Overlapping Free Trade Agreements and International Trade: A network Approach

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Abstract

In our work we analyze the effect on trade of the hub and spoke nature of FTAS. Differently from previous analysis we consider also what is the effect of the country position in the FTAs network on the bilateral trade of the country. We analyze in depth the global network of FTAs, focusing in particular in the evolution of it in the last fifteen years. We then use a panel dataset covering 1960-2010 to investigate the effects of the position of a country in the FTAs network on bilateral trade. Our results show that hubs export more than the other countries involved in a FTA, how not all the spokes are the same. An increase in the number of spokes which are not linked between them has, on average, a negative effect on trade of the hub, meaning that to sign FTAs with every country it is not the optimal strategy to increase trade. However, if we consider how new FTAs change the relative position of a country, we can observe that, if new

FTAs bring the country to become more central or more free in the network, this new agreements have a strong positive and significant effect on trade.

1 Introduction

The last twenty years have witnessed the proliferation of the number of trade agreements all over the world. According to the World Trade Organization (WTO) there are 275 trade agreements now in force of which almost 70% are free trade agreements (FTAs), (WTO 2015). Only in the last five years 53 new trade agreements have been signed. Only few countries are not part of any preferential agreement; counties as Mexico and Singapore have more than duplicate their number of FTAs in ten years. According to the WTO more than half of the global commerce is conducted under the rule of some preferential agreement; the rest is mainly trade between EU, US, Japan and China which, until now, do not have any preferential trade agreement.

This surge in the numbers of "crisscrossing" trade agreements has created what Bhagwati (2002) and Baldwin (2006) has called the spaghetti bowl which define a very complex interaction between different and often overlapping free trade agreements. This complex framework may turn some countries into hubs and some others into spokes according to the number of FTAs every country has. As an example, Israel has a FTA with the European Union and the US but, until now, EU and US has no FTA between them. In our example Israel is the hub while EU and US are the spokes. In this specific case EU is a spoke but if we considered EU, Israel and Morocco, the European Union has a FTA with both countries, while Israel and Morocco do not have one between them. Hence, in this case, EU is the hub while Israel and Morocco are the spokes.

In the near future it is likely that the picture will become even more complex. The possible entry into force of the Trans-Pacific Partnership (TPP)between Us-Japan, of the Transatlantic Trade and Investment Partnership (TTIP) the US-EU agreement and of the Regional Comprehensive Economic Partnership (RCEP) the ASEAN plus 3 with India Australia and New Zealand agreement is going to deeply change the general structure of the FTA network creating big mega regions.

The concept of hub and spokes was developed first in transport literature and introduced in international trade by Wonnacott (1975) as a "two-sided triangle" in which the hub and the spokes are the nodes. In his work Wonnacott considered a hub as arising from the decision of an outside country to form a bilateral agreement with only one member of a multimember preexisting RTA. The country which is inside this imaginary triangle is called the hub. This definition of "hub" is too narrow. We observe several different situation in which a hub and spokes system may arise and, in some case not only the countries search a strategic hub position but also group of countries, already part of the same FTA, jointly negotiate free trade agreement with third countries in search of better hub position.

Several reasons have been put forward to explain this phenomenon. The first is the problem connected to the negotiation of multilateral liberalization in the WTO framework with a large number of diverse members respect to a regional or even bilateral agreement. Moreover since trade agreements have in general deepened including service, investment and standards, the cost of negotiation have increased. The second is connected with the so called "Domino effect" Baldwin (1993). If the number of countries which are part of an agreements increases, the countries outside this agreement will face an increasing discrimination, which in principle will push them to sign new agreements: the "fear" of exclusion can force reluctant countries to engage in a FTA even if this wouldn't be their first decision.

Given this complex picture our aim is to study the effects of overlapping free trade agreements on bilateral trade. The effects of being a hub on bilateral trade is not clear. On one hand, an hub country, respect to a non-hub one, will gain preferential access to more markets facing an improvement in its export competitiveness. If this improved competitiveness translates into more export, the hub country will face an increase in its bilateral export. On the other hand, following Lloyd and MacLaren (2004) in a hub and spoke system both importer and exporter deal with a complex sets of rules of origin that can increase costs connected with the verification of this rules. If this costs are high enough, trade creation can be restrained and being a hub cannot have a positive effect on the bilateral export of the hub country.

The effects of being an hub for a country has been deeply analyzed in the trade literature, with mixed evidence. We confine to contributions which consider the effect on trade volume. As for the theoretical literature, the first work are the one of Wonnacott (1982, 1996) and Kowalsky and Wonnocott (1992), where they analyze the trade effect of the NAFTA agreement on Canada. Daltas et al. (2006) developing a simple model of comparative advantage conclude that, due to the decrease in trade among the two spokes, the hub will increase trade with both the spokes. For what concern the empirical studies, the main contributions are De Benedictis et alii (2005), who analyze the effects of the east enlargement of the European union in a gravity model, Deltas et alli (2012) on the hub and spokes system formed by Israel, USA and Europe, Lee et al alii (2008) and Alba et alii (2010), who use a panel of bilateral trade from 1960 to 1999 to investigate the average effects of being an hub on the bilateral trade of the countries. The results show a mixed evidence depending on the data considered.

Respect to this works, in our analysis, we try to investigate not only the effect of being an hub on bilateral trade, but also what is the effect of the country position in the global FTAs network. So far the importance of the hub's position in the overall system of free trade agreement has not be investigated and, to our knowledge, our paper is one of the first to empirically explore the FTAs network effect on trade.

Using network is a natural way to visualize this complex system of overlapping agreement. The power of the country in the network derives from its ties, countries with more and better connections may enjoy significant increase in bilateral trade. We suppose that the trade volume between two countries does not depend only on the possible agreement between the two but also on the larger network of FTAs each one of them is connected to.

In our work, first of all, we analyze in depth the global network of FTAs, focusing in particular in the evolution of it in the last fifteen years. Then in the second part we consider the effects of the FTAs network on bilateral trade. We developed a gravity model analysis in which we account for multilateral resistance whit country and time fixed effects. We follow the Baier and Bergstrand (2007) econometric approach who extend the Anderson and van Wincoop (2003) model to panel data to consider unobservable time- varying resistance terms. We add to this framework four variables: an FTA-hub variable, betweenness centralities, aggregate constrain and the number of a country's neighbor in the FTA network which are not connected to the other country involved in the bilateral trade. This variables jointly try to assess not only if a country is a hub but his position in the general network of FTAs. We run pooled OLS and we show that the error terms are serially correlated and the violation of the assumption of strict exogeneity. We then handle the likely presence of endogeneity between FTA variable and time-invariant variables using panel data model with fixed effect.

The rest of the paper is organized as follows. Section 2 defines and discusses the features of a hub and spoke system in a framework of overlapping FTAs. Section 3 describes the characteristic of the FTAs Network and compared the network in 2000 and in 2015. Section 4 shows the data and the methodology used in the empirical analysis. Section 5 presents the main results and, finally section 6 concludes our work

2 A Hub and Spoke System

Following Alba et alii (2010)[1]: "Suppose that country i has bilateral FTAs with m countries with m strictly greater than one and country j is one of the m countries. Country j is defined as a spoke country if it has bilateral FTAs with $m-2$ or less countries among the m countries that have bilateral FTAs with country i. Country i is defined as a hub country if it has at least two spokes."

A hub can arise in several different ways. As Wonnacott (1996) pointed out, it can be formed when a country which is a member of a FTA forms a new bilateral FTA with a country which is not part of the original one. It can be formed when a country, simultaneously, negotiates bilateral agreements with a number of countries, for example Singapore, or when it entered as a member in two different multimember FTAs, as Mexico. Moreover, we can have a structure of plurilateral hubs and plurilateral spokes when we have multimember FTA. As an example of multiple spokes, we can consider the US, which are member of NAFTA and have signed a multimember spokes agreement with the CACM, the Central America Common Market. This "multi-spoke" strategy in the last years has been followed by individual

[1]Alba, Joseph D., Hur, Jung,and Donghyun Park. "Effects of Hub-and-Spoke Free Trade Agreements on Trade: A Panel Data Analysis." *World Development 38, no. 8 (2010) pag.9*

states as Mexico, Chile and Singapore and also by multilateral FTA as the EFTA and the MERCOSUR which are used to negotiate as a party with other countries or FTA.

Against this background, we are interested in asking if being a hub, rather than being a spoke, can increase or decrease the trade of the country and its welfare. The answer to this question is not as simple as one might expect. There is little clear empirical support to an unambiguous answer since there are forces that push to an increase of the bilateral trade of a hub while, there are others which push to the opposite direction.

Spokes have less market access than hubs since a hub has preferential agreements with all the spokes, while the spokes have a preferential agreement only with the hub. If a hub adds new spokes, the preferential conditions previously enjoyed by the old spokes may diminish because of the increasing competition between the spokes or because the new ones can negotiate better conditions then the previous one. For a spoke, an intersecting hub and spokes system is the same that in a non-intersecting FTA except for the increasing competition. For what concern the hub, its bilateral trade can increase since a hub has preferential access to more markets so it can improve his competitiveness. On the other hand, in a multi-spokes system the tariff administration of the hub is more complicated since there are three or more columns in the tariff structure and every hub has to face multiple and usually complex sets of rules of origin and a higher level of rent-seeking waste. There will be a waste of time and effort which can increase the trade costs and potentially decrease trade.

To better analyze the final effects of an hub and spokes system we can consider what is the overall effect of adding a new spoke on the bilateral export between the hub and two spokes.

Let us consider three countries A, B and C which trade with one other. If A and B sign a free trade agreement, we expect that trade between the two countries will increase due to the preferential tariff treatment. Suppose now that A chooses to sign a new trade agreement with C, becoming a hub while B and C turn to become spokes. First of all we will expect that, due to the preferential tariff treatment trade between A and C will increase. How does the new agreement between A and C affect trade between A and B? There may be two simultaneous opposite effects. A's export to B can decrease because of the trade diversion of A's export to C caused by the new preferential tariff treatment between A and C. But trade between A and B can also increase, if the FTA between A and C would divert C's export from country B to A, letting room to increase trade between the hub and the old spoke. So, in this case, the hub country A would increase the volume of its trade with country B.

To clarify this statement we can consider the previous case of the hub and spoke system between Israel, USA and the European Union. When in 2000 the EU-Israel Association agreement entered into force Israel already have signed a free trade agreement with the US. Since the EU and the US do not have an agreement, Israel is the hub and EU and US are the spokes. After the new EU-Israel agreement, the export of Israel to EU has increased since Israel would enjoy a price advantage respect to US. Israel will face lower tariffs and non-tariff barrier which reduce the relative price of Israeli goods relative to Americans one. For what concern the Israel-US trade, there are two opposite effects. Israel can decrease its export to US if the new FTA will divert its export from the American market to the European one or it can increase its export to US if the European export will be diverted from the American market to the Israeli one due to the lower tariffs.

In our example, while it is clear that the trade between the hub and the new spoke will increase, we have no a priori answer about what could happen to the export from the hub to the old spoke. For this reason the average export of a hub in a FTA could rise or fall depending of the strength of the two forces. If two or more hub and spoke system intersect this discrimination is multilayered and the interaction between this pro-trade and anti-trade effects becomes even more complicated.

3 Network Analysis

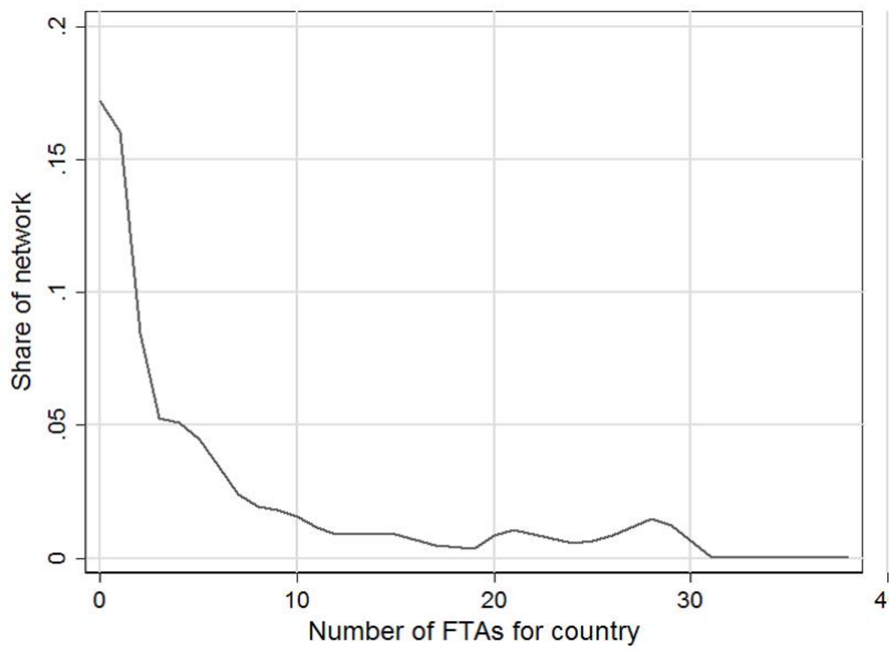
The Network analysis is concerned with the investigation of the structure of relations between actors. In our contest the presence of a link g_{ij} represent the existence of a FTA agreement between country i and country j. Given this basic framework we have an unweighted network since the relation is dichotomous.

To develop our network analysis we will use the WTO database on RTAs and the Baier and Bergstrand database 2013. From the list we eliminate the EU enlargement treaties, the Global System of Trade Preferences among Developing Countries (1988) and the Protocol on Trade Negotiations (1971) because they are very different from the others treaties considered and cannot be easily compared to others FTAs. We disaggregate the agreements according to the bilateral ties or dyads, for example the NAFTA agreement will be represented as three bilateral links connecting USA, Canada and Mexico between them. In our final dataset we consider 154 countries. For the sake of tractability in this part of our analysis we consider the EU as a single actor. It is not incorrect to do so because since 1958, the Commission of the European Communities has negotiated all trade agreements on behalf of the member states. Moreover, the EU is itself a member of the WTO, the only supranational association to hold this status. So every free trade agreement signed by EU is binding for all the states which are part of it. Since we are interested in the impressive surge of FTAs in the recent years we compared the FTAs network in 2000 and the FTAs network in 2015. In both networks, to improve the clarity of graphs, we choose not to represent graphically the links which symbolize the agreement between EU and the Overseas Countries and Territories. .We consider this agreements in the numerical analysis of the network.

If we consider the number of agreements we can see that the most involved actor in our network in 2000 is the EU, followed by the EFTAs country (Island, Norway, Liechtenstein and Switzerland) as well as Morocco, Tunisia and the Czech Republic. In 2015 the first position remain stable with EU and the EFTA countries, while we observe in the last position Chile, Turkey and Singapore. United States only rank twelfth.

To check how tight are two networks connected we consider the network density, i.e. what percentage of possible links is actually covered by a tie. Out of maximum number of 11,858 possible bilateral relations covered by a FTAs only 4.6% are covered in 2000. However 15 years later the network density surge to 9.2% confirming the magnitude of the observed increase in FTAs.

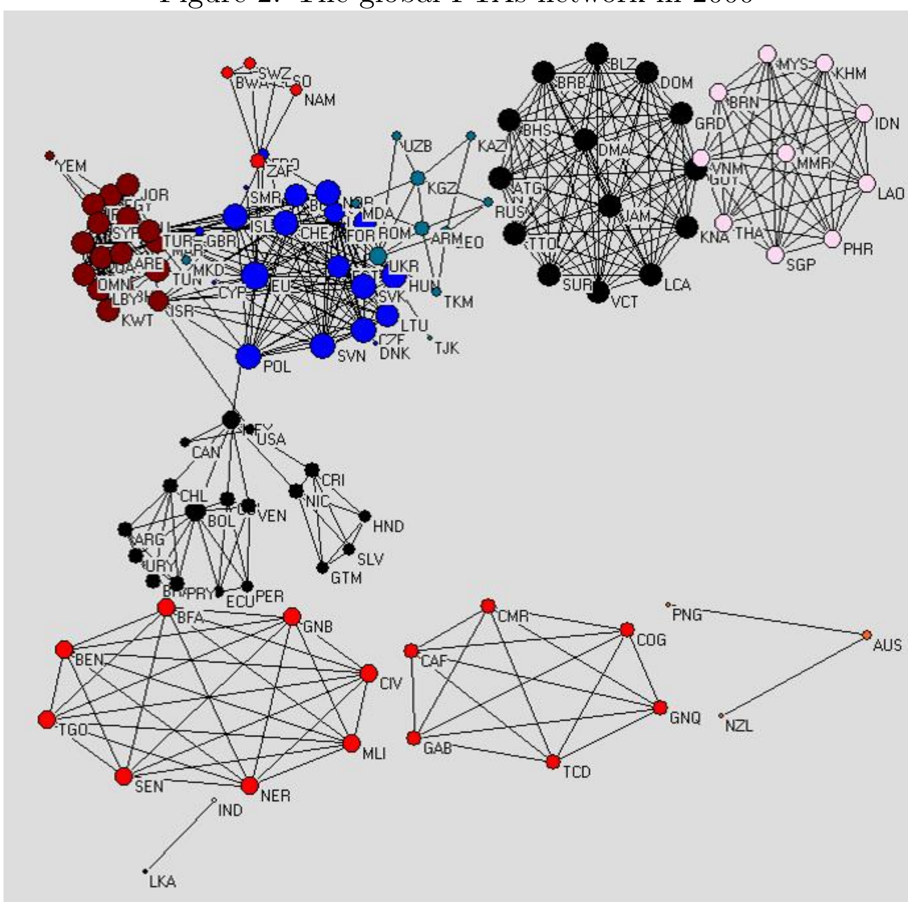
Figure 1: The distribution of FTAs in the network 2015



Source: Authors' estimation

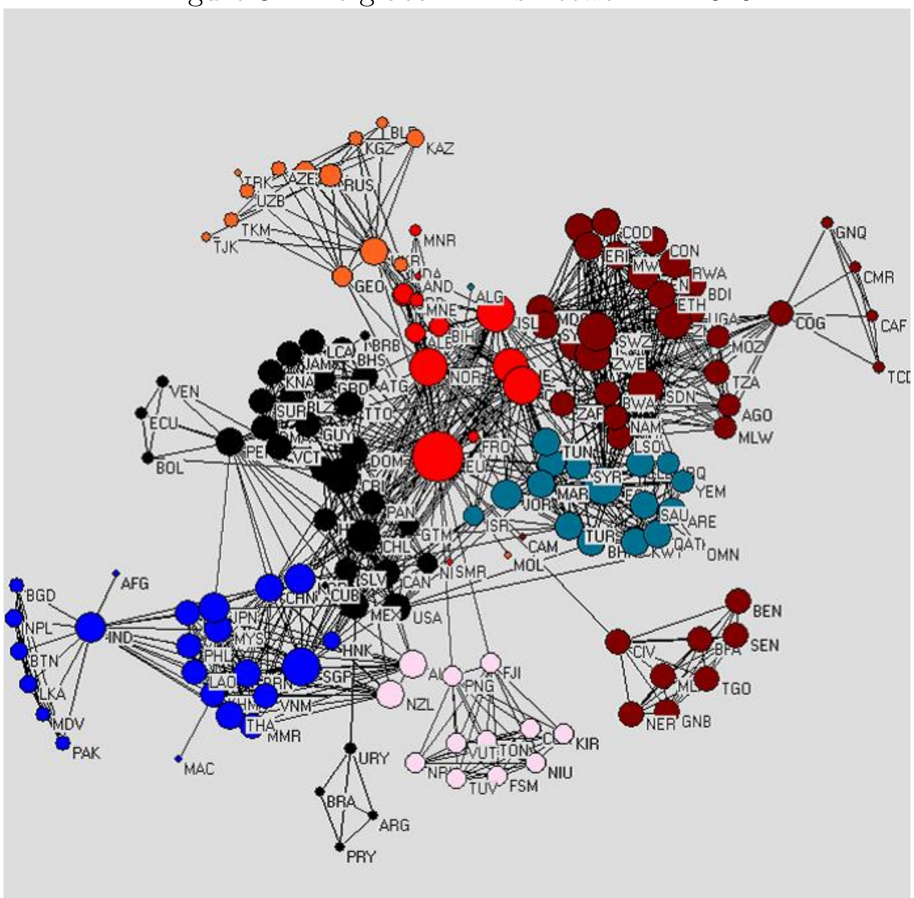
We now move to consider the distribution of the FTAs in the network. Were the FTAs randomly distributed between the countries, we would expect to find only a small share of countries with a very small or a very large amount of FTAs. This is not what we found. The distribution of FTAs within the network for both 2000 and 2015 is similar to a power law curves in which we have that few countries have a huge number of FTAs while the bulk has few agreements. Hence, we have few countries which are hubs and dominate the network. We can explain this preferential attachment process considering that if some countries have a huge number of agreements new comers will find profitable to set FTAs with well-connected countries to enter in a good position. Figure 2 below depicts the global FTAs network in 2000. We use a force-direct algorithm which equalize the length of the edges. We color-code for the different geographical area and we weight the size of each country's circle by the number of neighbors every country has, larger circle representing more neighbors.

Figure 2: The global FTAs network in 2000



Source: Authors' estimation

Figure 3: The global FTAs network in 2015



Source: Authors' estimation

Figure 3 shows the network in 2015. As we can see comparing the two figures, from 2000 to 2015 the FTAs network changes substantially. While in 2000 the graph is organized in separate components except for Europe and North Africa and Middle East, suggesting that the global system of FTAs is organized mainly around multilateral regional agreements, in 2015 all the countries are directly or indirectly mutually connected.

In 2015 the FTAs network is still organized in regional cluster with the European Union, which is the one with the highest number of neighbors, in the middle as pivoting point. As we can see from the graph, most of the clusters correspond to specific regions which are linked by few countries which act as a bridge, connecting different multilateral regional agreements. We can see a notable exception to this statement for the countries of East Asia and America which are forming a larger cluster and are moving to create a mega-regional FTAs.

We now move to consider centrality measures in a network. There are a huge number of different measures for centrality, each considering different nodes' characteristic to assess what is the meaning of importance in a network. In our work, we consider degree, betweenness and eigenvector centrality. The degree centrality is simply the number of neighbors that a node has in the network. Betweenness centrality is the ratio between the number of shortest path which flows through the given node, divided by the total number of path which flows through that node and it measures how much a node links otherwise unconnected parts of the network. Eigenvector centrality is a measure of the influence of a node in the network and is a core proportional to the sum of the scores of his neighbors. It accounts not only for the number of path a node has, but also for the importance of the nodes it is connected with.

As we can see from the table, we confirm the importance of the EU in the global FTAs network. However, we can notice that the comparatively low

Table 1: Centrality in the network

Degree centrality		**Betweenness centrality**		**Eigenvector centrality**	
EU	80	EU	0.4601	Swaziland	0.2388
Egypt	39	India	0.0894	Egypt	0.2377
Chile	34	Ivory Coast	0.0878	Mauritius	0.2269
Sudan	34	Singapore	0.0783	Zimbabwe	0.2267
Libya	33	Korea	0.0777	EU	0.2254
Switzerland	32	Egypt	0.0603	Zambia	0.216
Island	31	Papua New Guinea	0.0594	Sudan	0.2033
Norway	31	Island	0.0588	Burundi	0.1785
Liechtenstein	30	Mexico	0.0555	Kenya	0.1785
Swaziland	30	Congo	0.0512	Libya	0.1657
Turkey	30	Norway	0.0497	Djibouti	0.1548

Source: Authors' calculation

eigenvector rank for the EU (only 5) underlines that many of the EU's agreements have been concluded with minor trading partners. Other somewhat counter-intuitive results, like the high ranking of North African countries such as Egypt, Libya[2] and Sudan, can be explained by the fact that these countries are members of several multi-party (in contrast to bilateral) FTAs which place them centrally in certain regions without, however, reaching global relevance. We can see also from the eigen-vector centrality that, except Europe, countries with high values are newcomers. Since they entered later, they probably preferred to sign agreement with countries already highly involved

[2]We consider Lybia before the militar cup in 2014

in the FTAs network, confirming the presence of a preferential attachment process

4 Data and Econometric

In this section we describe briefly the data we are going to use for the gravity equation. Following Baier and Bergstrand (2007), we consider 96 potential trading partners over 5-year intervals beginning in 1960 and ending in 2010. Differently from their work, we choose to add the post-2000 period because we would like to analyze also the increasing surge of new FTAs in this period.

The nominal bilateral flows are from the IMF's Direction of Trade Statistics, we scaled these data by the exporter GDP deflators to create real trade flows. The exporter and the importer GDPs are from the World Bank's World Development Indicators and they are scaled by the GDP deflators to generated real GDPs. Bilateral distance, adjacency and common language dummies are obtained by the CEPII gravity dataset by Head and Mayer(2010). The data for the dummies FTA and HUB are from the Baier and Bergstrand database and the WTO database on RTAs, we use those data also to calculate the network variables. For our analysis we construct our key variables using the open source network analysis program Pajek: betweenness centralities, aggregate constrain and the number of a country's neighbors in the FTA network which are not connected to the other country involved in the bilateral trade, jointly this three variables try to assess not only if a country is a hub but its position in the general network of FTAs. Betweenness centrality is an indicator which measures the connectivity of a node's neighbors. It is equal to the number of shortest path from all vertices to all the other links that pass through that node. Betweenness centrality of node v is equal to $g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st(v)}}{\sigma_{st}}$ with σ_{st} equal to the total number of shortest path from node s to node t and $\sigma_{st(v)}$ equal to the total number of shortest path from node s to node t which pass through v. In our setting betweenness centrality measures the number of countries that a country connects indirectly through their direct FTAs links.

We add betweenness centrality to our estimate to control if a country position in the FTA's network can offer advantages for local bridge countries with respect to the others. We suppose that gatekeepers countries can increase their trade connecting otherwise unconnected countries.

We also suppose that to consider the network effects of FTA's on trade, it is important not only to account for the characteristics of the links a country has but also for the characteristics of the links of its neighbors. If a country is connected via free trade agreement with countries which are already highly connected between them, it will lose some of its brokerage opportunity. To check this specific effects we include an aggregate constrain measure. Aggregate constrain is a summary measure which indicates the extent to which a country, in the FTAs network, is connected with others country which are already well connected between them. It gives an idea about how much freedom you have in your relation within the network, since it measures how many potential alternatives a country has, given the structure of the network. Network constrain vary according to three different dimension: size, density and hierarchy. The constrain is high if a country has a FTAs with few other countries or if the countries it is connected with are strongly connected to one other, either directly or through a central hub country.

In line with Baier and Bergstrand (2007), we add two lags for the FTAs variable, this because generally FTAs are phased in over 5 to 10 years and so they will not become fully effective before this time period. We also try to add up to five lags in the equation but after fifteen years the specific effects of a FTA tend to become insignificant. We account for the omitted variable bias introduced by ignoring the relative prices in the gravity equation Anderson and van Wincoop (2003) including country-and-time dummy variables to value the multilateral price term.

The specification of our log-linearized gravity model is:

$$lnT_t^{ij} = \alpha_0 + \beta X_t^{ij} + \mu_0 FTA_t^{ij} + \mu_1 HUB_t^{ij} + \mu_2 VNV_t^{ij} + \mu_3 BC_t^i + \mu_4 AG_t^i + D_t^i + Dum_t^i \xi_t^{ij} \quad (1)$$

Where T_t^{ij} is the non-zero exports of country i to country j at time t scaled by country i's GDP deflator. The vector X_t^{ij} includes the log of real GDP of the exporter and the importer country, the log of the distance between the two countries and the dummy variables for common language and adjacency. VNV_t^{ij} represents the neighbor of i in the network of FTAs which are not neighbor of j in time t, BC_t^i is the betweenness centrality of i in time t and AG_t^i is the aggregate constrain of country i in time t. We also include up to three lags of FTA_t^{ij} in the estimation and the dummy variables Dum_t^i and Dum_t^j to assess the multilateral price terms.

At first, we estimate our gravity equation adjusting for serial correlation. Even if we adjust for serial correlation, however, our OLS adjusted estimation violates the assumption of strict exogeneity resulting in a biased estimation of the coefficients.

The presence of potential endogeneity, which can seriously bias the final results, is a standard problem of the gravity model. The error term ϵ_{ij} may include unobservable policy related barriers which tend to reduce trade between the countries, that are not included in the gravity specification. Moreover, countries which are part of a FTA, tend to have similar economic characteristic that will further increase the effects of the FTA related variables. To treat this endogeneity problem, in line with Wooldridge (2000) we will use panel data analysis with bilateral fixed effects which allows us to consider the unobserved heterogeneity of our data.

We run use fixed effects rather than random effects estimation for two reason. First, as already pointed out in the literature (cf. Egger, 2000), the evaluation of the Hausman test for gravity model with country fixed effect shows a clear evidence for the rejection of the random effects and, second, we believe that it is more plausible to assume an arbitrary correlation between the unobserved time invariant bilateral variables w_{ij} and FTA_t^{ij}, as fixed effects do, than zero correlation between w_{ij} and FTA_t^{ij} as random effects.

This gives an unbiased estimation of μ.

As Wooldridge (2000) underlines, to deal with endogeneity bias using panel data we must focus on the choice between estimation with fixed effects or with first differencing (depending on the nature of the series). If the numbers of periods is equal to 2, the two techniques give the same results but, when the numbers of periods is higher, the two techniques differ in the relative efficiency of the estimators: fixed effect estimators are more efficient, if we assume that the error terms are serially uncorrelated while, first differencing is more efficient when the error term is correlated, for example if it follows a random walk. Since we cannot easily compare the efficiency of the fixed effects and the first differencing we use fixed effect as a benchmark and we will check the robustness of our results using differenced data.

The form of our first differencing equation will be:

$$dlnT^{ij}_{t-(t-1)} = \beta dX^{ij}_{t-(t-1)} + \mu_0 dFTA^{ij}_{t-(t-1)} + \mu_1 dHUB^{ij}_{t-(t-1)} + \mu_2 dVNV^{ij}_{t-(t-1)} + \mu_3 dBC^{i}_{t-(t-1)} + \mu_4 dAG^{i}_{t-(t-1)} + dDum^{i}_{t-(t-1)} + dDum^{j}_{t-(t-1)} d\xi^{ij}_{t-(t-1)} \quad (2)$$

We follow the Baier and Bergstrand's procedure to estimate this equation. At first, we take the first difference of the log of real export dln $T^{ij}_{t-(t-1)}$, of the log of real GDP for country i and country j $dlnGDP^{i}_{t-(t-1)}$ and $dlnGDP^{j}_{t-(t-1)}$, of the FTAs variables (including the lags $dFTA^{ij}_{t-(t-1)}$, $dFTA^{ij}_{(t-1)-(t-2)}$ and $dFTA^{ij}_{(t-2)-(t-3)}$, of all the network variables $dHUB^{ij}_{t-(t-1)}$, $dVNV^{ij}_{t-(t-1)}$, $dBC^{i}_{t-(t-1)}$, $dAG^{i}_{t-(t-1)}$. Then we regress each of the differenced variables on the difference of the country-and-time dummies $dDum^{i}_{t-(t-1)}$, $dDum^{j}_{t-(t-1)}$ and we hold the residuals of all this estimation. Finally we regress the residual of the $dlnT^{ij}_{t-(t-1)}$ regression over the residual of all the other variables in the gravity equation. This procedure will estimate the first differencing equation.

To be efficient, both fixed effect and first differencing estimates need the assumption that the errors in the regression are serially uncorrelated. In our estimation we may expect that bilateral trade levels in one period can affect bilateral trade levels in the next ones. To test this we use the Wooldridge test (2002) for fist order serial correlation AR(1). This test is based on ρ which is the coefficient obtained from regressing the residual of each of our regression on the lagged values of them. The true value for the fixed effect estimation is $-1/(T-1)$ which in or case is -0.1 while, for first differencing the true values is -0.5.

We also test for strict exogeneity, since it can result in biased estimates. To test for exogeneity, we apply the Wooldridge test (2002) as in Head and Ries (2010). We try to find any possible feedback effects between potentially endogenous and dependent variables. To do so we included in the regression the future values of FTAs and the future values of betweenness centrality testing if this is correlated with the present values of trade.

First of all we test for serial correlation in the pooled OLS. We find evidence of serial correlation, since the coefficient is -0.302, significant at 1%

level. To solve this problem we correct our estimation applying the Prais-Winsten transformation. For what concern strict exogeneity, as expected, we reject the null for the PW OLS estimation, since the coefficients are positive and significant at 1%.

We then test the fixed effects and the first differencing estimation. The correlation between the errors and its lagged values are respectively -0.16 and -0.37 both close to the expected values of -0.1 and -0.5. Since they are quite close to their real value we find no clear evidence of serial correlation. For what concern strict exogeneity for both fixed effects and first differencing, therefore, we cannot reject the null, since both coefficients are not significant even if at 10%.

5 Results

Table 2: OLS estimations

Dependent Variable: lnT_t^{ij}						
OLS using Prais-Winstein transformation						
regressor	coefficient	Standard error	P value	coefficient	Standard error	P value
FTA_t^{ij}	0.159	0.045	0.000	0.159	0.045	0.000
FTA_{t-1}^{ij}	0.232	0.039	0.000	0.231	0.039	0.000
FTA_{t-2}^{ij}	0.064	0.043	0.135	0.064	0.043	0.135
FTA_{t-3}^{ij}	0.72	0.047	0.123	0.072	0.047	0.123
HUB_t^{ij}	0.144	0.042	0.001	0.144	0.42	0.001
VNV_t^{ij}	0.002	0.002	0.346	0.002	0.002	0.346
BC_t^i				2.138	0.743	0.000
AG_t^i				-1.654	0.523	0.001
$lnGDP_t^i$	1.8	0.752	0.017	1.8	0.752	0.017
$lnGDP_t^j$	3.419	1.014	0.000	3.419	1.014	0.001
lnD_t^{ij}	-1.263	0.028	0.000	-1.263	0.28	0.000
Com_t^{ij}	0.679	0.052	0.000	0.678	0.052	0.000
Adj_t^{ij}	0.559	0.097	0.000	0.559	0.097	0.000
C-t dummy	yes			Yes		
R sq	0.89			0.921		
Test exo	0.634	0.005	0.000	0.634	0.000	0.000
Test ser cor	-0.324	0.056	0.000	-0.301	0.0489	0.000

Table 3: Fixed effect estimations

Dependent Variable: lnT_t^{ij}

Fixed effects

regressor	1 coefficient	1 Robust standard error	1 P value	2 coefficient	2 Robust standard error	2 P value
FTA_t^{ij}	0.139	0.045	0.002	0.139	0.046	0.002
FTA_{t-1}^{ij}	0.219	0.038	0.000	0.22	0.038	0.000
FTA_{t-2}^{ij}	0.112	0.041	0.007	0.112	0.041	0.007
FTA_{t-3}^{ij}	0.151	0.028	0.000	0.154	0.029	0.000
HUB_t^{ij}	0.13	0.041	0.002	0.129	0.04	0.002
VNV_t^{ij}	-0.071	0.021	0.000	-0.071	0.023	0.001
BC_t^i				2.421	0.431	0.000
AG_t^i				-1.89	0.532	0.000
$lnGDP_t^i$	0.789	0.0675	0.000	0.785	0.0678	0.000
$lnGDP_t^j$	0.123	0.114	0.256	0.121	0.108	0.267
C-t dummy	Yes			Yes		
N obs	33807			33807		
R sq	0.875			0.896		
Test exo	-0.009	0.045	0.826	-0.009	0.046	0.827
Test ser cor	-0.16	0.06	0.006	-0.16	0.059	0.006

In table 2 and table 3 we show the results of the Ordinary Least Square estimations and the Fixed Effect estimations.

In the first OLS estimation we consider the usual gravity model explanatory variables: GDP of both the exporter and importer, distance, dummies for adjacency and common language and country-and-time dummy variables, along with our primary interest variables FTA and HUB dummies and the number of spokes of the exporter which are not linked to the importer. In the second one we add our two network specific variables: betweenness centrality and aggregate constraint.

In both specifications, the variables show the correct signs and are highly significant. The coefficient for FTA^{ij} is positive and significant for the first year, showing the presence of a pro-trade effect of free trade agreements, and remains positive and significant also in the next five years while, after 10 years it becomes insignificant. It may seem odd that the FTA variables show the highest coefficient after 5 years and not in the first year in which a FTA entered into force. A possible explanation for this is that, generally, a FTA is a complicated agreement which takes years to become fully effective, so that only after five years all the possible pro trade effects of the agreement become evident.

The HUB coefficient is positive, its numerical value is 0.144 and it is significant while the coefficient for the number of the exporter's neighbors in the FTA network which are not connected to the importer is positive, even if with a very small effect 0.002, and insignificant. This results suggest that being an hub increases on average the bilateral trade of a country and add new spokes in general will increases bilateral trade in particular.

The numerical value of the betweenness centrality coefficient is 2.138 and it is significant. This is a clear network effect: connect indirectly in the FTA networks otherwise unconnected countries will increase the bilateral trade of the countries which can act as a bridge increasing the competitiveness of the exporter.

The aggregate constrain coefficient is significant and negative -1.654. It varies from 0 to 1 and an increase means that the considered country is more constrained by its overall relations. A higher aggregate constrain coefficient has a negative impact on bilateral trade since, the more connected a country's partners in the FTA network are between themselves, the less bilateral trade the initial country has, countries that are highly constrained are less free within their own FTA relations. As a consequence their bilateral trade with particular trading partners is reduced.
This huge impact of the network related variables with respect to the others surprising, since this measures are of an order of magnitude greater than the others since a small change in a network variables implies a higher impact in the overall relation of the country.

However we could not rely on the OLS results to support the positive effects of the hub and spoke system on bilateral trade since, as noted earlier, the pooled OLS estimation suffer from endogeneity and the estimates are therefore likely to be biased.

To overcome this problem we consider the results of the fixed effect regression since, as Baier and Bergstrand (2007) pointed out, they do not suffer from the endogenous problem of the FTA related variables[3].

For what concern our most relevant coefficients, the FTA dummies are positive and significant up to the third lags. The average positive effect of an FTA on the bilateral trade of two countries is 0.625 after fifteen years. The HUB dummy is positive and significant with a coefficient of 0.129, meaning that, the average effect of being an hub- i.e the average positive effect on bilateral trade of being a hub ceteris paribus- is 0.754 after fifteen years.

The coefficient for number of the exporter's neighbors in the FTA network which are not connected to the importer in the fixed effect estimation is now negative, -0.071 and significant. From this result we can conclude that increasing the number of spokes has a negative small effect on bilateral trade, possibly due to trade diversion. One explanation to this effect could be the increase in costs connected to the obligation of several FTAs. If a country has several FTAs, it has to face different sets of rules of origin and tariff administration, and this increases in trade costs can, on average, induce a small reduction in bilateral trade.

Betweenness centrality and aggregate constrain show almost the same coefficients of the OLS estimation: the first one is positive and significant and the second negative and significant.

[3]The first differencing estimation is presented in appendix A. When comparing the sign of the coefficients of the regression, these remain the same of the fixed effect specifications, however some of them show lower significance

The fixed effect estimation coefficients, since the residuals are serially uncorrelated and strictly exogeneity assumption is not violated, are efficient. The results show the presence of a strong positive effect of the hub and spoke system in FTAs on trade. Our analysis, however, suggests that not all partners are the same. Adding new spokes can have a negative effect on bilateral trade but, if a country increases its betweenness centrality or lowers its aggregate constraint acting like a bridge with not well-connected countries or areas, the final effect on bilateral trade could be positive and significant.

6 Conclusion

We apply the well-known concept of hub and spoke in trade elements of network analysis to better understand how the overall effect of being a hub is influenced by the relative position of the country in the FTAs system.

More specifically, we analyze, using network instruments, the evolution of the global FTAs network from 2000 to 2015. We use a panel data set comprising 96 countries and covering 51 years (1960-2010) adding the hub and spoke concept and network indicators to empirically asses the effects of the position of a country in the FTAs network on bilateral trade.

Our analysis starts from the empirical observation of a massive explosion in the number of free trade agreements among countries in the last years, which resulted in multilayers hub and spoke. We assessed the effect of this multilayers hub and spokes on bilateral trade of a hub. In this setting, a hub, faces a competitive advantages respect to the spokes which enjoy price advantage only in the hub market while, the hub, enjoys price advantage in all the markets of the spokes. If this advantage faced by the hub results in higher exports, we expect this hub and spoke feature to increase trade more than the expected trade-liberalizing effect of FTAs. However, if the more complexed system of rules connected with overlapping FTAs, causes a massive increment in trade costs, ten we can observe a decrease in trade connected with hub and spokes system.

To properly address this issue we need to analyze not only the presence of hub and spokes but also how they are connected with the global network of FTAs. We analyze the change from 2000 to 2015, years in which several new (and relevant) FTAs has been signed. We can observe that while in 2000, when the global system of FTAs is organized mainly around multilateral regional agreements, in 2015, all the countries are directly or indirectly mutually connected. In 2015, most of the cluster in the graph correspond to specific regions which are linked by countries which act as a bridge connecting them. The relevant feature for our analysis is the relative importance of the countries which are not only a hub but also centrally placed in the network.

Our empirical analysis supports the view that the hub and spoke characteristics of FTAs has a positive and significant effect on bilateral trade of the members. Our results show that hubs export more than the other countries involved in a FTA, providing an incentive to countries to become an hub. This incentive can help to explain the proliferation of FTAs in the last decade. However adding other variables to control for the hub and spoke characteristic, we observe how not all the spokes are the same. An increase in the number of spokes which are not linked between them has, on average, a negative effect on trade of the hub, meaning that to sign FTAs with every country it is not the optimal strategy to increase trade. However, if we consider how new FTAs change the relative position of a country, we can observe that, if new FTAs bring the country to become more central or more free in the network, this new agreements have a strong positive and significant effect on trade.

This phenomenon of overlapping FTAS in international trade has grown in the last decade and is likely to continue in the e next years. However, supporting evidence about the overall effects on trade and welfare is lacking.

In our work, we underline how this trade- creating effect of the hub and spoke features depends on the strategic evolution of the FTAs scheme of a country. Thus policy maker and institution must carefully consider this evolutionary process and its consequences on the global trade.

7 Appendix

7.1 Appendix A: First differencing estimation

Dependent variable: lnT_t^{ij}			
First differencing			
Regressor	coefficient	Robust standard error	P value
$dFTA_{t-(t-1)}^{ij}$	0.194	0.051	0.000
$dFTA_{t-(t-2)}^{ij}$	0.159	0.046	0.000
$dFTA_{t-(t-3)}^{ij}$	0.049	0.051	0.342
$dHUB_{t-(t-1)}^{ij}$	0.041	0.051	0.422
$dVNV_{t-(t-1)}^{ij}$	-0.021	0.03	0.57
$dBC_{t-(t-1)}^{i}$	0.052	0.027	0.06
$dAG_{t-(t-1)}^{i}$	-0.015	0.008	0.058
$dlnGDP_{t-(t-1)}^{i}$	0.982	0.006	0.000
$dlnGDP_{t-(t-1)}^{j}$	0.349	0.004	0.000
C-t dummy	Yes		
N obs	31593		
R sq	0.5323		
Test exo	0.06	0.044	0.133
Test ser cor	-0.45	0.005	0.000

7.2 Appendix B: List of the country

Albania; Algeria; Angola; Argentina; Australia; Austria; Bangladesh; Belgium–Luxembourg; Bolivia; Brazil; Bulgaria; Burkina Faso; Cameroon; Canada; Chile; China, People‘s Republic of; Colombia; Congo, Democratic Republic of; Congo, Republic of; Costa Rica; Cote D‘Ivoire (Ivory Coast); Cyprus; Denmark; Dominican Republic; Ecuador; Egypt; El Salvador; Ethiopia;

Finland; France; Gabon; Gambia; Germany; Ghana; Greece; Guatemala; Guinea–Bissau; Guyana; Haiti; Honduras; Hong Kong, China; Hungary; India; Indonesia; Iran; Ireland; Israel; Italy; Jamaica; Japan; Kenya; Korea; Madagascar; Malawi; Malaysia; Mali; Mauritania; Mauritius; Mexico; Morocco; Mozambique; Netherlands; New Zealand; Nicaragua; Niger; Nigeria; Norway; Pakistan; Panama; Paraguay; Peru; Philippines; Poland; Portugal; Romania; Saudi Arabia; Senegal; Sierra Leone; Singapore; Spain; Sri Lanka; Sudan; Sweden; Switzerland; Syrian Arab Republic; Thailand; Trinidad & Tobago; Tunisia; Turkey; Uganda; United Kingdom; United States; Uruguay; Venezuela; Zambia; and Zimbabwe.

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