Carry-on Baggage Fee, Airline Pricing and Subcontracting

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Abstract

In 2010, Spirit airlines announced that it would start charging passengers for carry-on baggage. Using a vector of route level characteristics, we construct a matched group consisting of routes which best match those served by Spirit (treated group). We then run a diff-in-diff estimation using the treated and matched group, and examine the impact of Spirit's baggage fee policy on its rivals' ticket prices. Our results show that Spirit's rivals reduce their prices by about 5.8% after Spirit charges carry-on baggage fee. We also take into account the subcontracting status of Spirit's rivals, i.e., whether they subcontract operations to regional airlines. The results suggest that price reduction mainly comes from major carriers which subtract to regional carriers. In particular, price reduction by non-subcontracting carriers is small and insignificant, and price reduction by subcontracting carriers is large and remains significant. We also discuss how the significant price reduction on subcontracting routes may negatively impact regional carriers.

Keywords: Carry-on baggage fee; Unbundling; Subcontracting; Airline industry

JEL Classification Codes: D43, L13, L24, L93.

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1 Introduction

In recent years the U.S. airline industry has experienced a significant increase in unbundling where charging all-inclusive ticket prices are replaced by a business model of lower basic prices plus additional fees for add-ons. Examples include baggage fees, premium seats upgrade etc. Airlines have also found new sources of revenue from services such as Wi-Fi and Entertainment. Most major airlines started charging for checked bags in 2008, and in 2017 United and American started selling Basic Economy fares for which travelers cannot bring a carry-on baggage or pick a seat and so on for free. Our paper investigates the impacts of a specific unbundling strategy, namely Spirit's decision to charge for carry-on baggage. This refers to the baggage which travelers put in the overhead bin, as opposed to under the seat in front.

In April 2010, Spirit announced that it would charge travelers $20 to $45 for items they place in the overhead bins.[1] Spirit Airlines was the first carrier to charge for carry-on baggage, and was the only one doing so during our sample period. Other Ultra-Low-Cost carriers like Frontier and Allegiant followed Spirit's step in 2012 and 2014 respectively. More recently, legacy carriers also started offering Basic Economy fares, which put restrictions on carry-on baggage among other things. This behavior change by the legacy carriers would impact a much larger set of markets and travelers. While further research is needed, understanding the impact of Spirit's carry-on baggage fee helps provide insights on legacy carriers' behavior change and the corresponding impacts.[2]

We also believe Spirit's policy change offers a few advantages over legacy carriers' in terms of identifying the true policy impact. Spirit was the only airline adopting the baggage fee policy in our study, and the fee applies to all markets it serves. These make the treatment, and treated/control group distinction easy to identify. In contrast, legacy carriers' basic economy fares impose constraints beyond just carry-on baggage fee (e.g., seat selection, boarding group) so the exact treatment is less clear. In addition, several legacy carriers started offering basic economy fares around the same time, and roll out basic economy class fares selectively across routes.[3]

In this paper, we investigate the impacts of Spirit's carry-on baggage fee and answer to the following questions: (1) What are the effects of carry-on baggage fee on competing carriers' ticket prices? (2) Do carriers' responses vary depending on their subcontracting status?

We first offer some conjectures on the two questions above. After unbundling, Spirit's basic ticket quality (and cost) goes down because it does not allow travelers to bring carry-on baggage

[1] The exact cost depends on whether passengers are members of the airline's ultra-low fare club and whether travelers pay for carry-on baggage in advance. See "Airline to charge for carry-on bags," CNN, April 6, 2010.

[2] Based on Spirit's 2012 earnings statement, 40% of its revenue comes from ancillary fees which include baggage fees. See "Spirit Air to charge up to $100 for carry-on bags," *CNN Money*, May 3, 2012. Also, Bureau of Transportation Statistics (2017) reports that the total baggage fee (including checked and carry-on) revenue of U.S airlines reached 4.2 billion dollars in 2016.

[3] Route selection is itself an interesting question. For example, which airlines started offering basic economy class first, and on what routes? Do different airlines roll out around the same time or is there a leader-follower pattern?

anymore. Moreover, Spirit would have an incentive to lower basic ticket prices to attract more passengers, which in turn leads to more opportunities to collect carry-on baggage fees. Combined, one would thus expect Spirit's basic ticket fares to go down. The impact of the policy on Spirit's rivals is more subtle. On one hand, facing lower prices from Spirit, its rivals may need to reduce their prices as well to stay competitive. On the other hand, since Spirit charges for carry-on baggage but its rivals do not, one may expect travelers to make adjustment. In particular, travelers with (without) carry-on baggages are more (less) likely to fly with Spirit's rivals. This raises Spirit's rivals' cost of serving their travelers so they should raise prices. We expect the first impact to dominate, so Spirit's carry-on baggage fee would lead to reduction in its rivals' ticket prices. But what role does subcontracting status play in this process, if any?

A typical contract for subcontracting can be one of two types, depending on how the revenue from ticket sales is split between the major and regional carriers (see Forbes and Lederman (2013) for more details). In a fixed payment contract, the major carrier pays the regional carrier a fixed amount (to purchase certain amount of capacity at agreed rate) and keeps all the revenue. In contrast, in a revenue-sharing contract, the ticket revenue from the subcontracted route is split between the major and regional carriers. In both types of contracts, the major carriers set flight schedule and airfare, and sell tickets to customers. The regional carriers operate the flights using their own crew and aircrafts, and bear most, if not all of the operation costs. When Spirit charges baggage fee, it lowers its basic fare but the all-inclusive fare (including baggage fee) goes up. At the margin, passengers without carry-on baggage will switch to Spirit, while passengers with carry-on baggages will switch to major carriers. Both increase major carriers' costs. This has no impact on subcontracting major carriers since the cost is borne by regional carriers. However, non-subcontracting major carriers take operating cost into account, and higher cost would lead to higher ticket prices. As a result, price reduction is less for non-subcontracting major carriers relative to subcontracting ones. Subcontracting major carriers may also have an incentive to reduce price further when passengers' itineraries involve connecting flights where parts of the flight itineraries are operated by major carriers and others are operated by regionals.

To test these conjectures, we rely on difference-in-difference estimation. The treated group includes markets where Spirit operates, while the control group consists of routes where Spirit does not operate. One would expect that Spirit likely chooses to operate in specific markets, and such selection makes the control group not a good comparison group for the treated group. Using a set of route-level characteristics, we construct a matched group – a subset of routes within the control group which best match the routes in the treated group. The treated group and matched group are shown to have common trend, which allows us to run diff-in-diff estimation. The estimation results show that in response to Spirit's carry-on baggage fee, its rivals lower their prices by about 5.8% or $10. We also explore the impact of baggage fee policy on different points of the price distribution. The effects are all negative and significant at the 20th-, 50th- and 80th-percentile of the price distribution, and the impact on the median prices is the largest (decrease by 6.9%).

We then investigate whether an airline's response to Spirit's baggage fee policy depends on its subcontracting status. Technical breakthrough in the early 2000s led to the development of small yet cost effective jet aircrafts. This greatly helped regional airlines which usually operate aircrafts with less than 90 seats. Legacy carriers quickly learned that on some low density routes, instead of operating their own flights, if they subcontract the operations to regional airlines, they can improve cost effectiveness. Subcontracting became popular and rapid expansion of regional carriers soon followed. According to the official Regional Airline Association report, in 2007 regional carriers provide services to nearly two-thirds of airports, and operate in about 42% of all departures in domestic routes. If we only consider the routes served by at least one regional airline, regionals' roles are a lot more prominent – 95% of departures on these routes are operated by regional airlines.

The popularity of subcontracting by legacy carriers in the U.S. airline industry has garnered much attention among scholars recently. The focus has been on when the legacy carriers subcontract routes to regional carriers (Forbes and Lederman (2009) and Tan (2018)), as well as the choice between independent regionals and subsidiaries. Little attention has been given to how subcontracting affects legacy carriers' pricing behavior. In our setting, Spirit's carry-on baggage fee policy affects legacy carriers that it competes with, and these legacy carriers may or may not subcontract. This distinction allows us to look at how legacy carriers' responses to the baggage fee policy vary depending on their subcontracting status, and gives a sneak peak into the impacts of subcontracting on legacy carrier's pricing strategies.

To this end, we divide the treated group (Spirit markets) and control group (non-Spirit markets) further into subcontracting and non-subcontracting subgroups depending on whether the carrier subcontracts operations in the market. We then run a triple-difference estimation, and the triple interaction term tells us the differential impact of baggage fee on legacy carrier's prices depending on their subcontracting status. Our results show that among Spirit's rivals, subcontracting carriers reduce their ticket prices more than non-subcontracting carriers, by about 10.6%.[4] The impact is particularly strong and significant for median prices - the difference in price reduction is 16.5%.[5] After controlling for subcontracting status, price reduction for carriers which do not subcontract is much smaller and the estimates become mostly insignificant.

Our paper contributes to the empirical price unbundling literature. While the theory literature on bundling/unbundling is extensive, empirical studies have been scarce, especially those studying the U.S. airline industry. Our paper adds to the few studies that empirically look at how checked

[4]On routes which some major carriers subcontract, we drop major carriers which operate on the same route but do not subcontract. These non-subcontracting carriers compete with subcontracting carriers and thus are not immune to the impact of subcontracting status. Therefore, we are comparing subcontracting carriers (on subcontracting routes) with non-subcontracting carriers (on non-subcontracting routes).

[5]Caution is needed when interpreting our results on subcontracting. The relative short time periods of our sample allows us to treat subcontracting status as exogenous. Over a longer period, major and regional carriers make decisions on whether or not enter into partnership and if yes, the exact contract terms. As a result, subcontracting status will be endogenous, and can be impacted by Spirit's baggage fee, possibly through its impact on ticket prices.

bag fees and additional services (e.g., inflight wi-fi) affect ticket prices. We do so by looking at the impact of carry-on bag fee by one airline on its rivals' ticket prices. Consistent with Brueckner et al. (2015), we find that unbundling leads to reduction in own basic prices but increase in all-inclusive prices (price plus carry-on baggage fee). We also investigate the impact on Spirit rival's prices, and find results opposite to existing studies. For example, Zou et al. (2017) find that checked bag fees by legacy carriers raised the prices of their rivals' (Southwest and JetBlue which do not charge for checked bags). In contrast, we find that carry-on baggage fee by Spirit leads to lower ticket prices by its rivals (which do not charge for carry-on baggage fee). Our paper also contributes to the nascent literature on subcontracting in the U.S. airline industry. We show that when an airline competes with Spirit on a route, its subcontracting status is a significant predictor of how its ticket prices will respond to Spirit's carry-on baggage fee. Carriers which subcontract to regional carriers will see a significantly larger price reduction after Spirit charges for carry-on baggage.

Our results have important policy implications. First, Spirit's baggage fee leads to lower basic ticket prices for not only Spirit but also its rivals. Since Spirit's rivals do not charge for baggage fee, their customers are unambiguously better off. However, caution is warranted for consumers who still fly with Spirit but bring with them carry-on baggages, often unaware of the carry-on baggage fee. The reduction in Spirit's ticket prices is insufficient to offset the carry-on baggage fee, especially if travelers fail to pay for it in advance, and have to pay at the gate instead. In light of this, it is important for consumers to be well informed of the baggage fee policy, and understand the terms of their tickets.[6] From competition perspective, requirement on proper disclosure of add-on pricing needs to be in place so consumers can compare the total prices across different airlines. This is especially true for items such as carry-on baggage fee which used to be taken for granted as complimentary, and the exact pricing may not be uniform across carriers or time.[7]

Second, our results suggest that regulators need to take a closer look at the relationship between major and regional carriers. While regionals are responsible for the operation costs, ticket pricing decisions are made by major carriers. When a demand or supply side shock takes place in the subcontracted routes, operation costs may not be a main factor entering into major carriers' pricing decisions which can then negatively affect the regional carriers. In the case where the major and regional carriers share revenue from the operations, a significant price reduction by the major carriers obviously hurts the regional carriers. But even in the case of fixed-price contracts, lower price is likely to be accompanied by higher quantity which increases the regional carriers' costs. In addition, Spirit's baggage fee likely will shift the allocation of travelers across carriers and increase

[6]Spirit's passengers are often surprised when they find, at the gate, that they have to pay for carry-on baggage fee. This is one of the most common complaints of Spirit. See, for example, https://www.consumeraffairs.com/travel/spirit.html, accessed on April 28, 2018.

[7]American Airlines initially charged fee for carry-on baggage for its Basic Economy fares but then reversed policy in July 2018. See "American Airlines basic economy tickets allow free carry-ons," *USA Today*, July 26, 2018. In contrast, United still charges carry-on baggage fee for its Basic Economy fares. https://www.united.com/web/en-US/content/travel/inflight/basic-economy.aspx, accessed in April 2019.

the regional carriers' costs. Those without carry-on baggage may find Spirit more attractive while travelers with carry-on baggage have more incentive to shift to Spirit's competitors because they do not charge for carry-on baggage. This would also raise regional carriers' costs for which they won't be compensated by the fixed-price contracts. Regional carriers provide important services, especially in medium to small distance markets. Industry consolidation has significantly reduced the number of major airlines and shifted bargaining power further away from regional airlines toward the major airlines.

1.1 Literature Review

There is an extensive literature looking at competition and pricing in the airline industry.[8] For example Borenstein and Rose (1994), Gerardi and Shapiro (2009), Dai et al. (2014) and Kim and Shen (2017), analyze the relationship between competition and price dispersion. Goolsbee and Syverson (2008) analyze how entry affects incumbents' prices, while Kim and Singal (1993) studies the impacts of merger. Our paper shows that controlling for competition, adopting a carry-on baggage fee leads to price reductions of incumbents across the board.

There is a fast growing literature which studies the impacts of price unbundling in the airline industry, usually focusing on checked bag fee.[9] Within this literature, our paper is most closely related to Brueckner et al. (2015) who analyze how airlines' checked baggage fee affects their ticket prices. They develop a theory model which predicts that basic ticket price would go down after unbundling, but the full-trip price (fare plus bag fee) may go up or down. Their empirical findings confirm that when airlines charge for checked baggage fee, their own basic ticket prices go down. However, the all-inclusive prices (ticket price plus bag fee) go up because the ticket price reduction is insufficient to compensate for the checked bag fee. Similar to Brueckner et al. (2015), Kim et al. (2018) also look at add-on services, in particular, in-flight amenities such as in-flight wi-fi, in-seat power etc.[10] Using self-collected data, they show that carriers provide significantly higher product quality (Wi-Fi, entertainment, and power) on more competitive routes. They also find that having Wi-Fi and entertainment lead to significantly lower basic ticket prices. Zou et al. (2017) show that charging checked baggage fee has positive effect on competing carriers which do not charge checked baggage fee (Southwest and JetBlue).

Our paper differs from these studies in several important aspects. First, while they study checked baggage fee, we analyze carry-on baggage fee which is relatively new and hard for travelers to avoid. Second, the fact that only Spirit charges for carry-on baggage and that Spirit only

[8] Besides competition, Sengupta and Wiggins (2014) use a unique dataset and study the impact of online airline ticket purchasing on prices.

[9] Exceptions include Kim et al. (2018) who investigate the provision of in-flight amenities across flights and see how they affect basic ticket prices. Nicolae et al. (2017) study the relationship between checked baggage fee and on-time performance.

[10] They interpret in-flight amenities as quality and explore how competition affects quality provision – a topic which has generated increasing attention in recent years (see, for example, Prince and Simon (2014, 2017)).

operates in some markets allow us to use a difference-in-difference estimation to better identify the impacts of the baggage fee policy. We focus on the impacts of Spirit's baggage fee policy, not on its own prices, but on its rivals' prices. Also, we include all Spirit's rivals whereas in Zou et al. (2017), the rivals are restricted to Southwest and JetBlue since most other rivals also charged for checked baggage. Lastly, we also explore the policy's differential impacts on different points of the price distribution or different types of carriers depending on their subcontracting status.

Beyond airline industry, there is a general literature on price unbundling and add-on pricing, covering both monopoly and competition.[11] Fruchter et al. (2011) consider monopoly and they are mainly concerned with whether and how the monopolist should charge for add-ons. In a duopoly setting, Ellison (2005), Gabaix and Laibson (2006), Dahremöller (2013), and Shulman and Geng (2013) analyze how firms price add-ons when some consumers are unaware of the add-on fees. Other research such as Shugan et al. (2016) and Lin (2017) explains why firms price add-on in some industries but not others. Note that these studies generally assume that all firms choose price unbundling, and do not consider the case of unilateral adoption where only one firm chooses price unbundling.

Our paper is also closely related to the literature on subcontracting in the airline industry.[12] Forbes and Lederman (2009), the seminal work in the airline subcontracting literature, investigates when carriers use their own regionals vs. independent regionals. Tan (2018) shows that legacy carriers are more likely to outsource (and also charge lower ticket prices) on routes with stronger competition. Shi (2016) studies what factors determine carriers' subcontracting behavior, and provides evidence that carriers with and without subcontracting have different responses to market entry. We investigate whether carriers with subcontracting behavior respond to carry-on baggage fee differently from carriers without subcontracting behavior. Studying their differential responses to baggage fee can help us better understand how subcontracting affects the way airlines compete with each other and the corresponding welfare implications. In this aspect, our paper is the first one to estimate how subcontracting status affects a carrier's response to price unbundling by its rival.

The rest of the paper is organized as follows. Section 2 describes the data and variable construction. We discuss the estimation method in Section 3, and present the empirical results in Section 4. Section 5 includes several robustness checks and we conclude in Section 6.

[11] The unbundling literature usually considers only competition between two firms, likely for convenience of analysis. Zhou (2017) analyzes competitive bundling and shows that the welfare implications can reverse when number of firms increases from 2 to more than 2.

[12] Two different terms, subcontracting and outsourcing have been used for the same behavior. For example, Forbes and Lederman (2009) uses "subcontracting" while Tan (2018) uses "outsourcing".

2 Data and Variable

The main data set is the Airline Origin and Destination Survey (DB1B) data, a quarterly survey of 10% domestic airline tickets sold to passengers. The data includes information such as time (year-quarter), carrier, ticket price, number of passengers and origin and destination airport. Ticket price is the basic fare without add-ons (e.g., bag fee). The number of passengers indicates how many passengers bought their tickets at the given price. We focus on non-stop routes and define a market as a directional nonstop airport-to-airport route. That is, the route from SFO to LAX is a different market from LAX to SFO. The data is then aggregated to carrier-route-quarter level. For example, an observation in our data can be that American Airlines transported 11,675 passengers from New York LaGuardia to Chicago O'Hare in the 3rd quarter of 2010, with average ticket price of $206.6. Spirit's policy (charging $20 for carry-on baggage) took effect in August 2010. We restrict ourselves to the periods from 2009 first quarter to 2011 fourth quarter. We choose this time span to maximize the number of time periods yet avoid known confounding factors.

To solve the potential endogeneity problem raised by one of the key control variables (market competition level or HHI), we use instrumental variables. We instrument HHI because we want to interpret the competition effects in addition to the policy treatment effects that is our main interest. Following the literature, many of our instruments are constructed based upon enplanement. The enplanement is the number of passengers boarded on flights between two airports, which are not necessarily the origin or destination of passengers' itineraries (due to connecting flights). The T-100 Domestic Segment Data reports enplanement directly, but we do not use this enplanement data for the following reason. DB1B data set reports both ticketing carrier and operating carrier. Ticketing and operating carriers may differ for a given itinerary because the ticketing carrier subcontracts the service to the operating carrier or two carriers may have code sharing agreements. We use ticketing carrier to study carriers' pricing behavior in this paper because it is the carrier who sells tickets and decides on ticket prices. On the other hand, the carrier reported by T-100 data is commonly recognized as operating carrier. One can merge DB1B data and T-100 data by operating carrier, but they cannot be matched perfectly and consequently some observations will be dropped. To avoid this problem, we use DB1B data to approximate enplanement (more details are provided in the Appendix). Following the literature, we also construct instrumental variables using the population estimates provided in the Metropolitan and Micropolitan Statistical Areas Population data.

We also filter our data as follows. Since our focus is on Spirit rival's behavior, our treated group includes only routes where Spirit and at least one other airline operate in each period of our sample. Relatedly, the control group includes routes where at least two carriers operate yet Spirit never operates in each period of the sample. We end up with a balanced panel of 983 directional non-stop routes, 12 quarters and a total of 31,831 observations (at the carrier-route-quarter level). Table 1 reports the summary statistics of the total sample as well as for Spirit and non-Spirit routes

separately. We can see that there is a large amount of variations in ticket prices as well as market competition levels (HHI). More than one third of the observations involve subcontracting behavior.

3 Estimation Method

We are interested in exploring the impacts of Spirit airlines' baggage fee policy, in particular, how the policy affects ticket prices. Spirit only operates in a few selected routes (markets) and we would expect the policy to have impact in these routes but not in others. This distinction naturally calls for a difference-in-difference (diff-in-diff) method which we will carry out. However, there are several problems which need to be fixed. Let *Spirit markets* be the markets which Spirit operates in and let *Non-Spirit markets* denote the other markets. The former (latter) is the treated (control) group.

The first problem concerns the treated group. Spirit makes baggage fee policy decision and price decision simultaneously, so the policy is endogenous to Spirit's own prices. To avoid this problem, we analyze the impact of policy on Spirit rivals' prices, not Spirit's own prices. Recall that our treated group includes only routes where Spirit and at least one other airline operate during each of our sample periods. Spirit's baggage fee policy, which applies to all Spirit markets, can be considered exogenous to competing carriers in any given Spirit market, as is commonly assumed in the literature (See, for example, Prince and Simon (2017)). Under this assumption, our treated group includes all carriers except Spirit in markets which Spirit operates.

The second problem concerns the comparability of the treated and control group. Spirit likely enters into routes selectively, implying that Spirit markets and non-Spirit markets may have systematic differences.[13] This difference may violate the common trend assumption which is critical for diff-in-diff estimation. To fix this problem, we do not use the whole control group, but rather construct a subsample of routes in the control group that best mimic the treated group. Since the selection (matching) is done at the route-level, we employ route level variables for matching, using data in the last quarter before Spirit's baggage fee policy change. These variables include distance, smaller and larger population of the two end cities, HHI, each of the top 3 carriers' market shares, passenger number, enplanement, a low-cost carrier dummy indicating whether a low-cost carrier operates on the route, and average fare. For each route in the treated group, we select top 5 routes in the control group with the minimal *metric distances* on these vector of variables. In particular, let $(v_1, \cdots, v_N)$ denote the N variables used for matching. We first calculate the sample variance of each variable (v_n) across routes in the treated group: var_n^T. Then, for any pair of routes consisting of route m in the treated group and route k in the control group, we calculate the metric distance: $MD_{mk} = \sqrt{\sum_{n=1}^{N} \frac{(v_{nm}^T - v_{nk}^C)^2}{var_n^T}}$. For each route in the treated group, we pick the 5 routes in the

[13] This can also be seen in Table 1 by comparing the summary stats for Spirit markets and Non-Spirit markets respectively.

control group with the smallest metric distance. We then combine all the matched routes and drop repetitions in the event that a route in the control group may be in the top 5 matches for multiple routes in the treated group.

To illustrate the outcome of matching, we report the mean of these matching variables for the treated, control and matched group respectively in Table 2. By design, the matched group would match better with the treated group, which can be seen from the table.

Diff-in-diff

As is common in diff-in-diff analysis, we introduce two dummy variables: $SptMkt_j$ and $Policy_t$. $SptMkt_j = 1$ if and only if the observation is in the treated group (both before and after treatment). $Policy_t = 1$ if and only if the time period is after treatment (both treated and control group). We then construct the interaction term, $SptMkt_j \times Policy_t$ and use it as an explanatory variable. The econometric model we estimate is,

$$Y_{ijt} = \alpha_0 + \alpha_1 \times SptMkt_j \times Policy_t + \delta X_{ijt} + \gamma_{ij} + \theta_t + \varepsilon_{ijt}, \quad (1)$$

where γ_{ij} and θ_t capture carrier-route and time fixed effects respectively, and X_{ijt} include route level and carrier-route level controls such as HHI, $Merger$ dummies etc. Because we control for time and route-carrier fixed effects, the stand-alone $Policy_t$ and $SptMkt_j$ are absorbed so only its interaction term shows up in the right hand side of the equation.

Several measures of fares are used as dependent variable Y_{ijt}. The baseline is the log of average fare. We also consider different parts of the fare distribution, in particular, log of the 20_{th}, 50_{th}, and 80_{th} percentile prices. While using log of fares helps us interpret the estimates as percentage changes, we also use average fare (i.e., without taking the log) as dependent variable and the corresponding estimate suggests level changes (as opposed to percentage changes) in prices. Our focus is on the interaction term which captures the diff-in-diff estimate.

Triple difference

In addition to the average treatment effect, we are interested in whether and how the treatment effect varies across carriers. In particular, we want to investigate where carriers which subcontract operations respond differently from carriers which do not subcontract. Often times a (major) carrier may sell tickets to travelers while the actual flights are operated by another carrier. We are not considering code-sharing between major airlines. Rather, we focus on the case where a major airline subcontracts the flight operations to a regional carrier on a route.

We define a variable $Subcontracting_{ij}$ (for carrier i at route j) which takes value 1 if carrier i subcontracts its operations to a regional carrier on route j for over 25% of all its pre-treatment periods (before Spirit's baggage fee policy). Note that subcontracting status is defined at the ij level, because it is possible that some major carriers subcontract while others do not on the same route. Moreover, subcontracting status does not vary with t, because we take a holistic view

and define it by *aggregating* over all pre-treatment periods for a given carrier-route combination. If we expect subcontracting carriers to respond differently, it would also indirectly affect the non-subcontracting carriers on the same market. To avoid this contamination, we drop the observations from the non-subcontracting carriers on routes which at least some carriers subcontract. Note that a major carrier may rely a combination of operating its own flights and subcontracting to a regional carrier on the same route.

Price responses have very different implications for the major carriers depending on their subcontracting status. When a major carrier is both the ticketing and operating carrier, it earns all ticket revenue and pays all costs. In contrast, when a major carrier subcontracts its operations to a regional carrier, it enjoys most or all of the ticket revenue, yet pays little to no operation cost beyond the fixed cost it pays to the regional carrier. Since operation cost does not enter into the major carriers' objective function for the most part, subcontracting major carriers have extra incentives to reduce prices when facing lower prices from Spirit, so as to remain competitive and retain their market share in the subcontracted routes. To investigate how a carrier's price response (to Spirit's policy) varies depending on its subcontracting status in a market, we consider the following econometric model,

$$\begin{aligned} Y_{ijt} &= \alpha_0 + \alpha_1 \times SptMkt_j \times Policy_t + \alpha_2 \times Policy_t \times Subcontracting_{ij} \\ &+ \alpha_3 \times SptMkt_j \times Policy_t \times Subcontracting_{ij} + \delta X_{ijt} + \gamma_{ij} + \theta_t + \varepsilon_{ijt}. \end{aligned} \tag{2}$$

Note that the stand-alone terms of $Policy_t$, $SptMkt_j$, $Subcontracting_{ij}$ and $SptMkt_j \times Subcontracting_{ij}$ are absorbed by the time and carrier-route fixed effects respectively. Our variable of interest is the triple interaction term $SptMkt \times Policy \times Subcontracting$. Similar to Diff-in-diff, we use several measures of fares (average vs. percentile; with and without taking log).

4 Estimating the effects of Spirit's carry-on baggage fee

A key assumption for diff-in-diff estimation to be valid is that the treated and control group have common trend pre-treatment. We thus test for common trend using the treated group and matched group. The results are reported in Table 3. Coefficient for the interaction term $SptMkt_j \times TimeTrend$ is insignificant in all models, suggesting that the two groups have common trend.

4.1 Effect on Spirit's own ticket prices

Charging a fee for carry-on baggage is a form of unbundling. It is intuitive that Spirit's base ticket price will go down but the inclusive ticket price (including carry-on baggage fee) will go up after the policy change.[14] To see whether this is the case, we compare Spirit's own prices before and

[14]Brueckner et al. (2015) provides evidence that price unbundling decreases the carrier's own ticket price but increases the full price for passengers bringing a checked baggage.

after policy change, using the following econometric model.

$$Y_{jt} = \alpha_0 + \alpha_1 \times Policy_t + \delta X_{ijt} + \lambda_j + u_{jt} \quad (3)$$

Our variable of interest is $Policy_t$, which captures the change of Spirit's prices before and after the policy. We do not claim this as a causal effect because the policy is endogenous to Spirit's own prices. Moreover, we cannot control for time fixed effects. The results are presented in Table 4. We can see that Spirit's own prices experience a reduction, which is marginally significant at the 20- and 50-percentiles. From column (5), we can see that the basic fare goes down by about \$4.5 (insignificant). Adding the carry-on baggage fee (say \$20), however, the all-inclusive ticket price will go up, consistent with our intuition and with empirical findings in Brueckner et al. (2015).

4.2 Effect on Spirit rivals' ticket prices

Before we run regressions using the econometric model in (1), we first present some simple evidence to illustrate the policy impact on Spirit rivals' prices. Figure 1 plots the prices at two markets in our sample: a Spirit market (from Detroit to Orlando) and a Non-Spirit market (from Buffalo to Orlando). The vertical line illustrates when Spirit starts charging carry-on baggage fee. This baggage fee policy became effective on August 1, 2010, covering 2 out of 3 months for the 3rd quarter of 2010. From the figure, we can see that the two markets generally follow the same trend pre-treatment. However, immediately after the policy change, the two markets diverge: the non-Spirit market sees a price increase while the Spirit market experiences a significant price drop. This figure provides a preliminary evidence that Spirit's carry-on baggage fee policy has a negative impact on its rivals' ticket prices. Next, we rely on more rigorous econometric methods to combine all markets and also control for covariates.

We first control for mergers involving major airlines during our sample periods: Delta-Northwest, Southwest-AirTran and United-Continental. Figure 2 provides the timeline of these mergers. One concern is that our estimation may be biased by mergers.[15] To disentangle the impact of Spirit's baggage fee policy from the potential merger effects, we include a set of merger dummy variables for each of the 3 mergers.[16] Using merger dummies also introduces a complication. Because merging carriers make merger and pricing decisions simultaneously, mergers must be endogenous to merging carriers' ticket prices. To avoid this endogeneity problem, we drop observations of merging carriers during the merger process (i.e., merger has started but not finished). We believe, however, that mergers are exogenous to non-merging carriers on a specific route. Merging decisions are made at the carrier level, so they should not be affected by factors that determine prices at a specific route.

The diff-in-diff estimation results are presented in Table 5. We can see that after Spirit adopts carry-on baggage fee, its rivals reduce their prices by about 5.8%. If we use average price rather

[15] See Kim and Singal (1993) for more detailed discussions.

[16] More details about the merger dummies are provided in the Appendix.

than the log, then price goes down by $10 after the policy change. Moving onto different parts of the price distribution, the results are similar. Baggage fee policy has the largest impact on the 50-percentile – rivals' median prices go down by about 6.9%. The impact is slightly smaller in magnitude and marginally significant (at 10% level) for the 80-percentile prices. We also include HHI in regressions, and construct IVs to deal with the endogeneity of HHI.[17] However, the estimate for HHI is insignificant.[18]

4.3 Heterogeneous responses to policy by Spirit's rivals

We have shown that carriers adjust different points on their price distributions somewhat differently. But do different carriers respond to Spirit's baggage fee policy differently? In this section, we focus on whether the price response varies across one specific carrier characteristic, namely, subcontracting status.

Note that on routes where some major carriers subcontract to regional carriers, there may be other major carriers on the same route which do not subcontract. These non-subcontracting major carriers are indirectly affected by subcontracting status. We remove non-subcontracting carriers on routes where some major carriers subcontract. Therefore, observations for non-subcontracting major carriers all come from routes where no major carrier subcontracts. Table 6 presents the summary stats for subcontracting and non-subcontracting carriers respectively. On average, carriers are more likely to subcontract on routes with shorter distance, fewer passengers, lower ticket prices and slightly less concentration.[19] The regression results are presented in Table 7. We focus on the triple interaction term.

Relative to carriers on routes where no major carrier subcontracts, carriers which subcontract reduce their average prices down by about 10.6%. The impact is particularly strong and significant for median prices – the differential price reduction for subcontracting carriers goes up to 16.5% (significant at 1% level). The median fares for subcontracting and non-subcontracting carriers are around $150 so a 16.5% reduction is about $25. To put this amount into perspective, Spirit charges $20-$45 for carry-on baggage fees in 2010. This is also in line with the result in model (5) which

[17] Most of our IVs are similar to those used in the literature (e.g., Gerardi and Shapiro (2009)). These IVs all pass under-identification test, weak identification test and over-identification test.

[18] This is the case in most of our regressions. The culprit is likely insufficient variation in HHI in the treated and matched group. For example, for the treated group, we restrict that Spirit and at least one other airline operates during each sample period. This limits the HHI variation across time on any given Spirit market, which is what matters since we control for route fixed effects. The matching process looks for comparable routes to form the matched group. Together there is no enough variation across time in both treated and matched groups. The standard deviation of HHI is about 0.21 in the whole sample (including routes not in the treated and matched group), but goes down drastically to 0.10 and 0.12 in the treated group and matched group respectively.

[19] We also divide subcontracting and non-subcontracting markets further depending on whether Spirit operates in that market. The comparisons between subcontracting and non-subcontracting carriers are similar for Spirit markets, Non-Spirit markets and all markets.

suggests that subcontracting status leads to a $22 reduction as response to Spirit's baggage fee policy. Note that after controlling for subcontracting status, price reduction for non-subcontracting carriers (i.e., on routes with no subcontracting) becomes smaller and the estimates become mostly insignificant. This suggests that much of the price reduction found in Table 5 mainly comes from routes where major carriers subcontract their operations to regional carriers.

4.4 Discussions

Previously we have shown that Spirit's rivals reduce their prices after Spirit charges baggage fee. Moreover, price reduction is larger when the major airline subcontracts its operations to regional carriers. Let us first see why Spirit's rivals reduce prices after the policy change.

Spirit reduces its basic ticket prices after charging carry-on baggage fee, because the cost of serving passengers without carry-on bags is lower, and because lower basic fare attracts more passengers which in turn generates more opportunities to profit from add-on prices. Price unbundling gives consumers more flexibility when flying with Spirit since they can choose between lower basic fare without carry-on baggage or higher inclusive fare with carry-on baggage. The lower basic fare, together with the option of paying a fee for carry-on baggage, forces Spirit's rivals' to lower their prices to stay competitive with Spirit.

But why is the price reduction larger for subcontracting carrier-routes? When Spirit reduces its basic fare after the baggage fee policy, major airlines have different incentives to respond depending on their subcontracting status on the routes where they compete with Spirit. If the major carrier operates its own flights on a route, it pays all the cost and earns all the revenue. In contrast, if it subcontracts to a regional carrier, say through a fixed payment contract, the major carrier takes all ticket revenue (after paying the regional carrier a fixed amount), but usually pays little to no operation cost. When Spirit charges carry-on baggage fee, basic fares go down but all-inclusive fares (including baggage fee) go up. Passengers with carry-on baggage will now find major carriers more attractive (no carrry-on baggage fee), yet passengers without carry-on baggage fee will find Spirit more attractive (lower basic fares go). The subsequent passenger reallocation thus raises major carriers' cost. Major carriers take higher cost into account and charge higher fares only when they do not subcontract. Thus, the price reduction must be larger for subcontracting major carriers.

5 Robustness checks

In this section, we perform several robustness checks.

We start with falsification tests to better illustrate that our econometric specification properly controls for factors other than Spirit's baggage fee policy. That is, we construct settings where similar factors exist but there is no true policy change, and show that the fake policy change has no significant impacts.

Fake treatment group

We first drop the observations of Spirit markets. Next, we randomly pick markets among Non-spirit markets and assign them to the treated group (and subject to Spirit's baggage fee policy). That is, we assign $Fake\_SptMkt_j = 1$ randomly to some non-Spirit markets. $Policy_t$ is coded the same way as before. The results are presented in Table 8. The top panel is for diff-in-diff and we can see that the interaction term is insignificant in all models, suggesting no true impact. This is expected because no market in the group actually receives the treatment of baggage fee policy. Similarly, in the bottom panel, the triple interaction terms are all insignificant as well.

Fake treatment time

We assume that Spirit adopted its baggage fee policy at a different time period. To avoid the impact of the actual policy, we only include data from pre-treatment periods, i.e., before the actual policy was adopted. The pre-treatment data has 6 periods, and we select the middle to be when the fake policy starts. That is, there are 3 periods each before and after the fake policy. We define a new variable $FakePolicy_t$ which takes value 0 for the first 3 periods and 1 for the last 3 periods. We then run regressions with the same specification of Table 5 except $Policy_t$ is replaced by $FakePolicy_t$. The results are presented in Table 9. The interaction term in the top panel and the triple interaction term in the bottom panel are all insignificant, suggesting that the fake treatment has no real impacts.

Alternative comparison groups

Our diff-in-diff and triple difference regressions are run using the treated group and the matched group. The matched group is constructed to best mimic the treated group using a vector of route characteristics. One may be concerned that the specific choice of our matched group is the driving force behind our results. To alleviate such concerns, we use two different comparison groups and show that the main results continue to hold.

First, we construct a different matched group. While it is unclear to us what criteria Spirit relies on when deciding which market to enter, Spirit itself is endowed with such information and is likely to use it to guide future entry decisions as well. Taking advantage of this observation, we construct the first alternative comparison group as consisting of routes which Spirit entered after our sample period ended in 2011. There is a little tweak though. Entry into a new market takes time, and preparation may have started long before actual entry. If so, incumbent carriers may respond to Spirit's entry preparations. Taking this into account, we drop year 2012-2013 and select the routes which Spirit entered in 2014-2015. Using these routes as the comparison group, we then re-run the regressions. The results are qualitatively the same (see Table 10), except that the magnitude of the coefficients go down slightly. These trends continue when we use the whole control group, which is our second alternative comparison group (see Table 11).

6 Conclusion

In this paper, we analyze the impacts of Spirit's carry-on baggage fee policy on its rivals' prices. Our results suggest that Spirit's rivals reduce their prices significantly in response to its carry-on baggage fee. Linking price response to the rival airlines' subcontracting status, we find that the price reduction is significantly larger for Spirit's rivals which subcontract their operations to regional airlines. Due to the nature of the subcontracting contracts, regional carriers endure significant risk when demand or supply shocks affects their operation costs, yet the major carriers do not pay for the operation costs and thus do not necessarily take operation costs into account when adjusting their prices in response to these shocks.

There are several extensions which we want to explore in future research. First, we would like to run additional analysis that helps illustrate the mechanism and intuitions behind the patterns of price responses observed in the data. Second, there are routes where some major carriers subcontract but other major carriers do not. Our current treatment is to drop these non-subcontracting major carriers on subcontracting routes. One may argue that a better comparison is exactly such routes, by comparing subcontracting and non-subcontracting carriers on the same routes. This would be an interesting direction.

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Appendices

A Data Filter

We discuss how we construct our sample in this appendix. The main data set we use is the Airline Origin and Destination Survey (DB1B) data, a 10% quarterly sample of airline tickets sold to passengers. It contains three different data sets: *Coupon* data, *Market* data, and *Ticket* data, and we use variables from all three data sets. *Ticket* data is at the itinerary level, and we use the variables *roundtrip* and *dollarcred* from this data.[20] *roundtrip* indicates whether the itinerary is round trip or one-way, and *dollarcred* indicates whether the ticket price is reliable. We drop observations whose ticket price is unreliable. *Market* data is at the directional market level and is the main data set we use. Variables we use from Market data include year, quarter, origin airport, destination airport, ticketing carrier, operating carrier, passenger numbers, market fare in dollars, market distance in miles, and market geography type. The last variable allows us to identify and use only the tickets of flights within the lower 48 states in the US. *Ticket* data is at the segment level.[21] The variable we use from Ticket data is fare class, which identifies passengers' service class level (e.g., economy class).

[20] If a passenger travels from A to B with a connecting point at C, and then travels back from B to A with a connecting point at D, the whole trip $A \to C \to B \to D \to A$ is an itinerary. An itinerary can be one-way or round trip, and can include non-stop flights and/or connecting flights.

[21] Segments are routes, which compose a market. A segment can be a part of a market or a market itself. For example, the itinerary $A \to C \to B \to D \to A$ contains four segments.

We only use tickets of non-stop flights according to our market definition: directional non-stop route. It includes one-way non-stop flights and roundtrip flights with both way non-stop. For major ticketing carriers, we only use tickets of economy class. We do so because Spirit Airlines is an Ultra-Low-Cost Carrier, and mainly competes with major carriers for their economy class passengers. Following the literature, we drop all tickets with prices less than $10, which are generally considered as frequent-flyer tickets. We also drop the tickets with highest 2% prices for a ticketing carrier on a route in a quarter for concern of coding error when the data were entered. Subcontracting occurs when a major carrier subcontracts its service to a regional carrier. For each carrier-route-quarter (ijt), we observe whether the carrier subcontracts its service. We then construct a variable $Subcontracting_{ij}$ (at the carrier-route level) which takes value 1 if carrier i subcontracts its operations to a regional carrier on route j for over 25% of all its pre-treatment periods (before Spirit charges for carry-on baggage). Note that a major carrier may also have its own subsidiary operating the flights. We do not consider this case as subcontracting, because the major and regional carriers in this case have the same owner. In the end we aggregate the data to carrier-route-quarter level, and calculate average, 20 percentile, 50 percentile, and 80 percentile ticket prices, and passenger numbers. From passenger numbers, we calculate market share for each carrier on a route in a quarter, and then HHI as well.

After aggregating the data, we drop the observation (carrier-route-quarter cell) if its passenger number is smaller than 5. As we are more interested in the response of large ticketing carriers, we drop all small or regional ticketing carriers. In our treatment group there must be at least one carrier competing with Spirit so that we can tell the competing carriers' response to Spirit's policy change, so in our control group it is not appropriate to have some routes where a monopolist serves without any competition. As a result, we eliminate all the routes whose HHI is equal to 1 in the quarter. Alaska Airline and Virgin American began to charge $15 first checked baggage fee on July 7th and May 5th separately, which are in the middle of our sample periods. So we eliminate all the routes in which Alaska and Virgin American operate to avoid complication to our identification. We then merge Metropolitan and Micropolitan statistical areas population estimation data into our main data set. Some airports need to be matched manually to the corresponding metropolitan or micropolitan statistical areas. Matching between the MSA data and the DB1B data is imperfect – a few small airports cannot be matched and have to be dropped from the sample.

Last, we discuss how enplanement is approximated in this paper. Instead of obtaining enplanement information from T-100 segment data, we approximate it from DB1B Coupon data. By aggregating passenger numbers of each segment in each quarter, we can get how many passengers each ticketing carrier delivers from one airport directly to another airport. This number is no smaller than the passenger number in each market we derived above, because these two airports are not necessarily passengers' origin airport or destination airport in Coupon data, and the segment can be one of the passengers' connecting flights. This is exactly what we need as enplanement, the only difference is that the enplanement from Coupon data is a 10% survey instead of the actual

enplanement.

B Merger Dummies

The following merger dummies are defined at the route level, and thus route specific.

$Merged$ is equal to 1 if two carriers finish merging in the quarter on the route, and equal to 0 otherwise.

$Merged\_Lead_n$ is equal to 1 in the nth quarter before two carriers finish merging on the route, and equal to 0 otherwise.

$Merged\_Lag_n$ is equal to 1 in the nth quarter after two carriers finish merging on the route, and equal to 0 otherwise.

For the variables above, we divide the routes into 4 groups as follows:

- Both merging carriers operate before but one operates after the merger.
- Both merging carriers operate before but none operates after the merger.
- Only one merging carrier operates before and one operates after the merger.
- Only one merging carrier operates before but none operates after the merger.

$MgrAnn$ is equal to 1 in the quarter when two carriers announce their merger decisions on the route where at least one of them operate.

$Merger$ is equal to 1 in the quarter when the merger is approved and two carriers begin to merge and on the route where at least one of them operate.

$MgrAnn\_Leads$, $MgrAnn\_Lags$, and $Merger\_Lags$ are defined in the same way as $Merged\_Leads$ and $Merged\_Lags$.

For the variables above, we also divide them into 2 groups:

- the route where both merging carriers operate.
- the route where only one merging carrier operates.

C Instrumental Variables for HHI

We have 7 IVs in total. Six of them are used and described in Gerardi and Shapiro (2009):

$lndis_j$: The logarithm of nonstop distance in miles between endpoint airports.

$ameanpop_{jt}$: The arithmetic mean of the metropolitan and micropolitan population[22] of endpoint cities in each year.

$gmeanpop_{jt}$: The geometric mean of the metropolitan and micropolitan population of endpoint cities in each year.

$lnpassrte_{jt}$: The logarithm of total enplanement on route j in period t.[23]

$GENSP$: $\sqrt{ENP_{j1}} * \sqrt{ENP_{j2}} / \sum \sqrt{ENP_{k1} * ENP_{k2}}$, where k indexes all carriers, j is the observed carrier, and ENP_{k1} and ENP_{k2} are carrier k's average quarterly enplanements at the two endpoint airports.

$IRUTHERF$: $\hat{MKTSHARE}_{ijt}^2 + \frac{HHI_{jt} - MKTSHARE_{ijt}^2}{(1 - MKTSHARE_{ijt})^2} * (1 - \hat{MKTSHARE}_{ijt})^2$. $\hat{MKTSHARE}_{ijt}$ is the fitted value for $MKTSHARE_{ijt}$ from its first-stage regression.

Besides theirs, another IV we use is $Other\_Enplanement$: $\sqrt{(\sum TENP_{kj1} - TENP_{ij1}) * (\sum TENP_{kj2} - TENP_{ij2})}$, where k indexes all carriers, i is the observed carrier, and j indexes route. $TENP_{kj1}$ and $TENP_{kj2}$ are carrier k's total quarterly enplanements at the two endpoint airports.

[22] Gerardi and Shapiro (2009) use 2000 census data. We use annual population estimation.

[23] Gerardi and Shapiro (2009) drop the observations that ticketing carrier is not the same as operating carrier from DB1B data when they match DB1B with T-100 Data which provides enplanement. In order to avoid droping observations, we use DB1B Coupon data to approximate enplanement rather than using T-100 data. So the enplanement numbers across markets in our paper are a little different from those in their paper. Please see Section 2 Data and Variable, and Appendix A for more details.

Table 1: Summary Statistics

	Observations	Mean	SD	Min	Max
SpiritMkt (Treated Group)					
Distance	1129	955.903	377.904	177.000	1750.000
Carrier Passenger number	1129	1803.625	1671.358	5.000	7363.000
Market Passenger number	1129	6136.777	3546.539	280.000	16325.000
Carrier Enplanement	1129	2808.235	3096.555	5.000	17545.000
Carrier Average Ticket Price	1129	149.785	50.369	44.347	355.115
Carrier 20 Percentile Ticket Price	1129	94.853	30.547	20.500	201.490
Carrier 50 Percentile Ticket Price	1129	136.830	42.954	42.000	324.750
Carrier 80 Percentile Ticket Price	1129	199.277	75.019	45.000	684.060
Herfindahl-Hirschman Index (HHI)	1129	0.479	0.105	0.250	0.791
Outsourcing	1129	0.070	0.255	0.000	1.000
NonSpiritMkt (Control Group)					
Distance	30702	919.635	553.086	73.000	2565.000
Carrier Passenger number	30702	920.548	1109.680	5.000	9440.000
Market Passenger number	30702	2781.327	2369.200	8.000	15701.000
Carrier Enplanement	30702	2218.402	2453.238	5.000	20701.000
Carrier Average Ticket Price	30702	196.915	65.128	19.510	699.737
Carrier 20 Percentile Ticket Price	30702	127.341	39.934	10.010	581.030
Carrier 50 Percentile Ticket Price	30702	175.587	56.584	19.510	742.940
Carrier 80 Percentile Ticket Price	30702	263.657	101.981	19.510	1314.590
Herfindahl-Hirschman Index (HHI)	30702	0.563	0.177	0.205	0.999
Outsourcing	30702	0.347	0.476	0.000	1.000
All Routes					
Distance	31831	920.921	547.869	73.000	2565.000
Carrier Passenger number	31831	951.869	1146.030	5.000	9440.000
Market Passenger number	31831	2900.340	2498.989	8.000	16325.000
Carrier Enplanement	31831	2239.323	2481.252	5.000	20701.000
Carrier Average Ticket Price	31831	195.243	65.246	19.510	699.737
Carrier 20 Percentile Ticket Price	31831	126.189	40.092	10.010	581.030
Carrier 50 Percentile Ticket Price	31831	174.212	56.612	19.510	742.940
Carrier 80 Percentile Ticket Price	31831	261.373	101.845	19.510	1314.590
Herfindahl-Hirschman Index (HHI)	31831	0.560	0.175	0.205	0.999
Outsourcing	31831	0.337	0.473	0.000	1.000

Notes: The variables are summarized at route-carrier-quarter level for the sample of the treated and the whole control groups.

Table 2: Summary Stats (Mean) by Groups

	Treated Group	Control Group	Matched Group
HHI	0.478	0.600	0.464
Top1Share	0.580	0.687	0.552
Top2Share	0.320	0.264	0.323
Top3Share	0.084	0.044	0.111
Passengers	5498.583	2463.306	4379.218
Enplanement	8714.622	5875.356	9063.577
LCC	0.533	0.594	0.603
AvgFare	141.901	189.660	164.865
SmallPop	3.234	2.316	2.871
LargePop	7.520	7.337	6.507
Distance	900.600	887.764	791.641
Observations	180	5718	468

Notes: The variables are summarized at route-quarter level for the periods before Spirit's baggage fee.

Table 3: Common Trend Test

	(1)	(2)	(3)	(4)	(5)
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
$TimeTrend$	0.0305***	0.0357***	0.0329***	0.0332***	4.979***
	(0.00660)	(0.00629)	(0.00701)	(0.00832)	(1.153)
$SptMkt \times TimeTrend$	0.00527	-0.000435	0.00951	0.00880	0.286
	(0.00901)	(0.00713)	(0.00769)	(0.0111)	(1.702)
Observations	1450	1450	1450	1450	1450
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	104	104	104	104	104

Standard error in parentheses is robust and clusted at route level.

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

Notes: Results are from the sample of the treated and the variable matched groups in the periods before Spirit's baggage fee. Additional controls include merger dummies. Merging carriers are dropped during their merging process. IV are used for HHI. IV tests are passed.

Table 4: Change in Spirit's Own Prices before and after the Policy

	(1)	(2)	(3)	(4)	(5)
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	-0.107	0.0241	-0.188	-0.145	-21.97*
	(0.145)	(0.191)	(0.143)	(0.111)	(11.90)
$Policy$	-0.0392	-0.0883**	-0.0648**	-0.0441	-4.468
	(0.0342)	(0.0387)	(0.0304)	(0.0313)	(3.427)
Observations	360	360	360	360	360
Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	30	30	30	30	30

Standard error in parentheses is robust and clusted at route level.

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

Notes: Results are from the sample of Spirit Airline itself. Additional controls include merger dummies.

Table 5: Effects of Spirit's Policy on Competing Carriers' Price Distribution

	(1)	(2)	(3)	(4)	(5)
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	-0.323	-0.393	-0.257	-0.352	-50.52
	(0.292)	(0.275)	(0.291)	(0.342)	(42.83)
$SptMkt \times Policy$	-0.0575**	-0.0542**	-0.0692***	-0.0603*	-10.07**
	(0.0247)	(0.0267)	(0.0260)	(0.0310)	(4.732)
Observations	2520	2520	2520	2520	2520
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	108	108	108	108	108

Standard error in parentheses is robust and clusted at route level.

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

Notes: Results are from the sample of the treated and the variable matched groups. Additional controls include merger dummies. Merging carriers are dropped during their merging process. IV are used for HHI. IV tests are passed.

Table 6: Summary Statistics (Mean): NonSubcontracting v.s. Subcontracting

	NonSubcontracting Routes	Subcontracting Routes
j level		
Distance	1151.849	635.257
jt level		
Herfindahl-Hirschman Index (HHI)	0.464	0.446
Market Passenger number	5774.646	4569.844
ijt level		
Carrier Passenger number	1639.671	1342.061
Carrier Enplanement	2601.516	3501.806
Carrier Average Ticket Price	180.185	166.231
Carrier 20 Percentile Ticket Price	120.035	106.400
Carrier 50 Percentile Ticket Price	164.889	150.165
Carrier 80 Percentile Ticket Price	235.839	223.876
Observations	953	903

Notes: The variables are summarized at route-carrier-quarter level for the sample of treated and variable matched groups. On routes where some carriers subcontract, carriers which do not subcontract are dropped. However, a subcontracting carrier may also operate its own flights on the same route. Due to aggregated nature of ticket price data, tickets from major carriers' own flights and those from subcontracting flights are grouped together.

Table 7: Effects of Spirit's Policy on Competing Carriers' Prices
and Subcontracting Carriers' Differential Response

	(1)	(2)	(3)	(4)	(5)
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	-0.287	-0.246	-0.113	-0.132	-38.67
	(0.322)	(0.310)	(0.279)	(0.367)	(49.39)
$SptMkt \times Policy$	-0.0442*	-0.0471	-0.0345	-0.0266	-6.736
	(0.0265)	(0.0307)	(0.0286)	(0.0307)	(4.550)
$Policy \times Subcontracting$	0.0257	0.0186	0.0473**	0.0402*	6.581*
	(0.0201)	(0.0230)	(0.0226)	(0.0234)	(3.889)
$SptMkt \times Policy \times Subcontracting$	-0.106***	-0.101**	-0.165***	-0.138***	-21.97***
	(0.0316)	(0.0449)	(0.0361)	(0.0421)	(5.225)
Observations	1833	1833	1833	1833	1833
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	107	107	107	107	107

Standard error in parentheses is robust and clusted at route level.

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

Notes: Results are from the sample of the treated and the variable matched groups. Nonsubcontracting carriers on subcontracting routes are dropped. Additional controls include merger dummies. Merging carriers are dropped during their merging process. IV are used for HHI. IV tests are passed.

Table 8: Falsification Test: Fake Treatment Markets

	(1)	(2)	(3)	(4)	(5)
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	-0.299	-0.673*	-0.276	-0.230	-38.17
	(0.287)	(0.348)	(0.316)	(0.302)	(39.51)
$Fake\_SptMkt \times Policy$	-0.0219	-0.0201	-0.0198	-0.0178	-5.200
	(0.0194)	(0.0276)	(0.0214)	(0.0211)	(3.303)
Observations	2055	2055	2055	2055	2055
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	78	78	78	78	78
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	-0.0394	-0.455	-0.122	0.0197	-22.22
	(0.315)	(0.429)	(0.337)	(0.323)	(51.71)
$Fake\_SptMkt \times Policy$	0.000963	0.0341	0.00791	-0.0145	0.0547
	(0.0326)	(0.0567)	(0.0347)	(0.0329)	(5.891)
$Policy \times Subcontracting$	0.0451*	0.0499*	0.0629**	0.0471	9.567**
	(0.0240)	(0.0268)	(0.0263)	(0.0294)	(4.767)
$Fake\_SptMkt \times Policy \times Subcontracting$	-0.0512	-0.0912	-0.0495	-0.0278	-8.953
	(0.0391)	(0.0651)	(0.0426)	(0.0435)	(7.258)
Observations	1445	1445	1445	1445	1445
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	78	78	78	78	78

Standard error in parentheses is robust and clusted at route level.

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

Notes:

Results on the top are from the sample of the variable matched group.

Results on the bottom are from the sample of the variable matched group, but nonsubcontracting carriers on subcontracting routes are dropped.

Additional controls include merger dummies. Merging carriers are dropped during their merging process. IV are used for HHI. IV Tests are passed.

Table 9: Falsification Test: Fake Treatment Time

	(1)	(2)	(3)	(4)	(5)
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	-0.584	-0.423	-0.594	-0.487	-107.7
	(0.412)	(0.348)	(0.367)	(0.455)	(73.11)
$SptMkt \times FakePolicy$	0.0141	-0.00601	0.0157	0.0299	0.647
	(0.0239)	(0.0206)	(0.0227)	(0.0289)	(4.351)
Observations	1450	1450	1450	1450	1450
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	104	104	104	104	104
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	-0.858	-0.666	-0.674	-1.460*	-176.4*
	(0.544)	(0.449)	(0.613)	(0.760)	(100.0)
$SptMkt \times FakePolicy$	0.00763	0.0132	0.0215	0.0254	0.379
	(0.0292)	(0.0266)	(0.0256)	(0.0411)	(5.493)
$FakePolicy \times Subcontracting$	0.00952	0.0420	0.0254	0.000736	3.110
	(0.0229)	(0.0264)	(0.0247)	(0.0314)	(4.134)
$SptMkt \times FakePolicy \times Subcontracting$	0.0675	-0.00346	0.0478	0.0570	13.13
	(0.0750)	(0.0571)	(0.0675)	(0.0834)	(13.25)
Observations	1024	1024	1024	1024	1024
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	97	97	97	97	97

Standard error in parentheses is robust and clusted at route level.

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

Notes:

Results on the top are from the sample of the treated and the variable matched groups in the periods before Spirit's baggage fee.

Results on the bottom are from the sample of the treated and the variable matched groups in the periods before Spirit's baggage fee, but nonsubcontracting carriers on subcontracting routes are dropped.

Additional controls include merger dummies. Merging carriers are dropped during their merging process. IV are used for HHI. IV tests are passed.

Table 10: Robustness Check: Future Entry Markets as Control Group

	(1)	(2)	(3)	(4)	(5)
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	-0.259	0.307	-0.143	-0.681	-92.06
	(0.434)	(0.400)	(0.404)	(0.572)	(92.53)
$SptMkt \times Policy$	-0.0506**	-0.0224	-0.0736**	-0.0615*	-8.363
	(0.0246)	(0.0312)	(0.0303)	(0.0342)	(5.136)
Observations	1622	1622	1622	1622	1622
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	92	92	92	92	92
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	-0.178	-0.266	0.0427	-0.167	-16.91
	(0.236)	(0.173)	(0.232)	(0.359)	(53.59)
$SptMkt \times Policy$	-0.0185	0.0179	-0.0288	-0.0192	-5.323
	(0.0264)	(0.0288)	(0.0358)	(0.0344)	(5.850)
$Policy \times Subcontracting$	0.0153	0.0276	0.0335	0.0114	-1.759
	(0.0304)	(0.0316)	(0.0328)	(0.0365)	(6.687)
$SptMkt \times Policy \times Subcontracting$	-0.0746*	-0.0994**	-0.122**	-0.0856	-9.653
	(0.0421)	(0.0450)	(0.0489)	(0.0584)	(8.816)
Observations	1252	1252	1252	1252	1252
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	90	90	90	90	90

Standard error in parentheses is robust and clusted at route level.

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

Notes:

Results on the top are from the sample of the treated and the future matched groups.

Results on the bottom are from the sample of the treated and the future matched groups, but nonsubcontracting carriers on subcontracting routes are dropped.

Additional controls include merger dummies. Merging carriers are dropped during their merging process. IV are used for HHI. IV tests are passed.

Table 11: Robustness Check: Use Whole Control Group

	(1)	(2)	(3)	(4)	(5)
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	0.236**	0.313***	0.225*	0.136	46.39**
	(0.110)	(0.117)	(0.124)	(0.145)	(23.24)
$SptMkt \times Policy$	-0.0287	-0.0323*	-0.0561***	-0.0262	-7.027*
	(0.0222)	(0.0194)	(0.0216)	(0.0287)	(4.235)
Observations	19821	19821	19821	19821	19821
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	983	983	983	983	983
	$LnFare$	$LnFare20$	$LnFare50$	$LnFare80$	$Fare$
HHI	0.280**	0.490***	0.108	0.276*	90.88***
	(0.125)	(0.103)	(0.129)	(0.155)	(20.19)
$SptMkt \times Policy$	-0.0259	-0.0310	-0.0386	-0.0174	-7.253
	(0.0240)	(0.0223)	(0.0252)	(0.0332)	(4.513)
$Policy \times Subcontracting$	-0.00119	-0.0162*	0.0109	0.00644	-2.977
	(0.00842)	(0.00932)	(0.00930)	(0.0101)	(1.927)
$SptMkt \times Policy \times Subcontracting$	-0.0674**	-0.0617**	-0.108***	-0.0897*	-11.08*
	(0.0273)	(0.0296)	(0.0323)	(0.0469)	(6.288)
Observations	14175	14175	14175	14175	14175
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Carrier-Route Fixed Effect	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
# of Clusters	979	979	979	979	979

Standard error in parentheses is robust and clusted at route level.

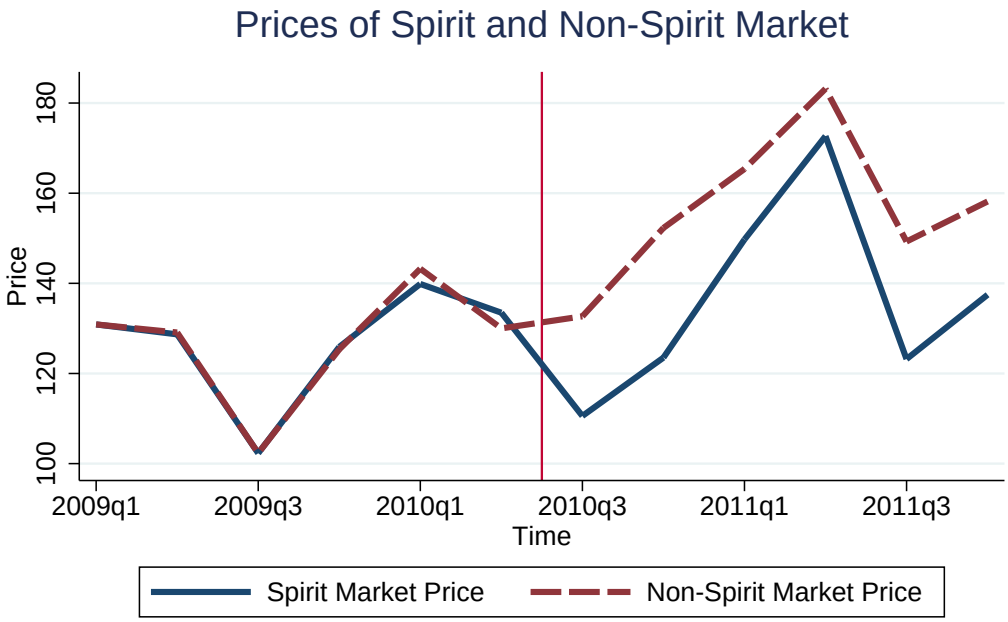
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes:

Results on the top are from the sample of the treated and the whole control groups.

Results on the bottom are from the sample of the treated and the whole control groups, but nonsubcontracting carriers on subcontracting routes are dropped.

Additional controls include merger dummies. Merging carriers are dropped during their merging process. IV are used for HHI. IV tests are passed.



Notes: This graph plots prices of Spirit and Non-Spirit Market before and after the policy.
The vertical line represents the time when Spirit begins to charge carry-on baggage fee.
The Spirit Market is the directional non-stop route from Detroit Airport to Orlando Airport.
The Non-Spirit Market is the directional non-stop route from Buffalo Airpor to Orlando Airport.

Figure 1: Prices of Spirit and Non-Spirit Market

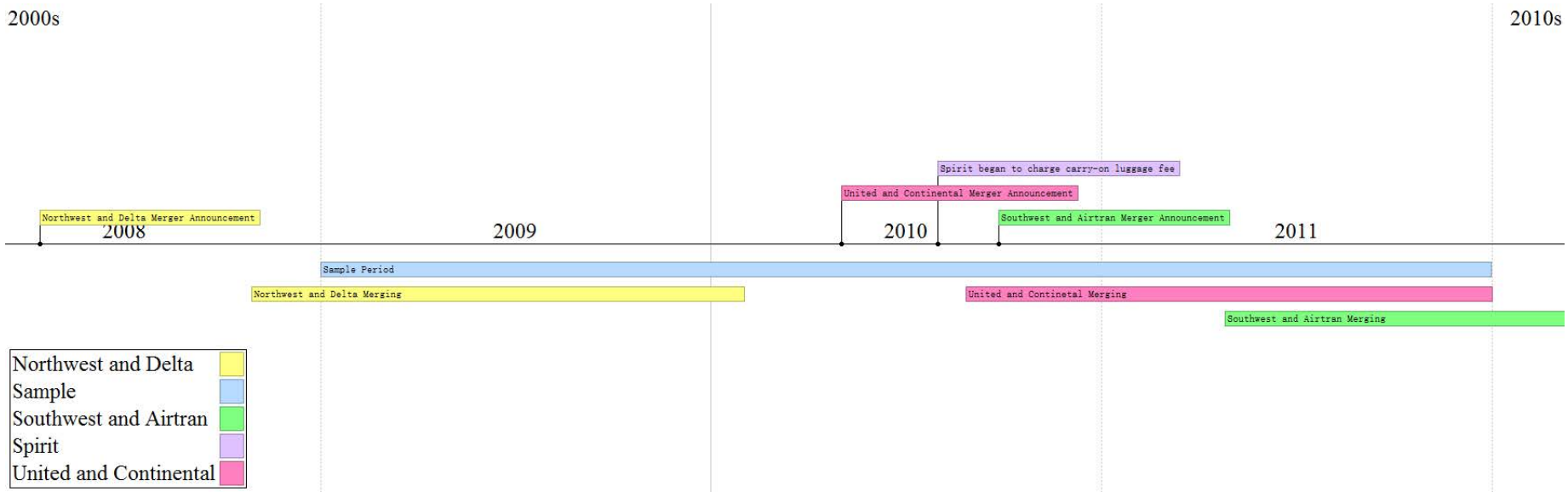


Figure 2: The Timeline of Three Mergers