The Regulation of International Air Cargo Services

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Sciences Po, année universitaire 2008/2009
Master Relations Internationales, mention Economie

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Abstract

Air Cargo services are regulated by a complex web of bilateral and reciprocal Air Services Agreements (ASA) that limit the ways in which carriers can provide services and reduce trade flows. This paper estimates a gravity model, which uses an index measuring air cargo liberalization to capture the effects of regulation on air cargo flows. The model is estimated using panel data of the top 100 routes between 2002 and 2008 collected by the International Air Transport Association. A significant correlation is found between liberal ASAs and higher air cargo flows.

Keywords: Gravity Model, Panel Data, Composite Indicator, Factor Analysis, Network Industry, Air Services Agreement

Acknowledgments

I wish to thank Professor Patrick Messerlin for having given me the opportunity to work as a research assistant at the Groupe d'Economie Mondiale. I am thankful to Professor Patrick Jomini for having supervised my work all over the year. His comments and support have helped me to substantially improve this work. I wish to thank Pierre Latrille and Antonia Carzaniga of the World Trade Organization for introducing me to the issues related to air services regulation and for sharing their expertise with me. I wish to thank Sébastien Miroudot of the Organisation of Economic Cooperation and Development and Ben Shepherd from Princeton University for their advices on gravity models. Last but not least I wish to thank Judith Rupp with whom I work on the passenger side of a research project on air services' regulation from September 2008 to February 2009.

All errors and omissions remain mine only.

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Introduction

Despite growing economic integration and increases in trade flows, international passenger and cargo air transport services are still regulated by a complex web of bilateral and reciprocal Air Services Agreements (ASA). These agreements limit the way in which carriers can provide services and reduce trade flows. Although passenger traffic has been studied extensively, there is less information on the ways in which ASAs affect cargo services. So far no specific theoretical framework has been developed to assess the level of restrictiveness of ASA clauses on cargo services and their impact on trade flows.

In this paper, we will test empirically the assumption that, everything being equal, more liberal ASAs are associated with higher trade flows.

Air cargo is a major industry carrying a large share of world trade. Its regulation has an impact on the world economy. It is therefore important to perform the economic analysis of this sector.

The main purpose of this paper is to answer the two following questions:

- Compared to passenger services, how do bilateral agreements affect air cargo operations?
- Is there a strong statistical correlation between larger air cargo flows and a higher degree of liberalization?

In this paper, we build a gravity model explaining the volume of air cargo as a function of regulation. The degree of restrictiveness of regulation can be assessed in two ways, (i) by calculating a composite indictor, a Cargo Air Liberalization Index (CALI) or (ii) by using dummy variables for a series of identified restrictive clauses. For this purpose, a database of about a hundred Air Services Agreements has been built. These agreements have been "coded", which means the main provisions related to market access have been listed for each ASA.

This paper is divided into three sections.

The first section reviews the main characteristics of the air cargo industry and explains how it is regulated. This section is based on (i) a descriptive analysis of the air cargo flows of the top hundred cargo routes between 2002 and 2007[1] and (ii) the study of the legal provisions of most of the ASAs regulating these routes. Although the purpose of this paper is not to design an index assessing the level of air cargo services' liberalization, it will explore different scenarios on how the passenger index developed by the WTO (the Air Liberalization Index, ALI) might be adapted to account for cargo operations.

The second section develops a theoretical model linking trade flows with the degree of liberalization of the market. The model is a standard gravity model, augmented to account for specific characteristics of the cargo services industry.

The third section estimates the model using panel data collected by the International Air Transport Association (IATA) of the top 100 routes between 2002 and 2007 to assess the correlation between the degree of liberalization and the volume of air cargo.

What does this paper bring to the existing literature?

- It develops a specific analytical framework for cargo services and uses for the first time a specific index (which is experimental at this stage) to measure the restrictiveness of ASAs on air cargo activities.
- It uses for the first time panel data on air cargo for the top 100 routes between 2002 and 2007[2].

Review of the literature

Three papers [InterVista 2006, Gelosso Grosso 2008 and Rousova Piermartini 2008] have used econometric methods to estimate the impact of the degree of liberalization on passenger flows. Although they use slightly different models[3], they all find significant positive correlations between the degree of liberalization and passenger traffic.

Their findings have influenced policy makers. There is now a strong consensus among stakeholders on the necessity to move towards broader liberalization as shown by the Istanbul

[1] For 2008, we only have data until October, we can only use 2002 to 2007 data

[2] Previous studies only used cross sections data. Compared to cross sections, panel adds more observations and is less dependent on specific events of the year for which data has been collected.

[3] All three papers have developed a gravity model but they use different variables to account for the degree of liberalization and the 'size' of the countries

initiative where airlines and government officials from 42 countries jointly signed a declaration calling for more liberalization of the market [Jomini, Achard, Rupp 2009][4]. Prior to this initiative, more and more liberal ASAs had been concluded between major country pairs (for instance EU-US or US-Australia). Recent ASAs tend to include specific provisions for all-cargo that are usually more liberal than passenger clauses.

Although the air cargo industry is an important and growing sector, only one analysis [Gelosso Grosso, 2008] has so far estimated the effects of ASAs on trade flows. This study is centred on Asian Pacific countries and uses cross section data for total trade (without any distinction between the different modes of transport). There is a need to analyse more closely air cargo services from a theoretical and empirical point of view.

[4] Jomini, Achard and Rupp, The Istanbul Declaration and the Agenda for Freedom Summit-an opportunity for broad liberalization, GEM Working Paper, February 2009

Section 1 The Cargo industry and the regulation of its activity

Although the regulation of passenger services has been extensively analyzed [InterVista 2006, Gelosso Grosso 2008 and Rousova Piermartini 2008], only one paper [Gelosso Grosso 2008] has studied empirically the effects of the regulation that affects cargo operations. The purpose of this section is to begin filling this blank. This section reviews the main characteristics of the air cargo industry and its regulation. It explains how regulation can reduce trade flows and how we can account for it to later (in section 2 and 3) build and estimate an econometric model. Our analysis relies on two sources: quantitative data collected by IATA on the volumes carried on the top hundred cargo routes between 2002 and 2008 and qualitative data on the ASAs regulating these routes[5].

1. The Air Cargo industry

Although this paper is an empirical economic analysis of regulation in air cargo services and is not a business review of the cargo industry, it appeared important to provide the background required to put the study in context.

a. The market for air cargo services and its size

To define the market served by air cargo carriers we must identify what products they transport. We can't tell exactly what goods are carried by air cargo because such data are not available on a consistent basis. However, without giving any precise estimation, we can reasonably assume that air lifted trade consists of high value to weight goods such as medicines, microelectronic components, chemicals, aerospace components and perishable goods…

Some analysts have produced estimates. For instance, according to Kasarda [2006][6] the electronics industry accounted for 40% of the value of international air cargo in 2005 and 80% of the international trade in cut flowers travel by air. These figures are consistent with the expectation of high value to weight ratio.

[5] A database of legal agreements regulating air services has been created on www.gem.sciences-po.fr

[6] KASARDA John, APPOLD Stephen, MORI Makoto. The Impact of the Air Cargo Industry on the Global Economy, 2006. Available at http://www.tiaca.org/images/TIACA/PDF/The%20Impact%20of%20the%20Air%20Cargo%20Industry%20on%20the%20Global%20Economy.pdf

Air cargo is one of the largest and fastest growing transport industry. As shown in table 1, between 2001 and 2006, air freight (in tonne kilometres, which is tonnes carried time distance in km) grew by 24% despite the decrease following the 2001 slowdown and the terrorist attacks that affected US and world trade.

Table 1 Annual growth of air freight in freight tonne kilometres, 2001-2006

Year	2001	2002	2003	2004	2005	2006
Growth rate in relation to previous year (%)	-7%	+5%	+3.5%	+13%	+4%	+4.6%

Source: World Trade Organization Secretariat, QUASAR Second Review of Air Transport Annex

According to Kasarda, Appold and Mori [2005], the air cargo industry:

- accounted for revenues amounting to US$52 billion
- transported nearly 30 per cent of international trade by value
- transported almost 35 per cent of non-land based trade
- transported goods worth US$2.7 trillion.

b. Who is operating air cargo services?

Since airlines have strong ties with their national governments and play an indirect but crucial role in the negotiations (as shown by the dual liberalization agendas stated in the Istanbul declarations made by State officials and airlines' managers[7]), it is crucial to identify the main cargo operators and their respective interests and logics.

Air cargo services are supplied by three major types of operators:

- All Cargo carriers
- Belly Carriers
- Express Delivery companies

[7] International Air Transport Association (IATA) 2008a, Istanbul Declaration, available at http://www.iata.org/events/agm/2008/instanbul-declaration.htm

All Cargo carriers are airlines carrying freight on specific airplanes exclusively dedicated to cargo. They earn their entire revenue from this activity (the main carriers include Cargolux and companies that operate passenger and cargo services separately, such as Lufthansa Cargo, Singapore Airlines Cargo…).

Belly carriers are airlines that perform both passenger and cargo operations by carrying freight in the hold ('belly') of passenger flights. The main belly carriers are Air France KLM, Korea Air, Cathay Pacific…

Express Delivery carriers are devoted to delivering packages and freight. The main differences with all cargo and belly carriers are the timeframes under which they operate (they must deliver their merchandise in a limited number of days…) and their "door to door" services (they do not carry the freight only from airport to airport but to the final destination). The main express delivery companies are Fedex and UPS. Freight carried by Express delivery companies is not included in our trade flow data. They are mentioned however because they play a key role in the industry : they carry a large share of total cargo flows (for instance Fedex is the main cargo carrier generating in 2005 a revenue of 14 461 million of tonne kilometre which represents 6,50% of the revenue generated by the top 50 cargo carriers) and their business model has influenced other carriers that also now operate door to door operations[8].

Airlines have strong ties with their national governments. After World War II to prevent the US and the UK from being the only countries with their own airline industries, some countries created their 'flag' carrier (national company) and protected them from competition. Privatized passenger airlines still use their influence to limit the scope of liberalization reforms. Nowadays this problem is less acute with cargo carriers because prestige is not at stake.

Between 2002 and 2007, among the hundred routes we have data for, nine agreements have been modified (either replaced by a new agreement or modified by a memorandum of understanding, MOU, between the two States)[9]. In six cases, more liberal provisions have been negotiated for cargo services. For instance, the European Union-United States agreement (which applies to a large share of air cargo) and the Australia-United States agreement grant 7th

[8]For instance Korean Airlines and Lufthansa Airlines (with United Cargo) have launched door to door services for small packages

[9] The routes changed are EU-US, Australia-US, Mexico-US, China-US, India-France, India-Italy, India-Germany, India-Italy, India-Great Britain and Hong Kong-Japan

freedom rights[10] for all cargo operations (but not for belly carrier operations, which are regulated by passenger regulations). Four MOUs have been signed with India, implementing the unilateral open cargo policy carried out by India, which consist in loosening provisions on capacity and pricing controls.

According to Earl Scott [2006] and Kasarda [2006], cargo liberalization could pave the way for a broader loosening of regulation in the international air service industry. However conflict might arise between all cargo carriers (who want to extend their network to operate on more routes) and belly carriers (who might want to protect their position on certain passenger markets). Major airlines still earn a larger share of their revenue from passenger operations than cargo ones. In the recently signed ASAs both groups have been satisfied (because of the division between some of the cargo and passenger provisions), but this situation could change in the future.

c. Geographical analysis of cargo flows

To have an idea of the main international air cargo flows, we can look at the list of main cargo airports :

Table 2 Top 15 cargo airlines by tonne kilometres, 2007

Rank	City	Airport	Country	Freight (thousands of tonnes) flying through
1	Memphis	International	USA	3 692
2	Hong Kong	Chep Lap Kok	China	3 609
3	Seoul	Incheon International	South Korea	2 337
4	Tokyo	Narita	Japan	2 280
5	Shangai	Pudong	China	2 159
6	Frankfurt	International	Germany	2 128
7	Louisville	Louisville International	USA	1 983
8	Singapore	Changi	Singapore	1 932
9	Los Angeles	International	USA	1 907
10	Paris	Charles de Gaulle	France	1 855
11	Miami	International	USA	1 831
12	Tapei	Chiang Kai Shek International	Taiwan	1 699
13	New York	JFK	USA	1 660
14	Chicago	O'Hare International	USA	1 618
15	Amsterdam	Schipol	Netherlands	1 560

Source: Airline Business

[10] Seventh freedom- the right of an airline of home country to operate flights between countries A and B without the flight originating or terminating in its own country for more see annex

The main world centres of air cargo trade are located in Asia and in the United States (twelve out of fifteen largest airports).

A large part of the cargo transiting in some specialised airports is domestic (Memphis in the American Midwest is used as a hub by UPS, Hong Kong is close to the major cities on the Chinese East coast; domestic routes are certainly served from these airports) whereas the focus of this paper is international air freight. To have a more specific idea of the international flows of air cargo, we can draw on an interregional analysis for the hundred top routes between 2002 and 2008. We have been provided by IATA with the volume of cargo traded between the top hundred most frequented routes for eight years. For legal reasons we could not have access to cargo flows leaving the United States. In spite of this shortcoming, these data give a comprehensive picture of the situation and recent evolution of world air cargo trade. Eight regional blocs have been created and are presented in table 3.

Table 3 Countries included in analysis and regional aggregation

Region	*Abbr.*		*Countries*
Australasia	A'asia	Australia	New Zealand
East Asia	EA	China	Korea
		Hong Kong	Taiwan
		Japan	
Europe	Europe	Norway	Turkey
		Switzerland	
European Union	EU	Austria	Hungary
		Belgium	Ireland
		Cyprus	Italy
		Czech Republic	Luxembourg
		Denmark	Malta
		Finland	Netherlands
		France	Portugal
		Germany	Spain
		Great Britain	Sweden
		Greece	
India	India	India	
Other NAFTA	Other NAFTA	Canada	Mexico
Southeast Asia	SEA	Indonesia	Singapore
		Malaysia	Thailand
		Philippines	
United States	US	United States	
Other	Other	Argentina	Morocco
		Brazil	Panama
		Chile	Peru
		Costa Rica	Saudi Arabia
		Ecuador	South Africa
		Egypt	United Arab Emirates
		Israel	Uruguay
		Jordan	Venezuela

Table 4 presents the interregional flows in 2002 and 2007. It shows: the growth rate of total flows, the average annual growth (the geometrical mean of the total growth rate) between the regions and the share of each interregional flow in the total traffic of the sample in 2002 and 2007.

Table 4 Cargo traffic, top 100 country pairs, 2002-2007

All data	*Units*	*EU-US*	*EA-EA*	*EU-EA*	*EA-US*	*EA-EU*	*Other-US*	*EU-Other*	*EA-SEA*	*A'asia-A'asia*	*EU-India*	*EU-Other NAFTA*	*Europe-US*	*Other-EU*	*A'asia-EA*	*A'asia-SEA*
Country pairs	Nb	11	12	20	4	20	6	9	9	2	4	5	2	3	3	2
Weight:																
- 2002	Mio t	850	276	498	257	128	243	139	75	94	53	81	57	29	83	78
- 2007	Mio t	929	796	673	495	557	346	231	162	106	102	72	45	82	47	49
Years with data	Nb	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Growth	%															
2002-2007		9,3	187,9	35,2	93,1	334,1	42,2	66,7	116,2	13,1	92,4	-11,2	-20,5	178,9	-43,0	-37,4
- Avg annual	%	1,8	23,5	6,2	14	34,1	7,2	10,7	16,7	2,5	14	-2,3	-4,5	22,8	-10,6	-8,9
Share in total Top 100 traffic																
- 2002	%	26,2	8,5	15,4	7,9	4,0	7,5	4,3	2,3	2,9	1,6	2,5	1,7	0,9	2,6	2,4
- 2007	%	18,5	15,9	13,4	9,9	11,1	6,9	4,6	3,2	2,1	2,0	1,4	0,9	1,6	0,9	1,0

All data	*Units*	*EU-SEA*	*EU-A'asia*	*SEA-EA*	*A'asia-US*	*Other NAFTA-US*	*Europe-EA*	*EA-India*	*EA-A'asia*	*SEA-US*	*Europe-EU*	*Other NAFTA-EU*	*Other NAFTA-EA*	*EU-Europe*	*SEA-EU*	*A'asia-Other*
Country pairs	Nb	3	2	4	2	1	2	3	2	1	2	1	1	1	1	1
Weight:																
- 2002	Mio t	52	38	43	43	28	31	-	-	18	13	17	16	-	-	-
- 2007	Mio t	52	50	70	20	24	20	20	31	19	-	-	-	19	-	-
Years with data	Nb	7	7	7	7	7	6	5	5	6	5	5	3	2	2	1
Growth	%															
2002-2007		-0,5	32,2	61,9	-53,3	-14,6	-34,3	N/A	N/A	1,8	N/A	N/A	N/A	N/A	N/A	N/A
- Avg annual	%	1	5,7	10,1	-14,1	-3,1	-10	N/A	N/A	0,45	N/A	N/A	N/A	N/A	N/A	N/A
Share in total Top 100 traffic																
- 2002	%	1,6	1,2	1,3	1,3	0,9	1,0	-	-	0,6	0,4	0,5	0,5	-	-	-
- 2007	%	1,0	1,0	1,4	0,4	0,5	0,4	0,4	0,6	0,4	-	-	-	0,4	-	-

Source: Calculations based on IATA cargo data on the top 100 routes between 2002 and 2007

From 2002 and 2007:

- There is steady but unequal growth in the volumes traded. On the top hundred routes, the volume of total trade grew by 52% (from 3,3 to 5 million of tonnes) in only five years. Traffic flows decreased in only a few cases (EU-other NAFTA, A'asia-East Asia...), on a small share of our sample.

- The structure of trade is stable. Most of the routes remain in the top hundred list during the seven years. The ranking of bilateral flows doesn't really change: the EU-US flows are the largest in 2002 and 2007, the share of flows originating and having for destination the EU does not change a lot (41,4% in 2002 and 36,7% in 2007). Although the share of cargo traffic to the US decreased from 46,1% to 37,5%, the US remains the country that attract the largest share of air cargo.

- The rapidly growing importance of East Asia both in trade within the region and with other regions. Intra East Asian traffic grew almost 25 per cent per year and the volume of trade from East Asia to the US almost doubled between 2002 and 2007 when trade from East Asia to the EU increased more than five times.

Contrary to passenger flows, we observe structural unbalances between air freight flows. When passengers leave a country they usually come back. Cargo flies to a direction where freight is unloaded and doesn't need to go back from where it is from if there are no goods to be transported there. Belly carriers used to fly cargo may return to their point of origin but all cargo tend to fly in one direction. This difference is fundamental because it modifies the needs of the carriers. All-Cargo carriers need more flexibility than passenger carriers in the way they set up flying routes.

Table 5 compares the structure of passenger and cargo flows. On the top hundred cargo routes, some routes are round trips[11]. We selected some of these routes (those for which we observed round trips for at least two years) and compared them to the passenger figures for 2005. For every year and every type of flow we calculated an index of how balanced flows were by dividing the flow in one direction with the flow in the other direction (the choice of the numerator and denominator is made at random, here the above figure is divided by the figure below). The closer the index is to 1 the more balanced flows are. We can see that for passengers almost all routes (except 2 out of 16 observations) have similar flows (within a range of 0,1 point) whereas for cargo routes, the similar quotient ranges from 0,32 to 2,59.

[11] There is two separate flows, from A to B and B to A, it occurs when A and B are major actors of the world economy

Table 4 Balanced passengers, unbalanced cargo

Route	Passengers	Freight (in millions of kg)					
	2005	2002	2003	2004	2005	2006	2007
Japan – Australia	670 516			16	17	16	
Australia – Japan	737 858	36	31	34	27	22	20
Balance index	0,91			0,47	0,64	0,76	
New Zealand – Australia	1 920 535	42	41	47	50	48	45
Australia - New Zealand	1 922 977	52	52	58	63	61	61
Balance index	0,99	0,80	0,77	0,80	0,79	0,79	0,73
Germany – Brazil	192 059	24	22	31	31	32	43
Brazil – Germany	201 968				18	20	22
Balance index	0,95				1,74	1,61	1,97
Great Britain – Canada	1 100 456	18	20	21	21	20	19
Canada - Great Britain	1 078 908	17	17	18	17	17	
Balance index	1,02	1,07	1,17	1,17	1,21	1,16	
Hong Kong – Germany	156 628						91
Germany - Hong Kong	148 222	30	29	32	31	33	35
Balance index	1,05						2,59
Japan – Germany	416 724	28	63	75	80	79	85
Germany – Japan	371 441	56	59	62	66	67	72
Balance index	1,12	0,49	1,07	1,19	1,20	1,17	1,17
Korea – Germany	172 997	22	25	38	51	44	39
Germany – Korea	201177	29	31	38	44	52	56
Balance index	0,85	0,73	0,80	0,99	1,14	0,83	0,70
South Africa – Germany	253 008	12	14	15	18	18	19
Germany - South Africa	251 058	25	24	33	37	38	43
Balance index	1,00	0,47	0,57	0,46	0,48	0,47	0,44
Japan – France	398 095		21	28	26	25	26
France – Japan	473 997	43	43	45	42	43	40
Balance index	0,83		0,48	0,62	0,62	0,57	0,63
Japan - Great Britain	445 150	16	32	39	36	37	31
Great Britain – Japan	442 857	37	39	38	38	36	31
Balance index	1,00	0,43	0,80	1,01	0,95	1,00	1,01
Great Britain - Hong Kong	510 577	24	22	24	22	22	22
Hong Kong - Great Britain	498 912					30	75
Balance index	1,02					0,71	0,29
Japan – Italy	313 038		13	16	14	16	
Italy – Japan	313 022	44	40	44	43	43	40
Balance index	1,00		0,33	0,37	0,32	0,36	
Korea – Japan	3 422 092	56	61	65	61	45	40
Japan – Korea	3 524 249	32	71	89	91	92	93
Balance index	0,97	1,76	0,85	0,73	0,67	0,49	0,42
Netherlands – Japan	109 958	33	28	30	27	24	23
Japan – Netherlands	111 501	18	34	44	42	48	53
Balance index	0,98	1,86	0,82	0,67	0,63	0,50	0,44
Philippines – Japan	647 627	29	23	23	21	23	21
Japan – Philippines	642 010		19	17	20	21	
Balance index	1,00		1,19	1,32	1,04	1,06	
Thailand – Japan	1 257 292					19	19
Japan – Thailand	1 219 741	25	50	64	67	59	57

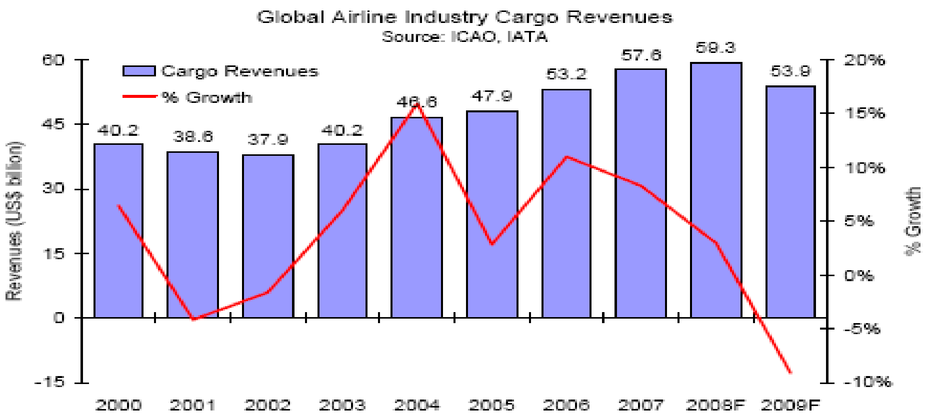
Balance index	1,03					0,32	0,32

Source: Author's calculation based on IATA's passenger data for 2005 and cargo data on the top 100 routes between 2002 and 2007

This table illustrates the differences in network organisation between passenger and cargo carriers. This difference affects the way in which we assess air services restrictions to take into account the specificity of cargo operations.

d. Recent developments

The air cargo industry is affected by the current crisis. The sector is currently suffering from the economic slowdown certainly because high value to weight goods has high income elasticity and consumers tend to reduce their expenditure on these goods in times of economic slowdown. As shown in the graph below representing the evolution of the financial situation of major airlines the revenue of the major airlines have decreased sharply since the beginning of the current turmoil and are forecast to be negative in 2009.



Source: IATA, Cargo E-Chartbook, Q4 2008

2. The regulation of cargo services

Air Services Agreements include provisions on how airlines can set their prices, capacity, frequency, routes and many other aspects of carrier operations. **When studying how the market for air cargo services is regulated, one must keep in mind that every route is regulated by a specific ASA and that specific rules can differently regulate each market**.

We have focused our study on the top hundred routes between 2002 and 2007. Each year, the top hundred list can vary. In total:

- 111 ASAs regulate the traffic on the routes for which we have data for.
- We have found 85 ASAs and 31 memorandums of understanding (MOUs, that amend ASAs).
- With this information we have been able to code the ASAs regulating 87 bilateral relations (and 9 for which there is a change in regulation between 2002 and 2008, which makes a total of 96 routes out of 120, counting a route with a change in regulation as a different route). **We have coded 80% of our sample**.
- **There are 19 routes for which we have more accurate data than QUASAR** (the Quantitative Air Service Agreements Review used by the WTO and the OECD) , which represents almost 20% of the agreements we have found (5 agreements were not in QUASAR, 8 were signed after the QUASAR was made, 3 have been changed by MOU not coded in QUASAR and in 3 cases, QUASAR codes an old agreement that was replaced before 2002). We also have a detailed analysis of each ASA (the final database on gem.sciences-po.fr is currently the largest publicly available on the subject, the results of the coding of the cargo provisions are in annex).

Although it is estimated that more than three thousands ASAs are currently in force and although one might fear that it is not possible to apply the same framework of analysis to so many diverse agreements, the provisions are very similar. It makes it relatively easy to compare ASAs. We assessed the level of restrictiveness of ASAs by coding specific provisions.

a. The different provisions relevant for market access:

The provisions we coded to assess the effects of agreements on cargo flows are almost the same as to those used in QUASAR to calculate the passenger index (ALI). This subsection reviews the main provisions of the ASAs and how they might affect cargo operations.

- Grant of rights clauses: States have full sovereignty on their territory and decide which carriers can enter their air space. There are different freedoms of the air, some defined by international conventions (such as the 1st and 2nd freedoms which have been almost universally granted by the Chicago International Convention signed in 1944), some that were defined later[12]. Restrictions on the grant of rights limit the ways in which carriers can set up routes and impose extra costs. CALI codes for the 5th, 7th and 9th freedoms. The 5th freedom is granted in almost all ASAs covered by our study[13] whereas 7th freedom is scarcely given (only for France-United States that has been replaced by the European Union-United States agreement, for Australia-United States and for Australia-New Zealand) and only for all cargo services (with the exception of the routes between Australia and New Zealand where 7th is also given for passengers). This result is consistent with the assumption that cargo services can be more easily liberalized than passenger services. Cabotage is only granted between Australia and New Zealand and between EU members but in many ASAs there is a safeguard clause explicitly forbidding cabotage. It appears very unlikely that we will witness any subsequent move towards more liberal regulation of cabotage services.

- Capacity clauses: States can define the conditions under which carriers can set their capacity and can restrict the frequency of flights, as well as the number or type of aircraft used, thus constraining supply. Different levels of restrictiveness are coded for:

1. Predetermination, when the capacity has to be agreed beforehand by the two countries (civil authorities and/or directly carriers)
2. "Other restrictive", in between Predetermination and Bermuda I
3. Bermuda I (the name of the first UK-US ASA). This ASA was the first major bilateral agreement (after the war, the UK and the US were the only remaining aeronautical powers). It adopted a formulation of capacity clauses that was later reused. Under a Bermuda I clause, there is no ex ante predetermination of the volumes or the frequency but an ex post verification of the volume carried. This clause is quite vague and has sometimes been difficult to interpret as explained in the annex.
4. "Other liberal", in between Bermuda I and free determination
5. Free determination, when airlines can freely set the capacity of freight they carry and the frequency of flights.

Most of the agreements studied are still regulated by restrictive provisions (32 by predetermination and 30 by Bermuda I). However, a large share of the sample, 25 agreements,

[12] A detailed chart is provided in annex
[13] But for China-Netherlands, Germany-United Arab Emirates, France-Korea, Italy-United States, Mexico-United States

grants airlines the freedom to organise capacity (with free determination or other liberal provisions). Capacity restrictions can be loosened or released. So called “Open Sky” agreements suppress capacity control and the Istanbul declaration recommends countries to follow this example.

- Tariffs clauses: States can define through which procedure carriers price their services. They can require every airline operating on their territories to agree beforehand on the tariffs they will charge, thus organizing an oligopoly and limiting the benefits of competition for consumers. Different levels of restrictiveness are coded for:

1. Dual Approval, when both countries (civil authorities and/or airlines) need to approve the tariffs.
2. Country of origin, when only the country from which the flight is originating has to approve the tariffs.
3. Dual disapproval, when only one country (regardless if it is the origin or the destination of the flight) must agree with the tariffs
4. Zone pricing, when a reference point is set around which various types of tariff control are agreed.
5. Free pricing, when airlines can freely set up their tariffs.

Pricing is tightly controlled by ASAs, 78 agreements include dual approval clause. However an important part of our sample is regulated by free pricing, 25 agreements. This situation for tariff is similar to the situation for capacity whereas for tariff there is no intermediate restrictive scenario as it is the case with Bermuda I for capacity.

- Withholding clauses: States grant rights to specific companies (airlines can not operate before having been fully accredited by the relevant authorities of the contracting states), which have to fulfil certain nationally conditions, preventing mergers and acquisitions and limiting the benefits arising from exploiting a large network. Different levels of restrictiveness are coded for:

1. Substantial Ownership and Effective Control (SOEC), when "SOEC" must be vested in the designated party or its nationals. There is no definition of above which threshold, substantial ownership is considered vested in nationals but it is usually at least 51%.
2. Community of interest, SOEC can be vested in one or more of the countries that are parties to the agreement or one or more countries that are not necessarily party to the agreement but are within a predefined group, within a 'community of interest'. For example, the European Commission is pushing its partners to incorporate "community clauses" in MOUs. Under this clause airlines would be considered as Europeans and no more as controlled by one member State.
3. Principal place of business, the carrier has to be incorporated in the designated party and its principal place of business or permanent residence has also to be in the designated party, including one incorporated and effectively controlled by the designated party, which removes the substantial ownership requirement.

Almost all the ASAs we have information for are governed by the very restrictive SOEC clause. Only 18 agreements have liberal provisions (principal place of business) but Honk Kong is a contracting party in all these agreements. Liberal rules are explained by Hong Kong's specific political situation and not by the will to lighten the burden of regulation.

- Designation clauses: ASAs determined how many carriers can operate between two countries, thus limiting and even potentially forbidding competition. Different levels of restrictiveness are coded for:

1. Single designation, when only one carrier from both countries is allowed to operate air services.
2. Multiple designation, when more than one airline (from 2 to an unlimited number) can serve the market.

Multiple designation is enforced in most of the ASAs, 78 out of 96 but on some large commercial routes, only one airline is still authorized (for instance between China and Germany, Japan and Germany...).

- Statistics: Airlines or civil companies can require their contracting partner to provide them with statistical information on the flows of passenger and cargo served by the airline(s) of the contracting state, thus limiting the strategic behaviour of firms.

- Cooperative arrangements: airlines can go into cooperative agreements with each other carriers to reduce the anticompetitive consequences of restrictive provisions.

Only 28 agreements allow cooperative arrangements between airlines. Even though it only represents 30% of our sample, there is a clear upward trend in the inclusion of cooperative agreements provisions in ASAs overtime. Only one agreement before the 1990s allowed them and since then 27 ASAs out of 44 had cooperative agreements clauses (about 60%).

- Wet leasing is a special type of agreement according to which an airline can rent airplanes and/or crew from a foreign airline. Wet leasing is mentioned in ASAs but is also covered by domestic regulations which make it difficult to code for. In our analysis we focused on wet leasing provisions integrated in the ASAs.

- Change of gauge is a clause allowing a change in aircraft during a journey.

- Intermodal rights are clauses easing the connections between cargo aircrafts and other land based modes of transport.

We must be very careful when dealing with the three new provisions that are not coded in passenger ALI (intermodal rights, change of gauge and wet leasing) because they are not only designated by ASAs. However, we keep them in our study to enlarge the scope of analysis of existing composite indicators.

To sum up the analysis of ASAs, we can say that cargo regulation tends to be more liberal than passengers' even though it is still tight on many aspects[14]. **There is clear distinction between clauses which tend to be loosened (like capacity and pricing) and provisions that are unlikely to be modified (specially withholding restrictions and grant of 9th freedom).**

[14] A detailed comparison between passenger and all cargo clauses in the ASAs is available on gem.sciences-po.fr

It is sometimes difficult to code ASAs, we faced two major problems: how to code Bermuda I and how to code 5th and 7th freedoms. We explain in annex how we handled them to make sure our database was built using systematically the same framework.
We will try now to combine all the elements and build a Cargo Air Liberalization Index (CALI), a composite index assessing the level of restrictiveness of ASAs as was done with the ALI index developed by the WTO. This approach is very experimental because talks between the WTO Secretariat, IATA and airlines on the creation of the CALI are still under way. However this work would not be complete if it did not include projections of what could be the CALI.

b. Cargo Air Liberalization Index

There are two different ways of building composite indicators : by consulting experts or by using statistical techniques for example factor analysis. In this subsection both techniques are experimented to have an idea of what values a Cargo Liberalization Index could have.

<u>Index built through a consultation of stakeholders</u>

A CALI is currently being developed by the WTO Secretariat. It is based on the PALI but gives different weights to the same provisions. It could add three new clauses wet leasing, change of gauge and intermodal rights. So far only two complete weighting schemes exist, the first one presented by the WTO Secretariat (that we will name scenario 1) and the other based on the answers given by a carrier (scenario 2) to questions designed by the WTO Secretariat.

<u>Index through factor analysis</u>

We use the methodology set by Nicoletti and al [1999][15] and applied to passenger services by Piermartini and Rousova [2008][16]. The basic idea of factor analysis is to get a small set of variables from a large set of variables. Factor analysis involves a series of steps. After having defined a database (in our case the coding of the provisions of the 96 ASAs), we need to extract

[15] NICOLETTI Giuseppe, SCARPETTA Stefano, BOYLAUD Olivier. Summary Indicators of product market regulation with an extension to employment protection legislation, OECD Economic Department Working Papers n°226, 2000, 87 pages
[16] PIERMARTINI Roberta, ROUSOVA Linda. Liberalization of Air Transport Services and Passenger Traffic, World Trade Organization Economic Research and Statistics Division Staff Working Paper, 2008

the main factors. In other words, we identify the number of latent factors that best represent the database. This specific factor analysis method called principal component analysis provides us with a set of loadings (coefficients) that show the correlation between each component of the ASA and the latent factor. The first factor accounts for the larger share of the variance, the second one for less and so on. To select how many factors we keep we apply the Kaiser criterion according to which we should not keep a factor whose associated eigenvalue is less than 1. We then operate a rotation of the factors to reduce the number of significant components. Finally we give weights to the different clauses to construct the index.

We will illustrate the methodology by explaining the results of factor analysis of cargo provisions when coding the seven original clauses (the provisions coded in the passenger ALI)[17]. According to the Kaiser criteria only two factors are kept, the first one explaining 42% of the variance and the second 18%. In table 6, we report the values of the factor loadings.

Table 6: Construction of Cargo index using factor analysis

	Factor 1		Factor 2		FA_7 Index
Explained Variance	42%		18%		60%
Indicators of openness	Loadings	Weights (1)	Loadings	Weights (2)	Relative weights (5)
Freedoms	0.2223	0.02	0.5636	0.24	0.09
Capacity	-0.3487	0.04	0.7076	0.38	0.15
Pricing	0.8934	0.27	0.0692	0.00	0.19
Withholding	0.2925	0.03	0.672	0.34	0.13
Designation	0.8278	0.23	0.0984	0.01	0.16
Statistics	0.7397	0.19	-0.171	0.02	0.14
Cooperative	0.8094	0.22	-0.0151	0.34	0.15
Weight of factors (4)		0.69		0.31	1

Source: Author's calculation based on the database of ASAs available on gem.sciences-po

This table is constructed as the one in Piermartini and Rousova [2008] using the method developed by Nicoletti and al [1999] (the standard OECD approach for building composite indexes to account for market regulation). More precisely the weight for each indicator of each factor (1, 2 and 3) is the normalised[18] value of squared factors loadings, the weight of each factor (4) is the ratio of the sum of squared loadings for one factor divided by the sum of

[17] In Annex 5, one can see the results of both factor analysis with 7 or 10 provisions (wet leasing, change of gauge and intermodal rights). The methodology is the same but to keep the formalisation as light as possible we presented the full results in Annex.

[18] Normalised for the value 1

squared loadings for the three factors. The final weighting (5) scheme is obtained by summing the product of the weight of each indicator multiplied by the associated "weight of factors". For instance 0.16 = (0.23*0.69) + (0.01*0.31).

Two important caveats are to be mentioned. First the results of factor analysis depend on the original database. Even though our sample covers the main cargo routes, it still accounts for a small share of the total number of ASAs (estimated to be around 3 000). Research based on a larger database should not use the weights calculated in this paper since the new database could have very different characteristics. **The results of factor analysis depend on the number of variables taken to analyse market regulation**. For instance, we have calculated different weights for seven or ten variables[19]. Table 7 summarises the potential values of CALI depending on the estimation technique. Two expert weighting schemes are shown as two weighting schemes for factor analysis.

[19] Whether we keep the original provisions set by the WTO secretariat and used in Piermartini and Rousova [2008] or add the three new elements: wet leasing, change of gauge and intermodal rights although they are not only regulated by ASAs.

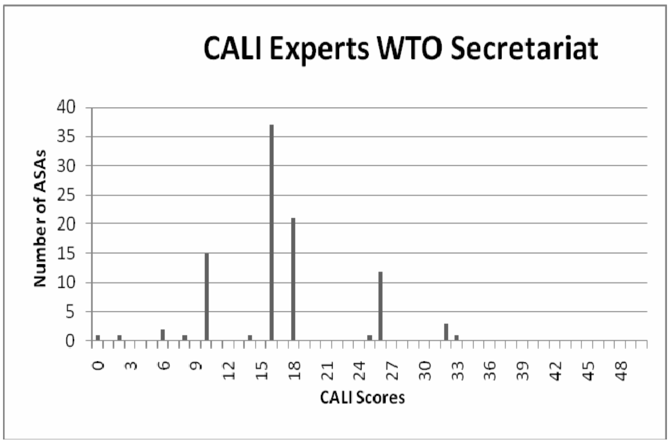
Table 7: ALI and potential CALIs

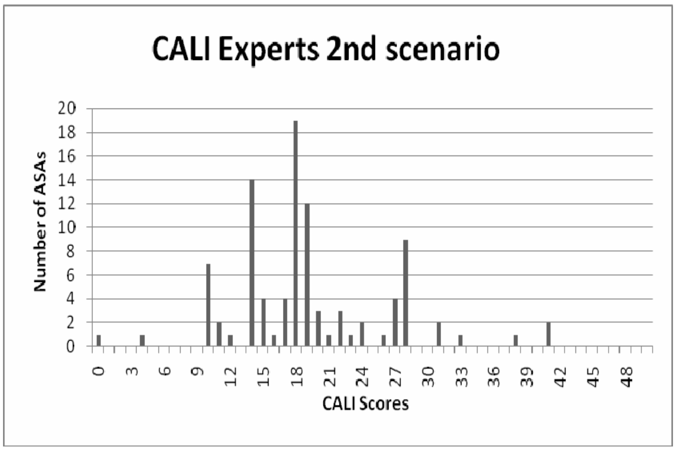
ELEMENT	PASSENGER (ALI STD) and relative weight over total		TENTATIVE CARGO SCORING Expert 1st scenario and relative weight over total		TENTATIVE CARGO SCORING Expert 2nd scenario and relative weight over total		TENTAIVE CARGO SCORING Factor Analysis with seven variables (as in ALI) and relative weight over total		TENTATIVE CARGO SCORING Factor Analysis with ten variables and relative weight over total	
GRANT OF RIGHTS										
Fifth Freedom	6	*12%*	10	*20%*	10	*20%*	1.5	*3%*	2	*4%*
Seventh Freedom	6	*12%*	14	*28%*	10	*20%*	1.5	*3%*	2	*4%*
Cabotage	6	*12%*	8	*16%*	4	*8%*	1.5	*3%*	2	*4%*
CAPACITY										
Predetermination	0		0		0		0		0	
"Other restrictive"	2	*4%*	0		2	*4%*	1.875	*3.75%*	1.25	*2.75%*
Bermuda I	4	*8%*	0		4	*8%*	3.75	*7.5%*	2.5	*5.5%*
"Other liberal"[1]	6	*12%*	0		6	*12%*	5.625	*11.25%*	3.75	*8.25%*
Free Determination	8	*16%*	0		7	*14%*	7.5	*15%*	5	*11%*
TARIFFS										
Dual Approval	0		0		0		0		0	
Country of Origin	3	*6%*	0		1	*2%*	2.375	*4.75%*	1.5	*3%*
Dual Disapproval	6	*12%*	0		2	*4%*	4.75	*9.5%*	3	*6%*
Zone Pricing	7	*14%*	0		2	*4%*	7.125	*14.25%*	4.5	*9%*
Free Pricing	8	*16%*	0		3	*6%*	9.5	*19%*	6	*12%*
WITHHOLDING										
Substantial Ownership and Effective Control	0		0		0		0		0	
Community of Interest	4	*8%*	7	*14%*	2	*4%*	3.25	*6.5%*	2.75	*5.5%*
Principal Place of Business	8	*16%*	10	*20%*	5	*10%*	6.5	*13%*	5.5	*11%*
DESIGNATION										
Single Designation	0		0		0		0		0	
Multiple Designation	4	*8%*	6	*12%*	4	*8%*	8	*16%*	5.5	*11%*
STATISTICS										
Exchange of Statistics	0		0		0		0		0	
No exchange of Statistics	1	*2%*	0		1	*2%*	7	*14%*	4	*8%*
COOPERATIVE ARRANGEMENTS										
Not allowed	0		0		0		0		0	
Allowed	3	*6%*	2	*4%*	3	*6%*	7.5	*15%*	4.5	*9%*
WET LEASING										
Not allowed	0		0		0		0		0	
Allowed	0		0		3	*6%*	0		3	*6%*
CHANGE OF GAUGE										
Not allowed	0		0		0		0		0	
Allowed	0		0		0		0		5.5	*11%*
INTERMODAL RIGHTS										
Not allowed	0		0		0		0		0	
Allowed	0		0		0		0		4.5	*9%*
TOTAL	50		50		50		50		50	

Source: Author's calculation

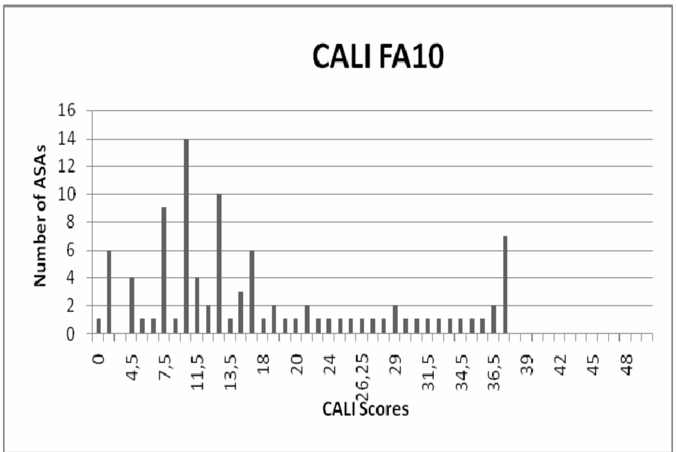
The four graphs below represent the distribution of potential CALI scores for the routes we have coded[20].

[20] The details are in Annex 4

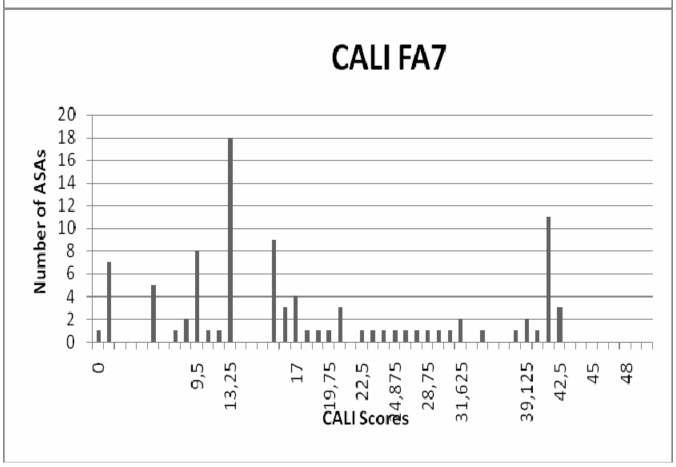


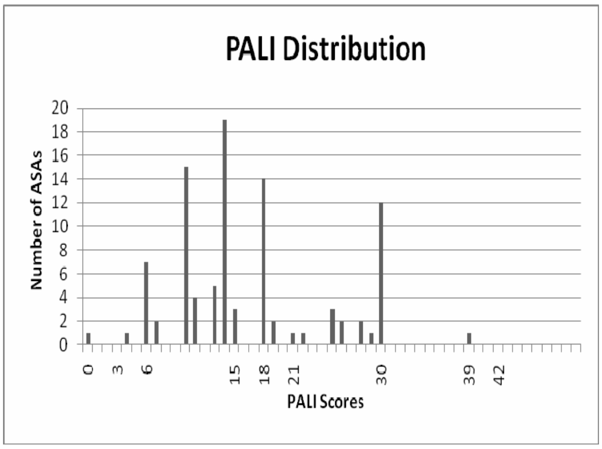


For potential cargo indexes built through consultation of experts we see that the 1st scenario CALI gives a lot of importance to the grant of rights (almost half of the value of the indicator). As a result the scores are very concentrated (more than half of the ASAs have either a score of 16 or 18). On the contrary the variance of the 2nd scenario is bigger (a variance of 49,30 for the second scenario and a variance of 37,55 for the first) and may capture more different types of effects than the first one.



For potential cargo indexes built through factor analysis, the results are less concentrated when the factor is built for seven provisions instead of ten.





There is no perfect index and every technique (expert based or using factor analysis) has limits. Even though factor analysis seems more objective, it can be criticized. Factor analysis gives weights in proportion of the variance explained by each clause but it may not always account for the "real" importance of a provision for market access. For instance, the grant of freedoms has been highlighted by the WTO Secretariat as a major element (it is given almost fifty percent of the total points in the first scenario CALI) whereas the same clauses only account for nine or twelve percent of the index when calculated using factor analysis. 7th freedom is only scarcely granted which means it explains little of the variance (as there is a concentration of ASAs having 5th freedom and not 7th) but probably remains a very important feature for market access. The fact that 7th is only given in few occasions also signify it is important for carriers and politically difficult to give. **What is important is that all indexes are positively associated with higher trade flows**.

The first section has given us the opportunity to review how air cargo services are regulated in general and to present in details how the routes we analyse are regulated. We have elaborated different scenarios of cargo liberalization indexes that differently capture the relative importance of the main aspects of regulation. We will reuse these indexes in the third section when we will estimate the model we build in the second section.

Section 2 A gravity model explaining cargo flows

This section shows how we can build a model to explain cargo flows as a function of regulation. It develops the now standard type of trade models used to explain bilateral flows: a gravity model. Gravity models have become very popular in the economic literature. They are not only used to account for trade in goods but also to explain capital and physical flows (FDI and migration). **However, the fact that gravity models are now widely used in the literature is not in itself a sufficient justification to choose them. It is important to know where they come from, the assumptions that underlie them and under which conditions they hold**.

This section is divided into two subsections. The first subsection reviews the theoretical foundations of gravity models. It details where gravity models come from and derives a simple general expression of gravity. The second subsection reviews the recent literature on air services regulation in which authors have used gravity models [IATA 2006, Piermartini and Rousova 2008, Gelosso-Grosso, 2008 and Gelosso Grosso, 2008] to see how the authors have adapted the general model to the case of air services regulation and dealt with various estimation problems.

Section 3 applies the theory developed in section 2 and estimates a gravity model which uses the indexes measuring air cargo liberalization developed in section 1.

1. Background information on gravity models

a. Where do gravity models come from and why are they so popular?

The theoretical basis for the gravity model used in trade is derived from physics. Newton's "Law of Universal Gravitation" states that the force attracting two objects depends on their size and on the distance between them.

The original Newton's apple formula is:

$$F_{ij} = G\frac{M_i M_j}{D_{ij}^2}$$

With F_{ij} the attractive force, M_i and M_j the masses, D_{ij} the distance between the two objects and G a gravitational constant. Gravity models were first used in economics by Jan Tinbergen at the beginning of the 1960s to explain trade flows. We can easily understand why using economic masses and distance to explain trade flows. The richer countries are, the larger are their output and the range of goods they can trade, and the larger likely trade flows. On the other hand, the larger the distance between two countries is, the higher the costs of transportation are likely to be, exerting a negative influence on trade flows.

Gravity models have become very popular because of their good statistical fit and the ease with which the necessary data can be found. At the end of the 1970s and beginning of the 1980s gravity models began to be extensively used, making it necessary to specify their theoretical grounds. Anderson [1979] was the first to give the gravity model a solid microeconomic foundation by deriving it from a demand expenditure system. Gravity models were used again at the end of the 1990s and have been refined over the years especially by the inclusion of geographical dummies in the estimated equations (for common languages, border, historic ties or former colony) to account for different aspects of distance: countries that share a border are likely to trade more than countries separated by a long distance, it may be harder to start a business in a country that doesn't share your language…

We now show how we can very easily derive a gravity type equation. The demonstration that follows is taken from Baldwin and Taglioni [2006], it is the easiest we can find in the literature. Since one can not only use gravity models because it has good results and because it has been done before, we quickly demonstrate that gravity equations hold in very general conditions. As Baldwin and Taglioni [2006] wrote, "*the gravity equation is essentially an expenditure equation with a market clearing condition imposed*", it fits a variety of trade models.

b. The theoretical foundations of gravity models

The demonstration used by Baldwin and Taglioni involves six steps. For each of them we will both present the algebra and the corresponding explanation in the clearest way possible.

Step 1: The expenditure share identity

For matters of simplicity, we assume symmetrical elasticities of substitution and symmetrical preferences among all agents[21].

[21] The assumption of "love of variety" derived from Dixit Stiglitz preferences

This first step sets up an expenditure identity. Following steps give a better formulation of each variable. (1) expresses the value of a trade flows as the share of country d expenditure allocated to imports from country o.

(1) $p_{od} x_{od} \equiv share_{od} E_d$ with p_{od} the price, x_{od} the quantity, E_d the total expenditure on tradable goods (all goods are assumed to be traded) in the destination country and $share_{od}$ the share of expenditure on tradable goods coming from the origin country.

Step 2: The expenditure function: shares depend on relative prices

The second step sets two new identities derived from assuming a Constant Elasticity of Substitution (CES) demand function. In this case the expenditure share is :

(2) $share_{od} \equiv \left(\frac{P_{od}}{P_d} \right)^{1-\sigma}$ where σ is the elasticity of substitution among varieties (σ >1 in this model), P_{od} is the price of the goods imported from country o by the destination country d and P_d is the price index in the destination country. The higher P_{od} relative to P_d, and the higher the elasticity of substitution (σ), the lower the $share_{od}$.

Prices in country d are defined by a CES index: $P_d \equiv \left(\sum_{k=1}^{R} n_k (p_{kd})^{1-\sigma} \right)^{1/(1-\sigma)}$. The prices in country d are the sum of the prices of the products bought by country d from its k partners, and from the home country[22]. **It is very important to note that $share_{od}$ depends not only on the prices in the destination, but also on the prices of traded goods in all the importing country's trading partners. Bilateral flows between o and d depend on the relative prices between them but also on the relative prices of country d's other trading partners.**

Step 3: Adding a pass-through equation

The "landed price" of the exported good is higher in the importing country to account for transportation costs and a bilateral markup.

[22] The home country is counted as a trading partner

(3) $P_{od} = \mu p_o \tau_{od}$ with μ the bilateral markup (set equal to one for simplicity) and Γ_{od} reflects all trade costs (natural and man-made).

Step 4: Aggregating across individual goods

Total exports are equal to the sum of exports of each sector. The total value of trade V_{od} is equal to $V_{od} \equiv n_o s_{od} E_d$, the value of trade flows in (1) times the number of products (n_o)[23] and can be rewritten, by using (2) and (3) in (1) :

(4) $V_{od} = n_o (p_o \tau_{od})^{1-\sigma} \frac{E_d}{P_d^{1-\sigma}}$ the value of exports is equal to the number of goods time their relative prices time the total expenditure on tradable goods.

Step 5: Market clearing condition

With step 4, we have an expression of trade flows. Step 5 adds a market clearing condition to the model. Total output (Y_o) equals the sum of exports to every country (including the home country).

(5) $Y_o = \sum_{d=1}^{R} V_{od}$ which can be rewritten as $Y_o = n_o p_o^{1-\sigma} \sum_{d=1}^{R} \left(\tau_{od}^{1-\sigma} \frac{E_d}{P_d^{1-\sigma}} \right)$

(6) We can rewrite (5) as $n_o p_o^{1-\sigma} = \frac{Y_o}{\Omega_o}$, where $\Omega_o \equiv \sum_{d=1}^{R} \left(\tau_{od}^{1-\sigma} \frac{E_i}{P_d^{1-\sigma}} \right)$ with Ω_o being used as a proxy for "openness": the bigger the expenditure E_i the higher potential exports (and the higher Ω_o), because $\sigma > 1$, the lower the costs τ_{od} the higher the potential for exports (and the higher Ω_o).

Step 6: A first-pass gravity equation

Substituting (6) into (4), we get the first pass gravity equation:

[23] Since the preferences are symmetrical across sectors, we can calculate total exports by multiplying the values of exports in a sector by the number of sector

(7) $V_{od} = \tau_{od}^{1-\sigma}\left(\frac{Y_o E_d}{\Omega_o P_d^{1-\sigma}}\right)$

At this point we have a gravity type equation where bilateral trade can be expressed as follows:

(8) $V_{od} = G\frac{Y_o Y_d}{\tau_{od}^{\sigma-1}}$ with $E_d = Y_d$ in (7), GDP of the country d being used as a proxy of its expenditure on traded goods and bilateral costs accounting for bilateral distance ($\tau_{od}^{\sigma-1}$ is in the denominator in 8 as was distance in Newton's original equation) to make the gravity equation used in economics look like the one used in physics. G, $G \equiv \frac{1}{\Omega_o}\frac{1}{P_d^{1-\sigma}}$ is called the 'gravitational un-constant' [Baldwin and Taglioni, 2006] because it contains the costs term (τ_{od}) and price indexes that vary over time.[24]

From a theoretical model to an estimated equation: the role of the 'multilateral resistance' term

As pointed out by Baldwin and Taglioni [2006], early estimations of the gravity model didn't take into account the gravitational 'un-constant'. The estimated equations were the log linearized expression of the model excluding G. The expression had the following general form: $\ln V_{od} = \ln Y_o + \ln Y_d - \ln \tau^{1-\sigma}{}_{od}$ but taking into account G, we have:

$$\ln V_{od} = \ln G + \ln Y_o + \ln Y_d - \ln \tau^{1-\sigma}{}_{od}.$$

G contains the price index of the destination country $P_d^{1-\sigma}$ that is expressed as a function that includes prices not directly involving the origin and destination countries. This is why it is also called the 'multilateral resistance' term. **The rationale behind the multilateral resistance term is that trade between two countries depends on the relative (and not absolute) trade costs between them**. Trade between A and B depends on the relative cost of trading between A and B and that of other routes. **This theoretical contribution of Anderson and Van Wincoop [2003] has changed the estimated equations of gravity models**. Most of the economic literature now estimates the following model:

$$\ln V_{od} = \ln Y_o + \ln Y_d - \ln \tau_{od} - \ln \Omega_o - \ln P_d^{1-\sigma}.$$

[24] By analogy with physics, where G is used to represent the gravitational constant. Baldwin and Taglioni argue, however that G varies over time, and therefore term it the un-constant.

In this expression, the model is greatly refined but more difficult to estimate since it is very hard to obtain the required general price index. One of the solutions to this problem has been to use country specific dummies. These dummies capture the effects of unobserved characteristics of the trading countries (and act as a substitute for price indexes that carry a lot of information of the information that is specific to countries o and d). However when including these country specific dummies and estimating a model with cross section data[25], one must drop out every country specific variable which does not vary across partner countries because it would induce co linearity problems. **Theoretically GDPs and relative prices are included in gravity models but econometrically (with cross section data) GDPs have to be dropped to take into account the 'multilateral resistance' term**.

The gravity equation we end up with has solid theoretical grounds and can easily be estimated. The overview on gravity models in this subsection shows how it can easily be derived from standard microeconomic theory, starting from an expenditure function. Gravity models can be easily derived and are consistent with very diverse trade theories. It is a very useful model because it includes trade costs (natural and manmade) and multilateral resistance as the determinants of trade flows. **As we are studying the impact of air services regulation (which affect cost) on trade flows, the gravity model suits our purpose**.

2. The use of gravity models to study air services regulation

This subsection focuses on four previous papers analyzing the impact of air services regulation on passenger or trade flows. For each of the mentioned paper we will review (1) the estimated model, (2) the type of data used, (3) the proxies chosen for economic masses, trade flows and transport costs and (4) the econometric techniques performed. This review of the literature will helps us identify the strengths and weaknesses of previous research and see what the best way to estimate our model is. The four papers are Inter-Vista [2006] on passenger flows, Piermartini and Rousova [2008] on passenger flows, Gelosso Grosso [2008] on passenger flows and Gelosso Grosso [2008] on cargo flows.

a. Inter-Vista 2006

The study carried out by Inter-Vista was centered on passenger services. The gravity model built for passengers was also used for cargo flows but the purpose of the report was mainly

[25] As we will see in section 3 the estimation techniques are different with panel data

centered on passenger services. The analysis was commissioned by IATA and aimed at showing the benefits of liberalization and promoting it to passenger airlines.
The estimated equation was:

$$\ln Pax_{ij} = \alpha + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln dis_{ij} + \beta_4 \ln inertia + \beta_5 \ln services_{ij}$$
$$+ ASAs\ clauses + others\ + \varepsilon_{ij}$$

In addition to standard gravity models variables (GDPs and distance), the model includes a moment of inertia calculated on the basis of the area of the country (to calculate the possibility for travelers to substitute a domestic flight for an international one when the home country is big), dummy variables for restrictive clauses of ASAs, the flow of services between the two countries and other variables (tourism demand, quality of the service, cultural affinities…). A similar model is estimated for cargo inserting new variables that end up being not statistically significant.
The model is estimated with cross section data (bilateral passenger data) for 2005 and using Ordinary Least Squares estimation.
In view of the theoretical inputs from Anderson and Van Wincoop, using GDPs in the estimated equation neglects the 'multilateral resistance' term. There is also a risk of co linearity bias in the estimation since GDPs and flows of service variables (already counted as part of exports in the GDP) are used at the same time.

b. Piermartini – Rousova 2008

The study by Piermartini and Rousova from the WTO Secretariat estimates passenger services as:

$$\ln Pax_{ij} = \alpha + \beta_1 \ln dis_{ij} + \beta_2 air\ \ liberalization + \beta_3 border + \beta_4 colony + \beta_5 language + \beta_6 ASA\ age$$
$$+ \beta_7 low\ income + \sum_k \gamma_k D_k + \varepsilon_{ij}$$

The model is estimated with cross section passenger data for 2005 using either the passenger ALI developed by the WTO or a passenger index calculated through factor analysis to account for the degree of liberalization. The model uses country specific dummies (to account for multilateral resistance) and two other variables: the age of the ASA and a dummy for low income countries. This equation is estimated using several techniques, standard OLS, Poisson and Negative Binomial regressions and IV estimations using two instrumental variables[26] to correct for potential endogeneity bias.

c. Gelosso-Grosso 2008 on passenger and cargo services

Gelosso Grosso estimates two different models: one for passenger and the other for cargo services. For passenger services, bilateral flows in 2005 are explained as a function of GDPs, distance and dummies for common language, historic ties, border, existing direct service, remoteness and the ALI. Four equations are estimated, accounting for ‘multilateral resistance’:

- With the two GDPs (and then without the ‘multilateral resistance’ term)
- With the GDP of the importing country and a country specific dummy for the exporting partner
- With the GDP of the exporting country and a country specific dummy for the importing partner
- With two country specific fixed effects

Two estimation methods are used: OLS and Poisson Maximum Likelihood

The cargo model is very similar: it is estimated with OLS and Poisson Maximum Likelihood but only with country fixed effects (GDPs are not in the estimated equation). Gelosso Grosso could not use cargo flows and instead used total trade flows and dummies for restrictive provisions (instead of an index).

[26] The two instrumental variables are the product of the average levels of ALIs and the absolute difference between the indexes of rule of law of the two countries in the pair.

Section 3 The empirical estimation of the gravity model

This section estimates a gravity model using panel data to study the effects of air cargo services regulation on cargo flows. This section is divided in three subsections: the first subsection presents the estimated equations and the data used. The second subsection presents the econometric techniques performed and the different statistical tests made to correct for potential bias. Estimating a gravity model with panel data requires modifying the estimated equations used in previous studies on air services regulation (and presented in section 2). The third subsection presents the results.

1. The estimated models

a. The different equations to estimate

As we saw in section two, the standard gravity model (the Anderson and Van Winccop model) adds a multilateral resistance term to the usual variables employed in gravity (masses, distance…). Considering that it is very difficult to calculate price indexes of the goods transported by cargo (we do not have disaggregated data on the products carried) we use two other techniques to account for the multilateral resistance term when using panel data and estimate two models, one with time invariant country fixed effects and the other with time varying country fixed effects.

In the first model to account for the multilateral resistance term we use time invariant country fixed effects. Importers and exporters country dummies capture the effects of unobserved characteristics of the trading countries (as with estimations using cross section) but there is a time dimension in panel that requires the use of time varying variables. In this case we keep GDPs. The estimated equation is the following:

$$\ln(V_{od})_t = \alpha + \beta_1 \ln GDP_{ot} + \beta_2 \ln GDP_{dt} + \beta_3 \ln distance_{od} + \beta_4 border + \beta_5 colony + \beta_6 common\_language + \beta_7 (CALI_{od})_t + \sum c_o I_o + \sum d_d E_d + u_{od}$$

In the second model we also use exporters and importers country dummies to account for the multilateral resistance term but to take into account the time dimension of the panel we don't use GDPs and instead let the importer and exporter dummies vary overtime. We also use fixed effects for each year.

The estimated equation is the following:

$$\ln(V_{od})_t = \alpha + \beta_3 \ln dis\tan ce_{od} + \beta_4 border + \beta_5 colony + \beta_6 common\_language + \beta_5 (CALI_{od})_t + \sum c_{ot} I_{ot} + \sum d_{dt} E_{dt} + \sum e_t L_t + u_{odt}$$

b. The variable chosen and the data

The dependent variable is the natural logarithm of the volume (expressed in million of kg) exchanged by air cargo between two countries. This data has been collected by the International Air Transport Association between 2002 and 2007 of the top 100 cargo routes; we only have aggregated data for these years **so we assume that the composition of cargo flows do not change**. The geographical variables (distance, border, common language, former colony) are taken from the CEPII (Centre d'Etudes Prospectives et d'Informations Internationales). The GDPs are expressed in real terms (the value of the dollar in 2000) and are taken from the World Bank. To account for cargo regulation we use the different versions of the CALI and not the PALI. Although an important share of cargo flows is carried by belly carriers (an estimated 60% according to the WTO Secretariat), it appears more relevant to use the CALI. Since most cargo and passenger clauses are the same the PALI and the different CALIs are highly correlated[27] because they account for air services regulation in general. However we can only use one index since including both indexes in a regression would induce co linearity bias. CALIs appear more relevant to account for the level of restrictiveness of cargo flows because they are calculated on the basis of cargo clauses of the ASAs. We built importers and exporters country fixed effects (both time invariant and time varying), in the first model we added 62 dummies and in the second model we added 336 dummies.

2. The econometric techniques performed

We performed panel OLS (Ordinary Least Squares) for the two models. In each case we tested the four main hypothesis of OLS concerning residuals:

- Residuals should have a mean of zero

[27] The correlation coefficient between the PALI and CALIs are : 0,61 with the expert first scenario, 0,89 with the expert second scenario, 0,91 with the factor analysis using seven clauses and 0,86 with the factor analysis using ten clauses.

- Residuals should be distributed according to a Gaussian law
- Residuals should be heteroscedastic
- Residuals should not be auto correlated

The first regressions verified the three first hypotheses but not the absence of autocorrelation, for both models the values of the Durbin Watson test (accounting for first order autocorrelation) were between 0,15 and 0,30. It is very likely that the autocorrelation was due to an omitted variable. To correct for this bias we included a lag variable in the model. In addition to the variables shown above we added an explaining variable $(V_{od})_{t-1}$.

Model 1 becomes:

$$\ln(V_{od})_t = \alpha + \beta_1 \ln GDP_{ot} + \beta_2 \ln GDP_{dt} + \beta_3 \ln distance_{od} + \beta_4 border + \beta_5 colony + \beta_6 common\_language + \beta_7 (CALI_{od})_t + \beta_8 \ln(V_{od})_{t-1} + \sum c_o I_o + \sum d_d E_d + u_{odt}$$

And model 2 becomes:

$$\ln(V_{od})_t = \alpha + \beta_3 \ln distance_{od} + \beta_4 border + \beta_5 colony + \beta_6 common\_language + \beta_7 (CALI_{od})_t + \beta_8 \ln(V_{od})_{t-1} + \sum c_{ot} I_{ot} + \sum d_{dt} E_{dt} + \sum e_t L_t + u_{odt}$$

In the first model the inclusion of this variable reduces the number of observations, the first and the last years of our sample could not be used but corrects the autocorrelation (with a very good Durbin Watson test, 1,67 or 1,68 even though this test is less accurate when included a lagged variable). In the case of the second model the inclusion of a lagged variable makes all the other variables insignificant (not only CALIs but also GDPs and distance) but the lagged variable that has a coefficient of one. Traffic in a given year is then only explained by traffic in the year before. **As a result we present the results of the second model in annex acknowledging that it suffers from autocorrelation bias and only presents the first model here, the one for which we corrected the different bias**.

3. The results

Here is the table summing up the results of the different regressions. The coefficients and t-statistics of the fixed effects are not shown since they have little explanatory power for our analysis.

Table 8 The econometric results

	CALI 1			CALI 2			CALI 7			CALI 10		
Variables	Coefficient	Robust Standard Error[28]	t-Statistics	Coefficient	Robust Standard Error	t-Statistics	Coefficient	Robust Standard Error	t-Statistics	Coefficient	Robust Standard Error	t-Statistics
Constant	15.71	4.14	3.79***	15.78	4.18	3.77***	15.71	4.19	3.74***	15.91	4.17	3.81***
Ln gdp departure	-0.79	0.08	-9.69***	-0.794	0.081	-9.69***	-0.79	0.08	-9.83***	-0.76	0.078	-9.72***
Ln gdp arrival	0.19	0.10	2.01**	0.19	0.10	1.95**	0.19	0.101	1.95**	0.16	0.101	1.63*
Ln distance	-0.075	0.051	-1.46	-0.81	0.051	-1.56	-0.08	0.051	-1.74*	-0.095	0.052	-1.80*
Common Language	0.054	0.019	2.77***	0.061	0.018	3.37***	0.055	0.021	2.61***	0.051	0.021	2.42**
Colony	-0.02	0.013	-1.51	-0.024	0.012	-1.97**	-0.022	0.011	-1.93**	-0.021	0.012	-1.69*
Lagged variable	0.88	0.063	13.7***	0.87	0.063	13.73***	0.87	0.063	13.72***	0.872	0.063	13.71***
CALI1	0.0017	0.001	1.79*									
CALI2				0.0025	0.0006	3.72***						
CALI7							0.0034	0.0006	5.81***			
CALI10										0.0046	0.0007	6.49***
Adjusted R-Squared	0.963			0.963			0.964			0.963		

Source: Author's calculation

The R^2 is very big since we have included a lagged variable. Almost all the variables are significant (although at different levels[29]) and have the expected sign.

Only one result differs from the gravity theory, the GDP of the exporting country has a negative sign. Two main hypotheses can explain this unusual result:

- The specificity of our database. The data we use excludes the United States has an exporting country. We only have flows going to the US and not leaving it. This includes a bias because the world largest GDP is often a "GDP arrival" value and never a "GDE departure" value. In our sample importing countries may appear richer on average which can partially explain the negative sign.
- The substitution between different modes of transportation. Large countries may have a greater share of their exports transported by maritime or land based transports.

To check for it, the same model should be tested with a larger database.

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[28] White Robust standard errors correcting for heteroscedasticity on the cross section dimension of the panel

[29] *account for significativity at 10%, ** at 5% and *** at 1%

The different CALIs have the expected positive sign and are very significant (at the 1% level for three of the potential CALIs). In annex are the graphs representing the repartition of the residuals to show they have a Gaussian type distribution. The coefficients can be interpreted as follows, $\partial \ln cargo/\partial CALI1 = 0,0017$ which means that if the CALI value of an ASA would increase by one, the natural logarithm of cargo flows would increased by 0,0017 which means cargo flows would increase by 1% (since exponential of 0,0017 is roughly equal to one). It is interesting to note that even though the coefficients are very different from the different CALIs, their exponential (the only useful number to give an economical meaning to the results) is very close (exponential of 0,0046 is also roughly equal to one).

Conclusion

The air cargo industry plays a major role in world trade. However the current bilateral framework of regulation limits the way in which carriers can provide services.

In this paper, we showed that:

- Although each bilateral cargo route was regulated by a specific agreement, one could compare different ASAs and set a common framework of analysis of air cargo regulation.
- Although air services regulation was similar for passenger and cargo services, it has a different impact on cargo operations. It is then necessary to have a specific framework of analysis for cargo.
- There is a significant positive correlation between more liberal ASAs and trade flows.

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Australia's Ministry of Foreign Affairs
www.infrastructure.gov.au/aviation/international/agreements.aspx
Canada's Ministry of Foreign Affairs
www.treaty-accord.gc.ca/TreatyList.asp?Type=1&Page=TLB
Indian Civil Aviation Department http://civilaviation.nic.in/

Technical annexes

1. Cargo provisions coded in 96 Air Services Agreements
2. Table representing Freedoms of the air
3. Handbook on how to code ASAs
4. Factor analysis of ASAs' clauses
5. Distribution of PALI and CALI Scores
6. Distribution graphs of the residuals for the different CALIs
7. Regression results for the model with time varying fixed effects and auto correlation

Annex 1 Cargo provisions coded for 96 ASAs

ASA	5th freedom?	7th freedom?	Cabotage?	Substantial Ownership and effective control?	Community of interest?	Principal place of business?	Single designation?	Multiple designation?	Cooperative agreements?	Predetermination?	Other restrictive?	Bermuda I?	Other liberal?	Free determination?	Dual approval?	Country of origin?	Dual disapproval?	Zone Pricing?	Free Pricing?	Statistics?	Wet leasing?	Change of gauge?	Intermodal rights?
Argentina - United States	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Austria - Korea																							
Austria - United States	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Australia - United Arab Emirates	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0
Australia - Germany	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Australia - Great Britain	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0
Australia - Hong Kong	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Australia - Japan	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0
Australia - Malaysia	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Australia - New Zealand	1	0	1	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0
Australia - Singapore	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Australia - United States (OLD ONE)	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1
Belgium - Japan	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Belgium - United States	1	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1
Brazil - Germany	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Brazil - United States	1	0	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	1	1	1
Canada - Germany	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Canada - France	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Canada - Great Britain	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0
Canada - Italy	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Canada - Japan	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Switzerland - Japan																							
Switzerland - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1
Chile - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1
China - Germany	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
China - France																							
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China - Japan																							
China - Korea	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
China - Luxembourg																							
China - Malaysia																							
China - Netherlands	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
China - United States (OLD ONE)	1	0	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	1	1	1	0
Costa Rica - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	1	0
Germany - United Arab Emirates	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Germany - Hong Kong	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Germany - India (OLD ONE)	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Germany - Japan	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Germany - Korea																							
Germany - Mexico	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0
Germany - Singapore																							

Germany - Thailand	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Germany - Turkey																							
Germany - Taiwan																							
Germany - United States	1	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0
Germany - South Africa																							
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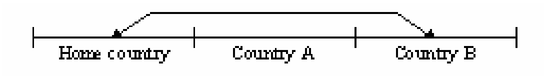
Ecuador - United States	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Spain - Hong Kong																							
Spain - United States	1	0	0	1	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0
France - United Arab Emirates	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
France - Hong Kong	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
France - India (OLD ONE)	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0
France - Japan	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
France - Korea	0	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
France - United States	1	1	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Great Britain - United Arab Emirates	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0
Great Britain - Hong Kong	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Great Britain - India (OLD ONE)	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Great Britain - Japan	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Great Britain - Korea	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Great Britain - Singapore																							
Great Britain - Turkey																							
Great Britain - United States	1	0	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0
Great Britain - South Africa	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0
Hong Kong - India																							
Hong Kong - Italy																							
Hong Kong - Japan (OLD ONE)	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Hong Kong - Korea	1	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Hong Kong - Netherlands	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Hong Kong - Philippines	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Hong Kong - Singapore	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Hong Kong - Thailand	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Hong Kong - Taiwan																							
Hong Kong - United States	1	0	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Indonesia - Japan	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Ireland - United States	1	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Italy - United Arab Emirates																							
Italy - India (OLD ONE)	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Italy - Japan	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1 0	0	0	0	0	1	0	0	0
Italy - Korea																							
Italy - United States	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0
Japan - India																							
Japan - Korea	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Japan - Malaysia	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0
Japan - Netherlands	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Japan - Norway	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Japan - New Zealand	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Japan - Philippines																							
Japan - Singapore	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Japan - Thailand	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Japan - Taiwan																							
Japan - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0		0	0	1	0	1	1	0
Korea - India	1	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Korea - Malaysia																							
Korea - Netherlands	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Korea - Singapore	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0

Korea - Taiwan																							
Korea - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1
Mexico - United States (OLD ONE)	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1
Netherlands - United Arab Emirates	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Netherlands - Israel	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Netherlands - Singapore	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0
Netherlands - United States	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1
New Zealand - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1
Peru - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1
Philippines - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	1	0	1	1
Sweden - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1
Turkey - United States	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1
European Union-United States of America	1	1	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1
Australia-United States (NEW ONE)	1	1	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1
Mexico-United States (NEW ONE)	0	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1
China-United States of America (NEW ONE)	1	0	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	1	1	1	0
Hong-Kong - Japan (NEW ONE)	1	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0
France-India (NIEW ONE)	1	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0
Great Britain - India (NEW ONE)	1	0	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Germany-India (NEW ONE)	1	0	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Italy-India (NEW ONE)	1	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0
TOTAL	**91**	**3**	**1**	**82**	**2**	**12**	**18**	**78**	**28**	**39**	**2**	**30**	**4**	**21**	**78**	**0**	**2**	**0**	**25**	**61**	**8**	**29**	**17**

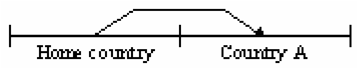
The Freedoms of the Air

First freedom- the right of an airline of the home country to fly over the territory of country A without landing

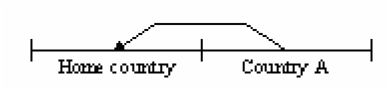


Second freedom- the right of an airline of the home country to land in country A for non-traffic purposes such as refuelling or maintenance, while en route to country B

Third freedom- the right of an airline of the home country to carry traffic (passengers, cargo or mail) from its territory to country A

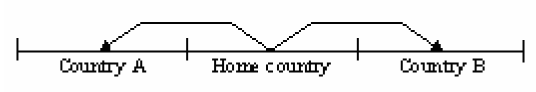


Fourth freedom- the right of an airline of the home country to carry traffic from country A to its own territory.

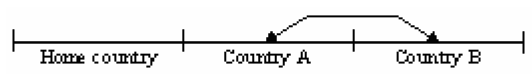


Fifth freedom- the right of an airline of the home country to carry traffic between countries A and B providing the flight originates or terminates in its own country

Sixth freedom- the right of an airline of the home country to carry traffic between two countries A and B via its own country: effectively a combination of the third and fourth freedoms

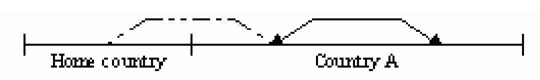


Seventh freedom- the right of an airline of homecountry to operate flights between countries A and B without the flight originating or terminating in its own country

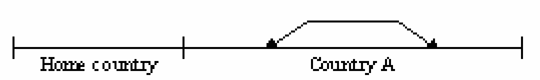


Cabotage rights- the right of an airline of the home country to carry traffic between two points within the territory of countries A and B:

consecutive cabotage rights allows a foreign airline stopping at two or more domestic points to carry domestic passengers and freight (eighth freedom)



stand-alone cabotage rights allows dedicated domestic flights by foreign carriers (ninth freedom).



Source: PC (1998).

- Grant of rights: stated vs combinatory 5th and 7th freedoms?

By definition, 5th and 7th freedoms involve more than two parties. Under these provisions, airplanes can come from or go to a third country. If countries A and B grant each other 5th and 7th freedoms to or from C, the relevant agreements to code are A-B, A-C and B-C; By consulting all these agreements, we can study the combination of rights effectively granted as opposed to the grant of rights stated in the ASAs. So far no analysis has combined the different rights. We leave this task to future research and base our work on the rights granted in each agreements (without checking that they are also granted by the other relevant agreements).

- Capacity clauses: how to code Bermuda I?

As we mentioned earlier, it is difficult to code Bermuda I provisions. We considered an agreement regulated by Bermuda I clauses if the following paragraph was in the ASA:

1) There shall be a fair and equal opportunity for the designated airlines of both Contracting States to operate the agreed services on the specified routes between their respective territories.

(2) In operating the agreed services the designated airline of each Contracting State shall take into consideration the interests of the designated airline of the other Contracting State so as not to affect unduly the services which the latter provides on the whole or part of the same routes.

(3) The agreed services provided by the designated airlines of the Contracting States shall bear close relationship to the requirements of the public for transportation on the specified routes and each shall have as its primary objective the provision, at a reasonable load factor, of capacity adequate to meet the current and reasonably anticipated requirements for the carriage of passengers, mail and/or cargo originating in or destined for the territory of the Contracting State which has designated the airline. Provision for the carriage of passengers, mail and/or cargo originating in the territory of the other Contracting State and destined for third countries or vice versa shall be made in accordance with the general principles that capacity shall be related to:

(a) the requirements for traffic originating in or destined for the territory of the Contracting State which has designated the airline;

(b) traffic requirements of the area through which the airline passes, after taking account of other transport services established by airlines of the States comprising the area; and

(c) the requirements of through airline operation

Indeed this clause is restrictive without setting predetermination of capacities.

Annex 4 Factor analysis of ASAs' clauses

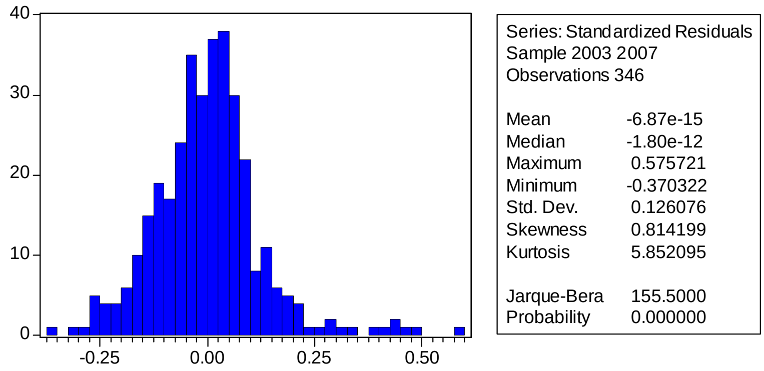
	F1	SFL1	scaled to unity ou weights normalised squared factor loadings	F2	SFL2	scaled to unity ou weights normalised squared factor loadings	F3	SFL3	scaled to unity ou weights normalised squared factor loadings	weights final
freedoms	0,1005	0,01	0,00	0,8637	0,75	0,59	0,1121	0,01	0,01	0,12
capacity	-0,3019	0,09	0,02	0,0753	0,01	0,00	0,7626	0,58	0,48	0,11
designation	0,8499	0,72	0,18	0,1045	0,01	0,01	0,0442	0,00	0,00	0,11
pricing	0,8588	0,74	0,19	0,1424	0,02	0,02	0,0338	0,00	0,00	0,12
wet	0,4051	0,16	0,04	0,4714	0,22	0,18	-0,1227	0,02	0,01	0,06
intermodal	0,8416	0,71	0,18	-0,0141	0,00	0,00	-0,0314	0,00	0,00	0,11
change	0,5476	0,30	0,08	-0,4976	0,25	0,20	-0,0537	0,00	0,00	0,09
statistics	0,7239	0,52	0,13	-0,0708	0,01	0,00	-0,09	0,01	0,01	0,08
cooperative	0,7587	0,58	0,15	0,0597	0,00	0,00	-0,0148	0,00	0,00	0,09
withholding	0,3057	0,09	0,02	0,0714	0,01	0,00	0,7629	0,58	0,48	0,11
		3,93	0,61		1,27	0,20		1,21	0,19	
		sum of squared factors loading 1	normalized sum of square factors loading		sum of squared factors loading 2	normalized sum of square factors loading		sum of squared factors loading 3	normalized sum of square factors loading	
		sum of squared factors loading 1+2+3	6,40							
freedoms	0,2223	0,0494	0,02	0,5636	0,3176	0,24				0,09
capacity	-0,3487	0,1216	0,04	0,7076	0,5007	0,38				0,15
designation	0,8278	0,6853	0,23	0,0984	0,0097	0,01				0,16
pricing	0,8934	0,7982	0,27	0,0692	0,0048	0,00				0,19
statistics	0,7397	0,5472	0,19	-0,171	0,0292	0,02				0,14
cooperative	0,8094	0,6551	0,22	-0,0151	0,0002	0,00				0,15
withholding	0,2925	0,0856	0,03	0,672	0,4516	0,34				0,13
		2,94	0,69		1,3139	0,31				
		sum of squared factors loading 1			sum of squared factors loading 2					
		sum of squared factors loading 1+2+3	4,2561							

Annex 5 Distribution of PALI and CALI scores

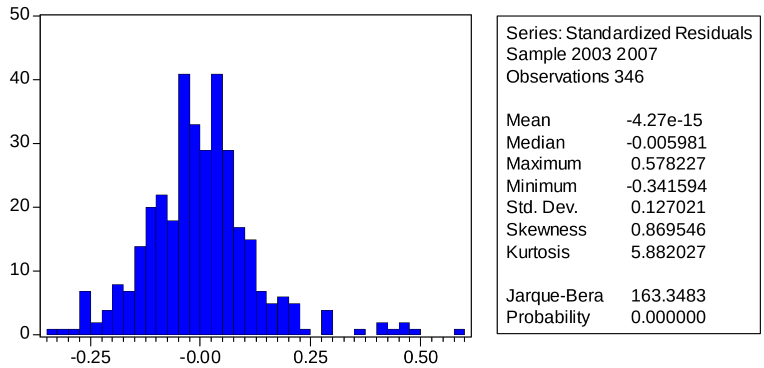
ASA	ALI	Nb ASA ALI	CALI (P.Latrille)	Nb ASA CALI (P.Latrille)	CALI (Experts 2nd scenario)	Nb ASA CALI (Experts 2nd scenario)	CALI FA 10 clauses	Nb ASA CALI FA 10	CALI FA 7 clauses	Nb ASA CALI FA 7
Argentina - United States	11	4	16	37	15	4	11,5	4	16,5	3
Austria - United States	25	3	16	37	24	2	21,25	1	31,625	2
Australia - United Arab Emirates	18	14	16	37	17	4	13,5	1	19	1
Australia - Germany	14	19	16	37	18	19	10	14	13,25	18
Australia - Great Britain	14	19	16	37	18	19	15,5	6	13,25	18
Australia - Hong Kong	18	14	26	12	19	12	13	10	16	9
Australia - Japan	10	15	10	15	16	1	7,5	9	10	1
Australia - Malaysia	6	7	10	15	10	7	2	6	1,5	7
Australia - New Zealand	39	1	33	1	33	1	27,75	1	38,75	1
Australia - Singapore	6	7	10	15	10	7	2	6	1,5	7
Australia - United States (OLD ONE)	19	2	18	21	31	2	34,5	1	41	11
Belgium - Japan	14	19	16	37	18	19	10	14	13,25	18
Belgium - United States	28	2	18	21	27	4	30,25	1	39,125	2
Brazil - Germany	14	19	16	37	18	19	10	14	13,25	18
Brazil - United States	14	19	18	21	21	1	29	2	24	1
Canada - Germany	10	15	16	37	14	14	7,5	9	9,5	8
Canada - France	14	19	16	37	18	19	10	14	13,25	18
Canada - Great Britain	10	15	16	37	14	14	13	10	9,5	8
Canada - Italy	10	15	16	37	14	14	7,5	9	9,5	8
Canada - Japan	14	19	16	37	18	19	10	14	13,25	18
Switzerland - United States	30	12	18	21	28	9	37	7	41	11
Chile - United States	30	12	18	21	28	9	31,5	1	41	11
China - Germany	11	4	10	15	15	4	8,5	1	12,25	1
China - Great Britain	6	7	10	15	10	7	2	6	1,5	7
China – Italy	7	2	10	15	11	2	6	1	8,5	2
China – Korea	10	15	16	37	14	14	7,5	9	9,5	8
China - Netherlands	6	7	14	1	10	7	2	6	1,5	7
China - United States (OLD ONE)	13	5	18	21	20	3	20,5	2	17	4
Costa Rica - United States	30	12	18	21	28	9	32,5	1	41	11
Germany - United Arab Emirates	4	1	6	2	4	1	5,5	1	8	1
Germany - Hong Kong	18	14	26	12	19	12	13	10	16	9
Germany - India (OLD ONE)	6	7	10	15	10	7	2	6	1,5	7
Germany - Japan	10	15	10	15	14	14	4,5	4	5,25	5
Germany - Mexico	7	2	10	15	11	2	11,5	4	8,5	2
Germany - Thailand	10	15	16	37	14	14	7,5	9	9,5	8
Germany - United States	14	19	18	21	20	3	24,5	1	28,75	1
Denmark - United States	30	12	18	21	28	9	37	7	41	11
Ecuador - Netherlands	11	4	16	37	15	4	11,5	4	16,5	3
Ecuador - United States	11	4	16	37	15	4	11,5	4	16,5	3
Spain - United States	18	14	18	21	22	3	24	1	27,75	1
France - United Arab Emirates	10	15	16	37	14	14	7,5	9	9,5	8
France - Hong Kong	18	14	26	12	19	12	13	10	16	9
France - India (OLD ONE)	6	7	10	15	10	7	7,5	9	1,5	7
France - Japan	15	3	16	37	19	12	14	3	20,25	3
France - Korea	0	1	0	1	0	1	0	1	0	1
France - United States	30	12	32	3	38	1	29	2	42,5	3
Great Britain - United Arab Emirates	14	19	16	37	18	19	15,5	6	13,25	18
Great Britain - Hong Kong	18	14	26	12	19	12	13	10	16	9
Great Britain - India (OLD ONE)	10	15	16	37	14	14	7,5	9	9,5	8
Great Britain - Japan	14	19	16	37	18	19	10	14	13,25	18
Great Britain - Korea	14	19	16	37	18	19	10	14	13,25	18
Great Britain - United States	13	5	16	37	17	4	18,25	2	18,375	1
Great Britain - South Africa	18	14	16	37	18	19	15,5	6	13,25	18
Hong Kong - Japan (OLD ONE)	18	14	26	12	19	12	13	10	16	9
Hong Kong - Korea	22	1	26	12	23	1	15,5	6	19,75	1
Hong Kong - Netherlands	18	14	26	12	19	12	13	10	16	9
Hong Kong - Philippines	18	14	26	12	19	12	13	10	16	9
Hong Kong - Singapore	18	14	26	12	19	12	13	10	16	9
Hong Kong - Thailand	18	14	26	12	19	12	13	10	16	9
Hong Kong - United States	21	1	26	12	22	3	18,25	2	24,875	1
Indonesia - Japan	10	15	10	15	14	14	4,5	4	5,25	5
Ireland - United States	28	2	18	21	27	4	25,75	1	39,125	2
Italy - India (OLD ONE)	6	7	10	15	10	7	2	6	1,5	7
Italy – Japan	10	15	10	15	14	14	4,5	4	5,25	5
Italy - United States	19	2	6	2	12	1	20	1	22,5	1

Japan - Korea	14	19	16	37	18	19	10	14	13,25	18
Japan - Malaysia	14	19	16	37	18	19	15,5	6	13,25	18
Japan - Netherlands	14	19	16	37	18	19	10	14	13,25	18
Japan - Norway	14	19	16	37	18	19	10	14	13,25	18
Japan - New Zealand	14	19	16	37	18	19	10	14	13,25	18
Japan - Singapore	14	19	16	37	18	19	10	14	13,25	18
Japan - Thailand	15	3	16	37	19	12	14	3	20,25	3
Japan - United States	26	2	18	21	31	2	35,5	1	41	11
Korea – India	10	15	16	37	14	14	7,5	9	9,5	8
Korea - Netherlands	15	3	16	37	19	12	14	3	20,25	3
Korea - Singapore	10	15	10	15	14	14	10	14	5,25	5
Korea - United States	30	12	18	21	28	9	37	7	41	11
Mexico - United States (OLD ONE)	18	14	2	1	14	14	29,5	1	31,5	1
Netherlands - United Arab Emirates	14	19	16	37	18	19	10	14	13,25	18
Netherlands - Israel	10	15	10	15	14	14	4,5	4	5,25	5
Netherlands – Singapore	14	19	16	37	18	19	15,5	6	13,25	18
Netherlands - United States	25	3	16	37	27	4	28,75	1	31,625	2
New Zealand - United States	30	12	18	21	28	9	37	7	41	11
Peru - United States	30	12	18	21	28	9	37	7	41	11
Philippines - United States	29	1	18	21	27	4	33	1	34	1
Sweden - United States	30	12	18	21	28	9	37	7	41	11
Turkey - United States	30	12	18	21	28	9	37	7	41	11
European Union-United States of America	30	12	32	3	41	2	36,5	2	42,5	3
Australia-United States (NEW ONE)	30	12	32	3	41	2	36,5	2	42,5	3
Mexico-United States (NEW ONE)	18	14	8	1	18	19	35	1	39,5	1
China-United States of America (NEW ONE)	13	5	18	21	20	3	20,5	2	17	4
Hong-Kong - Japan (NEW ONE)	26	2	26	12	26	1	18	1	23,5	1
France-India (NIEW ONE)	25	3	25	1	22	3	26,25	1	29,75	1
Great Britain - India (NEW ONE)	13	5	18	21	17	4	12	2	17	4
Germany-India (NEW ONE)	13	5	18	21	17	4	12	2	17	4
Italy-India (NEW ONE)	10	15	16	37	24	2	18,5	1	26,5	1
Minimum	0		0		0		0		0	
Maximum	39		33		41		37		42,5	
Mean	16,40		16,90		19,14		16,35		19,26	
Variance	61,74		37,55		49,30		113,23		157,15	
standard error	7,86		6,13		7,02		10,64		12,54	

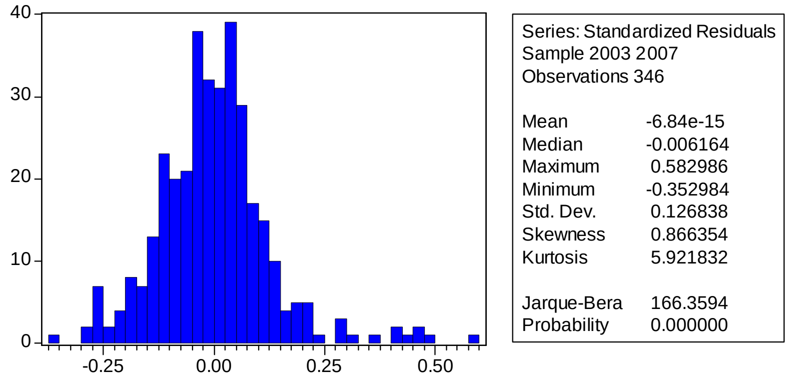
Annex 6 Distribution graphs of the residuals for the different CALIs



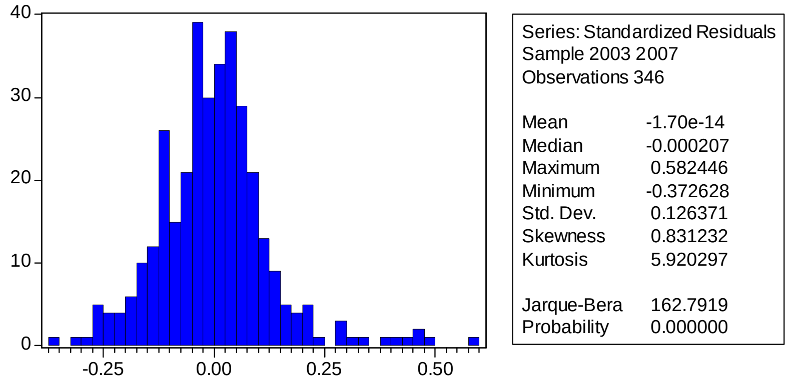
For CALI 10



For CALI 1



For CALI 2



For CALI 7

Annex 7 Regression results for the model with time varying fixed effects and auto correlation

Dependent Variable: LN_TRAFFIC
Method: Panel Least Squares
White cross-section standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic
C	8.333143	0.525610	15.85422
LN_DISTANCE	-0.593811	0.068598	-8.656379
CALI_1	**0.010960**	**0.006081**	**1.802343**
COLONY	-0.172401	0.058535	-2.945252
COMMON_LANGUAGE	0.265488	0.086707	3.061886

R-squared	0.829336
Adjusted R-squared	0.575135
Durbin-Watson stat	**0.180040**

Dependent Variable: LN_TRAFFIC
Method: Panel Least Squares
White cross-section standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic
C	8.613747	0.587225	14.66856
LN_DISTANCE	-0.616570	0.079939	-7.713047
CALI_2	**0.008513**	**0.004683**	**1.817738**
COLONY	-0.170549	0.072897	-2.339597
COMMON_LANGUAGE	0.284313	0.092130	3.085982
R-squared	0.829049		
Adjusted R-squared	0.574422		
Durbin-Watson stat	**0.190028**		

Dependent Variable: LN_TRAFFIC
Method: Panel Least Squares
White cross-section standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic
C	8.767821	0.605712	14.47522
LN_DISTANCE	-0.639378	0.079383	-8.054342
CALI_7	**0.013225**	**0.004272**	**3.095400**
COLONY	-0.172922	0.070299	-2.459820
COMMON_LANGUAGE	0.255959	0.109594	2.335521

R-squared	0.833474
Adjusted R-squared	0.585439
Durbin-Watson stat	**0.196193**

Dependent Variable: LN_TRAFFIC
Method: Panel Least Squares

Variable	Coefficient	Std. Error	t-Statistic
C	8.915452	0.684111	13.03218
LN_DISTANCE	-0.655153	0.088536	-7.399838
CALI_10	**0.015331**	**0.005524**	**2.775284**
COLONY	-0.177401	0.068971	-2.572098
COMMON_LANGUAGE	0.256852	0.124021	2.071032

R-squared	0.832696
Adjusted R-squared	0.583500
Durbin-Watson stat	**0.200330**