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Competition regimes and air transport costs: The effects of open skies agreements

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Abstract

The relevance of transport costs has increased as liberalization continues to reduce artificial barriers to trade. Is it worthwhile to implement policies designed to increase competition in transport markets? Focusing on air transport, this paper quantifies the effects of liberalization of air cargo markets on transport costs. Between 1990 and 2003, the United States implemented a series of Open Skies Agreements, providing a unique opportunity to assess the effect that a change in the competition regime has on prices. In our sample, Open Skies Agreements reduce air transport costs by 9% and increase by 7% the share of imports arriving by air. Those results hold for developed and upper-middle-income developing countries but for lower-middle-income and low-income developing countries Open Skies Agreements do not reduce air transport costs.
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1. Introduction

A close relationship exists between trade costs and the capacity of a country to increase its exports and to integrate in the world economy. The relevance of transport costs, as a component of trade costs, has been increasing as liberalization continues to reduce artificial barriers to trade.

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In many cases, the effective rate of protection provided by transport costs is higher than the one provided by tariffs (Clark et al., 2004; Hummels, 1999).

One of the most important and evident components of transport costs is distance. In its simplest formulation, the gravity model for trade, introduced by Linnemmann (1966), states that bilateral trade flows depend positively on the product of the gross domestic products (GDPs) of both economies and negatively on the distance between them, which stands for bilateral transport costs. The effect of distance on countries' volume of trade is significant: recent estimates of the elasticity of trade volumes with respect to distance indicate that when distance increases by 10%, the volume of trade is reduced between 9% and 15% (Overman et al., 2003).[2]

In addition to distance, many other elements influence transport costs. As Limão and Venables (2001) explain, transport costs and trade volumes depend on many complex details of geography, infrastructure, and administrative barriers, and on the state of competition in the transport industry. Given that distance and infrastructure-related costs are major determinants of the success of a country's export sector, immediate questions arise: What can governments do to "get closer" to markets with high import demand? Can improvements in infrastructure and regulation reduce transport costs? Is it worthwhile to implement policies designed to increase competition in transport markets? Do those policies have a quantifiable effect on transport costs and trade volume?

Not many papers have tried to estimate the effect on transport costs of policies that improve the quality of regulation and infrastructure or that implement new competition regimes. Focusing on infrastructure and using data from maritime shipping companies, Limão and Venables (2001) show that poor infrastructure accounts for more than 40% of predicted transport costs. In a study specific to the port sector, Clark et al. (2004) show that an improvement in port efficiency from the 25th to the 75th percentile reduces shipping costs by more than 12%. Fink et al. (2002) argue that both public policies, such as restrictions on the provision of port services, and private practices, such as collusive carrier arrangements, significantly influence maritime transport costs. Their argument implies a policy need to pursue attempts to break up international cartels in the maritime transport market. However, because their data do not include a change in the intensity of competition in the market (that is, from cartel to noncollusive behavior), they cannot estimate the effects on transport costs of a change in the competition regime.

The aim of this paper is to close this gap in the literature by estimating the effect of a change in the competition regime on air transport costs. We focus exclusively on air transport costs because of the increasing importance of the air transport mode, the availability of detailed microdata for U.S. imports, and the recent change in competition regimes introduced by Open Skies Agreements (OSAs).

The advent of wide-body aircraft in the 1970s made available large volumes of aircraft space. With the increased ability to accept palletized or containerized freight, airlines began addressing the air cargo market more aggressively. As the evolution and design of aircrafts made it possible to carry more cargo in an efficient manner, dedicated cargo airlines entered this market.

The size of the air freight and express market worldwide is approximately US$75 billions; during the 1990s, this market grew at an average rate of 6% per year.[3] The United States explains almost 40% of total worldwide revenue. In the United States, as indicated by Fig. 1, the value of air shipments relative to the aggregate value of air and vessel shipments increased from 24% in 1990 to 36% in 2000. The drastic drop in air shipments in 2001 may have been caused by the

[2] Deardorff (1984) surveys the early work on this subject.
[3] Data obtained from Air Cargo Management Group (www.cargofacts.com).

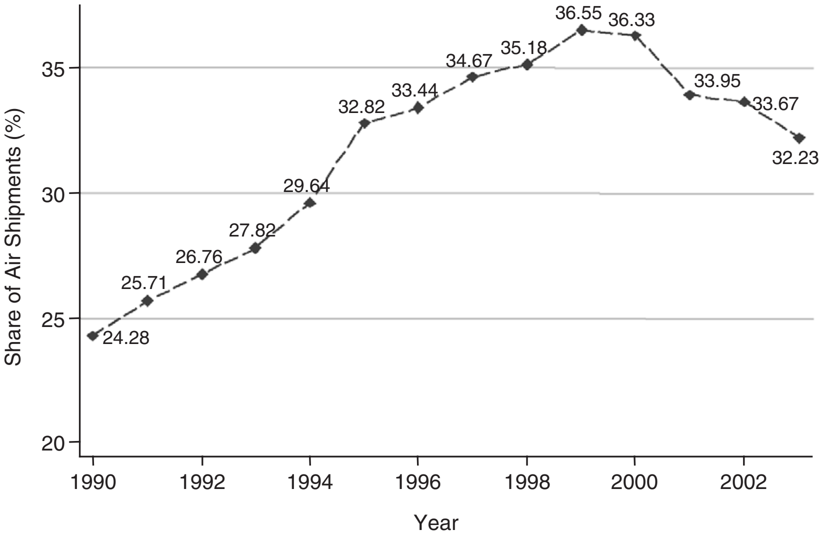

Fig. 1. Share of air shipments in U.S. imports. Share: Value of Air Shipment/Sum of the value of Air and Vessel. Source: U.S. Imports of Merchandise - U.S. Department of Commerce 19902003. Shipment.

restrictions that the United States applied to air traffic after September 11, 2001. In 2003, the relative value of air shipments was 32%, a fall of four percentage points from the peak in 2000.

In 1992 the United States signed the first OSA with the Netherlands. Since then, the United States has signed more than 55 OSAs with developed and developing countries in all continents (see Appendix B, Table B1). Those agreements give us a special opportunity to estimate the effect that a liberalized air cargo market has on transport costs. Given the literature's lack of estimation of the effects of OSAs–or any other change in competition regime–on cargo rates, this paper adds a new dimension to the literature that estimates the determinants of transport costs.

The results obtained have important policy implications. We find strong evidence that a more competitive air transport market–through OSAs–reduces air transport costs by about 9% and increases by 7% the share of imports arriving by air within 3 years after an OSA is signed.[4] The results are driven by high- and medium-high-income countries. For low-income countries, we do not find a positive effect (that is, reductions in air transport costs) of OSAs. We interpret this result as evidence that in low-income countries other overriding barriers to competition prevent those countries from taking advantage of OSAs.

Improvements in infrastructure and in the quality of regulation also influence the level of transport costs significantly. For instance, our results suggest that for countries like Uzbekistan and Honduras, moving from their level of infrastructure availability (p25 in our sample) to that of France (p75) would reduce their transport costs by 10%. For the quality of regulation, our results suggest that for countries like Ecuador and India (p25), improving their regulations to the level prevailing in Greece (p75) would reduce transport costs by 14%.

The paper is organized as follows. Section 2 briefly summarizes the economics of air cargo. Section 3 presents the empirical framework, and Section 4 shows the results for the cross-section, the panel data estimations, and the change in the shares of imports arriving by air induced by Open Skies Agreements. Finally, Section 5 presents our conclusions.

[4] This effect corresponds only to developed and middle-high-income developing countries.

2. The determinants of air transport costs, economics of air cargo and open skies agreements

This section qualitatively describes the main determinants of air transport costs, emphasizing recent developments in the economics of air cargo.

The nature of the services provided by air cargo airlines forces them to be both capital intensive and transnational, thereby serving more than one country. In general, those companies have access to international capital markets, and they are able to hire some of their workers from all over the world.[5] Thus, we should not expect differences in capital or labor costs to be the main factors explaining differences in transport costs across countries. However, the following important factors do specifically affect transport costs across countries.

The most studied determinant of transport cost is geography, particularly distance. The greater is the distance between two markets, the higher are the expected transport costs. For air carriers, the cost variable most affected by distance is fuel cost, which during most of the 1990s represented between 12% and 15% of airlines' total operating costs (Doganis, 2001).

Dedicated freight airlines pay special attention to airport use-related fees. Cargo carriers have more flexibility than passenger airlines because they do not have to operate from airports with the best location for business passengers and can avoid slot-constrained airports or operate during off-peak hours. Consequently, dedicated freight airlines usually have a broader selection of competing airports to choose from. The available airport infrastructure and the quality of regulation, which directly affect airport use fees, are important variables for cargo airlines when deciding which airports they serve and thus are relevant variables in the determination of air transport costs.

No unique model exists for tariff regulation in airports. However, in the majority of airports, tariffs for "aeronautical services" (runway and taxiway, air control, aircraft parking, security) are regulated by a government agency or sector-specific regulator (Serebrisky and Presso, 2002). The quality of regulation–that is, what the level and structure of tariffs are for aeronautical services, how they are set, and what the regulatory process is for modifying them–is a key factor that directly affects airlines' operating costs and transport costs.

The creation of cargo airlines and the implementation of yield-management strategies by passenger-cargo airlines allowed those companies to adopt a flexible approach to the selling of cargo space. Consequently, not only do directional differences in rates exist, mainly because of bilateral trade imbalance,[6] but also the rates offered to bulk contract shippers as opposed to one-time clients vary widely.[7]

Trade composition additionally helps explain other differences in transport costs. Because of the insurance component of transport costs, products with higher unit value have higher charges per unit of weight. On average, insurance fees are 1.75% of the traded value and represent about 15% of total air charges. Therefore, high-value-added exporting countries should have higher

[5] Doganis (2001) shows that for passenger airlines labor costs explain between 25% and 35% of total operating costs. Undoubtedly, for dedicated freight carriers, this percentage is much lower because they do not need to employ flight attendants and other personnel who work in passenger-related services (VIP lounges, check-in counters, customer service personnel in airports).

[6] Directional imbalance in trade between countries implies that many air carriers are forced to haul empty cargo space either on outgoing or return trips. As a result, either imports or exports become more expensive.

[7] Transport is a classic example of an industry that faces increasing returns to scale.

charges per unit of weight because of this insurance component.[8] In addition, some products require special transport features and, therefore, have different freight rates.

Finally, competition regimes matter for air transport costs. Since 1992, the United States has signed more than 50 bilateral OSAs. The main objective sought by the agreements is the promotion of an international aviation system based on competition among airlines with minimum government regulation. As stated in the agreements, the government's motivation to support them is the desire to facilitate the expansion of air-transport opportunities, making it possible for airlines to offer the traveling and shipping public a variety of service options at the lowest prices.

All OSAs signed by the United States have the same substance; they apply to passenger, all-cargo, and combination air transportation, and they encompass both scheduled and charter services. Key provisions include the following:[9]

Free market competition: no restrictions on number of designated airlines, capacity, frequencies, and types of aircraft can be imposed by the signing parties.

Pricing determined by market forces: a fare can be disallowed only if both governments concur–"double disapproval pricing"–and only for certain, specified reasons intended to ensure competition.

Fair and equal opportunity to compete: all carriers of both countries may establish sales offices in the other country and can convert and remit earnings in hard currencies at any time. Designated airlines are free to provide their own ground-handling services, and airlines and cargo consolidators may arrange ground transport of air cargo and are guaranteed access to customs services. According to the OSA model text, user charges cannot be discriminatory and should be based on costs. The text also includes procedures for resolving differences that arise under the agreement.

Optional seventh-freedom all-cargo rights: provide authority for an airline of one country to operate all-cargo services between the other country and a third country, through flights that are not linked to its homeland. Most of the OSAs signed by the United States include the seventh freedom for all-cargo services.

The inclusion of specific provisions for air cargo in the OSAs signed by the United States suggests that, irrespective of the size of the air cargo market, the U.S. government is concerned about entry barriers, competition, and ultimately prices of air cargo services.

Most of the empirical literature in the area of air transport focuses on the effects that OSAs have on passengers. A recent and comprehensive study (Brattle Group, 2002) estimates the effects on passengers of OSAs between the United States and countries in the European Union. Button (2002) describes the potential effects that the liberalization of the U.S.–European air transport market could have on airlines, passengers, and labor, but he does not provide any quantitative evidence. The U.S. Department of Transportation (2000) published a report that argues that between 1996 and 1999 average passenger airfares in transatlantic markets declined 10.3% in non-open-skies countries and 20.1% in open-skies countries. That report neither controls for other factors nor explains the methodology used to estimate the reduction in airfares.

[8] Clark et al. (2004) show that the insurance component is an important determinant for maritime transport costs as well.

[9] The text of OSAs can be found at http://ostpxweb.dot.gov/aviation/.

A survey of the empirical literature, however, shows that no estimate exists of the effects of OSAs on cargo rates, a task we pursue in this paper.

3. Empirical framework

To estimate the importance of each of the factors that explain air transport costs, we use a standard reduced form approach. Air transport freight prices are assumed to be equal to the marginal cost multiplied by the air shipping companies' markup. Expressed in logarithms, the reduced form equation takes the following form:

$$p_{ijkt} = \mathrm{mc}(i,j,k,t) + \mu(i,j,k,t) \tag{1}$$

where i corresponds to a foreign country, j to a U.S. import district, and k to the product aggregated at four digits of the Standard International Trade Classification (SITC). The variable stands for air transport cost (or freight charges), which summarizes the aggregate cost of all freight, insurance, and other charges incurred in bringing merchandise to the United States. At the same time, mc corresponds to the marginal cost (ln) and μ corresponds to the markup.

Therefore, p_{ijkt} represents air transport costs,[10] and it is measured by the logarithm of the freight charges per unit of weight for each of the k products transported between foreign country i to any of the U.S. districts in period t.[11]

We assume that the marginal cost and markup are functions of factors that depend on the airport or country of origin (i) and on the airport or district of entry in the United States (j) for each of the k product types. Specifically, we assume that the marginal cost has the following functional form:

$$\mathrm{mc}(i,j,k,t) = \alpha_j + \lambda_k + \psi \mathrm{wv}_{ijkt} + \partial d_{ij} + \eta q_{ijt} + \kappa \mathrm{imb}_{it} + \omega \mathrm{FAII}_i^{\mathrm{type}} + \varepsilon_{ijkt} \tag{2}$$

where α_j is a dummy variable referring to U.S. region J in which district j is. λ_k is a dummy variable referring to product k. wv_{ijkt} represents the value per unit of weight of product k (ln). d_{ij} is the distance between country i and district j in the United States (ln). q_{ijt} represents the value of imports carried by air from country i to the United States (ln). imb_{ijt} is the imbalance between country i and the United States, and $\mathrm{FAII}_i^{\mathrm{type}}$ represents the foreign country i airport Infrastructure Index.[12]

The first dummy variable takes into account potential differences in airport efficiencies across U.S. customs regions or districts, and the second accounts for different marginal transport costs across products. Then wv_{ijkt} represents the value per unit of weight of product k and is used as a proxy for the insurance component of air transport cost (p_{ijkt}).[13] Imbalance between country i and the United States (imb_{it}) corresponds to the ratio between the difference of the volume of U.S. exports and imports and the total volume of bilateral trade between the two countries.

The variable $\mathrm{FAII}_i^{\mathrm{type}}$ is a proxy for airport infrastructure availability in a foreign country i. This proxy indicates the fraction of the population that has access to an airport with paved runways at least 2000 m long and 40 m wide. The choice of this runway specification corresponds to the following Federal Aviation Administration definition: "The recommended length for a primary runway is determined by considering either the family of airplanes having

[10] We do not take into account the observations that have zero trade with the United States.

[11] We consider 36 U.S. import districts grouped in three regions (see Appendix A).

[12] The word "type" identifies the index of infrastructure used. See Appendix A.

[13] We assume that insurance costs increase with the value per unit of weight of the transported goods.

similar performance characteristics or a specific airplane needing the longest runway. In either case, the choice should be based on airplanes that are forecasted to use the runway on a regular basis."[14] The standard aircraft in the air cargo industry (such as the Boeing 757, 727 and DC-8) that have an estimated width of 33 m must use a runway at least 1875 m long when arriving or departing from an airport with an estimated elevation of 2000 ft.

A person who lives in a city c that is at most 75 km away from an airport is considered to have access to that airport.[15] We assume that only urban population (Urbanpop_i) has access to an airport. To account for the "quality" of the airport infrastructure, understood as runway availability per million city inhabitants, we interact the share of population with the quantity of runways per million inhabitants in each city $([\text{Ra}_{c,i}]/[\text{Pop}_{c,i}])^{\alpha}$ to the power of alpha that takes the value of 0, 1/3, and 1/2. Alpha equal to 0 corresponds to our baseline (access to airport without controlling for "quality").

$$\text{FAII}_i^{\text{type}} = \frac{\sum_{\text{Cities with access}} \text{Pop}_{c,i} \left(\frac{\text{Ra}_{c,i}}{\text{Pop}_{c,i}} \right)^{\alpha}}{\sum_{\text{cities}} \text{Pop}_{c,i}} \text{Urbanpop}_i \tag{3}$$

In addition to our proxies for airport infrastructure availability, we include a variable that captures the quality of regulation.[16]

With respect to the second term of the reduced form, we assume that air shipping companies' markups have the following functional form:

$$\mu(i,k,t) = \rho_k + \varphi \text{OSA}_{it} \tag{4}$$

where OSA_{it} is a dummy variable for the OSA between country i and the United States, and ρ_k is a product-specific dummy that captures differences in transport demand elasticities across goods (derived from the final demand of each good k in the United States). OSA_{it} is a variable that specifies whether a country i has signed an Open Skies Agreement with the United States.

Substituting Eqs. (2) and (4) into Eq. (1), we obtain the econometric model to be estimated:

$$p_{ijkt} = \alpha_j + \beta_k + \psi \text{wv}_{ijkt} + \partial d_{ij} + \eta q_{ijt} + \kappa\, \text{imb}_{it} + \omega \text{FAII}_i + \varphi \text{OSA}_{it} + \varepsilon_{ijkt} \tag{5}$$

where $\beta_k \equiv \lambda_k + \rho_\text{k}$, and ε_{ijk} is an error term.[17]

In the estimation, we should expect the coefficients associated with insurance costs (ψ) and distance (∂) to be positive, and the coefficients of the variables volume of trade (η), trade imbalance[18] (κ), airport infrastructure (ω), and OSA (φ) to be negative.

We divide our empirical results into three sets. First, following the existing literature (see Fink et al., 2002; Clark et al., 2004; Limão and Venables, 2001), we run cross-sectional regressions to

[14] FAA. Airport Advisory Circulars. Circular 150/5325-4A.

[15] Using the 75-km criterion, a firm located in Washington, DC has access to three airports: Ronald Reagan Washington National (DCA), Washington Dulles International Airport (IAD), and Baltimore Washington International Airport (BWI).

[16] This variable is quite broad and does not capture the specifics of the airport sector. However, to the extent of our knowledge, a variable that compares the quality of regulation across airports is not available. We are implicitly assuming that the quality of regulation in a given country is highly correlated across infrastructure sectors and other markets.

[17] We allow the error term to be correlated among country clusters.

[18] Our dependent variable is the transport cost of imported merchandise. Thus, the bigger the trade imbalance, the lower the expected transport costs, because it indicates the existence of "excess supply" of cargo space "traveling" to the United States.

identify the effects on air transport costs of those variables that rarely or never vary over time. The variables are distance and foreign airport infrastructure. In addition, using cross-sectional regressions, we are able to identify whether countries that implemented an OSA face lower or higher transport costs than countries that did not. Although this information by itself is valuable, it is not the most relevant question for a policy maker. A policy maker would like to know the effect of signing an OSA, that is, whether implementing this type of agreement reduces transport costs over time.

To determine whether transport costs are reduced over time, in our second set of results, we rely on panel data that include country-product fixed effects in order to isolate the time series dimension of OSAs and their effect on air transport costs, leaving out the cross-sectional variation. Thus, time-invariant country-specific variables such as distance between a foreign country and the United States will be subsumed in those country-fixed effects. The inclusion of country dummies addresses potential endogeneity problems that would arise if countries, following a cost-benefit analysis, tended to sign OSAs only with partners with which they have high air transport costs, given that the potential benefits for those countries derived from more competition will be higher. If that is the case, a cross-sectional analysis would underestimate the effect of OSAs on transport costs.[19]

The relation between transport costs and imported volume causes an additional endogeneity problem. To control for this problem, following the gravity literature on trade, we use a foreign country's GDP as an instrument for the volume of imports.[20]

Finally, to ensure that our OSA variable does not capture the possible presence of a trend in countries' transport costs that is not related to the agreement, we control for the evolution of maritime transport costs (vessel index).[21]

4. Empirical results

Data on air transport costs come from the U.S. Imports of Merchandise Database put together by the U.S. Department of Commerce. The level of data aggregation is SITC four digit, and the period covered is 1990–2003. Our dependent variable, air transport costs, is the variable of *imports charges* (per unit of weight), which is defined by the U.S. Bureau of Census as "the aggregate cost of all freight, insurance, and other charges (excluding U.S. import duties) incurred in bringing the merchandise from alongside the carrier at the port of exportation–in the country of exportation–and placing it alongside the carrier at the first port of entry in the United States."[22]

Our explanatory variables were obtained from different sources. Total volume, product unit value, vessel index, and directional imbalance all come from the U.S. Imports of Merchandise Database. Total volume, product unit, and vessel index are SITC four-digit aggregated variables.

[19] Glick and Rose (2001) and Micco et al. (2003) use this method to identify the effect of currency union on trade.

[20] Unreported results use population and area as instruments for total volume instead of GDP because trade may affect the level of GDP and therefore it would not be a good instrument for trade volume. Results, however, are qualitatively unchanged. In the paper we use GDP as IV because population and area do not vary over time (in our sample of 14 years) and, therefore, they cannot be used as an instrument in our panel specification. In addition, if there is some causality from trade transported by air to GDP, it should be small because this mode accounts for only one-third of total U.S. imports during the period covered.

[21] We thank our referees for this suggestion.

[22] To avoid a measurement error, we use only countries that have 50 or more observations. Results are robust to the use of all observations. We use information only for shipments that have value and volume (weight) available at 10-digit HS level.

Area, GDP, GDP per capita in U.S. dollars, and the percentage of urban population per country were obtained from the World Bank's 2005 *World Development Indicators*. In addition, the dummy variable of high-income countries was obtained using the World Bank's country classification by income. Data on regulatory quality were extracted from Kaufmann et al. (2003). Distance between U.S. import districts of entry and foreign countries was computed using the country coordinates of the CIA's World Factbook (2002). Data on airports and cities' geographic coordinates, population of major urban cities, number of paved runways, and runway length and width were obtained from www.tageo.com. In our estimations, we also use the infrastructure index provided by Limão and Venables (2001). Finally, the OSA dummy variables were constructed with the information on OSAs obtained from the Aviation and International Affairs office of the U.S. Department of Transportation. Appendix A describes all variables.

4.1. Cross-section results

Cross-section results are presented in Table 1. This table reports our estimates for Eq. (5) for the year 2000. We chose 2000 because it was the only year for which we had information to construct the variable of directional trade imbalance.[23] In all the specifications, we control for distance, volume (U.S. imports measured in kilograms), product unit value, directional trade imbalance, type of product, region of cargo entry into the United States, a proxy for airport infrastructure in the exporter country, and an OSA dummy, and we allow the error term to be correlated among country clusters to avoid misspecifications of the error var–cov matrix.[24] In some specifications we control for country development level using a dummy variable for developed countries,[25] the country's GDP per capita (log average during the period), or the country's GDP per capita orthogonal component of our infrastructure proxies.

As previously mentioned, when we introduce import volume, an endogeneity problem arises. It is expected that the bigger the trade volume, the lower the transport costs (as a result of economies of scale); however, lower transport costs may increase trade. To solve this problem in all specifications shown, we use GDP as an instrument for volume of imports.

Column 1 of Table 1 reports the results obtained for the benchmark regression specified in Eq. (5) using the fraction of population that has access to an airport in the foreign country as our measure of airport infrastructure—alpha equal to 0 in Eq. (3). As shown, distance has a significant (at 1%) and positive effect on air transport costs. For instance, doubling the distance between country i and the United States generates a 17% increase in air transport costs. The variable capturing economies of scale is the level of trade that goes through a particular route.[26] This variable, calculated in terms of volume, is never significantly different from zero. The value per unit of weight variable is positive and highly significant. The regressions include dummy variables for products aggregated at the four-digit SITC level.

One might think that unit values would be quite similar across countries at that level of aggregation, but such is not the case. Clark et al. (2004) found the same results for maritime

[23] Unreported regressions show those results are robust to the use of years other than 2000 (using imbalance for the year 2000).

[24] Clusters control for the fact that most of our variables of interest vary across countries only.

[25] We define *developed countries* as those classified by the World Bank Income Classification (2002) as a high-income country.

[26] Each "foreign country and U.S. region" pair is defined as an air route. We define three regions in the United States: East, West, and Gulf Coast (see Appendix A).

Table 1
Cross-section analysis: product fixed effect

Dependent variable: air transport cost per unit of weight (ln)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Distance per port of entry (ln)	0.244	0.226	0.264	0.227	0.227	0.221	0.220	0.223	0.250	0.167	0.289
	(0.040)***	(0.042)***	(0.053)***	(0.043)***	(0.042)***	(0.045)***	(0.048)***	(0.043)***	(0.051)***	(0.048)***	(0.037)***
Total volume (ln)	0.001	0.005	0.006	0.007	0.008	−0.009	−0.008	−0.001	−0.001	−0.004	−0.002
	(0.020)	(0.017)	(0.028)	(0.016)	(0.015)	(0.016)	(0.017)	(0.016)	(0.023)	(0.026)	(0.011)
Product unit value (ln)	0.476	0.482	0.473	0.482	0.483	0.483	0.483	0.481	0.476	0.499	0.450
	(0.011)***	(0.011)***	(0.011)***	(0.010)***	(0.011)***	(0.010)***	(0.011)***	(0.011)***	(0.012)***	(0.012)***	(0.015)***
Imbalance	−0.079	−0.014	−0.126	−0.009	0.001	−0.054	−0.051	−0.049	−0.052	0.108	−0.120
	(0.072)	(0.063)	(0.076)	(0.061)	(0.054)	(0.052)	(0.051)	(0.057)	(0.076)	(0.100)	(0.045)***
Open sky agreement	−0.040	0.009	−0.025	0.012	0.019	0.011	0.012	−0.012	−0.019	0.067	0.030
	(0.046)	(0.037)	(0.055)	(0.034)	(0.031)	(0.031)	(0.031)	(0.036)	(0.056)	(0.049)	(0.032)
Foreign airport infrastructure index II ($FAII^1$)	−0.390	−0.236		−0.235	−0.228					−0.129	−0.080
	(0.119)***	(0.092)**		(0.095)**	(0.105)**					(0.148)	(0.070)
Foreign airport infrastructure index II ($FAII^3$)						−0.066					
						(0.025)***					
Foreign airport infrastructure index II ($FAII^2$)							−0.025				
							(0.011)**				
Infrastructure index (INFI)			−0.071						−0.032		
			(0.024)***						(0.020)		
Orthogonal foreign airport inf. index II ($FAII^1$)								−0.218			
								(0.108)**			

Regulatory quality		−0.150		−0.142	−0.137	−0.140	−0.142	−0.179	−0.137	−0.114	−0.172
		(0.035)***		(0.051)***	(0.061)**	(0.059)**	(0.062)**	(0.037)***	(0.082)*	(0.092)	(0.033)***
Dummy high-income countries				−0.018							
				(0.066)							
Log GDP per capita					−0.012	−0.001	−0.008		0.006		
					(0.035)	(0.037)	(0.037)		(0.042)		
Implied effect infrastructure index	−0.183***	−0.111**	−0.186***	−0.110***	−0.107**	−0.120***	−0.104**	−0.075**	−0.084	−0.061	−0.038
Sample	All countries									Industrial	Developing
Observations	164,721	164,721	160,304	164,721	164,721	164,721	164,721	164,721	160,304	106,256	58,465
R-squared	0.335	0.337	0.332	0.337	0.337	0.337	0.337	0.337	0.333	0.364	0.313

"Distance per port of entry" is the distance between country i and the district of entry in the United States (ln). "Total volume" is the volume of imports from country i (ln). "Product unit value" is the value per unit of weight at 4-digit SITC (ln). "Imbalance" is the ratio between the volume imbalance and total volume traded. "Open sky agreement" is a dummy for an agreement between the United States and country i. "Foreign airport infrastructure index II (FAII1)" is the share of total population that has access within a distance of 75 km to an airport with runaways length greater than 2000 m. ($FAII^3$) and ($FAII^2$) adjust ($FAII^1$) by quality. "INFI" is the Limão and Venables (2001)'s infrastructure Index (ln). "Orthogonal foreign airport infrastructure index II ($FAII^1$)" is the GDP orthogonal component of ($FAII^1$). "Regulatory quality" is the Kauffman et al. (2003)'s Regulatory Index. "The dummy high-income countries" is a dummy for countries classified by the World Bank as having a high income. "The infrastructure implied effect" is the product of the infrastructure coefficient and two standard deviations. "Total volume" is instrumented with GDP (ln). All regression have country-product and region fixed effect.

Cluster robust standard errors in parentheses (by country).

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

transport costs. Additionally, Feenstra (1996) shows that there is a large variation in unit values even at the 10-digit HS level. He cites the example of cotton shirts for men, which the United States imports from almost half of its 162 trading partners. The unit values range from US$56 (Japan) to US$1 (Senegal). The differences in unit values lead to large differences in insurance costs per kilogram, even for "homogeneous" products. Thus, it is not surprising that we find that the more expensive the product per unit of weight, the higher the insurance and hence the overall transport cost.

Directional imbalance in trade between the United States and the source country has the expected negative sign in almost all specifications although it is not significant at standard levels. For column 1, if we move from a favorable imbalance (from the point of view of the exporters to the United States[27]) of 25% to a negative one of the same amount, air transport costs would increase about 4%.

The coefficient associated to our airport infrastructure index is negative and significant (at 1%) in all specifications but one. This result implies that the greater the investment in infrastructure, the lower the transport costs.[28]

In column 2, in addition to our baseline infrastructure availability index, we introduce the quality of regulation obtained from Kaufmann et al. (2003). The results are in line with the intuition that a better institutional framework–measured by regulatory quality–reduces air transport costs.[29] Column 2 suggests that for countries like Uzbekistan and Honduras, moving from their level of infrastructure availability (p25 in our sample) to that of France (p75) would reduce their transport costs by 17%. In addition, for countries like Ecuador and India (p25), improving their regulations to the level of those of Greece (p75) would reduce transport costs by 15%.

Column 3 introduces a different infrastructure index–INFI–constructed and used by Limão and Venables (2001). This index, which not only measures infrastructure more broadly but also is related to the quality of air transport infrastructure, has the expected signs and does not change the results obtained when using the infrastructure indexes we built.[30]

The first three columns of Table 1 show that distance, value per unit of weight, and infrastructure have the expected sign, and they are significant at conventional levels. However, it is important to note that our proxy for infrastructure could be correlated with countries' development level; therefore, they could be capturing the relationship of air transport costs and the level of development instead of explaining how infrastructure affects air transport costs. To determine whether those results are robust to the addition of country-income controls, we modified our specifications to include either a dummy variable for developed countries (column 4) or the average log GDP per capita during the 1990s (columns 5–7), or we used the component of our main infrastructure index that is not explained by the variation of foreign country GDP per capita (column 9). As shown, all our results are robust to those modifications.

[27] For foreign exporters, the larger the imbalance of U.S. bilateral trade (exports minus imports divided by bilateral trade) the lower the transport costs they face should be because of the low capacity use of the airplanes flying to the United States.

[28] This result may be because of the following reverse causality: airport infrastructure reduces air transport costs, but at the same time low air transport costs increase trade and may induce investments in airport infrastructure. Unreported regressions, using telephones per capita and fraction of paved roads as IV for the airport infrastructure indexes, find similar results.

[29] See Kaufmann et al. (2003) for a general discussion of the role of the institutional environment in the economy.

[30] When we control for regulatory quality, INFI is significant only at 20% (unreported results). This result could be explained by the fact that both the variable regulatory quality and INFI are highly correlated with GDP per capita. The correlation between regulatory quality and INFI is 0.66, while the correlations with the other infrastructure indexes do not exceed 0.5. See Appendix B.

When we control for income level using the dummy for industrial countries (column 4), the variables of airport infrastructure and regulatory quality keep their negative signs, and they remain statistically different from zero at conventional levels. When we use GDP per capita (ln) instead of the developed dummy variable, our results remain unchanged (column 5). In columns 6 and 7, we modify our infrastructure index to account for the quality of infrastructure–understood as runway availability per million of city inhabitants–by varying the value of alpha in Eq. (3). The results are robust to those changes. When alpha equals to 0, one-half or one-third of a two standard deviation increase in the infrastructure index reduces transport costs by about 11%.[31] The results hold using as a proxy for infrastructure the orthogonal component to GDP per capita of our infrastructure proxy (column 8), as well as when we use the infrastructure index (INFI) developed by Limão and Venables (column 9), although in both cases a two standard deviation has a lower effect of only 8% on transport costs. For the Limão and Venables index, the coefficient is only significant at 20%. Finally, columns 10 and 11 show that when we split the sample between developed and developing countries, results for the infrastructure index hold although they are not significant at conventional levels. This result is not surprising, considering that we reduce the variability of the index, as well as the number of observations. Regulatory quality is negative in both samples, although statically significant only for developing countries.[32]

When we focus on the OSA dummy variable, our main variable of interest, Table 1 shows that in some cases–columns 1, 3, 8, and 9–this variable has the expected sign, but it is not statistically different from zero at conventional levels. In all other columns of Table 1, this dummy has a positive sign although it is not significantly different from zero. The result may be biased to a positive coefficient because of the endogeneity problem described at the beginning of this section (countries with high transport cost are willing to sign OSAs).[33] The next section accounts for this problem using panel data.

4.2. Panel data results

In the cross-section estimations, we mentioned the possibility that the estimated coefficients of OSA might be upward biased. For us to solve this problem, Table 2 presents the results of a country-product, fixed-effect estimation for the period 1990–2003. The inclusion of country-product dummies allows us to focus on the time series effect of OSAs. The country-product fixed effect captures the initial level of transport costs, as well as those variables that do not change over time (for instance, distance).[34] As we did in the cross-section estimation, we still allow the error term to be correlated within countries in a given year, and we control for U.S. region and year-fixed effects.

In column 1 of Table 2, as we found in the cross-section regressions, volume has a negative sign but is not significant at standard levels. Unit weight values remain highly significant with a similar coefficient. More interesting, in our panel setup, OSA takes a negative value and

[31] The results obtained in this section are robust to changes in the values for length of runway and the distance from an airport used to construct our indexes of infrastructure. Unreported regressions show that the results are virtually unchanged when instead of using 2000 m for the length of runways, we use 1500 or 2500 m. Results also hold when a person who lives in a city *c* that is at most 50 or 100 km away from an airport is considered to have access to an airport.

[32] For developing countries, more variation in regulatory quality exists; therefore, there is more statistical power.

[33] Unreported regressions show that our results are robust to the use of years in our sample other than 2000.

[34] We do not include our institutional variables because they are available only since 1996 and show almost no change over time. We have information for airport infrastructure for only 1 year.

Table 2
Panel analysis: country-product fixed effect

Dependent variable: air transport cost per unit of weight (ln)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Total volume (ln)	−0.011	−0.011	−0.083	−0.047	0.008	−0.067	−0.029
	(0.053)	(0.053)	(0.050)*	(0.050)	(0.052)	(0.048)	(0.050)
Product unit value (ln)	0.500	0.500	0.500	0.500	0.500	0.500	0.500
	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***
Open sky agreement	−0.024	−0.026	−0.003	−0.013	−0.019	0.005	−0.005
	(0.010)**	(0.009)***	(0.009)	(0.009)	(0.009)**	(0.009)	(0.009)
Open sky agreement × Year since signed			−0.014			−0.015	
			(0.002)***			(0.002)***	
Open sky agreement × Three years or more since signed				−0.044			−0.047
				(0.010)***			(0.010)***
Open sky agreement × Distance					−0.110	−0.109	−0.109
					(0.020)***	(0.019)***	(0.019)***
Vessel index		0.090	0.095	0.097	0.102	0.108	0.109
		(0.049)*	(0.046)**	(0.047)**	(0.048)**	(0.045)**	(0.046)**
Observations	2,006,728	2,006,690	2,006,690	2,006,690	2,006,690	2,006,690	2,006,690
R-squared	0.409	0.409	0.409	0.409	0.409	0.409	0.409
Implied effect of OSA	−0.024**	−0.026***	−0.045***	−0.057***	−0.019***	−0.040***	−0.052***
Sample	1990–2003						

"Total volume" is the total volume–in kilograms–of goods imported by the United States from country i (ln). "Product unit value" is the value per unit of weight of the good at 4-digit SITC (ln). "Open sky agreement" is a dummy if there is an agreement signed in that particular year between the United States and country i. "Open sky agreement years since signed" is the number of years that the open sky agreement has been signed. "Open sky agreement three years or more since signed" is a dummy if the agreement was signed at least 3 years ago. "Open sky agreement interacted with distance" is the product between the Open Sky Agreement variable and distance (ln and demean). "Vessel index" is a proxy for maritime transport cost. For columns (3) and (6) the Implied effect of the OSA is the sum of the OSA dummy and the coefficient of "OSA × Year since signed" multiplied by 3. Columns (4) and (7) are the sum of the OSA dummy plus "Three years or more since signed". "Total volume" is instrumented with GDP (ln). All regression have country-product, region, and year fixed effects.

Cluster robust standard errors in parentheses.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

becomes significant at standard levels. In column 2, we include the variable of vessel transport costs to control for the evolution in unobservables at the country level that could be influencing the main transport modes (maritime and air transport) simultaneously. Controlling for vessel transport costs, our OSA dummy captures the effect of an open skies agreement on air transport costs relative to maritime freights. To construct the vessel transport cost variable, we regress the maritime freight charge (ln) on the unit price of the good at the SITC four-digit level (ln) plus a country-product and year-fixed effects. The variable of vessel transport costs is the mean value of the residuals obtained from those regressions plus the year-fixed effect, and it is calculated per year and per foreign country.[35] Two complementary explanations exist for the positive and significant coefficient of the vessel transport costs index. First, air transport costs may react in the same way as vessel transport costs when they are affected by changes in common cost factors (for example, oil costs). Second, according to a competition argument, for some products competition exists between the maritime and air transport modes; therefore, price increases in the maritime mode bring about price increases in the air transport mode. The estimates presented in Table 2 are consistent with both explanations.

The results in column 1 of Table 2 suggest that, even though statistically significant (at 1%), OSAs imply only a small decline of about 2% in air transport costs. This decrease is the average effect of OSAs on freight rates independent of the number of years the agreement has been in place. OSAs may reduce freight rates over time, in which case the total effect of the agreements would be larger than 2%. We want to test the hypothesis that air carriers take time to adapt to the new rules in the market and need to go through an underlying "learning by doing" process. A similar hypothesis, which cannot be tested separately, would be that those firms that survive after the start date of an OSA are more efficient and, given the existence of more contestable markets, they set lower tariffs. The process of fighting to survive is not a one-period game and that would explain why freight rates decrease over time. To test the first hypothesis, we include in columns 3 and 4, in addition to our OSA dummy, the number of years since the agreement was signed and a variable that indicates if OSAs have been in place for at least 3 years. The variables are negative and significant at standard levels, indicating that the effect of OSAs grows over time. After 3 years, freight rates are on average 5.7% lower in countries with OSAs. The row labeled *Implied Effect of OSAs* captures the effect of OSAs on air transport costs after 3 or more years of their being signed.[36]

Columns 5, 6, and 7 include the interaction of OSAs with distance to assess whether countries that are farther from the United States benefit more from the agreements. Results show that this interaction is negative, implying that countries farther away from the United States benefit more from OSAs. We interpret this result as follows: the final price of freight (the dependent variable in our model) has two components: (a) the tariff set by air cargo companies (which is the product of markup and marginal cost, including distance, cost of fuel, and airport handling costs as the major components) and (b) the tariff set by other agents (for example, insurance). For countries located farther away from the United States, the distance component in the tariff set by air cargo companies is more important, and the total price of freight is higher. Thus, when more competition (OSAs) drives down the markup charged by air cargo companies, the effect on final

[35] This index is equivalent to regressing the maritime freight on the unit price, country-product dummies, and country-years dummies. In this case, this last set of country-year dummies is our maritime transport cost index. See Appendix A for a complete description.

[36] For example, the value 5.7 in column 4 of the implied effect row is the sum of the dummy variables Open Skies Agreement and Open Skies Agreement 3 years or more since being signed.

freight rates is larger for countries where the distance component is more important, which is the case for countries located farther from the United States.

This result does not allow us to identify the source of the reduction in air transport costs associated with OSAs. Costs could be lower because a more-intense competition induced a lower markup. An alternative explanation consistent with the reduction in transport costs would be that airlines became more efficient and, keeping markups constant, were able to reduce freight rates.

4.3. Differential effect of open skies agreements by income groups

Our previous results indicate that air transport costs fall after OSAs are signed. Are those effects homogeneous across different income groups? It could be the case that developing countries, which are characterized by a higher level of distortions, cannot take full advantage of OSAs because other restrictions are binding in their air transport markets.

Table 3 estimates columns 2 and 7 of Table 2, but splitting the sample by income groups.[37] Columns 1 and 2 of Table 3 present the results for developed countries. For this group, all our previous results for OSAs hold. In particular, three years after the OSAs were signed, air freight rates are 6.8% lower. In developing countries (columns 3 and 4), the effect of OSAs on freight rates 3 years after OSAs were signed is small (−0.8%) and not statistically different from zero (column 4). This result is driven mainly by poor countries. In columns 5 and 6, we focus on upper-middle-income countries; for that group of countries, we observe that OSAs reduce air freight rates, and their effect is significant at conventional levels. Three years after the OSAs were signed, freight rates are 9.2% lower (column 6), a similar effect to the one found for developed countries (or even a little higher). For the other developing countries (about 16% of the sample), we do not find that OSAs reduce air freight rates.[38] We understand this result as an indication that low-income developing countries cannot take advantage of OSAs because other barriers to competition prevent them or because they have limited market size. In line with the latter interpretation is the fact that our proxy for economies of scale is negative and highly significant for developing countries.

To estimate the time effect of OSAs more accurately, Table 4 allows the effect of OSAs to differ over time by year. The dummy variable *OSA year signed* captures the change in freight rates in the year when the agreement was signed. The dummy *one year after* captures the change in air transport costs 1 year after the agreement was signed, and the dummies up to the fourth year capture the effect for the corresponding subsequent years. Finally, the dummy *five or more years after* captures the average fall in freight rates after 5 or more years have passed since the agreement was signed. Columns 1 to 4 present the results for the whole sample; they differ by the inclusion of maritime transport costs (vessel index) or by the interaction between OSAs and distance. All columns show similar results. The fall in freight charges increases 1% per year after the agreement is signed.[39] Four years after the OSA was signed, we observe a 5% to 6% fall in rates, which is significant at conventional levels in all the specifications. If we focus on columns

[37] To split the sample, we use the World Bank classification of countries by income level: high-income countries (developed), upper-middle-income countries, lower-middle-income countries, and low-income countries (developing countries).

[38] Unreported results show that for medium-low-income countries and low-income countries, OSAs are related to higher transport costs, although, in both cases, results are driven by two countries—Dominican Republic and Philippines for medium-low-income countries and India and Kenya for low-income countries.

[39] For the whole sample, the sum of *year signed*, *one year after*, and *two years after* is significant at conventional levels.

Table 3
Panel analysis: country-product fixed effect by income level

Dependent variable: air transport cost per unit of weight (ln)

	(1)	(2)	(3)	(4)	(5)	(6)
Total volume (ln)	0.060 (0.336)	0.174 (0.245)	−0.189 (0.053)***	−0.188 (0.051)***	−0.626 (0.195)***	−0.424 (0.167)**
Product unit value (ln)	0.517 (0.003)***	0.517 (0.003)***	0.452 (0.004)***	0.452 (0.004)***	0.465 (0.006)***	0.466 (0.006)***
Vessel index	−0.016 (0.282)	0.113 (0.222)	0.159 (0.041)***	0.174 (0.039)***	0.106 (0.082)	0.156 (0.086)*
OSA	−0.047 (0.019)**	−0.022 (0.013)*	0.005 (0.014)	0.008 (0.013)	−0.079 (0.036)**	−0.019 (0.036)
Open sky agreement × Three years after or more		−0.046 (0.018)**		−0.016 (0.015)		−0.073 (0.025)***
Open sky agreement × Distance		−0.150 (0.029)***		−0.042 (0.018)**		−0.032 (0.042)
Implied effect of OSA	−0.047***	−0.068**	0.005	−0.008	−0.079**	−0.092***
Observations	1,382,607	1,382,607	624,083	624,083	269,453	269,453
R-squared	0.415	0.415	0.398	0.399	0.401	0.401
Sample	Developed countries		Developing countries		Upper-middle-income countries	

"Total volume" is the total volume of goods imported by the United States from country i per year (ln). "Product unit value" is the value per unit of weight of the good at the 4-digit SITC. "Open sky agreement" is a dummy for Open Sky Agreement signed between the U.S. and country i. "Open sky agreement × Three years after or more" is dummy for agreement signed at least 3 years ago. "Open Sky Agreement × Distance" is the product between Open Sky Agreement dummy and distance (ln and demean). "Vessel index" is a proxy for maritime transport cost. In columns (2), (4), and (6), "Implied effect of OSA" is the sum of the OSA coefficient and OSA × Three years after or more. In the other columns, the "Implied effect of OSA" is the OSA coefficient. "Total volume" is instrumented with GDP (ln). All regressions have country-product, region, and year fixed effects. Robust standard errors in parentheses.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

Table 4
Panel analysis: the effect of open skies agreements over time

Dependent variable: air transport cost per unit of weight (ln)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Total volume (ln)	−0.076	−0.060	−0.077	−0.061	−0.146	0.077	−0.188	−0.188	−0.451	−0.436
	(0.047)	(0.046)	(0.047)	(0.046)	(0.235)	(0.221)	(0.053)***	(0.052)***	(0.166)***	(0.181)**
Product unit value (ln)	0.500	0.500	0.500	0.500	0.517	0.517	0.452	0.452	0.465	0.465
	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.004)***	(0.004)***	(0.006)***	(0.006)***
Open sky agreement ×	−0.005	0.004	−0.005	0.003	−0.023	−0.004	−0.005	−0.007	−0.042	−0.031
Year signed	(0.010)	(0.009)	(0.009)	(0.009)	(0.010)**	(0.010)	(0.020)	(0.017)	(0.038)	(0.046)
Open sky agreement ×	−0.016	−0.008	−0.018	−0.010	−0.039	−0.026	0.018	0.016	−0.024	−0.015
One year after	(0.011)	(0.010)	(0.010)*	(0.009)	(0.014)***	(0.013)**	(0.018)	(0.016)	(0.031)	(0.037)
Open sky agreement ×	−0.023	−0.015	−0.027	−0.020	−0.045	−0.037	0.020	0.017	−0.018	−0.009
Two years after	(0.015)	(0.014)	(0.014)*	(0.014)	(0.022)**	(0.021)*	(0.017)	(0.015)	(0.033)	(0.041)
Open sky agreement ×	−0.029	−0.022	−0.034	−0.026	−0.044	−0.044	0.008	0.005	−0.120	−0.108
Three years after	(0.015)**	(0.014)	(0.015)**	(0.014)*	(0.028)	(0.027)	(0.024)	(0.020)	(0.053)**	(0.066)
Open sky agreement ×	−0.051	−0.045	−0.054	−0.047	−0.062	−0.060	0.014	0.012	−0.023	−0.012
Four years after	(0.016)***	(0.015)***	(0.016)***	(0.015)***	(0.025)**	(0.024)**	(0.023)	(0.018)	(0.030)	(0.037)
Open sky agreement ×	−0.090	−0.086	−0.093	−0.088	−0.080	−0.090	−0.041	−0.049	−0.163	−0.155
Five or more years after	(0.018)***	(0.017)***	(0.018)***	(0.017)***	(0.036)**	(0.035)***	(0.031)	(0.024)**	(0.045)***	(0.047)***
Open sky agreement ×		−0.107		−0.109		−0.161		−0.045		−0.034
Distance		(0.018)***		(0.019)***		(0.028)***		(0.018)**		(0.047)
Vessel index			0.094	0.107	−0.153	0.042	0.160	0.175	0.135	0.156
			(0.047)**	(0.045)**	(0.229)	(0.212)	(0.041)***	(0.039)***	(0.077)*	(0.088)*
Observations	2,006,728	2,006,728	2,006,690	2,006,690	1,382,607	1,382,607	624,083	624,083	269,453	269,453
R-squared	0.409	0.409	0.409	0.409	0.415	0.415	0.398	0.399	0.401	0.401
Sample	All countries				Developed countries		Developing countries		Upper-middle-income countries	

"Total volume" is the volume–in kilograms–of imports from country i (ln). "Product unit value" is the value per unit of weight at 4-digit SITC (ln). "Open sky agreement × Year signed" is a dummy that takes the value of 1 if the agreement between the United States and country i was signed in that year. "Open Sky Agreement × One year after" is a dummy variable that takes the value of 1, if the agreement was signed 1 year ago. "Open Sky Agreement × Five or more years after" is a dummy variable that takes the value of 1, if the agreement has been signed at least 5 years ago. "Open Sky Agreement interacted with Distance" is the product between the Open Sky Agreement variable and distance (ln and demean). "Vessel index" is a proxy for maritime transport costs. "Total volume" is instrumented with GDP (ln). All regressions have country-product, region, and year fixed effects.

Cluster robust standard errors in parentheses.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

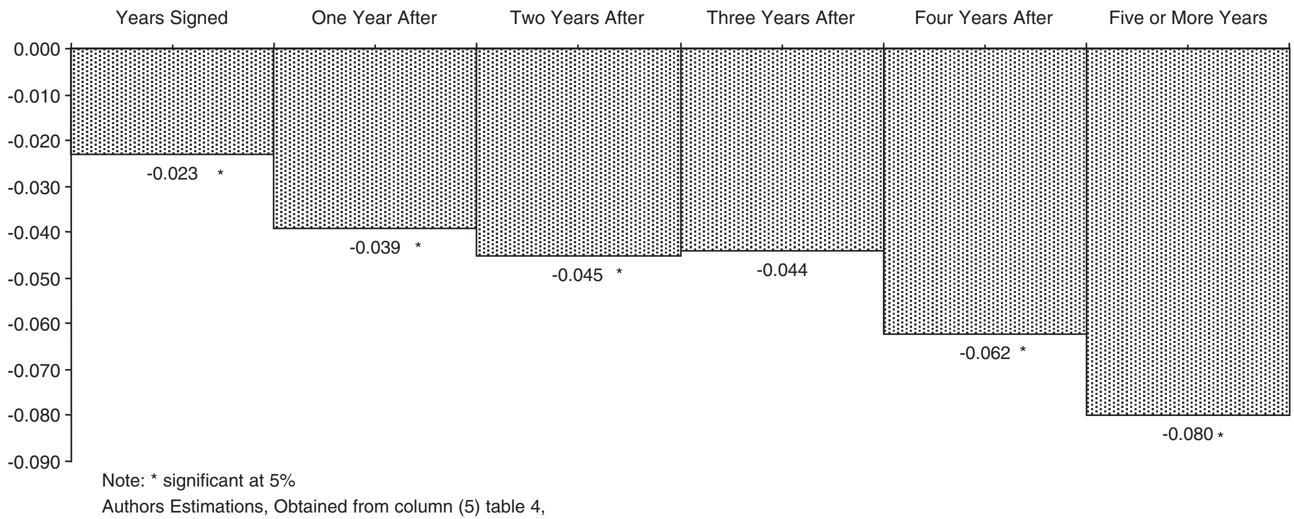

Fig. 2. The effect of OSA on air transport costs over time.

Table 5
Panel analysis: share of imports carried by aircraft

Dependent variable: share of imports carried by aircrafts				
	(1)	(2)	(3)	(4)
Open sky agreement	−0.007 (0.013)	0.020 (0.011)*	0.023 (0.013)*	0.036 (0.021)*
Open sky agreement × Three years after or more	0.014 (0.013)	0.047 (0.011)***	0.058 (0.013)***	0.026 (0.025)
Open sky agreement × Distance	0.063 (0.015)***	0.035 (0.022)	−0.011 (0.029)	0.099 (0.031)***
Implied effect OSA	0.007	0.067***	0.081***	0.062**
Observations	2268	1064	644	420
R-squared	0.707	0.820	0.853	0.771
Sample	All countries	Developed and upper middle income countries	Developed countries	Upper middle income countries

"Open Sky Agreement" is a dummy if there is an Open Sky agreement signed. "Open Sky Agreement × Three years or more since signed" is a dummy that is 1 if at least 3 years have passed since the agreement was signed. "Open Sky Agreement × Distance" is the product between the Open Sky Agreement variable and distance (ln and demean). The "Implied effect OSA" is the sum of the OSA dummy and the "OSA × Three years after or more" dummy. All regressions have country and year fixed effects.
Robust standard errors in parentheses.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

3 and 4, the long-term effect of OSAs is a fall in air transport costs of about 9% (*five or more years after*).

Given that the effect of OSAs on transport costs differs across income groups (Table 3), the increasingly negative effect of OSAs with time could reflect a narrowing of the sample toward developed countries because many developing countries signed an OSA only in 2000 or later. To account for this composition problem, the last six columns in Table 4 replicate columns 3and 4 of Table 3, but restrict the sample to developed countries, developing countries, and upper-middle-income countries. For developed countries, results are similar to those obtained for the whole sample, although the effect shows up early on. Fig. 2 presents the yearly evolution of the effects of OSAs on air transport costs for developed countries (column 5 of Table 4). For all developing countries, columns 7 and 8 show that OSAs have a weak effect on transport costs that shows up only later on. For upper-middle-income countries, columns 9 and 10 show that, as for developed countries, OSAs have an increasing effect on transport costs although results are noisy.[40]

4.4. Open skies agreements and the share of imports arriving by air

Our results indicate that air transport costs fall after OSAs are signed. As a consequence, an increase in the relative importance of air transport in total import flows should be observed. Is that the case? Does the reduction of air transport costs cause an increase in the share of imports arriving by air? To answer this question, we regress the share of imports arriving in the United States by air on a series of open skies dummy variables that indicate how long the OSAs have been implemented and what interaction is between OSAs and distance. The share of imports

[40] The results for high-middle-income countries are also subject to composition problems because many of the countries signed OSAs at the end of our sample period.

arriving by air is obtained by considering as total imports only those arriving by air and sea and including only those sectors that have a positive share of air imports.[41]

The results, presented in Table 5, show that the share of air imports responds to OSAs in the predicted way: OSAs reduce air transport costs, and this reduction increases the share of imports arriving by air. When the whole sample is considered (column 1), the share of imports arriving by air increases by only 0.7% three years after the OSAs are signed, and it is not significant at standard levels. Given that OSAs do not reduce freight rates in low-income developing countries (see Table 4), column 2 restricts the sample to developed and upper-middle-income developing countries. For this group, the share of imports arriving by air increases by 6.7% three years after the OSAs are signed. This increase is not small, considering that the average share of imports arriving by air between 1990 and 2003 was 33% for this group. Columns 3 and 4 restrict the sample to developed and upper-middle-income developing countries, respectively. In both cases, the share of imports arriving by air increases, and the effect is significant at standard levels 3 years after the OSAs are signed (8.1% and 6.2%, respectively).

5. Conclusion

During the 1980s and 1990s, many countries engaged in a process of reducing tariff and nontariff barriers to trade. As a consequence, the relevance of transport costs as a determinant of the ability of a country to integrate into the global economy increased significantly. At first glance, one might argue that governments cannot reduce transport costs because they are, to a great extent, determined by exogenous factors, mainly distance. Even though it is true that distance is an important explanatory variable of transport costs, this paper shows that governments can implement policies to reduce transport costs and effectively help their countries “get closer” to high-demand markets.

This paper concentrates on air transport, the fastest-growing cargo transport mode. Relying on detailed microdata and the opportunity that Open Skies Agreements provide for evaluating the effect of a change in the competition regime, our estimations show that the liberalization of air cargo markets reduces air transport costs by about 9%.

The effects of OSAs are not restricted exclusively to reductions in freight tariffs. The evidence indicates that the reduction in tariffs caused an important increase in the share of U.S. imports arriving by air from those countries that signed OSAs. If we use previous estimates of transport cost trade elasticity (1.3) (see Clark et al., 2004), and generalize the estimates of this paper, an Open Skies Agreement could bring about an increase in trade of about 12%.

OSAs do not have the same effects in all countries. For developed and upper-middle-income developing countries, we find that OSAs reduce air transport costs. For low-income developing countries, we do not find that OSAs can be associated with a fall in freight rates. We understand this result as an indication that low-income developing countries cannot take advantage of OSAs either because other barriers to competition are binding or because of their limited market size.

As a by-product result, the cross-section analysis of the paper finds that in countries with greater access to airports and better regulatory quality air transport costs are lower. The findings are in line with previous results for maritime transport costs.

The results obtained in this paper have important policy implications. Negotiating Open Skies Agreements has been difficult and strongly resisted, especially by airlines. However, this paper

[41] We do not include the following sectors: coal and mining, crude petroleum and natural gas, and electricity gas steam.

provides sound evidence that many economic sectors could benefit, through a reduction in trade costs, from a deregulated air cargo market.

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Appendix A. Data description

Distance per port of entry (ln): is defined as the logarithm of the distance between the import district of entry and the origin import country. The distance is in kilometers, and it is obtained using longitude and latitude coordinates obtained from CIA's World Factbook (2002).

Dummy high-income countries: is a dummy variable that takes the value of 1 when the country is classified by the World Bank as a high-income country, and otherwise is 0.

Foreign Airport Infrastructure Index II ($FAII^1$): corresponds to the percentage of population that has access to an airport with paved runaways at least 2000 m long and 40 m wide. The index is weighted by the percentage of urban population per country. By access, we mean that the city must be located, at most, 75 km from the airport. To determine if the city is located within the 75-km requirement, we estimated the distance between the airport and the city using the polar coordinates obtained from www.tageo.com. After we estimated the distance, we identified the cities that have access to a nearby airport and quantified Eq. (3) in the main text (with alpha equal 0). In Eq. (3), $\mathrm{Urbanpop}_i$ is the percentage of urban population of country i. This information was obtained from World Bank (2005).

Foreign Airport Infrastructure Index II ($FAII^2$ or $FAII^3$): is similar to $FAII^1$ but accounts for the "quality" of the airport infrastructure, which is understood as runway availability per million city inhabitants. We interact the share of population with the quantity of runways per million inhabitants in each city $([\mathrm{Ra}_{c,i}]/[\mathrm{Pop}_{c,i}])^{\alpha}$ to the power of alpha equals 1/2 ($FAII^2$) and 1/3 ($FAII^3$).

GDP (ln): is the logarithm of GDP in U.S. constant dollars. The data were obtained from World Bank (2005).

GDP per capita (ln): is the average of GDP per capita in U.S. constant dollars (ln). The data were obtained from World Bank (2005).

Imbalance: is defined by the following equation:

$$\mathrm{Imbalance}_{i,t} = \frac{\mathrm{exp}_{i,t} - \mathrm{imp}_{i,t}}{\mathrm{exp}_{i,t} + \mathrm{imp}_{i,t}},$$

where $\mathrm{exp}_{i,t}$ and $\mathrm{imp}_{i,t}$ are total U.S. volume of exports and imports to and from country i in year t, respectively. The data were obtained from the U.S. Import and Export Database of the U.S. Census Bureau, year 2000.

Infrastructure Index (INFI): is the 1990–1995 country average of the Infrastructure Index estimated by Limão and Venables (2001).

Open Skies Agreement: is a dummy variable that takes the value of 1 since the year when the United States signed an Open Skies Agreement with import country i. The variables of 1 year, 2 years, 3 years, 4 years, and 5 years are dummy variables that take the value of 1 when 1, 2, 3, 4, and 5 years have passed since the OSA was signed. Finally, the *three years after* variable is a dummy variable that takes the value of 1 when only 3 years have passed since the OSA was signed. The data were obtained from the Aviation and International Affairs office of the U.S. Department of Transportation, http://www.ostpxweb.dot.gov/aviation.

Open Skies Agreement interacted with distance: is the Open Skies Agreement variable interacted with the average of the logarithm of the distance variable of the sample used in the regression. The data were obtained from the Aviation and International Affairs office of the U.S. Department of Transportation, http://www.ostpxweb.dot.gov/aviation.

Orthogonal Foreign Airport Infrastructure Index II ($FAII^{\alpha}$): corresponds to the residuals obtained when we orthogonalized the Airport Infrastructure Index II ($FAII^{\alpha}$) with GDP per capita (2000). We orthogonalized the three infrastructure indexes used in the cross-section results (when $\alpha=0$, 1/2, and 1/3). The data were obtained from www.tageo.com, and GDP data were obtained from World Bank (2005).

Orthogonal Infrastructure Index (INFI): corresponds to the residuals obtained when we orthogonalized the Limão and Venable Infrastructure Index with GDPpc in logs (ln).

Product unit value (ln): is the product unit value. This variable is at the four-digit SITC level of desegregations. It is obtained from the U.S. Import database 1990–2003.

Regulatory quality: is the country average of the Regulatory Quality Index obtained by Kaufmann et al. (2003).

Total weight (ln): is the logarithm of the total volume of annual U.S. imports transported per air from a given country. It is obtained from the U.S. Import database 1990–2003.

U.S. regions: are groups of districts of entry in the U.S. Imports of Merchandise Database (U.S. Department of Commerce). We define three regions. The east region includes Baltimore, Maryland; Boston, Massachusetts; Buffalo, New York; Chicago, Illinois; Cleveland, Ohio; Detroit, Michigan; New York, New York; Norfolk, Virginia; Ogdensburg, New York; Philadelphia, Pennsylvania; Portland, Maine; Providence, Rhode Island; St. Albans, Vermont; St. Louis Missori; and Washington, DC. The west region includes Charleston, South Carolina; El Paso, Fort Worth, Texas, Houston, and Laredo, Texas; Miami, Florida; Milwaukee, Wisconsin; Mobile, Alabama; New Orleans, Louisiana; Port Arthur, Texas; Savannah, Georgia; Tampa, Florida; Wilmington, and North Carolina. Finally, the Gulf of Mexico region includes Columbia-Snake; Duluth, Minnesota; Great Falls, Montana; Los Angeles, California; Minneapolis, Minnesota; Nogales, Arizona; Pembina, North Dakota; San Diego and San Francisco, California; and Seattle, Washington.

Vessel Index: to construct this index, we first run the following regression on the vessel transport costs per unit of weight, at the four-digit SITC desegregation product level, for sample 1990–2003:

$$\text{Freight}_{i,t} = \beta\ \text{unitval}_{i,t} + D_{\text{year}} + D_{\text{ctysitc}} + D_{\text{reg}} + \varepsilon_{i,t}$$

where $\text{Freight}_{i,t}$ corresponds to the vessel transport cost of the good imported from country i in year t; $\text{unitval}_{i,t}$ is the unit value of the goods imported from country i in year t; and D_{year}, D_{ctysitc}, and D_{reg} are year, product-country, and region fixed effect. Then we estimate the residuals, and we calculate the Vessel Index as the average value of the residuals per country and year. Therefore, our index is defined as

$$\text{Vessel index}_{i,t} = \frac{1}{n_{i,t}} \sum_{i,t} \left(\text{Freight}_{i,t} - \hat{\beta}\ \text{unitval}_{i,t} - \hat{D}_{\text{ctysitc}} - \hat{D}_{\text{reg}} \right) = \frac{1}{n_{i,t}} \sum_{i} \hat{\varepsilon}_{i,t} + \hat{D}_{\text{year}}$$

where n is the number of observations for products imported by vessel from country i in year t. The data were obtained from the U.S. Import Database 1990–2003 of the U.S. Census Bureau.

Appendix B. Data used

Table B1
Bilateral open skies agreements, United States 1992–2003

Year	Country	Year	Country	Year	Country	Year	Country	Year	Country
2003	Albania	2000	Malta	1999	Portugal	1997	Brunei	1996	New Zealand
2003	Thailand	2000	Morocco	1999	Qatar	1997	Chile	1995	Austria
2003	Tonga	2000	Namibia	1999	Tanzania	1997	Costa Rica	1995	Belgium
2002	Samoa	2000	Nigeria	1999	United Arab E.	1997	El Salvador	1995	Czech R.
2002	Uganda	2000	Rwanda	1998	France	1997	Guatemala	1995	Denmark
2001	Oman	2000	Senegal	1998	Italy	1997	Honduras	1995	Finland
2001	Poland	2000	Slovenia R.	1998	Korea, Rep. of	1997	Nicaragua	1995	Iceland
2001	Sri Lanka	2000	Turkey	1998	Malaysia	1997	Panama	1995	Luxembourg
2000	Benin	1999	Argentina	1998	Neth. Antilles	1997	Singapore	1995	Norway
2000	Burkina Faso	1999	Australia	1998	Peru	1997	Taiwan	1995	Sweden
2000	Gambia, The	1999	Bahrain	1998	Romania	1996	Germany	1995	Switzerland
2000	Ghana	1999	Dominican R.	1998	Uzbekistan	1996	Japan	1992	Netherlands
2000	Jamaica	1999	Pakistan	1997	Aruba	1996	Jordan		

Source: Aviation and International Affairs of the U.S. Department of Transportation, http://www.ostpxweb.dot.gov/aviation/, U.S. Department of State, http://www.state.gov/e/eb/tra/c661.htm.

Tables B2 and B3 present the summary statistics for the variables used for year 2000 and for the whole sample, respectively.

Table B2
Summary statistics year 2000

Variable	Obs.	Mean	S.D.	Pct.5	Pct.95
Air transport cost per unit of weight (ln)	164,721	0.858	1.282	−1.268	2.688
Total weight (ln)	164,721	17.775	1.528	14.780	19.592
Product unit value (ln)	164,721	3.726	1.582	1.373	6.506
Imbalance	164,721	−0.078	0.331	−0.727	0.509
Distance per port of entry (ln)	164,721	8.933	0.539	7.891	9.590
Open sky agreement	164,721	0.592	0.492	0.000	1.000
Foreign airport infrastructure index II (FAII^1)	164,721	0.629	0.214	0.250	0.915
Foreign airport infrastructure index II (FAII^3)	164,721	1.182	0.717	0.223	2.704
Foreign airport infrastructure index II (FAII^2)	164,721	1.801	1.465	0.187	5.724
Infrastructure index (INFI)	160,304	0.409	1.157	−1.542	1.779
Orthogonal foreign airport infrastructure index II (FAII1)	164,721	−0.343	0.163	−0.609	−0.104
Regulatory quality	164,721	0.892	0.629	−0.206	1.635
Dummy high income countries	164,721	0.645	0.478	0.000	1.000
GDP per Capita cte. US$ (ln)	164,721	9.332	1.402	6.410	10.710
GDP cte. US$ (ln)	164,721	26.649	1.608	23.539	29.368

These summary statistics are obtained for the variables used to estimate the results from Table 2, column 1, year 2000.

Table B3
Summary statistics whole sample (1990–2003)

Variable	Obs.	Mean.	S.D.	Pct.5	Pct.95
Air trans. price per unit (ln)	2,006,690	0.965	1.234	−1.038	2.773
Total weight (ln)	2,006,690	17.560	1.480	15.025	19.369
Product unit value (ln)	2,006,690	3.745	1.555	1.409	6.458
Distance per port of entry (ln)	2,006,690	8.929	0.548	7.851	9.586
Open sky agreement	2,006,690	0.340	0.474	0.000	1.000
Imbalance	1,986,770	−0.074	0.317	−0.727	0.509
GDP per capita cte. US$ (ln)	2,006,639	9.360	1.380	6.264	10.697
Log GDP cte. US$	2,006,690	26.639	1.616	23.390	29.258
Vessel index	2,006,690	0.001	0.064	−0.093	0.093
OSA, year signed	2,006,690	0.046	0.209	0.000	1.000
OSA, one year after	2,006,690	0.047	0.212	0.000	1.000
OSA, two years after	2,006,690	0.048	0.213	0.000	1.000
OSA, three years after	2,006,690	0.047	0.211	0.000	1.000
OSA, four years after	2,006,690	0.042	0.201	0.000	1.000
OSA, five or more years after	2,006,690	0.110	0.313	0.000	1.000
Dummy agree interacted with distance	2,006,690	0.013	0.191	−0.181	0.359
Share of imports transported by air	2268	0.291	0.265	0.007	0.879
Main effect of distance interacted with OSA in total sample	2268	−0.013	0.174	−0.146	0.070
Main effect of distance interacted with OSA of high and middle high income countries	1064	0.016	0.178	−0.052	0.443
Main effect of distance interacted with OSA of developed countries	644	0.024	0.176	−0.043	0.476
Main effect of distance interacted with OSA of high-middle-income countries	420	0.009	0.181	0.000	0.326

These summary statistics are obtained for the variables used to estimate the results from Table 4, column 4.

Table B4
Correlations of the infrastructure indexes

	Foreign airport inf. index II (FAII[1])	Foreign airport inf. index II (FAII[3])	Foreign airport inf. index II (FAII[2])	GDP per capita US$ (ln)	Inf. index (INFI)	Orthogonal foreign airport inf. index II (FAII[1])	Foreign airport inf. index II (FAII[1]) within 100 m	Regulatory quality
Foreign airport infrastructure index II (FAII[1])	1							
	113							
Foreign airport infrastructure index II (FAII[3])	0.7240*	1						
	113	113						
Foreign airport infrastructure index II (FAII[2])	0.5863*	0.9779*	1					
	113	113	113					
GDP per capita cte. US$ (ln)	0.6817*	0.6009*	0.5184*	1				
	113	113	113	114				
Infrastructure index (INFI)	0.6246*	0.6612*	0.6200*	0.7570*	1			
	81	81	81	82	82			
Orthogonal foreign airport Infrastructure index II (FAII[1])	0.7316*	0.4296*	0.3183*	0	0.0681	1		
	113	113	113	113	81	113		
Foreign airport infrastructure index II (FAII[1]) within 100 m	0.9945*	0.7117*	0.5722*	0.6758*	0.6257*	0.7296*	1	
	113	113	113	113	81	113	113	
Regulatory quality	0.4989*	0.4268*	0.3569*	0.8099*	0.6650*	−0.0696	0.5043*	1
	113	113	113	114	82	113	113	114

"Foreign airport infrastructure index II (FAII[1])" accounts for the share of total population that has access within a distance of 75 km to an airport with runaways length greater than 2000 m. "Foreign airport infrastructure index II (FAII[3])" and "Foreign airport infrastructure index II (FAII[2])" adjust the first index by quality. Index INFI is the logarithm of mean value of Limão and Venables (2001)'s infrastructure Index for the period 1990–1995. "Orthogonal foreign airport infrastructure index II (FAII[1])" is the orthogonalized "Foreign Airport Infrastructure Index II (FAII[1])". "Foreign airport infrastructure index II (FAII[1])" within 100 m is the share of population that has access within a distance of 100 km to an airport with runaways length greater than 2000 m. "Regulatory quality" is the average of Kaufmann et al. (2003)'s regulatory index.
*Significant at 1%. The second line reports the number of observations (countries used to compute the correlation).

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