No 2023-17 – July

# Working Paper

CEPII

# Cheaper and Faster: The Role of Air Services Agreements on Transportation

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## Highlights

- We assess the impact of bilateral air services agreements (ASAs) on air transportation using an unique dataset providing direct observations of bilateral air transport cost and time for a standardized good, for 1,190 country-pairs, between 2011 and 2015.
- ASAs are found to reduce transportation cost by 8% while they only impact transportation time for landlocked countries and RTA members.
- Bilateral trade decreases cost of transport but not time.

## Abstract

We assess the impact of bilateral air services agreements (ASAs) on air transportation using an unique dataset providing direct observations of bilateral air transport cost and time for a standardized good, for 1,190 country-pairs, between 2011 and 2015. Our results show that ASAs reduce transportation cost by 8% while they only impact transportation time for landlocked countries and RTA members. Our estimates also reveal that bilateral trade decreases cost of transport, which highlights the role of backhauling in air transportation.

## Keywords

Transport Cost, Transport Time, Air Services Agreements, Trade.

## JEL

F14, F13, L91.

Working Paper

CEPII



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*CEPII Working Paper*
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Editorial Director:
Antoine Bouët

Visual design and production:
Laure Boivin

ISSN 2970-491X

July 2023

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# 1 Introduction

The reduction of tariffs induced by the creation of the GATT (1947) and the WTO (1995) and by the expansion of regional trade agreements in the 90s has led to an increase in world trade (Baier, Yotov, and Zylkin, 2016). However, multilateral and bilateral trade agreements are not the only international agreements that may impact trade. Different types of agreements aim at reducing non-tariff trade costs, whether within the WTO, such as the Trade Facilitation Agreement (2014), within the World Custom Organization, such as the Simplification and Harmonization of Customs Procedures convention (1976) or within the International Civil Aviation Organization (ICAO), the UN agency charged with coordinating international air travel. The objective of the ICAO is to organize and foster the development of air transport through the implementation of standards and good practices. Under its umbrella, many countries have signed Air Services Agreements (ASA) in order to facilitate air transportation. By increasing the number of air routes, the frequency of flights and the capacities of carriers, and by decreasing airport fares, these ASA may reduce both air freight rate and time of transportation.

This paper investigates the effect of air services agreement on air transportation cost and time.[1] We rely on an original and unique dataset of bilateral transportation cost and time by airfreight retrieved from the United Parcel Service (UPS) for 35 countries in 2011, 2013 and 2015. We assess the impact of the signature of ASA and of their depth separately on transportation cost and time, controlling for other factors such as distance, border and bilateral trade.

This paper contributes to the literature on Agreements in Air transportation. Based on the numerous Open Skies Agreements (OSA) signed by the USA and its partners between 1990 and 2003, Micco and Serebrisky (2006) show that such air agreements reduce air transport costs by 9 % and raises the share of imports by air by 7 %, but only for developed and upper-middle-income developing countries. They also highlight the differential effect of such agreements overtime. For developed countries, the signature of an OSA with the US is associated with around a 1% fall in freight rates per year, which means a 5% to 6% fall after four years. Grosso and Shepherd (2011) go further and explore the level of openness of the agreements for APEC countries. They show that an increase in the bilateral Air Liberalisation Index (ALI, index developed by the WTO) of one point is associated with an increase of 4% in the bilateral trade of the most time sensitive sector (parts and components). Yilmazkuday and Yilmazkuday (2017) also rely on the ALI and focus on direct flights. They find that these latter lower trade costs and are determined by bilateral air services agreements. Finally, considering both bilateral and plurilateral air services agreements, Cristea, Hillberry, and Mattoo (2015) highlight that the depth of the agreement is associated with larger passenger flows. Our paper explores the impact of ASA by assessing their impact both on cost and time, using an unique dataset on transportation, for 1,190 country-pairs.

More globally, this paper is also related to the strand of literature on the effect of service agreements on trade. Most of the papers focus on and highlight the positive impact of such trade agreements on bilateral trade in services (see among others Van der Marel and Shepherd (2013); Guillin (2013); Nordås and Rouzet (2017); Lamprecht and Miroudot (2020)) while Miroudot and Shepherd (2014) emphasise their impact on the reduction of trade costs in services. In this paper, we focus on a particular type of services agreements, the ASA, as a determinant of the cost and time of transportation which ultimately impacts bilateral trading flows.

[1] Excluding insurance.

Our work also connects to papers dealing with transportation time. Hummels and Schaur (2013) put forward the figure of a tariff-equivalent between 0.6% and 2.1% for each day in transit while Djankov, Freund, and Pham (2010) reaffirm the negative effect of delays on trade in particular for perishable agricultural products: on average, each additional day of delay is equivalent to rising the distance between a given country and its partners by approximately 70 km involving a reduction of trade by 1%. According to Evans and Harrigan (2005) and Deardorff (2003), timeliness may also determine country specializations since remote countries tend to be specialized in time-insensitive sectors. Hummels and Schaur (2010) show that exporters pay higher transportation costs in order to be able to respond faster to the foreign demand, in particular in low demand seasons to limit the risk exposure to excessive stocks. Literature on trade and time is not restricted to transportation. Several studies analyze the impacts of the delays associated to customs procedures on trade.[2] Among others, Martincus, Carballo, and Graziano (2015) demonstrate that an increase in customs delays results in higher costs for exports which in turn decrease firm exports. In this paper, we focus on air services agreements on transportation time and compare with their impact on freight costs.

The contribution of this article is threefold. First, we show that bilateral air services agreements reduce on average air transportation cost by 8%. This result is robust to the introduction of different controls. Second, we demonstrate that ASAs only affect transportation time for landlocked countries, island importers, or countries with regional trade agreements. Third, we document the 'backhaul problem', which refers to an increase in transportation cost due to imbalance in transport demands between locations (here countries), for air transportation while the literature has especially highlighted the backhauling for maritime transportation (Jonkeren, Demirel, van Ommeren, and Rietveld, 2011). This result relates to the literature on the endogeneity of transportation costs such as Asturias (2020) which relies on containerized maritime transportation data and demonstrates that the endogeneity of transportation costs is an important mechanism to consider when we evaluate the effect of trade policies.

Overall, we conclude that distance is an imperfect proxy for transport costs, which depend not only on standard gravity variables (common border, RTA) but also on trade in both directions and air services agreements. Our paper argues in favor of inclusion of ASA in gravity models as it appears to be an important determinant of trade costs and, as a consequence, trade.

The paper is organized as follows. Section II describes the dataset of transportation cost and time and on air services agreements. Section III presents our empirical strategy and discusses our results. Section IV concludes.

# 2 Data and descriptive statistics

## 2.1 Data: Transportation cost and time

Our goal is to get a proxy for bilateral air transportation cost which is comparable over time and across countries. We build an original and unique dataset on transportation by retrieving information from the United Parcel Service (UPS) website. Few carriers operate worldwide with a global presence. UPS is one of the biggest

[2] See in particular Màrquez-Ramos and Martinez-Zarzoso (2008); Portugal-Perez and Wilson (2012); Persson (2013); Hornok and Koren (2015).

companies serving more than 200 countries and territories, this is why it seems to be fairly representative of bilateral air transportation costs. On this website, users have the possibility to calculate freely shipping quotes for a given origin, destination, and weight of the freight shipment. To end-up with a sample composed of 3,555 observations, we made exactly the same request for 35 pays (representing 1,190 country-pairs per year) in 2011, 2013 and 2015.[3]

In 2011, simulations of time and cost for freight were available for 35 countries of origin and a large number of destinations when we started the data collection.[4] As we are interested in the cost and time dimensions of the air transport services in both directions, we restrict our sample to these 35 countries in both origin and destination. The 35 countries are displayed in Table 5. As the service offered is door-to-door, we looked for a central location in the origin country and in the destination one. In the request form, i) the place of origin (country, city and zipcode); ii) the place of destination (country, city and zipcode); iii) the size, the weight and the value of the shipment must be filled in.

Shipment information have been extracted for one pallet, with the following characteristics: a weight of 900 kgs, L590xW235xH240 mm (the dimensions of a standard container). The dimensions of the shipment are justified by the fact that we are interested in genuine trading relationships between firms across countries and not in parcel shippings between private individuals. We are aware that this type of shipment is not appropriate for all products. It is however relevant for high value-added and/or time-sensitive products with a small or intermediate size which are more likely to be transported by air than by sea.[5]

The transportation company offers the possibility to include insurance which can account for a significant proportion of the final transport cost.[6] This insurance is imposed when the value of the shipment exceeds 500 US dollars. Although it may appear unrealistic, we choose the minimum value of the shipment to do our simulations to avoid surpluses associated to high values shipment and to cancel out the insurance part from our measure of transportation cost.

We consider capital cities of every country as the point of departure and arrival except for Turkey (we took Istanbul as Ankara was not available) and Brazil (we took Rio de Janeiro as Brasilia was not available). This exercise has been carried out in 2011 (departure on Monday, November28$^{th}$, 2011), 2013 (departure on Monday, December 2$^{nd}$, 2013) and 2015 (Monday, November 30$^{th}$, 2015). We target the same period of time for each year to avoid spurious data just due to a seasonality effect.

UPS provides several sorts of delivery depending on the cost and the swiftness.[7] Since all are not available for all countries, the attention is focused on the cheapest delivery. In using only one source of information, we eliminate all types of problems related to the setting price.

Our measure of transportation costs is not a perfect measurement since the data we collected are simple estimations which cannot be considered contractual. We are aware that larger companies negotiate directly

[3] Missing values: in 2015, China-Hungary, China-Portugal, China-Spain, Portugal-Romania, Russia-Romania and Switzerland-Romania; in 2013, China-Hungary, China-Portugal, China-Spain, Portugal-Romania, Russia-Romania and Switzerland-Romania; in 2011, Portugal-Romania, Russia-Romania and Switzerland-Romania.

[4] More origin countries are now available.

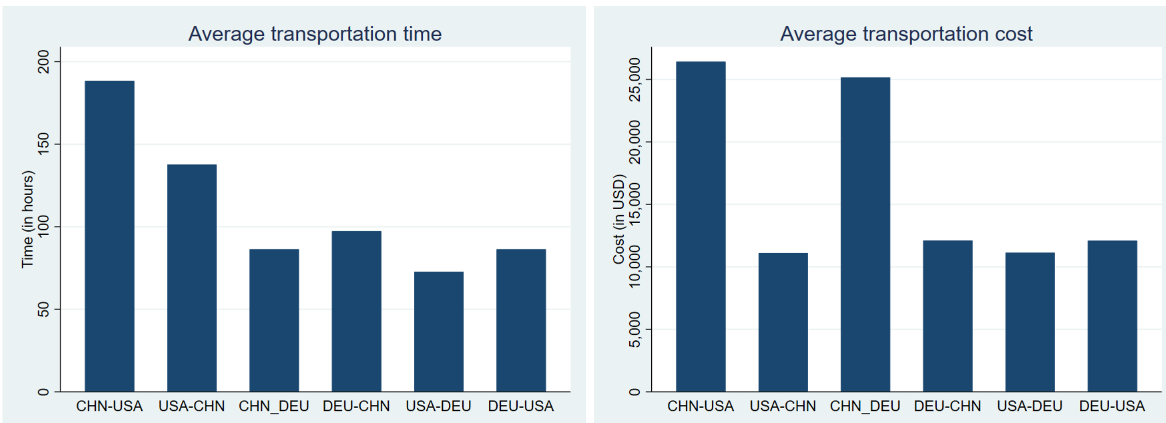
[5] Maritime shipment can be highly costly compared to other transportation options when the demand for transportation is uneven (small and medium size enterprises for example) and when the size of the shipment does not ensure optimal use of the container transportation.

[6] Customers may also purchase insurance from other insurers.

[7] When the cost was expressed in local currency, we converted it into US dollars using the corresponding exchange rate.

with the carrier and are able to obtain lower prices. Thus, our cost measurement is more relevant for smaller exporters for instance. Note that our focus is not to explain the level of transportation cost or time but to estimate the impact of ASA on transport. Our identification strategy relies on variation in transportation time and cost across country-pairs, for a similar standardized good of same size and value, exchanged by the same type of firm. Another limitations of our database is that we do not take into account possible substitutions of air transport with other modes of transport such as maritime or rail transport. Because of data limitations, we cannot account for this potential composition effect.

Figure 1: Time and cost differences




In Figure 1, we report the average time and cost for air transportation for 3 countries especially integrated in world trade (China, Germany and the USA). Our data demonstrate that the patterns of transport time and cost are different, which suggests that they have distinct determinants. Transport costs and, to a lesser extent, time, appear to be asymmetrical, but not in all cases. For example, the cost for a shipment from China to Germany is twice as expensive than the other way around while for the USA-DEU country-pair, the $\frac{cost_{DEU-USA}}{cost_{USA-DEU}}$ ratio is around 1.1.

In Figures 5 and 6 in annex, we display the average time and cost for all partners over the whole period, for each country of the sample. Some countries seem to be more easily accessible than others. Customs formalities, in addition to country-specific determinants, can be manifold for carriers which result in more expensive and longer transport services.

We ended up with a rich and original dataset on bilateral time and cost of transportation covering different regions of the world that allows us to compare short-distance shipments with long-distance ones.

## 2.2 Data: Air Services Liberalization

To assess the degree of air services liberalization, we exploit information from the WTO's Air Services Agreements Projector.[8][9]

The WTO provides information on Air Services Agreements (ASA) and allows us to know which countries have signed an ASA with which partner and when. Nowadays, more than 3,000 ASAs are in force (including

[8]http://asap.wto.org/index
[9]Following the WTO, we consider equally air services agreements and air transport agreements in our analysis.

multilateral ones). As shown in figure 2, the USA, Russia and Switzerland are among the countries with the higher number of bilateral agreements (more than 100).

Figure 2: Number of bilateral Air Services Agreements (ASA) signed by country


Based on the WTO's Air Services Agreements Projector (ASAP)

### 2.3 Descriptive evidence

Table 1 displays some descriptive statistics on our variables of interest, that is the bilateral transportation time and cost, distinguishing the country-pairs involved in a common ASA from the others. In our sample, around 60% of the country-pairs are linked with an ASA. More generally, the time and the cost vary substantially across country-pairs since the duration for this door-to-door shipment goes from 28 hours to 353 hours between the departure and the arrival while the minimum cost is 1,353 USD against 73,185 USD at most.

Table 1: Descriptive statistics

| | # obs | Mean | Median | Min | Max |
|---|---|---|---|---|---|
| ASA dummy | 3,555 | 0.606 | 1 | 0 | 1 |
| Air Liberalization Index | 2,153 | 12.425 | 11 | 0 | 50 |
| Time (in hour) | 3,555 | 117 | 97 | 28 | 353 |
| *with ASA* | 2,153 | 122 | 104 | 32 | 283 |
| *without ASA* | 1,402 | 110 | 82 | 28 | 353 |
| Cost (in US dollar) | 3,555 | 19,037 | 18,246 | 1,353 | 73,185 |
| *with ASA* | 2,153 | 18,423 | 17,126 | 1,353 | 73,185 |
| *without ASA* | 1,402 | 19,979 | 19,396 | 4,460 | 70,315 |

We note that the bilateral cost of transportation is slightly lower on average for the country-pairs bound by an ASA while belonging to the same ASA does not seem to reduce the bilateral time of transportation. The correlation between the transportation time and cost is around 0.12 for our sample, confirming that the determinants of transportation time differ significantly from the ones of transportation cost.

Figure 3: Distribution of transportation cost

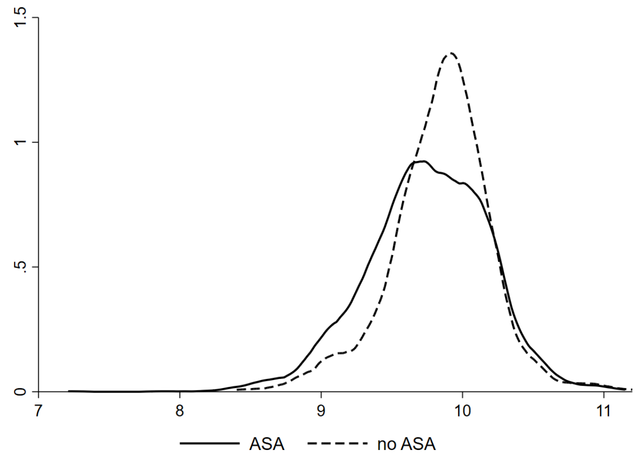
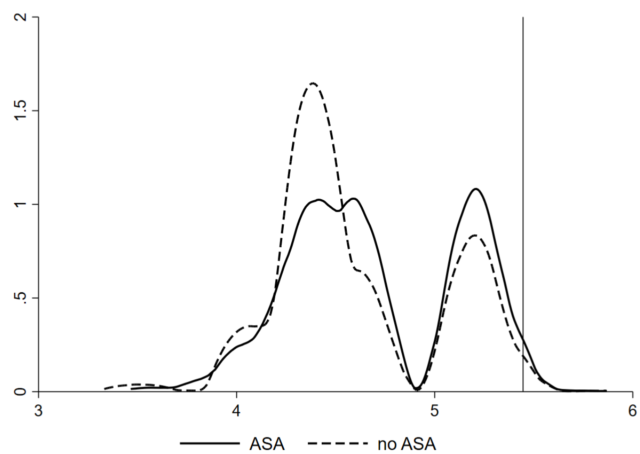



Figure 4: Distribution of transportation time




Figures 3 and 4 display the distribution of transportation cost and time depending on whether an ASA exists between the two countries that year. Transportation costs seems to be higher for country-pairs without any ASA. The effect of ASA is less clear on transportation time which appears to be bimodal (corresponding to long and short distance). Our empirical analysis will allow us to go further on the impact of ASA on transportation.

# 3 Empirics

## 3.1 Empirical strategy

The objective of the paper is to assess the impact of air service liberalization on transport. We follow Micco and Serebrisky (2006) and evaluate the role played by Air Services Agreements (ASA) on air transportation cost and time, using the following estimation:

$$lnC_{ijt} \quad = \quad \alpha_1 + \alpha_2 ASA_{ijt} + \alpha_3 \Pi_{ij} + \alpha_4 Z_{ijt} + \gamma_{it} + \gamma_{jt} + \gamma_{IJ} + \epsilon_{ijt} \tag{1}$$

$C_{ijt}$ corresponds alternatively to the bilateral cost and time to ship from $i$ to $j$ at year $t$.[10] $ASA_{ijt}$ is a dummy variable equals to one if both countries are involved in a common bilateral air services agreement at year $t$ and 0 otherwise. $\Pi_{ij}$ is a set of bilateral time-invariant variables commonly used in gravity models, coming from the CEPII's geodist database (Mayer and Zignago, 2011). $Z_{ijt}$ is a set of bilateral time variant variables controlling for trade agreements (RTA dummy comming from the CEPII's gravity database (Conte, Cotterlaz, and Mayer, 2020) and trade relationship between $i$ and $j$, using trade data computed from the BACI dataset (Gaulier and Zignago, 2010). Exporter-year and importer-year fixed effects control for all time variant characteristics of countries that may impact trade costs, such as national infrastructures or customs procedures. $\gamma_{IJ}$ correspond to bilateral continent fixed effect with $I$ continent of the exporter $i$ and $J$ continent of the importer $j$.[11] Our identification thus relies on the bilateral variation of freight across countries.[12]

## 3.2 Impact of Air Services Agreements on transportation cost and time

Table 2 lists estimations of equation 1 on transportation cost. The variable $ASA_{ijt}$ attracts a significant and negative coefficient in column (1), suggesting that Air Services Agreements reduce trade costs by 8%.

This result is robust to the inclusion of different control variables in columns (2) to (7). In column (2), we add gravity variables to our specification. The coefficients of these bilateral controls are in line with the literature. As expected, the distance between countries $i$ and $j$ significantly increases transportation costs while having common language and historical colonial links reduce them. The positive effect of common borders on transportation is the opposite of what we expected but may reflect the preference for land transport for countries sharing a border, which relatively increase air transportation cost. It is worth noting that RTA are not found to reduce transportation costs, which is not surprising given that the objective of RTAs is to reduce tariffs not to address transportation issues.

In column (3), we control for the average weighted unit value of shipments between trade partners. Expensive products are more likely to be traded by air, which suggests that air transportation is more developed between two countries if they are trading high valued products. Our results confirm this intuition as the coefficient of the variable Unit value$_{ijt}$ attracts a negative coefficient. The higher the average price of goods exchanged between

[10] Note that Micco and Serebrisky (2006) include insurance among control variables.
[11] See list of continent table 5 in annex.
[12] Too few agreements were signed between 2011 and 2015 to let us exploit the time dimension of the database.

trade partners, the lower the transport cost.

In column (4), we follow the literature on the backhaul effect in transportation and add the total export from country $i$ to $j$ and total import of $i$ from $j$ the year $t$ to our specification. Our result are in line with Ishikawa and Tarui (2018) and Friedt and Wilson (2020) who show that the cost of transport between two countries depends on trade in both directions. Exports from country $i$ to country $j$ reduce transportation cost thanks to economy of scale, higher volumes of trade resulting in more frequent flights and larger carriers. Impact of imports of country $i$ from country $j$ on transportation is explained by the fact that carriers choose their transportation capacities according to the possibility of loading their cargo on the return trip.

In column (5) we go further and introduce the trade imbalances between the country $i$ and $j$ as determinant of transportation costs. Countries pairs with high differences between the two directions trade volumes are found to have higher transportation costs. This result is connected with the work of Tanaka and Tsubota (2017) who, using data on truck freight transportation in Japan, find that trade imbalances explain directional imbalances in freight rates. Jonkeren et al. (2011) obtain a similar result using inland waterway transport data in north-west Europe. In the same way, Friedt and Wilson (2020) highlight the simultaneity between bilateral trade and bilateral transport costs: long-run trade deficits lead to asymmetric adjustment of bilateral transportation costs on imports and exports.

In column (6), we add the number of direct flights between countries $i$ and $j$ as additional control variable.[13] Direct flights facilitate business travel and thereby commercial relationships (Alderighi, Gaggero, et al., 2012; Cristea, 2011) as well as reduce the time/cost air transportation by offering a cheapest and/or a fastest transport. As expected, a larger direct flight offer results in lower transportation costs.

In column (7), we follow Djankov et al. (2010) and Grosso and Shepherd (2011) and consider trade in time-sensitive products rather than total trade. For this purpose, we use the classification by Hummels (2001) and Djankov et al. (2010). Basically, industries with positive days/rate ratio are considered as *time-sensitive industries* while industries with negative ratio are *time-insensitive industries*.[14] Our result on the impact of ASA on transport cost remains. Signing an air service agreement significantly reduces air transportation costs.

Table 3 displays the estimation of equation 1 on transportation time. The coefficient of the variable $ASA_{ijt}$ is significant and negative in column (1), suggesting that Air Service Agreements reduce time of transportation between trade partners by 3%. However, contrary to estimates showed in table 2, this result is not robust to the inclusion of different controls variables. Adding gravity controls causes the lost of coefficients significance in columns (2) to (7). We thus conclude that ASAs only reduce transport cost for exporters, but do not have any impact of transport time on average. This result can be explained by the fact that ASAs mainly deal with rights, capacities and ownership, which allows airlines to benefit from economy of scale by increasing the number of carriers, for example, but does not impact the time of transportation.

[13] Information is given by the OpenFlights/Airline Route Mapper Route Database the OpenFlights/Airline Route Mapper Route Database based on 67663 routes between 3321 airports on 548 airlines in 2014 (https://openflights.org/data.html).

[14] Hummels (2001) provides the estimates of days/rate ratio which measures the degree of time sensitivity.
Time-sensitive sectors: ofce machines; electrical machinery; photographic apparatus.
Time-insensitive sectors: textile yarns and fabrics; non-metallic minerals; furniture.

Table 2: Effect of Air Services Agreements (ASA) on transportation cost

| Dependent variable | $\text{cost}_{ijt}$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $\text{ASA}_{ijt}$ | -0.085*** | -0.089*** | -0.088*** | -0.065*** | -0.065*** | -0.062*** | -0.067*** |
| | (0.011) | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) | (0.012) |
| $\text{Distance}_{ij}$ | | 0.211*** | 0.226*** | 0.148*** | 0.147*** | 0.137*** | 0.149*** |
| | | (0.012) | (0.012) | (0.014) | (0.014) | (0.014) | (0.014) |
| $\text{Common border}_{ij}$ | | 0.067*** | 0.058*** | 0.087*** | 0.088*** | 0.071*** | 0.058*** |
| | | (0.021) | (0.021) | (0.021) | (0.021) | (0.021) | (0.021) |
| $\text{Common currency}_{ij}$ | | 0.006 | 0.011 | -0.003 | 0.001 | 0.000 | -0.006 |
| | | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) |
| $\text{Common language}_{ij}$ | | -0.034** | -0.032* | -0.017 | -0.017 | -0.017 | -0.025 |
| | | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| $\text{Colonial relationship}_{ij}$ | | -0.085*** | -0.085*** | -0.054** | -0.054** | -0.038 | -0.044* |
| | | (0.025) | (0.025) | (0.025) | (0.025) | (0.025) | (0.025) |
| $\text{UE}_{ijt}$ | | 0.040 | 0.042 | 0.140*** | 0.141*** | 0.163*** | 0.122*** |
| | | (0.031) | (0.031) | (0.032) | (0.032) | (0.032) | (0.031) |
| $\text{USMCA}_{ijt}$ | | 0.495*** | 0.509*** | 0.598*** | 0.590*** | 0.579*** | 0.553*** |
| | | (0.078) | (0.078) | (0.078) | (0.078) | (0.077) | (0.077) |
| $\text{Other RTA}_{ijt}$ | | -0.023 | -0.025 | 0.010 | 0.011 | 0.009 | -0.005 |
| | | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| $\text{Unit value}_{ijt}$ | | | -0.036*** | -0.023*** | -0.022*** | -0.023*** | -0.017** |
| | | | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| $\text{Export}_{ijt}$ | | | | -0.040*** | -0.040*** | -0.035*** | |
| | | | | (0.007) | (0.007) | (0.007) | |
| $\text{Import}_{ijt}$ | | | | -0.040*** | -0.040*** | -0.036*** | |
| | | | | (0.007) | (0.007) | (0.007) | |
| $\text{Imbalances}_{ijt}$ | | | | | 0.032* | 0.035** | 0.020 |
| | | | | | (0.017) | (0.017) | (0.017) |
| $\text{Routes}_{ijt}$ | | | | | | -0.053*** | -0.062*** |
| | | | | | | (0.010) | (0.010) |
| $\text{Export Sens. prod.}_{ijt}$ | | | | | | | -0.016*** |
| | | | | | | | (0.005) |
| $\text{Import Sens. prod.}_{ijt}$ | | | | | | | -0.036*** |
| | | | | | | | (0.006) |
| Observations | 3555 | 3555 | 3555 | 3555 | 3555 | 3555 | 3555 |
| R-squared | 0.67 | 0.71 | 0.72 | 0.72 | 0.72 | 0.73 | 0.72 |

Robust standard errors in parentheses.
Origin-time, destination-time, exporting continent-importing continent fixed effects included.
* p<0.10, ** p<0.05, *** p<0.01.

## 3.3 Air Services Agreements and geography

Table 4 investigates further the effect of ASA on transportation and time according to geography. In columns (1) and (4), we test the non linearity of the effect of ASAs according to the distance separating the two trade partners. To do so, we interact the ASA dummy with three dummies. The first one, $dist_{ij}$<1000 is equal to one if the distance between countries $i$ and $j$ is below 1,000km and zero otherwise. The second, 1000<$dist_{ij}$<$10,000$ corresponds to distance between 1,000 and 10,000 km. The third one, $dist_{ij}$>$10,000$ corresponds to long distances and is equal to one if the distance between $i$ and $j$ is higher than 10,000 km, zero otherwise. Only coefficient related to medium distance is found to be negative in column (1), which suggests that only ASAs between countries separated by distance between 1,000 and 10,000 km impact transportation cost. Interestingly, the coefficient is also negative and significant in column (4), meaning that ASAs between countries at medium distance also reduce transportation time. In column (1), the coefficient of the variable $dist_{ij}$<1000 turns out positive and significant. This result is contrary to our expectations, but can be explained by the fact that countries separated by less than 1,000 kilometers may prefer to use land transport rather than air transport, which relatively increase air transportation cost and make ASAs less relevant.

Table 3: Effect of Air Services Agreements (ASA) on transportation time

| Dependent variable | time$_{ijt}$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| ASA$_{ijt}$ | -0.027** | -0.020 | -0.020 | -0.012 | -0.012 | -0.008 | -0.007 |
| | (0.013) | (0.013) | (0.013) | (0.014) | (0.014) | (0.014) | (0.014) |
| Distance$_{ij}$ | | 0.089*** | 0.097*** | 0.073*** | 0.073*** | 0.060*** | 0.055*** |
| | | (0.014) | (0.014) | (0.017) | (0.017) | (0.017) | (0.017) |
| Common border$_{ij}$ | | 0.167*** | 0.162*** | 0.171*** | 0.171*** | 0.150*** | 0.150*** |
| | | (0.024) | (0.024) | (0.024) | (0.024) | (0.024) | (0.024) |
| Common currency$_{ij}$ | | 0.025 | 0.027 | 0.023 | 0.021 | 0.020 | 0.016 |
| | | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) |
| Common language$_{ij}$ | | 0.004 | 0.005 | 0.010 | 0.010 | 0.010 | 0.010 |
| | | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) |
| Colonial relationship$_{ij}$ | | -0.064** | -0.065** | -0.055* | -0.055* | -0.035 | -0.034 |
| | | (0.029) | (0.029) | (0.029) | (0.029) | (0.029) | (0.029) |
| UE$_{ijt}$ | | 0.038 | 0.039 | 0.070* | 0.069* | 0.098*** | 0.096*** |
| | | (0.036) | (0.036) | (0.038) | (0.038) | (0.038) | (0.037) |
| USMCA$_{ijt}$ | | 0.034 | 0.041 | 0.068 | 0.071 | 0.058 | 0.061 |
| | | (0.090) | (0.090) | (0.091) | (0.091) | (0.091) | (0.091) |
| Other RTA$_{ijt}$ | | 0.032 | 0.031 | 0.042** | 0.042** | 0.039* | 0.039** |
| | | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) |
| Unit value$_{ijt}$ | | | -0.019** | -0.015 | -0.015 | -0.017* | -0.014 |
| | | | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |
| Export$_{ijt}$ | | | | -0.010 | -0.010 | -0.004 | |
| | | | | (0.008) | (0.008) | (0.009) | |
| Import$_{ijt}$ | | | | -0.014* | -0.014* | -0.009 | |
| | | | | (0.008) | (0.008) | (0.008) | |
| Imbalances$_{ijt}$ | | | | | -0.009 | -0.005 | -0.010 |
| | | | | | (0.020) | (0.020) | (0.020) |
| Routes$_{ijt}$ | | | | | | -0.066*** | -0.066*** |
| | | | | | | (0.012) | (0.012) |
| Export Sens. prod.$_{ijt}$ | | | | | | | -0.013* |
| | | | | | | | (0.006) |
| Import Sens. prod.$_{ijt}$ | | | | | | | -0.004 |
| | | | | | | | (0.007) |
| Observations | 3555 | 3555 | 3555 | 3555 | 3555 | 3555 | 3555 |
| R-squared | 0.64 | 0.65 | 0.65 | 0.65 | 0.65 | 0.66 | 0.66 |

Robust standard errors in parentheses.
Origin-time, destination-time, exporting continent-importing continent fixed effects included.
* p<0.10, ** p<0.05, *** p<0.01.

In columns (2) and (5) we interact the ASA dummy with countries' geographical characteristics. In column (2), the negative and significant coefficient of the variable ASA$_{ijt}$ $\times$ Landlocked$_j$ testifies that the effect of ASAs on transportation cost is higher when the importing country is landlocked. Similarly, in column (5) it appears that ASAs have only a negative impact on transportation time for landlocked countries and when the importing country is an island (whereas the positive coefficient we obtain for exporting island is contrary to our expectation).

In a last specification columns (3) and (6) we explore whether Air transportation agreements' impacts on transportation cost and time differ when the two trading countries have signed a Regional Trade Agreement. While the effect of ASAs on transportation cost appears to be the same for all countries, in column (6) we obtain a negative coefficient for countries that have signed RTA with each other (other than the EU or USMCA). Again, if the effect of ASAs is found to be overall non significant on transportation time in table 3, their impact is positive in some special cases such as landlocked countries, RTA partners, or ASAs with small degrees of opening.

The closest countries have relatively higher air cost of transportation as compared to more distant ones. This latter result may be due to a substitution effect. When countries are nearby, more alternatives are available to ship the good (road/rail) in comparison with more distant countries for which the air transportation may be more efficient than the other modes of transport.

# 4 Conclusion

Exploiting a unique dataset on transport based on our own data collection on the United Parcel Service (UPS) website, we investigate the impact of Air Service Agreements on the bilateral cost and time to ship a standardized good from one country to another for 1,260 country-pairs between 2011 and 2015.

We show that Air Services Agreements reduce the cost of transportation. Transportation time appears to be impacted by ASA only for countries that are difficult to reach such as landlocked countries or island importers. Interestingly, air service agreements are found to reduce transport time between countries involved in a regional agreement, suggesting that signing an ASA potentially makes RTA more efficient by promoting trade in time sensitive goods.

Our work demonstrates the limitations of using only geographical distance and other gravity variables to approximate transportation costs. It argues in favor of the inclusion of air services agreements in gravity models to take better account of all the components of trade costs. This paper also calls for the consideration of transport time in trade analysis. We show that the determinants of transport cost and time are not exactly alike, and that being specialized in time sensitive goods spurs countries to offer faster air transport services. Exporters choose their destinations not only on the basis of cost but also on the basis of transport time. Taking this element into account and considering the trade-off between time and cost in empirical trade models opens new research perspectives.

Table 4: Effect of Air Services Agreements (ASA) on transportation, effect of geography

| Dependent variable | $cost_{ijt}$ | | | $time_{ijt}$ | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $Distance_{ij}$ | 0.154*** | 0.135*** | 0.137*** | 0.060*** | 0.058*** | 0.060*** |
| | (0.015) | (0.014) | (0.014) | (0.017) | (0.017) | (0.017) |
| Common $border_{ij}$ | 0.054*** | 0.070*** | 0.071*** | 0.145*** | 0.147*** | 0.150*** |
| | (0.021) | (0.021) | (0.021) | (0.024) | (0.024) | (0.024) |
| Common $currency_{ij}$ | 0.007 | 0.002 | -0.004 | 0.022 | 0.030 | 0.021 |
| | (0.020) | (0.020) | (0.020) | (0.023) | (0.023) | (0.024) |
| Common $language_{ij}$ | -0.035** | -0.019 | -0.016 | 0.003 | 0.008 | 0.008 |
| | (0.017) | (0.017) | (0.017) | (0.020) | (0.020) | (0.020) |
| Colonial $relationship_{ij}$ | -0.029 | -0.043* | -0.040 | -0.034 | -0.045 | -0.034 |
| | (0.024) | (0.025) | (0.025) | (0.029) | (0.029) | (0.029) |
| $UE_{ijt}$ | 0.190*** | 0.155*** | 0.178*** | 0.096** | 0.076** | 0.101** |
| | (0.032) | (0.032) | (0.034) | (0.038) | (0.038) | (0.040) |
| $USMCA_{ijt}$ | 0.533*** | 0.581*** | 0.583*** | 0.041 | 0.063 | 0.067 |
| | (0.077) | (0.077) | (0.077) | (0.091) | (0.090) | (0.091) |
| Other $RTA_{ijt}$ | 0.018 | 0.008 | 0.025 | 0.044** | 0.037* | 0.116*** |
| | (0.017) | (0.017) | (0.030) | (0.020) | (0.020) | (0.035) |
| Unit $value_{ijt}$ | -0.019** | -0.022*** | -0.024*** | -0.015 | -0.015* | -0.019** |
| | (0.008) | (0.008) | (0.008) | (0.009) | (0.009) | (0.009) |
| $Export_{ijt}$ | -0.034*** | -0.035*** | -0.035*** | -0.004 | -0.005 | -0.004 |
| | (0.007) | (0.007) | (0.007) | (0.009) | (0.009) | (0.009) |
| $Import_{ijt}$ | -0.034*** | -0.036*** | -0.036*** | -0.009 | -0.010 | -0.010 |
| | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) |
| $iImbalances_{ijt}$ | 0.028 | 0.035** | 0.035** | -0.006 | -0.007 | -0.011 |
| | (0.017) | (0.017) | (0.017) | (0.020) | (0.020) | (0.020) |
| $Routes_{ijt}$ | -0.050*** | -0.055*** | -0.054*** | -0.063*** | -0.069*** | -0.065*** |
| | (0.010) | (0.010) | (0.010) | (0.012) | (0.012) | (0.012) |
| $ASA_{ijt} \times dist_{ij} < 1000$ | 0.110*** | | | 0.020 | | |
| | (0.027) | | | (0.032) | | |
| $ASA_{ijt} \times 1000 < dist_{ij} < 10{,}000$ | -0.087*** | | | -0.024* | | |
| | (0.012) | | | (0.014) | | |
| $ASA_{ijt} \times 10{,}000 < dist_{ij}$ | -0.021 | | | 0.040* | | |
| | (0.017) | | | (0.021) | | |
| $ASA_{ijt}$ | | -0.058*** | -0.050*** | | 0.009 | 0.004 |
| | | (0.013) | (0.015) | | (0.015) | (0.018) |
| $ASA_{ijt} \times Landlocked_i$ | | -0.005 | | | -0.112*** | |
| | | (0.028) | | | (0.032) | |
| $ASA_{ijt} \times Landlocked_j$ | | -0.088*** | | | -0.132*** | |
| | | (0.028) | | | (0.032) | |
| $ASA_{ijt} \times Island_i$ | | -0.001 | | | 0.079** | |
| | | (0.027) | | | (0.031) | |
| $ASA_{ijt} \times Island_j$ | | 0.032 | | | -0.055* | |
| | | (0.027) | | | (0.031) | |
| $ASA_{ijt} \times$ Other $RTA_{ijt}$ | | | -0.019 | | | -0.092*** |
| | | | (0.030) | | | (0.035) |
| $ASA_{ijt} \times EU_{ijt}$ | | | -0.035 | | | 0.020 |
| | | | (0.030) | | | (0.035) |
| $ASA_{ijt} \times USCA_{ijt}$ | | | 0.000 | | | 0.000 |
| | | | (.) | | | (.) |
| Observations | 3555 | 3555 | 3555 | 3555 | 3555 | 3555 |
| R-squared | 0.73 | 0.73 | 0.73 | 0.66 | 0.66 | 0.66 |

Robust standard errors in parentheses.
Origin-time, destination-time, exporting continent-importing continent fixed effects included.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$.

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# Appendix

Table 5: List of 35 countries

| | | |
|---|---|---|
| **East Asia and Pacific** | | |
| Australia | Japan | Singapore |
| China | Malaysia | Taiwan |
| Hong Kong | South Korea | Thailand |
| **Europe and Central Asia** | | |
| Austria | Hungary | Romania |
| Belgium | Ireland | Russia |
| Czech Republic | Italy | Spain |
| Denmark | Netherlands | Sweden |
| Finland | Norway | Switzerland |
| France | Poland | United Kingdom |
| Germany | Portugal | Turkey |
| **Latin America and the Caribbean** | | |
| Brazil | Mexico | |
| **North America** | | |
| Canada | United States | |
| **South Asia** | | |
| India | | |

Source of classification by region: World Bank

Figure 5: Distribution of average cost across countries

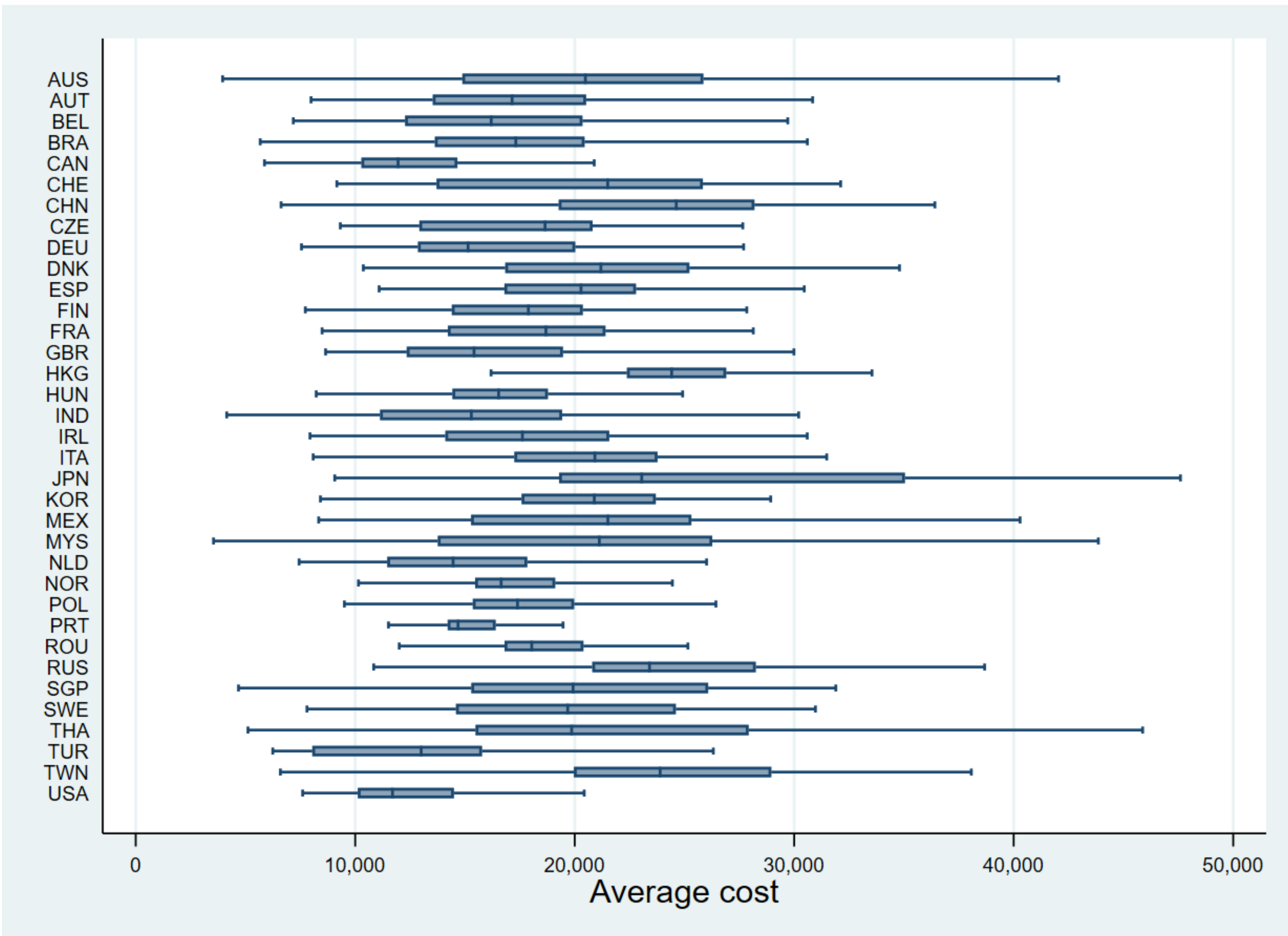

Figure 6: Distribution of average time across countries