Estimating the Gains from Liberalizing Services Trade: The Case of Passenger Aviation*

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Abstract:

Although services are increasingly traded, the ability of firms to access foreign markets remains hindered by complex regulatory policies. Little is known about the magnitude and effect of these barriers to services trade. Detailed data on services flows are rare and identifying changes in regulatory regimes can be difficult. This paper exploits detailed transactions data from an important service sector – passenger aviation – and the sequential signing of 87 bilateral "Open Skies Agreements" over a 16 year period. We identify the channels through which barriers restrict services trade, identify the magnitude of these barriers, and the gains associated with their removal. Countries that liberalize aviation services trade see expansions in route offerings, reductions in prices, and large increases in quantities traded conditional on prices. Carriers previously constrained by regulations re-orient capacity away from highly contested routes and toward routes with little competition, and achieve improvements in capacity utilization. We estimate that the combined effect of these changes yields a 31 percent reduction in quality- and variety-adjusted prices for liberalized markets relative to those who remain regulated.

JEL: F13; L43; L93

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1. Introduction

Services represent a large (20 percent) and growing share of world trade, but the exact reasons for that growth are not immediately clear. Growth in services trade may simply reflect the rising share of services in employment and output worldwide, or be due to trade facilitating improvements of information technology and telecommunications.[3] It may also be that a sustained focus on liberalizing services trade at the multilateral level through the WTO General Agreement on Trade in Services (GATS) and through bilateral agreements have succeeded in eroding regulatory barriers to entry.

While the literature features an extensive array of papers on the effects of merchandise trade liberalization, careful empirical work on services trade liberalization is scarce.[4] The difference in research emphasis is largely due to the paucity of detailed data on international service transactions. Feenstra et al. (2010) report that "value data for imports and exports of services are too aggregated and their valuation questionable, while price data are almost non-existent".[5] Making matters worse, it can be challenging to identify changes associated with service liberalization events. Service liberalizations are infrequent, and often target domestic market regulations (e.g., privatizations, foreign investments), whose overhaul tends to coincide with complex national reforms. This stands in stark contrast to manufacturing sectors, where tariffs provide an exact measure of the price wedges imposed by policy intervention, and liberalization efforts correspond to well-defined reductions in these wedges.

This paper provides a careful account of the consumer gains from liberalizing services trade by focusing on a traded service sector, passenger aviation, where these data limitations can be overcome. Trade in passenger aviation services is important: it has more than doubled in the past two decades and now represents $190billion of trade for the US and EU; it is an important input into exporting (Poole,

[3] Freund and Weinhold (2002) empirical evidence for the impact of internet on the growth of services trade. Also, Ariu and Mion (2011) find that an increase in computer use or analytical tasks increases the number of service-trading firms.
[4] The few exceptions are Fink et al. (2003), who investigate the impact of telecommunication reforms on output and productivity in a panel of developing countries, and Arnold et al. (2011), who bring evidence from Czech Republic for the productivity effects of services liberalization on downstream manufacturing firms. See Hoekman et al. (2007) for a discussion on the state of services trade negotiations, and Francois and Hoekman (2010) for an excellent survey on the advances in services trade.
[5] It is only very recent that firm level studies on services trade have surfaced. See for example Hanson and Xiang (2011), Breinlich and Criscuolo (2011), Ariu and Mion (2011).

2009; Cristea 2011), knowledge flows across countries (Hovhannisyan and Keller 2011), and flows of other services, especially Mode 2 (consumption of services abroad, e.g. tourism), and Mode 4 (presence of natural persons abroad, e.g. forms of business services).

The airline industry is one of the most global service sectors by scope of operations, yet has also been one of the most tightly regulated. Countries routinely limit the number of foreign entrants, the services they can offer, and the prices they can charge. This was the case in the United States until a concerted effort was made to liberalize passenger aviation. Between 1993 and 2008, the US signed more than 90 bilateral "Open Skies Agreements" (OSA) that removed barriers to cross-border air transport with partner countries. This provides us with an ideal policy experiment. As shown in Figure 1, these agreements come into force discretely and sequentially, allowing us to identify changes pre/post agreement within a given bilateral pair in comparison to pairs that have not yet liberalized.

Unlike many services, the output of passenger aviation - moving passengers between two locations - and the corresponding (ticket) prices and service attributes are well-defined, and so measurable with great specificity. We use two datasets that provide firm-specific information on the quantity of passengers and ticket prices for each international city-pair during the liberalization period.

Figure 2 illustrates the large increase in passenger traffic during the liberalization period. The increase is driven in part by the provision of new non-stop city-pair aviation routes, and in part by the growth of air traffic along previously offered routes. The volume of departures per route has also increased during this time period, while average (economy class) airfares dropped more than 20 percent (see Figure 3B). The questions central to this paper are how much of the observed changes in international air passenger transport can be attributed to services liberalization, what margins are important in the sector's adjustment to the new air traffic levels following the liberalization, and to what extent these policy changes map into consumer welfare gains.

We follow methods applied to goods trade and investigate three distinct channels though which services liberalization may generate welfare gains: 1). new variety effects, 2). efficiency gains from cost savings, and 3). service quality effects. In markets where entry and capacity restrictions were binding, Open Skies Agreements are likely to expand the number of routes available for a given destination, to raise market competition, and possibly to improve travel convenience (e.g., increased departure frequency, shorter connections). In quantifying these consumer welfare gains, we proceed in three steps.

First, we decompose the country level bilateral air passenger traffic into extensive (i.e., new city-pair routes) and intensive (i.e., more traffic per existing routes) margins, and evaluate how each component responds to the liberalization of air services trade. The nature of liberalization is ideal for identification, as we are able to identify changes pre/post agreement within a given bilateral pair in comparison to pairs that have not yet liberalized.

Second, we examine the link between Open Skies Agreements and changes in prices and quantities demanded for passenger aviation across thousands of city-pair markets. We start from reduced form demand and price equations that are specific to each country pair and air traffic route, and model Open Skies Agreements as shifters in both equations. Opening international aviation markets to foreign competition may directly affect prices via lower mark-ups, cost synergies from the formation of carrier alliances, and/or economies of traffic density. At the same time freeing trade in aviation services also affects air traffic volumes both directly by improving the travel experience (flight frequency, connections) and indirectly via changes in prices. Given the level of detail in the data, we are able to separate between air traffic flows that only connect in an Open Skies country (transit passengers) and traffic flows that terminate in a liberalized market (final destination passengers). This distinction helps us understand third country effects implied by the bilateral policy changes, such as the extent to which air services liberalization generates new traffic (trade creation) or just reallocates travelers to connect through Open Skies hubs (trade diversion).

Finally, we combine the variety, efficiency and quality effects in an overall air service price index adapted from Feenstra (1994). This index is interpreted as the price equivalent measure of air services liberalization. In implementing the consumer welfare calculations, we infer the elasticity of substitution among air transport service from the observed changes in product market share.

We find evidence for significant gains associated with opening aviation markets to foreign competition. Five or more years after the signing of an Open Skies Agreement, total U.S. outbound air traffic is on average 18 percent higher in liberalized markets compared to regulated ones. 40 percent of this increase is explained by the introduction of new non-stop routes to the liberalized foreign country (extensive margin effects), and the remaining 60 percent is attributed to air traffic growth along previously offered routes (intensive margin effects).

Looking at prices and quantities for each route, we find that the introduction of Open Skies Agreements leads to a 2-4 percent average drop in air fares (controlling for trip characteristics). These effects are larger on inbound markets, and on routes with net entry of carriers, and we provide evidence that the magnitudes are consistent with unregulated carriers achieving higher capacity utilization on each route. OSA lead to a 6-16 percent rise in quantities conditional on prices, and we provide evidence that this is consistent with consumers perceiving a quality change on these routes, and not consistent with a view that it reflects capacity constraints imposed by previous regulation. This quality effect translates into the equivalent of an additional 4.8 to 12.8 percent drop in prices. Combining the price, quality, and net routes effect we find the Open Skies Agreements lower prices by 32 percent relative to regulated markets.

The liberalization of air transport services has been the focus of few recent studies. Micco and Serebrisky (2006) estimate the effect of Open Skies Agreements on air cargo freight rates available from U.S. data on merchandise imports. Using a shorter panel than ours, and unit value type data, they find that air services liberalization reduces freight rates by 9 percent. Piermartini and Rousova (2009) estimate the impact of air services liberalization on the bilateral volume of air passenger flows using a cross-section sample of worldwide country-pairs, and an index of air services liberalization. While both studies find significant price, respectively quantity effects associated with air transport liberalization, neither one employs data of sufficient level of detail in order to implement the quantitative methods and to estimate the post-liberalization industry responses that we document in this paper.

Several industrial organization studies employ the same datasets that we use here to investigate the price effects of the inter-airline strategic alliances, which are granted by U.S. authorities conditional on market liberalization (Brueckner and Whalen, 2000; Brueckner, 2003; Whalen, 2007; Bilotkach, 2007). These studies find that airline alliances reduce airfares, which is consistent with our price results as Open Skies Agreements facilitate the formation of airline alliances.[6]

The paper proceeds as follows. Section 2 provides an overview of the evolution of the aviation industry towards full international liberalization. Section 3 describes the firm and transaction level air travel datasets used in the empirical analysis. Section 4 presents the econometric strategy and main estimation results, and is organized in two parts: Section 4.1 describes the air traffic decomposition and the impact of liberalization on the intensive and extensive margins. Section 4.2 analyses the price and quantity effects of Open Skies Agreements using demand and price equations for air transport services at city-pair market level.

2. Liberalization in International Air Transport Services

Historically, the provision of international air services has been severely restricted by the complex web of economic regulations and government controls, which limited access to new foreign markets, controlled entry on routes within those markets, and altered pricing and output decisions even for those routes where access was granted.[7] Efforts to set a flexible regulatory framework to govern international aviation markets go back to the Chicago Convention of 1944 when the International Civil Aviation Organization (ICAO) was established under the auspices of the United Nations. But besides safety and technical rules, the Convention failed to reach common grounds among participating countries in terms of key economic provisions such as traffic rights, market access, price and capacity decisions, leaving their negotiations to

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[6] Whalen (2007) is one study from this literature that extends beyond strategic alliances to tackle Open Skies Agreements using the same data sources but a substantially different sample. Surprisingly, he finds that Open Skies Agreements have a positive significant effect on route level air fares and an insignificant effect on the volume of international air passengers once controlling for market competition and strategic alliances. Unlike Whalen (2007), in this paper we do not distinguish the policy change effects from either competition or strategic alliance effects, as we consider them interrelated.

[7] As Doganis (2006) puts it "the airline industry is a paradox. In terms of its operations it is the most international of industries, yet in terms of ownership and control it is almost exclusively national."

be settled on a bilateral basis. Little has changed since then, as bilateralism has become the norm for regulating the global aviation market until today.[8]

A standard bilateral aviation agreement specifies a limited set of points/airports to be serviced by a restricted number of designated airlines (typically one or two carriers from each country). It also states the traffic rights granted to operating carriers, the capacity that can be supplied in each origin-destination city pair (with exact rules for sharing capacity), and the air fares to be charged on each route (with both countries' approval required before they can enter into effect). The prices generally decided upon in the agreements have been the fixed rates set by IATA during periodic air fare conferences (Doganis, 2006).[9] As an example of the restrictiveness of standard bilateral air transport agreements, the U.S. -- China Aviation Treaty (1980) restricts market access to two designated airlines per country, who can operate at most two round-trip flights per week each on routes connecting four U.S. points (New York, San Francisco, Los Angeles, Honolulu) to two Chinese cities (Shanghai, Beijing). Tokyo is the only third country location from where service to either country's designated airports can be operated. Prices charged on all routes must be submitted to government authorities two months in advance for double approval. In addition, both countries can take 'appropriate' action to ensure that traffic is 'reasonably balanced' and mutually beneficial to all designated airlines.

The strict regulation of operations in international aviation markets has shielded designated carriers from potential competition, discouraging efficiency and innovation. Earlier studies of the U.S. domestic airline industry have shown that the inability of airlines to actually compete in prices forced them to invest in service enhancements such as lower density seating or more flight attendants (Borenstein and Rose, 1998). Further, limitations in route and capacity choices increased operating costs by restraining airlines' ability to optimize their network structure, size and traffic density (Baltagi et. al,

[8] This may be among the reasons why international air transport services are left outside of the General Agreement on Trade in Services (GATS).

[9] IATA (International Air Transport Association) is the trade association of international airlines and one of its main tasks has been to fix prices on most international city-pair routes. Because IATA prices have to be agreed upon by all member airlines, they tend to be high enough to cover the costs of the least efficient carrier (Brueckner, 2003).

1995). To the extent that similar forces are at work in international aviation, deregulation may result in pronounced changes in prices, service quality, and passengers served.

Recognizing the need for restructuring international aviation markets, shortly after the domestic deregulation the United States passed the International Air Transportation Competition Act (1980), which set the stage for international market openness. The liberalization efforts debuted with the renegotiation of many U.S. bilateral aviation agreements during the 1980s -- the "open markets" phase. The main focus of these treaty renewals was to relax market access and capacity restrictions by extending the number of designated airlines, the pre-defined points of service, and the flight frequencies. Some agreements also granted a partial relaxation of pricing provisions and beyond traffic rights (i.e., the right to fly passengers between two pre-approved foreign points on the way to/from a carrier's home country). However, it wasn't until the beginning of the 1990s - the "open skies" phase - when the move to free trade in international air services has actually occurred.[10] The newly introduced Open Skies Agreements grant unlimited market access to any carrier for service between any two points in the signatory countries, full flexibility in setting prices, unconstrained capacity choice and flight frequencies, unlimited access to third country markets, and a commitment to approve inter-airline commercial agreements (e.g., code-share, strategic alliances).

Over the period 1993-2008 the U.S. signed 94 Open Skies Agreements with countries from all geographic areas. The timing of these agreements is depicted in Figure 1, and the complete list of partner countries is reported in the Appendix Table A1.[11] While the focus in the last two decades has been on achieving complete liberalization, the U.S. still continued to engage in bilateral negotiations that resulted in a partial relaxation of existing agreements. Sometimes such partial liberalization served as a short

[10] The U.S. initiatives for air services liberalization do not necessarily reflect those of other countries. While bilateral air service agreements across the world have been amended to relax their provisions, overall the global aviation market remains fairly closed to trade. Piermartini and Rousova (2009) provide a comprehensive description of all bilateral aviation treaties and conclude, based on index calculations, that 70 percent of them are still very restrictive.

[11] To understand whether the signing of the Open Skies Agreements follows a systematic pattern based on key country characteristics, we calculate how far into the sample period an agreement enters into effect and regress that on key country characteristics. The results from this exercise are reported in Appendix Table A2. As noticed, the timing of the agreement is not systematically correlated with population, market size, trade volume or per-capita GDP, or with their respective cumulative growth rates. These findings ensure against any potential endogeneity coming from the selection of partners into these Open Skies Agreements.

transitory stage before signing Open Skies Agreements, but often countries maintained or gradually raised their degree of partial liberalization. In our estimations we are going to control for this subset of countries transitioning into a partial liberalization phase.

3. Data Sources and Description

The air travel data used in this paper is drawn from two separate sources provided by the U.S. Department of Transportation (DOT). They cover international travel to and from the United States over the period 1993-2008. The richness of the datasets is one remarkable feature of this study in the context of scarce micro level information on international trade in services.

The *Databank 1B (DB1B) Origin and Destination Passenger Survey* represents a 10 percent sample of airline tickets drawn from airport-pair routes with at least one end-point in the U.S. Each airline ticket purchase recorded in the data contains information on the complete trip itinerary at airport level of detail, the air carriers marketing the ticket and operating each flight segment, the total air fare, distance traveled split by flight segments, ticket class type, as well as other segment level flight characteristics. Even though more than one air carrier may operate the travel itinerary, the responsibility to report the complete flight information to the DOT falls on the marketing carrier, which is also the one setting the air fare.

We apply several filters to the original DB1B dataset before using it for the empirical analysis. First, we keep only international airline tickets, dropping all domestic itineraries and all international trips transiting only the U.S. Second, we remove circuitous itineraries and keep only tickets that have a single trip break point used in identifying the final destination of the traveler. Third, to limit heterogeneity and coding errors in ticket prices, we further drop the following observations: a). business and first class tickets; b). tickets flagged by the Department of Transportation during data assembly as having unreasonably high fares; c). tickets with fares below $100 or above $9,999; d). tickets with more than four flight connections per direction of travel; e). tickets that involve land segments longer than 35 miles (i.e., transfers between two airports of the same city would not be dropped). Using the resulting sample, we construct a few additional ticket-level variables such as indicators for one-way trip, for direct service, and for the U.S. outbound itinerary. For round trip tickets we replace the fare level and ticket distance with half their values, to be directly comparable with one-way tickets. All observations for the same origin-destination pair are collapsed across all quarters within a given year using passenger-share weights to obtain route level annual aggregates. Finally, for reasons dictated by our traffic decomposition methods and described later on, we restrict attention to foreign countries with at least one city-pair route serviced continuously over we remove the very thin and infrequent aviation routes to be able to exploit in the empirics within city-pair variation.[12] The resulting restricted sample is going to be used for the estimation exercises. It includes about 50,000 origin-destination airport pairs, with an average of 12 observations per pair. The summary statistics for the variables of interest are provided in the Appendix Table A3.

One limitation of the DB1B data is that foreign carriers that are not part of immunity alliances are not required to file ticket sales information to the U.S. Department of Transportation.[13] This implies that itineraries along routes with a U.S. gateway airport end-point (i.e., US gateway-to-foreign gateway and US gateway-to-beyond foreign gateway routes) are under-represented in the estimation sample. However, information about foreign operated flights does appear in the DB1B dataset provided at least one segment of the tickets is operated by a US carrier. In fact, since international air traffic on routes involving non-gateway U.S. airports always requires a U.S. air carrier to provide service on the domestic spoke, then these sampled itineraries are representative for the population. Appendix Table A4 summarizes the distribution of international air traffic by route categories. The most frequently sampled route category is the U.S. behind-to-gateway routes, which reflects the extensive coverage of the U.S. domestic network. However, when factoring in traffic densities, 70 percent of the observed international air passenger traffic

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[12] To do this, we drop the bottom 10% city-pairs in terms of sample frequency across all quarters and years, the bottom 5% state-country pairs in terms of sample frequency across all quarters and years and with and we also drop the bottom 10% city-pairs in terms of number of sampled passengers across all time periods. While we end up dropping 27% of origin-destination-time observations, they represent only 2 percent of the observed international air passenger flows. Note that eliminating infrequent state-country pairs as opposed to infrequent foreign countries has the benefit of maintaining international routes between gateway airports, for example New York City to Dakar, Senegal, while removing barely sampled routes such as Indianapolis to Dakar.

[13] Immunity alliances represent strategic alliances between domestic and foreign airlines with granted antitrust immunity from the U.S. Department of Transportation. Immunity grants allow carriers to behave as if they were merged, cooperating in setting prices and capacity on all joint international route to and from the U.S.

represents gateway-to-gateway trips.[14] In fact, there is significant difference in average traffic densities across route categories. Therefore, the trade-off between representativity and relevance of the estimation sample is serious. If we were to consider a representative sample and only focus on behind-to-gateway and behind-to-beyond routes, we would essentially omit at least 77 percent of international traffic. So instead of doing that, we keep all sampled ticket itineraries in the sample and augment the empirical analysis with an alternative air travel dataset, which is more aggregated but offers complete coverage.

A second dataset we use in this paper is *T100 International Segment*. This is a firm level dataset that provides information on capacity and air traffic volumes on all U.S. non-stop international flight segments (defined at airport-pair level), distinguished by the direction of travel, and operated by both domestic and foreign carriers. The data is collected at monthly frequencies and reports for each carrier-route pair the number of departures scheduled and operated, seats supplied, onboard passengers, segment distance and airborne time. A more detailed description of the data and sample construction is included in the Data Appendix. One important advantage of the T100 Segment dataset is that it provides an exhaustive account of all U.S. cross-border air passenger traffic by operating carrier and airport-pair route.[15] Appendix Table A5 summarizes the aggregate market share of U.S. and foreign air carriers in total international air passenger transport, with the foreign airlines distinguished based on participation in antitrust immunity alliances. Two aspects are worth pointing out. First, the market share of US carriers has constantly dropped in the first half of the sample -- consistent with on-going efforts towards openness in air services trade -- although this downward trend reversed after 2001. Second, the fraction of international traffic operated by non-immunized foreign carriers is on average 36 percent. A fraction of

[14] This is a lower estimate of the true value given the unobserved number of travelers flying on foreign carries.

[15] However, the T100 Segment data does not easily match to the true Origin and Destination Passenger data, since passengers with very different start and end point itineraries get lumped together in a single observation in the T100 Segment dataset if their cross-border flight segment is the same. Unlike goods, which feature a one-to-one relation between a product and its producer, international air travel often involves the service of more than one airline. This is why firm- and product-level air travel datasets are imperfectly compatible.

these passenger flows (those having *all* flight segments operated by foreign air carriers) are omitted from the DB1B ticket level dataset.[16]

To complete the data description, Table 1 provides a summary of the evolution of international traffic on non-stop segments during the sample period 1993-2008. By any measure of industry performance - passenger volumes, number of non-stop international routes or annual departures performed (unreported) - international air traffic has grown at remarkable rates.[17] This period of expansion in international air travel has overlapped with a time of "global deregulation" (DOT, 1999). In fact, by 2008, as much as 62 percent of total U.S. international air passenger traffic passed through a foreign gateway airport located in an Open Skies country. Table 1 reports for each world geographic region the passenger share accounted for by OSA countries. Variations in the extent of air services liberalization across the globe reflect not only differences in countries' participation in liberalization policies but also differences in the timing of these decisions.

4. Econometric Analysis

There are three related objectives that we pursue in this section with the main aim of estimating the consumer welfare gains from services liberalization. First, we estimate how much of the increase in international air transport can be attributed to liberalization efforts, once accounting for the standard determinants such as income and population growth, and for other control factors. Second, we investigate the channels through which the industry adjusts to the new air traffic levels following liberalization. Here we consider variety, price and quality effects associated with Open Skies Agreements. Finally, we investigate how much of the observed changes in output and performance driven by openness gets transmitted on to consumers in the form of welfare gains.

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[16] Because only U.S. carriers can operate domestic routes, all international passengers that enter (exit) the U.S. on foreign carriers, yet fly an extra domestic leg to (from) their final (starting) point of their itinerary, have the same likelihood of being sampled in the DB1B dataset through reports prepared by the domestic carrier.

[17] The September 11 terrorist attracts, followed by other disrupting events like the Iraq war and SARS, have significantly affected the international aviation industry curbing its ascending trend. However these shocks were temporary, so traffic growth rates picked up again.

4.1. International Air Traffic Decomposition: Methodology and Results

The regulations governing international air transport have constrained air transport service by limiting markets access to a pre-defined set of city-pair routes, and by restricting firms' entry and operations in existing markets, in spite of air carriers' heterogeneous preferences for city pairs (as dictated by their hub-and-spoke network). Both constraints, if previously binding, should generate significant industry dynamics once an Open Skies Agreement becomes effective, and result in a net increase in services to that foreign country from new route offerings (*extensive margin effects*). It is also possible, that service liberalization actually reduces the variety of routes offered, if the increase in market competition forces some firms to consolidate their activity by funneling traffic through fewer gateway airports to lower average costs.[18]

Besides route expansion, air transport regulations also affect the volume of international traffic on the existing routes. Price and capacity controls are more likely the norm than the exception. In thin markets, the inability of firms to employ competitive pricing strategies makes it difficult to achieve optimal `fill rates' on planes. On the other hand, in thick markets, capacity restrictions determine firms to respond strategically by upgrading service quality (e.g., leg room, in-flight amenities). It may also be that firms in regulated markets, shielded from foreign competition, lack the incentives to optimize departures time or flight frequency, which greatly affect travel convenience. All these hypotheses suggest that once air service liberalization enters into effect, price and non-price competition may lead to significant changes in the volume of air traffic on existing routes (*intensive margin effects*).

To identify the changes in international air transport from a complete liberalization, we proceed by decomposing bilateral passenger flows into traffic on newly introduced routes (extensive margin), and traffic on previously offered routes (intensive margin). We then estimate how each of these margins responds to Open Skies Agreements, and assess their relative contribution to the overall change in international air traffic following the liberalization.

[18] In this tradeoff between scope and scale of air transport, service quality should not be ignored. A consolidation of international hub activity, while lowering average cost, often imposes the discomfort of more connections per trip.

For the decomposition exercises, we regard the flight service to foreign country *j* in period *t* as a traded 'variety'. In the data, a service will be defined as an aviation route -- a distinct origin-destination airport pair -- that provides non-stop air transport service to country *j*. We count Chicago-Paris as distinct from Atlanta-Paris, but do not distinguish whether that service was operated by United Airlines or Air France. This approach considers traffic substitution across city-pairs and treats routes but not carriers as differentiated.

The simplest way to decompose total air traffic Q_{jt}, defined as the sum of traffic across all international routes *r* to country *j*, is to calculate the number of routes offered N_{jt} and the average passenger volume per route at a given point in time:

(1) $$Q_{jt} \equiv \sum_{r} Q_{rjt} = N_{jt} * \overline{Q}_{jt}$$

However, a drawback of this approach is that it treats all air services as having equal value weights in the total consumption of international travel.

A sensible way to assess the importance of each aviation route is to measure its share in total bilateral air travel flows. Similar to the extensive margin calculation in Feenstra (1994) and the decomposition method in Hummels and Klenow (2005), we denote by I_{jt} the set of all services offered between the US and country *j* in period *t*, and by I_j the subset of services performed between the US and country *j* in both the reference period t_0 and current period *t*, i.e., $I_j \subseteq \left(I_{jt} \cap I_{jt_o} \right)$.[19] Then the total bilateral volume of air passengers can be decomposed as follows:

(2) $$Q_{jt} = \left(\sum_{r \in I_j} Q_{rjt} \right) \left(\lambda_{jt} \right)^{-1}, \quad \text{where} \quad \lambda_{jt} = \frac{\sum_{r \in I_j} Q_{rjt}}{\sum_{r \in I_{jt}} Q_{rjt}}$$

[19] In the empirical exercises, we will define the common variety set I_j to include those varieties that are have been available in the current year as well as there years before. This ensures that experimental or temporary aviation routes are excluded from I_j. We also experiment with a common variety set including routes offered both currently and in the previous year.

The first term of the decomposition -- the intensive margin -- measures the volume of air traffic accounted by aviation routes that are available in both the current and reference periods, i.e., the demand for "common" varieties. The lambda term represents the (passenger-share) weighted count of aviation routes to country *j* available in both time periods t_0 and *t.* Alternatively, the lambda term can be viewed as one minus the passenger-share weighted count of aviation routes that are "new" relative to the reference period. If all routes carried the same traffic volume (i.e., they have equal weights), then the lambda term would correspond to the fraction of routes from the total number currently offered, that were already available in the reference period t_0. If traffic on new routes is non-negligible, then the inverse of lambda - the extensive margin - is large, having an important contribution towards the total bilateral air traffic flow.

It is useful to express total air traffic in terms of annual growth rates. Equation (2) then becomes:

(3) $$\frac{Q_{jt}}{Q_{jt-1}} = \left(\frac{\sum_{r \in I_j} Q_{rjt}}{\sum_{r \in I_j} Q_{rjt-1}} \right) \left(\frac{\lambda_{jt}}{\lambda_{jt-1}} \right)^{-1}$$

In this formulation, the first term after equality captures the growth in air passenger traffic on "common" service varieties (routes), while the second term measures the *net* change in route offerings between two consecutive years. A lambda-ratio greater (less) than one implies a gain (loss) in service varieties. The benefit of expressing the extensive margin as a net measure is that in this way it accounts not only for new route additions, but also for any disappearing routes since the reference period. However, if adding or withdrawing city-pair routes are discrete, less frequent events, then cumulative (rather than annual) growth rates represent a more relevant way of expressing the extensive and intensive margins. Summing equation (3) over time periods until current year, we get an expression for the cumulative air traffic growth relative to the first sample year 1993:

(4) $$\Delta Q_{j,t}^{93} = \Delta IM_{j,t}^{93} * \Delta EM_{j,t}^{93}, \qquad \text{where} \qquad \Delta Z_{j,t}^{93} = \prod_{y=1994}^{t} \frac{Z_{jt}}{Z_{jt-1}}$$

and $Z \in \{Q, IM, EM\}$, with each element defined as in equation (2). We normalize $Z_{j,93}^{93}$ to one.

Figure 2 panels A-C depict the cumulative growth rates for the bilateral (U.S. outbound) air traffic, the intensive and extensive margins, distinguishing between liberalized versus regulated foreign destination countries. Over the 18-year period there has been a significant almost three fold increase in the volume of international air passenger flows. Many factors contribute to the observed trends (they do not control for any economic variables other than country specific effects), but two of them are of particular interest to this paper: the liberalization of services through Open Skies Agreements, and the observed net increase in route offerings (extensive margin).

To estimate the impact of liberalization on air passenger transport, we rely on the time dimension of the T100 International Segment data. Our identification strategy compares the change in passenger volumes within a country pair before and after the introduction of the Open Skies Agreements with the corresponding value calculated for countries that maintain restrictive aviation policies (control group). In using this difference-in-difference estimation method we consider the following regression model:

$$\ln \Delta Z_{jqt}^{93} = \beta_1 OSA_{jqt} + \beta_2 \ln \Delta \left(Y/L\right)_{jt}^{93} + \beta_3 \ln \Delta L_{jt}^{93} + X\beta + \alpha_{jq} + \alpha_t + \varepsilon_{jqt} \tag{5}$$

where j, q and t index the country, quarter and year respectively, and $Z \in \{Q_{jqt}, IM_{jqt}, EM_{jqt}\}$ takes in turn each variable, expressed as cumulative growth rates. The variable of interest OSA_{jqt} is an indicator variable that equals 1 for all the years when an Open Skies Agreement exists between the U.S. and country j. Y/L and L denote the per-capita income and population of the foreign country respectively, and represent the standard factors determining the demand for air travel; X denotes a vector of additional control variables, such as a *Partial Liberalization* indicator for non-OSA countries with more relaxed air transport agreements, a *9/11* control variable, and its interaction with a Visa Waiver Program (*VWP*) indicator to capture any differential response to the tightened security post 9/11 (Neiman and Swagel, 2009)[20], as well as selected region and country trend variables. Finally, α_{jq} and α_y represent country-quarter and year fixed effects.[21]

One complication in policy evaluation analyses comes from the potential endogeneity between the change in policy and the outcome variable(s) of interest. In our case, a primary concern is that the scale and expected future growth of the bilateral air transport activity may influence the likelihood and timing of an Open Skies Agreement. A first remedy to this issue is the transformation of variables into cumulative growth rates: to the extent that the selection of foreign countries into Open Skies Agreements depends on the initial traffic volume or density of aviation routes, then differencing the data eliminates such correlations. In addition, if the subsequent growth in air traffic also influences the United States' incentives to engage in any liberalization efforts, then the use of country-quarter fixed effects, together with the controls for income and population growth, further reduces the concerns for endogeneity. One last point on endogeneity worth making concerns the link between the timing of liberalization and the volume of air transport activity: if the countries that concede first to signing the Open Skies Agreements are among those that already have in effect more relaxed aviation regulations, and if such partial liberalization environments lead on average to higher traffic flows, then by directly controlling for partial liberalization in our estimations we also account for the implicit link between the timing of OSA (often following previous partial liberalizations) and traffic growth. We conclude the discussion on the endogeneity of Open Skies Agreements with the graphical representations in Figure 4. The first panel traces the changes in the cumulative air traffic growth rate for several years before and after liberalization, after controlling for the same determinants of air traffic as in regression equation (5). Similar time series plots are done for the intensive and extensive margins of air transport, respectively. The take-away message from each plot is that in the years prior to signing of the Open Skies Agreements there are no statistically significant differences in the growth of air transport across countries that will liberalize in the future versus those that remain restrictive.

[20] Very few countries change Visa Waiver Program Status during our sample period, so including the VWP variable independently in the regression has no effect on the estimates.
[21] Since the air transport data is for the U.S., the year fixed effects also account for any US specific time varying factors, such as size or income level

Moving to the estimation results, Table 2 reports the coefficients from the regression model in equation (5) estimated using the cumulative growth rate decomposition in equation (4). From the aggregate effects reported in Column 1, we find that countries who liberalize their international aviation markets receive on average 7.9 percent (i.e., exp(0.076)-1) more air passenger traffic from the U.S. conditional on demand side factors such as per-capita income, country size, bilateral distance, seasonality, or post-September 11 effects (differentiated by countries' visa regime). This observed increase in the volume of international air travel is explained in part by the net expansion of international aviation routes.

Liberalization leads to an increase in the extensive margin between 3.9 percent (Column 4) and 2.4 percent (Column 6), depending on how we define the common variety set. In the former case, the extensive margin calculations are based on a common variety set I_j, which includes routes available both in the current year t and three years prior. The latter set of calculations is based on a common variety set, which includes routes offered both in the current and previous years. The advantage of the former specification is that it prevents experimental or temporary aviation services to enter the common variety set I_j. However, by comparison with the estimates in Column (2) obtained when using a simple count of new aviation routes, both (passenger share) weighted extensive margin effects are significantly smaller. This makes it transparent why it is essential to account for any differences in the market share of city-pair routes: when the marginal benefit of newly introduced routes is lower on average than the marginal benefit enjoyed from existing services, then by treating all services - new and continuing routes - as equally beneficial, we end up overstating the importance of new routes.

Liberalization also affects the cumulative passenger growth along routes previously offered. The intensive margin effects range between 3.7 percent (Column 5) and 5.3 percent (Column 7). Given the log-additive property of the components of the air traffic decomposition, the estimated intensive margin effects are equivalent to the difference between total air traffic and extensive margin coefficients.

The estimated effects of air services liberalization on the cumulative growth in the intensive and extensive margins of U.S. outbound air traffic, while positive, are not always significant. But more often than not, trade policy changes require time for the international markets to adjust to new equilibrium levels. For the case of air services liberalization, it may take time for airlines to reorganize their international hub-and-spoke network and learn about the profitability of newly introduced services. To explore this hypothesis, we amend the previously estimated regression model to account for lagged response effects to trade liberalization. More exactly, we replace the OSA_{jqt} indicator variable with a set of indicator variables, one for each year up to the fifth year since the signing of an Open Skies Agreement, with the fifth year dummy variable cumulating all the remaining sample periods (i.e., indicator for "five or more years" since OSA). We also include a control variable for the year immediate prior to the liberalization, to verify the exogenous and unanticipated nature of these policy changes.[22]

Table 3 reports the regression results. Two points emerge from these estimates. First, for all three dependent variables, the impact of air services liberalization increases monotonically over time. Focusing on the long run effects, we find that the cumulative growth of air passenger travel after five or more years since an Open Skies Agreement is 20 percent. Of this increase, 37 percent (i.e., 7 percentage points) is the result of a net gain in new aviation routes, and the remaining 63 percent (i.e., 12.2 percentage points) is explained by passenger growth along previously offered routes. These numbers correspond to estimates in columns (2) and (3). A more frequent (year-on-year) updating of the "common" variety set implies that the newly introduced routes start to be accounted as previously available varieties within one year. As a consequence, any rapid increases or deteriorations in the market share of new services in their first few years of activity are going to be captured in the intensive margin. This explains the much lower (larger) extensive (intensive) margin estimates reported in Column 4 (Column 5).

4.2. Cost and Quality Effects of Open Skies Agreements: Micro-Data Evidence

The analysis so far has focused on variety effects to explain the overall impact of air services liberalization on travel growth. At the same time the intensive margin also brings a significant

[22] This approach is consistent with Micco and Serebrisky (2006) who find that OSA have the largest impact on air cargo prices three or more years after signing. We have also experimented with separate dummy variables for each of the five years following the introduction of an Open Skies Treaty. Generally, the coefficients on the dummy variables are rising in magnitude and significance as we increase the time post-OSA, with the fourth and fifth lag being consistently significant.

contribution to the increase in cross-border air passenger flows, especially in a longer time horizon. What is not yet understood is what factors are responsible for the sizeable traffic growth along continuously offered routes in the period following an Open Skies Agreement. Possible answers may consist of price effects coming from cost efficiencies and/or changes in price mark-ups, as well as quality improvements (e.g., travel convenience), all of which could be triggered by a more competitive liberalized market. This will be the focus of this subsection.

Unfortunately, the previous T100 Segment dataset cannot be used for these purposes. Its great advantage in providing full coverage of all international air transport comes at the expense of detailed information on trip characteristics, including prices or number of connections till final destination.

Instead, we complement our results with additional insights based on an airline ticket database, Databank 1B (DB1B). As described in the data section, the DB1B data includes detailed information on prices, service characteristics and full itinerary captured at airport detail. Knowing the complete itinerary of travelers allows us to separate between air traffic flows that only connect in an Open Skies country (transit passengers), and traffic flows that terminate in a liberalized market (final destination passengers). This distinction is important for understanding third country effects implied by the bilateral policy change, such as the extent to which air services liberalization generates new traffic (trade creation) or just reallocates transit passengers across international routes covered by Open Skies Agreements (trade diversion).

Given this ticket level DB1B dataset, we proceed in two steps: first, we quantify the price effects associated with the introduction of Open Skies Agreements; second, we identify any quantity effects that may operate independent of price changes, and infer from such demand shifts quality effects. In each case, we separately identify the effects of Open Skies Agreements on transit versus final destination passengers, as a way to identify third country effects.

To introduce the estimating equations, we consider a simple set-up that describes a city-pair (origin-destination) international aviation market. To characterize the demand side, we start by assuming that the representative U.S. consumers derive utility from all available city-pair routes r reaching all destination countries *j*, formalized through an asymmetric CES utility function. Straightforward utility maximization subject to the budget constraint gives the demand function for air travel on route *r*. Summing the individual demands by direction of travel in each city pair market leads to the following route specific air travel demand:

$$Q_{rjt} = \alpha_{rjt}\left[p_{rjt}(.)\right]^{-\sigma}\left(\frac{\mu Y_t}{P_t}\right) \tag{6}$$

where α_{rjt} denotes any route specific attributes that are valuable to the traveler and are not captured by the level of air fare $p_{rjt}(.)$; σ is the own-price elasticity of demand (which in a CES framework also defines the elasticity of substitution across routes); μ is the constant expenditure share of international travel in total U.S. income Y_t; and P_t is the CES price index for air transport services.

The demand shifter α_{rjt} is assumed to depend on a multiplicative term of observable trip characteristics Z_{rj} (such as distance, average number of connections, direction of travel: outbound vs. inbound, etc.), and unobservable service quality attributes that become effective with the Open Skies Agreements. In log form, we express the quality shifter as:

$$\ln \alpha_{rjt} = g(OSA_{jt}) + \ln Z_{rjt} \tag{7}$$

The impact of OSA on quality is largely an empirical question. On one hand, OSA could lead to a rise in quality through competitive pressures or through the implicit value to passengers of airline alliances or code-share agreements. But at the same time quality could also fall after liberalization if, as in the domestic market case, regulation of prices and capacity controls have caused airlines to overinvest in service quality.

A similar equation as (6) can be written for the demand arising from country *j* consumers for travel on the same route *r*. Under symmetric technologies, the only difference comes from the inclusion of foreign country expenditures instead of those for the U.S.. Summing the two demand equations we get the expression for the total air travel demand at city-pair level. We further refine this aggregate demand by decomposing total expenditures into population and per capita income at origin and destination. Taking logs, and substituting out α_{rjt} using equation (7), we obtain the following reduced form estimating equation for the (city-pair) total air passenger traffic:

(8) $$\ln Q_{rjt} = \beta_0 \ln p_{rjt}(.) + \beta_1 OSA_{jt} + \beta_2 \ln Z_{rjt} + \beta_3 \ln L_{st} + \beta_4 \ln\left(\frac{Y/L}{P}\right)_{st} + $$
$$+\beta_5 \ln L_{jt} + \beta_6 \ln\left(\frac{Y/L}{P}\right)_{jt} + \alpha_t + \alpha_{rj} + \varepsilon_{rjt}$$

where *s* indexes the US state associated with the aviation route *r*, and α_t, α_{rj} represent year and (city-pair) route fixed effects, respectively. The vector Z_{rjt} of demand shifting itinerary characteristics includes flight distance, average segments per trip (i.e., connections), the fraction of outbound traffic (i.e., passengers that begin their journey in the US), and the fraction of direct traffic.

In characterizing the supply side of an aviation market we employ a reduced form approach where the average air fare on the international route *r*, $p_{rjt}(.)$, depends multiplicatively on the marginal cost MC_{rjt} and the price mark-up γ_{rjt}.[23] Open Skies Agreements may affect airfares through changes in mark-ups and/or changes in marginal costs. Without distinguishing between the two channels, we write the expression for prices as:

(9) $$\ln p_{rjt} = h(OSA_{jt}) + \ln MC_{rjt} + \ln \gamma_{rj}$$

where we impose a time invariant route specific mark-up, net of the competitive effects of liberalization. We further assume that the marginal cost is a log-linear function of traffic density at origin (Q_{st}) and destination (Q_{jt}), of input prices w_t (e.g., fuel, aircraft insurance costs[24]), and of cost-related travel characteristics Λ_{rj} (e.g., distance, one-way trip, number of segments per trip, direction of travel, etc.).

Embedding the marginal cost assumptions in the prices equation given by (9), we arrive at the following reduced-form price regression:

(10) $$\ln p_{rjt} = \gamma_1 OSA_{jt} + \gamma_2 \ln Q_{st} + \gamma_3 \ln Q_{jt} + \gamma_4 \Lambda_{rjt} + \gamma_5 \ln(Dist_{rjt} * Fuel_t) +$$

[23] With a small number of air carriers in each city-pair route, mark-ups fall with entry even in the presence of constant elasticity demand. See for example Feenstra and Ma (2007).

[24] Although aircraft insurance costs represent a small share (0.2%) of the overall operating costs, they have witnessed dramatic changes over the sample period 1993-2003; since identification relies only on time variation, their contribution to explaining changes in operating cost is sizeable. See Figure 5 for trends in airline costs.

$$+\sum_{i=6}^{n}\gamma_i(\ln Insur_t * D_i^{geo}) + \alpha_t + \alpha_{rj} + \varepsilon_{rjt}$$

where α_t and α_{rj} are year and origin-destination city-pair fixed effects. In the data, we measure traffic density (Q_{st}, Q_{jt}) using population size and number of destination cities reached from each origin city. Also, we interact the input costs with relevant location-specific variables (i.e., average distance in the case of fuel prices, and dummies for worldwide geographic regions for insurance costs) because the available cost data varies only by time, which would make the variables perfectly collinear with the year fixed effects.

It is not theoretically obvious what direction the price change should go as a result of the Open Skies Agreements. In principle, the change in prices could go either way. Liberalization could reduce markups as competition from foreign firms reduces the market power of domestic firms. It may also lower unit costs as firms exploit economies of scale and scope from increased foreign market access and better cooperation within airline alliances. Yet, at the same time Open Skies Agreements could increase prices if the deregulated markets tend to favor a hub-and-spoke network structure with dominant firms located at major international (hub) airports. Such consolidation could threaten potential entry, leading to less competition and higher markups (Borenstein, 1989). Market liberalization may also push up costs due to increased competition for scarce factors (e.g., gate-space) or lower capacity utilization on shorter, thinner routes (Morrison and Winston, 1990).

The demand estimation model in (8) and the price equation in (10) are the main regressions to be estimated using the DB1B ticket level dataset. Both models include time and route-specific fixed effects, so identification relies entirely on time variation within each origin-destination city pair.[25] Additional control variables not mentioned before include an indicator variable for post-September 11 period interaction with a time trend, and a country indicator for Partial Liberalization.

We begin with the estimation of the price equation and report the results in Table 4. Column 1 includes the benchmark estimates. We find that the impact of Open Skies Agreements on airfares is close

[25] Figure 3 shows graphically the average change in route level prices and quantities over the sample period using the DB1B dataset.

to zero and insignificant. We suspect however that this small effect is the outcome of a miss-specified control group. In particular, suppose that the benefits of the bilateral Open Skies Agreements may accrue not only to passengers ending their trip in liberalized countries, but also to those that fly some segments of their itineraries along routes covered by Open Skies Agreements. If that is the case, then not separating out both itinerary types -- which are directly affected by Open Skies Agreements -- from the reference group of fully regulated air travel flows, makes it difficult to identify the actual effects of liberalization. So, we construct another liberalization variable: *OSA Connect*Share of distance*, measuring the distance share of an itinerary not involving OSA partners, that is traveled along connections covered by Open Skies Agreements. More exactly, *OSA Connect* equals 1 if a trip *r* to/from country *j*, where *j* has no Open Skies Agreement, transits via an airport hub *h* located in a fully liberalized market; and *Share of distance* measures the fraction that the connection between hub *h* and a point in the U.S. takes in total flight distance.[26] Column 2 reports the results including this additional liberalization variable, and both the direct and the network effects of Open Skies Agreement are negative and significant. The direct effect of liberalization indicates an average 1.6 percent drop in air fares conditional on other itinerary characteristics, a result that is very close to the estimate found by Micco and Serebrisky (2006) using air cargo rates. Such fare reductions generated by international air service liberalization may be explained by factors such as increased competition and cost synergies via carrier alliance formation. Interestingly, the network price effect of Open Skies Agreements (which affects air traffic connecting via liberalized countries) is larger in magnitude than the direct price effect whenever the distance share flown on OSA segments increases by at least 14 percent (i.e., -0.105*0.14 = -0.015) for transit itineraries. One potential explanation for this latter result lies in the development of strategic airline alliances, which are directly tied to Open Skies Agreements, are shown to bring significant price reductions on inter-airline routes (Brueckner and Whalen, 2003), have an extensive network coverage that includes non-OSA countries. To

[26] Formally, we construct the following variable at ticket level: $\sum_{i\in\omega}\left\{I(OSA_{i\omega}=1)\frac{dist_{i\omega}}{\sum_i dist_{i\omega}}\right\}$, where *i* denotes a flight segment of an airline ticket ω; *I(.)* is an indicator function equal to 1 whenever the flight segment *i* crossing the US border is covered by an Open Skies Agreement.

understand whether the liberalization effects differ between U.S. outbound and inbound flows, next we interact the OSA dummy with the fraction of passengers that originate their trip in the U.S. (i.e., outbound traffic). The results reported in Column 3 point out to significant differences in the effect of Open Skies Agreements on outbound versus inbound air traffic. While incoming travelers to the U.S. see a 4 percent decrease in air fares as a result of market liberalization, the OSA price effect for passengers originating their trip in the U.S. is insignificant and close to zero (when evaluated at the sample average share of outbound passengers per route). Furthermore, separating the average treaty effect into immediate impact (first three years since the signing of the treaty) and longer-term effects (three or more years after the treaty is in effect) does not change previous findings. The results reported in Column 4 of Table 4 reinforces the differential impact of the agreement on inbound and outbound traffic, while highlighting the time lag necessary for the market liberalization benefits to affect transit passengers to third countries.

We turn next to the estimation of the air travel demand equation at route level. Table 5 reports the results. Column 1 includes the OLS estimates from the benchmark model with route and year fixed effects, and column 2 allows for separate effects of the Open Skies Agreements on transit versus final destination traffic. Because the consumption benefits from connecting flights in fully liberalized countries have more to do with the increased convenience of using those hubs than with the fraction of the total distance traveled to get to those hubs, this time *OSA Connect* is constructed slightly different. It reflects the OSA transit intensity of travel in a city-pair market r involving a strictly regulated foreign country j. More exactly, *OSA Connect* is an indicator variable equal to 1 if at least 10 percent of travelers in a city-pair market involving a non-liberalized country do connect through an OSA hub.[27] The pattern of results that we find is consistent with the price regression results. That is, separating out the direct and the network effects of Open Skies Agreements reveals a sizeable and significant impact of liberalization on route level traffic. In column 3 we distinguish between the quality effects of OSA on U.S. outbound

[27] Experimenting with higher cutoff shares, such as 20% of total route level traffic, decreases the magnitude of the estimates but not their significance level. Yet, raising too much the cutoff share comes with the risk of ignoring economically important effects of OSA on connecting air traffic. This is because it is reasonable to expect carriers operating direct or alternative hub services on non-OSA routes to respond to competitive pressure from OSA connecting services in order to avoid large loses in traffic shares.

versus inbound traffic flows, and the pattern of results is reversed compared to the price effects. This time, it is the outbound passengers that benefit more from the liberalization of air services.

One issue with the OLS estimates reported in the first three columns is that they do not account for the fact that, in theory, prices are endogenous in a demand equation. To deal with this econometric problem, we re-estimate the demand model by two stage least squares (2SLS) and rely on the price equation to identify cost shifters that can be used as exogenous instruments for airfares. In particular, we exploit the time variation in fuel prices (interacted with average trip distance) and the variation in insurance cost shocks (interacted with world geographical region dummies) to identify the price elasticity of demand. Figure 5 shows the time trends for various cost components constructed using IATA data. It is transparent that the indexes with the largest time series variation over the sample period are fuel and insurance costs, which is precisely the reason we focus on those cost indexes.

Column 4 reports the two-stage least squares estimates. Several points emerge. First, the estimated price elasticity of demand increases in absolute value relative to the OLS estimate, as was expected, and now it conforms to other estimates from the literature.[28] Second, route level traffic originating in the U.S. and terminating in countries signatories of Open Skies Agreements increases on average by 11.3 percent relative to traffic with similar itinerary characteristics but operated on restricted aviation routes.[29] Such significant traffic growth generated by trade liberalization *net* of price effects can be attributed to improvements in service quality (e.g., flight frequency, better coordinated schedules and gate proximity, broader coverage of frequent flier programs, etc.). Third, the impact of market liberalization on traffic incoming to the U.S. falls to zero and becomes insignificant, once correctly accounting for the OSA effect on inbound airfares. However, when decomposing the average effects into immediate impact (first three years since the signing of the treaty) and longer term effects (three or more years into the treaty), as seen in Column (5), there is evidence that liberalization has positive and

[28] Brons et al. (2001) provide a meta-analysis of price elasticities of demand for passenger air travel and report a mean estimate of -1.146 (st.dev. 0.619) based on a set of 204 elasticities from 37 studies.

[29] Note also that the quantity effect of air trade liberalization is in the ballpark of the traffic growth values obtained from the T100 Segment dataset (reported in Table 2), although the T100 traffic data combines both true origin-destination and connecting traffic across non-stop international flight segments.

significant quantity effects for inbound traffic. Fourth, the gains from liberalization enjoyed by travelers transiting an OSA hub are larger than the direct effects estimated for traffic whose final destination are the OSA countries. The volume of international passengers who connect in airport hubs covered by Open Skies Agreements but do not terminate their itineraries in liberalized destination markets is larger on average by 8.6 percent relative to the reference group. Again, this may suggest that quality gains in air transport service may be more important in thin, poorly accessible, non-gateway international routes. All the other variables in the model have the expected sign and are generally significant.

The price and quantity effects of air services liberalization are estimated as an average effect over heterogeneous origin-destination city-pair routes. One dimension on which aviation routes may differ is market competition. Market liberalization presumably brings significant entry and exit of carriers across routes. Using a subsample of gateway-to-gateway routes of direct or one-stop round tickets matched to corresponding cross-border flight segments in the T100 dataset, we identify the city-pair routes that saw a net increase in air carriers three years into OSA from city-pairs that saw no change or even a net decrease in operating air carriers. Focusing on outbound traffic only, Table 6 reports the results from estimating the impact of OSA on air fares using this subsample of city-pair routes. Column 1 reports the average effects over all route types, and the insignificant coefficient reinforces the findings in Table 4. However, Columns 2 and 3 provide the explanation for this result: the overall OSA effect averages out the counteracting impact of liberalization on routes with net entry versus routes with net exit. That is, market liberalization leads to 2.3 percent lower air fares on routes with intensified completion, but increases average air fares by 4.3 percent on routes witnessing firm exits. This pattern is persistent in the longer run, as shown by the phase-in effects estimated in Columns 4 to 6.

Table 7 provides the same data exercise for the net entry/exit subsample but focusing instead on quantity effects. All estimates are obtained by 2SLS using as excluded instruments the same cost shifters as in Table 5. Consistent with our expectation, city-pair routes with net exit of carriers see no increase in air traffic post liberalization, even after accounting for their higher average prices. This is in contrast to the estimated 14 percent increase in traffic on routes enjoying net entry of carriers after OSA.

To test the sensitivity of our findings to the estimation sample, as a robustness exercise we re-estimate the demand and price regressions on two separate subsamples. One subsample selects only routes involving the main US airports for each state, with the large states represented by the top three airports in terms of traffic, while medium and small states counted with two or one airports respectively (see Appendix Table A6 for the list of selected airports). This subsample eliminates all the unusual and infrequent trip itineraries while still covering all three types of airport sizes in relatively equal shares (by count). The second subsample includes only behind-to-gateway and behind-to-beyond aviation markets, which have the advantage of being representative of actual traffic volumes even if they tend to be on average much thinner markets. Table 8 reports the estimation results using the same sets of instruments as previously described. Overall, the estimates are quite similar both across the two subsamples and with the estimates from the full sample in spite of differences in the composition of routes and of airline tickets per route.

5. Conclusions

Services represent the fastest growing component of world trade. Their contribution to the volume of international transactions by value is hypothesized to be much larger than the current 20 share, had it not been for the many restrictions and regulations that impede their access or presence in foreign markets. However, there is little evidence on how large policy barriers actually are for services trade, since virtually all empirical research on gains from liberalization focuses on goods trade. Using U.S. firm and transaction level data form a particular yet essential service sector -- international air passenger transport -- this paper identifies and measures the gains associated with a complete bilateral liberalization of international air services.

Exploiting the level of detail available in the U.S. air passenger transport data, we develop a body of empirical evidence on the overall impact of liberalization on industry outcomes and on the particular components that respond the most to the increased market openness. We find that Open Skies Agreements are associated with an average increase of 7.9 percent in bilateral air passenger traffic after controlling for standard determinants like income and country size. This adjustment in output to bilateral liberalization occur over time, reaching significantly higher levels five or more years after the signing of an Open Skies Agreement. What explains this differential growth in air traffic for liberalized countries are a net increase in the number of route offerings (variety effects) combined with a systematic growth in traffic volumes on existing, previously offered routes (intensive margin effects).

A further inquiry about the potential factors that could explain the increase in the intensive margin of air passenger traffic after liberalization leads us to investigate the price and quality effects associated with services liberalization. Open Skies Agreements. Exploiting ticket-level data for thousands of true origin-destination aviation markets characterized through reduced-form demand and price regressions, we find robust evidence that Opens Skies Agreements are associated with a decrease in average airfares, and -- independent of price levels -- with an increase in the demand for international air traffic at route level, conditional on a full set of itinerary characteristics. We interpret the former result as suggestive of lower mark-up and/or increased efficiency brought by the Open Skies Agreements, while the latter result is indicative of air service quality improvements such as, for example, more frequent departures, better coordinated schedules, or increased gate proximity for airline partners. Interestingly, the estimated price and quality gains associated with the liberalization are enjoyed not only by consumers traveling to a liberalized market, but also by transit passengers connecting through gateway airports located in Open Skies Agreement countries.

These identified gains from trade liberalization in air services have important economic implications. Not only is air travel a service consumers demand directly, it is also an input into other economic activities including cross-border manufacturing trade (Cristea, 2011). In a broader sense, liberalizing services can positively affect the economic performance of inter-linked sectors. This complementarity between service sectors and the production and trade of goods has just started to receive attention in recent research (Arnold et al., 2011; Francois and Woerz, 2008; Forlani, 2009; Debaere et al., 2009). An interesting avenue for future work would be to examine whether the improvements in connectivity across remote city-pairs brought by Open Skies Agreements has an impact on the openness to trade and investment of those regions.

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Figure 1: Timing of Open Skies Agreements during 1992-2008

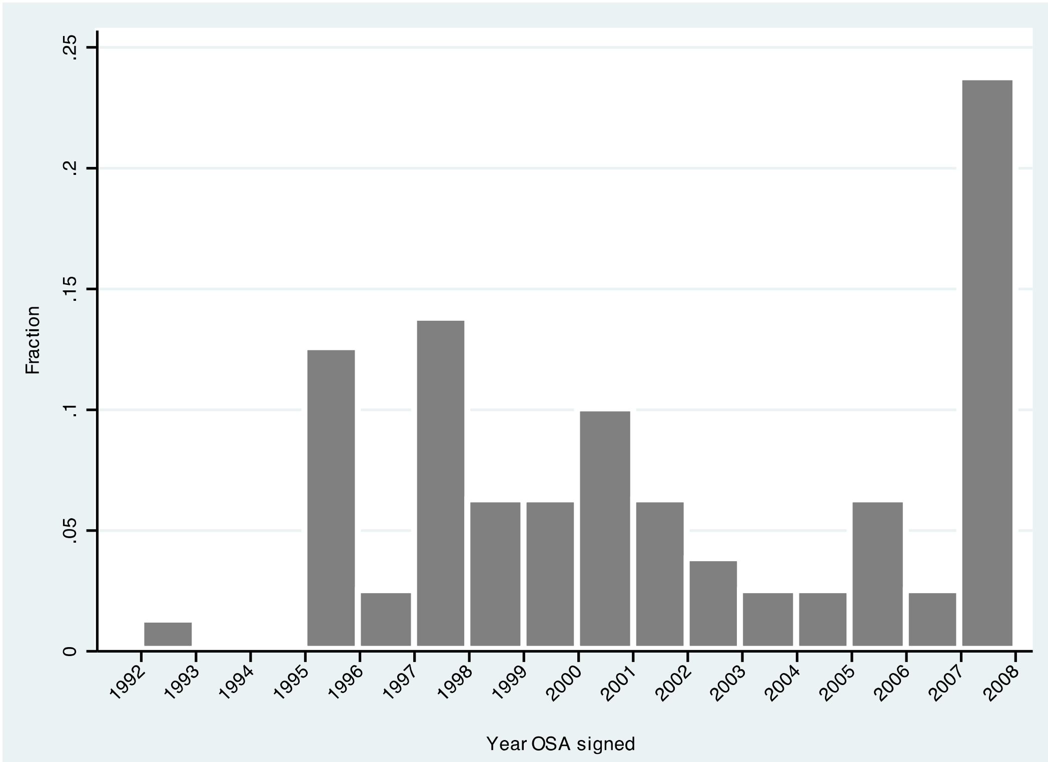
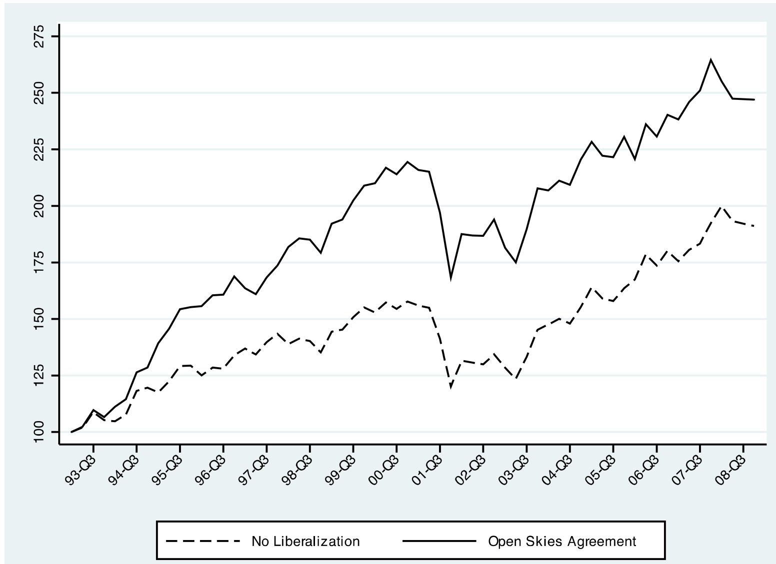
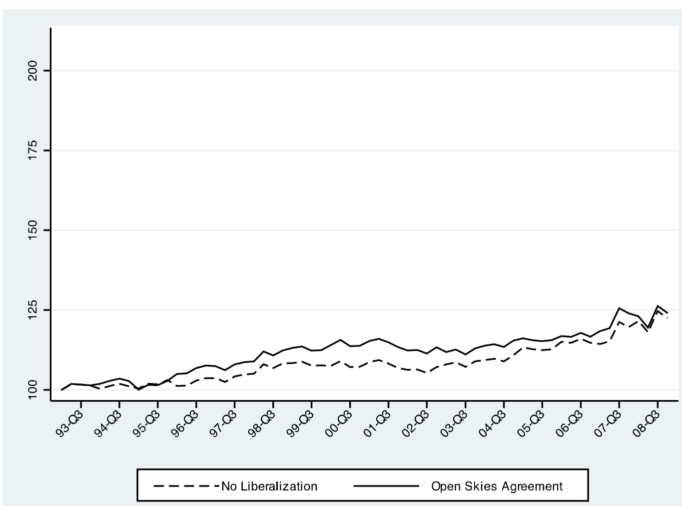


Figure 2: The Intensive and Extensive Margins of International Air Travel Services

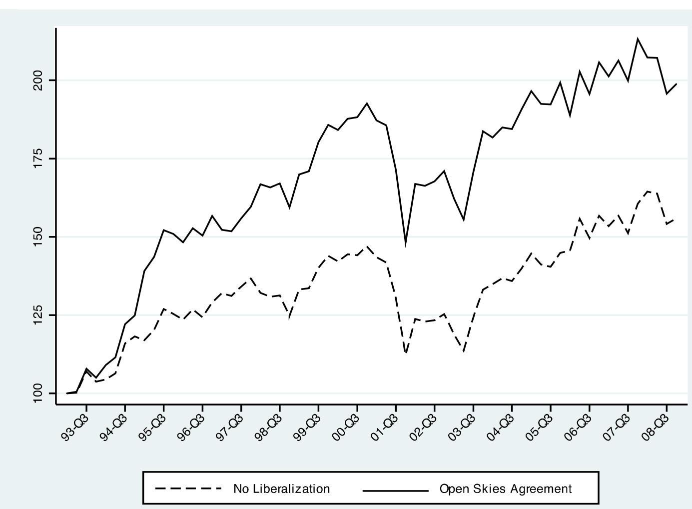
A. Total Traffic Growth



B. Extensive Margin: Cumulative Net Route Change



C: Intensive Margin: Air Traffic on Common Routes

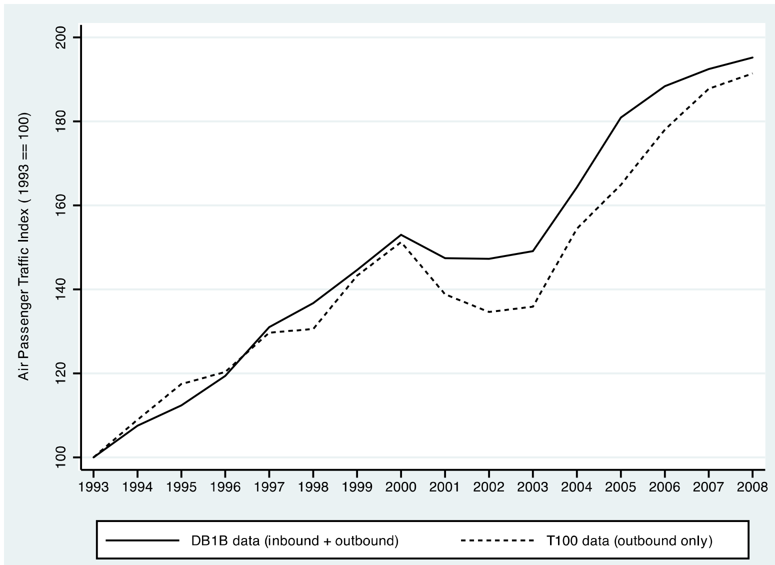


Notes:

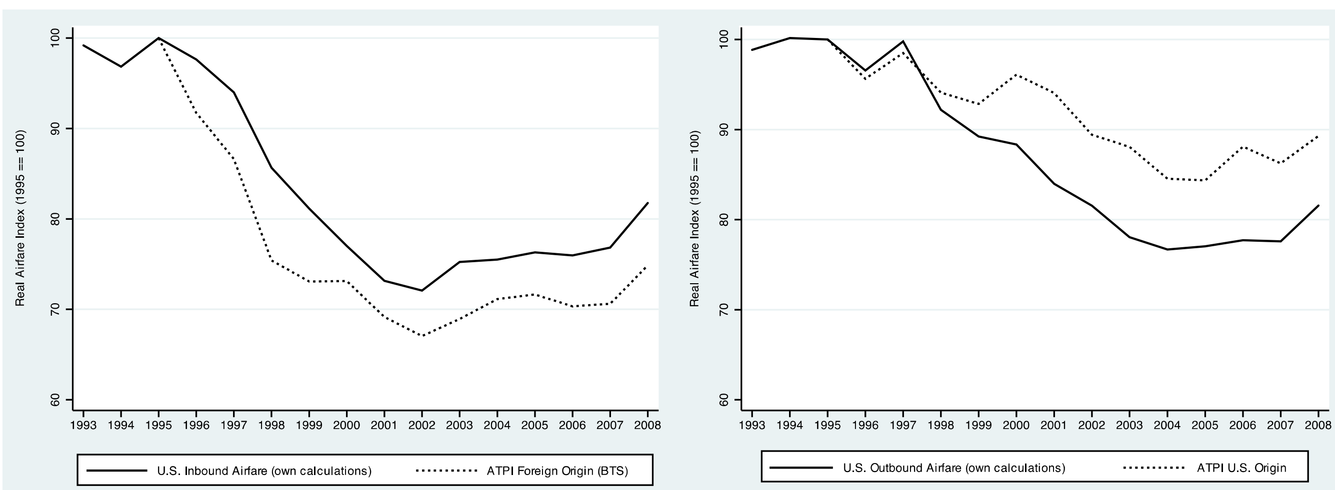
1. The data comes from the T100 International Segment dataset provided by the US Department of Transportation.
2. The series represent the (quarter-year) time period intercepts from a regression with destination country fixed effects. Any seasonality effects have been removed from the time series using moving averages.
3. *Total Traffic* measures the number of US outbound air passengers traveling from to a given destination country. *EM* denotes the extensive margin; it is calculated following the procedure described in the text and formalized by the inverse lambda term in equation (1). As a unit measure of a traded service, we use the number of international routes between the US and country *j*, and also the number of airlines trading air services between the two countries.

Figure 3: The Evolution of Air Travel using True Origin-Destination Data (DB1B)

3A: Air Passenger Traffic Trend



3B: Average Inbound and Outbound Airfare Trend

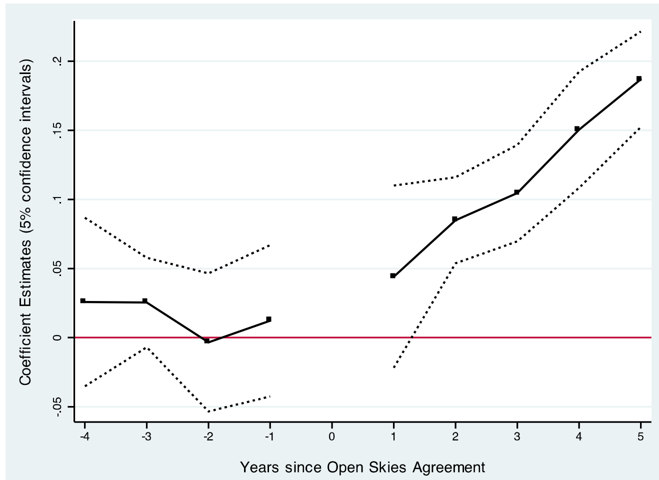


Notes:

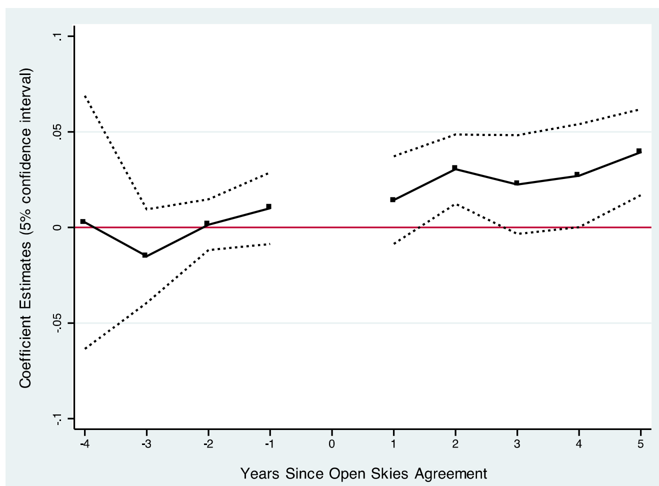
1. The series based on DB1B data represent the year intercepts from regressions with origin-destination city pair fixed effects. Economy class airfare values represent averages over inbound and outbound tickets within a route, and are first normalized using U.S. CPI values.
2. The Air Travel Price Index (ATPI) is a price index series provided by the Bureau of Transport Statistics starting from 1995. It is constructed based on the Fisher formula, separately for inbound and outbound travel flows.

Figure 4: Trends in Air Traffic Before and After the Policy Change

A. Total Air Traffic



B. Extensive Margin: Cumulative Net Route Changes



C. Intensive Margin: Traffic on Common Routes

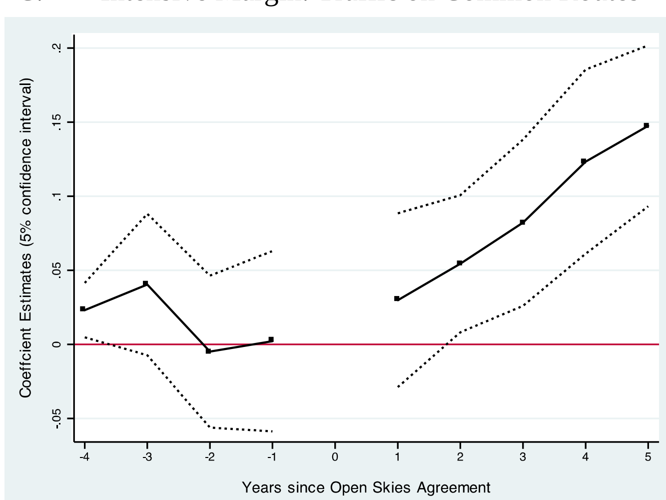
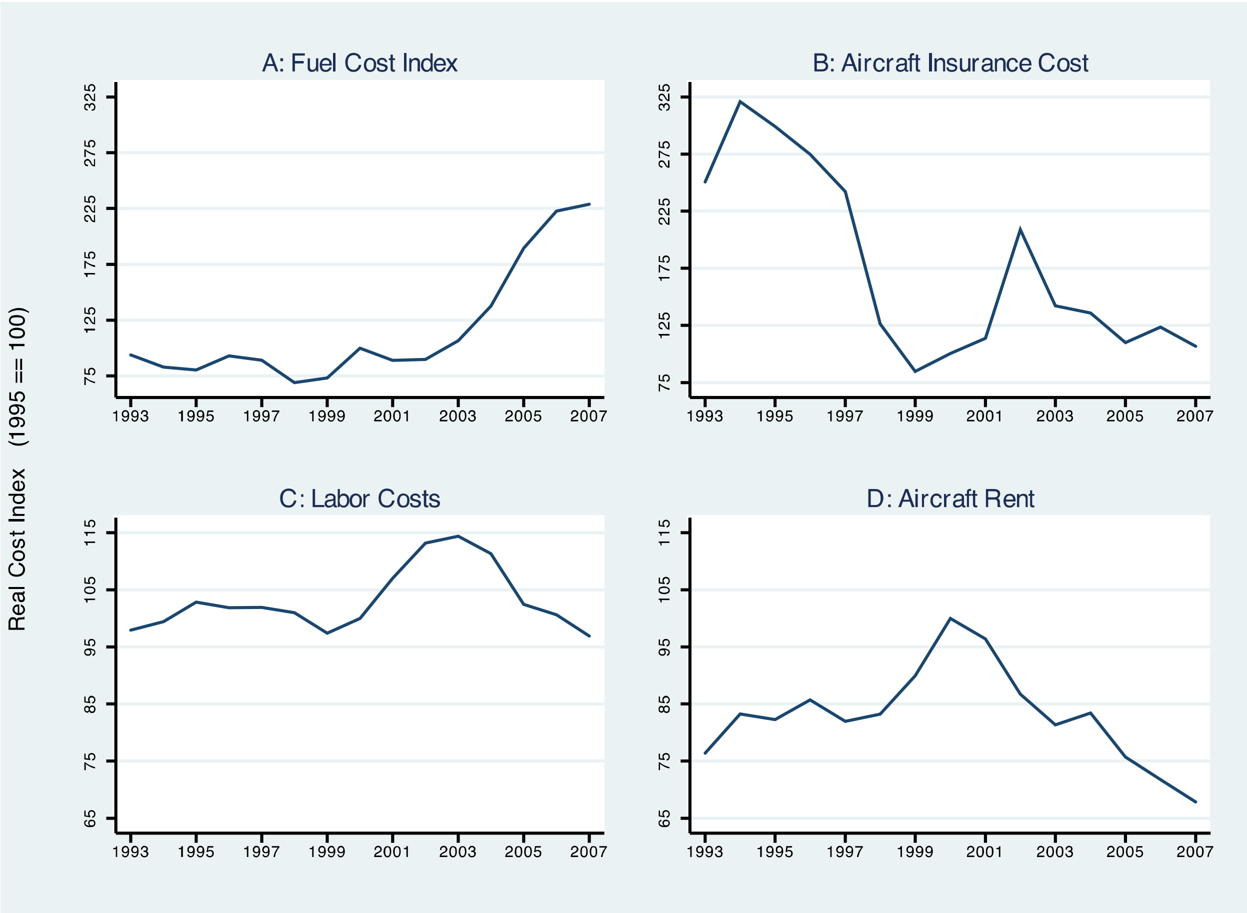


Figure 5: Aircraft Cost Indexes by Category

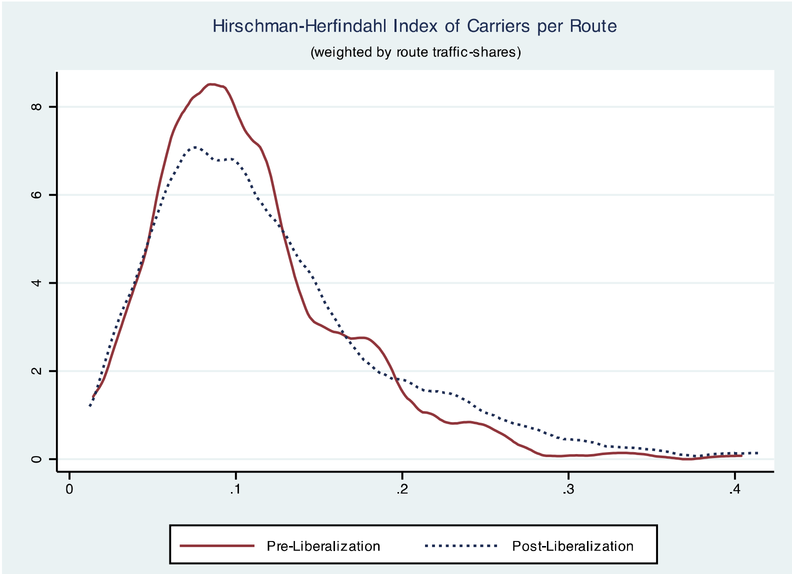


Notes:

1. Cost index series are taken from IATA. Each cost series is normalized using the CPI for the US and is scaled relative to year 2000 values.
2. Insurance costs are expressed as a percentage of hull net value. Labor costs represent wages per full time employee. Aircraft rent costs are expressed in dollars per operating seat.

Figure 6: Net Entry and Exit of Carriers across Routes after Liberalization

Panel A: Route Hirschman-Herfindahl Index Pre- vs. Post- OSA



Notes:

1. The HHI is calculated at the route level as the sum of squared market share per carrier. The number of carriers used for the kernel density plots are the residuals obtained from a regression on year and route fixed effects; this way, the graph is not distorted by other contemporaneous events to the signing of OSA, or by geography and average market size.
2. The kernel is drawn based on (passenger-share) weighted HHI across all routes offered pre- and post- OSA. The Pre-OSA (Post-OSA) period includes the 3 years prior to (following) the year of signing the agreement. So, the countries considered in this scatterplot are those that sign OSA between 1995 and 2005.

Panel B: Changes in the Number of Carriers per Route Pre- and Post- OSA

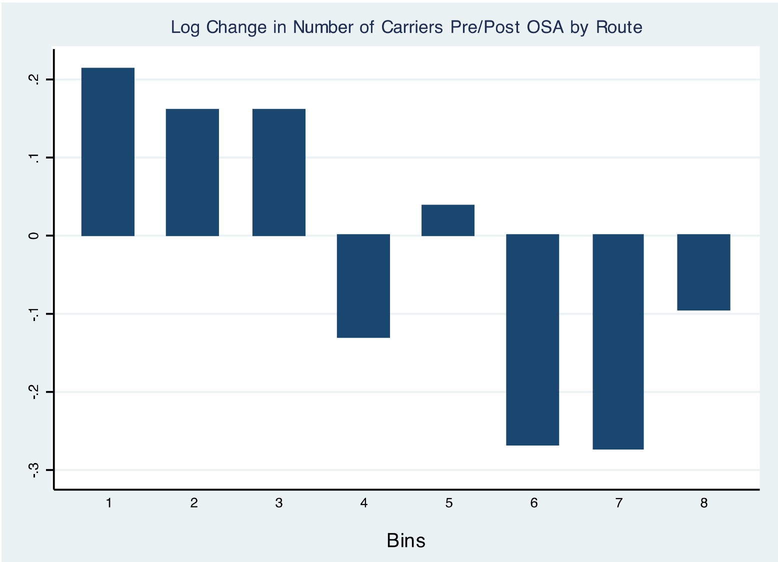


Table 1: Summary of U.S. International Air Passenger Transport

	1993	2000	2008	Cumulative Percent Change 1993-2000	Cumulative Percent Change 2000-2008
Total Passengers ('000), T100 Data					
NAFTA	10189	15821	20631	55.3	30.4
Latin America & Caribbean	8771	12903	17003	47.1	31.8
OECD Europe	14398	24454	25335	69.8	3.6
Europe & Central Asia	247	589	852	138.7	44.6
Southeast Asia & Pacific	8926	13029	12385	46.0	-4.9
Middle East & North Africa	423	734	856	73.5	16.5
TOTAL	*42953*	*67530*	*77061*	*57.2*	*14.1*
Non-Stop Routes, T100 data					
NAFTA	266	410	592	54.1	44.4
Latin America & Caribbean	235	312	436	32.8	39.7
OECD Europe	234	266	263	13.7	-1.1
Europe & Central Asia	13	18	20	38.5	11.1
Southeast Asia & Pacific	110	118	119	7.3	0.8
Middle East & North Africa	12	14	14	16.7	0.0
TOTAL	*870*	*1138*	*1444*	*30.8*	*26.9*
True Origin-Destination Markets, DB1B data					
NAFTA	6460	8077	8242	25.0	2.0
Latin America & Caribbean	4929	7658	6942	55.4	-9.3
OECD Europe	8969	12306	12241	37.2	-0.5
Europe & Central Asia	849	2260	2593	166.2	14.7
Southeast Asia & Pacific	5048	7113	7542	40.9	6.0
Middle East & North Africa	1177	1482	1160	25.9	-21.7
Sub-Saharan Africa	528	890	1104	68.6	24.0
TOTAL	*27960*	*39786*	*39824*	*42.3*	*0.1*
Traffic Share Covered by OSA, T100 data					
NAFTA	0	0.0	53.2	0.0	53.2
Latin America & Caribbean	0	28.5	41.0	28.5	12.5
OECD Europe	7.7	43.3	100.0	35.6	56.7
Europe & Central Asia	0	37.0	60.4	37.0	23.5
Southeast Asia & Pacific	0	22.2	32.6	22.2	10.4
Middle East & North Africa	0	8.9	7.1	8.9	-1.9

[a] In the case of traffic share accounted for by OSA, the values reported in columns 3 and 4 represent absolute percent differences rather than cumulative percentage changes.

Notes:

1. Data comes from the T100 Segment sample and includes only US outbound traffic in order to avoid double-counting of round-trip travelers.
2. All the reported values for total passengers, number of departures and non-stop routes are annual.
3. The number of non-stop routes represents a simple count of distinct origin-destination airport pairs within a year. So, if a route is serviced only in one quarter out of the full year, it counts the same as a route serviced in all four quarters. Results look quite different if quarter-origin-destination pairs are counted in the total number of routes because thick routes tend to receive more weight. Thus frequently traveled regions such as OECD Europe and Southeast Asia & Pacific would have small but positive growth rates until 2000, suggesting that the drop in routes comes from highly seasonal origin-destination pair

Table 2: Impact of Air Trade Liberalization on Country Level Passenger Transport

		Cumulative Margins of Adjustment (log)					
		Simple Route Count		Common routes defined relative to T-3		Common routes defined relative to T-1	
	Total Air Traffic	***Extensive***	***Intensive***	***Extensive***	***Intensive***	***Extensive***	***Intensive***
OSA	*0.076***	*0.107****	*-0.031*	*0.038***	*0.037*	*0.024*	*0.052**
	[0.031]	*[0.016]*	*[0.016]*	*[0.016]*	*[0.028]*	*[0.015]*	*[0.029]*
Ln Per Capita GDP (t/93)	0.334***	0.036	0.298***	0.011	0.323***	0.021	0.313***
	[0.056]	[0.038]	[0.038]	[0.028]	[0.055]	[0.028]	[0.054]
Ln Population (t/93)	0.001	1.510***	-1.509**	0.580***	-0.579	0.408***	-0.407
	[0.370]	[0.087]	[0.303]	[0.124]	[0.363]	[0.133]	[0.374]
11-Sep	-0.180***	-0.042	-0.139**	-0.018	-0.162***	-0.031**	-0.150***
	[0.027]	[0.051]	[0.040]	[0.016]	[0.026]	[0.014]	[0.025]
Sept 11*Visa Waiver	-0.098**	-0.016	-0.082**	0.004	-0.103**	0.033**	-0.132***
	[0.044]	[0.011]	[0.023]	[0.017]	[0.042]	[0.016]	[0.040]
Asia Crisis	-0.000**	-0.000*	0.000	-0.000	-0.000	-0.000	-0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Caribbean Trend	0.000	0.013***	-0.013***	0.004***	-0.003**	0.004***	-0.004*
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.002]
Partial Liberalization	0.046	0.098**	-0.051	0.049***	-0.003	0.029*	0.018
	[0.030]	[0.018]	[0.027]	[0.015]	[0.027]	[0.015]	[0.028]
Constant	0.037	-22.944***	31.054***	-0.072***	0.109***	-0.066**	0.104**
	[0.038]	[1.425]	[4.753]	[0.027]	[0.041]	[0.031]	[0.047]
Observations	4036	4036	4036	4,036	4,036	4,036	4,036
R-squared	0.506	0.303	0.223	0.299	0.339	0.288	0.368

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in brackets. All specifications include a constant, year and quarter-country fixed effects.

Notes:

1. The table reports the estimates from the regression models described by equation (5) in the text using as dependent variables each component from the decomposition in (4). The estimation sample is constructed from the T100 dataset and includes only non-stop flight segments originating in the US (i.e., outbound traffic).
2. *Total Air Traffic* is the total number of US outbound travelers to a given country in a quarter and year. The *Intensive Margin* measures air traffic on routes that are operated in the same quarter of both the reference year and year *t* (i.e., *common* services). The *Extensive Margin* (the *lambda*-term formalized in the text) represents the (passenger share weighted) count of routes that are new in quarter *q* and year *t* relative to the same quarter of the reference year (i.e, *new* services). *OSA* is a country-year indicator equal to one for all years when a bilateral Open Skies Agreement is in effect. All the other control variables are described in the text.

Table 3: Lagged Effects of Air Trade Liberalization on Country Level Passenger Transport

		Cumulative Margins of Adjustment (log)			
		Common routes defined relative to T-3		Common routes defined relative to T-1	
	Total Air Traffic	***Extensive***	***Intensive***	***Extensive***	***Intensive***
D (age_OSA == -1)	0.034	-0.000	0.034	0.002	0.032
	[0.022]	[0.013]	[0.023]	[0.010]	[0.022]
D (age_OSA == 0)	0.008	-0.001	0.009	-0.001	0.009
	[0.034]	[0.018]	[0.032]	[0.016]	[0.031]
D (age_OSA == 1)	0.048	0.018	0.030	0.016	0.032
	[0.031]	[0.018]	[0.030]	[0.015]	[0.030]
D (age_OSA == 2)	0.078**	0.046**	0.033	0.031*	0.047
	[0.036]	[0.020]	[0.034]	[0.018]	[0.035]
D (age_OSA == 3)	0.093**	0.046**	0.047	0.026	0.067*
	[0.042]	[0.021]	[0.038]	[0.020]	[0.040]
D (age_OSA == 4)	0.099*	0.056**	0.043	0.031	0.068
	[0.053]	[0.022]	[0.052]	[0.021]	[0.054]
D (age_OSA == 5+)	0.183***	0.068***	0.115**	0.044**	0.140***
	[0.053]	[0.023]	[0.049]	[0.022]	[0.050]
Ln Per Capita GDP (t/93)	0.337***	0.014	0.323***	0.023	0.314***
	[0.056]	[0.028]	[0.055]	[0.028]	[0.055]
Ln Population (t/93)	0.025	0.590***	-0.565	0.414***	-0.389
	[0.372]	[0.124]	[0.365]	[0.132]	[0.377]
11-Sep	-0.172***	-0.015	-0.157***	-0.029**	-0.143***
	[0.027]	[0.016]	[0.026]	[0.014]	[0.025]
Partial Liberalization	0.055*	0.051***	0.004	0.030**	0.025
	[0.030]	[0.015]	[0.028]	[0.015]	[0.029]
Observations	4,036	4,036	4,036	4,036	4,036
R-squared	0.513	0.303	0.343	0.290	0.374

Notes:

1. The table reports the estimates from the regression models described by equation (5) in the text using as dependent variables each component from the decomposition in (4). The estimation sample is constructed from the T100 International Segment dataset and includes only non-stop flight segments originating in the US (i.e., outbound traffic).
2. *D(age_OSA == n)* is an indicator variable equal to one for the n^{th} year since the introduction of an Open Skies Agreement. The control variables used in the estimation are the same as in Table 2. For conciseness, several estimates have not been reported in Table 3 (i.e., Sept 11* Visa Waiver, Caribbean Trend, dummy for Asian Crisis), but their sign and significance is as expected.

Table 4: Price Regressions: True Origin-Destination Air Travel (DB1B Sample)

	Dependent variable: Economy Class Airfare (log)				
	(1)	(2)	(3)	(4)	
				First 3 Years	*Past 3 Years*
OSA	0.004	-0.015***	-0.040***	-0.045***	-0.026***
	[0.005]	[0.005]	[0.006]	[0.007]	[0.009]
OSA Connect * Distance Share		-0.105***	-0.105***	0.020*	-0.119***
		[0.009]	[0.009]	[0.011]	[0.009]
OSA * Share US Origin (Outbound)			0.042***	0.047***	0.038***
			[0.007]	[0.008]	[0.008]
Ticket Distance (log)	0.176***	0.184***	0.183***	0.180***	
	[0.018]	[0.018]	[0.018]	[0.018]	
US State Population (log)	0.062*	0.069*	0.077**	0.070**	
	[0.036]	[0.036]	[0.036]	[0.036]	
US Airport Network Size (log)	0.039***	0.038***	0.038***	0.038***	
	[0.008]	[0.008]	[0.008]	[0.008]	
Foreign Country Population (log)	-0.347***	-0.335***	-0.337***	-0.347***	
	[0.039]	[0.039]	[0.039]	[0.039]	
Foreign Airport Network Size (log)	-0.122***	-0.122***	-0.122***	-0.119***	
	[0.006]	[0.006]	[0.006]	[0.006]	
No. Segments (log)	0.238***	0.243***	0.244***	0.243***	
	[0.008]	[0.008]	[0.008]	[0.008]	
Share US Origin	0.030***	0.030***	0.017***	0.017***	
	[0.004]	[0.004]	[0.005]	[0.005]	
Share One-way	0.395***	0.395***	0.394***	0.394***	
	[0.005]	[0.005]	[0.005]	[0.005]	
No. US Direct Routes (log)	-0.002	-0.002	-0.002	-0.002	
	[0.002]	[0.002]	[0.002]	[0.002]	
Fuel * Log Ticket Distance (log)	0.232***	0.228***	0.228***	0.219***	
	[0.068]	[0.067]	[0.067]	[0.066]	
Fuel * (Log Ticket Distance)^2	-0.015***	-0.015***	-0.015***	-0.014***	
	[0.004]	[0.004]	[0.004]	[0.004]	
Insurance*Lat. Am. & Caribbean	-0.060***	-0.059***	-0.059***	-0.045***	
	[0.006]	[0.006]	[0.006]	[0.006]	
Insurance*Mid East & North Africa	-0.021***	-0.024***	-0.026***	-0.021***	
	[0.007]	[0.007]	[0.007]	[0.007]	
Insurance*NAFTA	-0.086***	-0.084***	-0.085***	-0.072***	
	[0.006]	[0.006]	[0.006]	[0.006]	
Insurance*OECD Europe	-0.006	-0.005	-0.006	0.006	
	[0.005]	[0.005]	[0.005]	[0.005]	
Insurance*SE Asia/Pacific	-0.037***	-0.039***	-0.040***	-0.026***	
	[0.006]	[0.006]	[0.006]	[0.006]	
Insurance*Sub-Saharan Africa	0.031***	0.033***	0.032***	0.038***	
	[0.007]	[0.007]	[0.007]	[0.007]	
Partial Liberalization	-0.013**	-0.016***	-0.018***	-0.018***	
	[0.005]	[0.005]	[0.005]	[0.005]	
Observations	599533	599533	599533	599533	
R-squared	0.203	0.204	0.204	0.204	

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in brackets clustered by state-country pair.

Notes:

1. The table reports the estimates from the price regression described by the system of demand and supply equations in the text. The estimation sample comes from the DB1B dataset and includes only economy-class travel, inbound and outbound flows combined.
2. All specifications include year and city-pair fixed effects, as well as time trends for the Caribbean and Asian Crisis period.
3. *OSA Connect*Distance Share* is variable computed at city-pair level for routes that terminate in non-Open Skies countries, i.e., which have OSA indicator equal to zero. It measures the (passenger-weighted) average fraction of total trip distance that is flown on international segments involving an Open Skies airport hub (OSA connection).

Table 5: Quantity Regressions: True Origin-Destination Air Travel (DB1B Sample)

	Dependent variable: Number of Air Passengers (log)					
	OLS			2SLS	2SLS	
	(1)	(2)	(3)	(4)	(5)	
					First 3 Yrs.	*Past 3 Yrs.*
Economy Class Airfare (log)	-0.068***	-0.067***	-0.067***	-1.412***	-1.250***	
	[0.007]	[0.007]	[0.007]	[0.113]	[0.115]	
OSA	0.048***	0.088***	0.073***	0.002	0.019	0.048***
	[0.012]	[0.013]	[0.015]	[0.015]	[0.017]	[0.018]
OSA Connect		0.099***	0.099***	0.083***	0.108***	0.127***
		[0.008]	[0.008]	[0.009]	[0.009]	[0.010]
OSA*Share US Origin (Outbound)			0.024**	0.107***	0.069***	0.119***
			[0.012]	[0.015]	[0.018]	[0.017]
Ticket Distance (log)	-0.489***	-0.497***	-0.498***	--	--	
	[0.055]	[0.056]	[0.056]			
No. Segments (log)	-1.255***	-1.269***	-1.269***	-0.930***	-0.991***	
	[0.033]	[0.033]	[0.033]	[0.049]	[0.049]	
Share US Origin	-0.052***	-0.052***	-0.060***	-0.091***	-0.089***	
	[0.006]	[0.006]	[0.007]	[0.009]	[0.008]	
US State Per Capita Income (log)	-0.101	-0.103	-0.101	0.020	0.008	
	[0.123]	[0.124]	[0.124]	[0.108]	[0.104]	
US State Population (log)	0.678***	0.668***	0.672***	0.783***	0.782***	
	[0.128]	[0.129]	[0.128]	[0.094]	[0.092]	
Bilateral Exports (log)	0.026***	0.027***	0.027***	0.033***	0.031***	
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	
Foreign Per Capita GDP (log)	0.573***	0.575***	0.575***	0.335***	0.388***	
	[0.047]	[0.048]	[0.048]	[0.052]	[0.050]	
Foreign Country Population (log)	0.739***	0.716***	0.715***	0.242**	0.304***	
	[0.092]	[0.092]	[0.092]	[0.102]	[0.099]	
No. US Direct Routes (log)	0.066***	0.066***	0.066***	0.065***	0.065***	
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	
Asia Crisis Trend	-0.000**	-0.000***	-0.000***	-0.000***	-0.000***	
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	
Caribbean*Trend	0.019***	0.020***	0.020***	0.034***	0.035***	
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	
Partial Liberalization	0.010	0.017	0.017	-0.009	-0.007	
	[0.012]	[0.012]	[0.012]	[0.013]	[0.013]	
Observations	599,533	599,533	599,533	599,520	599,520	
R-squared	0.218	0.219	0.219	n.a.	n.a.	
First Stage Statistics:						
Instruments			Distance; Fuel*Distance; Fuel*Distance^2; Insurance*Regions			
Partial R-squared				0.0112	0.0101	
F-Test of ivs				108.2	97.85	
Hansen's j stat				126.6	139.1	

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in brackets clustered by foreign country. Year and airport-pair fixed effects included.

Notes:

1. The table reports the estimates from the quantity regression described by the system of demand and supply equations in the text. The sample comes from the DB1B dataset and includes only economy-class travel, inbound and outbound flows combined.
2. *OSA Connect* is an indicator variable equal to 1 if on a given route not belonging to an Open Skies country-pair the market share of travelers arriving at the destination via connection in an Open Skies hub airport is at least 10 percent. The list of exogenous instruments includes also interaction terms between fuel costs and route distance, and between insurance costs and seven world geographical regions.
3. In column (5), *First 3* refers to the first 3 years since OSA signing, while *Past 3* refers to the period 3 years or more into the treaty. These immediate and longer run effects of OSA are estimated in the same regressions.

Table 6: Price Effect of Liberalization in Markets with Net Entry or Exit (outbound flows)

	Dependent variable: Economy Class Airfare (log)					
	All Routes	*Net Exit*	*Net Entry*	*All Routes*	*Net Exit*	*Net Entry*
	(1)	(2)	(3)	(4)	(5)	(6)
OSA	-0.001	0.043***	-0.023***			
	[0.007]	[0.008]	[0.007]			
OSA First3 (Years 0, 1, 2)				-0.010	0.015*	-0.031***
				[0.006]	[0.008]	[0.007]
OSA Past3 (Years +3)				0.005	0.062***	-0.020**
				[0.008]	[0.010]	[0.009]
Partial Liberalization	-0.054***	-0.041***	-0.054***	-0.054***	-0.040***	-0.054***
	[0.009]	[0.009]	[0.010]	[0.009]	[0.009]	[0.010]
Direct	0.065***	0.052***	0.054***	0.065***	0.052***	0.054***
	[0.014]	[0.015]	[0.015]	[0.014]	[0.015]	[0.015]
US State Population (log)	0.021	0.049	0.043	0.020	0.049	0.043
	[0.048]	[0.055]	[0.051]	[0.047]	[0.055]	[0.051]
Foreign Country Population (log)	0.032	0.154	0.034	0.030	0.163*	0.033
	[0.073]	[0.094]	[0.075]	[0.073]	[0.095]	[0.075]
Ticket Distance (log)	-0.081***	-0.089***	-0.072***	-0.080***	-0.088***	-0.072***
	[0.019]	[0.022]	[0.021]	[0.019]	[0.022]	[0.021]
Fuel*Distance (log)	-0.291***	-0.292***	-0.283***	-0.292***	-0.286***	-0.284***
	[0.061]	[0.063]	[0.058]	[0.060]	[0.062]	[0.058]
Fuel* (Log Distance)^2	0.020***	0.020***	0.019***	0.020***	0.019***	0.019***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
Insurance*Europe & Central Asia	-0.042***	-0.031***	-0.026**	-0.040***	-0.028***	-0.024**
	[0.007]	[0.007]	[0.012]	[0.007]	[0.007]	[0.012]
Insurance*Lat. Am. & Caribbean	-0.084***	-0.100***	-0.084***	-0.083***	-0.099***	-0.083***
	[0.009]	[0.011]	[0.009]	[0.009]	[0.011]	[0.009]
Insurance*Mid. East & North Africa	-0.097***	-0.091***	-0.090***	-0.096***	-0.090***	-0.090***
	[0.009]	[0.010]	[0.010]	[0.009]	[0.010]	[0.010]
Insurance*NAFTA	-0.129***	-0.124***	-0.119***	-0.129***	-0.123***	-0.119***
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
Insurance*OECD Europe	-0.052***	-0.053***	-0.050***	-0.051***	-0.050***	-0.050***
	[0.005]	[0.005]	[0.006]	[0.005]	[0.005]	[0.006]
Asia Crisis Trend	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Caribbean*Trend	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	[0.000]	[0.001]	[0.000]	[0.000]	[0.001]	[0.000]
Observations	545,345	433,592	480,365	545,345	433,592	480,365
R-squared	0.063	0.063	0.058	0.063	0.063	0.058

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in brackets clustered by state-country pair.

Notes:

1. The table reports the estimates from the quantity regression described by the system of demand and supply equations in the text. This is a subsample of the DB1B ticket dataset that includes only round trip, economy-class, outbound travel, with at most one connection per direction of flight. For each of these tickets, the cross-border segment of the trip was matched to the corresponding segment in the T100 dataset.
2. A route is defined as having *net entry* if 3 years after OSA the number of carriers operating in that market is greater relative to 3 years prior to OSA. If the number of carriers post-liberalization remains constant or even decreases, then these routes are defined as having *net exit.*
3. Only city-pair markets that are active throughout the sample are used in this estimation, because only for these markets we can observe competition prior to liberalization. Similarly, countries that sign OSA too early or too late in the sample are also separately controlled for, since we again cannot observe changes in competition +/- 3 years since OSA.

Table 7: Quantity Effect of Liberalization in Markets with Net Entry or Exit (outbound)

	Dependent variable: Number of Air Passengers (log)					
	All Routes	*Net Exit*	*Net Entry*	*All Routes*	*Net Exit*	*Net Entry*
	(1)	(2)	(3)	(4)	(5)	(6)
OSA	0.077***	0.026	0.133***			
	[0.019]	[0.031]	[0.021]			
OSA First3 (Years 0, 1, 2)				0.023	-0.052	0.080***
				[0.019]	[0.033]	[0.021]
OSA Past3 (Years +3)				0.117***	0.064*	0.167***
				[0.021]	[0.033]	[0.023]
Economy Class Airfare (log)	-1.884***	-1.480***	-1.329***	-1.766***	-1.391***	-1.248***
	[0.195]	[0.196]	[0.182]	[0.187]	[0.190]	[0.179]
Partial Liberalization	-0.083***	-0.066***	-0.079***	-0.072***	-0.061***	-0.070***
	[0.021]	[0.019]	[0.020]	[0.020]	[0.019]	[0.019]
Direct	3.541***	3.596***	3.545***	3.532***	3.590***	3.539***
	[0.118]	[0.126]	[0.123]	[0.117]	[0.125]	[0.122]
US State Population (log)	0.490***	0.450***	0.435***	0.486***	0.442***	0.433***
	[0.146]	[0.154]	[0.145]	[0.140]	[0.150]	[0.141]
US State Per Capita Income (log)	0.577***	0.555***	0.488***	0.569***	0.539***	0.485***
	[0.158]	[0.159]	[0.145]	[0.151]	[0.155]	[0.141]
Foreign Country Population (log)	2.465***	2.379***	2.342***	2.459***	2.378***	2.328***
	[0.172]	[0.230]	[0.178]	[0.166]	[0.229]	[0.174]
Foreign Per Capita GDP (log)	0.333***	0.260***	0.280***	0.337***	0.251***	0.290***
	[0.049]	[0.051]	[0.048]	[0.048]	[0.050]	[0.048]
Bilateral Exports (log)	0.008	-0.005	0.005	0.005	-0.006	0.003
	[0.008]	[0.009]	[0.008]	[0.007]	[0.008]	[0.008]
Nominal Exchange Rate (log)	0.059**	0.054*	0.098***	0.066**	0.061**	0.101***
	[0.028]	[0.028]	[0.030]	[0.027]	[0.028]	[0.029]
Asia Crisis Trend	0.000*	0.000***	-0.000***	0.000**	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Caribbean*Trend	0.010***	0.008***	0.008***	0.010***	0.008***	0.008***
	[0.001]	[0.002]	[0.001]	[0.001]	[0.002]	[0.001]
Observations	538,042	427,852	473,543	538,042	427,852	473,543
R-squared	-0.152	-0.011	0.021	-0.109	0.014	0.042
First Stage Statistics:						
Instruments	Fuel*Distance; Fuel*Distance^2; Insurance*Regions					
Partial R-squared	0.00581	0.00624	0.00566	0.00602	0.00644	0.00584
F-Test of ivs	45.07	41.36	44.51	48.41	43.90	48.71
Hansen's j stat	132.2	80.92	101.8	139.6	82.54	105.1

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in brackets clustered by state-country pair.

Notes:

1. The table reports the estimates from the quantity regression described by the system of demand and supply equations in the text. This is a subsample of the DB1B ticket dataset that includes only round trip, economy-class, outbound travel, with at most one connection per direction of flight. For each of these tickets, the cross-border segment of the trip was matched to the corresponding segment in the T100 dataset.
2. A route is defined as having *net entry* if 3 years after OSA the number of carriers operating in that market is greater relative to 3 years prior to OSA. If the number of carriers post-liberalization remains constant or even decreases, then these routes are defined as having *net exit.*
3. Only city-pair markets that are active throughout the sample are used in this estimation, because only for these markets we can observe competition prior to liberalization. Similarly, countries that sign OSA too early or too late in the sample are also separately controlled for, since we again cannot observe changes in competition +/- 3 years since OSA

Table 8: Sample Sensitivity Analysis: Instrumental Variables Estimations

Dependent variable:	Airfare Coach (log)		Number Air Passengers (log)	
	Major State Airports	Behind Markets	Major State Airports	Behind Markets
Economy Class Airfare (log)			-1.584***	-1.221***
			[0.141]	[0.101]
OSA	-0.047***	-0.037***	0.004	-0.004
	[0.007]	[0.007]	[0.022]	[0.015]
OSA Connect	-0.115***	-0.098***	0.073***	0.097***
	[0.011]	[0.009]	[0.011]	[0.009]
OSA * Share US Origin (Outbound)	0.047***	0.041***	0.141***	0.103***
	[0.009]	[0.007]	[0.023]	[0.014]
Ticket Disrance (log)	0.193***	0.150***		
	[0.021]	[0.020]		
No. Segments (log)	0.246***	0.244***	-1.100***	-0.766***
	[0.010]	[0.010]	[0.066]	[0.042]
Share US Origin	0.047***	0.001	-0.099***	-0.070***
	[0.006]	[0.005]	[0.014]	[0.009]
No. US Direct Routes (log)	-0.007	-0.003*	0.059***	0.060***
	[0.004]	[0.002]	[0.011]	[0.006]
US State Population (log)	0.019	0.117***	0.998***	0.325***
	[0.039]	[0.042]	[0.120]	[0.097]
Foreign Country Population (log)	-0.316***	-0.350***	0.228*	0.289***
	[0.041]	[0.041]	[0.135]	[0.101]
US State Per Capita Income (log)			-0.374***	0.124
			[0.143]	[0.105]
Bilateral Exports (log)			0.032***	0.034***
			[0.005]	[0.004]
Foreign Per Capita GDP (log)			0.347***	0.334***
			[0.068]	[0.050]
Share One-way	0.402***	0.387***		
	[0.006]	[0.006]		
US Airport Network Size (log)	0.156***	0.016**		
	[0.027]	[0.008]		
Foreign Airport Network Size (log)	-0.101***	-0.172***		
	[0.006]	[0.008]		
Fuel*Log Distance	0.301***	0.237***		
	[0.076]	[0.066]		
Fuel* (Log Distance)^2	-0.019***	-0.015***		
	[0.005]	[0.004]		
Insurance*Lat. Am. & Caribbean	-0.040***	-0.069***		
	[0.006]	[0.006]		
Insurance*Mid East & North Africa	-0.018**	-0.026***		
	[0.008]	[0.008]		
Insurance*NAFTA	-0.069***	-0.089***		
	[0.006]	[0.006]		
Insurance*OECD Europe	-0.007	-0.005		
	[0.005]	[0.005]		
Insurance*SE Asia & Pacific	-0.041***	-0.034***		
	[0.006]	[0.006]		
Insurance*Sub-Saharan Africa	0.037***	0.030***		
	[0.008]	[0.009]		
Partial Liberalization	-0.022***	-0.014***	-0.004	-0.004
	[0.006]	[0.005]	[0.017]	[0.012]
Observations	311,784	403,774	311,775	402,533
R-squared	0.232	0.187	n.a.	n.a.
First Stage Statistics:				
Partial R-squared			0.00981	0.0116
F-Test of ivs			94.67	88.26
Hansen's j stat			99.56	125.2

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in brackets clustered by foreign country.

Table 9: Welfare Calculations

	OSA direct		OSA connect	
Sigma == 1.25	*outbound*	*inbound*	*outbound*	*inbound*
D Airfare (price effect)	0.000	-0.026	-0.060	-0.053
D Quality (quantity effect net of prices)	-0.098	-0.038	-0.102	-0.102
D *Quality Adjusted* Price Index	**0.902**	**0.936**	**0.839**	**0.846**
D Lambda-ratio Variety Index	0.755	0.755	0.755	0.755
D *Variety Adjusted* Price Index	**0.681**	**0.706**	**0.633**	**0.638**
Drop in Price Index due to OSA (%)	**31.91%**	**29.41%**	**36.70%**	**36.18%**

Notes:

1. The welfare calculation assumed that the extensive margin effect estimated in the T100 data sample affects travelers in the same way no matter whether they connect and terminate their travel in the liberalized country. That is, the variety index enters in the same way the welfare calculations for direct and connect traffic.

2. The average price and quantity effects estimated using the DB1B data sample are assumed not to differ across routes that are offered continuously (i.e., common varieties) versus routes that are newly introduced.

Appendix Tables

Table A1: List of Countries and Years when Open Skies Agreements were signed

Year OSA	Country	Region	Population 1993	Pop. Growth 1993-2008	Per-capita Income 1993	Income Growth 1993-2008
1992	Netherlands	OECD Europe	16.54	4.68	9.88	4.95
1995	Austria	OECD Europe	15.89	4.66	9.89	4.92
1995	Belgium	OECD Europe	16.13	4.66	9.85	4.88
1995	Denmark	OECD Europe	15.46	4.66	10.11	4.88
1995	Finland	OECD Europe	15.44	4.65	9.78	5.10
1995	Iceland	OECD Europe	12.48	4.79	10.13	5.02
1995	Norway	OECD Europe	15.28	4.71	10.30	4.96
1995	Sweden	OECD Europe	15.98	4.66	10.00	4.98
1995	Switzerland	OECD Europe	15.75	4.70	10.37	4.78
1995	Czech Republic	Europe & Central Asia	16.15	4.61	8.46	5.09
1996	Germany	OECD Europe	18.21	4.62	9.91	4.84
1996	Jordan	Middle East & North Africa	15.18	5.02	7.41	5.01
1997	Chile	Latin America & Caribbean	16.45	4.79	8.23	5.11
1997	Costa Rica	Latin America & Caribbean	15.01	4.92	8.15	5.01
1997	El Salvador	Latin America & Caribbean	15.53	4.70	7.49	5.00
1997	Guatemala	Latin America & Caribbean	16.07	4.97	7.33	4.83
1997	Honduras	Latin America & Caribbean	15.49	4.92	7.02	4.85
1997	Malaysia	East Asia & Pacific	16.79	4.93	8.06	5.09
1997	New Zealand	East Asia & Pacific	15.09	4.78	9.34	4.90
1997	Nicaragua	Latin America & Caribbean	15.31	4.85	6.45	4.96
1997	Panama	Latin America & Caribbean	14.76	4.89	8.15	5.11
1997	Singapore	East Asia & Pacific	15.01	4.98	9.74	5.17
1998	Italy	OECD Europe	17.86	4.66	9.73	4.76
1998	Korea	East Asia & Pacific	17.60	4.70	9.02	5.23
1998	Peru	Latin America & Caribbean	16.95	4.83	7.42	5.17
1998	Romania	Europe & Central Asia	16.94	4.55	7.35	5.21
1999	Bahrain	Middle East & North Africa	13.21	4.96	9.34	5.00
1999	Pakistan	South Asia	18.57	4.96	6.21	4.87
1999	Portugal	OECD Europe	16.12	4.67	9.08	4.88
1999	Tanzania	Sub-Saharan Africa	17.15	5.02	5.53	4.97
1999	UAE*	Middle East & North Africa	14.60	9.99	9.99	4.78
2000	Ghana	Sub-Saharan Africa	16.61	4.97	5.44	4.96
2000	Malta and Gozo*	Europe & Central Asia	12.82	8.92	8.92	4.95
2000	Morocco	Middle East & North Africa	17.08	4.80	7.04	5.03
2000	Nigeria	Sub-Saharan Africa	18.47	4.97	5.90	4.90
2000	Senegal	Sub-Saharan Africa	15.92	5.00	6.10	4.79
2000	The Gambia*	Sub-Saharan Africa	13.82	5.81	5.81	4.69
2000	Turkey	Europe & Central Asia	17.90	4.83	8.19	4.95
2001	France	OECD Europe	17.87	4.69	9.87	4.83
2001	Oman*	Middle East & North Africa	14.53	8.93	8.93	4.86
2001	Poland	Europe & Central Asia	17.47	4.60	8.02	5.32
2001	Sri Lanka	South Asia	16.69	4.74	6.47	5.22
2002	Jamaica	Latin America & Caribbean	14.71	4.70	8.19	4.65
2002	Uganda	Sub-Saharan Africa	16.79	5.08	5.27	5.18
2003	Albania	Europe & Central Asia	14.98	4.58	6.57	5.53
2004	Indonesia	East Asia & Pacific	19.04	4.80	6.60	5.00
2004	Uruguay	Latin America & Caribbean	14.97	4.66	8.72	4.96
2005	India	South Asia	20.62	4.84	5.82	5.36
2005	Mali	Sub-Saharan Africa	16.03	4.93	5.25	5.05
2005	Paraguay	Latin America & Caribbean	15.34	4.91	7.26	4.67

2005	Thailand	East Asia & Pacific	17.89	4.74	7.45	5.04
2006	Cameroon	Sub-Saharan Africa	16.41	4.97	6.39	4.77
2007	Bulgaria	Europe & Central Asia	15.95	4.50	7.30	5.16
2007	Canada	NAFTA	17.18	4.75	9.85	4.94
2007	Cyprus	Europe & Central Asia	13.47	4.80	9.18	4.99
2007	Greece	OECD Europe	16.16	4.67	9.18	5.05
2007	Hungary	Europe & Central Asia	16.15	4.57	8.19	5.15
2007	Ireland	OECD Europe	15.09	4.82	9.60	5.34
2007	Liberia	Sub-Saharan Africa	14.48	5.27	4.42	5.18
2007	Spain	OECD Europe	17.48	4.76	9.35	4.95
2007	United Kingdom	OECD Europe	17.87	4.67	9.91	4.97
2008	Australia	East Asia & Pacific	16.69	4.80	9.78	4.96
2008	Kenya	Sub-Saharan Africa	17.07	5.01	6.02	4.70
2008	Laos	East Asia & Pacific	15.33	4.91	5.49	5.27

* Growth rates are for the period 1993-2007.
Note: The following 16 countries have signed an Open Skies Agreement with the U.S. but there is missing data on either population or income for the period of interest: Armenia (2008), Aruba (1997), Bosnia-Hercegovina (2007), Croatia (2008), Estonia (2007), Georgia (2007), Kuwait (2006), Latvia (2006), Lithuania (2007), Luxembourg (1995), Quatar (2001), Slovakia (2000), Slovenia (2007), Tonga (2003), Uzbekistan (1998), Western Samoa (2002).

Table A2: Testing for Endogeneity in the Timing of Open Skies Agreements

	Dependent Variable: (Year OSA - 1992)					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Population 1993	0.504				0.180	0.501
	[0.307]				[0.412]	[0.513]
Log Population Growth ‘93-‘08	3.413				-1.041	-7.399
	[3.422]				[4.363]	[5.509]
Log GDP 1993		-0.154				
		[0.310]				
Log GDP Growth ‘93-‘08		3.635				
		[2.506]				
Log Per-Capita GDP 1993			-0.501		-0.470	-0.173
			[0.513]		[0.692]	[1.062]
Log Per Capita GDP Growth ‘93-‘08			3.292		2.452	-2.564
			[2.758]		[3.561]	[3.892]
Log Exports 1993				-0.279		
				[0.214]		
Log Export Growth ‘93-‘08				-0.838	-0.420	-0.175
				[0.688]	[0.615]	[1.062]
Log Distance					1.499	
					[1.697]	
Log Average Tariffs (year 2001)						0.683
						[0.858]
High & Upper Middle Income Dummy			-1.299	-1.868	-1.568	-2.124
			[1.611]	[1.205]	[1.661]	[1.849]
Constant	-16.101	-6.729	-3.277	19.862***	-8.113	51.420
	[18.107]	[17.785]	[15.610]	[6.570]	[34.723]	[47.141]
Observations	64	64	64	64	64	41
R-squared	0.039	0.048	0.124	0.105	0.160	0.171

*** p<0.01, ** p<0.05, * p<0.1; Robust standard errors in brackets

Table A3: Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Air Traffic Indicators					
Econ Passengers	599533	63.18	422.87	1	39572
Econ Airfare	599533	619.94	393.28	50	9238
OSA	599533	0.31	0.46	0	1
OSA connect	599533	0.13	0.34	0	1
OSA connect* Dist. Share	599533	0.06	0.17	0	0.97
US Direct Routes	523740	31.04	35.71	1	186
Itinerary Characteristics					
Direct	599533	0.01	0.09	0	1
Segments	599533	2.72	0.56	1	4
Share One-Way	599533	0.17	0.25	0	1
Share US Origin	599533	0.62	0.34	0	1
Ticket Distance	599533	4886.73	2684.15	37	17818
EU Indicator	599533	0.35	0.48	0	1
NAFTA indicator	599533	0.21	0.40	0	1
Caribbean Indicator (incl. Mexico)	599533	0.16	0.37	0	1
Cost Indexes					
Fuel Cost Index	599533	130.62	66.83	69.10	290.21
Insurance Cost Index	599533	163.40	76.71	79.29	320.91
Demand Shifters					
State Population (log)	599533	15.85	0.99	13.07	17.42
US State Income (log)	599533	5.65	0.15	5.21	60.26
Country Population (log)	599533	17.16	1.75	10.60	21.00
Per Capita GDP (log)	599533	9.04	1.26	4.42	11.19
Real Exports (log)	599533	18.73	2.66	7.84	24.80

Table A4: Distribution of Route Categories in the DB1B Dataset

	US Gateway-to-Foreign Gateway	US Gateway-to-Foreign Beyond	US Behind-to-Foreign Gateway	US Behind-to-Foreign Beyond
Routes	57,396	138,363	249,505	154,269
Fraction of Total Routes (%)	10.26	24.73	44.59	27.57
Avg. Passengers per Route	447.05	18.44	33.08	5.77
Fraction of Total Int'l Traffic (%)	69.69	7.68	20.07	2.56

Notes:

1. The reported values are annual.
2. The U.S. gateways are defined as airports that offer at least one international flight per business day per direction of travel. Similarly, foreign gateways are defined as airports that offer at least one flight per business day anywhere in the US per direction of travel. The number of departures performed by sampled airports is provided in the T100 Segment dataset, which is the source of data used in constructing the gateway indicator.
3. The distribution of routes and passengers by route categories is calculated on the restricted DB1B sample. See the text for details on sample construction.

Table A5: Airline Market Shares at Route Level in the T100 Segment Data

	Share of Total International Air Passenger Traffic Supplied by:		
	U.S. Domestic Carriers (%)	*Foreign Carriers with Immunity (%)*	*Foreign Carriers No Immunity (%)*
1993	54.48	1.61	43.91
1994	53.37	1.55	45.08
1995	52.01	1.47	46.52
1996	51.01	6.76	42.22
1997	49.55	11.15	39.29
1998	48.99	11.38	39.63
1999	48.37	12.60	39.03
2000	48.29	12.49	39.22
2001	49.36	13.38	37.25
2002	50.41	16.30	33.29
2003	51.03	16.84	32.12
2004	52.14	15.78	32.07
2005	53.71	15.76	30.54
2006	54.89	14.74	30.37
2007	55.66	15.65	28.68
2008	56.09	15.40	28.50
Entire sample	*51.96*	*12.19*	*35.85*

Note: The list of foreign carriers with and the year in which they have been granted antitrust immunity is provided online by the US Department of Transportation at http://ostpxweb.dot.gov/aviation/X-50 Role_files/All Immunized Alliances.pdf

Table A6: List of Major Airports by State

No.	US State	City	Airport	FAA Hub Type	FAA Rank
1	AL	Birmingham	Birmingham International	Small	71
2	AR	Little Rock	Adams Field	Small	80
3	AZ	Tucson	Tucson International	Medium	66
4	AZ	Phoenix	Phoenix Sky Harbor International	Large	5
5	CA	San Francisco	San Francisco International	Large	8
6	CA	Los Angeles	Los Angeles International	Large	3
7	CA	San Diego	San Diego International-Lindbergh Field	Large	30
8	CO	Denver	Denver International	Large	6
9	CT	Windsor Locks	Bradley International	Medium	48
10	DC	Arlington	Ronald Reagan Washington National	Medium	32
11	DC	Chantilly	Washington Dulles International	Large	27
12	FL	Orlando	Orlando International	Large	15
13	FL	Miami	Miami International	Large	13
14	FL	Tampa	Tampa International	Large	29
15	GA	Atlanta	Hartsfield Atlanta International	Large	1
16	IA	Des Moines	Des Moines International	Small	89
17	ID	Boise	Boise Air Terminal/Gowen Field	Small	75
18	IL	Chicago	Chicago O'Hare International	Large	2
19	IN	Indianapolis	Indianapolis International	Medium	46
20	KS	Wichita	Wichita Mid-Continent	Small	104
21	KY	Louisville	Louisville International-Standiford Field	Medium	64
22	LA	New Orleans	New Orleans International/Moisant Field	Medium	40
23	MA	Boston	Logan International	Large	18
24	MD	Baltimore	Baltimore-Washington International	Large	22
25	ME	Portland	Portland International Jetport	Small	98
26	MI	Detroit	Detroit Metropolitan Wayne County	Large	11
27	MN	Minneapolis	Minneapolis-St Paul International	Large	10
28	MO	Kansas City	Kansas City International	Medium	36
29	MO	St. Louis	Lambert-St Louis International	Large	16
30	MS	Jackson	Jackson International	Small	97
31	MT	Billings	Billings Logan International	Small	134
32	NC	Charlotte	Charlotte/Douglas International	Large	20
33	NC	Raleigh/Durham	Raleigh-Durham International	Medium	39
34	ND	Fargo	Hector International	Non-primary	162
35	NE	Omaha	Eppley Airfield	Medium	65
36	NH	Manchester	Manchester	Small	69
37	NJ	Atlantic City	Atlantic City International	Small	123
38	NM	Albuquerque	Albuquerque International Sunport	Medium	53
39	NV	Las Vegas	Mc Carran International	Large	7
40	NY	New York	John F Kennedy International	Large	14
41	NY	Newark	Newark International	Large	12
42	NY	New York	La Guardia	Large	21
43	OH	Cincinnati, Oh	Cincinnati/Northern Kentucky International	Large	26
44	OH	Columbus	Port Columbus International	Medium	51
45	OH	Cleveland	Cleveland-Hopkins International	Medium	35
46	OK	Tulsa	Tulsa International	Small	68
47	OK	Oklahoma City	Will Rogers World	Medium	67
48	OR	Portland	Portland International	Medium	33
49	PA	Pittsburgh	Pittsburgh International	Large	23
50	PA	Philadelphia	Philadelphia International	Large	19
51	RI	Providence	Theodore Francis Green State	Medium	57
52	SC	Greer	Greenville-Spartanburg International	Small	93
53	SC	Charleston	Charleston AFB/International	Small	90
54	SD	Sioux Falls	Joe Foss Field	Small	136
55	TN	Memphis	Memphis International	Medium	38
56	TN	Nashville	Nashville International	Medium	42
57	TX	Fort Worth	Dallas/Fort Worth International	Large	4
58	TX	Houston	George Bush Intercontinental	Large	9
59	UT	Salt Lake City	Salt Lake City International	Large	25
60	VA	Norfolk	Norfolk International	Small	73
61	VT	Burlington	Burlington International	Small	108
62	WA	Seattle	Seattle-Tacoma International	Large	17
63	WI	Milwaukee	General Mitchell International	Medium	55
64	WV	Charleston	Yeager	Non-primary	156
65	WY	Jackson	Jackson Hole	Non-primary	183

Data Appendix

T100 International Segment Data

The original data contains international non-stop segment information reported by both U.S. and foreign air carriers, including the origin and destination airport, transported passengers, available capacity, departures scheduled and performed, when at least one point of service is in the United States. The data is reported at monthly frequencies, with origin-destination-carrier observations distinguished by the direction of air travel.

We perform minor changes to the original dataset to get our estimation sample. First, we drop entries that correspond to freight or mail air services, and also entries registering positive transported passengers but zero departures operated. Then we create an indicator for outbound air travel equal to 1 if the origin of the flight segment is in the U.S. To avoid the double counting for the (majority) case of round-trip passengers we keep only U.S. outbound observations. Finally, we remove the monthly frequency of the data by aggregating all the origin-destination-carrier observations within each quarter. The resulting sample becomes the main estimation sample for T100 Segment data analyses.

For the calculation of the intensive and extensive margins, we trim the estimation sample further to ensure there are sufficient 'common variety' observations. The reason for doing this is because our estimation exercises rely on within group time variation, and so not having a common variety offered for several periods affects the calculation of the intensive and extensive margins and makes our identification problematic. Therefore, we trim the data as follows:

- When a traded service is defines as a distinct route within a country-pair, we keep all quarter-country pairs with at least one segment that is sampled more than 6 times (irrespective of which air carrier operates on that route), i.e., more than half the number of years in the sample.

The choice of cutoff values is made to ensure sufficiently many observations within a cross-section group to be able to rely exclusively on time variation for model identification. However, for narrowly defined cross-sections – e.g., route level – the threshold had to be lowered to maintain sample coverage. Overall, these data trimmings no not remove more than 4 percent of all passenger flows.