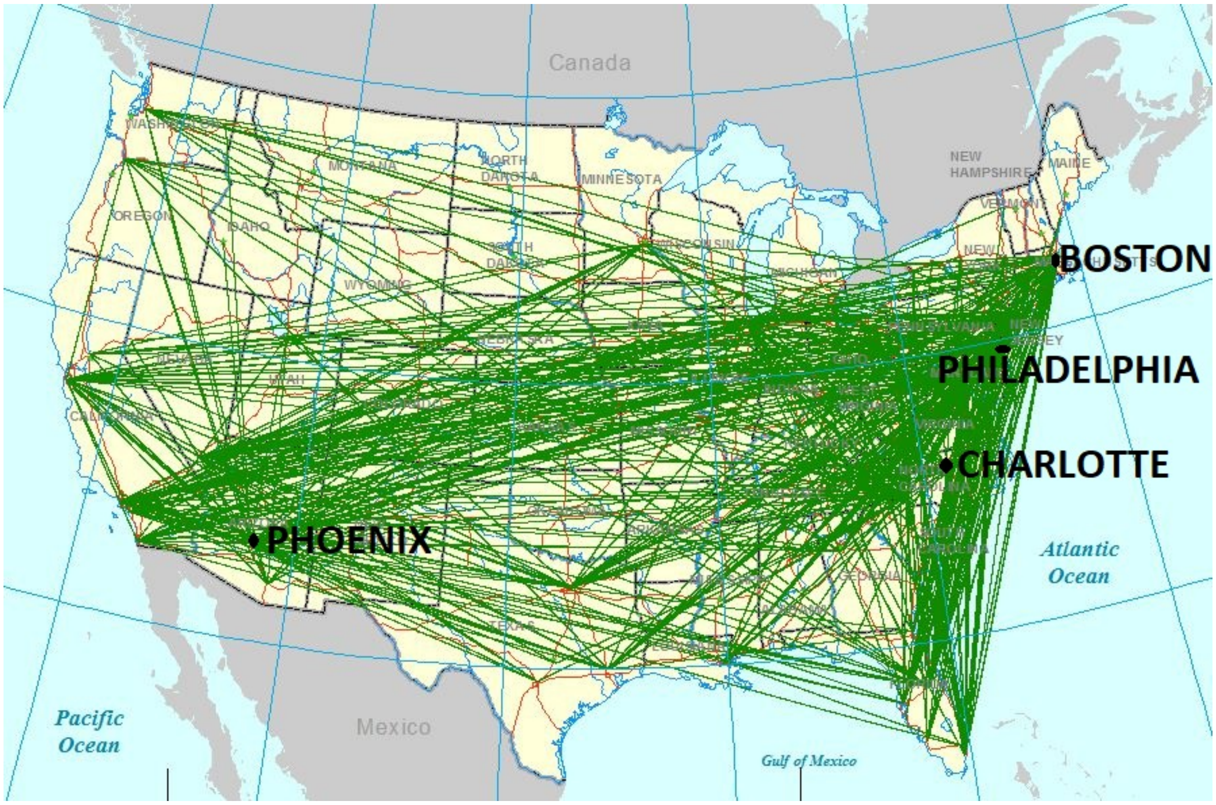


Figure 1.8.: Route Network of US Airlines in the Pre-merger Period

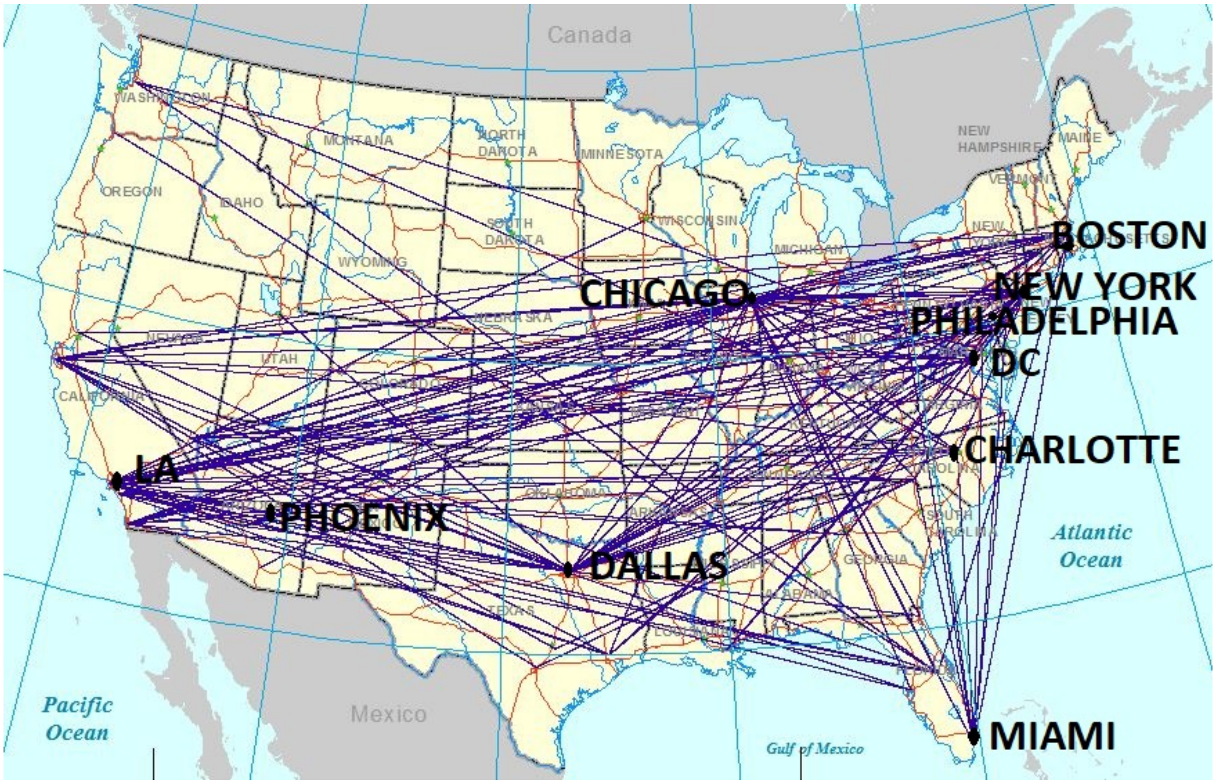


Figure 1.9.: Overlapping Route Network of American Airlines and US Airlines in the Pre-merger Period

Robustness Checks

The following section provides robustness checks for the DID analysis results shown in the paper. Table 1.35 provides the DID analysis results for price with cluster and fixed effect. The results are qualitatively similar to the DID analysis results for price shown in the paper.

Table 1.35.: Diff-in-Diff Analysis: Price

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	-0.417	0.0256	-4.619	-4.344	-10.95**
	(-0.08)	(0.01)	(-0.88)	(-0.42)	(-2.60)
Treated	14.62***	22.97***	28.46***	28.43**	34.90***
	(3.67)	(3.65)	(4.83)	(2.56)	(5.15)
DID	24.48***	15.12**	-3.566	-19.25**	-5.189
	(4.38)	(2.10)	(-0.38)	(-2.10)	(-0.81)
Constant	279.1***	105.9***	29.47**	181.0***	489.1***
	(25.14)	(7.25)	(2.32)	(12.83)	(97.07)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	19628	8609	7356	2663	38256
adj. R^2	0.565	0.578	0.529	0.475	0.323

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.36 provides the DID analysis results for price with market size defined according to the number of competitors in the pre-merger period. The results are qualitatively similar to the DID results for price shown in the paper implying the robustness of the results shown in the paper.

Table 1.36.: Diff-in-Diff Analysis: Price; Separating the markets with Pre-merger Number of Competitors

	(1)	(2)	(3)	(4)	(5)
	price	price	price	price	price
	<2	<3&>=2	<4&>=3	>=4	All
Time	-11.75***	-13.58***	-9.272	-14.87	-10.95**
	(-2.85)	(-2.80)	(-1.18)	(-1.53)	(-2.60)
Treated	26.96***	25.83***	34.68***	9.136	34.90***
	(2.69)	(4.03)	(3.66)	(0.78)	(5.15)
DID	16.05*	3.198	-17.04	-4.857	-5.189
	(1.77)	(0.38)	(-1.61)	(-0.49)	(-0.81)
Constant	598.0***	643.1***	213.8***	250.1***	489.1***
	(12.17)	(10.58)	(7.38)	(14.69)	(97.07)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	11584	12339	6636	4591	38256
adj. R^2	0.537	0.448	0.439	0.393	0.323

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.37 provides the DID analysis results for price with market size defined according to the population in the origin and the destination. The results are qualitatively similar to the DID results for price shown in the paper implying the robustness of the results shown in the paper.

Table 1.37.: Diff-in-Diff Analysis: Price with Population as Market Size

	(1) price <=.75M	(2) price <=1.5M&>.75M	(3) price <=2M&>1.5M	(4) price >2M	(5) price All
Time	-34.95**	22.77***	18.19*	-16.83***	-11.01***
	(-2.63)	(2.97)	(1.96)	(-4.11)	(-2.62)
Treated	-8.772	25.54**	35.03***	33.25***	34.94***
	(-1.05)	(2.37)	(3.67)	(4.17)	(5.15)
DID	25.32**	15.13*	-0.849	-2.382	-5.216
	(2.21)	(1.68)	(-0.13)	(-0.37)	(-0.81)
Constant	192.5***	325.0***	308.1***	747.1***	677.3***
	(32.94)	(4.46)	(8.55)	(24.44)	(12.88)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	176	2950	4420	30522	38068
adj. R^2	0.883	0.648	0.357	0.319	0.319

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.38 provides the DID analysis results for price with divestiture with fixed effect and clustering. The results are qualitatively similar to the DID results for price with divestiture shown in the paper implying the robustness of the results shown in the paper.

Table 1.38.: Diff-in-Diff Analysis: Price (Divestiture)

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	-0.532	0.100	-4.635	-4.158	-10.88**
	(-0.11)	(0.02)	(-0.88)	(-0.41)	(-2.60)
Treated	14.41***	22.94***	28.64***	27.96**	34.36***
	(3.63)	(3.65)	(4.88)	(2.52)	(5.11)
DID	24.54***	14.81**	-3.454	-19.55**	-5.347
	(4.40)	(2.05)	(-0.36)	(-2.10)	(-0.83)
Divestiture	-71.64***	-28.54	8.843	-8.359	-12.77
	(-6.34)	(-1.44)	(0.54)	(-0.35)	(-0.75)
Constant	277.3***	105.4***	29.96**	181.5***	488.2***
	(25.01)	(7.20)	(2.35)	(12.37)	(90.68)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	19628	8609	7356	2663	38256
adj. R^2	0.566	0.578	0.529	0.475	0.323

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.39 provides the DID analysis results for price with divestiture with fixed effect and clustering. Divestiture has been defined as a dummy variable as the number of gates divested. The results are qualitatively similar to the DID results for price with divestiture shown in the paper implying the robustness of the results shown in the paper.

Table 1.39.: Diff-in-Diff Analysis: Price (Divestiture as Number of Gates)

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	3.244	-5.057*	-2.040	-0.801	-6.715***
	(1.39)	(-1.65)	(-0.70)	(-0.15)	(-3.34)
Treated	39.29***	57.71***	65.95***	70.27***	46.77***
	(21.11)	(21.34)	(24.69)	(16.65)	(25.75)
DID	21.07***	8.334*	-15.49***	-23.53***	-9.202***
	(6.38)	(1.79)	(-3.37)	(-3.25)	(-2.81)
Divest1	-7.830*	-15.03**	-10.56	30.01***	-1.903
	(-1.82)	(-2.25)	(-1.58)	(4.74)	(-0.48)
Divest2	-36.47***	-39.60***	-11.18	16.81**	-23.73***
	(-6.09)	(-4.62)	(-1.31)	(2.25)	(-4.76)
Constant	380.8***	355.7***	315.0***	245.0***	325.3***
	(85.25)	(51.47)	(45.90)	(34.94)	(80.67)
N	19628	8609	7356	2663	38256
adj. R^2	0.050	0.086	0.106	0.107	0.050

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Divest1=1 if number of gates divested is equal to 2, Divest2=1 if number of gates divested is equal to 34

Table 1.40 provides the DID analysis results for price with the treatment group defined as the markets where both AA and US used to operate. The results are qualitatively similar to the DID results for price shown in the paper implying the robustness of the results shown in the paper in terms of the definition of the treatment group.

Table 1.40.: Diff-in-Diff Analysis: Price (Treatment-both AA and US, Control-only AA, only US, and other)

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
	(1) price	(2) price	(3) price	(4) price	(5) price
Time	8.066*	4.412	-2.994	-9.032	-8.581**
	(1.72)	(0.96)	(-0.64)	(-0.98)	(-2.07)
Treated	11.05*	25.70***	55.11***	57.06***	57.19***
	(1.71)	(2.91)	(6.41)	(4.05)	(6.25)
DID	15.60**	7.357	-21.01	-27.83***	-28.83***
	(2.17)	(0.69)	(-1.36)	(-3.45)	(-3.98)
Constant	279.6***	113.6***	35.62***	192.3***	508.1***
	(23.69)	(8.15)	(2.87)	(17.19)	(74.73)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	19628	8609	7356	2663	38256
adj. R^2	0.559	0.574	0.544	0.502	0.334

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.41 provides the DID analysis results for price with the treatment group defined as the markets where both AA and US used to operate and the control group defined as the all markets where neither AA nor US used to operate. The results are qualitatively similar to the DID results for price shown in the paper implying the robustness of the results shown in the paper in terms of the definition of the treatment and control groups.

Table 1.41.: Diff-in-Diff Analysis: Price (Treatment-both AA and US, Control-other)

	(1)	(2)	(3)	(4)	(5)
	price	price	price	price	price
	<5K	<10K&>=5K	<25K&>=10K	>=25K	All
	(1)	(2)	(3)	(4)	(5)
	price	price	price	price	price
Time	1.167	0.382	1.233	-15.01	-6.981
	(0.20)	(0.09)	(0.24)	(-1.02)	(-1.63)
Treated	22.10	60.19***	104.5***	55.57	98.62***
	(0.90)	(2.78)	(4.14)	(1.67)	(5.25)
DID	39.38**	4.278	-68.61**	-81.03***	-58.16***
	(2.00)	(0.24)	(-2.59)	(-3.60)	(-3.75)
Constant	420.8***	17.35	316.0***	203.4***	668.4***
	(19.00)	(1.21)	(20.82)	(7.05)	(66.38)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	10542	4060	3023	676	18301
adj. R^2	0.613	0.648	0.612	0.734	0.426

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.42 provides the DID analysis results for price with pre-merger period from 2012Q2 to 2013Q4. The results are qualitatively similar to the DID results for price shown in the paper implying the robustness of the results shown in the paper in terms of the definition of the pre-merger period.

Table 1.42.: Diff-in-Diff Analysis: Price (Pre-merger Data from 2012Q2-2013Q4)

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	-12.01***	-29.08***	-12.07***	-14.43**	-13.22***
	(-3.08)	(-5.54)	(-2.66)	(-2.31)	(-4.04)
Treated	15.11***	39.30***	50.03***	32.28**	53.16***
	(3.41)	(5.64)	(7.20)	(2.70)	(7.89)
DID	22.92***	2.211	-12.47	-23.70***	-14.38***
	(5.35)	(0.34)	(-1.52)	(-3.04)	(-2.62)
Constant	463.6***	153.2***	-54.19**	193.3***	576.8***
	(10.52)	(6.83)	(-2.18)	(15.29)	(53.24)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	16344	7446	6249	2295	32334
adj. R^2	0.569	0.590	0.533	0.526	0.349

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.43 provides the DID analysis results for price with all the data from 2012 to 2016 without excluding any data during the period when merger was undergoing. The results are qualitatively similar to the DID results for price shown in the paper implying the robustness of the results shown in the paper in terms of the selection of the pre- and post-merger period.

Table 1.43.: Diff-in-Diff Analysis: Price (Including all the Years from 2012 to 2016)

	(1) price <5K	(2) price <10K&>=5K	(3) price <25K&>=10K	(4) price >=25K	(5) price All
Time	-17.16***	-21.61***	-14.41***	-14.83***	-15.25***
	(-7.93)	(-7.07)	(-4.22)	(-2.97)	(-5.64)
Treated	14.26***	32.38***	40.55***	34.56***	44.59***
	(3.59)	(5.54)	(7.51)	(3.20)	(6.91)
DID	23.00***	5.903	-7.160	-23.45***	-11.67**
	(6.26)	(1.13)	(-1.01)	(-3.38)	(-2.54)
Constant	409.6***	106.2***	17.33	158.6***	545.1***
	(7.06)	(7.09)	(1.20)	(11.76)	(29.73)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	39954	18047	15154	5489	78644
adj. R^2	0.563	0.586	0.532	0.516	0.340

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.44 provides the DID analysis results for frequency of flights. There is no significant effect of the merger on frequency of flights across different types of markets.

Table 1.44.: Diff-in-diff Analysis: Frequency of Flights

	(1)	(2)	(3)	(4)	(5)
	freq	freq	freq	freq	freq
	<5K	<10K&>=5K	<25K&>=10K	>=25K	All
	(1)	(2)	(3)	(4)	(5)
	freq	freq	freq	freq	freq
Time	-133.9***	-222.1***	-362.5***	-518.8***	-270.1***
	(-9.56)	(-9.58)	(-12.07)	(-10.32)	(-13.25)
Treated	8.851	-40.52	-63.35*	-40.20	-66.49**
	(0.47)	(-1.21)	(-1.94)	(-0.25)	(-2.18)
DID	4.170	25.10	40.48	-77.60	8.755
	(0.31)	(1.29)	(1.53)	(-1.47)	(0.55)
Constant	54.63	957.8***	885.1***	356.1**	-474.8***
	(0.68)	(8.32)	(9.52)	(2.67)	(-6.67)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	9446	7440	7633	2976	27495
adj. R^2	0.621	0.630	0.629	0.568	0.489

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.45 provides the DID analysis results for the number of seats. There is no significant effect of the merger on number of seats across different types of markets.

Table 1.45.: Diff-in-diff Analysis: Number of Seats

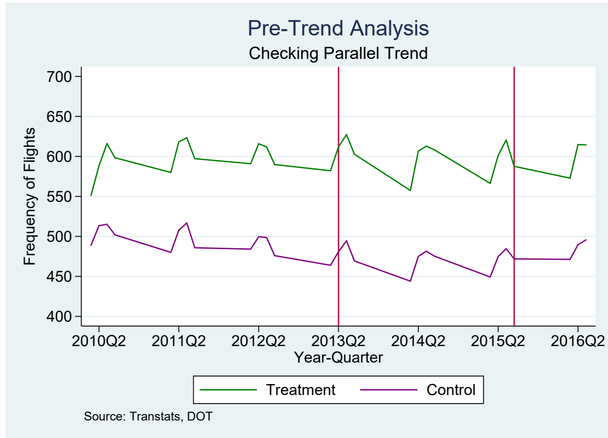
	(1)	(2)	(3)	(4)	(5)
	seat	seat	seat	seat	seat
	<5K	<10K&>=5K	<25K&>=10K	>=25K	All
	(1)	(2)	(3)	(4)	(5)
	seat	seat	seat	seat	seat
Time	-10174.0***	-21420.9***	-39376.3***	-68253.3***	-28754.3***
	(-7.42)	(-9.38)	(-13.54)	(-11.14)	(-13.37)
Treated	-1319.3	-6385.8*	-10430.3***	-15453.5	-10098.2**
	(-0.70)	(-1.74)	(-2.66)	(-0.73)	(-2.38)
DID	1596.8	2418.3	2043.5	-6816.6	886.2
	(1.49)	(1.34)	(0.79)	(-1.10)	(0.64)
Constant	-14622.7**	61354.8***	46999.0***	49090.1***	-103283.4***
	(-2.26)	(5.23)	(3.37)	(3.06)	(-13.61)
Year-quarter FE	Y	Y	Y	Y	Y
Origin FE	Y	Y	Y	Y	Y
Destination FE	Y	Y	Y	Y	Y
Cluster	Y	Y	Y	Y	Y
N	9446	7440	7633	2976	27495
adj. R^2	0.609	0.672	0.680	0.629	0.551

t statistics in parentheses

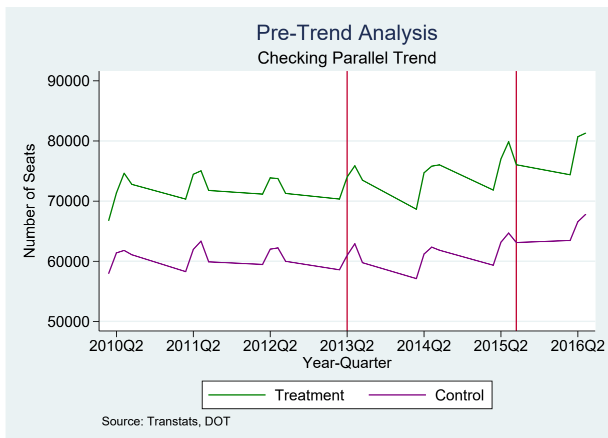
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Pre-trend Analysis

The following figures depict the pre-trend for frequency of flights (1.10(a)), number of seats (1.10(b)), delay in departure (1.11(a)), delay in arrival (1.11(b)) and number of cancellations (1.12) respectively.

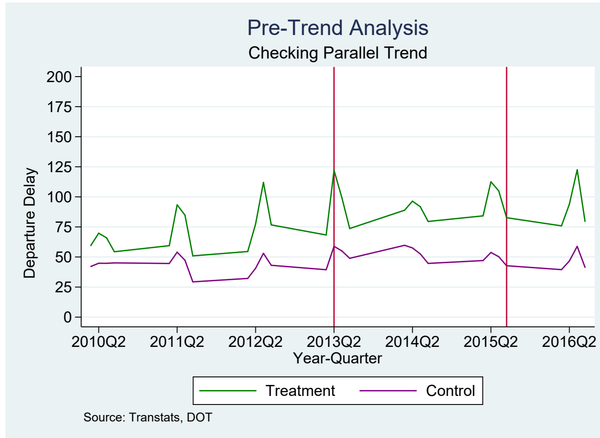


(a) Figure A

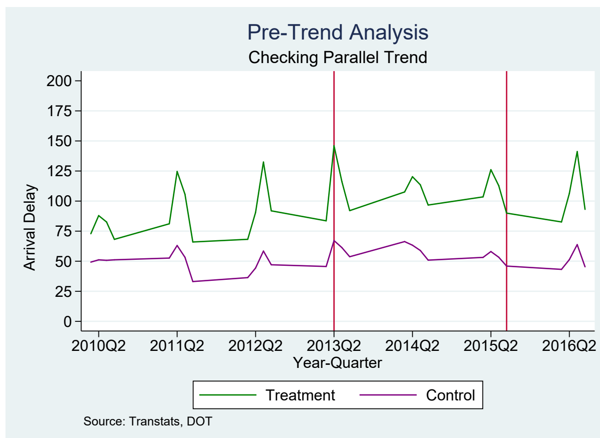


(b) Figure B

Figure 1.10.: Pre-trend Analysis for Flight Frequency and Number of Seats



(a) Figure A



(b) Figure B

Figure 1.11.: Pre-trend Analysis for Delay in Arrival and Delay in Departure

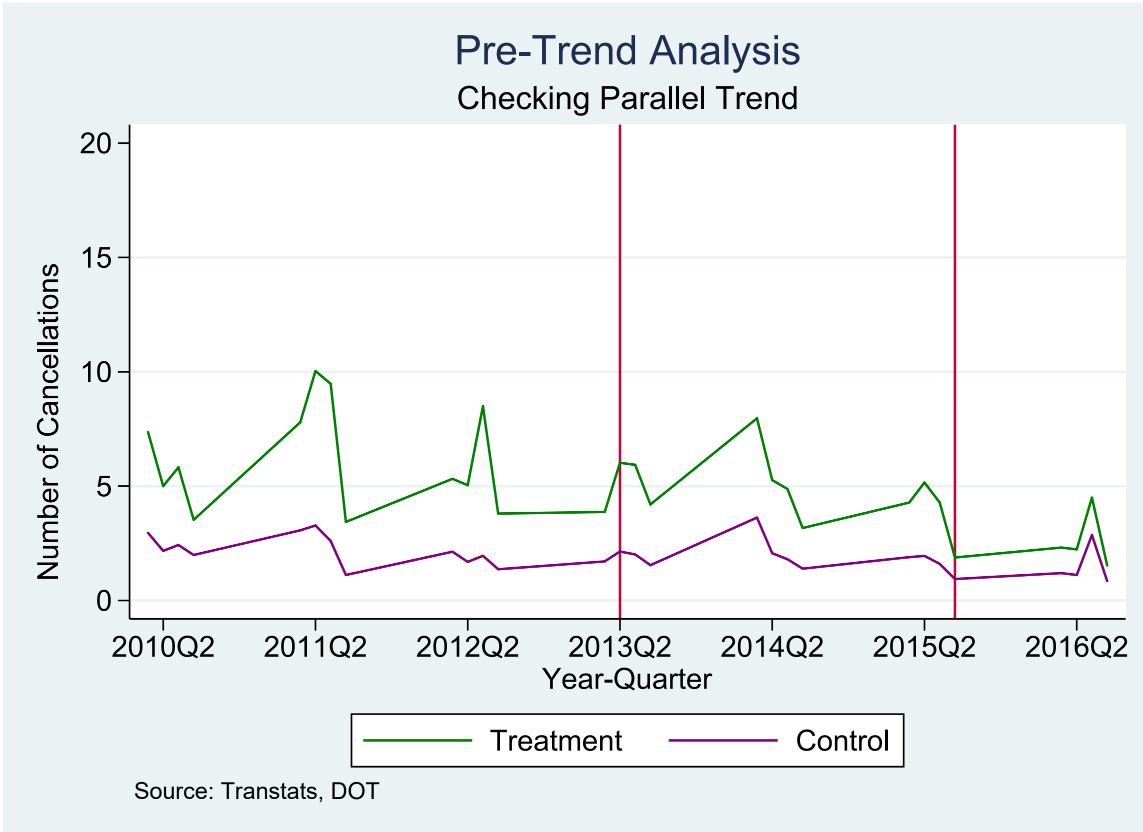


Figure 1.12.: Pre-trend Analysis for Cancellation of Flights

2. IS THERE A CRITICAL NUMBER OF FIRMS? EVIDENCE FROM THE U.S. AIRLINE INDUSTRY

I analyze possible reasons why airline prices are higher in the smaller markets compared to larger markets. In the literature, most of the studies ignore the fact that the smaller markets are different compared to larger markets in terms of the nature of competition. I find that a combination of lower competition, and lack of entry from low cost carriers (LCCs) are the reasons behind higher prices in the smaller city-pair markets. I show that price is substantially higher in a market with a fewer number of firms controlling for several other factors. My paper estimates the modified critical number of firms to be 5 and the critical value of the HHI to be .6.

2.1 Introduction

A merger can be favorable or unfavorable in terms of its effect on price, depending on whether the cost savings, due to several factors such as economies of scale, combined human resources and technology, dominates the market power effect; this effect is generated due to fewer number of firms in the market in the post-merger period.

One of the important aspects of airline mergers which is ignored in the existing literature is the heterogeneity in the effects across different markets. A smaller market which transports only a few thousand passengers in a quarter and is operated by two or three airlines might be affected in a very different way than a larger market which transports a lot more passengers and is operated by more than four or five airlines. The nature of competition that exists in different markets is related to the number of competitors in that market. In smaller markets it is either a monopoly or a duopoly. Sometimes it is a triopoly. In the larger markets there are more than four or five firms competing against one another. Naturally the effects of a change in the market structure such as a merger will be different in the smaller markets compared to the bigger markets.

This chapter takes a more detailed approach and analyzes the different markets in more details. One of the main objectives of this paper is to figure out with empirical evidence about the channels which contribute to the unfavorable effects, observed in the smaller markets as in Das (2018a). There can be several possible reasons why smaller markets do not benefit from a merger such as lower demand specifically lack of business passengers, existing hub and spoke network structure, and lower competition from low cost airlines.

Most LCCs operate mainly in the bigger city-pair markets instead of smaller city-pair markets which is one of the reason of low competition and high price in smaller markets. The only exception among the LCCs is Southwest Airlines. It has been studied in the literature that Southwest Airlines has entered into many smaller markets, operated by only the legacy carriers and there is considerable decrease in price after Southwest Airlines' entry into those markets. Price has been reduced by the incumbents even with a perceived threat of entry (see Goolsbee and Syverson (2008)). I present the case of Dallas-Wichita market to show that how price has decreased by almost 50% after the entry of Southwest Airlines in June 2013. But Southwest or other low cost airlines such as JetBlue do not operate in many smaller markets leading to high concentration in those smaller markets.

In this chapter, I analyze the factors leading to higher prices in the smaller markets. I find that the Herfindahl-Hirschman Index (HHI) has positive and significant effect on price. Similarly, the number of competitors in a market has a negative and significant effect on price. I find that if the number of firms is fewer than 5 in a market, price is substantially higher in that market. This result has implications for merger and smaller markets since a merger reduces the number of firms in a market. This clearly demonstrates that very high level of HHI and lower competition in the smaller markets nullify the favorable effect of a merger on price.

Section 2 of the chapter describes the related literature briefly. Section 3 includes the data and the variables. Section 4 outlines the identification strategy and the estimation technique. Section 5 discusses the results. Section 6 provides a few case studies showing how entry by LCCs in smaller markets has caused substantial reduction in price. Finally section 7 indicates the conclusion.

2.2 Literature Review

There is a number of academic papers and government reports that address the problem of high level of HHI in many smaller markets in the United States in many different ways. The Government Accounting Office (GAO) and the Transportation Research Board (TRB) released a series of reports regarding limited competition in many smaller airports.

Snider and Williams (2015) studies the the effect of AIR-21 legislation on the price in the affected markets. The paper finds that there is a considerable decrease in price due to AIR-21 in markets where either the origin airport or the destination airport or both of them were involved in the process. Goolsbee and Syverson (2008) shows that the legacy carriers reduce price in many markets due to the threat of entry by Southwest Airlines. This chapter is going to examine the effect of the HHI on price in a different angle and one of the objectives of this paper is to determine the modified critical number of competitors or the critical value of the HHI in the spirit of Bain (1951), Azzam et al. (1996), and Dalton and Penn (1976). The determination of a critical number of firms have policy implications for airline mergers and their effect on smaller markets.

Bain (1951) is one of the first papers to study the relationship between concentration and profitability in the U.S. manufacturing industry. The paper finds that high concentration leads to greater profitability because of existence of tacit collusion and market power. Azzam et al. (1996) studies the Portland cement industry and investigates the issue of the critical value of the HHI. The paper concludes that the critical value of the HHI for Portland cement industry is .32.

One of the important questions that is not addressed in the airline literature is how many firms are necessary to generate competitive price level in a market. My paper addresses this question and estimates the number of firms and the level of HHI as well. My paper shows the possible reasons why the smaller markets pay higher prices, and the answer, I find, is higher level of HHI. One of the remedies to reduce the oligopolistic power of the firms is the entry by the LCCs. Kwoka and Shumilkina (2010) investigates the effect of US Air-Piedmont merger on potential competition and prices in the post-merger period. The paper finds that the merger between US Air and Piedmont raised prices in many markets by reducing the potential competition level. I include some recent evidence of reduction in prices due to entry by the LCCs at the end of this paper.

2.3 Data

The main source of data for this project is DB1B database of the Department of Transportation. The database is a 10% quarterly sample of airline origin and destination survey. The database has three different parts: DB1B Coupon, DB1B Market, and DB1B Tickets.

For the purpose of this study, I restrict the data to 48 U.S. contiguous states only. DB1B Tickets dataset contains information about each itinerary: the sequence of airport visited including the origin and the final destination, number of connections each way, ticket price, the number of passengers, information about ticketing carrier, operating carrier, and distance traveled. I adjust all prices using the CPI assuming 2009 as the base. I drop itineraries with fares which are unreasonably high or low (itineraries with fares above $2000 or below $50 are dropped)[1]. I also exclude round-trip itineraries with more than one connection each way. Itineraries with multiple

[1]Extremely low fares indicates that those tickets were purchased using frequent flier miles or some kind of promotion by the airlines. I also drop the itineraries with “not credible” fare.

destinations are also excluded. These are standard steps in the literature to clean and simplify the data.

For the analysis, I combine different smaller airlines owned by the same parent company. For example, American Eagle is a subsidiary of parent company American Airlines. Codeshare agreements are also treated in a similar way. For the simplification of the analysis, I assign the ownership of the codeshare flights to the ticketing carrier who actually sells the ticket to the consumer. I drop itineraries with multiple ticketing carriers.

I define a market with a unique year-quarter-origin-destination combination. A market is defined as a directional city to city trip in a particular year and a particular quarter, for example, travel from Indianapolis (IND) to Chicago (ORD) in 2016Q1. Directional market implies that air travel from Indianapolis to Chicago is a distinct market from air travel from Chicago to Indianapolis. This implies also that the characteristics of the origin airport are important factors affecting air travel demand. Examples of different types of markets are provided in Table 2.1 such as Chicago (ORD) to Dallas (DFW) in 2012Q1. Notice that 2012Q2 ORD to DFW is a different market from 2012Q1 ORD to DFW.

Table 2.1.: Example of Different Markets

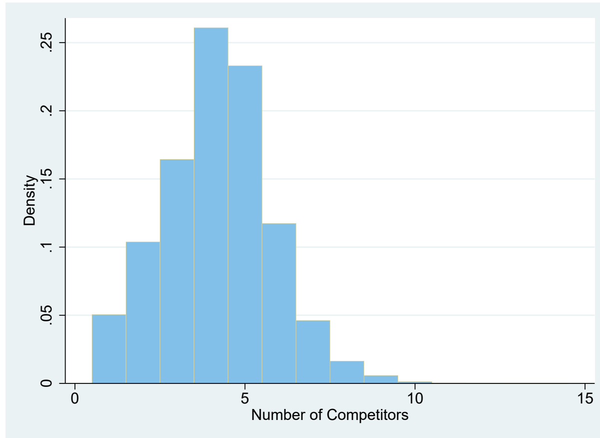
Year	**Quarter**	**Origin**	**Destination**
2012	1	ORD	DFW
2012	2	ORD	DFW
2012	1	ORD	IAH
2012	2	IAH	ORD
2012	3	ORD	IAH

Source:DB1B

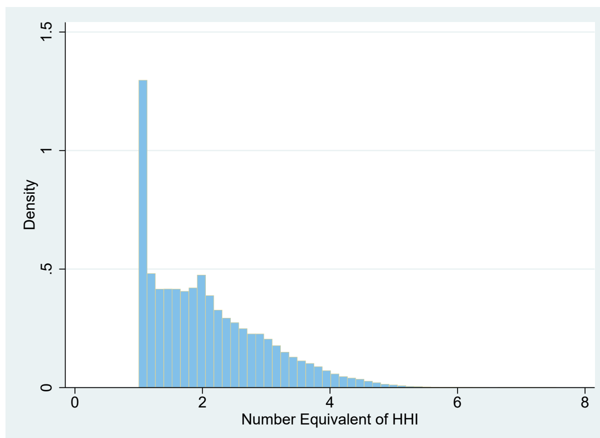
The period of analysis for this study is from 2010Q2 to 2016Q4. The summary statistics of the data are given in Table 2.2. In total, I have 120899 distinct observations of different markets as defined in Table 2.1. Price is calculated as the average price of all tickets weighted with the number of passengers in a particular market. The average round-trip fare across all markets is $396.92. Average number of competitors in any market is approximately 4 with 1 is the lowest and 14 is the highest number of competitors. Figure 2.1(a) shows that there are few markets with 8 or more number of competitors. Most markets have 4 competitors. Number equivalent of HHI ranges from 1 to 8 as in Figure 2.1(b). HHI ranges from .1 to 1 as shown in Figure 2.1(c). The distribution of market distance is given in Figure 2.2. Market distance ranges from 250 miles to 2750 miles. I constructed the dummy variable outside option to control for alternative transportation systems' effect on price in smaller markets. The outside option dummy variable takes the value of 1 if the distance is less than 400 miles; otherwise, it takes the value of zero.

Table 2.2.: Summary Statistics

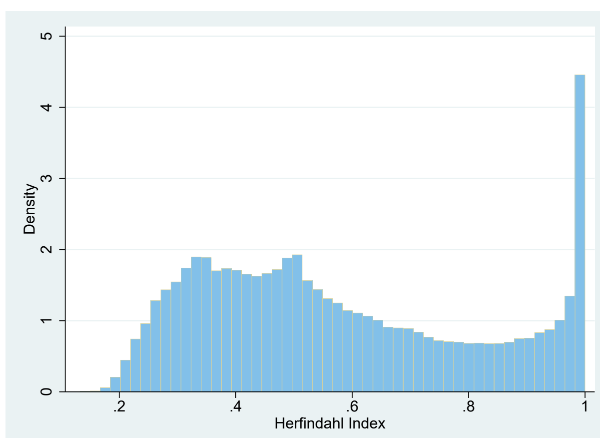
Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Price	120899	396.92	105.79	68.65	1117.79	321.36	396.34	468.77
Herfindahl Index	120899	.58	.24	.13	1	.38	.53	.77
Number of competitors	120899	4.19	1.61	1	14	3	4	5
Number equivalent of HHI	120899	2.07	.91	1	7.55	1.3	1.9	2.63
Passengers	120899	6522.25	9576.85	970	117510	1610	2920	7140
Jet fuel price	120899	2.51	.73	1.09	3.3	1.79	2.92	3.18
Real GDP growth rate	120899	2.16	.73	1	3.8	1.5	2	2.7
Unemployment rate in USA	120899	4.97	.15	4.74	5.15	4.79	5	5.11
Market distance	120899	1077.53	606.86	250.09	2721.29	595.93	937.54	1446.32
Outside Option	120899	.09	.29	0	1	0	0	0



(a) Figure A



(b) Figure B



(c) Figure C

Figure 2.1.: Number of Competitors, HHI, and Number equivalent to HHI

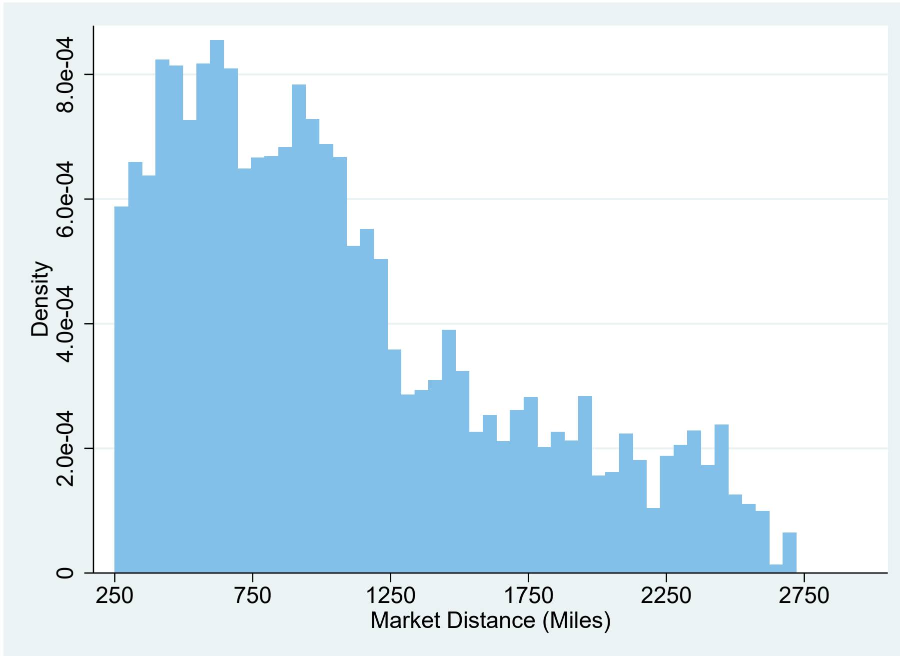


Figure 2.2.: Distribution of Market Distance

2.4 Identification Strategy

The main identification strategy is reduced form regression analysis with fixed effects and a dummy variable approach. I also use clustering at the level of destination to get robust standard errors for unbiased inference. Equation (2.1) includes one of the main regression specifications used in the model. HHI is the Hirschman-Herfindahl index[2] and NOC is the number of competitors in a market. NOEQHHI is the number equivalent to HHI which is defined as the inverse of HHI. In equation (2.1), I have used HHI, NOC, and NOEQHHI alternatively in different specifications. γ_o is the

[2]There might be concern about possible endogeneity problem using HHI or the number of competitors as explanatory variable to explain observed price level. One possible instrument to control this bias will be the gate ownership data at different airports. Unfortunately, I do not have access to that data.

origin fixed effect, γ_d is the destination fixed effect, and λ_t is the year-quarter fixed effect.

$$\begin{aligned}
Price_{mt} &= \gamma_o + \gamma_d + \lambda_t + \delta_1 * HHI_{mt} + \delta_2 * Jetfuel_t + \delta_3 * distance_m \\
&\quad + \delta_4 * realgdp_t + \delta_5 * unemployment_t + \delta_6 * outside_option_m + \epsilon_{mt} \\
Price_{mt} &= \gamma_o + \gamma_d + \lambda_t + \delta_1 * NOC_{mt} + \delta_2 * Jetfuel_t + \delta_3 * distance_m \\
&\quad + \delta_4 * realgdp_t + \delta_5 * unemployment_t + \delta_6 * outside_option_m + \epsilon_{mt} \\
Price_{mt} &= \gamma_o + \gamma_d + \lambda_t + \delta_1 * NOEQHHI_{mt} + \delta_2 * Jetfuel_t + \delta_3 * distance_m \\
&\quad + \delta_4 * realgdp_t + \delta_5 * unemployment_t + \delta_6 * outside_option_m + \epsilon_{mt}
\end{aligned} \tag{2.1}$$

The second regression specification in equation (2.2) is using the dummy variable approach with fixed effects and clustering as well. I construct different dummy variables from HHI which are denoted by dhhi where dhhi1 represents the dummy variable when HHI is between .1 and .2 and so on. Similarly, I create the dummy variables from NOC and NOEQHHI as dnoc and dnoeqhhi. dnoc1 represents the dummy variable when NOC is 1 and so on. dnoeqhhi1 represents the dummy variable when NOEQHHI is between 1 and 2 and so on.

$$\begin{aligned}
Price_{mt} &= \gamma_o + \gamma_d + \lambda_t + \sum_{j=1}^{9} \delta_{1j} * dhhij_{mt} + \delta_2 * Jetfuel_t + \delta_3 * distance_m \\
&\quad + \delta_4 * realgdp_t + \delta_5 * unemployment_t + \delta_6 * outside_option_m + \epsilon_{mt} \\
Price_{mt} &= \gamma_o + \gamma_d + \lambda_t + \sum_{j=1}^{9} \delta_{1j} * dnocj_{mt} + \delta_2 * Jetfuel_t + \delta_3 * distance_m \\
&\quad + \delta_4 * realgdp_t + \delta_5 * unemployment_t + \delta_6 * outside_option_m + \epsilon_{mt} \\
Price_{mt} &= \gamma_o + \gamma_d + \lambda_t + \sum_{j=1}^{7} \delta_{1j} * dnoeqhhij_{mt} + \delta_2 * Jetfuel_t + \delta_3 * distance_m \\
&\quad + \delta_4 * realgdp_t + \delta_5 * unemployment_t + \delta_6 * outside_option_m + \epsilon_{mt}
\end{aligned} \tag{2.2}$$

2.5 Results

Table 2.3 shows the effect of HHI, NOC, and NOEQHHI on the market price controlling for several factors such as fuel price, market distance, real GDP growth rate, unemployment rate in USA, and the outside option. Column 1 in Table 2.3 indicates that the HHI has a significant positive effect on the market price. Column 2 in Table 2.3 shows that the NOC has a significant negative effect on the market price. Finally, column 3 in Table 2.3 implies that the NOEQHHI has a significant negative effect on the market price.

Table 2.4 illustrates the effects of the different dummy variables which are constructed from the NOEQHHI. The first three dummy variables have a positive effect on price, and the third dummy variable has a negative effect on price. When NOEQHHI is greater or equal to 4, the effect on price is negative, and the effect is positive when the NOEQHHI is less than 4.

Table 2.5 demonstrates the effects of the different dummy variables constructed from the NOC[3]. The first five dummy variables have positive significant effect on price which implies that if the number of competitors in a market is 5 or fewer, price will go up due to market power effect. This also indicates that 5 is approximately the threshold number of competitors (see Selten (1973)). 6 competitors are sufficient to generate a competitive level of price whereas 4 competitors are insufficient for the same. The empirical result obtained here is very similar to what Selten (1973) had in 1973 and what Chamberlain (1933) had in 1933. So this result implies that the modified critical number of firms in any airline market is 5. Dummy variable dnoc6 has a significant negative effect on price.

Table 2.6 shows the effects of different dummy variables constructed from HHI on price. The first 5 dummy variables have negative significant effect on price which implies that HHI level lower than .6 have negative impact on market price due to higher competition in the market. This result indicates that the critical value of the

[3] I have conducted robustness checks by dropping the control variables or the fixed effect dummies and the results are robust.

HHI in the airline markets is approximately .6 which again roughly corresponds to 5 competitors in the market as shown in Figure 2.4(b). This result supports the result in Table 2.5.

Table 2.3.: Regression Analysis

	(1) Price	(2) Price	(3) Price
Herfindahl Index	52.61***		
	(6.50)		
Jet fuel price	19.86***	19.07***	19.69***
	(16.57)	(16.64)	(16.39)
Market distance	0.118***	0.116***	0.119***
	(40.46)	(40.61)	(42.21)
Real GDP growth rate	1.982***	3.169***	2.089***
	(5.09)	(7.93)	(5.33)
Unemployment rate in USA	-134.2***	-124.0***	-133.2***
	(-12.27)	(-12.24)	(-12.21)
Outside Option	-11.21**	-12.93***	-6.551
	(-2.37)	(-2.75)	(-1.37)
Number of competitors		-7.972***	
		(-7.42)	
Number equivalent of HHI			-12.08***
			(-6.67)
Constant	1081.5***	1084.0***	1135.8***
	(17.86)	(18.54)	(18.94)
Observations	120899	120899	120899
Adjusted R^2	0.634	0.633	0.634

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.4.: Regression Analysis

	(1) Price
Number equivalent to HHI between 1 and 2	25.32**
	(2.15)
Number equivalent to HHI between 2 and 3	9.285
	(0.82)
Number equivalent to HHI between 3 and 4	4.185
	(0.37)
Number equivalent to HHI between 4 and 5	-2.428
	(-0.22)
Number equivalent to HHI between 5 and 6	-11.55
	(-1.22)
Number equivalent to HHI between 6 and 7	-8.581
	(-0.77)
Jet fuel price	19.74***
	(16.55)
Market distance	0.118***
	(43.18)
Real GDP growth rate	1.969***
	(5.12)
Unemployment rate in USA	-134.1***
	(-12.37)
Outside Option	-5.873
	(-1.24)
Constant	1101.1***
	(18.51)
Observations	120899
Adjusted R^2	0.634

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.5.: Regression Analysis

	(1) Price
Number of Competitors=1	46.92***
	(5.44)
Number of Competitors=2	40.02***
	(5.99)
Number of Competitors=3	33.62***
	(6.35)
Number of Competitors=4	24.61***
	(5.40)
Number of Competitors=5	14.20***
	(3.42)
Number of Competitors=6	0.831
	(0.22)
Number of Competitors=7	0.756
	(0.21)
Number of Competitors=8	-1.217
	(-0.37)
Jet fuel price	19.44***
	(17.11)
Market distance	0.117***
	(40.56)
Real GDP growth rate	3.198***
	(8.23)
Unemployment rate in USA	-124.5***
	(-12.37)
Outside Option	-13.36***
	(-2.97)
Constant	1028.9***
	(17.75)
Observations	120899
Adjusted R^2	0.634

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

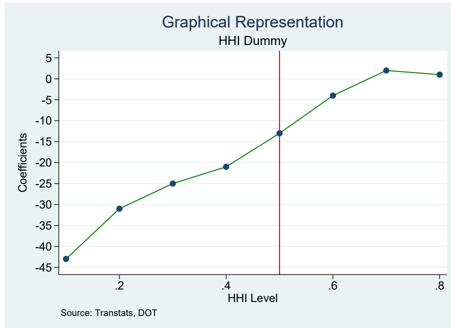
Table 2.6.: Regression Analysis

	(1) Price
HHI between .1 and .2	-43.38***
	(-6.26)
HHI between .2 and .3	-30.58***
	(-5.33)
HHI between .3 and .4	-25.23***
	(-4.91)
HHI between .4 and .5	-20.50***
	(-4.25)
HHI between .5 and .6	-12.96***
	(-3.03)
HHI between .6 and .7	-4.419
	(-1.14)
HHI between .7 and .8	1.726
	(0.48)
HHI between .8 and .9	0.964
	(0.37)
Jet fuel price	19.84***
	(16.58)
Market distance	0.119***
	(42.02)
Real GDP growth rate	1.960***
	(5.04)
Unemployment rate in USA	-134.4***
	(-12.36)
Outside Option	-8.079*
	(-1.75)
Constant	1129.1***
	(18.97)
Observations	120899
Adjusted R^2	0.635

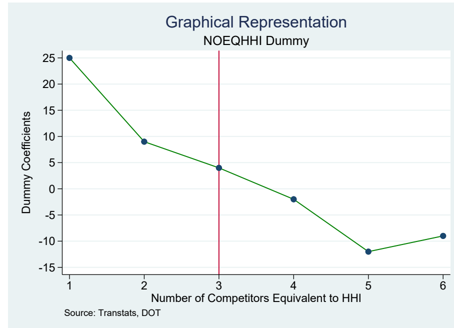
t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

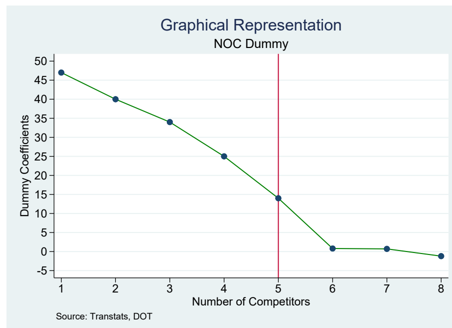
From the regression results, I find that if the number of firms is lower than 5 in a market then price is higher due to market power of the firms. I also find that if the number equivalent to HHI is lower than 3 in a market, the price is higher. The regression results and Figure 2.4 indicates that the modified critical number of firms is 5. 6 if high and 5 is few in case of airline industry. The critical value of the HHI is approximately .6. Figure 2.3 shows the coefficients of different dummy variables such as Figure 2.3(a) shows the coefficients for HHI dummies, Figure 2.3(b) shows the coefficients for number of competitors equivalent to HHI dummies, and Figure 2.3(c) shows the coefficients for number of competitors dummies. The coefficients of HHI dummies are monotonically increasing and are negative below .6 and positive above .6. HHI level of .6 represents the critical value of the HHI. On the other hand, the coefficients of NOEQHHI dummies are monotonically decreasing and are negative above 3 and positive below 3. NOEQHHI of 3 represents the modified critical number. Similarly, the coefficients of NOC dummies are monotonically decreasing and are negative above 5 and positive below 5. NOC of 5 represents the modified critical number of competitors.



(a) Figure A



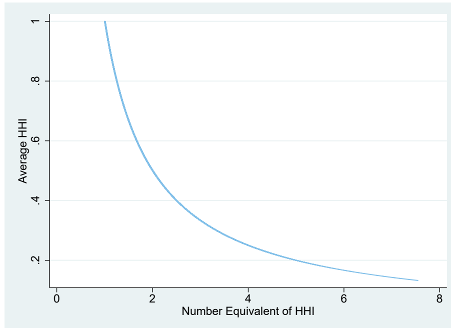
(b) Figure B



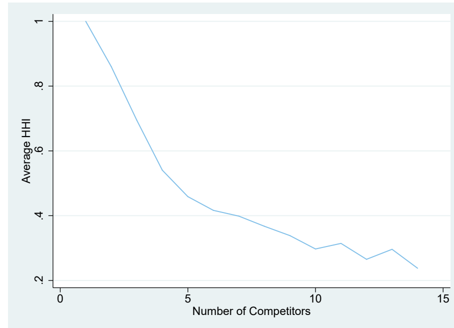
(c) Figure C

Figure 2.3.: Coefficient Plots for NOC, HHI, and NOEQHHI

Consumers have to pay extra in a market where number of firms is 5 or fewer due to oligopolistic power of the firms in that market. This result has implications for smaller markets and merger policy in general. Since a merger reduces the number of firms in a market smaller markets will suffer because the market power will increase for the existing firms in those markets. For the larger markets where number of firms is already very high will be affected less because of merger. This result is consistent with my finding in my previous paper where I show that the smaller markets did not benefit from the American Airlines and US Airways merger.



(a) Figure A



(b) Figure B

Figure 2.4.: Relationship among HHI, NOEQHHI, and NOC

2.6 Effect of LCC Entry in Smaller Markets

2.6.1 Effect of Southwest Entry: Dallas-Wichita Market

Dallas-Wichita market is a very small market in terms of number of passengers transported. On average the total number of passengers transported in this market is 2000. During the period of analysis 2010Q2 to 2016Q2, the beginning years from 2010Q2 to 2013Q2 are marked by high average price of around $550 as shown in Figure 2.5. Southwest announced to enter the Dallas-Wichita market on November 19, 2012[4]. Figure 2.5 shows that the price actually dropped almost 50% upon actual entry of Southwest Airlines into the market on June 2, 2013[5]. Figure 2.6 depicts that the capacity in the market and the number of passengers traveled increased after 2013Q2.

[4]https://www.flywichita.com/southwest-airlines-begins-service-june-2/
[5]https://www.flywichita.com/southwest-airlines-starts-wichita-service/

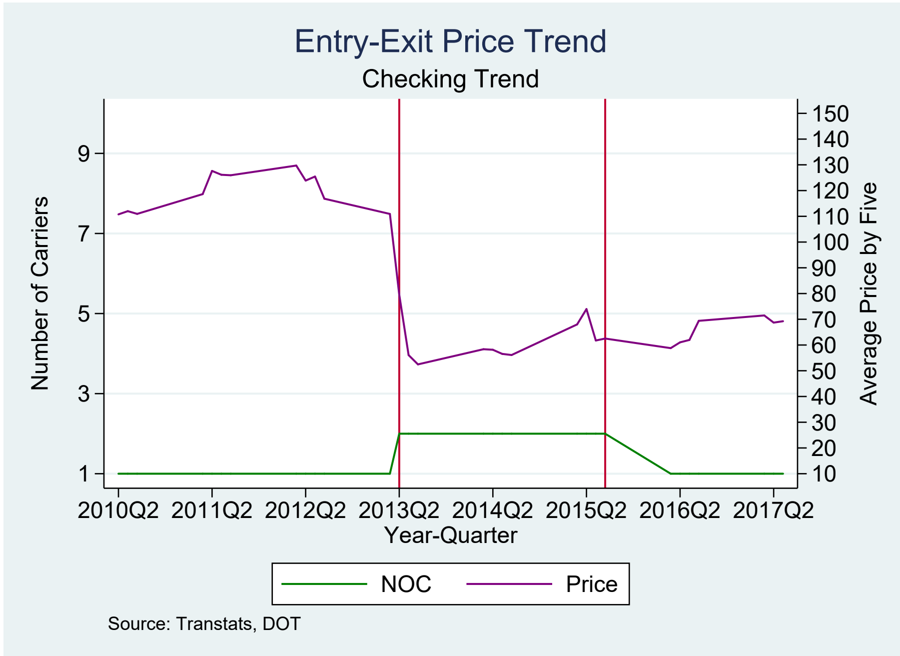


Figure 2.5.: Price in Dallas-Wichita Market

American Airlines was earning monopoly profits in the Dallas-Wichita market until the entry of Southwest Airlines in 2013Q2. But unfortunately the larger markets are most lucrative and financially viable for entry for the LCCs. Consumers in many smaller markets with higher concentration and low competition have to pay higher and most of the time the positive effects of cost saving are not transferred to consumers in terms of lower price unlike the case of larger markets.

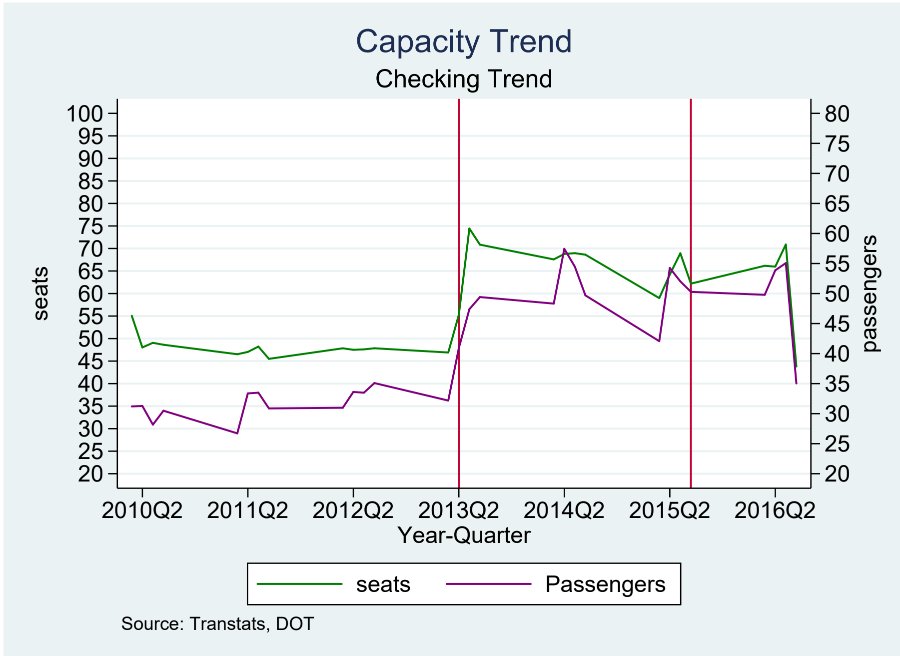
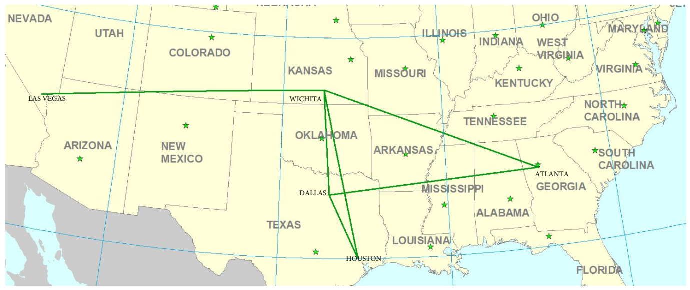


Figure 2.6.: Capacity in Dallas-Wichita Market

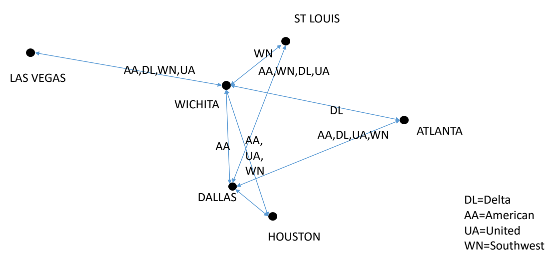
Price was decreased by American Airlines only when Southwest Airlines actually entered the route. American Airlines did not respond by cutting price to the potential entry threat. Figure 2.7(a) shows that there was entry threat from United Airlines which was present at both end point of the Dallas-Wichita market providing service to both Dallas and Wichita from its hub airport Houston. Similarly Southwest Airlines was present at the both end point providing service to Dallas and Wichita from its focus airport St. Louis. Delta Airlines was also present at both endpoint airport of this market providing service to Dallas and Wichita from its hub airport Atlanta. Southwest Airlines exited the Dallas-Wichita market in 2015Q4 unable to make profit from that route[6]. Southwest airlines got subsidy from the Wichita Airport authority for the three years it operated from 2013 to 2015. The obvious question is how American Airlines with higher marginal cost did make profit in those three years or

[6]http://www.kansas.com/news/business/aviation/article30507192.html

it just showed a predatory pricing strategy. The price did not go up to the pre-entry level even after the exit of Southwest Airlines.



(a) Figure A



(b) Figure B

Figure 2.7.: Networks of Competitors for Dallas-Wichita Market

The second example is about the Boston-Cleveland market. The price was considerably high before 2015Q2 around \$500 for a round trip. Jet Blue Airlines announced to enter in April 2015[7]. The price dropped considerably from 2015Q2 after the actual entry[8] of JetBlue Airlines into this market as in Figure 2.8.

[7]http://www.cleveland.com/travel/index.ssf/2014/12/top-rated_jetblue_to_start_fly.html
[8]http://www.mediaroom.jetblue.com/investor-relations/press-releases/2015/04-30-2015-015001699

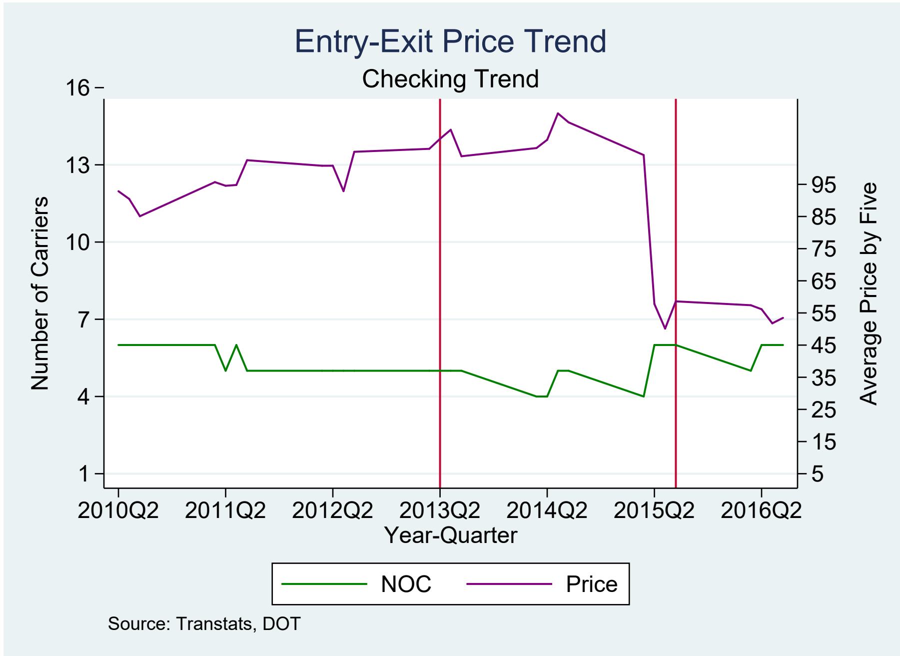


Figure 2.8.: Boston-Cleveland Market

2.7 Conclusion

According to the theory of contestable markets (Baumol et al. (1982)) competitors will enter if prices are too high and will exit if prices are too low given the sunk cost of entry is low. Unfortunately, due to restrictions in access to gates (Ciliberto and Williams (2010)) competition is limited in many smaller markets which lead to higher prices.

This paper empirically examines if there is a modified critical number of competitors below which price is very high and I find that the modified critical number of competitors is 5. If the number of airlines in a market is less than 5, price is substantially higher in the market after controlling for several other factors such as jet fuel price, distance. Similarly, I find that the critical value of the HHI is .6. If the

HHI is higher than .6 in a market, the price is substantially higher in that market controlling for other factors[9].

The results of this paper have implications for merger policy and consumer welfare. Divestiture increases the number of firms in a market and therefore is a important policy tool to reduce the anticompetitive effects of a merger on price in smaller and highly concentrated markets.

[9]It is important to notice the difference between the results that I found in this paper with Bresnahan and Reiss (1991). First, the results in this paper are based on the airline industry only. Bresnahan and Reiss (1991) analyzes multiple other industries and the nature of those industries are different from airline industry for my period of analysis which is from 2000-2015. Second, Bresnahan and Reiss (1991) shows that if the number of competitors is more than three then the next entrant has almost no effect on price. I show in this paper that when the number of competitors is more than 5 then the effect on price of an additional competitor flattens out. It is important to note that the focus of this paper is on the relationship between the number of competitors and the average price level in a market while Bresnahan and Reiss (1991) emphasizes on the role of additional entry into a market.

3. EFFECT OF R&D ANNOUNCEMENTS ON FIRM VALUE: EVIDENCE FROM THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY

This chapter studies the effect of announcement of investment in research & development (R&D) on the value of a firm in the pharmaceutical industry. Three types of R&D by the pharmaceutical firms are considered for the analysis: acquisition of other smaller firms, internal investment in R&D, and collaborative investment in R&D. This chapter measures the changes of the stock prices to these three different types of investment announcements and analyzes the difference. This chapter finds that few target specific characteristics and financial characteristics of the acquiring firm are important drivers of the abnormal returns around the announcement period. The ways that the characteristics of the target and acquirer firm affect the value of the acquiring firm differ for different types of investment announcements.

3.1 Introduction

According to the efficient market hypothesis, the share price of a firm reflects all the information available to the public at a particular point in time. So, it is difficult to beat the stock price in an attempt to arbitrage across time to outperform the market. The stock price changes instantly with availability of new information. When new information is available, the investors react to that information either positively or negatively. If the new information indicates positive things in the future, stock price increases, otherwise it decreases.

When firms make announcements regarding their investments in R&D, new information becomes available and the stock price changes abnormally. In the literature, three types of hypotheses exist regarding the effect of investment announcement on stock price. First, the shareholder value maximization hypothesis predicts a positive change in the firm's value in response to investment announcement by firms because the market rewards the managers for adopting strategies for creating the shareholder's wealth. Second, the rational expectations hypothesis predicts no change in firm value in response to investment announcements, and third, the institutional investors hypothesis which predicts negative change in firm value in response to investment announcement as institutional investors may dislike long term investments such as R&D as it reduces short term earnings. This paper analyzes which of these hypotheses is true for R&D announcements in the pharmaceutical industry. I am particularly focusing only one industry because of potentially confounding unobserved differences across different industries (see Chevalier (1995a), Chevalier (1995b), and Ciliberto and Schenone (2012)). The pharmaceutical industry is one of the most R&D intensive industry where firms invest heavily in R&D to build pipeline of new products to stay competitive in the market (see Chesbrough (2006)).

Pharmaceutical firms can invest in R&D in different ways. Firms can acquire smaller innovative firms which are highly productive in developing new drugs[1] or can invest directly to enlarge their own R&D facility (see Higgins and Rodriguez (2006)). There are three different types of theories behind the corporate mergers and acquisitions. The first is the agency theory. According to agency theory, firms' agents (managers) make acquisition of other firms to expand the business. Sometimes, they do that by sacrificing the short run earning prospect of the firm. The second theory focuses on increasing market power. According to this theory, acquisitions take place to increase market power. The third theory is that by making acquisition of other firms the acquirer gains synergistic benefits which helps the acquirer to reduce cost and thereby increase profits.

Information regarding tangible asset creation affects the share price in a different way compared to information about intangible asset creation. One of the reason is

[1] It is important to mention here that I do not have data to verify if the big pharmaceutical firms are acquiring smaller firms for their under-priced established products. An important future research topic will be to confirm if mergers are for promising technology.

that book value of tangible asset can be observed by the investors in the balance sheet while the value of intangible asset is difficult to measure. The benefits of R&D investment is also not very clear in the short run (Chan et al. (2001)). This paper specifically examines how the investors react to new information about firm's investment in one of the intangible assets R&D.

There is a long standing debate in the literature whether investment in R&D creates shareholder wealth. According to Hall (1993) the stock market valuation of intangible asset created by R&D investment in the manufacturing sector has fallen sharply in the during 1980s. On the other hand, Jensen (1993) finds that investors overvalue the R&D productivity,

Contrary to generally held beliefs, real research and development (R&D) expenditures set record levels every year from 1975 to 1990, growing at an average annual rate of 5.8 percent. The Economist (1990), in one of the media's few accurate portrayals of this period, noted that from 1980 to 1985 "American industry went on an R&D spending spree, with few big successes to show for it."

Sundaram et al. (1996) analyzes the announcement effect of R&D investment during 1985-1991 and finds that the overall announcement effect is close to zero. The paper constructs a competitive strategy measure (CSM) for different industries and makes a hypothesis that if CSM is less than zero (Strategic Substitute) then announcement effects will be positive. For the pharmaceutical industry the estimate of CSM is -0.01 which is almost close to zero. This implies that it is difficult to predict the announcement effects for the pharmaceutical industry according to the CSM measure. My paper finds similar evidence as the announcement effects are negative for internal investment while the effect is positive for collaboration and acquisitions[2].

Higgins and Rodriguez (2006) analyzes cumulative abnormal return (CAR) for different types of acquisitions in the pharmaceutical industry and their research finds

[2]Following Mullin et al. (1995), I have also calculated the announcements effects on the stock prices of the competitors but the results are mixed. I have not included the results here but available on request.

that if the acquirer has pre-acquisition information about the target, CAR is higher for the acquirer.

There are studies in the literature that analyze various announcement effects on stock price of the firm. One of the objective of those studies is to test whether the firm value maximization hypothesis holds or not. According to the firm value maximization hypothesis stock price will increase after an announcement of news of investment which is supposed to yield return more than the market rate of return.

In this paper, I analyze the announcement effect of R&D investment on stock price in the pharmaceutical industry and compare that with the announcement effect of mergers during the same period of time (2000-2015). The main contribution of the paper is to differentiate the effects of different types of announcements of R&D investments on stock price.

In the theoretical literature, there is debate between what is best for the maximization of firm value. While some studies show that increasing the in house R&D is better than going through an acquisition, other studies show the opposite. This paper analyzes that question empirically.

Section 2 of the paper describes related literature in brief. Section 3 includes the data and the variables. Section 4 outlines the methodology and identification strategy. Section 5 describes the results. Finally, section 6 indicates the conclusion.

3.2 Literature Review

The literature on announcement effect is quite large. There are many studies in the early 80's and 90's that analyzes different types of announcement effects on firm value.

McConnell and Muscarella (1985) analyzes the effect of capital expenditure decisions and finds that for the industrial firms the announcement effect is positive while for the public utility sector there is no effect. Their paper supports the firm value maximization hypothesis and refutes other hypothesis such as size maximization hypothesis. Burton et al. (1999) analyzes the reaction of the stock market to the capital expenditure announcement. Their paper finds that market reacts more to the joint venture compared to other types of announcements. Their paper also finds that larger gains were earned by smaller companies.

Zantout and Tsetsekos (1994) analyzes the effect of R&D announcement on the market reaction. Their paper finds that the announcing firms gain and the competitors loose. Their paper finds evidence that the first mover advantage dominates the spillover effect. Chan et al. (1990) studies 95 announcements of increase in R&D during the period 1979-1985. Their paper finds that the effect on stock price is positive on average and the effect is higher for high technology firms. Their paper finds significant positive two day announcement period cumulative abnormal return of 1.38%. Their paper also finds that the response of stock price to positive R&D announcement is positive even when there is earnings decline which shows that the investors in stock market are not myopic and they do value the long term prospects of R&D.

Few papers discuss the effect of public status of the firms on stock market return such as Chang (1998), and Capron and Shen (2007). Both of these papers finds that the announcement return for the private firms is higher compared to public firms. One of the major differences with these studies and with my study is that my paper mainly focuses on the Pharmaceutical industry and analyzing different types of announcement including the direct and collaborative announcements.

This paper contributes to the literature by analyzing the difference between different types of announcements effects of R&D on firm value in the pharmaceutical industry. This paper also contributes to the larger literature of in-house vs outside R&D and shows that from the shareholder perspective outside collaborative R&D is better for the Pharmaceutical firms.

3.3 Data

Three main data sources are used for the analysis. For the R&D announcement dates the Factiva dataset of Dow Jones & Company is used. The announcements regarding R&D investment by the pharmaceutical and bio-technology firms from 2000 are collected. For mergers and acquisitions announcements dates, the Thomson One database is used[3]. For stock price data database of center for research in security prices at University of Chicago (CRSP) is used.

Firms in the pharmaceutical (SIC Code:2833-2836) and bio-technology (SIC Code:8731) industry are included in the sample. 6-digit cusip is used as identifier. The missing observations are dropped in the process of cleaning the data. Thomson One merger database (previously called SDC platinum) is used for the announcement dates of mergers and acquisitions (M&A). The 6-digit cusip is used for matching the Thomson One database with CRSP. M&A with less than 100% share acquisitions are dropped from the sample. Finally, there are total 854 acquisitions from 2000 to 2016 by 248 firms. The distribution of the acquisitions is given in Figure 3.2(a) in the appendix. One important observation to notice is that few firms have acquired many firms during these years. The distribution of acquisitions among big firms are given in Figure 3.2(b).

The estimation window is 200 days in length. Three different event windows are considered which are 1,3 and 5 days respectively. Events having less than required number of days in the event window or the estimation window are dropped from the sample for final analysis.

Financial characteristics of the acquirer and the target firms are downloaded from compustat database for all the publicly traded companies. The data for the Fama-French factor model is downloaded from Professor Kenneth French's personal website[4].

[3] It is important to mention that the nature of the merger data is panel. I have data regarding which year a particular merger took place. In the empirical analysis I have taken into account the different times when the merger announcements took place with year fixed effects.

[4] *http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html*

In Table 3.4 in the appendix, I have listed the summary statistics of the CAR (cumulative abnormal return) calculated with the market model. In the first three rows, CAR is calculated using S&P as benchmark index. In rows 4-6 CAR is calculated using equal-weighted index as benchmark. Finally, in rows 7-9, CAR is calculated using value-weighted index as benchmark. We can see from Table 3.4 that the mean of CAR across all the acquiring firms is positive and is approximately .005 with a average standard deviation of .06. Similarly, in Table 3.5, I have listed the summary statistics of the CAR calculated with the Fama-French three factor model. The statistics from the Fama-French three factor model are similar to statistics derived using market model.

In Table 3.6, I have recorded the summary statistics of the CAR calculated with the market model for the cases involving private target. We can see in Table 3.6 that the mean of CAR across all the acquiring firms acquiring a private target is approximately .008 which is higher than the mean of CAR across all the acquiring firms. In Table 3.7, I have listed the summary statistics of the CAR calculated with the market model for the cases involving public target. We can see in Table 3.7 that the mean of CAR across all the acquiring firms acquiring a public target is approximately -.01 which is lower than the mean of CAR across all the acquiring firms acquiring a private target. We get the same information from Table 3.8 and Table 3.9 for the Fama-French three factor model.

In Table 3.11, I have enumerated the summary statistics of the CAR calculated with the market model for the cases involving foreign target. We can see in Table 3.11 that the mean of CAR across all the acquiring firms acquiring a foreign target is approximately .001 which is lower than the mean of CAR across all the acquiring firms. In Table 3.10, I have listed the summary statistics of the CAR calculated with the market model for the cases involving domestic target. We can see in Table 3.10 that the mean of CAR across all the acquiring firms acquiring a domestic target is approximately .006 which is higher than the mean of CAR across all the acquiring firms acquiring a foreign target. We get the same information from Table 3.12 and table 3.13 for the Fama-French three factor model.

In Table 3.17 in the appendix, I have included the summary statistics of the CAR calculated with the Fama-French 3 factor model for direct investment announcements. We can see that the mean CAR is negative which is because of the negative skewness of the distribution of CAR in this case. In Table 3.18 in the appendix, I have listed the summary statistics of the CAR calculated with the Fama-French 3 factor model for collaborative investment announcements. We can see that the mean CAR is positive which is because of the positive skewness of the distribution of CAR in this case.

In Table 3.19, I have recorded the summary statistics of all the regressor variables used in the CAR regression analysis for M&A. Share is the percentage of share of the target firm acquired. Value is the amount of $ (in million) paid to target firm. Domestic is a dummy variable which takes the value of 1 if the target firm is a US firm otherwise it is zero. FSIZE is size of the acquirer firm which is defined as logarithm of total assets of the firm. ROA is the rate of return on assets which is defined as net income over total assets. TQ is Tobin's Q ratio which is defined as market value of the firm over book value of the firm[5]. LEV is the leverage ratio of the firm which is defined as (DLTT+DLC)/SEQ where DLTT=Long Term Debt Total, DLC= Debt in Current Liabilities Total, and SEQ= Stockholders Equity (Parent). RDIN is the R&D intensity of the the acquiring firm which is defined as R&D/sales. Finally PUB is a dummy variable which takes value of 1 if the target firm is a public otherwise takes value of 0. For 27 firms, the data of percentage of shares acquired is not available and for 195 firms the data of deal value ($ million) is not available. I have imputed these values with 0. I have checked the results after dropping these imputed observations for robustness purposes and the results are robust and do not depend on these observations. In Table 3.20, the summary statistics of all the regressors

[5]TQ=(Market value of equity + Book value of debt)/Book value of asset, where Market value of equity=CSHO*PRCC_F where CSHO=Common Shares Outstanding and PRCC_F= Price Close Annual Fiscal, book value of debt=DLTT+DLC where DLTT=Long Term Debt Total and DLC=Debt in Current Liabilities Total, and book value of asset=Total asset-intangible asset-total liabilities.

are given for the case of direct investment announcements[6]. Similarly in Table 3.21, the summary statistics of all the regressors are given for the case of collaborative investment announcements. UNI is the dummy variable which takes the value of 1 if the company makes collaboration with a university or research institute.

In Figure 3.2(a), the distribution of number of acquisitions per firm is shown. We can see from the above graph that 131 acquirers have acquired only one target firm. The distribution is skewed to the right and one of the acquirers has acquired more than 40 target firms. In Figure 3.2(b), the number of acquisitions are given for the top acquiring firms acquiring more than 10 target firms during the period of analysis.

Figure 3.3 shows the distribution of CAR for 1 day. Figure 3.3(a) shows the distribution for the m&a. Figure 3.3(b) shows the distribution for the direct R&D announcements. Figure 3.3(c) conveys the distribution for the collaborative R&D announcements. In order of skewness the the distribution of collaborative R&D announcements is most positively skewed while the distribution for the direct R&D announcements is most negatively skewed. Figure 3.4 reveals the distribution of CAR for 3 day. Figure 3.4(a) shows the distribution for the m&a. Figure 3.4(b) exhibits the distribution for the direct R&D announcements. Figure 3.4(c) shows the distribution for the collaborative R&D announcements. In order of skewness the the distribution of collaborative R&D announcements is most positively skewed while the distribution for the direct r&d announcements is most negatively skewed. Figure 3.5 conveys the distribution of CAR for 5 day. Figure 3.5(a) shows the distribution for the m&a. Figure 3.5(b) reveals the distribution for the direct R&D announcements. Figure 3.5(c) shows the distribution for the collaborative R&D announcements. In order of skewness the the distribution of collaborative R&D announcements is most positively skewed while the distribution for the direct R&D announcements is most negatively skewed.

[6]The number of announcements is not that high and the reason might be that the companies do not want to reveal information. Many firms do not want to disclose information due to several reasons such as issue of imitation by rivals. Companies in USA did not have to report R&D investment information in 10-K before 1976 (Doukas and Switzer (1992)).

3.4 Methodology

MacKinlay (1997) gives a thorough description of the literature and the methodologies that are used to conduct event study. The paper discusses about two commonly used model: 1) the Constant Mean Return Model, and 2) Market Model. For these two models, the assumptions that the assets are jointly distributed as multivariate normal and identically and independently distributed over time are imposed. The paper also discusses why the Capital Asset Pricing Model is no longer considered as a good alternative with other methodologies. Even though the above two models are simple these models are able to produce pretty good result similar to more complicated models as Brown and Warner (1980, 1985) find in their simulation studies. One of the reasons they mention is that the variance of the daily abnormal returns is not reduced much by implementing some complex models.

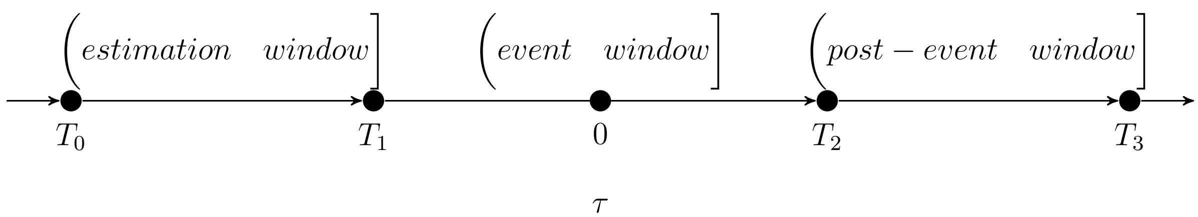


Figure 3.1.: Time line for the event study

In Figure 3.1, the time line of an event study is outlined. In the figure, τ is used to index time. The period from $T_0 + 1$ to T_1 is the estimation window. The data in the estimation window is used to estimate the parameters of the model to predict the normal return in the event window. The event window is from the $T_1 + 1$ to T_2. By construction, the event window and the estimation window are non-intersecting with each other so that the estimated parameters of the model are not biased by the reaction of the event. The period from $T_2 + 1$ to T_3 is the post-event window.

The paper estimates the model with an estimation window of 200 days. The estimation window ends 60 days prior to the event window to stop any possible contamination of the event to the estimated parameters of the model. The cumulative abnormal return is calculated with an event window of 5 days. The appendix of the paper also reports the results with different other event windows for checking robustness of the result. The market index used is the S&P 500 Composite Index[7]. If there is multiple events within the same event window for a particular company, the events are dropped to avoid clustering.

The returns are estimated using a market model and for robustness checks the Fama-French 3 factor model is also used. For Firm i and time t the abnormal return is calculated by subtracting the estimated return from the actual return. In equation 1, AR is abnormal return, R is the actual return and $\hat{R}$ is the estimated return.

$$AR_{it} = R_{it} - \hat{R}_{it} \tag{3.1}$$

I used the market model which assumes a linear relationship between the return of a particular stock and the market return. In equation 2, R_m is the return of the market portfolio. ϵ is the residual term. α and β are constants.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it} \tag{3.2}$$

The Fama-French model uses three factors to explain the variation of the stock price. The model uses two additional factors: small market capitalization minus large (SML) and high book-to-market ratio minus low (HML). In equation 3, R_f is the risk-free rate of return.

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \beta_{smb} SMB_t + \beta_{hml} HML_t + \epsilon_{it} \tag{3.3}$$

[7] According to Brown and Warner (1980) the equal-weighted index has more power compared to value-weighted index. According to Fama (1998) the value-weighted index is better for long-term return studies. In the appendix the analysis is done using all the three indexes: 1) S&P Composite Index, 2) Value-weighted Index, 3) Equal-weighted Index

The cumulative abnormal return (CAR) is calculated as the sum of the abnormal returns during the event window period. The CAR is regressed on different target and acquirer firm characteristics.

$$\begin{aligned} CAR &= \sum_{(\tau \in EventWindow)} AR_{it} \\ CAR &= \sum_{\tau=T_1+1}^{T_2} AR_{it} \end{aligned} \tag{3.4}$$

After deriving CAR for different R&D announcement dates, I run the regression specified in Equation (3.5) for M&A. In Equation (3.5), domestic represents the dummy variable indicating whether the target firm is domestic or foreign. Pub represents the dummy variable which indicates whether the target firm is a public target or a private target firm. Share represents the percentage of the target firm acquired. Value represents the amount paid in millions of dollars to the target firm. All other variables are for the acquirer firm characteristics.

$$\begin{aligned} CAR_i = \alpha_1 + \alpha_2 * share_i + \alpha_3 * value_i + \alpha_4 * domestic_i + \alpha_5 * fsize_i \\ + \alpha_6 * roa_i + \alpha_7 * tq_i + \alpha_8 * lev_i + \alpha_9 * rdin_i + \alpha_{10} * pub_i + \epsilon_i \end{aligned} \tag{3.5}$$

where i represents the acquirer firm and the definition all the regressors variables are given in the data section. Similarly for the direct R&D investment announcement I run the following regression:

$$\begin{aligned} CAR_i = \alpha_1 + \alpha_2 * fsize_i + \alpha_3 * roa_i + \alpha_4 * tq_i \\ + \alpha_5 * lev_i + \alpha_6 * rdin_i + \alpha_7 * domestic_i + \epsilon_i \end{aligned} \tag{3.6}$$

Finally for the collaborative R&D investment announcement I run the following regression:

$$\begin{aligned} CAR_i = \alpha_1 + \alpha_2 * fsize_i + \alpha_3 * roa_i + \alpha_4 * tq_i \\ + \alpha_5 * lev_i + \alpha_6 * rdin_i + \alpha_7 * domestic_i + \alpha_8 * uni_i + \epsilon_i \end{aligned} \tag{3.7}$$

3.5 Results

Regression results are provided in Tables 3.1 to 3.3. Table 3.1 shows the result of the different firm characteristics on the cumulative abnormal return of the acquiring firm. Cumulative abnormal returns are calculated using market model and using S&P index as benchmark index[8]. In the first three columns, the dependent variables are CAR for 1, 3, and 5 days respectively. Columns 4-6 have the same dependent variables. Only difference is that columns 4-6 have year fixed-effects. We can see that even with the year fixed effects the results are very similar to the results without the year fixed effects. We can see from Table 3.1 that the deal value of the acquisition has negative and significant effect on the CAR which implies that if the acquiring firm is paying a smaller deal value to the target firm the acquiring firm will experience a higher abnormal return. The variable domestic has a positive and significant impact on the CAR which implies that acquiring firm acquiring a domestic target will experience a higher CAR. Return on assets has a positive effect on CAR but the effect is only significant for 5-day CAR. Leverage of an acquiring firm has a negative and significant effect on the CAR. If the target firm is private the acquiring firm experience a higher CAR which is evident from the negative and significant effect of the variable pub on CAR. Other variables such as percentage of shares acquired, firm size, tobin's q, does not have a significant effect on the CAR. R&D intensity of the acquiring firm has a negatively significant effect on the 5-day CAR which means that the stock market punishes the acquiring firm having already a large amount of R&D investment.

[8] CAR has been re-scaled to percentage level by multiplying with 100 for better presentation of the coefficients from the regression analysis.

Table 3.1.: CAR Regression Analysis (Market Model with S&P Benchmark)

	(1)	(2)	(3)	(4)	(5)	(6)
	c_a_r_1d	c_a_r_3d	c_a_r_5d	c_a_r_1d	c_a_r_3d	c_a_r_5d
share	0.00455	-0.000661	0.00962	0.00329	-0.00253	0.00633
	(0.82)	(-0.09)	(1.16)	(0.57)	(-0.35)	(0.74)
value	-0.000131***	-0.000142***	-0.000133**	-0.000133***	-0.000159***	-0.000137**
	(-4.72)	(-4.52)	(-2.37)	(-5.05)	(-5.06)	(-2.37)
domestic	0.604*	1.236**	1.832***	0.717*	1.474**	2.088***
	(1.65)	(2.14)	(2.68)	(1.88)	(2.51)	(3.09)
fsize	0.0550	0.117	0.0935	0.0163	0.0676	0.0250
	(0.68)	(0.95)	(0.69)	(0.20)	(0.53)	(0.18)
roa	0.0115	0.0252*	0.116***	0.0142	0.0208	0.118***
	(0.95)	(1.75)	(7.30)	(1.16)	(1.22)	(6.62)
tq	-0.0000762	-0.000253	-0.000737	-0.0000552	-0.000137	-0.000535
	(-0.17)	(-0.59)	(-1.58)	(-0.12)	(-0.28)	(-1.02)
lev	-0.00538	-0.0943***	-0.122***	-0.00750	-0.0909***	-0.124***
	(-0.32)	(-4.54)	(-3.53)	(-0.49)	(-3.99)	(-3.13)
rdin	0.0000416	-0.0000318	-0.000392***	0.000144*	0.000121	-0.000237*
	(0.67)	(-0.38)	(-4.66)	(1.73)	(0.72)	(-1.86)
pub	-1.367**	-1.451*	-1.745**	-1.226*	-1.260	-1.640*
	(-2.13)	(-1.88)	(-2.07)	(-1.89)	(-1.63)	(-1.96)
cons	-0.811	-1.070	-2.330	-0.541	-0.972	-3.243*
	(-0.88)	(-0.80)	(-1.55)	(-0.49)	(-0.62)	(-1.79)
Year FE	N	N	N	Y	Y	Y
N	726	726	726	726	726	726
R^2	0.028	0.020	0.027	0.077	0.053	0.067

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In the appendix, Tables 3.23 to 3.27 are to check the robustness of the results across different models and different benchmarks. The results are similar which proves the robustness of the results.

Since in the sample of the acquiring firms few firms have acquired more than 10 target firms during the period of analysis (2000-2015) I have run the same regression specification after dividing the sample firms into two sub-samples. Table 3.28 in the Appendix shows the results for the acquiring firms acquiring more than 10 target firms. We can see that the sign and the significance of some of the variables are different here compared to Table 3.1 where the full sample of firms were taken for the analysis. We see that the coefficient of percentage of share acquired is positive and significant for 1-day CAR. Deal value has negative and significant effect on the CAR. The variable domestic is no longer significant which means that for these big firms the location of the target firms does not matter for CAR. The coefficient of return on assets is positive and significant for 1-day CAR. Tobin's Q has negatively significant effect on 3-day and 5-day CAR. Leverage, R&D intensity, and whether the target firm is a public or private is no longer significant.

Table 3.29 in the appendix conveys the results for the acquiring firms acquiring less than 10 target firms. We can see that the sign and the significance of some of the variables are different here compared to Table 3.1 where the full sample of firms were taken for the analysis. We see that the coefficient of percentage of share acquired and deal value are not significant. The variable domestic is significant and positive which means that for these small firms the location of the target firms does matter for CAR. The co-efficient of return on assets is positive and significant for 1-day and 5-day CAR. Tobin's Q is not significant. Leverage of the acquiring firm has negatively significant effect on the CAR. R&D intensity has positive and significant effect on the 5-day CAR. Public status of the target firm has a negative and significant effect on the 5-day CAR which means if the target firm is private the CAR is higher for the acquiring firm.

Table 3.2 exhibits the results for the direct investment announcement. We see that the coefficient of firm size is negative and significant for 1-day CAR with year fixed effects. Return on assets and Tobin's Q both are not significant. Leverage of the firm has significant negative effect on the CAR. R&D intensity of the firm has negative effect but the significance goes away with the year fixed effects. The variable domestic is significant and negative which means that for the direct investment announcements investing in foreign location results in higher CAR.

Table 3.2.: CAR Regression Analysis (Direct R&D Announcements) Fama-French Three-Factor Model with Value-weighted Benchmark

	(1) c_a_r_1d	(2) c_a_r_3d	(3) c_a_r_5d	(4) c_a_r_1d	(5) c_a_r_3d	(6) c_a_r_5d
fsize	-0.144	-0.299	0.0157	-0.533*	-0.857	-0.219
	(-0.51)	(-0.48)	(0.02)	(-2.10)	(-0.66)	(-0.11)
roa	3.967	-13.15	-38.41	4.964	-12.51	-43.66
	(0.83)	(-1.14)	(-1.53)	(0.80)	(-0.68)	(-1.17)
tq	0.00437	0.0103	0.0106	0.00508	0.0129	-0.0186
	(0.76)	(0.88)	(0.70)	(0.64)	(0.71)	(-0.51)
lev	0.0726	-0.211	-0.395*	-0.0116	-0.407*	-0.591
	(1.36)	(-1.43)	(-1.73)	(-0.14)	(-1.87)	(-0.98)
rdin	1.082	-6.324**	-13.43*	-0.176	-8.084	-14.78
	(0.77)	(-2.13)	(-1.71)	(-0.14)	(-1.56)	(-1.38)
domestic	-0.949*	0.141	0.430	-1.339*	0.0717	2.235
	(-1.76)	(0.15)	(0.38)	(-1.96)	(0.06)	(0.78)
cons	1.374	5.307	5.241	4.869**	11.06	9.111
	(0.40)	(0.69)	(0.46)	(2.37)	(0.78)	(0.40)
Year FE	N	N	N	Y	Y	Y
N	33	33	33	33	33	33
R^2	0.159	0.305	0.434	0.685	0.416	0.481

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.3 reveals the results for the collaborative investment announcement. We see that the coefficient of firm size is negative and significant for 3-day and 5-day CAR. Return on assets has positive and significant effect on 5-day CAR while Tobin's Q has positive and significant effect. Leverage of the firm has significant negative effect on the CAR. R&D intensity of the firm has negative and significant effect on 3-day and 5-day CAR. Leverage of the firm, whether collaborating with a domestic firm or not, and whether collaborating with a university or not do not have any significant effect on the CAR.

Table 3.3.: CAR Regression Analysis (Collaborative R&D Announcements) Fama-French Three-Factor Model with Value-weighted Benchmark

	(1)	(2)	(3)	(4)	(5)	(6)
	c_a_r_1d	c_a_r_3d	c_a_r_5d	c_a_r_1d	c_a_r_3d	c_a_r_5d
fsize	-0.634	-1.168*	-1.148*	-0.761	-1.419*	-1.391
	(-1.15)	(-1.70)	(-1.77)	(-1.19)	(-1.69)	(-1.64)
roa	-20.51	-21.59	-25.08**	-21.75	-23.10	-27.98**
	(-1.42)	(-1.47)	(-2.04)	(-1.35)	(-1.48)	(-2.08)
tq	0.00314	0.0429**	0.0446*	0.00826	0.0741*	0.0734*
	(0.21)	(2.20)	(1.81)	(0.26)	(1.86)	(1.83)
lev	0.653	0.991	1.058	0.651	0.934	1.050
	(0.92)	(1.21)	(1.33)	(0.87)	(1.05)	(1.23)
rdin	-0.833	-0.927*	-0.999**	-0.623	-0.750*	-0.810*
	(-1.61)	(-1.87)	(-2.24)	(-1.39)	(-1.77)	(-1.96)
domestic	-1.543	-1.899	-1.927	-1.085	-1.439	-1.049
	(-0.57)	(-0.75)	(-0.76)	(-0.36)	(-0.51)	(-0.39)
uni	-0.434	1.800	0.0995	2.336	5.025	3.572
	(-0.25)	(1.08)	(0.04)	(0.56)	(1.07)	(0.75)
cons	8.670	14.17**	14.37**	-4.923	1.873	1.858
	(1.51)	(2.02)	(2.18)	(-0.49)	(0.13)	(0.16)
Year FE	N	N	N	Y	Y	Y
N	62	62	62	62	62	62
adj. R^2	0.153	0.231	0.315	0.032	0.115	0.229

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.6 Conclusion

Distribution of the cumulative abnormal return is different for different types of investment announcements by the pharmaceutical firms. For collaborative investment announcements the distribution of the CAR is most positively skewed and for the direct investment announcement the distribution of the CAR is most negatively skewed which implies that the collaborative investment announcements are valued more than two other types of announcements by the stock market in the short run[9].

Also, target firm characteristics and the financial characteristics of the acquiring firm affects the cumulative abnormal return in a significant way. The effect of these characteristics on the cumulative return is different when we consider different types of announcements. First, for investments done through M&A if the target firm is domestic, CAR is higher contrary to lower CAR in case of direct domestic investment announcement. The location of the investment does not have any significant effect on CAR for the collaborative investment announcement. Leverage of the acquiring firm has negative significant effect on CAR for M&A and direct investment announcements but has no significant effect in case of collaborative announcements. Return on assets has positively significant effect on CAR in case of M&A, while negative significant effect on CAR in case of collaborative investment announcements and finally having no significant effect on CAR in case of direct investment announcements.

[9]It is important to mention here the possible economic explanations behind the observed different results for these three different types of announcements. It might be possible that the stock market investors believe that collaborative projects are good news while the internal investment by a particular firm may be bad news. On the other hand mergers and acquisition announcements fall in the middle. For M&A announcements, the acquisition may either be good in some cases or bad in other cases for the acquirer depending on several factors such as private information about the target firm, amount of money paid for the acquisition. The probability of discovering a drug with collaboration may be higher which might be one of the reasons behind collaborative investments being a good news for investors.

3.7 Appendix

Data

Table 3.4.: Summary Statistics All (CAR Market Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d	854	.0043	.06	-.2405	.7941	-.012	.0007	.0152
c_a_r_3d	854	.0061	.0787	-.6872	.6726	-.02	.0017	.0254
c_a_r_5d	854	.004	.0859	-.3956	.5506	-.0304	-.0002	.0325
c_a_r_ew_1d	854	.0048	.0601	-.2398	.7944	-.0114	.001	.0159
c_a_r_ew_3d	854	.0064	.0789	-.6591	.6362	-.0204	.0031	.0263
c_a_r_ew_5d	854	.0039	.0866	-.3922	.5527	-.0313	-.0002	.0337
c_a_r_vw_1d	854	.0044	.06	-.2403	.7942	-.0118	.0009	.0153
c_a_r_vw_3d	854	.0061	.0787	-.6764	.6656	-.0195	.002	.0254
c_a_r_vw_5d	854	.004	.0859	-.3965	.5536	-.0299	-.0009	.0319

Table 3.5.: Summary Statistics All (CAR Fama-French 3 Factor Model)

Variable	Obs	Mean	Std. Dev.	T-Stat	Min	Max	P25	P50	P75
c_a_r_1d_ff3	854	.0045	.0599	2.19**	-.241	.7686	-.0109	.0015	.015
c_a_r_3d_ff3	854	.006	.0793	2.21**	-.7408	.6149	-.0203	.0021	.0245
c_a_r_5d_ff3	854	.0037	.0867	1.25	-.4105	.5497	-.0279	.001	.034
c_a_r_ew_1d_ff3	854	.005	.0601	2.43**	-.2404	.7741	-.0106	.0016	.0156
c_a_r_ew_3d_ff3	854	.0064	.0797	2.35**	-.7407	.613	-.0203	.0033	.027
c_a_r_ew_5d_ff3	854	.0043	.0876	1.43	-.4043	.553	-.0278	.0013	.0356
c_a_r_vw_1d_ff3	854	.0046	.0599	2.24**	-.2409	.7675	-.0107	.0016	.0148
c_a_r_vw_3d_ff3	854	.006	.0794	2.20**	-.7374	.6144	-.0204	.0023	.0252
c_a_r_vw_5d_ff3	854	.0038	.087	1.28	-.4055	.5503	-.0279	.0021	.0333

d=day, ew=equal-weighted, vw=value-weighted, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.6.: Summary statistics (Private Target, CAR Market Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d	709	.0075	.0583	-.2405	.7941	-.0101	.0018	.0166
c_a_r_3d	709	.0091	.0794	-.6872	.6726	-.0182	.0035	.0299
c_a_r_5d	709	.0072	.0867	-.3379	.5506	-.0277	.0013	.0367
c_a_r_ew_1d	709	.008	.0584	-.2398	.7944	-.0101	.0019	.0187
c_a_r_ew_3d	709	.0094	.0795	-.6591	.6362	-.0197	.0047	.0288
c_a_r_ew_5d	709	.0072	.0876	-.3406	.5527	-.0292	.0011	.0385
c_a_r_vw_1d	709	.0076	.0583	-.2403	.7942	-.0103	.002	.0173
c_a_r_vw_3d	709	.0091	.0793	-.6764	.6656	-.0187	.0042	.0298
c_a_r_vw_5d	709	.0072	.0868	-.3371	.5536	-.0268	.0006	.0373

Table 3.7.: Summary statistics (Public Target, CAR Market Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d	145	-.0111	.0659	-.2361	.4292	-.0221	-.0042	.0071
c_a_r_3d	145	-.0085	.0741	-.3427	.3775	-.0288	-.0017	.0132
c_a_r_5d	145	-.0118	.0799	-.3956	.3181	-.0324	-.006	.0197
c_a_r_ew_1d	145	-.0107	.0661	-.2309	.422	-.0266	-.0036	.0067
c_a_r_ew_3d	145	-.0086	.0745	-.3412	.3633	-.0287	-.0034	.0138
c_a_r_ew_5d	145	-.0123	.0796	-.3922	.3026	-.0369	-.0013	.0156
c_a_r_vw_1d	145	-.0111	.0659	-.2357	.428	-.0236	-.0048	.0069
c_a_r_vw_3d	145	-.0086	.0743	-.3433	.3746	-.0264	-.0028	.0136
c_a_r_vw_5d	145	-.0119	.0799	-.3965	.3159	-.0333	-.0042	.0211

Table 3.8.: Summary statistics (Private Target, CAR Fama-French Three Factor Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d_ff3	709	.0076	.058	-.241	.7686	-.0091	.0024	.0173
c_a_r_3d_ff3	709	.0089	.08	-.7408	.6149	-.0185	.0035	.0275
c_a_r_5d_ff3	709	.007	.0877	-.4105	.5497	-.0273	.0028	.0379
c_a_r_ew_1d_ff3	709	.0081	.0583	-.2404	.7741	-.0089	.0031	.0177
c_a_r_ew_3d_ff3	709	.0093	.0806	-.7407	.613	-.0186	.0048	.0283
c_a_r_ew_5d_ff3	709	.0075	.0888	-.4043	.553	-.0269	.0037	.0383
c_a_r_vw_1d_ff3	709	.0077	.058	-.2409	.7675	-.0087	.0027	.0172
c_a_r_vw_3d_ff3	709	.0089	.0801	-.7374	.6144	-.0188	.0037	.0287
c_a_r_vw_5d_ff3	709	.0071	.0879	-.4055	.5503	-.0269	.0034	.0378

Table 3.9.: Summary statistics (Public Target, CAR Fama-French Three Factor Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d_ff3	145	-.0105	.0667	-.2363	.435	-.0214	-.0034	.0081
c_a_r_3d_ff3	145	-.0079	.0742	-.342	.3399	-.0277	-.0009	.0155
c_a_r_5d_ff3	145	-.0122	.0799	-.396	.2704	-.0321	-.0042	.019
c_a_r_ew_1d_ff3	145	-.0102	.0664	-.2313	.4277	-.0238	-.0036	.0084
c_a_r_ew_3d_ff3	145	-.0075	.0738	-.3406	.3283	-.0251	-.0023	.0155
c_a_r_ew_5d_ff3	145	-.0113	.08	-.3947	.2603	-.0361	-.0034	.0224
c_a_r_vw_1d_ff3	145	-.0106	.0668	-.2356	.4335	-.0221	-.0036	.0069
c_a_r_vw_3d_ff3	145	-.008	.0749	-.3428	.3378	-.0261	-.0011	.0163
c_a_r_vw_5d_ff3	145	-.0121	.0808	-.3968	.2699	-.0325	-.004	.0189

Table 3.10.: Summary statistics (Foreign Target, CAR Market Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d	254	.0018	.0626	-.2405	.7941	-.0109	-.0001	.0152
c_a_r_3d	254	.0003	.0688	-.3199	.5349	-.0185	.0025	.0229
c_a_r_5d	254	-.0059	.0801	-.3379	.4068	-.0353	-.0014	.0289
c_a_r_ew_1d	254	.0025	.0625	-.2398	.7944	-.0111	0	.0155
c_a_r_ew_3d	254	.0007	.0704	-.3205	.5807	-.0194	.0039	.0236
c_a_r_ew_5d	254	-.006	.0827	-.3406	.4896	-.0329	-.0034	.0293
c_a_r_vw_1d	254	.002	.0625	-.2403	.7942	-.0104	0	.0154
c_a_r_vw_3d	254	.0003	.069	-.3204	.5419	-.0186	.0039	.0227
c_a_r_vw_5d	254	-.006	.0806	-.3371	.4201	-.0359	-.002	.0271

Table 3.11.: Summary statistics (Domestic Target, CAR Market Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d	600	.0054	.0589	-.2361	.6842	-.0129	.001	.0153
c_a_r_3d	600	.0086	.0825	-.6872	.6726	-.0207	.0016	.0272
c_a_r_5d	600	.0082	.0879	-.3956	.5506	-.0282	.0007	.0348
c_a_r_ew_1d	600	.0058	.0591	-.2309	.6827	-.0123	.0012	.0162
c_a_r_ew_3d	600	.0088	.0821	-.6591	.6362	-.0209	.0024	.0271
c_a_r_ew_5d	600	.0081	.0879	-.3922	.5527	-.0292	.0013	.036
c_a_r_vw_1d	600	.0055	.059	-.2357	.6851	-.0122	.0013	.0149
c_a_r_vw_3d	600	.0085	.0824	-.6764	.6656	-.0203	.0012	.0278
c_a_r_vw_5d	600	.0082	.0878	-.3965	.5536	-.0268	0	.0357

Table 3.12.: Summary Statistics (Foreign Target, CAR Fama-French Three Factor Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d_ff3	254	.0019	.0617	-.241	.7686	-.0091	.0007	.0162
c_a_r_3d_ff3	254	-.0005	.0694	-.326	.5182	-.0191	.0022	.0242
c_a_r_5d_ff3	254	-.007	.0802	-.3696	.3986	-.0312	-.0002	.031
c_a_r_ew_1d_ff3	254	.0025	.0618	-.2404	.7741	-.0095	.001	.016
c_a_r_ew_3d_ff3	254	-.0001	.0697	-.3215	.5399	-.0185	.0035	.0263
c_a_r_ew_5d_ff3	254	-.0063	.0809	-.3682	.4364	-.0322	.0007	.0327
c_a_r_vw_1d_ff3	254	.0021	.0616	-.2409	.7675	-.0087	.0006	.0152
c_a_r_vw_3d_ff3	254	-.0004	.0692	-.3258	.5126	-.0197	.0022	.0236
c_a_r_vw_5d_ff3	254	-.0068	.0803	-.3698	.3894	-.0292	.0004	.0298

Table 3.13.: Summary statistics (Domestic Target, CAR Fama-French Three Factor Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d_ff3	600	.0056	.0592	-.2363	.6942	-.0115	.0019	.0148
c_a_r_3d_ff3	600	.0088	.083	-.7408	.6149	-.0203	.0021	.0256
c_a_r_5d_ff3	600	.0082	.089	-.4105	.5497	-.0272	.0016	.0354
c_a_r_ew_1d_ff3	600	.0061	.0593	-.2313	.6899	-.011	.0021	.0154
c_a_r_ew_3d_ff3	600	.0092	.0835	-.7407	.613	-.0205	.0033	.0272
c_a_r_ew_5d_ff3	600	.0089	.09	-.4043	.553	-.0269	.0017	.0374
c_a_r_vw_1d_ff3	600	.0057	.0593	-.2356	.6945	-.0113	.0017	.0148
c_a_r_vw_3d_ff3	600	.0088	.0833	-.7374	.6144	-.0204	.0024	.0263
c_a_r_vw_5d_ff3	600	.0083	.0894	-.4055	.5503	-.0274	.0025	.0356

Table 3.14.: Summary Statistics (Biotechnology Target, CAR Fama-French Three Factor Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d_ff3	60	-.0059	.0346	-.1091	.0661	-.0166	-.0023	.0158
c_a_r_3d_ff3	60	-.0055	.0583	-.2914	.1171	-.0294	.0034	.0222
c_a_r_5d_ff3	60	-.0078	.0847	-.3696	.1581	-.0269	-.0032	.037
c_a_r_ew_1d_ff3	60	-.006	.035	-.1054	.0748	-.0165	-.0018	.011
c_a_r_ew_3d_ff3	60	-.0058	.0587	-.286	.1083	-.0297	.0065	.0219
c_a_r_ew_5d_ff3	60	-.0072	.0862	-.3682	.1513	-.0301	-.0005	.0347
c_a_r_vw_1d_ff3	60	-.0056	.0345	-.1091	.0665	-.0164	-.0017	.0167
c_a_r_vw_3d_ff3	60	-.0051	.0583	-.2919	.1158	-.0292	.0047	.0236
c_a_r_vw_5d_ff3	60	-.0069	.0847	-.3698	.1595	-.0256	-.0035	.0385

Table 3.15.: Summary Statistics (Pharmaceutical Target, CAR Fama-French Three Factor Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d_ff3	614	.0049	.0608	-.241	.7686	-.0115	.0016	.0157
c_a_r_3d_ff3	614	.005	.083	-.7408	.5483	-.0198	.0008	.0241
c_a_r_5d_ff3	614	.002	.0879	-.4105	.5497	-.0286	-.0005	.0339
c_a_r_ew_1d_ff3	614	.0056	.061	-.2404	.7741	-.0106	.0021	.016
c_a_r_ew_3d_ff3	614	.0057	.0834	-.7407	.5473	-.0204	.0018	.027
c_a_r_ew_5d_ff3	614	.0033	.0889	-.4043	.553	-.0274	.0008	.037
c_a_r_vw_1d_ff3	614	.005	.0609	-.2409	.7675	-.0111	.0017	.0155
c_a_r_vw_3d_ff3	614	.0049	.0831	-.7374	.5546	-.0204	.0013	.0238
c_a_r_vw_5d_ff3	614	.002	.0884	-.4055	.5503	-.0282	-.0003	.0329

Table 3.16.: Summary Statistics (Other Target, CAR Fama-French Three Factor Model)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
c_a_r_1d_ff3	180	.0065	.0632	-.1465	.6942	-.0086	.002	.0135
c_a_r_3d_ff3	180	.0133	.0719	-.1504	.6149	-.0179	.0085	.0279
c_a_r_5d_ff3	180	.0132	.0828	-.1715	.5483	-.0252	.0074	.0343
c_a_r_ew_1d_ff3	180	.0067	.0632	-.1472	.6899	-.0084	.0018	.0145
c_a_r_ew_3d_ff3	180	.0131	.0724	-.149	.613	-.0176	.0078	.0301
c_a_r_ew_5d_ff3	180	.0118	.0835	-.1748	.5505	-.0293	.006	.0329
c_a_r_vw_1d_ff3	180	.0067	.0633	-.1465	.6945	-.009	.002	.0137
c_a_r_vw_3d_ff3	180	.0135	.0719	-.1497	.6144	-.0178	.0091	.0287
c_a_r_vw_5d_ff3	180	.0136	.0826	-.172	.5486	-.0257	.0075	.0341

Table 3.17.: Summary Statistics (Direct Investment Announcement, CAR Fama-French 3 Factor Model)

Variable	Obs	Mean	Std. Dev.	T-Stat	Min	Max	P25	P50	P75
c_a_r_1d_ff3	41	-.0022	.0316	-.46	-.1669	.0545	-.0085	-.0002	.0101
c_a_r_3d_ff3	41	-.0119	.0426	-1.79*	-.1337	.0877	-.0275	-.0054	.0089
c_a_r_5d_ff3	41	-.0208	.0687	-1.93*	-.3413	.0822	-.0315	-.008	.0108
c_a_r_ew_1d_ff3	41	-.0024	.0311	-.49	-.1658	.0529	-.0085	-.0028	.0082
c_a_r_ew_3d_ff3	41	-.0102	.0425	-1.54	-.1305	.0891	-.0263	-.0069	.0071
c_a_r_ew_5d_ff3	41	-.0185	.0674	-1.76*	-.3253	.0817	-.0349	-.0052	.0119
c_a_r_vw_1d_ff3	41	-.0023	.0311	-.47	-.1669	.0526	-.0074	.0002	.0098
c_a_r_vw_3d_ff3	41	-.0124	.0449	-1.77*	-.146	.0887	-.0276	-.0054	.0091
c_a_r_vw_5d_ff3	41	-.0215	.0741	-1.86*	-.3857	.0823	-.0316	-.0053	.0102

d=day, ew=equal-weighted, vw=value-weighted, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.18.: Summary Statistics (Collaborative Investment Announcement, CAR Fama-French 3 Factor Model)

Variable	Obs	Mean	Std. Dev.	T-Stat	Min	Max	P25	P50	P75
c_a_r_1d_ff3	65	.0242	.1053	1.85*	-.0879	.7322	-.0084	.0032	.0146
c_a_r_3d_ff3	65	.0348	.1125	2.49**	-.0853	.72	-.0106	.0023	.0317
c_a_r_5d_ff3	65	.0375	.114	2.65***	-.1111	.6589	-.0121	.0058	.0457
c_a_r_ew_1d_ff3	65	.0242	.1054	1.85*	-.0866	.7291	-.0105	.0008	.0136
c_a_r_ew_3d_ff3	65	.0349	.1118	2.52**	-.11	.7106	-.0113	.0066	.0337
c_a_r_ew_5d_ff3	65	.0378	.1132	2.69***	-.0986	.6485	-.0167	.0088	.0363
c_a_r_vw_1d_ff3	65	.024	.1054	1.84*	-.0873	.7313	-.0081	.0024	.0127
c_a_r_vw_3d_ff3	65	.0344	.1123	2.47**	-.0852	.7169	-.0111	.0021	.0321
c_a_r_vw_5d_ff3	65	.037	.1137	2.62***	-.1055	.6557	-.0118	.0067	.0388

d=day, ew=equal-weighted, vw=value-weighted, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.19.: Summary Statistics (Regressors of the CAR Regression, M&A)

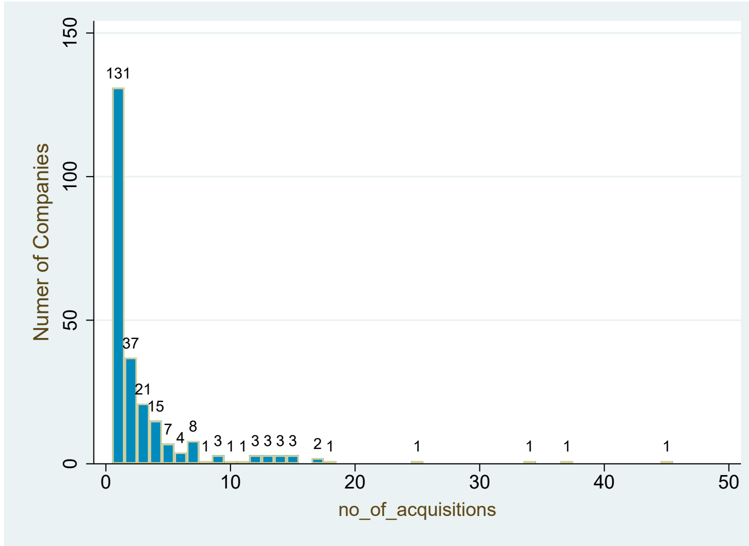
Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
share	801	91.49	25.41	0	100	100	100	100
value	801	654.09	3725.8	0	67285.7	.57	36	250
domestic	801	.71	.46	0	1	0	1	1
fsize	801	7.67	2.59	-.15	12.27	5.75	7.5	10.12
roa	801	-.18	3.55	-100.01	.46	-.07	.04	.1
tq	790	-7.48	219.33	-2984.51	788.74	-1.51	5.6	12.27
lev	801	.51	4.57	-117.35	42.69	.08	.34	.73
rdin	737	19.36	461.45	0	12522.1	.09	.17	.38
pub	801	.17	.38	0	1	0	0	0

Table 3.20.: Summary Statistics (Regressors of the CAR Regression, Direct Investment Announcements)

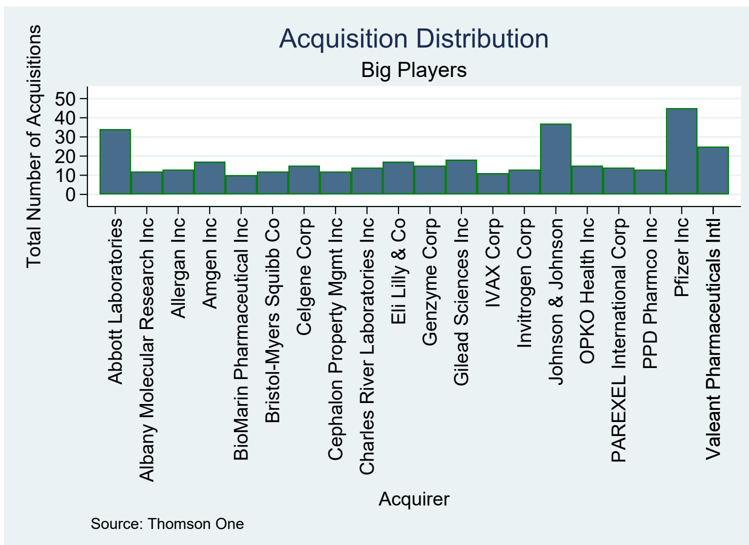
Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
domestic	35	.77	.43	0	1	1	1	1
fsize	35	9.4	2.1	4.16	12.05	8.2	10.16	10.74
roa	35	.07	.11	-.34	.27	.04	.08	.12
tq	34	9.46	28.38	-86.24	118.61	3.93	7.21	16.34
lev	35	.62	1.31	0	7.95	.18	.39	.65
rdin	33	.34	.56	.02	2.52	.13	.17	.27

Table 3.21.: Summary statistics (Regressors of the CAR Regression, Collaborative Investment Announcements)

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
domestic	64	.42	.5	0	1	0	0	1
fsize	64	8.58	2.84	2.97	12.18	5.61	9.99	10.78
roa	64	-.06	.29	-1.32	.2	-.1	.06	.1
tq	63	2.44	33.8	-161.49	93.02	1.69	6.75	12.07
lev	63	.24	2.11	-10	8.62	.11	.32	.55
rdin	63	1.57	5	.02	34.15	.12	.2	.63
uni	64	.14	.35	0	1	0	0	0



(a) Figure A



(b) Figure B

Figure 3.2.: Acquisition Frequency and Big Acquirers

Table 3.22.: CAR Regression Analysis (All Types of Announcements)

	(1)	(2)	(3)	(4)	(5)	(6)
	c_a_r_1d	c_a_r_3d	c_a_r_5d	c_a_r_1d	c_a_r_3d	c_a_r_5d
Firm Size	-0.129	-0.0566	-0.0393	-0.168*	-0.0988	-0.0951
	(-1.42)	(-0.44)	(-0.28)	(-1.86)	(-0.75)	(-0.67)
Return on Assets	0.0387***	0.0153	0.109***	0.0428***	0.0110	0.112***
	(3.66)	(1.06)	(6.76)	(3.84)	(0.65)	(6.08)
Tobin's Q Ratio	-0.000188	-0.000302	-0.000669	-0.000105	-0.000215	-0.000508
	(-0.47)	(-0.60)	(-1.43)	(-0.26)	(-0.40)	(-1.01)
Leverage	0.00723	-0.0826***	-0.135***	0.00285	-0.0818***	-0.135***
	(0.50)	(-3.30)	(-2.89)	(0.24)	(-3.17)	(-2.79)
R&D Intensity	-0.00000526	-0.000171**	-0.000186**	0.0000883	-0.0000592	-0.000119
	(-0.10)	(-2.21)	(-2.48)	(1.16)	(-0.38)	(-0.91)
Investment within USA	0.0462	0.522	1.089*	0.184	0.708	1.223*
	(0.11)	(0.94)	(1.71)	(0.45)	(1.26)	(1.92)
M&A Dummy	-0.0906	0.711	1.754	-0.276	0.860	1.920
	(-0.28)	(0.93)	(1.30)	(-0.64)	(0.97)	(1.27)
Collaboration Dummy	2.352*	4.144***	5.728***	1.435	3.370**	4.655**
	(1.83)	(2.69)	(3.01)	(1.24)	(2.30)	(2.43)
Constant	1.182	-0.357	-2.066	0.175	0.343	-0.392
	(1.10)	(-0.22)	(-0.98)	(0.16)	(0.16)	(-0.22)
Year Fixed Effects	N	N	N	Y	Y	Y
Observations	825	825	825	825	825	825
Adjusted R^2	0.007	0.007	0.015	0.025	0.016	0.030

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.23.: CAR Regression Analysis (Market Model with Equal-weighted Benchmark)

	(1) c_a_r_1d	(2) c_a_r_3d	(3) c_a_r_5d	(4) c_a_r_1d	(5) c_a_r_3d	(6) c_a_r_5d
share	0.00687	0.00492	0.0156*	0.00561	0.00277	0.0118
	(1.21)	(0.73)	(1.90)	(0.95)	(0.39)	(1.40)
value	-0.000135***	-0.000156***	-0.000136**	-0.000138***	-0.000175***	-0.000140**
	(-4.81)	(-4.76)	(-2.49)	(-5.09)	(-5.15)	(-2.54)
domestic	0.589	1.221**	1.859***	0.707*	1.470**	2.114***
	(1.61)	(2.11)	(2.70)	(1.85)	(2.51)	(3.11)
fsize	0.0579	0.137	0.117	0.0187	0.0856	0.0419
	(0.72)	(1.10)	(0.87)	(0.23)	(0.67)	(0.31)
roa	0.000876	0.0253*	0.112***	0.00387	0.0220	0.117***
	(0.08)	(1.80)	(7.25)	(0.33)	(1.33)	(6.68)
tq	-0.000106	-0.000324	-0.00101**	-0.0000786	-0.000228	-0.000825
	(-0.26)	(-0.68)	(-1.97)	(-0.17)	(-0.43)	(-1.46)
lev	0.000460	-0.0931***	-0.128***	-0.00174	-0.0900***	-0.130***
	(0.02)	(-3.75)	(-3.32)	(-0.10)	(-3.48)	(-3.11)
rdin	0.0000248	-0.000138	-0.000259***	0.000112	0.00000451	-0.000122
	(0.40)	(-1.64)	(-3.03)	(1.37)	(0.03)	(-0.95)
pub	-1.364**	-1.471*	-1.835**	-1.220*	-1.257	-1.673**
	(-2.12)	(-1.90)	(-2.20)	(-1.88)	(-1.63)	(-2.02)
cons	-0.984	-1.679	-3.068**	-0.772	-1.884	-4.655***
	(-1.06)	(-1.28)	(-2.08)	(-0.69)	(-1.22)	(-2.61)
Year FE	N	N	N	Y	Y	Y
N	726	726	726	726	726	726
adj. R^2	0.017	0.009	0.017	0.047	0.026	0.047

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.24.: CAR Regression Analysis (Market Model with Value-weighted Benchmark)

	(1) c_a_r_1d	(2) c_a_r_3d	(3) c_a_r_5d	(4) c_a_r_1d	(5) c_a_r_3d	(6) c_a_r_5d
share	0.00491	0.000510	0.0108	0.00366	-0.00140	0.00742
	(0.89)	(0.07)	(1.31)	(0.63)	(-0.19)	(0.87)
value	-0.000132***	-0.000147***	-0.000135**	-0.000134***	-0.000165***	-0.000139**
	(-4.77)	(-4.66)	(-2.41)	(-5.09)	(-5.19)	(-2.41)
domestic	0.597	1.238**	1.841***	0.712*	1.479**	2.098***
	(1.64)	(2.14)	(2.69)	(1.87)	(2.53)	(3.11)
fsize	0.0565	0.124	0.101	0.0175	0.0742	0.0306
	(0.70)	(1.00)	(0.74)	(0.21)	(0.58)	(0.22)
roa	0.00807	0.0236	0.113***	0.0108	0.0192	0.115***
	(0.68)	(1.64)	(7.11)	(0.89)	(1.14)	(6.45)
tq	-0.0000826	-0.000261	-0.000798*	-0.0000596	-0.000155	-0.000613
	(-0.19)	(-0.60)	(-1.68)	(-0.13)	(-0.31)	(-1.16)
lev	-0.00425	-0.0941***	-0.123***	-0.00630	-0.0904***	-0.124***
	(-0.25)	(-4.45)	(-3.49)	(-0.41)	(-3.91)	(-3.11)
rdin	0.0000537	-0.0000569	-0.000376***	0.000153*	0.0000935	-0.000228*
	(0.86)	(-0.68)	(-4.46)	(1.85)	(0.56)	(-1.81)
pub	-1.370**	-1.444*	-1.761**	-1.230*	-1.256	-1.655**
	(-2.13)	(-1.87)	(-2.09)	(-1.90)	(-1.62)	(-1.98)
cons	-0.844	-1.238	-2.510*	-0.583	-1.192	-3.566**
	(-0.92)	(-0.93)	(-1.68)	(-0.53)	(-0.76)	(-1.99)
Year FE	N	N	N	Y	Y	Y
N	726	726	726	726	726	726
adj. R^2	0.016	0.008	0.015	0.046	0.022	0.038

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.25.: CAR Regression Analysis (Fama-French 3 Factor Model with S&P Benchmark)

	(1) c_a_r_1d	(2) c_a_r_3d	(3) c_a_r_5d	(4) c_a_r_1d	(5) c_a_r_3d	(6) c_a_r_5d
share	0.00475	0.000886	0.00901	0.00353	-0.000872	0.00581
	(0.86)	(0.14)	(1.13)	(0.61)	(-0.13)	(0.69)
value	-0.000131***	-0.000136***	-0.000134**	-0.000135***	-0.000157***	-0.000144**
	(-4.80)	(-4.42)	(-2.52)	(-5.17)	(-5.10)	(-2.48)
domestic	0.590	1.285**	2.004***	0.701*	1.505**	2.236***
	(1.62)	(2.20)	(2.94)	(1.83)	(2.54)	(3.29)
fsize	0.0668	0.163	0.203	0.0299	0.119	0.139
	(0.82)	(1.29)	(1.47)	(0.36)	(0.91)	(1.00)
roa	0.0320***	0.00627	0.101***	0.0334***	-0.000457	0.102***
	(2.85)	(0.43)	(5.96)	(2.88)	(-0.03)	(5.47)
tq	-0.000154	-0.000323	-0.000713	-0.000122	-0.000235	-0.000539
	(-0.40)	(-0.61)	(-1.44)	(-0.29)	(-0.39)	(-0.95)
lev	0.0122	-0.0864***	-0.138***	0.0103	-0.0831***	-0.140***
	(0.70)	(-3.94)	(-3.19)	(0.65)	(-3.52)	(-3.02)
rdin	0.0000617	-0.0000681	-0.0000284	0.000153*	0.0000800	0.000109
	(0.99)	(-0.81)	(-0.34)	(1.81)	(0.45)	(0.75)
pub	-1.322**	-1.466*	-1.988**	-1.180*	-1.244	-1.841**
	(-2.03)	(-1.90)	(-2.38)	(-1.79)	(-1.60)	(-2.19)
cons	-0.907	-1.600	-3.198**	-0.773	-1.781	-4.718**
	(-0.98)	(-1.22)	(-2.14)	(-0.69)	(-1.15)	(-2.55)
Year FE	N	N	N	Y	Y	Y
N	726	726	726	726	726	726
adj. R^2	0.016	0.006	0.018	0.043	0.021	0.039

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.26.: CAR Regression Analysis (Fama-French 3 Factor Model with Equal-weighted Benchmark)

	(1)	(2)	(3)	(4)	(5)	(6)
	c_a_r_1d	c_a_r_3d	c_a_r_5d	c_a_r_1d	c_a_r_3d	c_a_r_5d
share	0.00623	0.00447	0.0140	0.00514	0.00278	0.0108
	(1.11)	(0.70)	(1.64)	(0.88)	(0.41)	(1.23)
value	-0.000133***	-0.000144***	-0.000139***	-0.000136***	-0.000165***	-0.000147***
	(-4.62)	(-4.35)	(-2.66)	(-5.00)	(-5.02)	(-2.63)
domestic	0.594	1.292**	2.007***	0.707*	1.520**	2.248***
	(1.63)	(2.22)	(2.93)	(1.84)	(2.58)	(3.29)
fsize	0.0759	0.193	0.237*	0.0402	0.151	0.175
	(0.94)	(1.52)	(1.71)	(0.48)	(1.15)	(1.25)
roa	0.0309***	0.00688	0.111***	0.0324***	0.00125	0.114***
	(2.85)	(0.48)	(6.77)	(2.87)	(0.07)	(6.21)
tq	-0.000141	-0.000392	-0.000910*	-0.000120	-0.000340	-0.000786
	(-0.37)	(-0.68)	(-1.78)	(-0.29)	(-0.54)	(-1.36)
lev	0.0117	-0.0956***	-0.151***	0.0110	-0.0891***	-0.148***
	(0.64)	(-3.86)	(-3.23)	(0.65)	(-3.54)	(-3.12)
rdin	0.00000496	-0.000290***	-0.000257***	0.0000973	-0.000117	-0.0000720
	(0.08)	(-3.44)	(-2.93)	(1.16)	(-0.66)	(-0.48)
pub	-1.349**	-1.459*	-1.944**	-1.208*	-1.218	-1.754**
	(-2.09)	(-1.89)	(-2.32)	(-1.84)	(-1.57)	(-2.08)
[1em] cons	-1.059	-2.126	-3.873**	-0.852	-2.309	-5.539***
	(-1.14)	(-1.62)	(-2.55)	(-0.75)	(-1.49)	(-2.90)
Year FE	N	N	N	Y	Y	Y
N	726	726	726	726	726	726
adj. R^2	0.017	0.009	0.021	0.044	0.026	0.047

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.27.: CAR Regression Analysis (Fama-French 3 Factor Model with value-weighted Benchmark)

	(1) c_a_r_1d	(2) c_a_r_3d	(3) c_a_r_5d	(4) c_a_r_1d	(5) c_a_r_3d	(6) c_a_r_5d
share	0.00478	0.00119	0.00905	0.00355	-0.000628	0.00578
	(0.87)	(0.19)	(1.13)	(0.62)	(-0.09)	(0.68)
value	-0.000132***	-0.000139***	-0.000135**	-0.000135***	-0.000160***	-0.000144**
	(-4.81)	(-4.47)	(-2.56)	(-5.17)	(-5.14)	(-2.49)
domestic	0.592	1.284**	1.998***	0.702*	1.502**	2.227***
	(1.62)	(2.20)	(2.93)	(1.83)	(2.54)	(3.27)
fsize	0.0708	0.172	0.210	0.0337	0.128	0.146
	(0.87)	(1.36)	(1.52)	(0.40)	(0.97)	(1.04)
roa	0.0298***	0.00408	0.0989***	0.0312***	-0.00264	0.0997***
	(2.68)	(0.28)	(5.91)	(2.70)	(-0.15)	(5.38)
tq	-0.000151	-0.000322	-0.000736	-0.000119	-0.000242	-0.000578
	(-0.39)	(-0.60)	(-1.49)	(-0.28)	(-0.40)	(-1.03)
lev	0.0124	-0.0870***	-0.139***	0.0107	-0.0829***	-0.140***
	(0.72)	(-3.97)	(-3.20)	(0.69)	(-3.53)	(-3.02)
rdin	0.0000660	-0.000106	-0.0000659	0.000155*	0.0000397	0.0000666
	(1.06)	(-1.26)	(-0.77)	(1.83)	(0.22)	(0.46)
pub	-1.337**	-1.468*	-1.981**	-1.199*	-1.252	-1.845**
	(-2.06)	(-1.89)	(-2.35)	(-1.81)	(-1.60)	(-2.18)
cons	-0.935	-1.697	-3.246**	-0.839	-1.970	-4.876***
	(-1.01)	(-1.29)	(-2.17)	(-0.75)	(-1.26)	(-2.61)
Year FE	N	N	N	Y	Y	Y
N	726	726	726	726	726	726
R^2	0.028	0.019	0.030	0.075	0.054	0.071

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.28.: CAR Regression Analysis (Fama-French 3 Factor Model with Value-weighted Benchmark and Big Acquirers)

	(1)	(2)	(3)	(4)	(5)	(6)
	c_a_r_1d	c_a_r_3d	c_a_r_5d	c_a_r_1d	c_a_r_3d	c_a_r_5d
share	0.00841**	0.00650	0.00988	0.00860**	0.00678	0.00905
	(2.53)	(1.31)	(1.60)	(2.41)	(1.27)	(1.38)
value	-0.000149***	-0.000153***	-0.000153***	-0.000151***	-0.000162***	-0.000162***
	(-6.92)	(-5.17)	(-2.97)	(-7.50)	(-5.84)	(-2.90)
domestic	-0.286	-0.150	0.137	-0.270	-0.161	0.203
	(-1.15)	(-0.33)	(0.25)	(-1.03)	(-0.34)	(0.36)
fsize	0.0449	0.160	0.280*	0.0464	0.184	0.255
	(0.53)	(1.11)	(1.68)	(0.50)	(1.29)	(1.46)
roa	4.484**	6.291*	4.142	3.897**	4.435	2.933
	(2.28)	(1.80)	(1.32)	(2.11)	(1.28)	(0.89)
tq	-0.00188	-0.00639*	-0.0104*	-0.00237	-0.00693**	-0.0108**
	(-1.26)	(-1.85)	(-1.84)	(-1.52)	(-1.98)	(-1.98)
lev	0.130	0.0475	0.339	0.114	-0.0151	0.237
	(0.94)	(0.21)	(1.50)	(0.69)	(-0.06)	(0.90)
rdin	1.143*	0.877	0.287	1.030	0.567	0.0541
	(1.69)	(0.68)	(0.42)	(1.61)	(0.44)	(0.07)
pub	-0.436	-0.452	-0.281	-0.297	-0.362	-0.146
	(-1.27)	(-0.98)	(-0.55)	(-0.85)	(-0.76)	(-0.28)
cons	-1.405	-2.297	-4.130**	-0.415	-1.204	-3.666
	(-1.61)	(-1.48)	(-2.26)	(-0.39)	(-0.61)	(-1.44)
Year FE	N	N	N	Y	Y	Y
N	346	346	346	346	346	346
R^2	0.172	0.087	0.087	0.215	0.134	0.141

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.29.: CAR Regression Analysis (Fama-French 3 Factor Model with Value-weighted Benchmark and Small Acquirers)

	(1) c_a_r_1d	(2) c_a_r_3d	(3) c_a_r_5d	(4) c_a_r_1d	(5) c_a_r_3d	(6) c_a_r_5d
share	0.000447	-0.00847	0.00682	-0.00320	-0.0143	0.000180
	(0.03)	(-0.60)	(0.38)	(-0.24)	(-0.99)	(0.01)
value	0.0000255	-0.0000382	-0.0000216	-0.0000949	-0.000255	-0.000263
	(0.17)	(-0.19)	(-0.10)	(-0.44)	(-1.30)	(-1.34)
domestic	1.422*	2.709**	3.829***	1.462*	2.784**	3.886***
	(1.90)	(2.34)	(2.83)	(1.83)	(2.33)	(2.89)
fsize	0.153	0.317	0.366*	0.0455	0.202	0.237
	(1.16)	(1.59)	(1.71)	(0.33)	(1.00)	(1.05)
roa	0.0281**	-0.0000533	0.0983***	0.0343**	-0.00731	0.106***
	(2.48)	(-0.00)	(5.28)	(2.28)	(-0.30)	(3.93)
tq	0.000188	0.000449	0.000288	0.000158	0.000495	0.000255
	(0.45)	(0.76)	(0.52)	(0.32)	(0.71)	(0.36)
lev	0.0129	-0.0855***	-0.144***	0.0165	-0.0697***	-0.135***
	(0.83)	(-4.29)	(-3.76)	(0.98)	(-2.71)	(-2.87)
rdin	0.0000686	-0.000114	-0.0000145	0.000250*	0.000311	0.000434*
	(0.70)	(-0.96)	(-0.11)	(1.72)	(0.91)	(1.70)
pub	-2.446	-2.416	-3.824**	-2.469	-2.170	-3.769**
	(-1.63)	(-1.38)	(-2.05)	(-1.63)	(-1.25)	(-2.02)
cons	-1.407	-2.354	-4.777**	-1.686	-3.151	-7.223**
	(-0.85)	(-1.14)	(-2.01)	(-0.87)	(-1.33)	(-2.48)
Year FE	N	N	N	Y	Y	Y
N	380	380	380	380	380	380
R^2	0.025	0.024	0.044	0.103	0.090	0.118

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.30.: CAR Regression Analysis Market Model with S&P Benchmark (ROA Excluded)

	(1) c_a_r_1d	(2) c_a_r_3d	(3) c_a_r_5d	(4) c_a_r_1d	(5) c_a_r_3d	(6) c_a_r_5d
share	0.00456	-0.000633	0.00975	0.00331	-0.00252	0.00642
	(0.82)	(-0.09)	(1.18)	(0.57)	(-0.34)	(0.75)
value	-0.000131***	-0.000142***	-0.000135**	-0.000133***	-0.000159***	-0.000139**
	(-4.73)	(-4.54)	(-2.40)	(-5.06)	(-5.08)	(-2.41)
domestic	0.602*	1.233**	1.821***	0.716*	1.471**	2.074***
	(1.65)	(2.14)	(2.66)	(1.88)	(2.51)	(3.07)
fsize	0.0578	0.123	0.121	0.0200	0.0730	0.0555
	(0.72)	(1.01)	(0.90)	(0.24)	(0.58)	(0.41)
tq	-0.0000781	-0.000257	-0.000756	-0.0000572	-0.000140	-0.000551
	(-0.18)	(-0.60)	(-1.62)	(-0.12)	(-0.28)	(-1.05)
lev	-0.00539	-0.0944***	-0.122***	-0.00752	-0.0909***	-0.124***
	(-0.32)	(-4.54)	(-3.53)	(-0.49)	(-3.99)	(-3.14)
rdin	0.0000413	-0.0000325	-0.000395***	0.000143*	0.000120	-0.000240*
	(0.66)	(-0.39)	(-4.69)	(1.72)	(0.72)	(-1.89)
pub	-1.367**	-1.451*	-1.742**	-1.227*	-1.261	-1.645**
	(-2.13)	(-1.88)	(-2.07)	(-1.90)	(-1.63)	(-1.97)
cons	-0.835	-1.123	-2.573*	-0.568	-1.012	-3.466*
	(-0.91)	(-0.85)	(-1.72)	(-0.52)	(-0.64)	(-1.91)
Year FE	N	N	N	Y	Y	Y
N	726	726	726	726	726	726
adj. R^2	0.017	0.008	0.014	0.046	0.022	0.034

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.31.: CAR Regression Analysis (Market Model with S&P Benchmark (TQ Excluded)

	(1)	(2)	(3)	(4)	(5)	(6)
	c_a_r_1d	c_a_r_3d	c_a_r_5d	c_a_r_1d	c_a_r_3d	c_a_r_5d
share	0.00420	-0.00200	0.00674	0.00281	-0.00357	0.00385
	(0.79)	(-0.30)	(0.79)	(0.51)	(-0.51)	(0.45)
value	-0.000130***	-0.000140***	-0.000129**	-0.000131***	-0.000154***	-0.000130**
	(-4.65)	(-4.44)	(-2.29)	(-4.94)	(-4.99)	(-2.17)
domestic	0.634*	1.225**	1.790***	0.746*	1.457**	2.049***
	(1.74)	(2.14)	(2.63)	(1.95)	(2.51)	(3.05)
fsize	0.0352	0.0989	0.0598	-0.00304	0.0483	-0.0125
	(0.43)	(0.82)	(0.45)	(-0.04)	(0.38)	(-0.09)
roa	0.0126	0.0265*	0.119***	0.0152	0.0220	0.121***
	(1.11)	(1.88)	(7.55)	(1.28)	(1.31)	(6.77)
lev	-0.00559	-0.0953***	-0.123***	-0.00833	-0.0918***	-0.123***
	(-0.35)	(-4.71)	(-3.65)	(-0.57)	(-4.16)	(-3.19)
rdin	0.0000362	-0.0000455	-0.000422***	0.000139*	0.000109	-0.000264**
	(0.59)	(-0.56)	(-4.94)	(1.69)	(0.66)	(-2.07)
pub	-1.394**	-1.466*	-1.775**	-1.231*	-1.270	-1.676**
	(-2.17)	(-1.90)	(-2.11)	(-1.91)	(-1.64)	(-2.01)
cons	-0.612	-0.777	-1.733	-0.374	-0.598	-2.532
	(-0.68)	(-0.61)	(-1.15)	(-0.36)	(-0.40)	(-1.42)
Year FE	N	N	N	Y	Y	Y
N	737	737	737	737	737	737
adj. R^2	0.017	0.008	0.015	0.046	0.022	0.036

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.32.: CAR Regression Analysis Market Model with S&P Benchmark (Lev_inc included)

	(1) c_a_r_1d	(2) c_a_r_3d	(3) c_a_r_5d	(4) c_a_r_1d	(5) c_a_r_3d	(6) c_a_r_5d
share	0.00420	-0.00214	0.00633	0.00280	-0.00359	0.00411
	(0.78)	(-0.32)	(0.74)	(0.51)	(-0.52)	(0.48)
value	-0.000130***	-0.000140***	-0.000132**	-0.000130***	-0.000155***	-0.000135**
	(-4.66)	(-4.49)	(-2.35)	(-4.94)	(-5.00)	(-2.27)
domestic	0.632*	1.235**	1.733**	0.748*	1.467**	1.964***
	(1.73)	(2.15)	(2.57)	(1.96)	(2.52)	(2.98)
fsize	0.0354	0.0877	0.0709	-0.00434	0.0369	-0.00639
	(0.43)	(0.72)	(0.54)	(-0.05)	(0.29)	(-0.05)
roa	0.0126	0.0274*	0.117***	0.0153	0.0242	0.123***
	(1.10)	(1.90)	(7.52)	(1.26)	(1.39)	(6.96)
lev_inc	-0.0124	-0.0822***	-0.0709	-0.00924	-0.0695***	-0.0568
	(-0.87)	(-3.43)	(-1.19)	(-0.62)	(-2.60)	(-0.91)
rdin	0.0000371	-0.0000479	-0.000424***	0.000139*	0.000107	-0.000265**
	(0.60)	(-0.59)	(-4.90)	(1.69)	(0.64)	(-2.08)
pub	-1.392**	-1.467*	-1.719**	-1.235*	-1.267	-1.526*
	(-2.17)	(-1.90)	(-2.06)	(-1.91)	(-1.64)	(-1.86)
cons	-0.616	-0.731	-1.867	-0.366	-0.538	-2.593
	(-0.68)	(-0.57)	(-1.25)	(-0.35)	(-0.36)	(-1.46)
Year FE	N	N	N	Y	Y	Y
N	734	734	734	734	734	734
adj. R^2	0.017	0.008	0.012	0.046	0.020	0.030

t statistics in parentheses

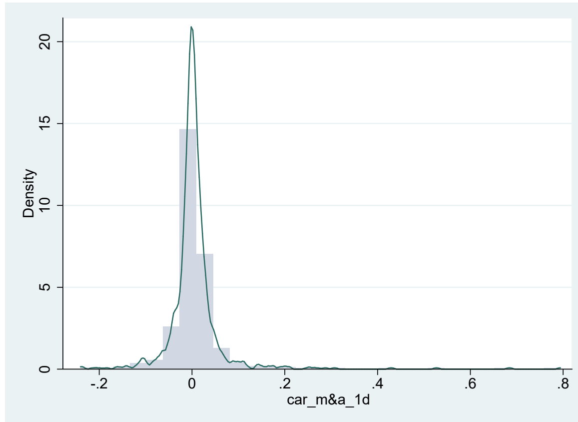
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.33.: CAR Regression Analysis (Market Model with S&P Benchmark (bkvalat=at-lt)

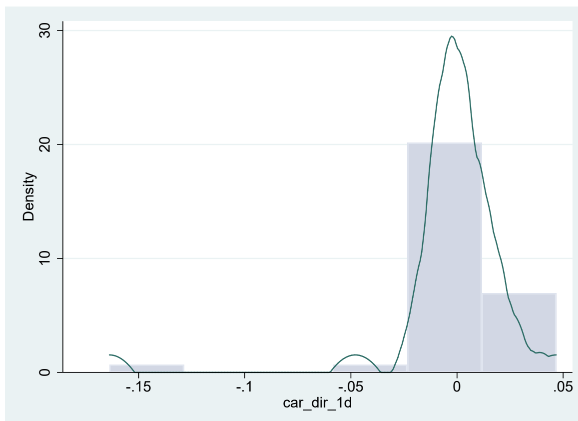
	(1)	(2)	(3)	(4)	(5)	(6)
	c_a_r_1d	c_a_r_3d	c_a_r_5d	c_a_r_1d	c_a_r_3d	c_a_r_5d
share	0.00425	-0.00207	0.00670	0.00286	-0.00362	0.00382
	(0.80)	(-0.30)	(0.78)	(0.52)	(-0.52)	(0.44)
value	-0.000130***	-0.000139***	-0.000129**	-0.000131***	-0.000154***	-0.000130**
	(-4.70)	(-4.43)	(-2.27)	(-5.01)	(-4.98)	(-2.16)
domestic	0.630*	1.231**	1.794***	0.743*	1.461**	2.051***
	(1.71)	(2.14)	(2.63)	(1.93)	(2.51)	(3.05)
fsize	0.0399	0.0929	0.0557	0.000993	0.0442	-0.0149
	(0.49)	(0.76)	(0.41)	(0.01)	(0.34)	(-0.11)
roa	0.0120	0.0274*	0.119***	0.0148	0.0225	0.121***
	(1.01)	(1.91)	(7.47)	(1.21)	(1.33)	(6.73)
tq_a	0.0106	-0.0138	-0.00943	0.0108	-0.0108	-0.00639
	(0.80)	(-0.56)	(-0.32)	(0.80)	(-0.46)	(-0.21)
lev	-0.0283	-0.0659	-0.103*	-0.0315	-0.0688	-0.109*
	(-1.25)	(-1.34)	(-1.81)	(-1.39)	(-1.49)	(-1.93)
rdin	0.0000389	-0.0000489	-0.000425***	0.000144*	0.000105	-0.000267**
	(0.64)	(-0.60)	(-4.95)	(1.75)	(0.62)	(-2.08)
pub	-1.407**	-1.449*	-1.763**	-1.243*	-1.258	-1.668**
	(-2.19)	(-1.88)	(-2.10)	(-1.93)	(-1.64)	(-2.00)
cons	-0.698	-0.667	-1.657	-0.455	-0.517	-2.484
	(-0.79)	(-0.51)	(-1.08)	(-0.44)	(-0.34)	(-1.37)
Year FE	N	N	N	Y	Y	Y
N	737	737	737	737	737	737
adj. R^2	0.016	0.008	0.014	0.045	0.021	0.035

t statistics in parentheses

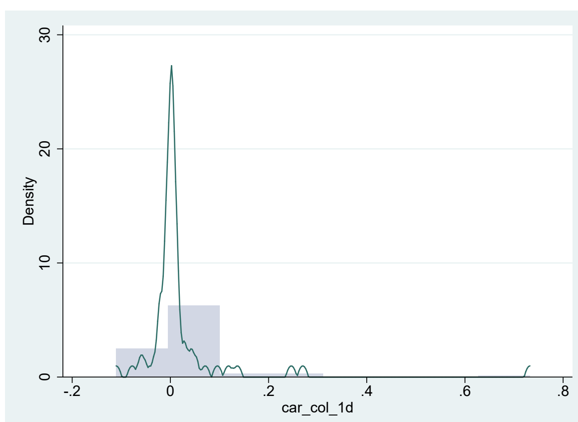
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



(a) Figure A

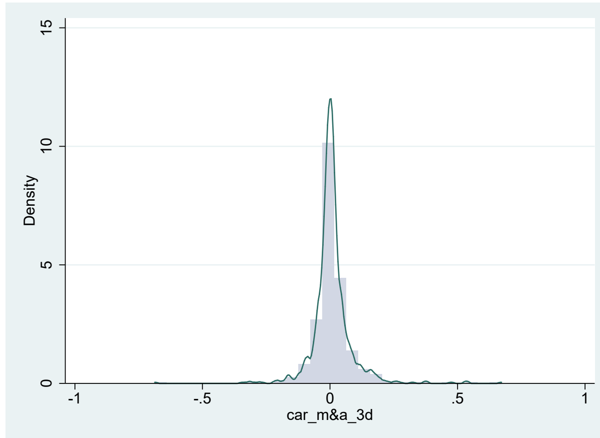


(b) Figure B

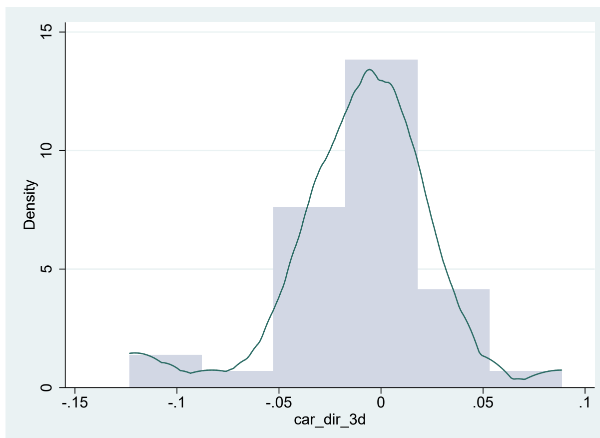


(c) Figure C

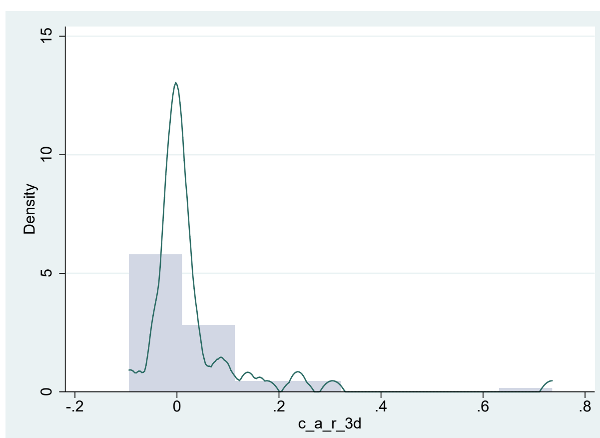
Figure 3.3.: CAR Distribution for One Day Window



(a) Figure A

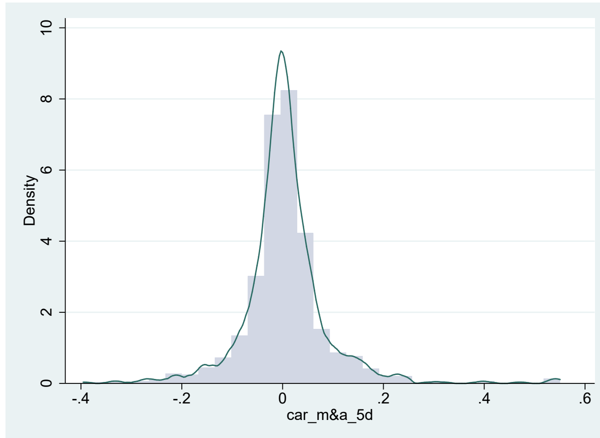


(b) Figure B

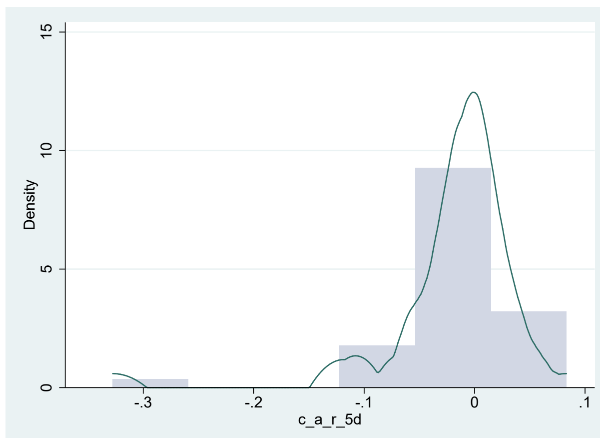


(c) Figure C

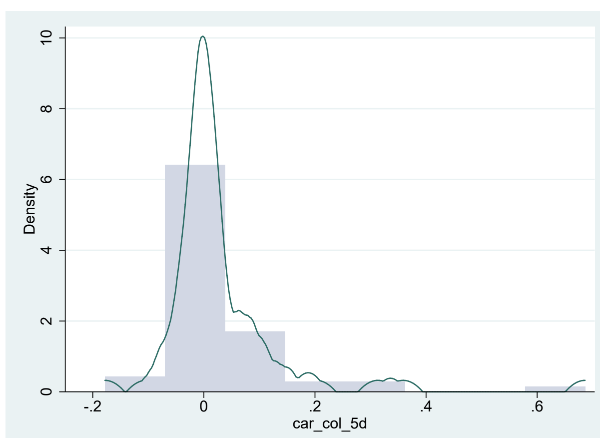
Figure 3.4.: CAR Distribution for Three Days Window



(a) Figure A



(b) Figure B



(c) Figure C

Figure 3.5.: CAR Distribution for Five Days Window

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