An empirical investigation of the relationship between interline cooperation and airline fares in the U.S. domestic airline industry

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Abstract:

Interline cooperation is the most basic type of cooperation in the airline industry. Although interline cooperation has limited benefits for producers and customers, this type of cooperation may still result in collusive behavior. In this paper we study the effect of interline cooperation on airline fares by focusing on the cancelled interline agreement between American Airlines and Delta Air Lines. We use a panel data set containing 10,559 unique routes over the period 2013-2017 and apply a difference-in-difference model in order to test whether ticket prices increased due to less competition and increased collusive behavior in the period after the interline cooperation. We add another dimension by dividing our sample in subsamples based on market structure. We do not find statistical evidence that airline fares changed after the cancelled interline agreement. However, we do find evidence that average airline fares increased on affected routes when looking at monopoly markets alone.

1. Introduction

In September 2015 American Airlines and Delta Air Lines, the two largest carriers in the U. S. domestic airline industry, mutually agreed on ending their traditional interline agreement. This agreement allowed the two carriers to sell multi-journey airline tickets with flight segments of their partner, to cooperate on baggage handling, and to re-accommodate disrupted passengers under special circumstances. Interestingly, in January 2018 the interline agreement between the two carriers was partially recovered. This partial recovery indicates that the previous interline agreement was mutually beneficial to a certain extent.

Interline contracts between airlines can benefit customers as the quality of airline service increases. As airlines provide the possibility to transfer passengers on a partner's aircraft in case of urgency the customer may benefit as they can see it as an insurance against time losses due to disruptions at the connecting airport. Airlines benefit as their network scope increases and they are guaranteed of reciprocal assistance when needed. However, interline contracts could be anti-competitive since cooperation may result in collusive behavior between the two interline partners. Extensive literature exists on the relationship between (closer types of) cooperation (i.e., code sharing and alliances) and airline fares. Brueckner and Whalen (2000) tested the impact of code sharing cooperation and concluded that cooperation between airlines has resulted in lower priced airline fares on overlapping routes. Bilotkach (2005) investigated price competition between two alliance partners and found higher priced fares on routes between hubs of both alliance partners.

As most legacy carriers in the U.S. have always been participating in interlining, this type of cooperation has not received much attention in the airline literature. The ending of the interline agreement between American and Delta enables us to contribute empirically to the existing literature by analyzing the impact of interline cooperation on pricing behavior. The ending of interline cooperation between airlines could impact the competitive setting in markets in various ways. For example, as noted by Reitzes and Moss (2008), if the gateway's dependence on connecting passengers is significant and there are few alternative routes available, the ending of cooperation through interlining may result in foreclosure: an increase of market power of the remaining airlines on these routes. However, carriers could decide to enter the interline market themselves by starting to provide direct non-stop flights. Hence, in this study we will try to answer the following research question: to what extent does cooperation through interlining lead to lower priced airline fares and is this potential pricing effect different in highly concentrated markets?

The first hypothesis, as will be further explained in section 3, states that the ending of interline cooperation will lead to higher airline fares. We expect that the ending of interline cooperation leads to fewer flights operated by airlines affected on routes in which airlines are reliant on connecting traffic (i.e., gateway-to gateway markets). We argue that airlines will lose customers as these customers are triggered to fly with other airlines providing one single airline ticket for the multi-journey flight. Thus, the remaining airlines gain market power and collusive behavior might result in higher priced airline fares. The second hypothesis states that the relationship between interline cooperation and higher priced airline fares is stronger in highly concentrated markets. If few carriers dominate a market with relatively many connecting passengers, we believe that the cancellation of interline cooperation may stimulate collusive behavior as competition decreases.

In order to measure the impact of interline cooperation on airline fares we focused on the cancelled interline agreement between American Airlines and Delta Air Lines. Using data from the U.S. Bureau of Transportation Statistics and applying a difference-in-difference fixed effects model, we tested whether airline fares increased in the period after the interline agreement in markets where American and Delta were most likely to be mutually dependent on each other in order to offer interline services, relative to markets in which neither of the two carriers had been operating in the period before the interline agreement was cancelled or markets in which both carriers simultaneously operated on a given route.

In brief, we did not find statistically significant results that airline fares increased in the period after interline cooperation on routes where American and Delta were most likely to be mutually dependent on each other. The non-significant findings indicate that interline cooperation between American and Delta was not crucial in order to be able to reach the final destination. However, when looking at monopoly markets alone, we do find higher airline fares on affected routes in period 2 relative to period 1 and relative to our control group.

This study is a first attempt to enhance our understanding of the competitive effects of interline cooperation. However, more research is needed to increase the external validity of the relationship between interline cooperation and airline fares.

The remainder of this paper is structured as follows. In section 2 we discuss the concept of interlining and the potential competitive effects. We further describe the background of the interline agreement between American and Delta. In section 3 we build towards our hypotheses. In section 4 the data will be explained; including an explanation of the dependent and control variables used in our model. In section 5 we introduce the empirical method used. In section 6 we present the empirical results of our main specifications as well as the robustness checks. In section 7 we discuss alternative strategies of airlines in response of a cancelled interline agreement. In section 8 we explain the limitations of our study and provide recommendations for further research into this topic. Finally, in section 9 we conclude with a brief summary of the main conclusions.

2. Theoretical background

This section is divided into four subsections. In the first subsection we discuss the concept of interlining. In the second and third subsection we discuss the potential pro- and anti- competitive effects of interline cooperation respectively. In the fourth subsection we describe the background of the interline agreement between American and Delta.

2.1 The concept of interlining

Cooperation in the airline industry is necessary to efficiently serve specific markets. Different types of cooperation can be created: interline agreements, code sharing, joint-ventures and alliances. An interline agreement is the most basic type of airline cooperation and allows two or more airlines to cooperate with each other in interline markets. By entering in an interline agreement, carriers accept another carrier's ticket on its own flight. This favors passengers as they are able to fly from airport A to airport C via airport B without having to check in again at the connecting airport. Without an interline agreement, airlines have to pay the full ticket price to transfer a passenger on the non-partner carrier. In general, a basic interline agreement benefit airlines as they have the possibility to (i) sell tickets for multi-journey flights with flight segments of the other airline, (ii) to check baggage through to flights from the other airline at the connecting airport and (iii) to re-accommodate disrupted passengers by transferring them to the other airline for a discounted price (Sneijder, 2015).

The interline concept was established by the International Air Transport Association (IATA) in 1947 with the aim to increase route network across the world and to ensure all revenues were equally split across airlines. To ensure fair tickets prices on all interline routes, special traffic conferences were held. The aim of these conferences was to set airline fares as low as possible in order to maximize consumer surplus. According to Sheehan (1953), as most of the U.S. airlines were involved during these conferences, they perceived the confidence to accept each other's tickets on multi-airline itineraries. And this development engendered the increase of interline services around the world. To participate in traffic conferences, airlines need to become a participant of the Tariff Coordination (TC) commission (IATA, 2018). Members have the possibility to propose and agree on changes in existing interline tariffs via an internet-based voting mechanism.

2.2 Pro-competitive effects

Interline agreements may generate pro-competitive effects. For example, the increase in travel convenience through interlining between airports that are not connected by one single carrier could lead to an increase in demand on a particular route when there are many time-sensitive customers (GRA-Incorporated, 2000). This increase in demand leads to an increase in frequency of service between two airports. The increase in travel could then lead to economies of density as airlines have the ability to utilize larger and more efficient aircrafts. As a consequence, increased flight frequencies and lower operating costs might result in more competition and lower airline fares. Furthermore, Interlining can reduce travel time and schedule delay as passengers can be transferred to a partner's aircraft in case of disruptions (IATA, n.d.).

Prior research has mainly focused on the effects of code sharing and alliance cooperation on airline fares and found that further consolidation, for example via code-sharing or alliances, would be more beneficial to customers in terms of airline fares (Bailey and Liu, 1995). According to Goh and Yong (2006), code sharing cooperation leads to coordination and flight schedule operationalization. They argue that code sharing is more favorable for customers in terms of lower airline fares as the double marginalization problem of the interlining mechanism would not exist. Goh and Yong argue that, compared to interlining, with code sharing firms do not apply their markup twice as there is only a single itinerary. Ito and Lee (2007) examined the impact of domestic code-sharing alliances on airline fares and found that code-share itineraries are priced lower than other ticket prices on the same route. Brueckner and Whalen (2000) found that customers benefit from alliances through lower airline fares due to shared cost and revenue. Overall, from the literature it appears that (closer types of) cooperation in the airline industry lead to lower airline fares.

2.3 Anti-competitive effects

Interline cooperation could also result in anti-competitive behavior. First, as interline fares are established at the IATA conferences, it is important to consider the number of routes and fares discussed and what exact information is exchanged by all participants during these conferences (Nordic competition authorities, 2002). There might be a possibility that airlines tacitly collude. For example, airline managers may share analyses regarding pricing strategies in certain markets which can distort competition in a market. Thus, airlines might be able to increase airline fares by coordinating interline fares during these conferences.

Second, as discussed by Peterman (2014), network coordination might create incentives to reduce the frequency of flights in order to increase profit margin for both airlines. According to Peterman, coordination involves conduct that is profitable for both carriers a result of the accommodating reaction of the other. When relating this theory to interlining, we would argue that both airlines simultaneously benefit from interlining. For example, when airline 1 provides services between airports AB and airline 2 flies between airports BC, the proposed network coordination between the partner airlines would on the one hand increase network scope for airline 1 and on the other hand increase passenger demand for airline 2. Furthermore, the interline contract allows airlines to transfer stranded passengers from cancelled flights onto the aircraft of the partner. I.e., airline 1 will gain customer trust as the airline takes effort in ensuring that all passengers reach their final destination and airline 2 will benefit as they potentially have an increased pool of passengers on its aircraft. As both airlines can take advantage of interlining, we argue that cooperative behavior among firms could lead to collusion. Lower flight frequency and less competitive incentives could lead to higher airline fares on interline routes.

Finally, an interline agreement could increase multimarket contact between interline partners. When an airline is active in more markets, it is likely that the airline has 'multimarket contact' (MMC) with a competitor. MMC means that an airline and one or more of its competitors encounter each other in more than one origin destination market. Previous studies have suggested and researched that an increase in MMC may lead to mutual forbearance (MF). MF means less intense competition in the markets where airlines encounter competitors with MMC, which is a result of fear of retaliation. A firm with MMC will not 'attack' (fare decrease or quality investment) its competitor in one market because the firm fears it will be 'attacked' in other markets where the firm encounters this competitor. According to Evans and Kessides (1994), an increase in multimarket contact between carriers reduces competition between them. When two firms enter into an interline agreement, the multimarket contact theory implies that both firms could have increased multimarket contact (as they can increase their network scope via interlining) and this increase in multimarket contact can consequently reduce competition. Hence, the ending of the interline cooperation would imply that firms are less reliant on each other and they might therefore increase competition by for example, entering the competitor's market by starting to offer non-stop direct services in order to serve the full interline route AC. Intuitively, it is less likely that a cancellation of interline cooperation will result in more 'attacks' from the competitor in interline markets as interlining is likely to result from the fact that it is economically non-beneficial to operate part of the interline route themselves. On the other hand, less cooperation means that carriers are less reliant on each other and this might lead in more aggressive behavior on all routes in general.

2.4 Delta/American interline agreement background

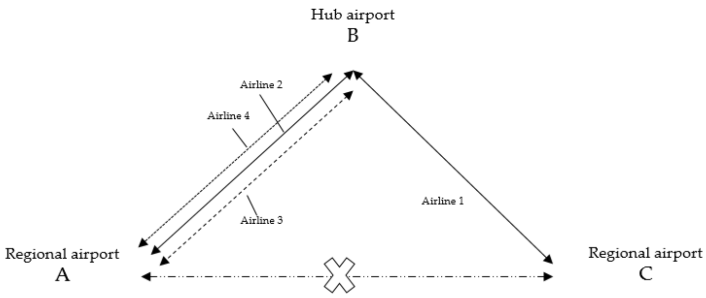
On September 15, 2015, American and Delta mutually agreed on ending their interline cooperation. To the extent of our knowledge, this is the first interline agreement cancellation by major legacy airlines in U.S. history. Prior to the cancellation, the two carriers were involved in a contract dispute. Delta argued that it did not benefit from the current interline deal as it was convinced that their on-time performance was the best among all carriers. Therefore, they wanted American to pay more money for each interline customer. American refused to pay a higher price and thus the interline contract ended (Bachman, 2015). From 2015 onwards, several major problems emerged at airport hubs from both Delta and American. In August 2016, a five-day meltdown across Delta's flight network in Atlanta affected the airline's worldwide reservations systems and forced huge cancellation and delays (Dastin et al., 2016). In January 2017, Delta suffered again from a major IT problem at Delta's hub airport in Atlanta (Duchon, 2017). During these major events, Delta was not able to transfer stranded passengers onto a flight from American. Two and a half years after the ending of the agreement, on January 24, 2018, the interline agreement between Delta and American was partially restored (Josephs, 2018). The new agreement involved irregular operations ticketing and a baggage re-accommodation agreement at a negotiated rate. The carriers did not restore their fare combinability agreement, which allows to sell multi-journey airline tickets with flight segments of their partner. The partial recovery of the interline agreement could imply that having the option to rebook passengers in the event of unexpected flight disruptions is crucial. However, the fact that both carriers did not restore their fare combinability agreement might indicate that cooperation through offering flight segments of both partners was not particularly crucial. On the other hand, it might also have been relatively easy to find other partners to cooperate through interline.

3. Hypotheses

Airlines can be competitors in one market and partners in another market at the same time. As explained by Fones (2015), when two airlines both offer non-stop services on a route, they are direct competitors. When those airlines cooperate through interlining the same connecting passenger from airport A to airport C, they assist each other to increase traffic on route AC. In large hub-to-hub markets, legacy carriers are competing directly with each other. As there is high frequency of flights on those routes, the most time-sensitive customer would be attracted to travel. Interline agreements would thus not be beneficial on those routes. However, interline agreements are considered to be more important when airlines want to offer gateway-to-gateway routes in which they need to cross another city (or airport) to reach their final destination and it is financially less attractive to offer non-stop direct flights themselves. "In some gateway-to-gateway markets, carriers must be able to obtain a minimum number of interline passengers from behind the gateway cities in order for their gateway-to-gateway route to be economically viable" (Fones, 2015, p. 65). We thus argue that cooperation through interlining is important in less dense interline markets with relatively many connecting passengers.

We illustrate the mechanism of interlining via figure 1. We assume that airport A and C are both located in a relatively small regional city and airport B is a hub airport. Airline 1 does not offer direct AC connections. As a consequence, passengers travelling from airport A to airport C (and vice versa) would need to travel on the beyond-gateway route, operated by airline 1. Without having any codeshare or alliance partnerships on route AB, airline 1 would be interested to enter into an interline agreement with both airline 2 and 3 in order to generate more demand on its BC route. As interlining would benefit all airlines in this network structure, we assume that all airlines have interline agreements with each other (but no closer type of cooperation exist). We further assume that there are many connecting passengers on route AB that want to reach airport C and there are few alternative routes.

Figure 1: The mechanism of interlining



We assume the following: (i) there are no alternative connection options, meaning that there are no direct flights operated between AC and (ii) there are relatively many connecting passengers on route AC.

This network structure changes if airline 1 and airline 3 decide to cancel their interline agreement and thus refuse to allow each other to offer multi-journey tickets with flight segments of the other airline. The ending of the interline agreement will affect competition. AC passengers of airline 3 are triggered to switch to airline 2 or airline 4 as they otherwise need to buy two single fares in order to reach their final destination and their baggage will not be checked in automatically at the connecting airport. These implications would suggest that airline 3 lowers its frequency of flights into and from airport B as it becomes economically non-rewarding to serve this market, while airline 2 and airline 4 would benefit by an increase in (interline) passengers. Obviously, airlines can decide to pursue alternative strategies in response to this changed structure. For example, Airline 3 could decide to start offering their own non-stop direct flights from the hub to the final destination (route BC). We consider these alternative explanations in section 4 when discussing our results of the analysis. Our economic reasoning would imply that airline 2 and 4 gain market power on route BC due to less competition from airline 3. As a result, the cancellation of the interline agreement leads to potential anti-competitive behavior. As there are less airlines competing in this market, the profit from tacit collusion might be greater. This anti-competitive outcome could result in higher airline fares. Resulting from the aforementioned intuitive arguments, we will test the following hypothesis:

Hypothesis 1: Airline fares are likely to increase in response to a cancellation of an interline agreement between airline 1 and 2 as airline 1 will operate fewer flights and transfer fewer interline passengers on interline markets involving hub airports.

We deepen our analysis by distinguishing between low- and high-concentration markets. Economic theory assumes that high market concentration facilitates collusion as the individual payoff resulting from collusion will be higher if it has to be divided by less companies. Levenstein and Suslow (2006) highlight that high market concentration makes tacit collusion easier as coordination issues can be simplified, and firm gains would be higher.

As illustrated in figure 2, when many airlines operate on route BC, it is more likely that airlines are able to choose from a wider range of potential interline partners in order to offer interline services on route AC. Moreover, anti-competitive behavior is more likely when there is a high percentage of connecting traffic on route AB and route BC is considered to be a monopoly. In these cases, if passengers flying from airport C have no alternative connection option to fly to airport A, the anti-competitive effects would be larger compared to a situation in which there are many alternative connection options. As airlines often dominate the market behind their respective hub airport (Borenstein, 1989), passengers would be hurt relatively more on these routes as they have less alternative connection options that benefit customers. We assume that all other strategies are considered (i.e., alternative connection option or market entry on route BC) and hypothesize that the increase in airline fares is higher in highly concentrated markets. This in turn leads us to the following hypothesis:

Hypothesis 2: The increase in airline fares is likely to be stronger in highly concentrated markets since the option to cooperate with other (potential) partners is smaller and, as a consequence, the remaining airlines will gain market power.

4. Data

This section is divided into three subsections. We first discuss the data sources used in our study. In the second subsection we discuss the construction of the final sample. In the third subsection we introduce the variables used in our study and justify each control variable.

4.1 Data sources

We obtained four datasets from two data sources. The first three datasets are retrieved from the Bureau of Transportation Statistics. This organization requires all airline carriers that have at least one percent market share in the U.S. domestic industry to report airline specific data. Our base sample comes from Airline Origin and Destination survey (DB1B). This data source consists of a 10% sample of all airline tickets of reporting carriers. The dataset covers quarterly information on ticket prices, fare classes, the ticketing and operating carriers and the origin and destination routes. The second data source is the T-100 dataset. This dataset includes monthly information about flight characteristics, such as the number of passengers, seats and distances on a given route. The third data source is the Form 41 dataset. This dataset includes yearly carrier-specific information, such as the available cash, operating expenses and the total assets of the carrier. The final data source is retrieved from the U.S. Census Bureau. This organization collects data about U.S. citizens and the U.S. domestic economy. From their database we collect annual data on population estimates per metropolitan area for the period 2013-2017.

4.2 Construction of the final sample

In order to construct the final sample to be used in the panel analysis we filter all datasets by applying certain restrictions. To filter our sample, we partially follow Ito and Lee (2007). First, itineraries from which the dollar credibility (a measure of the credibility of the quoted airline fare) are equal to zero are dropped out of the sample. Second, itineraries for which fares are considerably low are dropped out of the sample (fares below $10 dollar or above the 99th percentile) as these tickets relate to frequent-flyer programs. All observations for which the recorded distance is equal to zero are dropped out of the sample. In line with Ito and Lee we focus on coach class tickets (both restricted and unrestricted) and include itineraries from which the ticketing carrier differs from the operating carrier. As the T-100 domestic segment data only includes U.S. carriers with annual operating revenues of more than $20 million, smaller airlines are automatically removed from the sample. Removing these smaller airlines from the sample (on average eight airlines per year) does not impact our analysis as most of these airlines are considered to be charter flights (charter flights are not part of a scheduled service).

4.2.1 Carrier specification

We combine smaller airlines owned by the same parent company to ensure a fair comparison. Hence, we treat the regional carriers American Eagle, Envoy Air, Piedmont Airlines and PSA Airlines as flights operated by American Airlines during the full study period (American Airlines Group, n.d). Accordingly, we recoded the operating carrier code (for example, American Eagle ["MQ"]) to the airline code of its parent company (that is, American Airlines ["AA"]). Similarly, as Endeavor Air is a wholly-owned subsidiary of Delta, we treat a flight operated by Endeavor Air as a flight operated by Delta Airlines (Endeavor Air, 2018).

The merger between U.S. Airways and American Airlines in 2013 is an event that might bias our results. The holding companies of these carriers effectively merged in December 2013. The U.S. Airways brand name discontinued in October 2015, meaning that airline codes of all flights operated under the brand name from U.S. Airways ("US") changed into airline codes from American Airlines ("AA") in October 2015. Figure 2a presents the number of routes operated by American Airlines and as can be seen from the figure the adjustment of airline codes "US" into "AA" caused a significant increase in the number of routes operated by American. We argue that following the effective merge both companies behaved as one entity. Therefore, to account for the potential bias in our analysis, we adjust all airline codes of flights operated by U.S. Airways into airline codes of American from the first quarter after the airlines were effectively merged, namely the first quarter of 2014. Figure 2b shows the number of routes operated by American following this airline code adjustment in our sample. As can be seen in this figure, the increase of the number of routes operated shifted towards 2014Q1, the moment the two companies effectively merged.

Figure 2: Number of routes operated by American Airlines over time

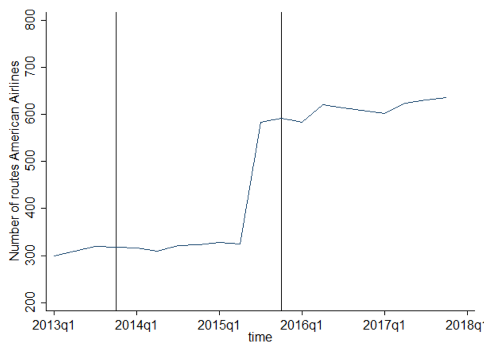


Figure 2a: Number of routes operated by American Airlines without recoding flights U.S. Airways into flights American Airlines in the sample

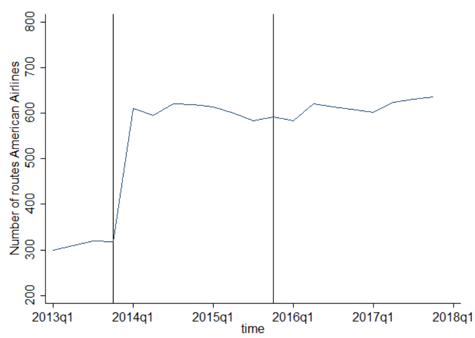


Figure 2b: Number of routes operated by American Airlines including recoded flights U.S. Airways into flights American Airlines in the sample

A market is defined as a directional origin-destination pair. The dataset allows us to use two approaches to define a given market: city-pair markets and airport-pair markets. In line with Ito and Lee (2007) we focus on city-pair markets. This will be the most relevant option because of the following. If airline 1 wants to operate interline route AC after the cancelled interline agreement with airline 2, it potentially has more alternative airport options in one city in order to reach the final destination. It is less likely that airline 1 considers an alternative route via another city as this might be too expensive in terms of fuel cost. We will include airport-pair markets in every specification as a robustness check.

Finally, we reduce our sample to gateway-to-gateway markets by dropping origin and destination routes when both the origin and destination are large hub airports. Hub-to-hub markets are characterized by more frequent flights with larger aircrafts and higher load factors. Besides, smaller gateway-to-gateway markets have less frequent flights and lower load factors, making interlining more attractive. As relatively many large carriers operate in hub-to-hub markets, there is a higher likelihood that code share or (international) alliance partners operate on a given route, making the need for interline partners even less important. We follow Yimga (2017) to define hub airports and delete all observations if the origin and destination are both defined as hub airports. After filtering and combining all datasets the final sample includes 137,574 observations and 10,559 city-pair markets.

4.3 Variables

We collected data from January 2013 up to December 2017. We chose this time-span as it includes a balanced sample of the period before the ending of the interline agreement and the period after. We define two periods in our analysis. Given that Delta and American ended their interline agreement in September 2015, *period 1* illustrates the period before the ending of the interline agreement (January 2013 to September 2015) and *period 2* illustrates the period after the ending of the interline agreement (October 2015 to December 2017).

The dependent variable (*Ln_fare*) is defined as the natural logarithm of the average airline fare and contains the average one-way price for airline i on route j in quarter t. We add the following control variables in all our specifications. Following Ito and Lee (2007), we control for market growth over time by including the mean of the origin and destination cities average Metropolitan Statistical Area population (*Population*). As markets increase due to population growth we expect this market growth to be related to an increase of potential travelers on a route. This increase of travelers leads to economies of scale and eventually to lower airline fares. In line with Ito and Lee, we add the Herfindahl-Hirschman index (*HHI*) in order to measure the competitive intensity at the route level. We expect a positive sign for the HHI coefficient since economic argumentation assumes that lower competition leads to higher airline fares. In addition, we control for economies of scope. Economies of scope occur when a firm producing a wide variety of products has a lower average cost than a firm producing only few products. In the airline industry we can view an origin destination pair as one single product. Airlines operating multiple routes can use their resources on all different routes and are thus more flexible in adjusting schedule to actual demand (Vermooten, 2004). The following example illustrates the benefit of economies of scope in the airline industry. Picture an airline route with relatively low traffic and two airlines operating this route. Suppose airline 1 only serves this particular route and uses small airlines with relatively low load factors. In contrast, airline 2 operates this route and many connecting routes as well. By including these connecting routes, airline 2 has the advantage of attracting more passengers (both non-stop and interline passengers) and can therefore operate larger aircrafts with higher load factors. Airline 2 may thus benefit from economies of scale on one route as the average unit cost declines due to higher traffic. However, economies of scope arise as airline 2 operates multiple routes and can therefore utilize larger and more efficient aircrafts at higher load factors. The airline thus benefits as it can produce 'two products' more cheaply together than separately. In line with Van Reeven and Pennings (2015), we use the variable (*number of routes operated)* of airline i in quarter t to control for economies of scope. We expect more routes operated to be associated with lower airline fares. We follow Gilo and Simonelli (2014) and control for market power of a carrier at an airport. This is measured as the average market share of the origin and destination airport of carrier i in quarter t *(average market share at route airports*). Following Dai et al. (2014) we include the variable (*operating expenses*) to control for cost-driven price fluctuations. This variable is estimated as the relative operating expenses divided by the firm's total assets. Finally, we control for the financial health of airlines by including the relative non-operating net income (*non-operating net income*). The summary statistics of the variables used in our analysis can be found in the appendix.

5. Methodology

This section is divided into two sections. In the first subsection we present the difference-in-difference model (DID) and the model needed to test hypothesis 1. In the second subsection we explain the methodology in order to test hypothesis 2.

5.1 Difference-in-Differences Estimation

In order to isolate the price effect, we apply the difference-in-difference (DID) method. We use the DID method as it allows us to estimate the effect of the ending of the interline agreement on airline fares by comparing the changes in airline fares over time between the treatment group and control group in gateway-to-gateway markets. Our treatment group includes all gateway-to-gateway routes in which either American or Delta was operating in period 1 but no alliance partner. We expect that on these routes both carriers were most likely to be interdependent in order to serve interline passengers. Our control group consists of gateway-to-gateway markets in which neither American nor Delta had been operating in period 1 and all routes in which both carriers simultaneously operated flights. We argue that the ending of the interline agreement did not affect competition in these markets as (i) they were direct competitors on these routes or (ii) they did not operate on these routes, making it less obvious to find competition effects.

To ensure validity of the DID estimator, the common trend assumption must hold. This assumption requires that airline fares of the treatment group would follow the same trend as airline fares on routes in the control group in the absence of the interline agreement cancellation. It is thus important to ensure both periods in the sample are comparable, meaning that all significant events within the sample period have to be examined. Two events are important to elaborate upon. First, American merged with U.S. Airways in December 2013 and they started to operate as one entity from October 2015 onwards. As the merge between American and U.S. Airways became effective in October 2013, we will view the two airlines as one entity from October 2013 onwards in our sample. We include a robustness test to identify if our outcome changes when we do not adjust the airline codes. Second, Virgin American had been acquired by Alaska Airlines in 2016 but started to operate as one entity from April 2018 onwards. We argue that this acquisition does not affect our results as the acquisition did not change the cooperation form between Delta, American and Alaska. We use the same approach as the U.S. Airways case by considering these two companies to be one entity from 2016Q2 onwards to ensure fair comparison. However, as we do not believe that this acquisition would impact our result we do not conduct an additional robustness check.

Table A1 in the appendix presents the summary statistics of the treatment group and the control group separately. As can be seen in table 1, the means of the two groups are relatively similar. The mean HHI of the control group is somewhat higher than the mean HHI of the treatment group. Moreover, the mean of the available seats of the control group is considerably lower than the mean of the treatment group. These differences might be due to the fact that American and Delta use generally larger aircrafts and operate more long-haul flights compared to regional airlines that generally focuses on smaller markets.

Figure 3: Average airline fare trends over time

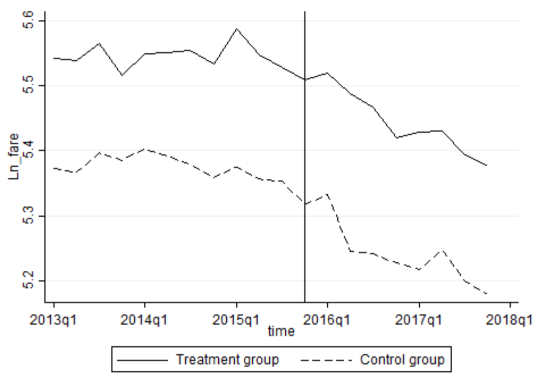


Figure 3 presents the average fare trends over time of the treatment and control group. As shown in figure 3, the trend of the average airline fare of both groups have evolved more or less similarly from 2013Q1 till 2014Q4. From 2015 onwards, we observe a slightly different trend. It seems that average airline fares of the treatment group decreased relatively stable from 2015 onwards, while the airline fares of the control group appear to decrease slightly faster in this same period. The figure thus partially confirms that the assumption of common pre-treatment trends in the treatment and control groups holds. This is an interesting starting point to deepen our analysis. To implement the DID estimator, we first specify the following linear fixed effects model used in our analysis:

$$\mathrm{Ln(Average\ airline\ fare)}_{ijt} = \beta_0 + \beta_1 * \mathrm{Control\ X\ period2} + \beta_2 * \mathrm{Treatment\ X\ period1} + \beta_3 * \mathrm{Treatment\ X\ period2} + \gamma X_{ijt} + \alpha_i + \alpha_{it} + \varepsilon_{ijt} \quad (1)$$

In the model subscript *i*, *j* and *t* denote carrier, route and time respectively. We control for carrier-route fixed effects through the fixed effects model. Fixed effects allow us to control for the fact that airlines may behave differently in different markets. Year-quarter period dummies are included to control for demand effects or macro-economic trends over time. Finally, carrier-time fixed effects are included to control for carrier-specific heterogeneity over time. In other words, by including carrier-time fixed effects, we control for the fact that not all the changes in airline fares are coming from the interline agreement cancellation alone, but also from other confounding time invariant characteristics such as pricing strategies of airlines.

The variable *controlXperiod*1 is our reference group in all our specifications. The coefficient β_1 estimates the change in airline fares of the control group in period 2 relative to period 1. The coefficient β_2 estimates the change in airline fares of the treatment group in period 1 relative to the reference group. Similarly, the coefficient β_3 estimates the change in airline fares of the treatment group in period 2 relative to the reference group. The variable X_{ijt} includes the control variables in our analysis. We are interested to observe whether the changes are different for the treatment group and control group in period 2 relative to period 1. Thus, the DID estimator is defined as the difference in the average airline fares in the treatment group in period 2 relative to period 1, less the difference in the average airline fares in the control group in period 2, relative to period 1. We specify the following difference-in-difference method:

$$\mathrm{DID\ (Treatment, control)} = [(\mathrm{Treatment} \mid \mathrm{period\ 2}) - (\mathrm{Treatment} \mid \mathrm{period1})] - [(\mathrm{Control} \mid \mathrm{period\ 2}) - (\mathrm{Control} \mid \mathrm{period\ 1})]$$

Hence, the post-estimation of the coefficients estimates of equation 1, $[(\beta_3 - \beta_2) - (\beta_1 - 0)]$), captures the DID effect. If we find positive and significant results, this indicates that we can accept hypothesis 1, i.e., airlines affected by the cancelled interline agreement operate fewer flights, while the remaining airlines gain market power and increase airline fares due to collusive behavior. The ending of the agreement is then argued to be undesirable from the consumers' perspective.

5.2 Subsample analysis: market structure

We extend our analysis by testing the relationship between market structure and airline fares. In line with Dai et al. (2014) we define market structure by dividing our sample into three subsamples: (1) monopoly routes defined as routes in which the share of a single carrier is greater than 90 percent, (2) duopoly routes defined as routes in which the sum of shares from the two biggest carriers is greater than 90%, and (3) competitive routes defined as all other routes (neither monopoly nor duopoly routes). We calculate the HHI by using the following formula:

$$HHI_{jt} = \sum_{i=1}^{N} s_i^2,$$

where *n* denotes the number of carriers on a given route and s_i represents the market share of carrier *i.* The market shares are calculated based on passenger enplanements on route j in quarter t. If we find positive and significant results from the monopoly sample relative to the duopoly or competitive sample, we suspect that the effect of the ending of the interline agreement on average airline fares is stronger on highly concentrated routes.

6. Results

In this section, we discuss the results of our specifications discussed in section 5. We first estimate the impact of interline agreements on airline fares using the full base sample. In the second subsection we split the sample into three subgroups according to market structure. Finally, we provide several robustness checks to identify the robustness of our results. All result tables include a sample of city-pair markets and airport-pair markets.

6.1 Results difference-in-difference model

The results of the difference-in-difference model of equation (1) are presented in table 1. First, we observe that the coefficient estimates of the city-pair market are almost identical to the airport-pair market estimates. The coefficient of the variable *Control X Period 2* is negative and significant at the 1% level, suggesting that airline fares of the control group are lower in period 2 compared to period 1. Similarly, the coefficient of the variable *Treatment X Period 2* is negative and significant, meaning that airline prices of the treatment group are lower in period 2 compared to period 1. This outcome is not surprising as the preliminary graphical evidence, as shown in figure 1, indicated a steady decrease of airline fares over time. The outcome of the variable *Treatment X Period 1* is non-significant in both the city-pair and airport-pair market regression. Moreover, the variable to control for market growth, measured as the (logged) mean of the population of the origin and destination end-points *(Ln Population)* is positive and significant at the 1% level, suggesting that one standard deviation percent increase in the average population of the origin and destination cities increases average airline fares with 5,5% on average. This outcome contradicts our expectation as we expected larger market size to be associated with economies of scale and thus lower airline prices. This outcome may suggest that economies of scale cannot be utilized in (relatively less dense) gateway-to-gateway markets. The coefficient estimate on *HHI* is positive and significant. Increasing the HHI by one standard deviation would increase airline fares by 4,7% on average. In other words, more concentrated markets are associated with higher airline fares. The coefficient estimate *Number of routes* is positive and significant, suggesting a positive relationship between the number of routes operated and airline fares. The coefficient estimate of the variable *average market share at an airport* is significant and negative at the 1% level. However, this estimate is not robust as the coefficient estimate is negative in model 2 when looking at the airport pair. Finally, our main variable of interest is the DID estimator. The estimated DID coefficient is non-significant at the 1% level for both the city-pair (DID coefficient = 0.000) and airport-pair (DID coefficient = 0.002) regression. We thus fail to accept hypothesis 1, meaning that airline fares of the treatment group are not statistically higher than airline fares of the control group in period 2 relative to period 1.

Table 1. Results difference-in-difference model

Model	**(1)** Full sample (City pairs)	**(2)** Full sample (Airport pairs)
Control X Period 2	-0.091***	-0.082***
	(0.004)	(0.004)
Treatment X Period 1	0.005**	0.001
	(0.002)	(0.002)
Treatment X Period 2	-0.085***	-0.079***
	(0.004)	(0.004)
Ln(Population)	0.572***	0.573***
	(0.089)	(0.090)
HHI	0.047***	0.022***
	(0.004)	(0.003)
Number of routes	0.083***	0.064***
	(0.002)	(0.002)
Average market share at route airports	-0.038***	0.023***
	(0.003)	(0.004)
Operating expenses	-0.005***	-0.009***
	(0.001)	(0.001)
Non-operating net income	-0.010***	-0.008***
	(0.001)	(0.001)
Constant	5.373***	5.371***
	(0.002)	(0.002)
No. of Obs.	137,574	137,574
R-squared	0.080	0.092
Unique routes	10,559	11,000

Dependent variable is the natural logarithm of the average airline fare. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include year-quarter and carrier-route fixed effects.

6.2 Results subsample analysis

In table 2 we present the summary statistics of the full sample and the subsamples competitive, duopoly and monopoly. As can be seen in the table, the mean of the HHI significantly differs between the different sub markets. Moreover, we observe significantly less carriers operating in monopoly markets (on average 1.83 carriers) relative to duopoly and competitive markets. As discussed in section 3, we expect interlining to be more important in less dense markets with few carriers operating. In these markets it is more likely that airlines cooperate in order to be able to offer interline itineraries. As there are on average less carriers operating in monopoly and duopoly markets, we expect interlining to be relatively more important in these markets compared to competitive markets.

Table 2. Summary statistics subsamples

	HHI	Carriers	Route passenger	Observations
Full Sample	0.561	4.04	85,685	137,574
Monopoly	0.780	1.83	24,104	70,910
Duopoly	0.382	4.74	91,694	48,057
Competitive	0.185	10.69	304,849	18,607

The summary statistics are calculated from the city-pairs sample. The calculation of the market structure subgroups can be found in section 5.2. The summary statistics include the following variables: (HHI) Herfindahl-Hirschman Index based on passenger enplanement, (Carriers) number of operating carriers on a given route per quarter and (Route passenger) number of route passengers on a given route per quarter.

The results of the sub analysis regressions are presented in table 3. The signs and significance of the coefficient estimates of the control variables are almost identical in all models, except for the average mean of the origin and destination cities' population. In the subsample competitive, the sign of the coefficient estimate is negative and significant, meaning that one standard deviation percent increase in population leads to 1.4% lower airline fares on average. This negative result may be related to the total number of passengers. There are significant more passengers in monopoly markets relative to duo- and competitive markets. On competitive routes, the continuous flow of passengers could benefit airlines by using larger aircrafts with high load factors. Our main variable of interest, the DID estimator is non-significant at the 1% confidence level for models 3, 5 and 6. This implies that there is no change in airline fares of the treatment group over time relative to period 1 and relative to the control group. However, the DID estimator of model 4 (DID coefficient = 0.008) is positive and significant at the 1% level, suggesting that airline fares of the treatment group are higher in the treatment group relative to period 1 and relative to the prices of the control group in monopoly markets. This indicates that the ending of the interline agreement between American and Delta led to less competition and higher airline fares in monopoly markets in which either Delta or American had been operating in period 1.

Table 3. Results subanalysis: market structure

Model	**(3)**	**(4)**	**(5)**	**(6)**
	Full sample	Monopoly routes	Duopoly routes	Competititve routes
Control X Period 2	-0.090***	-0.074***	-0.099***	-0.041***
	(0.004)	(0.006)	(0.006)	(0.008)
Treatment X Period 1	0.005***	-0.010***	0.012***	0.009**
	(0.002)	(0.003)	(0.003)	(0.004)
Treatment X Period 2	-0.083***	-0.074***	-0.093***	-0.040***
	(0.004)	(0.006)	(0.006)	(0.009)
Ln(Population)	0.549***	0.327**	0.484***	-1.458***
	(0.089)	(0.130)	(0.151)	(0.277)
HHI	0.047***	0.033***	0.097***	0.344***
	(0.004)	(0.004)	(0.009)	(0.034)
Number of routes	0.083***	0.110***	0.078***	0.053***
	(0.002)	(0.005)	(0.003)	(0.004)
Average market share at route airports	-0.038***	-0.036***	-0.037***	-0.044***
	(0.003)	(0.005)	(0.004)	(0.004)
Operating expenses	-0.005***	0.001	-0.010***	-0.016***
	(0.001)	(0.001)	(0.002)	(0.003)
Non-operating net income	-0.010***	-0.007***	-0.012***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.002)
Constant	5.373***	5.507***	5.311***	7.274***
	(0.002)	(0.064)	(0.046)	(0.291)
No. of Obs.	137,574	70,910	48,057	18,607
R-squared	0.080	0.088	0.087	0.110
Unique routes	10,559	6,118	3,266	1,175

Dependent variable is the natural logarithm of the average airline fares. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include year-quarter and carrier-route fixed effects.

6.3 Robustness analysis

In this section we will provide robustness checks to evaluate the robustness of our results. First, we specify a regression without adjusting U.S. Airways airline codes "US" to American Airline codes "AA". Second, we perform a general robustness checks by analyzing alternative measures for economies of scope (i.e., passenger, seats and seats per mile). The results of the aforementioned robustness checks can be found in table 4 and A3 respectively. The results of our base regressions (model 1 and 2) are robust when we do not adjust the airline codes of U.S. Airways into airline codes of American Airlines. In specific, all control variables have the same sign in model 7 and 8 of table 4 compared to base model 1 and 2 of table 1. Moreover, we do not find significant results of the DID estimator when we do not adjust the airline codes. In model 10, 11 and 12 of table A3 we change the variable *number of routes* into the variables seats per mile, passenger and seats. The coefficients of all control variables are almost identical in all different specifications. Our main variable of Interest, the post-estimation coefficient of the DID estimator is non-significant in all models. Thus, airline codes adjustments and changed measures for economies of scope do not lead to significant results of the DID estimator.

Table 4. Robustness test: Adjustment airline codes U.S. Airways

Model	**(7)** No adjustments airline codes (City pairs)	**(8)** No adjustments airline codes (Airport pairs)
Control X Period 2	-0.086***	-0.081***
	(0.004)	(0.004)
Treatment X Period 1	0.007***	0.001
	(0.002)	(0.002)
Treatment X Period 2	-0.081***	-0.080***
	(0.004)	(0.004)
Ln(Population)	0.522***	0.558***
	(0.089)	(0.090)
HHI	0.046***	0.023***
	(0.003)	(0.003)
Number of routes	0.077***	0.062***
	(0.002)	(0.002)
Average market share at route airports	-0.034***	0.025***
	(0.003)	(0.003)
Operating expenses	-0.005***	-0.009***
	(0.001)	(0.001)
Non-operating net income	-0.009***	-0.007***
	(0.001)	(0.001)
Constant	5.370***	5.370***
	(0.002)	(0.002)
No. of Obs.	137,574	137,574
R-squared	0.075	0.091
Unique routes	10,559	11,000

Dependent variable is the natural logarithm of the average airline fares. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include year-quarter and carrier-route fixed effects.

7. Discussion

In this section we discuss alternative strategies companies can pursue in response to a cancellation of interline cooperation. We highlight three strategies, namely substitution effects, customer-valuation and market-entry effects.

First, it is possible that American and Delta started exploring alternative travel itineraries. As both carriers cover a large route network, it could have been relatively easy to find efficient alternative routes. In this case, passengers would not be triggered to change airlines and thus the remaining carriers on the 'affected' route would not gain market power by attracting more passengers on their aircrafts. On the other hand, if there are few alternative connection options, the impact on airline fares might be larger. To estimate whether this alternative explanation is plausible, it would be necessary to test the flight frequency of alternative routes close to the interline route. It falls beyond the scope of this study to test this alternative explanation.

A second explanation for our results is related to customer types. It might be that customers flying with American or Delta via interlining are in general more high-value customers. If there is a high percentage of high-value customers flying on these routes, the ending of the interline agreement could have resulted in a decrease in this customer type. As we estimated our model using coach class passengers (Fare class X and Y) it is not possible to estimate the change of demand composition. However, it might be possible that airlines decided to lower ticket prices as a consequence of a lower proportion of high-value customers on its aircraft.

A final argument discussed in section 3 is the possibility of airlines to discontinue serving the AC through interlining and instead start to offer their own direct flights on this route. If this argument is true, more competition would lead to lower average prices on a given route. We would then see consistent changes in the number of operators on the affected routes. To examine this possibility, we tested whether Delta and American started to offer their own non-stop flights on treated routes in period 2. Contrary to our expectations, we find no evidence that either Delta or American started their own operations on these routes.

8. Limitations

There are several limitations to our research that need acknowledging. The first limitation is related to the lack of specific interline itineraries data, limiting the scope of this analysis. With our current data set it is impossible to identify whether flights are considered to be interline products or not. It might be a strategic decision to not publicly share the percentage of interline products in a market. As American and Delta are, in theory, the biggest competitors, showing the public that they cooperate may impact their own customer loyalty.

A second limitation relates to the common trend assumption of the difference-in-difference method. American merged with U.S. Airways in 2013. As they created the world's biggest airline, the merger most likely had a significant impact on competition within the U.S. domestic airline industry. Although we did account for this merger by adjusting the airline codes of U.S. Airways into airline codes of American Airlines from 2013 onwards (and included robustness tests), the discontinuation of the operations of the U.S. Airways brand in 2015 could still bias our results. For example, loyal customers of the U.S. Airways brand might have changed their flight preference to other non-American airlines after the U.S. Airways brand discontinued from 2015 onwards. As operations of the U.S. Airways brand ended two weeks after the cancellation of the interline agreement between American and Delta, estimating casual relationships between interline cooperation and airline fares alone becomes more complicated.

Finally, limitations arise regarding the choice of our treatment and control group. Our treatment group consists of all routes in which either Delta or American was present in period 1. This does not automatically mean that interlining is of importance on these routes. Furthermore, we did not distinguish between code share partners when defining our treatment group. However, it is likely that carriers would rely on other partners in choosing interline partners. Future research could address this research problem regarding the different groups in order to identify a more appropriate treatment and control group by for example, taking into account code share partners and the percentage of interline itineraries on a given route.

9. Conclusion

Interline cooperation between airlines is important to expand route networks when it is not financially attractive for carriers to operate the full interline route themselves. Moreover, interlining is arguably crucial for particular passengers as it enables them to reach relatively isolated locations by flying with multiple airlines. In this study, we investigate the price implications of interline cooperation and in the U.S. domestic airline industry. The research question was: to what extent does cooperation through interlining lead to lower airline fares and is this price implication more important in highly concentrated markets?

In order to address this research question, we focused on the cancelled interline agreement between American and Delta in 2015. We applied a difference-in-difference method in order to test the price difference using a panel data set covering the period 2013-2017. We did not find statistical evidence that airline fares of our treatment group increased in period 2 relative to the control group and relative to period 1. In other words, we failed to accept our first hypothesis, i.e. airlines affected by the cancelled interline agreement started to operate fewer flights which resulted in increased market power of the other airlines operating on this route. We extended our analysis by estimating the results of equation (1) while dividing the sample into subsamples based on market structure. We did find statistical evidence that airline fares of the treatment group increased relative to period 1 and relative to the control group in monopoly markets.

In this paper we focused on airline fares on routes including both non-stop and interline products. Further research into this topic might focus only on interline itineraries to identify which type of markets relates to interline cooperation and take into account the number of connecting passengers on a route. Furthermore, as most airline literature focused on the competitive effects of multimarket contact, other researchers might test the relationship between interline agreements and mutual forbearance. Finally, the overall likelihood of our results would improve if one is able to identify all itinerary products in the U.S. domestic airline industry.

This study is a first attempt at examining the importance of interline cooperation in the U.S. domestic airline industry. We contribute to the existing airline cooperation literature by analyzing the potential pro- and anti-competitive effects with respect to interline cooperation. We did not find enough evidence to support the claim of our main hypothesis that airlines gain market power and start to collude in response to a cancellation of interline cooperation between other airlines operating the same route. As we focused our research on the cancelled interline agreement between American and Delta, more research has to be conducted in order to isolate the price implications of interline cooperation and to improve the external validity.

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Appendix

Table A1: Summary statistics

	Full sample		Treatment group		Control group	
Variable	Mean	**Std. Dev.**	Mean	**Std. Dev.**	Mean	**Std. Dev.**
1. Ln(Population)	15.07	**0.63**	15.18	**0.52**	14.95	**0.70**
2. HHI	0.561	**0.298**	0.490	**0.250**	0.620	**0.320**
3. Number of routes	739,7	**385,1**	830,3	**372,8**	653,1	**376,5**
4. Average market share at route airports	0.27	**0.20**	0.28	**0.21**	0.25	**0.20**
5. Operating expenses	0.24	**0.28**	0.28	**0.32**	0.18	**0.20**
6. Non-operating net income	-0.004	**0.021**	-0.003	**0.022**	-0.003	**0.020**
7. Seats per mile	4.3^10^10	**9.4^10^9**	4.7^10^10	**8.5^10^9**	3.9^10^10	**1.1^10^10**
8. Ln(Passenger)	9.05	**1.27**	9.09	**1.34**	9.00	**1.19**
9. Ln(Seats)	9.27	**1.25**	9.31	**1.32**	9.22	**1.18**

Table A2: Correlation matrix

	1	2	3	4	5	6	7	8	9
1. Ln(Population)	1.00								
2. HHI	-0.56	1.00							
3. Number of routes	0.04	0.04	1.00						
4. Average market share at route airports	-0.18	0.31	0.50	1.00					
5. Operating expenses	0.01	0.02	0.17	0.10	1.00				
6. Non-operating net income	-0.03	0.06	0.05	0.04	0.04	1.00			
7. Seats per mile	0.05	-0.06	0.12	0.21	-0.05	0.00	1.00		
8. Ln(Passenger)	0.12	-0.12	0.23	0.35	-0.14	0.02	0.47	1.00	
9. Ln(Seats)	0.13	-0.12	0.23	0.35	-0.14	0.02	0.49	0.99	1.00

Table A3: Results robustness test: alternative measures of 'economies of scope'

Model	**(9)**	**(10)**	**(11)**	**(12)**
Control X Period 2	-0.090***	-0.076***	-0.075***	-0.075***
	(0.004)	(0.004)	(0.004)	(0.004)
Treatment X Period 1	0.005**	0.012***	0.012***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)
Treatment X Period 2	-0.084***	-0.061***	-0.061***	-0.061***
	(0.004)	(0.004)	(0.004)	(0.004)
Ln(Population)	0.573***	0.625***	0.622***	0.621***
	(0.090)	(0.090)	(0.090)	(0.090)
HHI	0.047***	0.044***	0.046***	0.046***
	(0.004)	(0.004)	(0.004)	(0.004)
Average market share at route airports	-0.037***	0.015***	0.018***	0.019***
	(0.003)	(0.003)	(0.003)	(0.003)
Operating expenses	-0.005***	0.001	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Non-operating net income	-0.009***	-0.006***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
Number of routes	0.083***			
	(0.002)			
Seats per mile		0.028***		
		(0.003)		
Ln(Passenger)			0.011***	
			(0.002)	
Ln(Seats)				0.008***
				(0.002)
Constant	5.373***	5.370***	5.370***	5.370***
	(0.002)	(0.002)	(0.002)	(0.002)
No. of Obs.	137,568	137,568	137,568	137,568
R-squared	0.079	0.050	0.048	0.047
Unique routes	10,559	10,559	10,559	10,559

The coeficients are calculated from the city-pairs sample. The dependent variable is the natural logarithm of the average airline fares. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include year-quarter and carrier-route fixed effects.