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Abstract

Using a gravity-type model to explain bilateral passenger traffic, this paper estimates the impact of liberalizing air transport services on air passenger flows for a sample of 184 countries. We find robust evidence of a positive and significant relationship between the volumes of traffic and the degree of liberalization of the aviation market. An increase in the degree of liberalization from the 25th percentile to the 75th percentile increases traffic volumes between countries linked by a direct air service by approximately 30 per cent. In particular, the removal of restrictions on the determination of prices and capacity, cabotage rights and the possibility for airlines other than the flag carrier of the foreign country to operate a service are found to be the most traffic-enhancing provisions of air service agreements. The results are robust to the use of different measures of the degree of liberalization as well as the use of different estimation techniques.

Keywords: bilateral air service agreements, air transport, air service trade liberalization, gravity model, passenger traffic, open skies agreements.

JEL Classification: F15, L93

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1. Introduction

Air transport has rapidly expanded in the last few decades. Passenger traffic experienced an average annual increase of about nine per cent between 1960 and 2000 and five per cent between 2000 and 2005 (Hanlon, 2006 and WTO, 2007a). Cargo shipped by air (measured in ton-miles) increased in the period 1997-2004 at an annual growth rate of over 10 per cent. Recent estimates show that air cargo accounts for over one third of the value of world merchandise trade (Hubner and Sauve, 2001). In particular, for the United States, air transport covers a third of its import value and half of United States' exports outside North America (Hummels, 2007).

The reason for this rapid expansion is the decline of air transport costs. Measured in terms of revenue per ton-kilometre, air transport costs dropped by 92 per cent between 1955 and 2004 (Hummels, 2007). The diffusion of jet engines was the principle factor of this reduction over the period 1955–72, the period when the use of jet engines became widespread. More recently, changes in the regulatory set-up helped to reduce air transport costs. For example, Micco and Serebrisky (2006) show that between 1990 and 2003 the introduction of the Open Skies Agreements (OSAs) in the United States has reduced nominal air cargo transport costs by nine per cent and has increased by seven per cent the share of imports arriving by air within three years after an OSA was signed.

International air transport in general and international passenger transport in particular play a crucial role in the process of international integration and also affect the development of other sectors of an economy. By reducing the time required to reach a distant location, air transport is an important determinant of overall transport costs. Time is an important determinant of trade[2] and it is a primary factor in determining the choice of the mode of transport to distant locations. For this reason, air passenger transport is essential to the development of the international tourism sector, especially in remote locations. By the same token, air passenger transport is essential to set up and maintain business relationships between distant economies. A number of recent studies have highlighted the importance of movement of people for trade (e.g. Rauch and Trindade, 2002; Herander and Saavedra, 2005; and Jansen and Piermartini, 2008). People travel to the country they import from in order to establish trade relationships, for example, because they need to find an appropriate supplier. Higher passenger flows between two countries also lower information and enforcement costs, thus fostering trade. In addition, rules and regulation governing passenger traffic are also important for air cargo. In fact, 50 per cent of overall amount of cargo is transported on passenger flights rather than dedicated cargo flights, using the otherwise empty belly space or "combi operations" (OECD, 2000).

The aim of this paper is to study the impact that air service liberalization has on the aviation industry and to identify which specific provision or which type of air service agreement provide most of the benefits from increased competition. The research is motivated by the observation that the international aviation market is heavily regulated. In fact, an intricate web of bilateral air services agreements (ASAs)[3] establishes the conditions under which air companies operate in each country. These rules define, for instance, whether airlines can freely set prices, how many airlines can operate a service and their capacity. Clearly, the degree of liberalization of air transport services between two countries is determined by the specific design of each ASA. Although the air service industry has been recently liberalized, through a number of bilateral and regional agreements, substantial restrictions remain. ASAs may not effectively promote competition if a specific restriction stays in the regulatory regime. There is, however, scarce empirical evidence on the impact of liberalization of international air services on the industry. Existing research is either limited to a few countries or suffer from important methodological shortcomings. This includes problems of omitted variable bias, collinearity and lack of robustness in the results.

[2] Using gravity models, recent studies find that a 10 per cent decrease in time to export increases trade by between 5 and 25 per cent depending on the sector and export destination (see for example Hausman et al.,2005, Djankov et al., 2006, and Nördas et al. 2006).

[3] Air transport services are excluded from GATS, the WTO multilateral agreement on trade in services. For a discussion on the regulatory environment of the aviation market see Hindley (2004).

Our analysis focuses on the impact of air service agreements on passenger flow. One reason is that the use of passenger flows as a proxy for the economic performance of the air service sector allows us to work with an extensive database. No worldwide information on the bilateral trade in goods by means of transport exists and the complete database on airfares is extremely expensive. Another reason is that airfares are very volatile, and existing studies based on this variable report a very low fit of the data.

In order to explain air passenger flow, we build on a gravity-type model augmented for the degree of liberalization of air passenger services. This model includes the standard explanatory variables used in gravity models of trade as well as several variables specific to the aviation market. Among these we include the number of years that each ASA has been in force and several indexes of the degree of liberalization of air service agreements between countries. The underling idea is that the extent of liberalization of the air service market is likely to influence the price and the quality of the service offered, thus determining the bilateral distribution of passenger traffic. We therefore expect a positive effect of air service liberalization on passenger traffic.

Our contribution to the literature is threefold. First, this is the first paper that assesses the impact of air service trade liberalization for a worldwide sample of countries (184 countries) using several measures of air service liberalization. While existing literature covers at most 35 countries or a specific region, our analysis covers approximately 2300 country-pairs involving 184 countries.

Second, we estimate the impact of the degree of liberalization of bilateral and regional air service agreements (ASAs) on air passengers' traffic by looking at alternative indexes of the overall degree of liberalization. Existing empirical studies (Gonenc and Nicoletti, 2000 and Doove et al., 2001) measured the degree of liberalization by means of an index built using factor analysis. This is a purely statistical technique and assigns the highest weights to the provisions that vary most independently in the database. Recently, the WTO Secretariat (WTO, 2006) has developed an informed index of the degree of liberalization of air services for passenger traffic, whereby different provisions are weighted on the basis of their importance in removing obstacles to trade in air services according to the judgment of experts of the sector. In this paper we use and compare the results of both approaches, the factor analysis and the expert-based approach, to measure the degree of air service liberalization.

Finally, we analyze how passenger flows are influenced by individual provisions contained in the agreements. In order to overcome problems of collinearity among provisions, we also use cluster analysis to identify different types of existing air service agreements. This allows us to compare the impact of each type of agreement on traffic volumes.

The rest of the paper is organised as follows: Section 2 reviews the literature. Section 3 describes the data on worldwide passenger flows and introduces the alternative measures of liberalization of the aviation market. In this section we will compare the informed index produced by the WTO Secretariat with the statistical index resulting from factor analysis. Section 4 explains our methodological approach. Section 5 describes the results. Finally section 6 concludes.

2. Review of the literature

Existing studies on the economic impact of air service liberalization look at the impact of air service regulation on airfares, passenger flows or on the share of trade occurring via air. The pioneer work of Gonenc and Nicoletti (2000) examine the effects of bilateral air service agreements on prices of air passenger transport in thirteen OECD countries, using a statistical index of bilateral air service liberalization built through principal component analysis. The study has then been extended by Doove et al. (2001) to cover 35 countries. Interestingly, they find a positive and significant effect of restrictiveness on airfares, with larger effects for developing countries than for developed countries.

A differentiated effect of air service liberalization for developed and developing countries is also found by Micco and Serebrisky (2006). Focussing on the US open skies agreements (OSAs), they investigate the impact of these agreements on airfares and on the share of US imports arriving by air. The analysis is conducted introducing a dummy variable for the existence of OSA in the equation for airfares and for the share of imports arriving by air. In particular, they estimate that for developed and upper-middle income countries signing OSAs on average reduces airfares by 9 per cent and increases the share of imports arriving by air by 7 per cent three years after the OSA is signed. In contrast, they do not find significant effects of OSAs for low income countries.

Turning to the studies that investigate the impact of air service liberalization on passenger flows, data availability allows in this case to work with a larger sample of countries than the studies looking at airfares. The most comprehensive study in this respect is that conducted by InterVISTAS-ga (2006). The study covers 1400 country-pairs worldwide and uses a gravity-type approach to explain passenger traffic. The impact of specific ASAs provisions is estimated introducing dummy variables in the regressions denoting whether the agreement provides the right for stop-over (the so called fifth freedom), price controls, capacity constraints and designation requirements (that is, a limit in the number of air companies that can provide a service). Compared to InterVISTAS-ga's study, our analysis addresses the issue of multicollinearity among these dummy variables, by using indexes of the degree of liberalization and different types of agreements. We also look at issues of endogeneity and adopt a specification of the gravity equation in line with standard practice.[4]

Recently a study conducted on intra-APEC passenger traffic (Geloso Grosso, 2008) provides some but not robust evidence of that air service liberalization increases traffic in the region. This study relies on the informed index built by the WTO Secretariat (2006) as the measure of the degree of liberalization, but uses a model specification different from ours. In particular, no distinction is made between country pairs with existing direct services and without a direct service link. This might substantially bias results, since regulations in bilateral air service agreements do not typically apply to passengers flying via a third country.

Our paper responds to the need to investigate the impact of air service liberalization for a wide range of countries, test the robustness of the results to alternative measures of liberalization of the aviation market, control for possible endogeneity bias and address the issue of a mismatch between data on bilateral passenger flow and the regulatory regime that actually apply.

3. Air passengers' traffic flows and liberalization of the aviation market

What is the coverage of our database? And how liberalised is the aviation market?

3.1 International air passenger traffic

There were in total 688 million international air passengers worldwide in 2005 according to IATA statistics for country-pair scheduled passenger traffic. As shown in Table 1, over 80 per cent of these passengers travelled between two high income countries or between a high income country and a middle income country.[5] The share of international air passenger traffic among low income countries is a mere one per cent of the worldwide scheduled traffic. Although based only on scheduled flights, this is likely to be a good approximation of overall trends in passenger traffic, as scheduled traffic accounts for 85 per cent of total passenger traffic, that is including also charter flights (Gonenc and Nicoletti, 2000). Hereafter we will refer to scheduled passenger traffic only.

[4] Intervista's study does not include distance among the regressors of the gravity model.

[5] The IATA database (On-Flight Origin-Destination Statistics) refers to true origin-true destination traffic data. That is, passengers that fly from country A to country B via country C are recorded as flying from A to B. There is no record of their stopover in country C.

Table 1 also shows patterns of passenger traffic between those country-pairs for which ICAO or WTO (2006 and 2007b) provides coded information on the characteristics of air service agreements in force in 2005. Hereafter we refer to these agreements as coded ASAs. This is a sample of 2299 country-pairs covering 184 countries and approximately 80 per cent of worldwide international scheduled passenger traffic (545 million passengers out of a total 688 million passengers worldwide). The figures reported in Table 1 show that this sample of country-pairs provides a good representation of the distribution of passenger flow by income group, although there appears to be a certain over-representation of passenger traffic among high income countries. In the sample of country-pairs for which a coded ASA exists, passengers' traffic among high income countries represent 61 per cents of traffic, while it represents only 51 per cent of traffic worldwide.

Table 1: International air passengers by income group of countries, 2005 (per cent)

	Total traffic			**Traffic covered by coded ASAs**		
Income Group	Low	Middle	High	Low	Middle	High
Low	1.0	2.1	5.2	0.7	1.4	3.4
Middle		5.4	30.8		3.9	29.4
High			51.2			61.2
Total (millions)		**688.2**			**544.9**	

Note: Low, middle and high income countries correspond to the World Bank definition. The sum of the percentages lies below 100 per cent, because of missing data for the income of some countries.
Source: Authors' calculations based on IATA On-Flight Origin-Destination Statistics 2005.

Table 2 relates the number of agreements to the (non-)existence of a direct service link.[6] It also indicates whether coded information on the characteristics of these agreements exists or not. In brackets, the percentages of worldwide air passenger traffic covered by these agreements are reported. The total number of air service agreements in force is unknown.[7] However, since in aviation law it is practically impossible to fly to a destination without a preliminary agreement, one can deduce that there is an agreement in virtually all cases where a direct service exists. This is the case for approximately 2400 country pairs. Of these, agreements for only 1302 pairs are coded. In addition, the ICAO database records a series of 997 agreements between countries that were not connected by a direct service in 2005. In terms of passenger traffic, the agreements with coded ASA information and signed between countries connected by a direct service represent 77 per cent of worldwide international air passenger traffic.

Table 2: Number of agreements by type of service and availability of information (percentage of worldwide air passenger in brackets)

	Coded	**Non-coded**
Direct service exists	1302 (77% of traffic)	approx. 1100 (12% of traffic)
Direct service does not exist	997 (2% of traffic)	Unknown (9% of traffic)
Total	2299 (79% of traffic)	Unknown (21% of traffic)

Source: Authors' calculations based on WASA database (ICAO, 2005), QUASAR database (WTO, 2006 and 2007b) and IATA On-Flight Origin-Destination Statistics 2005.

[6] A direct service is "a service operated under the same flight number". It can therefore comprise non-stop services as well as 5th freedom and 7th freedom services as long as the flight number remains the same.

[7] This is due to the potentially large number of agreements between countries without a direct air service. For instance, 57 of the 72 ASAs concluded by Zambia are not coded in the ICAO database and there is not a direct service operating on the corresponding country pairs (Mattoo and Payton, 2007).

In conclusion, the country-pairs for which coded information on the ASA exists provide a good coverage of overall worldwide passenger traffic. This is especially true for passengers travelling between countries where a direct service exists. The empirical analysis of the next section will focus on this sample.

3.2 The degree of liberalization of the aviation market

ASAs incorporate many features covering a wide range of topics such as aviation security, incident investigation, immigration, control of travel documents and many others. In a recent study, the WTO Secretariat (WTO, 2006) has identified seven features of ASAs as relevant indicators of openness for scheduled air passenger services. These include[8]:

a) **Grant of rights** that defines the rights to provide air services between the two countries. In particular, the WTO study focuses on the fifth freedom, seventh freedom and cabotage. *Fifth freedom* is the freedom to carry freight/passengers between two countries by an airline of a third country on a route with origin or destination in its home country. *Seventh freedom* allows carrying freight/passengers between two countries by an airline of a third country on a route with no connection with its home country. *Cabotage* is the freedom to carry freight/passengers within a country by an airline of another country on a route with origin/destination in its home country (see Appendix 1 Table A1 for a graphical representation of these freedoms);
b) **Capacity clause** that identifies the regime to determine the capacity of an agreed service. The capacity regime refers to the volume of traffic, frequency of service and/or aircraft type(s). Sorted from the most restrictive to the most liberal regime, three commonly used capacity clauses are: predetermination, Bermuda I and free determination. *Predetermination* requires that capacity is agreed prior to the service commencement; *Bermuda I* regime gives limited right to the airlines to set their capacities without a prior governmental approval and *free determination* finally leaves the capacity determination out of regulatory control;
c) **Tariff approval** that refers to the regime to price air services. The most restrictive regime is that of *dual approval*, whereby both parties have to approve the tariff before this can be applied. The most liberal regime is *free pricing*, when prices are not subject to the approval by any party. The semi-liberal regimes are *country of origin disapproval* (where tariffs may be disapproved only by the country of origin), *dual disapproval* (where both countries has to disapprove the tariffs in order to make them ineffective) and *zone pricing* (where parties agree to approve prices falling within a specific range and meeting certain characteristics, whilst outside the zone one or a combination of the other regimes may apply);
d) **Withholding** that defines the conditions required for the designated airline of the foreign country to operate in the home country. Restrictive conditions require *substantial ownership and effective control,* meaning that the designated airline is the "flag carrier" of the foreign country. More liberal regimes are *community of interests* and *principal place of business* regimes, when a foreign airline can be also designated by the foreign country. Community of interests regime still requires a vested substantial ownership and effective control of the airline in one or more countries that are defined in the agreement, but principal place of business regime removes the substantial ownership requirement and is thus more liberal;
e) **Designation** that governs the right to designate one (*single designation*) or more than one (*multiple designation*) airline to operate a service between two countries;
f) **Statistics** that provides rules on exchange of statistics between countries or their airlines. If exchange of statistics is (can be) requested, it is an indicator that the parties intend to monitor the performance of each other's airline and is thus viewed as a restrictive feature of an agreement;

[8] More detailed description of the indicators of openness is provided in the Appendix 1 Table A1 and in WTO (2006), App. 1, page II. 650.

g) **Cooperative arrangements** that define the right for the designated airlines to enter into cooperative marketing agreements (such as code sharing and alliances). This right is considered as a liberal feature because it provides a means to rationalise networks, much in the same way as the liberalization of the ownership clause.

Table 3 shows the number of agreements by provision. It is interesting to notice that the most restrictive regime is usually the most frequent. For instance, dual approval of air tariffs is required in more than 70 per cent of ASAs. Similarly predetermination, substantial ownership and effective control and the request for exchange of statistics are included in most of the agreements. Cooperative arrangements are mostly not allowed. 5th freedom right is included quite often, while 7th freedom and cabotage are very rare. Different pattern arises only for the designation of airlines, since multiple designation is allowed in more than 60 per cent of agreements.

Table 3: Number of ASAs by provision

Regime	Frequency	Regime	Frequency
Grant of righs		**Withholding/Ownership**	
5th freedom	1650	Substantial ownership and effective control	1735
7th freedom	417	Community of interest	396
Cabotage	353	Principal place of business	138
Missing values	0	Missing values	59
Pricing regimes		**Capacity regimes**	
Dual approval	1625	Predetermination	1324
Country of origin disapproval	37	„Other liberal“	125
Dual disapproval	153	Bermuda I	327
Zone pricing	8	„Other restrictive“	10
Free pricing	381	Free determination	464
Missing values	94	Missing values	49
Total	**2299**		**2299**
Designation		**Statistical exchange**	
Single	879	Exchange of statistics required	1492
Multiple	1411	Exchange of statistics not required	807
Missing values	9	Missing values	0
Total	**2299**		**2299**
Cooperative arrangements			
Not allowed	2173		
Allowed	126		
Missing values	0		
Total	**2299**		

Note: The frequencies of 5th freedom, 7th freedom and cabotage do not sum up to 2299 observations, because they are independent provisions, not excluding each other. Similarly, some ASAs report combination of ownership regimes.
Source: Own calculations based on WASA database (ICAO, 2005) and QUASAR database (WTO, 2006 and 2007b).

3.2.1 Two Indexes of air service liberalization

Indexes can be built to provide an indication of the overall degree of liberalization introduced by a certain air service agreement. The construction of an index involves the choice of weights to assign to each provision to denote its marginal contribution to liberalization of the aviation market. However,

the choice of the weights is arbitrary and many options exist. Two alternative approaches presented here are the use of expert knowledge and the use of factor analysis.

An informed index of air service liberalization: the ALI

The Air Liberalization Index (ALI) constructed by the WTO Secretariat (WTO, 2006) is an expert-based index. The weights assigned to the different provisions of air agreements were defined in consultation with a group of experts on aviation industry with the view to capture the relative importance of each provision in liberalizing the sector. The ALI ranges between 0 and 50, where 0 is associated with the most restrictive agreement and 50 denotes the most liberal agreement.

Four different weighting schemes were proposed, thus originating four different indexes. The weighting scheme of the so called standard ALI (*ali_standard* in Table 4) assigns a weight between 0 and 8 to each of the seven components of ASAs. Each of the three other indexes emphasises one specific feature of ASAs, namely the granting of fifth freedom traffic rights, withholding and designation clause. In particular, the *ali_5thfreedom* assigns a weight of 12 to the 5th freedom. The *ali_ownership* assigns a weight of 14 to the provision that allows foreign airlines to service a country if their principal place of business or substantial ownership and effective control is in the foreign country. The *ali_designation* assign a weight two times larger than in the standard ALI to multiple designation.[9] The reason for introducing these alternative indexes is to account for specific geographical and economic factors that may in some circumstances render these provisions more relevant to improve market access.

As shown in Table 4, the four ALI indexes are highly correlated among themselves, with correlation coefficients and the Spearman rank correlations around 90 per cent or above.

Table 4: Correlations between the different versions of ALI

	ali_standard	***ali_5thfreedom***	***ali_ownership***	***ali_designation***
ali_standard	1			
ali_5thfreedom	0.98 (0.95)	1		
ali_ownership	0.99 (0.99)	0.96 (0.92)	1	
ali_designation	0.99 (0.96)	0.97 (0.89)	0.99 (0.95)	1

Note: Spearman rank correlations reported in parenthesis.
Source: Authors' calculations based on WASA database (ICAO, 2005) and QUASAR database (WTO, 2006 and 2007b).

A Statistical Index: the *FA_index*

Following the approach of previous empirical literature on air transport services, we construct an index of air service liberalization by means of factor analysis technique as introduced in Nicoletti et al. (1999). Hereafter we will refer to this index as the *FA_index*.[10] The *FA_index* ranges than between 0 and 1 and is increasing in the degree of market liberalization.[11]

Factor analysis involves several steps. First, we need to define the database. There are over 100 provisions in ASAs and most of them do not relate to market access. Following the approach of previous literature and relying on the WTO study on air services agreements (WTO, 2006), we apply factor analysis to the seven components of the regulatory framework highlighted in the WTO study as

[9] The complete set of weights is provided in Appendix 1 Table A2.

[10] Factor analysis is a statistical tool that allows to summarise detailed information about regulations in an index where weights are assigned to each component of the regulatory framework on the basis of their contribution to the overall variance in the data.

[11] Note that an index of restrictiveness could easily be obtained, for instance, by calculating the difference 1- *FA_index*.

relevant to market access. Each component is normalized to take values between 0 and 1 (see Table A1 and A2 in Appendix 1).

The second step of factor analysis consists of extraction of the factors. That is, in this step we identify the number of latent factors needed to represent the database. The result of this extraction is a set of coefficients, called loadings, that show the correlation between each component of the ASA and the latent factor. There is a set of loadings for each factor extracted. The first factor accounts for most of the variance in the data. Subsequent factors account for a smaller and smaller portion of the variance. We adopt the following rule of thumb to select the relevant factors: i) each factor is associated with eigenvalues larger than one; ii) each factor contribute to explain more than 10 per cent of the overall variance of the data; and iii) cumulatively factors contribute to explain more than 60 per cent of the total variance of the data.[12] This step yields us two factors.

The third step consists in the "rotation" of these factors. This transformation is targeted to reduce the number of significant components (those with a loading larger than 0.5) in each factor, in order to allow for an interpretation of the factors. We do not however get a significant reduction in the number of significant components in Factor 1 after rotation.

The results of factor analysis are presented in Table 5. The first two factors together explain 68 per cent of the overall data variation. Factor 1 accounts individually for more than 50 per cent of data variability. The magnitude of its loadings (in general larger than 0.5) indicates that Factor 1 is highly correlated with all indicators of air service liberalization, but cooperative arrangements (*coop*). Factor 1 is therefore to be interpreted as an indicator for overall liberal agreements. The detection of one common factor for most of the indicators of liberalization is due to the strong correlation between them (in the range of 30 and 82 per cent). Factor 2 explains only 16 per cent of the data variability. Its main contribution to the overall variance is as an indicator for cooperative arrangements (*coop*).

Table 5: Construction of FA_index using factor analysis

	Factor 1: overall liberal		**Factor 2: *coop***		***FA_Index***	***ali_standard***
Explained variance	52%		16%		68%	
eigenvalues	3.64		1.10			
Indicators of openness	**Loadings**	**weights**	**loadings**	**Weights**	**weights**	**relative weights**
Freedoms	0.89	0.22	-0.07	0.00	0.17	0.36
Capacity	0.89	0.22	0.14	0.02	0.17	0.16
Pricing	0.91	0.23	0.13	0.02	0.18	0.16
withholding	0.68	0.13	-0.05	0.00	0.10	0.16
designation	0.50	0.07	0.35	0.11	0.08	0.08
Statistics	0.72	0.14	0.14	0.02	0.11	0.02
Coop	0.04	0.00	0.96	0.83	0.19	0.06
Weights of factors		0.77		0.23	1	1

Note: Factor loadings were obtained by the principal component method and after varimax rotation. Factor loadings over 0.5 and their relative weights are in bold face.
Source: Authors' calculations based on WASA database (ICAO, 2005) and QUASAR database (WTO 2006 and 2007b).

The final step of the factor analysis is the calculation of the weights needed for the construction of the overall index of liberalization, the *FA_index*. The approach we use to calculate weights consists in assigning to each component/factor a weight according to the proportion of the variance that is

[12] The same criteria have been followed by Nicoletti et al. (1999).

explained by the component/factor.[13] Weights for individual components of the seven indicators of openness are reported in Appendix 1 Table A2.

In order to compare the *FA_index* with the ALI, in the last column of Table 5 we report the relative importance of each component of liberalization in the calculations for the *ali_standard*. Figures show that the in the *ali_standard* the grant of rights and withholding components have a relative higher weight than in the *FA_index*, while the opposite is true for *statistics* and *coop*. However, overall the ALI (in its four versions) and the *FA_index* are highly correlated (correlations coefficients are always over 93 per cent). The Spearman correlation coefficient, based on the countries-pair ranking, is somewhat lower, but still over 84 per cent in all cases. These results are robust to running factor analysis on dummy variables related to 19 individual provisions of ASAs and on alternative sample sizes. Finally, our *FA_index* is broadly consistent with the index of bilateral restrictiveness (the BRI) calculated by Gonenc and Nicoletti (2000). The correlation coefficient between the indexes BRI index and *ali_standard* (*FA_index*) is -0.88 (-0.84). The negative sign is because the ALI and the *FA_index* denote the degree of liberalization while BRI is a measure of restrictiveness of air services. The average values for the ALI and the *FA_index* by country are reported in Appendix 1 Table A3.

3.2.2 How deep is air-transport service liberalization?

Table 3 above showed that restrictive regimes are very frequent in the design of ASAs. But, this information does not allow to assess the overall degree of liberalization of ASAs. To shed some light on this issue we analyse the distribution of the *ali_standard* and the *FA_index*.

Figure 1 displays histograms of *ali_standard* and *FA_index*.[14]. The distribution of both indexes is highly skewed to the left. Approximately 70 per cent of ASAs presents an *ali_standard* (*FA_index*) below 15 (0.4). Very few ASAs introduce an intermediate degree of liberalization (in the range 15-40 for the *ali_standard* or 0.4-0.8 for the *FA_index*). A high degree of liberalization of the aviation market (measured by an *ali_standard* in the range 40-45) is reached only in 15 per cent of country-pairs. This is mainly due the liberalization of air services intra EU for which *ali_standard*=43.

[13] Formally, this is done as follows: within each factor the weights for the individual components are calculated as the ratio of the squared factor loading and the sum of all squared factor loadings for that factor. The weights associated to each factor are calculated as the ration of the sum of all squared factor loadings related to the factor and the sum of the squared factor loadings related to both factors. Finally, the weigh associated to each component in the *FA_index* is a weighted average of the weights of each component in the two factors. Algebraically, these weights are calculated as:

$$\text{weight}_{i,j} = \text{factor loading}_{i,j}^{\,2} \Big/ \left(\sum_{k=1}^{7} \text{factor loading}_{k,j}^{\,2} \right),$$

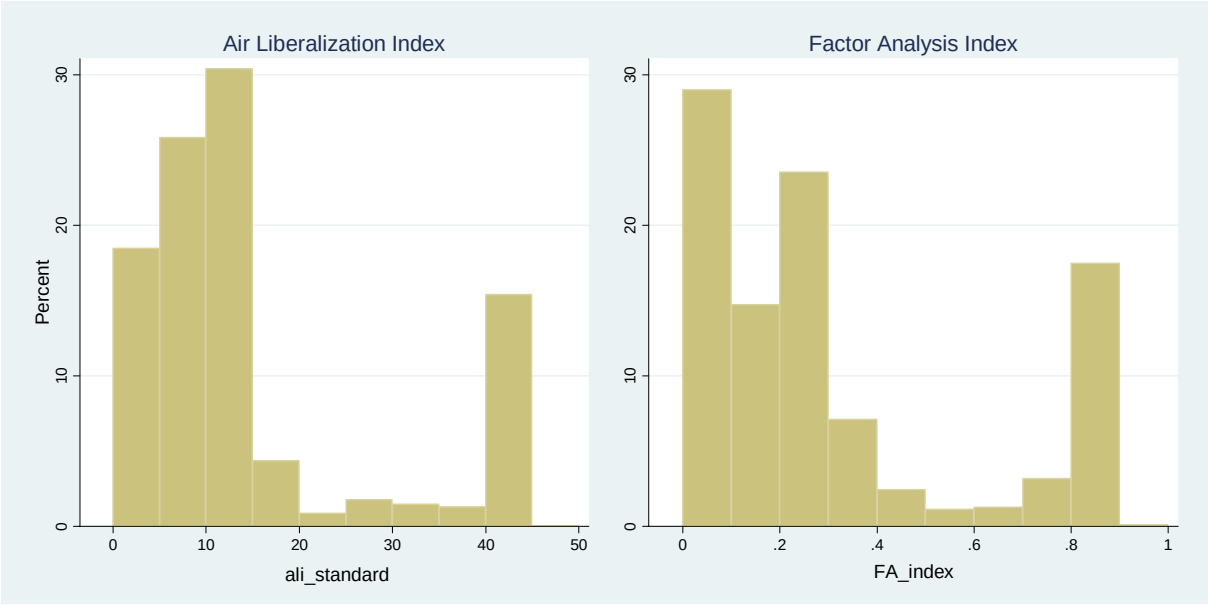
$$\text{weight}_{j} = \left(\sum_{k=1}^{7} \text{factor loading}_{k,j}^{\,2} \right) \Big/ \left(\sum_{l=1}^{2} \sum_{k=1}^{7} \text{factor loading}_{k,l}^{\,2} \right),$$

$$\text{weight}_{i} = \sum_{j=1}^{2} \text{weight}_{ij} \cdot \text{weight}_{j}$$

where i denotes the component and j the factor.

[14] Recall that the *ali_standard* takes values between 0 and 50, whereas the FA_index ranges between 0 and 1. In both cases low values indicate restrictive ASAs.

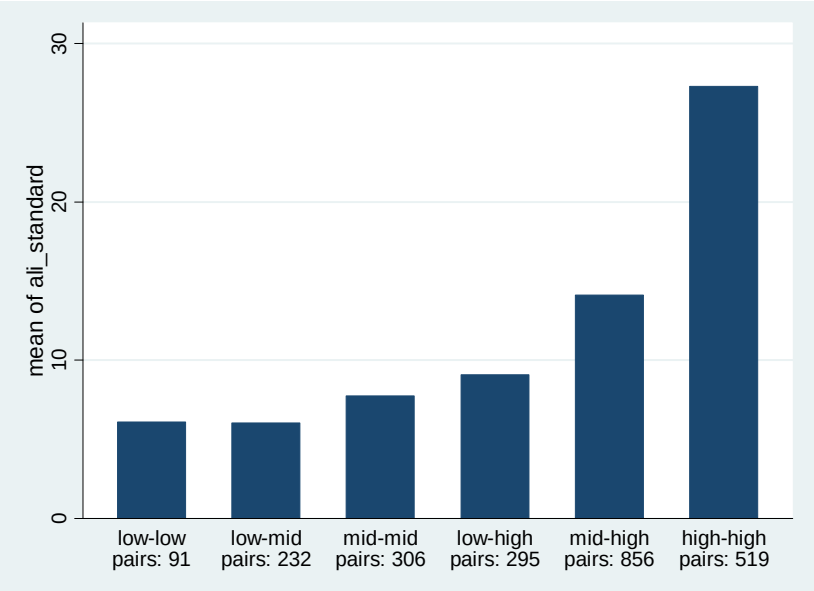
Figure 1: Histograms of the degree of liberalization of the aviation market



Source: Authors' calculations based on WASA database (ICAO, 2005) and QUASAR database (WTO, 2006 and 2007b).

An interesting aspect of the complicated web of regulation set up by the plethora of bilateral air service agreements singed between countries is to what extent they liberalize South-South relative to North-South and North-North air services trade. Figure 2 shows the average level of the *ali_standard* by level of income. The figure shows that ASAs between high-income countries are more liberal than ASAs between low and middle-income countries.

Figure 2: The extent of liberalization of aviation market by income levels



Note: Low, middle (mid) and high income countries correspond to the World Bank definition.
Source: Authors' calculations based on WASA database (ICAO, 2005) and QUASAR database (WTO, 2006 and 2007b).

To sum up, overall ASAs seem to provide a limited degree of liberalization of the aviation market. The extent of liberalization appears to be linked to the average level of income of the countries

involved in the specific agreement. High degree of liberalization is achieved only among high income countries, while ASAs between low income countries are in general restrictive.

4. The empirical model

In order to assess the impact of air traffic liberalization on international air passenger traffic, we estimate a gravity type model of the bilateral passenger flow. The gravity model originally inspired by Newton's gravity law is widely used in social sciences to describe spatial flows. The gravity model is the workhorse model to analyze international trade flows[15], but it is also used to describe migration flows[16] and trip distributions in general. The analogy with the physical law of gravity derives from the fact that the interaction between two locations depends on some elements of mass and distance.

Using data on the overall number of passengers between two countries for a cross section of 2299 country-pairs, covering 184 countries for the year 2005, we estimate a gravity-type model augmented for the degree of regulatory liberalization of air passenger services.

The basic empirical specification of the equation we estimate is the following:

$$(1)\quad \ln(PassengerTraffic) = \alpha + \beta_1 \ln(distance) + \beta_2\, border + \beta_3\, colony + \beta_4\, language + \beta_5\, low\_income + \beta_6\, ASA\_age + \beta_7\, air\_liberalization + \Sigma_k \gamma_k D_k + \varepsilon$$

where *PassengerTraffic* is the total number of passengers traveling between two countries, ε is the error term, the symbol ln denotes logarithms, D_k denotes country k fixed effect and it is defined as a 0-1 dummy equal to 1 when country k is either the country of origin or the destination country.[17] Fixed effects are introduced to account for any country specific factor that may determine differences in the number of passengers across countries.

The focus of this study is on the variable *air_liberalization*, that denotes the degree of liberalization of air services trade between two countries. As discussed in section 3, this is measured by the ALI – specifically, the four versions of the ALI- and the FA_index. We expect that the degree of liberalization of air passenger services has a positive impact on the number of air passengers. To the extent that bilateral air services agreements introduce more competition in the sector and allow for a better rationalization of the air service, they will yield lower airfares and/or better quality of the air service. Consumers will respond to these changes by flying more.

The other variables in equation (1) are the standard gravity regressors and some control variables specific to air services trade. In particular, the variables *distance, border*, *colony* and *language* denote the distance in kilometers between the most populated cities in countries i and j, whether countries i and j share a common border, a colonial link or a common official language, respectively. Data sources for all variables used in the estimations are provided in Appendix 2. We expect that passenger traffic is negatively affected by distance. Distance is a proxy of the cost of travel, including in terms of the time required to reach destination. So it has to be expected that traffic between two countries is lower the further away the countries are from each other. In addition, we expect cultural vicinity to increase passenger traffic between two countries. Following common practice, we capture cultural proximity with the dummies for common colonial link (*colony*) and common language (*language*) and we expect these variables to have a positive impact on passenger traffic.

[15] Recent literature has provided theoretical foundations for the gravity model equation applied to trade flows on the basis of models of intra-industry trade and models of trade with heterogeneous firms (see Anderson and van Wincoop, 2003 and Helpman et al. 2008). But, "just about any plausible model of trade would yield something very like the gravity equation (Deardoff, 1998).

[16] For recent applications of gravity models to migration models see Herander and Saavedra (2005) and Jansen and Piermartini (2008).

[17] Since our dependent variable is symmetric we do not distinguish whether a country is the country of origin or the destination country.

In the gravity models applied to trade flows, the dummy indicating whether two countries are adjacent (*border*) is in general estimated to be positive and significant. Instead, in the case of air transport services, we expect a negative impact of adjacency on the number of passengers. The reason is that the existence of a common border makes it easier for people to use means of transport alternative to air transport (e.g. rail and road transport) to travel between two countries. The higher substitutability between air and road/rail transport among adjacent countries implies average lower transport costs between two countries and therefore more trade in goods, but it also implies a lower propensity to travel by air transport in favor of cheaper means of transport and therefore less trade in international air services.[18]

We augment the standard gravity model with two additional variables that are meant to capture characteristics specific to the demand for air transport services. These include: (i) The number of years (*ASA_age*) since the first ASA has entered into force. This variable attempts to account for the effective implementation of an agreement and the more likely realization of its pro-competition effects. We expect this variable to positively affect passenger flows; (ii) A dummy (*low_income*) equal 1 if one and only one country in the pair is a low-income country. This variable is introduced to capture the relatively low attractiveness of low income countries for passengers from other countries.

We estimate equation (1) using OLS, Poisson and Negative Binomial estimation method as well as instrumental variable (IV) approach. The results are reported in the next section. Both the Poisson and the Negative Binomial estimations take into account that bilateral passengers' traffic is a count variable, i.e. non-negative and discrete, and address heteroscedasticity in the data (Silva and Tenreyro, 2006). Although Poisson regression is the baseline estimation technique for count data, we implement also the more flexible Negative Binomial regression as it allows for more general form of heteroscedasticity in the data and is to be preferred when the mean is different form the variance, a feature of our data.

The IV approach allows for possible endogeneity of the degree of air service liberalization in relationship with the bilateral number of passengers. One way in which the endogeneity problem can arise in the model is if countries respond to the actual traffic volumes by signing more liberal ASAs. For instance, a country could tend to sign liberal agreements with partners with which it has low traffic volumes in order to promote bilateral traffic. In this case OLS estimations will be biased downwards. On the contrary, OLS will overestimate the impact of liberalization on passenger traffic, if a country tends to sign liberal agreements with partners with which it has already high traffic volumes. In order to address the endogeneity problem we run IV regressions, using two instruments for the degree of air service liberalization. One instrument is constructed as the geometrical average of the average levels of the ALI (denoted as WALI) of two countries in a pair. That is, for a pair of countries *i* and *j* $geom\_wali_{ij} = \sqrt{wali_i * wali_j}$, where $wali_i = \sum_k ali_{ik}$. The rationale for using this instrument is that the average level of air service liberalization of each country across all partners is likely to be exogenous to the bilateral traffic flows with a specific partner. The second instrument for bilateral air service liberalization (*rule_difference*) is defined as the absolute difference between the indexes of rule of law of the two countries in the pair. The rationale for using this instrument is that countries with very different institutional quality are not likely to sign liberal service agreements. At the same time it seems implausible that the number of air passengers affect the quality of institution of two countries.

[18] An alternative modelling approach to capture this non linear effect of distance on the likelihood to use air transport to travel between two countries is, for example, that to include also a quadratic function of distance. We expect a positive effect of distance on traffic flows for country pairs that are close, (i. e. when substitutability between alternative means of transport is high), but a negative effect of distance on traffic for countries that are located far away. Our results are robust to these different specifications. Hereafter we will present only the results for the standard gravity-type specification.

It is worth noticing that equation (1) is estimated only for the sample of country-pairs that are connected by a direct air service. We have excluded country-pairs that are not connected by a direct service for several reasons. First, our database provides a much larger coverage of country-pairs with direct flights (85 per cent) than country-pairs without direct flights (25 per cent). Second, our database does not allow to properly account for the regimes governing air services operating between two countries that are not linked by a direct services. When a direct service between two countries exists, we can reasonably assume at least on short distance flights that bilateral passenger traffic is regulated on the basis of the bilateral agreement signed by the two countries. In fact, case studies suggest that the number of passengers traveling via a third country when a direct service exists is a small percentage of total passenger flows.[19] In contrast, when there is no direct flight, the degree of air service liberalization defined in the agreement between two countries does not represent the conditions under which airlines operating the indirect connection work. To the extent that passengers from country A to country B travel via country C (unknown), the relevant ASAs are those between A and C and B and C. But, we cannot take this into account in the analysis. Since the problem of mismatch between the air transport regulation in force between two countries and the regulation applying to each of the passenger flying between the two countries is likely to be more relevant for long distance flights, we also run regressions only for the sample of countries located at a distance below 5000 km.

5. The results

The gravity-type model of equation (1) is estimated for alternative measures of liberalization of the aviation marker: overall indexes, individual provisions and types of agreements.

5.1 Evidence based on the overall degree of liberalization of the aviation market

Table 6 shows the results for the estimations of the gravity model of equation (1) using different estimation techniques: OLS, Instrumental Variable, Poisson and Negative Binomial. Column 1 reports the results obtained using the OLS method. All coefficients of the explanatory variables have the expected sign and are significant. As expected, the number of passengers decreases with distance. Air passengers between countries that share a common border are less than between non adjacent countries. Common colonial links and common language increase the number of passengers between two countries. Passenger traffic is less than normal if one of the two countries is a low- income country. Overall, the gravity-type model explains an important proportion of the variance of the data, with an adjusted R^2 over 75 per cent.

Turning to the role of liberalization of aviation markets, Table 6 reports the results based on the index of liberalization developed by the WTO Secretariat, the standard ALI (*ali_standard*). The results show a positive and significant effect of liberalization on passenger flows. In particular, an increase in the degree of liberalization as measured by the *ali_standard* from the 25th percentile (when *ali_standard* = 6) to the 75th percentile (when *ali_standard* = 34) is estimated to increase traffic volumes by approximately 30 per cent using the most conservative estimate in column (1). We also tend to find a positive and significant coefficient for the number of years since the first air service agreement was signed. This is in line with the expectation that older agreements are more likely to be effectively implemented. Agreements with *ASA_age* of 43 years (75th percentile) are related on average to traffic volumes around 21 per cent higher than those with *ASA_age* of 12 years (25th percentile).

[19] For example, estimates for a flight London Gatwick-Dallas based on 1996 information show that non-EU passengers are less than 20 per cent of total passengers (Hanlon, 2007). Since London is an important hub for long-haul flights we should expect this percentage to be even lower for other countries and on other routes.

Table 6: The determinants of passenger flows: different estimation techniques

	OLS	IV	Poisson	Negative Binomial
	(1)	(2)	(3)	(4)
l_distance	-0.90***	-0.86***	-0.78***	-0.96***
	(0.00)	(0.00)	(0.00)	(0.00)
low_income	-0.19#	-0.20*	-0.42**	-0.074
	(0.12)	(0.08)	(0.03)	(0.49)
border	-0.25*	-0.24**	-0.22	-0.087
	(0.06)	(0.04)	(0.26)	(0.42)
colony	0.53***	0.56***	0.41**	0.56***
	(0.00)	(0.00)	(0.03)	(0.00)
language	0.57***	0.56***	0.38**	0.58***
	(0.00)	(0.00)	(0.02)	(0.00)
ASA_age	0.0063***	0.0064***	0.0033	0.0037**
	(0.00)	(0.00)	(0.37)	(0.02)
ali_standard	0.0095***	0.018***	0.021***	0.0098***
	(0.01)	(0.01)	(0.00)	(0.00)
Country FE	YES	YES	YES	YES
Observations	1294	1294	1294.	1294
Adjusted/Pseudo R^2	0.75	0.75	0.87	0.08
Bayesian Inf. Criterion	4123.35	4259.94	2.01e+08	33799.95

Additional IV estimation results:

First stage estimates: geom_wali: 4.40*** (0.00), rule_difference : -0.48* (0.10)

Test of excluded instruments: F(2,117)=236 , p-value = 0.00

Test of endogeneity of *ali_standard* (Wu-Hausmann F-test, H0: exogeneity): F(1,1117) = 2.79, p-val. = 0.095

Test of overidentifying restrictions (Sargan test): $\chi^2(1) = 0.18$, p-value=0.67

Additional Negative Binomal estimation results:

LR test of $\alpha = 0$: $\alpha = 0.477$, p-value = 0.00 (in estimation without robust SE)

Note: ***, **, *, # denote 1, 5, 10 and 15 per cent significance level, respectively. Dependent variable is log(PassengerTraffic) in OLS and IV regressions (adjusted R^2 reported), PassengerTraffic in Poisson and Negative Binomial regressions (Pseudo R^2 reported). Robust SE used in (1), (3), (4). P-values reported in parentheses.

In Column 2 we address the endogeneity problem by using instrumental variable (IV) estimations. The results obtained using IV estimation confirm a positive and significant effect of the degree of liberalization on the number of passengers. The coefficient of the *ali_standard* estimated with IV method is higher than that estimated with OLS. This support the hypothesis that endogeneity arises because countries tend to sign more liberal agreements with the view to promote traffic flows. In general, our IV approach appears to be properly set up. Tests for the goodness of the instruments (the geometric average of the WALI calculated from *ali_standard geom_wali* and the institutional gap between the two countries *rule_difference*) show that our instruments are highly relevant (with an F-test equal 236). Moreover, the Sargan test for overidentifying restrictions does not reject the null hypothesis of valid instruments.

Column 3 and 4 present the results we obtain using the Poisson and the Negative Binomial estimation method respectively. The coefficient for *ali_standard* remains positive and significant. The Negative Binomial appears a more suitable estimation technique than the Poisson method according to the likelihood ratio test of $\alpha = 0$[20] as well as the Bayesian Information Criterion. It is worth highlighting that the coefficients estimated with the negative binomial are very similar to those obtained with the OLS in Table 6. Although the negative binomial is a methodology explicitly designed for count data,

[20] For details on the LR test of $\alpha = 0$ and count data models in general, see Cameron and Trivedi (2006).

OLS estimations are in this case a satisfactory method since the values of the count variable are in our case very high (the average number of passengers across our sample is over 410 thousand passengers). Since the OLS method appear to provide the most conservative estimates, the results reported hereafter will be based on OLS estimations. However, all our results are robust to the use of the negative binomial estimation method.

As we discussed in the previous section, in order to minimise the bias that may be introduced by the mismatch between passenger traffic and the relevant agreement, we run our regressions on the sample of country pairs connected by a direct services.[21] In Table 7 we further address this issue and check the robustness of our results with three sub-samples. First we exclude from the sample the most distant country pairs (those located at a distance above 5000 km), where only long-haul flights operate and the probability that passengers between the two locations fly via a third country is relatively high. The resulting sub-sample is therefore less likely to include passengers flying indirectly. Interestingly, we find a stronger impact of air service liberalization on traffic flows in this subsample. As shown in Column 2, the coefficient of *ali_standard* is 0.023 in this case, much higher than the estimated 0.009 for the full sample. Furthermore, we check the robustness of the results with respect to different income groups. Estimations presented in column 3 refer to the sample where observations of passenger traffic between two low income countries are dropped, whereas estimations presented in column 4 refer to the sample obtained dropping observations of passenger traffic between two high income countries. The estimated coefficient for *ali_standard* is always significant and positive and it is higher for agreements signed by high and middle income countries than for agreements signed by low and middle income countries.

Table 7: Robustness checks: different sample sizes

	Full Sample	**Subsamples**		
	(1)	**(2)**	**(3)**	**(4)**
		distance < 5000km	**distance < 5000km & no low-low**	**distance < 5000km & no high-high**
l_distance	-0.90***	-0.75***	-0.76***	-0.83***
	(0.00)	(0.00)	(0.00)	(0.00)
low_income	-0.19#	-0.26#	2.71***	-0.14
	(0.12)	(0.11)	(0.00)	(0.40)
border	-0.25*	-0.29**	-0.37**	-0.054
	(0.06)	(0.03)	(0.01)	(0.72)
colony	0.53***	0.36**	0.38**	0.30
	(0.00)	(0.04)	(0.03)	(0.17)
language	0.57***	0.58***	0.52***	0.87***
	(0.00)	(0.00)	(0.00)	(0.00)
ASA_age	0.0063***	0.0051**	0.0045*	0.0020
	(0.00)	(0.03)	(0.06)	(0.46)
ali_standard	0.0095***	0.023***	0.024***	0.012*
	(0.01)	(0.00)	(0.00)	(0.09)
Country FE	YES	YES	YES	YES
Observations	1294	905	848	641
Adjusted R^2	0.75	0.76	0.76	0.71

Note: ***, **, *, # denote 1, 5, 10 and 15 per cent significance level, respectively. Robust standard errors used. P-values reported in parentheses.

[21] Iraq is dropped from the sample as data for flights from and to Iraq are likely to be unreliable. For example, 13 countries including Germany, France or Belgium record no passengers to and from Iraq in 2005 though a direct service to Iraq exists according to the data. If there were no civil passengers flying to Iraq in that year , then the existence of a regular direct service is quite unlikely.

Results are also robust to the use of different indexes for the overall degree of liberalization introduced by air service agreements. Table 8 shows the estimations for the four versions of the ALI produced by the WTO Secretariat and the *FA_index*. For all measures, the flow of passengers between two countries is positively and significantly correlated with the degree of liberalization of air transport services. The different magnitude of the coefficients between the various ALI measures and the *FA_index* is explained by the scale of the indexes (all versions of the ALI range between 0 and 50, while the *FA_index* takes values between 0 and 1). When this is taken into account, the effects implied by similar liberalization policies are relatively similar. That is, for example, on the basis of the estimations obtained using the *FA_index*, an increase in degree of liberalization from the 25th percentile (*FA_index* = 0.08) to the 75th percentile (*FA_index* = 0.73) is estimated to increase traffic volumes between country-pairs with a direct service by 36 per cent. This is similar to the predicted 30 per cent estimated using the *ali_standard*.

Table 8: The impact of ASAs on passenger flows based on country pairs with existing direct services: a comparison across different measures of the degree of liberalization

Index	Coefficients	Values of the indexes at percentile		Estimated effect
		25th	75th	
ali_standard	0.0095***	6	34	30%
	(0.01)			
ali_5thfreedom	0.0078**	10.5	36	22%
	(0.02)			
ali_ownership	0.0094**	5	29	25%
	(0.01)			
ali_designation	0.0095***	6.5	35	31%
	(0.00)			
FA_index	0.47***	.08	.73	36%
	(0.01)			

Note: ***, ** denote 1, 5 per cent significance level, respectively. Estimates are based on OLS with robust standard errors using the same specification as in Table 6 except that indexes vary. P-values reported in parentheses. The column titled "Estimated effect" refers to the impact on passenger volumes of an increase in the index from the 25th to the 75th percentile

To sum up, there is robust evidence that liberalization in the aviation market increases passenger flows. The effect is stronger for agreements signed by high income and middle income countries than for agreements by middle and low income countries. Furthermore, the effect is stronger for agreements among relatively close countries. This is an important result as passengers between relatively close countries are more likely to use direct flight connections. Therefore, we may conclude that the possible problem created by a mismatch between data for bilateral passengers (that may include passengers travelling through indirect routes) and data for the degree of liberalization of air services between two countries (that only apply to passengers flying through direct flights) does not appear to affect our results. On the contrary, if any, it acts toward underestimating the impact of air service liberalization on the number of air passengers.

5.2 Evidence on the impact of individual provisions and types of agreements

Being an overall measure of the degree of liberalization, indexes do not provide an understanding of which provision has the largest impact on passenger flows. It is very difficult to disentangle the effect of each provision on passenger flow, because of the high correlation among them. In order to shed some light on this, we also run gravity-type regressions for each provision of the air service agreements using a set of dummy variables.

Table 9 shows the results of these regressions. The results show that several provisions have a significant effect on passenger traffic. In particular, seventh freedom, cabotage, free determination of capacity, free pricing, community of interest withholding regime, multiple designation and no requirement for statistical exchange show up with a positive and significant coefficient, thus implying a positive relationship with passenger traffic. On the contrary, predetermination of capacity,

substantial ownership and effective control, dual approval as well as the requirement of country of origin disapproval as to the pricing regime, are associated to lower passenger flows.

Table 9: The impact of ASAs on passenger flows by individual components

Provision	regressions for 17 different provisions/regimes
Fifth Freedom	0.047
	(0.58)
Seventh Freedom	0.30**
	(0.04)
Cabotage	0.51***
	(0.00)
Predetermination	-0.13*
	(0.09)
Bermuda 1	-0.044
	(0.61)
Free determination	0.36***
	(0.01)
Dual Approval	-0.22**
	(0.05)
Country of Origin Disapproval	-0.40*
	(0.06)
Zone Pricing combined with Dual Approval	0.21
	(0.19)
Dual Disapproval	0.073
	(0.62)
Zone Pricing combined with Dual Disapproval	-0.27
	(0.44)
Free Pricing	0.54***
	(0.00)
Substantial Ownership and Effective Control	-0.39***
	(0.00)
Community of Interest (more restrictive applies)	0.55***
	(0.00)
Principal Place of Business (more restrictive applies)	-0.033
	(0.87)
Multiple Designation	0.15**
	(0.05)
No Exchange of Statistics	0.22**
	(0.02)
Cooperative Arrangements Allowed	-0.17
	(0.19)
Observations	1144

Note: ***, **, * denote 1, 5, 10 per cent significance level, respectively. Incomplete agreements are excluded. Estimates are based on OLS with robust standard errors using the same specification as in Table 6 except that dummies for individual components are used instead of *ali_standard*.. P-values are presented in parentheses.

In order to address the issue of multicollinearity and understand which existing legal type of agreement is more liberalizing in the sense that it increases passenger flow the most, we turn to cluster analysis. Agreements are combinations of provisions. The overall effect of an agreement will depend on its specific design. Cluster analysis is a suitable tool to distinguish different types of agreements, because it classifies objects into different groups (clusters) according to their "similarity". In the analysis that follows, we use agglomerative hierarchical cluster analysis (see Härdle and Simar, 2003) that takes each observation as a separate cluster at the beginning and merges them successively into larger and larger clusters.

Using the components that are significant at the 5 per cent significance level in Table 9 (seventh freedom, cabotage, free determination, dual approval, free pricing, substantial ownership and effective control, community of interest, multiple designation and no request on statistical exchange) as distinguishing features for the cluster analysis, the first level of aggregation reveals 24 different types of existing agreements relevant for the country-pairs with existing direct services. However, 15 of these types are very rare, gathering less than 7 agreements, in six cases representing only one single agreement per type. In order to obtain more balanced clusters in terms of the number of agreements, higher levels of aggregation are investigated.

Table 10 part (1) displays the eight clusters obtained at the fourth level of aggregation ordered from the most restrictive to the most liberal type (from C1 to C8). Provisions are defined in a way that their presence denotes a liberal feature of the agreement. For example, "no substantial ownership and effective control" implies that the agreement establishes one of the other two possible ownership regimes. The table reports the percentage of agreements within each cluster by provision. For instance, cluster C1 includes the set of most restrictive air service agreements. In fact, seven out of the nine liberalizing features we have identified are not included in any agreement. Only 14 per cent of agreements in cluster C1 do not request statistical exchange and 2 per cent do not require dual approval in setting airfares. Three types of agreements denoted by clusters C1, C3 and C8 respectively are very frequent and account together for more than 90 per cent of the ASAs.

Table 10: The impact of ASAs on passenger flows by type of agreement

Part (1) Clusters								
provisions / clusters:	C1	C2	C3	C4	C5	C6	C7	C8
7th freedom	0	0	0	0	0	0	38	100
cabotage	0	0	0	0	0	0	0	92
free determination	0	0	0	100	0	100	92	100
no dual approval	2	0	13	0	0	100	98	100
free pricing	0	0	0	0	0	20	0	100
no substantial ownership and effective control	0	100	3	0	2	40	0	100
community of interest	0	0	0	0	0	0	0	99
multiple designation	0	0	100	50	100	100	100	100
no statistical exchange	14	0	0	0	100	0	100	100
observations	344	1	373	4	65	5	52	305
Part (2) Regression Results								
coefficient	ref	0.76***	0.050	0.31	0.20#	-0.10	0.46#	0.58***
p-value	.	(0.00)	(0.53)	(0.32)	(0.12)	(0.65)	(0.13)	(0.00)

Note: Part (1) reports percentage of agreements containing corresponding provision within each cluster. Incomplete agreements are excluded. In Part (2), ***, **, *, # denote 1, 5, 10, 15 per cent significance level, respectively. Ref denotes the agreement of reference. Estimates are based on OLS with robust standard errors using the same specification as in Table 6 except that dummies for different clusters of agreements are used instead of *ali_standard*.

Using the usual gravity-type model to explain bilateral passenger flow, we estimate the impact of different types of agreements by adding to the standards explanatory variables ten dummies, one for each cluster. Table 10 part (2) shows the results of this regression. The agreements falling in clusters C2, C5, C7 and C8 appear to have an increasingly positive and significant effect on passenger flow relative to the most restrictive agreements of cluster C1.

The significant coefficient for cluster C2 is hard to generalise as it only refers to one observation (the agreement between Macao and Thailand), but it points at the importance of setting up a regime that does not require substantial ownership of airlines. This is in line with the perception of industry commentators that have identified national ownership rules (as well as merger policy and airport

pricing) as one of the most important factor in limiting adjustments in the international air transport industry (Findlay and Round, 2006).

The positive coefficient for cluster C5 shows the importance of multiple designation in combination with no request of statistical exchange. These features together are associated with an increase in traffic by 22 per cent. Although 86 per cent of the country pairs belonging to this group include a middle income country, the countries that most frequently appear in this group are the United States and France (in 8 agreements), Tunisia and Brazil (in 6 agreements) and Paraguay (in 5 agreements).

Cluster C7 is the second most liberal cluster identified. It includes 44 agreements signed by the United States. Regressions results show that the simultaneous inclusion of multiple designation, free determination, other than dual approval regime and no requirement of statistical exchange in an air service agreement increase passenger traffic by approximately 58 per cent relative to the agreements falling in cluster C1.

Finally, the most liberal cluster C8 is found to have the largest impact on the number of passengers. Passenger traffic is estimated to be more than 78 per cent higher among countries applying these types of regulations than among countries falling in cluster C1. Cluster C8 includes all country pairs covered by the Air Transport Agreement between EU and Switzerland and the Agreement on the European Economic Area involving the EU countries, Norway, Iceland and Liechtenstein. Two bilateral agreements of New Zealand (with Brunei Darussalam and with Singapore) also fall in this cluster.

6. Conclusions

International air passenger transport is an important factor in facilitating trade and development of other sectors of an economy (such as tourism). The airline industry transport passengers both on scheduled and charter flights, but scheduled transportation account for about 85 per cent of passenger traffic (Gonenc and Nicoletti, 2000). The industry has been highly regulated both domestically and internationally, with governments setting conditions ownership, capacity and fares. Declared policy objectives include safety, national prestige and regional development. But the outcome of this regulation has been a highly restrictive global aviation market.

In the last 30 years countries have undertaken a process of liberalization of the industry. This has taken place mainly through bilateral air service agreements and few regional agreements. Some 3500 agreements have been signed involving more than 180 countries. Little progress has been made at the multilateral level. At the exception of aircraft repair and maintenance services, selling and marketing of air transport services and computer reservation system services, "core" air transport services remain excluded from GATS.

It is very difficult to get a measure of the degree of liberalization introduced by this plethora of ASAs. Recently, the WTO Secretariat has developed a very comprehensive index of bilateral air service liberalization based on consultations with industry experts. This is the first available index covering a wide range of bilateral agreements (involving over 180 countries) and it is the only informed index available for the industry. Previously indexes were developed through statistical techniques and covered at best 35 countries.

In order to assess the effective degree of liberalization of the aviation market introduced by bilateral air service agreements, this paper uses the index built by the WTO Secretariat and additionally builds a statistical index (by means of factor analysis) that cover the same range of countries. Using a gravity-type model, we estimate the impact of liberalizing air transport services on air passenger flows. We find robust evidence of a positive and significant relationship between the passenger traffic and the degree of liberalization (in terms of market access conditions) of the aviation market.

In particular, we estimate that increasing the degree of liberalization from 25th to 75th percentile increases traffic by approximately 30 per cent.

Turning to the analysis of the role of specific provisions and type of agreements in liberalizing the aviation market, we find that the removal of restrictions on the determination of prices and capacity, cabotage rights and the possibility for airlines other than the flag carrier of the foreign country to operate a service are the most traffic-enhancing provisions of air service agreements. Furthermore, the most liberal type of ASA is found to increase traffic by 78 per cent relative to the most restrictive type. These results are robust to the use of different estimation techniques.

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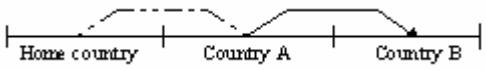
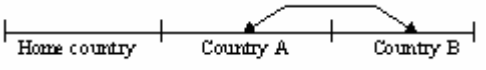
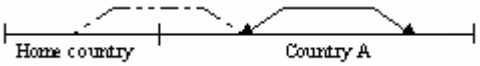
Appendix 1

Table A1: Indicators of openness and their categories/regimes

Name	Meaning	
freedoms	sum of the three **traffic rights** 5th freedom, 7th freedom and cabotage normalized to 1; i.e. *free0123* = (*freedom5* + *freedom7* + *cab*)/3	
freedom5	1 if **5th freedom**; i.e. freedom to carry freight/ passengers between two countries by an airline of a third country on route with origin/destination in its home country	
freedom7	1 if **7th freedom**, i.e. right to carry freight/ passengers between two countries by an airline of a third country on a route with no connection with its home country	
cab	1 if **cabotage** right; i.e. right to carry freight/ passengers within a country by an airline of on a route with origin/destination in its home country	
capacity	categories of **capacity regimes** (0-*pd*, ¼ -*other_rest*, ½-*b1*, ¾-*other_lib*, 1-*fd*)	
pd	1 if **predetermination** of capacity, i.e. capacity be agreed to prior to the commencement of the operation (either by governments, or their aeronautical authorities or designated airlines subject to government approval)	
b1	1 if **Bermuda I** capacity, i.e. the governments set out the capacity principles for the designated airlines to follow but allow each airline the *ab initio* freedom to determine its own capacity, subject only to *ex post fact* review by the governments through their consultation procedure	
fd	1 if **free determination** of capacity, i.e. capacity 0 free of regulatory control	
other_rest, other_lib	1 if capacity and related provisions cannot be classified as any one of the above three types of capacity arrangements, being a hybrid of more than one or not identifiable as any one of them. Two types, **"other restrictive"** and **"other liberal"** are distinguished.	
pricing	categories of **pricing regimes** (0-*da*, 3/8-*co*, 4/8 -*zp* combined with *da*, 6/8-dd, 7/8-*zp* combined with *dd*, 1-*fp*)	
da	1 if **dual approval**, i.e. approval by both parties of tariffs or agreement on tariffs before those tariffs can take effect	
co	1 if **country of origin disapproval**; i.e. a party may disapprove tariffs only for originations in its own territory	
dd	1 if **dual disapproval**; i.e. tariffs become effective unless both aeronautical authorities disapprove them	
zp	1 if **zone pricing**; i.e. this regime involves a reference point or points (zones) around which various types of tariff control are agreed. Tariffs are to be approved within the zone. Outside the zone, either free pricing and dual approval or free pricing and dual disapproval are combined.	
fp	1 if **free pricing**; i.e. tariffs shall not be subject to the approval of any party	
withhold	categories of **ownership/withholding regimes** (0-*wh1*, ½-*wh2*, 1-*wh3*); when more than 1 regime included, the less-restrictive one is preferred	
wh1	1 if **substantial** ownership and effective control are vested in the designating party or its nationals	
wh2	1 if **community of interests** regime, i.e. a foreign designated airline would be accepted to operate the agreed services under the condition that substantial ownership and effective control is vested: a) in a joint operating organization or a multinational carrier created by intergovernmental agreement b) in a one or more countries that are within a predefined group with a "community of interest"	
wh3	1 - a foreign airline is accepted if the carrier is incorporated in the designating party and its **principal place of business** or permanent residence is also in the designating party	
design	1 if **multiple designation**, i.e. each party may designate one or more airlines; 0 if **single designation**, i.e. each party may designate one airline	
statistics	0 if provision on the **exchange of statistics is included**, the exchange of statistics may be mandatory, upon request or required only in cases of disputes over capacity; 1 if absence of the provision	
coop	1 if **cooperative arrangements** allowed, i.e. presence of a provision for entering into cooperative marketing arrangements such as blocked-space and code-sharing	

Note: Source is the WASA database (ICAO, 2005) and QUASAR database (WTO, 2006 and 2007).

Table A2: Weights assigned to each component of the ASA in the construction of the Indexes of air service liberalization

Provision/Regime	ALI				*FA_index*	
	ali_standard	***ali_5thfreedom***	***ali_ownership***	***ali_designation***	**Ex ante weights**	**Ex post weights**
GRANT OF RIGHTS						0.17
Fifth Freedom	6	12	5	5.5	1/3	0.057
Seventh Freedom	6	5	5	5.5	1/3	0.057
Cabotage	6	5	5	5.5	1/3	0.057
CAPACITY						0.17
Predetermination	0	0	0	0	0	0
"Other restrictive"	2	1.5	1.5	1.5	1/4	0.043
Bermuda I	4	3.5	3.5	3.5	1/2	0.085
"Other liberal"	6	5	5	5.5	3/4	0.13
Free Determination	8	7	7	7.5	1	0.17
TARIFFS						0.18
Dual Approval	0	0	0	0	0	0
Country of Origin	3	2.5	2.5	2.5	3/8	0.07
Dual Disapproval	6	5	5	5.5	3/4	0.14
Zone Pricing	8	7	6	6	6.5	7/8	0.16
Free Pricing	8	7	7	7.5	1	0.18
WITHHOLDING						0.1
Substantial Ownership and Effective Control	0	0	0	0	0	0
Community of Interest	4	3.5	7	3.5	1/2	0.05
Principal Place of Business	8	7	14	7.5	1	0.1
DESIGNATION						0.08
Single Designation	0	0	0	0	0	0
Multiple Designation	4	3.5	3.5	7.5	1	0.08
STATISTICS						0.11
Exchange of statistics	0	0	0	0	0	0
No exchange of stats	1	1	1	1	1	0.11
COOPERATIVE ARRANGEMENTS						0.19
Not allowed	0	0	0	0	0	0
Allowed	3	2.5	2.5	2.5	1	0.19
TOTAL	**50**	**50**	**50**	**50**	**1**	**1**

Note: Weights for different versions of ALI are based on WTO (2006). Weights for FA_index are based on the results of factor analysis. Missing values are treated as if they belonged to the most restrictive regime.

Table A3: Air liberalization indexes: average by country

Country	Our data				
	ali_standard		*FA_index*		
	rank	average	rank	average	partners
Angola	1	0.67	15	0.08	3
Papua New Guinea	2	3.60	6	0.06	5
Mozambique	3	3.67	5	0.06	6
Burkina Faso	4	3.71	14	0.07	7
China	5	3.73	13	0.07	73
Georgia	6	3.83	20	0.08	6
Sao Tome And Principe	7	4.00	17	0.08	1
Lesotho	7	4.00	1	0.05	8
Central African Republic	9	4.25	16	0.08	4
Yemen	10	4.33	9	0.07	6
Ukraine	11	4.53	39	0.10	17
Togo	12	4.62	2	0.05	13
Niger	13	4.63	19	0.08	8
Moldova	14	4.71	32	0.10	17
Iran, Islamic Rep. Of	15	4.74	18	0.08	31
Kazakhstan	16	4.83	38	0.10	6
Cameroon	17	4.89	22	0.08	9
Zimbabwe	17	4.89	37	0.10	9
Bahamas	19	5.00	118	0.19	1
Solomon Islands	19	5.00	8	0.07	2
Fyr Macedonia	21	5.27	48	0.11	11
Kuwait	22	5.35	7	0.07	23
Bangladesh	23	5.50	21	0.08	16
Zambia	24	5.60	28	0.09	10
Seychelles	25	5.70	11	0.07	10
Israel	26	5.72	36	0.10	32
Russian Federation	27	5.78	56	0.12	94
Benin	28	5.81	44	0.11	16
Oman	29	5.82	29	0.09	34
Kyrgyz Republic	30	5.93	46	0.11	14
Mauritius	31	5.94	12	0.07	16
Comoros	33	6.00	4	0.06	2
Guyana	33	6.00	3	0.06	3
Congo	33	6.00	34	0.10	19
Korea, Dem. People's Rep. Of	35	6.17	26	0.09	6
India	36	6.25	27	0.09	73
Kenya	37	6.32	10	0.07	25
Somalia	38	6.33	30	0.09	3
Libyan Arab Jamahiriya	39	6.45	24	0.08	11
Algeria	40	6.47	51	0.12	17
Samoa	41	6.50	23	0.08	4
Uzbekistan	41	6.50	81	0.15	38
Bulgaria	43	6.57	49	0.12	30
Côte D'ivoire	44	6.64	25	0.09	22
Lao People's Dem. Rep.	45	6.67	66	0.14	6
Burundi	45	6.67	41	0.11	9
Cuba	47	6.68	35	0.10	31
Bosnia And Herzegovina	48	6.75	60	0.13	4
Vietnam	48	6.75	59	0.13	20
Senegal	50	6.76	47	0.11	21

Country	Our data				
	ali_standard		*FA_index*		
	rank	average	rank	average	partners
Romania	51	6.78	42	0.11	46
Saudi Arabia	52	6.95	50	0.12	19
Mauritania	53	7.00	58	0.12	11
Albania	54	7.14	116	0.19	7
Nigeria	55	7.20	31	0.09	20
Fiji	56	7.22	43	0.11	18
Equatorial Guinea	57	7.25	67	0.14	4
Croatia	57	7.25	71	0.14	12
Afghanistan	59	7.29	65	0.14	14
Pakistan	60	7.34	33	0.10	53
Ethiopia	61	7.43	40	0.10	14
Mexico	62	7.44	123	0.20	32
Serbia And Montenegro	63	7.58	100	0.17	40
Tanzania	64	7.62	75	0.15	13
Azerbaijan	65	7.67	117	0.19	3
Morocco	66	7.84	64	0.14	51
Mali	67	7.86	74	0.15	21
Iraq	68	7.98	55	0.12	54
Saint Kitts And Nevis	69	8.00	94	0.16	1
Chad	69	8.00	52	0.12	3
Maldives	71	8.08	61	0.13	13
Turkmenistan	72	8.13	104	0.17	8
Belarus	73	8.15	76	0.15	13
Malawi	74	8.19	54	0.12	16
Thailand	75	8.40	53	0.12	50
Guinea-Bissau	77	8.50	78	0.15	2
Bahrain	77	8.50	82	0.15	32
Philippines	77	8.50	95	0.16	38
Colombia	79	8.55	125	0.20	11
Korea, Republic Of	80	8.58	72	0.14	45
Argentina	81	8.58	83	0.15	19
Tonga	82	8.67	45	0.11	3
Bolivia	83	8.69	86	0.16	16
Myanmar	84	8.73	68	0.14	37
South Africa	85	8.73	91	0.16	52
Gabon	86	8.75	77	0.15	8
Tunisia	87	8.78	114	0.18	36
Turkey	88	8.89	99	0.17	46
Bolivarian Rep. Of Venezuela	89	8.93	89	0.16	14
Armenia	90	9.00	80	0.15	5
Syrian Arab Republic	91	9.03	121	0.20	30
Guinea	92	9.06	90	0.16	16
Cambodia	93	9.07	85	0.16	14
Egypt	94	9.08	69	0.14	40
Congo, Dem. Republic Of	95	9.08	79	0.15	12
Jordan	96	9.29	115	0.19	31
Barbados	97	9.38	92	0.16	13
Qatar	98	9.42	108	0.17	19
Botswana	99	9.44	124	0.20	9
Sri Lanka	100	9.48	88	0.16	25
Canada	101	9.51	97	0.17	45

Country	Our data				
	ali_standard		*FA_index*		
	rank	average	rank	average	partners
Lebanon	102	9.68	102	0.17	41
Nepal	103	9.75	73	0.15	12
Malaysia	104	9.79	87	0.16	39
Bhutan	105	10.00	62	0.13	1
Djibouti	105	10.00	62	0.13	1
Tuvalu	105	10.00	70	0.14	2
Suriname	105	10.00	57	0.12	3
Paraguay	105	10.00	122	0.20	15
Ecuador	110	10.08	120	0.19	12
Sudan	111	10.09	106	0.17	11
Brazil	112	10.17	103	0.17	36
Uganda	113	10.20	112	0.18	10
Mongolia	114	10.22	111	0.18	9
Costa Rica	115	10.25	142	0.27	12
Sierra Leone	116	10.38	93	0.16	8
Australia	117	10.38	84	0.16	42
Liberia	118	10.42	119	0.19	12
Ghana	119	10.46	98	0.17	26
Uruguay	120	10.47	96	0.16	15
Indonesia	121	10.52	105	0.17	25
Brunei Darussalam	122	10.74	113	0.18	34
Japan	123	10.80	107	0.17	51
Peru	124	10.93	133	0.23	15
Cape Verde	125	11.00	140	0.27	3
Trinidad And Tobago	125	11.00	110	0.18	13
United Arab Emirates	127	11.10	128	0.21	20
Dominican Republic	128	11.25	138	0.25	8
Jamaica	129	11.32	132	0.23	19
Cook Islands	130	11.33	101	0.17	3
Rwanda	131	11.40	134	0.23	5
Guatemala	132	11.43	135	0.24	7
Panama	133	11.75	143	0.27	16
Madagascar	134	11.80	139	0.25	5
Hong Kong, China	135	11.98	109	0.18	50
Saint Lucia	136	12.00	126	0.20	3
Namibia	136	12.00	149	0.30	3
Nicaragua	138	12.20	137	0.25	5
Singapore	139	12.29	127	0.21	68
Vanuatu	140	13.00	136	0.24	3
Gambia	140	13.00	144	0.27	4
Swaziland	143	14.00	129	0.22	1
Antigua And Barbuda	143	14.00	129	0.22	1
Haiti	143	14.00	129	0.22	1
New Zealand	145	15.68	147	0.28	34
Nauru	146	15.75	146	0.28	4
American Samoa	147	16.00	141	0.27	1
Honduras	147	16.00	163	0.42	3
Chile	149	16.08	158	0.35	26
Macao, China	150	16.61	145	0.28	31
Switzerland	151	16.93	148	0.29	105
Austria	152	17.42	152	0.31	86

Country	Our data				
	ali_standard		***FA_index***		
	rank	average	rank	average	partners
Marshall Islands	153	17.67	155	0.32	3
Germany	154	17.77	151	0.31	104
Netherlands	155	17.83	154	0.32	107
Spain	156	17.98	153	0.32	85
Grenada	157	18.00	150	0.31	2
United Kingdom	158	18.93	157	0.34	114
Belgium	159	19.17	156	0.33	90
France	160	20.13	159	0.35	86
Sweden	161	21.53	160	0.38	77
Italy	162	22.78	161	0.41	60
Czech Republic	163	22.93	164	0.42	68
Denmark	164	23.09	162	0.41	69
El Salvador	165	23.50	177	0.60	2
Norway	166	24.20	166	0.44	64
Cyprus	167	24.90	165	0.43	49
United States	168	24.96	176	0.60	98
Poland	169	26.65	167	0.47	48
Finland	170	26.75	168	0.48	52
Greece	171	28.67	169	0.50	45
Portugal	172	28.87	171	0.52	46
Hungary	173	28.89	170	0.51	44
Luxembourg	174	30.57	172	0.55	46
Malta	175	32.92	173	0.59	38
Slovenia	176	33.74	174	0.60	35
Latvia	177	33.75	175	0.60	36
Aruba	178	34.00	183	0.80	1
Netherlands Antilles	178	34.00	183	0.80	1
Ireland	180	35.00	178	0.63	35
Lithuania	181	35.55	179	0.63	33
Slovak Republic	182	35.88	180	0.64	34
Iceland	183	39.06	181	0.71	32
Estonia	184	41.43	182	0.74	28

Appendix 2: Data Sources

Data on distance, common border, common colonial link and common language were obtained from the CEPII database. The index for rule of law and the grouping of countries by low, middle and high income correspond to the World Bank definition. Data on passenger traffic and the existence of direct services between two countries are from the International Aviation Transport Association (IATA). Information on the agreements and the number of years since they were first signed are from World Air Service Agreements (WASA) database provided by ICAO (ICAO, 2005). This database covers 2000 bilateral air service agreements. Information on regional agreements is obtained from QUASAR database (WTO, 2007b). In particular, we include the Air Transport Agreement between EU and Switzerland and the Agreement on the European Economic Area involving the EU countries, Norway, Iceland and Liechtenstein.[22] We ignore other regional agreements because their effective implementation is improbable (see WTO, 2007b, Add. 2, Introduction for more details). The informed index of air transport liberalization, the ALI, is from the QUASAR database (WTO, 2006 and 2007b).

[22] Although the regional EAA agreement is not included in WTO (2006), its main features are the same as in the agreement of the European Common Aviation Area (ECAA). Therefore, we use the same *ali_standard* for the two agreements.