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Deep integration and production networks: an empirical analysis

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Abstract

In this paper, the two way relationship between deep integration and production networks trade is investigated. Deep integration is captured by a set of indices constructed in terms of policy areas covered in preferential trade agreements. An augmented gravity equation is estimated to investigate the impact of deep integration on production networks. The results show that on average, signing deeper agreements increases production networks trade between member countries by almost 35 percentage points. In addition, the impact of deep integration is higher for trade in automobile parts and information and technology products compared with textiles products. To analyse whether higher levels of network trade increase the likelihood of signing deeper agreements the literature on the determinants of preferential trade agreements is followed. The estimation results show that, after taking into account other PTAs determinants, a ten per cent increase in the share of production network trade over total trade increases the depth of an agreement by approximately 6 percentage points. In addition, the probability of signing deeper agreements is higher for country pairs involved in North-South production sharing and for countries belonging to the Asia region.

Keywords: regionalism, deep integration, production networks

JEL Classifications: F13, F15, F14

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I. Introduction

During the last 3 decades, there has been an increased role of production networks in the global economy[1], which are characterized by the unbundling of stages of production across borders. Production networks have evolved due to technological innovation in communication and transportation that has not only decreased physical distance, but has also facilitated the establishment of services links, necessary for the efficient combination of various fragments of the production processes.

Preferential trade agreements (PTAs) participation has also accelerated over time. As the World Trade Report 2011 shows, in 1990 there were only about 70 PTAs in force. Subsequently, PTA activity increased noticeably with almost 300 preferential trade agreements in force in 2010. The coverage of policy areas in PTAs, particularly those of a regulatory nature, has also been widening in recent years. Recent agreements go beyond tariff liberalization and include disciplines such as the movement of capital, investment, intellectual property, competition policy, services trade and technical barriers to trade.

The expansion of international production networks is related with the proliferation of deep agreements going beyond traditional market access issues. Lawrence (1996) was the first to highlight the systemic implications of international production networks and deep integration. In order for cross-border production to operate smoothly, certain national policies need to be harmonized to facilitate business activities taking place in several countries. This generates a demand for deep forms of integration. In other words, agreements including disciplines such as infrastructure, institutions, competition policy, the standardization and harmonization of product regulations, amongst others,

[1] See papers such as Feenstra and Hanson (1996), Feenstra (1998), Campa and Goldberg (1997), Hummels, Ishii and Yi (2001), Yeats (2001), and Borga and Zeile (2004).

would make production sharing activities more secure and less likely to encounter disruptions or restrictions.

More recently, Antras and Staiger (2008) have modelled the interaction between international production networks and deep integration. The authors show that an increase in trade flows involving the exchange of customized inputs, incomplete contracts and costs associated with the search for suitable foreign input suppliers creates new forms of cross-border policy effects compared to a situation where goods are produced in a single location. The changing nature of trade, from trade in final goods to trade in intermediate goods, is therefore directly responsible for the growing demand for deeper agreements that can address these new cross-border effects.

Whilst the determinants and the effects of PTAs have been widely studied,[2] the empirical literature on the relationship between trade and deep integration is very limited. One of the main reasons for this derives from the difficulties that arise when defining and measuring the depth of an agreement. In this paper an attempt will be made to investigate the relationship between deep integration and production networks for a set of 200 countries during the time period from 1980 to 2007. A total 96 preferential trade agreements that were signed during this time interval is considered. They represent almost 90 per cent of world trade. The depth of an agreement will be defined in terms of coverage and will be captured by a set of indices that will be described in detail in section II.

Descriptive evidence suggests that there is a positive relationship between production networks trade and deep integration (see Figure 1). However, this relationship can go in both directions. On the one hand, deep PTAs may stimulate the creation of production networks by facilitating trade among potential members of a supply chain. On the other hand, countries already involved in international fragmentation of production are willing to sign deeper preferential trade agreements with their

[2] See papers such as Baier and Bergstrand (2004) and (2007); Bergstrand *et al*. (2010)*;* Silva and Tenreyro (2006); Soloaga and Winters (2001); Ghosh and Yamarik (2004) and Magee (2008).

partners in order to secure their trading relationships as providers of intermediate goods and services. In this paper both directions of causality will be empirically tested.

To investigate the first direction of causality, specifically the impact of deep integration on production networks trade, an augmented gravity equation is estimated. In addition, it is explored whether the impact of deep integration is heterogeneous across different industries. This kind of estimation potentially suffers from endogeneity deriving from omitted variables and simultaneity bias. In order to control for this, the approach by Baier and Bergstrand (2007) is followed and country-time and country-pair fixed effects are included in the regression. In addition, in order to control for selection bias deriving from the presence of zero trade flows, a two-steps Heckman selection model is also estimated.

The estimation results show that the greater the depth of an agreement, the bigger the increase in network trade among member countries. On average, signing deep agreements increases trade in production networks between member countries by almost 35 percentage points. In addition, the impact of deep integration is different across industries. Specifically, signing deeper agreements increases trade in automotive parts and in information and communications technology (ICT) products significantly more than trade in textiles. One interpretation of this result is that the textiles industry might be less influenced by deep integration due to the higher levels of standardization and the lower levels of capital intensity of its production processes. The estimation results also show that the average impact of deeper integration has become more relevant in recent years. This is not surprising given that there has been an increasing occurrence of production networks trade in the automobile and ITC industries over time compared to traditional industries such as textiles (see Figure 2).

To analyse whether higher levels of network trade increase the likelihood of signing deeper agreements (second direction of causality), studies such as Baier and Bergstrand (2004) and Baier,

Egger and Larch (2010), on the determinants of preferential trade agreements, are followed and an equation in which the dependent variable is represented by the level of depth of an agreement is estimated. The explanatory variable of interest is represented by the share of trade in parts and components over total trade. This variable captures the impact that network trade relative to total trade has on the probability of signing deeper agreements. In the regression a series of control variables capturing other economic factors such as the distance between countries, their remoteness with respect to the rest of the world, their similarity in economic size and their differences in relative factor endowments, is also included.

In this second part of the paper it is also investigated whether countries involved in North-South production networks are more likely to sign deeper agreements. Countries engaging in production sharing were initially mainly rich countries.[3] From the mid1980s, however, production networks between developed and developing countries started to increase. As Baldwin (2011) points out, in this scenario, some of the costs related with international fragmentation of production such as managerial and logistic costs of monitoring and coordinating international production and learning about the laws and regulations to do business in another country might be particularly high for developing nations who mostly lack the sophisticated business law and the product and labour regulations which are essential for rich countries to consolidate their trade in intermediates.

Finally, it is examined whether the impact of production networks trade on the likelihood of signing deeper agreements is more pronounced for countries belonging to the Asia region. Papers such as Athukorala and Menon (2010), Ando and Kimura (2005) and Kimura et al. (2007) show that production networks are an extremely important phenomenon for this region. In addition, one feature that makes Asian production networks distinctive is that they take place between countries of different income levels. In the region, the growth of production sharing first took place through de facto economic integration. However, deep integration is necessary for production networks to continue to

[3] See Grunwald and Flamm (1985).

prosper. More recent agreements, such as Japan's economic partnerships with Malaysia, Indonesia, Thailand and Viet Nam, or ASEAN's push for deeper disciplines and clearly show that this region is moving towards deeper integration.

Results show that higher levels of trade in production networks increase the likelihood of signing deeper agreements containing provisions of regulatory nature such as TRIPS, intellectual property rights, movement of capital. This effect is still significant after taking account of other PTA determinants, such as the economic similarity between countries and their differences in relative factor endowments. As expected, the results also confirm that the probability of signing deeper agreements is higher for country pairs involved in North-South production networks or belonging to the Asia region.

The paper is organized as follows. Section II discusses the definition and measurement of deep integration and presents the data sources. Section III investigates the impact of production networks on the likelihood of signing deeper agreements. Section IV analyses the effect of deep integration on networks trade. Section V concludes.

II. Data sources and variable definitions

For our investigations we use WTO data[4] on the content of preferential trade agreements based on a comprehensive mapping and coding of 96 PTAs signed during the time interval 1958-2010. The dataset is an extension of Horn et al. (2010) dataset in which only EU and USA agreements were analysed. It contains 33 EU and 11 USA agreements, the remaining 52 PTAs cover ASEAN, China, India, Japan and MERCOSUR. The agreements included in this mapping represent almost 90 per cent

[4] This dataset has been created by the Research division of the WTO for the World Trade report (WTR) 2011.

of world trade and cover most regions from around the world.[5] Finally, the dataset includes PTAs concluded between WTO members and also agreements where not all partners are WTO members.[6]

The methodology of Horn et al. (2010) is followed in order to define the content and the legal enforceability of PTAs. As a first step, a set of policy areas covered in PTAs is identified. These areas can be classified into two different groups. The first group is represented by WTO+ provisions which fall under the current mandate of the WTO and are already subject to some form of commitment in WTO agreements. The second group of policy areas, which is denoted as WTO-X provisions, includes those obligations that are outside the current mandate of the WTO. Table 1 lists the 52 policy areas that are identified.

The legal enforceability of the PTA obligations is established according to the language used in the text of the agreements. In other words, it is assumed that commitments expressed with a clear, specific and imperative legal language, can more successfully be invoked by a complainant in a dispute settlement proceeding, and therefore are more likely to be legally enforceable. In contrast, unclearly formulated legal language might be related with policy areas that are covered but that might not be legally enforceable.[7]

As a final step, a set of indices is constructed in order to capture the depth of an agreement. The main objective of these indices is to condense a large amount of data on the existence and enforceability of each single provision into a single number that can be compared across different countries. A first group of indices is constructed on the basis of the number of legally enforceable WTO+ and WTO-X

[5] The regions covered are US, EU, South-, East- and West Africa, Middle East, Oceania, Asia, Central and South America.

[6] For a detailed analysis of the patterns of PTAs content see WTR 2011 section D.2.

[7] For more information on the definition, strengths and limitations of legal enforceability see the WTR 2011.

provisions included in each agreement. The higher the number of enforceable provisions covered by an agreement, the deeper the agreement. A limitation of these indices is that they give the same weight to each of the areas covered in a PTA, thereby assuming that the potential impact of each provision on production networks is of the same magnitude.

To deal with this problem, an alternative methodology that takes into account the frequency with which a particular provision appears among the agreements is implemented. Specifically, principal component analysis (PCA) is used in order to generate a comprehensive measure of the depth of an agreement.[8] This index (*PCA aggregate*), being aggregate by nature, might include provisions such as social matters, cultural co-operation, health, information society, amongst others, that might not have any specific or direct relation with production networks. As a result, performing an analysis on the causes and effects of deep integration on production networks using this measure might bias the results downwards.

As an alternative, principal component analysis is also used to generate an index (*PCA top 5*) containing only those provisions with the highest degree of commonality across the agreements.[9] In this case, deep integration will be captured by five areas only, two WTO+ areas, namely state trading enterprises and TRIPS and three WTO-X areas, namely competition policy, intellectual property rights and movement of capital. The assumption behind this approach is that if one of the main causes

[8] Principal Component Analysis is a procedure that orthogonally transforms a number of possibly correlated variables into a number of uncorrelated variables called principal components. This transformation is defined in a way such that the first principal component accounts for the highest level of variability in the data. Each succeeding component has the highest variance possible under the constraint of being orthogonal to the preceding components. The index used for this investigation derives from the first principal component and explains 10% of the overall variability in the matrix of the 52 PTAs areas.

[9] The top five areas presenting the highest coefficients are chosen from weights associated to the first component of the principal component analysis (PCA). These coefficients are then used as weights to generate the index.

for signing deeper agreements is the promotion of production networks, the set of provisions that most frequently appear in these agreements should be more correlated with production networks trade.[10]

Adoption of competition policy, for instance, preventing the abuse of market power, will allow multinational firms to take full advantage of differences in costs among countries by fragmenting production. In addition, provisions such as movement of capital, aimed at protecting firms-specific assets such as human capital and intellectual property, will give international firms a competitive advantage and therefore will encourage more production sharing. Finally, provisions on intellectual property rights aimed at the harmonization of standards to a single regulatory regime, including a common set of rules that governments apply to private firms in many nations, will tend to foster competition and trade. The summary statistics of the different indices used to proxy for deep integration are presented in Table 2.

Following the approach of Yeats (2001) and Hummels et al. (2001), import values in parts and components from COMTRADE during the period 1980-2007 for a set of 200 countries are used to proxy for production networks trade. Parts and components are defined as the SITC Rev.3 equivalent of codes 42 and 53 in the Broad Economic Categories (BEC) classification, supplemented with unfinished textile products in division 65 of the SITC classification. The rest of the data comes from standard sources: gravity variables such as country-pair distances are taken from the Mayer and Zignago dataset. GDP and GDP per capita come from the World Development Indicators (World Bank). Table 3 presents correlations between the variables used in the analysis.

[10] Another way to choose a sub-set of provisions would be according to their correlation with production networks trade. However, given that the main objective of this paper is to analyse the impact of deep integration on production networks trade, using an index generated in such a way would overestimate the results.

III. The effects of deep integration on production network trade

In order to investigate the impact of deep integration on production networks trade an augmented gravity equation is estimated:

$$Ln\ Imports_{ijt} = \alpha + \phi_{it} + \phi_{jt} + \phi_{ji} + \beta\, PTA\, depth_{ijt} + \varepsilon_{ijt} \quad (1)$$

where the subscripts i , j and t correspond to the importer , the exporter and the year respectively. The dependent variable is the log bilateral imports in parts and components from country i to country j at time t ; $PTA\, depth_{ijt}$ captures the depth of an agreement that has been signed between country j and country i at time t. This variable takes the value of zero for those pairs of countries that have never implemented an agreement. For those countries that have entered into an agreement during the time period 1990-2007, this variable is equal to zero before the agreement is signed and takes a positive value, captured by the different indices defined in section II, from the year in which the agreement is signed onwards [11]; ϕ_{it} and ϕ_{jt} capture importer and exporter time varying characteristics such as their economic size or their GDP per capita; ϕ_{ij} captures characteristics that are specific to the importer and the exporter such as sharing the same official language or border.

As has been shown in the empirical literature[12], an endogeneity problem deriving from omitted variables bias and to a lesser extent to simultaneity bias, arises when estimating the effect of trade policies such as preferential trade agreements on trade volumes. Omitted variables bias arises since the error term may be correlated with some unobservable country-specific policy variables (e.g. trade-

[11] With the exception of enlargements, there is no information on the evolution of an agreement in the dataset. In the case of the PCA top five index, this variables will be zero also for those agreements which do not contain any of the top five provisions

[12] See papers such as Trefler (1993), Lee and Swagel (1997), Baier and Bergstrand (2004) and (2007), Magee (2003).

restrictive domestic policy regulation), which at the same time affect both trade and the probability of forming a PTA. Simultaneity bias will occur when, for instance, two countries that trade more than their "natural" level of trade may be induced to form a PTA in order to decrease the probability of trade diversion. The set of fixed effects included in specification (1) deals with both sources of endogeneity.[13] Specifically, country-pair fixed effects account for unobserved country-pair heterogeneity. In addition, country and time fixed effects account for unobserved factors such as multilateral price terms. [14]

The results are reported in Table 4. For the sake of comparison with the existing literature on the impact of preferential trade agreements, columns (1) and (2) show the effect of having a PTA on production networks trade and on trade in final goods[15] respectively. The average impact of preferential trade agreements on production networks trade is 51 per cent ($e^{0.415}$-1 =0.51). The magnitude of the impact on final goods is slightly higher an equal to 54 percentage points ($e^{0.434}$-1 =0.54). These outcomes are in line with Bair and Bergstrand (2007), who find that a preferential trade agreement increases total trade by 58 percent on average.

In the next columns, the effects of deep integration are represented by the different indices defined in section II. [16] In columns (3) (4) and (5) the impact of deep integration is captured by the total number of provisions, the total number of WTO+ and the total number of WTO-X provisions respectively.

[13] See Baier and Bergstrand (2007)

[14] As noted in Wooldridge (2001) when the time dimension exceeds two periods, the fixed effects estimator is more efficient tan the first differences estimator under the assumption that the error term is serially uncorrelated. As a robustness check, specification (1) is also estimated using first differences. Results, available under request, are very similar to those obtained with the fixed effects model.

[15] Final goods are defined as the difference between total trade in manufacturing and trade in parts and components.

[16] Specification (1) has also been regressed using a Propensity Score Matching methodology in order to separate the impact of signing a preferential trade agreement from the impact of the level of depth of such agreement. Results are very similar in magnitude to the ones presented in this table.

The results show that having an additional provision in an agreement increases production networks trade by 2 per cent on average (see column (3)). In addition, the impact of an increase in the number of WTO+ provisions is slightly higher than the impact of an increase in WTO-X provisions. Specifically, whilst including an additional WTO-X provision in an agreement increases trade by 3 percentage points, having an additional WTO+ provision increases production network trade by more than 4 percentage points (see columns (4) and (5)).

In column (6) the effects of deep integration are captured using the aggregate principal components index (*PCA index*). The results show that a 1 per cent increase in the depth of an agreement increases production networks trade by 30 percentage points on average. Interpreting the magnitude of deep integration when it is measured using principal component analysis is less intuitive, since it is not easy to understand the meaning of a one-percent increase in such an index. In addition, the outcomes obtained using PCA are not directly comparable with the ones where deep integration is captured by the total number of provisions included in an agreement (see column 3). However, a greater coefficient on the impact of deep integration, when measured with the PCA index, confirms the fact that some policy areas are more relevant in terms of production networks trade than others.

In column (7), an index including only the five most common provisions is considered.[17] Here the impact of deep integration is more than 10 percentage points higher compared to the one of the overall PCA index. One interpretation of this result is that aggregate indices of deep integration might include certain provisions such as social matters, cultural co-operation, health, information society, amongst others, that do not have any relation with production networks and hence their presence would bias the impact of deep integration downwards. In addition, this result confirms the relevance that further liberalization in terms of state trading enterprises and movement of capital or higher levels of

[17] Notice that in this index, a value of zero is attributed either to a pair of countries that do not have an agreement or to a pair of countries that have an agreement that does not included any of the top 5 provisions.

harmonization and better regulation in areas such as competition policy, intellectual property rights, TRIPS have in terms of production networks development.

The impact of deep integration on trade in final goods is also analyzed in the last two columns of Table 4.[18] The coefficients on the *PCA aggregate* and the *PCA top 5* presented in columns (8) and (9) respectively are very similar in terms of magnitude to the ones in columns (6) and (7), implying that the impact of deep integration on final goods trade and on production networks trade is very similar. One intuition of these results is that whilst the need for deeper agreements might be more pressing for production networks trade than for final goods trade, the effects of deep integration might de facto be extended to areas of the economy other than production networks. Specifically, the regulatory character of some deep integration provisions will apply not only to trade in intermediates but also to trade in final goods.

Specification (1) has been estimated considering only positive trade flows. As papers such as Helpman et al. (2008), Silva and Tenreyro (2006), Chen and Mattoo (2011) argue, excluding zero trade flows from the estimation does not take into account important information about non-trading countries. In order to control for selection bias a modified two-stages Heckman selection model is adopted, in which the first stage regressions are performed using a linear probability model rather than a probit model.[19] This approach was first introduced by Olsen (1980) in order to deal with the incidental parameters problem in probit models when fixed effects are included.

Results from the second stage regression are presented in Appendix table A.2 and confirm the fact that deeper agreements increase production networks trade. The coefficients capturing deep integration are in line with the ones on Table 4. In other words, deep integration has a positive and very similar

[18] In order to make the regressions comparable a sub-sample of countries that trade in both final goods and parts and components is considered.

[19] See Heckman (1979).

impact on both production networks trade and trade in final goods. In addition, results of the first stage regression show that in general signing deeper agreements increases the probability that two countries will start trading or will start making part of a production network (see Appendix table A1).

Next, the impact of deep integration is analysed for three different sectors separately: textiles, automotive and ICT. Results, reported in Table 5 show that the impact of deep integration in the automotive and the ICT sectors is more than three times bigger than the impact in the textile sector.[20] Specifically, whilst a 1 per cent increase in the depth of an agreement increases production networks trade in automotive parts and ICT products by 81 and 56 per cent respectively, the impact on textiles trade is only 20 per cent on average. One interpretation of this last outcome is that the textiles industry might be less influenced by deep integration due to the higher levels of standardization and the lower levels of capital intensity of its production processes, compared with other industries. In other words, whilst regulating areas such as intellectual property rights or capital movement will be fundamental for the development of automotive or ICT production networks, these areas are not that relevant for the promotion of textiles production networks.

Finally the evolution of production networks and deep integration over time is investigated. In order to do this, the effect of deep integration on production networks trade is estimated for three different sub-periods: 1980-2007, which represents the benchmark regression, 1990-2007 and 2000-2007. The results reported in Table 6 show that the impact of deep integration has increased over time. This increase is more pronounced when the depth of an agreement is proxied with *PCA top 5* instead of the *PCA aggregate*. Considering the former, the impact of deep integration is 10 percentage points higher

[20] In the rest of the section deep integration is going to be captured only by the PCA aggregate and the PCA top 5 indices. This given the fact that this proxies are the ones that better capture the impact of deep integration on trade. However, all regressions are also replicated using the simple count indices. Results, available under request, are always in line with the ones using the PCA indices.

in the time period 1990-2007 (see column (5)) and almost 30 per cent higher in the period 2000-2007 (see column (6)) compared to the whole sample regression (see column (7)).

The fact that the impact of deep integration on production networks trade has evolved over time is not surprising given that in recent years, industries such as the automotive sector and ICT, which require higher levels of integration by their very nature, have become more important. In the past decade, the growth rate of production networks trade was very high for the automotive industry (93 per cent) compared to the ICT and textiles industries, where production network trade grew only 47 and 36 percentage points respectively.

III. The effect of production networks trade on deep integration

The impact of production networks on PTAs depth will be investigated in this section. In order to do this the following linear regression is estimated:

$$PTA\ depth_{ij} = \alpha + \phi_i + \phi_j + \beta_1 \ln \text{SharePNTrade}_{ij} + \beta_2 \sum \text{X}_{ij} + \varepsilon_{ij} \qquad (2)$$

where the subscripts *i* and *j* correspond to the importer and the exporter respectively. The dependent variable represents the depth of a preferential trade agreement between country *i* and country *j* . Specifically, this variable will have a positive value capturing the depth of an agreement for a pair of countries *ij* with a PTA in force in 2007, and zero otherwise. As in the previous section, the depth of an agreement will be captured by the set of proxy variables defined in section II. $Share\,PN\,trade_{ij}$ represents the share of trade in parts and components over total trade. This variable captures the impact that production networks relative to trade in final goods have on the likelihood of signing deeper agreements; ϕ_i and ϕ_j are importer and exporter fixed effects respectively; X_{ij} is a vector of

country pair specific controls and includes the following variables: $Dist_{ij}$ is the distance between country *i* and country *j*; $REMOTE_{ij}$ is the remoteness of two continental trading partners from the rest of the world and is calculated following Baier and Bergstrand (2004) [21]; $GDPSUM_{ij} = \ln(GDP_i + GDP_j)$ captures the economic size of country *i* and country *j* in terms of their Gross Domestic Products; $GDPSIM_{ij} = \ln\left(\frac{GDP_i}{GDP_i + GDP_j} \times \frac{GDP_j}{GDP_i + GDP_j}\right)$ represents the economic similarity between country *i* and country *j*; $GDPDIF_{ij} = \left|\ln GDPPC_i - \ln GDPPC_j\right|$ represents the difference in factor endowments and is approximated by the absolute value of the difference in GDP per capita between country *i* and country j; $SQGDPDIF_{ij} = (GDPDIF)_{ij}^2$ captures the effect of an increasing specialization among countries.

One potential concern with specification (2) is the presence of endogeneity. Specifically, variables such as trade, income and factor endowments are likely to change over time and therefore might be influenced by trade liberalization, especially for those country pairs in which a PTA was signed before the 2007. In order to account for this, all time varying explanatory variables are computed as the average between the earliest year in the sample, namely 1980 and the year before an agreement was signed.[22]

From specification (2) it is not possible to disentangle the impact that production networks trade has on the probability of signing a preferential trade agreement from its effect on the depth of such agreements. In order to deal with this, we use a Propensity Score Matching (PSM) model.[23] The idea

[21] $REMOTE_{ij} = D\_region_{ij} \times \frac{1}{2} \times \left[\log\left(\sum_{k=1,k\neq j}^{N} Dist_{ik} \Big/ N-1\right) + \log\left(\sum_{k=1,k\neq i}^{N} Dist_{jk} \Big/ N-1\right)\right]$, where *D_region* is a dummy variable equal to one if country i and j are in the same region.

[22] As an alternative all time varying variables were computed in 1980.

[23] Caliendo and Kopeining (2008); Dehejia and Wahba (2002)

behind this methodology is to imitate a randomized experiment in which there is a treatment group of country pairs that have signed an agreement and a control group of country pairs that have never signed an agreement and that are very similar, in terms of their probability to sign a PTA, to the treatment group of countries.

The estimation is performed in several stages. First a probit model on the probability of signing a preferential trade agreement is performed.[24] The estimated probability (propensity score) is then used as criteria in order to match[25] country pairs that make part of a PTA with similar country pairs that have never signed an agreement. Finally, to test the impact of production networks trade on the level of depth of preferential trade agreements, equation (2) is regressed for the sub-sample of country pairs that were matched in the previous stage.

Results for both the OLS and the PSM model are presented in Table 7. In general, production networks trade has a positive and significant impact on the degree of depth on newly signed agreements. Considering the indices computed using principal components analysis it is possible to say that a ten per cent increase in the share of production networks trade over total trade, will increase the depth on an agreement by approximately 6 percentage points (see columns (4) and (5)). With respect to the PSM model, results from the first stage regression are in line with the findings of papers on the determinants of PTAs formation such as Baier and Bergstrand (2004) and Bergstrand et al. (2010). Specifically, variables such as distance tend to discourage the formation of a PTA. In

[24] Specifically, the following regression is estimated:

$$Prob(PTA_{ij}=1)=\alpha+\beta_1\ln(dist)_{ij}+\beta_2 GDPSUM_{ij}+\beta_3 GDPSIM_{ij}+\beta_4 GDPDIF_{ij}+\beta_5 SQGDPDIF_{ij}+\beta_6 REMOTE_{ij}+\varepsilon_{ij}$$

Here country specific fixed effects are not included given that the probability of having a PTA between two countries (*i* and *j*) is country pair specific and depends on whether the PTA increases the utility for both countries' consumers (see Baier and Bergstrand 2004).

[25] The matching, or selection of these countries has been done using a kernel estimator. A one-to-one estimator has also been performed as a robustness check. Results are available under request.

contrast, variables such as total economic size and similarity between reporter and partner tend to increase the probability of signing an agreement (see Appendix Table A.3).

Next it is investigated whether countries involved in North-South production networks are more likely to sign deeper agreements. In order to do this a term capturing the interaction between the share of production networks trade and the fact that that a pair of countries belong to different income levels[26] is introduced in specification (2). Results are presented in Table 8. Whilst the interaction term using the aggregate PCA index is positive but not significant (see column (1)), it becomes significant when considering the PCA top five index (see column (2)). Specifically, a ten per cent increase in the share of production networks trade increases the depth of an agreement by approximately 30 percentage points if countries belong to different income levels (and only by 6 per cent otherwise). This outcome confirms the fact that one of the reasons why deep agreements are signed is to fill the governance gap between countries. In particular, signing agreements including disciplines such as competition policy, capital movement, TRIPS, intellectual property rights and state trading enterprises, would make production sharing activities between North and South countries more secure and less likely to encounter disruptions or restrictions.

Finally, the effect that the share of production networks trade over total trade has on deep integration is examined for different regions. The results, presented in Table 9 show that whilst the impact of production networks trade on the likelihood of signing deeper agreements is positive and significant for both Asia and East Asia regions (see columns (1) and (2)), this effect is not significant for the rest of the regions. This outcome is in line with studies such as Pomfret and Sourdin (2009) and (2010), which showed that one of the driving forces behind recent agreements signed among South Asian countries, is in part a response to the need to facilitate trade in order to make regional value chains more profitable.

[26] The North-South dichotomous variable is equal to unity for the set of country pairs in which one of the countries is high income or upper middle income and the other is low income.

The results also confirm the fact that in regions such as Asia, where production sharing is a very important phenomenon, integration going beyond tariff liberalization and aiming at higher levels of predictability in economic policy is a prerequisite for production networks to prosper. High trade costs could still be an obstacle for the development of production networks because of inadequate infrastructural services. In addition, differences in legal systems and economic institutions among countries in areas such as intellectual property rights protection or investment protection are a potential obstacle for production networks to develop.

V. Conclusions

This paper provides new evidence on the two-way link between deep integration and production networks trade. The findings suggest that signing deeper agreements increases trade in production networks between member countries by almost 35 percentage points on average. In addition, the impact of deep integration is more significant for industries that by their very nature require higher levels of regulation. In fact, whilst signing deeper agreements increases production networks trade in automotive parts and ITC products by 81 and 56 per cent respectively, the impact on textiles trade is only 20 per cent on average.

With respect to the impact of production networks trade on deep integration, the results show that higher levels of trade in production networks raise the likelihood of signing deeper agreements by approximately 6 percentage points. Furthermore, the effect of an increase in production networks trade on the likelihood of signing deeper agreements is 5 times higher for agreements between North-South countries compared to agreements between countries with similar income levels. Finally the positive effect of production networks trade on deep integration is mainly driven by the Asian region, where production sharing is an extremely important phenomenon.

This analysis can be used as a starting point for further research on the relationship between production networks and deep integration. For instance, more theoretically founded methodologies should be developed in order to quantify the level of depth of preferential trade agreements. In addition, new techniques should be considered in order to better characterize the global pattern of production networks and therefore to assess the complexity of an economy and its relationship with deep integration. Finally, this paper opens more general questions that deserve further investigation such as the complementarity between trade liberalization and deep integration in a world where supply chains are becoming more relevant.

References

Ando, M. and Kimura, F. (2005), "The formation of international production and distribution networks in East Asia", in Ito, T. and Rose, A. (eds), International trade in East Asia, NBER-East Asia Seminar on Economics, Volume 14, Chicago: University of Chicago Press: 177-216.

Antràs, P. and R. Staiger (2008) "Offshoring and the Role of Trade Agreements" CEPR Discussion Papers 6966, C.E.P.R. Discussion Papers.

Athukorala, P. C. and Menon, J. (2010), "Global production networks and regional integration", Manila, Asian Development Bank (ADB) Working Papers series on regional economic integration No. 41

Baier S.L. and Bergstrand J.H. (2004) "Economic Determinants of free Trade Agreements" in Journal of International Economics, 64, pp.29-63.

Baier S.L. and Bergstrand J.H. (2007) "Do free trade agreements actually increase members' international trade?" in Journal of International Economics, 71, pp.72-95.

Baldwin R. (2011) "21st century regionalism: filling the gap between 21st century trade and 20th century trade rule', WTO Economic Research and Statistic Devision working paper, April 2011.

Bergstrand J.H., Egger, P. and Larch M. (2010) "Economic Determinants of the timing of Preferential trade Agreement Formation and Enlargements", Working Paper University of Notre Dame .

Borga, M. and Zeile, W.J. (2004), "International Fragmentation of Production and Intra.rm Trade of U.S. Multinational Companies".Bureau of Economic Analysis Working Paper WP # 2004-02.

Caliendo M. and Kopeinig S. (2008) "Some Practical Guidance for the Implementation of Propensity Score Matching" Journal of Economic Surveys, vol. 22(1), pp. 31-72

Campa, J.M. and Goldberg, L.S. (1997), "The Evolving External Orientation of Manufacturing Industries: Evidence from Four Countries" in.Federal Reserve Bank of New York Economic Policy Review, vol.3, pp. 53-81

Chen M.X. and A. Mattoo (2011) "Regionalism in standards: good or bad for trade?" in Canadian Journal of Economics, vol.41(3), pp.838-863.

Dehejia R.H. and Wahba S. (2002) "Propensity Score Matching Methods fpr Nonexperimental Causla Studies", in The Review of Economics and Statistics, vol. 84(1), pp. 151-161.

Feenstra, R.C. (1998), "Integration of Trade and Disintegration of Production in the Global Economy", in.Journal of Economic Perspectives, vol. 12, pp. 31-50
Feenstra, R.C. and Hanson G.H. (1996), "Globalization, Outsourcing, and Wage Inequality".in. American Economic Review, vol 86(2), pp. 240-245

Frankel, J.A. and D., Romer (1999) "Does Trade Cause Growth?" American Economic Review, vol. 89(3), pages 379-399.

Ghosh, S. and Yamarik, S. (2004), "Does trade creation measure up? A reexamination of the effects of regional trading arrangements", Economics Letters 82(2): 213-219.

Grunwald, J. and Flamm, K. (1985), "The Global Factory: Foreign Assembly in International Trade", Washington DC: Brookings Institution.

Heckman, J. (1979). "Sample selection bias as a specification error". Econometrica 47 (1): 153–61

Helpman, E., Melitz, M. and Y. Rubinstein (2008) "Estimating Trade Flows: Trading Partners and Trading Volumes", in The Quarterly Journal of Economics, MIT Press, vol. 123(2), pages 441-487

Horn, H., Mavroidis P.C. and A. Sapir (2010) "Beyond the WTO? An Anatomy of EU and US Preferential Trade Agreements" in The World Economy, vol.33(11) pp.1565-1588.

Hummels, D., Ishii, J. and Yi, K. M. (2001), 'The nature and growth of vertical specialization in international trade', Journal of International Economics 54(1): 75-96.

Kimura, F., Takahashi, Y. and Hayakawa, K. (2007), "Fragmentation and parts and components trade: comparison between East Asia and Europe", The North American Journal of Economics and Finance 18(1): 23-40

Lawrence, R. Z. (1996), "Regionalism, Multilateralism and Deeper integration" Washington DC: Brookings Institution

Lee, J. and P. Swagel (1997), "Trade barriers and trade flows across countries and industries" in Review of Economics and Statistics, vol.79, pp. 372-382.

Magee, C. (2003), "Endogenous preferential trade agreements: an empirical analysis" in Contributions to Economic Analysis and Policy, vol.2, n.1. Berkeley Electronic Press.

Magee, C. (2008), 'New measures of trade creation and trade diversion', Journal of International Economics 75(2): 340-362.

Silva, J. M. C. S. and Tenreyro, S. (2006), 'The Log of Gravity', The Review of Economics and Statistics 88(4): 641-658.

Soloaga, I. and Winters, L. A. (2001), 'Regionalism in the nineties: what effect on trade?', The North American Journal of Economics and Finance 12(1): 1-29

Swann, P., Temple, P. and M. Shurmer (1996) "Standards and trade performance: the UK experience", in Economic Policy, vol.15, pp. 7-46.

Tobin, J.L. and Busch M.L. (2010) "A Bit id better than a lot. Bilateral Investment Treaties and Preferential trade Agreements" in World Politics, vol.62(1), pp.1-42.

Trefler, D. (1993) "Trade Liberalization and the Theory of endogenous protection: an econometric studiy of U.S. imports policy", in Journal of Political Economy, vol.101(1), pp. 138-160.

Wooldridge J. (2001) "Econometric Analysis of Cross Section and Panel Data", Cambridge MIT Press.

Yeats, A. J. (2001), "Just How Big Is Global Production Sharing?" In Arndt, S.W., and Kierzkowski, H. eds., "Fragmentation: New Production Patterns in the World Economy", Oxford University Press

Table 1: WTO+ and WTO-X policy areas in PTAs

WTO+ AREAS	WTO-X AREAS	
PTA Industrial goods	Anti-Corruption	Health
PTA Agricultural goods	Competition Policy	Human Rights
Customs Administration	Environmental Laws	Illegal Immigration
Export Taxes	IPR	Illicit Drugs
SPS Measures	Investment Measures	Industrial Cooperation
State Trading Enterprises	Labour Market Regulation	Information Society
Technical Barriers to Trade	Movement of Capital	Mining
Countervailing Measures	Consumer Protection	Money Laundering
Antidumping	Data Protection	Nuclear Safety
State Aid	Agriculture	Political Dialogue
Public Procurement	Approximation of Legislation	Public Administration
TRIMS Measures	Audiovisual	Regional Cooperation
GATS	Civil Protection	Research and Technology
TRIPs	Innovation Policies	SMEs
	Cultural Cooperation	Social Matters
	Economic Policy Dialogue	Statistics
	Education and Training	Taxation
	Energy	Terrorism
	Financial Assistance	Visa and Asylum

Source: Horn *et al.* (2010).

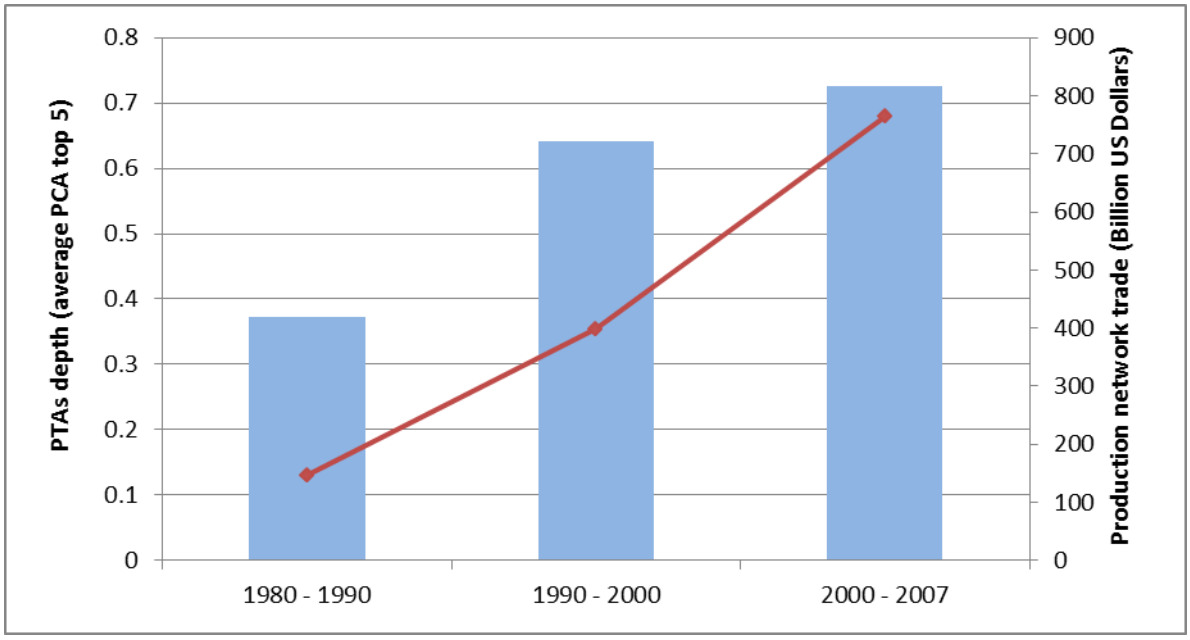
Table 2: Summary statistics

	Total number of provisions	Total number of WTO-X provisions	Total number of WTO+ provisions	PCA aggregate	PCA top 5
Mean	2.98	1.31	1.76	0.44	0.18
Standard deviation	6.29	3.64	3.36	0.96	0.41
Max	24	16	14	3.57	1.52
Min	0	0	0	0	0

Table 3: Correlation matrix

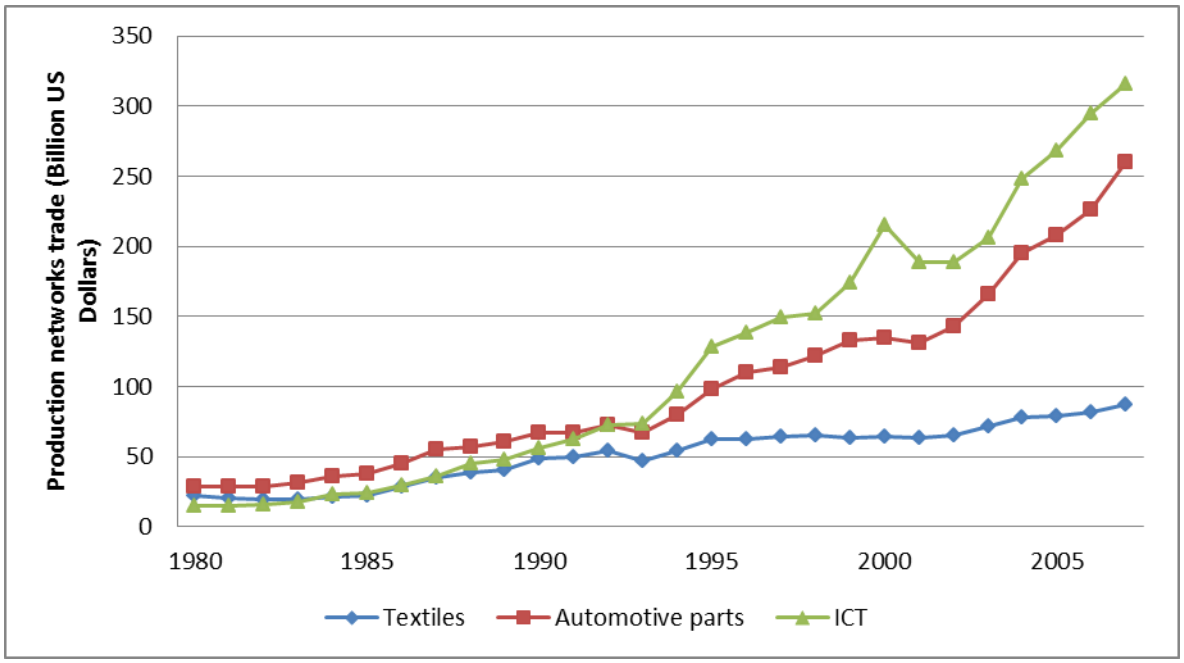
	Production network trade	Trade in final goods	PTA	Total number of provisions	Total number of WTO-X provisions	Total number of WTO+ provisions	PCA aggregate	PCA top 5	GDPSUM	GDPSIM	GDPDIF	SQGDPDIF	REMOTE
Production network trade	1												
Trade in final goods	0.8741	1											
PTA	0.1024	0.1221	1										
Total number of provisions	0.1766	0.2250	0.8166	1									
Total number of WTO-X provisions	0.1792	0.2365	0.6196	0.9306	1								
Total number of WTO+ provisions	0.1453	0.1776	0.8993	0.9233	0.7230	1							
PCA aggregate	0.1572	0.1943	0.7786	0.9102	0.8071	0.8761	1						
PCA top 5	0.1540	0.1944	0.7457	0.9225	0.8177	0.8893	0.9428	1					
GDPSUM	0.1953	0.2128	-0.0470	0.1167	0.1785	0.0292	0.0292	0.1233	1				
GDPSIM	0.0281	0.0383	0.2317	0.1777	0.1338	0.1976	0.1976	0.1596	-0.4392	1			
GDPDIF	-0.0456	-0.0682	-0.1174	-0.1987	-0.2121	-0.1552	-0.1552	-0.1670	0.2318	-0.2329	1		
SQGDPDIF	-0.0257	-0.0391	-0.0887	-0.1678	-0.1774	-0.1330	-0.1330	-0.1479	0.2173	-0.2036	0.9461	1	
REMOTE	0.0988	0.1061	0.2456	0.2856	0.2935	0.2410	0.2410	0.2011	-0.1469	0.2794	-0.2010	-0.1630	1

Figure 1: Production networks trade and deep integration



Source: authors calculations on WTR2011 and Comtrade databases.

Figure 2: Production networks trade patterns across industries



Source: authors calculations on Comtrade data.

Table 4: Effect of deep integration on production networks trade (OLS regression)

Dependent variable in logs	Production network trade	Trade in Final goods	Production network trade	Production network trade	Production network trade	Production network trade	Trade in final goods	Production network trade	Trade in final goods
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PTA_{ij}	0.415***	0.434***							
	(0.027)	(0.019)							
Total n. of provisions$_{ij}$			0.020***						
			(0.001)						
Total n. of WTO-X provisions$_{ij}$				0.030***					
				(0.002)					
Total n. of WTO+ provisions$_{ij}$					0.042***				
					(0.003)				
PCA aggregate$_{ij}$						0.301***	0.310***		
						(0.022)	(0.016)		
PCA top 5$_{ij}$								0.433***	0.458***
								(0.038)	(0.0281)
Country pair fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country-time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	63,414	63,414	63,414	63,414	63,414	63,414	63,414	63,414	63,415
R-squared	0.374	0.402	0.373	0.372	0.373	0.373	0,400	0.372	0.400
Number of id	3,604	3,604	3,604	3,604	3,604	3,.604	3,.604	3,604	3,605

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Effect of deep integration on production networks trade by industry (OLS regression)

Dependent variable	TEXTILES		AUTOMOTIVE		ITC	
Log of Production networks trade	(1)	(2)	(3)	(4)	(5)	(6)
PCA aggregate$_{ij}$	0.128***		0.528***		0.358***	
	(0.022)		(0.031)		(0.031)	
PCA top 5$_{ij}$		0.192***		0.812***		0.561***
		(0.037)		(0.051)		(0.051)
Country pair fixed effects	yes	yes	yes	yes	yes	yes
Country-time fixed effects	yes	yes	yes	yes	yes	yes
Observations	29,272	29,272	29,272	29,272	29,272	29,272
R-squared	0.330	0.330	0.424	0.423	0.422	0.421
Number of id	2,333	2,333	2,333	2,333	2,333	2,333

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Effect of PTA's depth on production networks trade by period (OLS regression)

Dependent variable: *Log of Production network trade*	1980 - 2007	1990 - 2007	2000 - 2007	1980 - 2007	1990 - 2007	2000 - 2007
	(1)	(2)	(3)	(4)	(5)	(6)
PCA aggregate$_{ij}$	0.301***	0.354***	0.450***			
	(0.022)	(0.022)	(0.024)			
PCA top 5$_{ij}$				0.433***	0.526***	0.721***
				(0.038)	(0.037)	(0.040)
Country pair fixed effects	yes	yes	yes	yes	yes	yes
Country-time fixed effects	yes	yes	yes	yes	yes	yes
Observations	63,414	48,813	25,045	63,414	48,813	25,045
R-squared	0.373	0.234	0.064	0.372	0.233	0.065
Number of id	3,604	3,627	3,580	3,604	3,627	3,580

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Effect of production networks trade on PTA's depth (OLS and Propensity Score Matching estimations)

	OLS estimation				
	Total number of provisions	Total number of WTO-X provisions	Total number of WTO+ provisions	PCA aggregate	PCA top 5
	(1)	(2)	(3)	(4)	(5)
Log Share PN trade	0.0371* (0.019)	0.0112 (0.015)	0.0263** (0.012)	0.0065*** (0.002)	0.0060*** (0.001)
Importer fixed effects	yes	yes	yes	yes	yes
Exporter fixed effects	yes	yes	yes	yes	yes
R^2	0.956	0.952	0.937	0.927	0.879
Observations	2,970	2,970	2,970	2,970	2,970
	Propensity Score Matching Estimation				
	(1)	(2)	(3)	(4)	(5)
Log Share PN trade	0.0344* (0.019)	0.0103 (0.015)	0.0244* (0.013)	0.0060** (0.002)	0.0058*** (0.001)
Importer fixed effects	yes	yes	yes	yes	yes
Exporter fixed effects	yes	yes	yes	yes	yes
R^2	0.956	0.949	0.938	0.930	0.880
Observations	2,819	2,819	2,819	2,819	2,819

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Other controls include: log distance, GDPSUM, GDPSIM, GDPDIF, SQGDPDIF, REMOTE.

Table 8: The role of North-South agreements on PTA's depth (OLS regression)

	PCA aggregate	PCA top 5
	(1)	(2)
Log Share PN trade	0.0068***	0.0060***
	(0.002)	(0.001)
North-South	-0.0721	0.1310***
	(0.069)	(0.046)
Log Share PN trade*North-South	0.0143	0.0238**
	(0.019)	(0.011)
Importer fixed effects	yes	yes
Exporter fixed effects	yes	yes
R^2	0.925	0.882
Observations	2,859	2,859

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Other controls include: log distance, GDPSUM, GDPSIM, GDPDIF, SQGDPDIF, REMOTE.

Table 9: Effect of production networks trade on PTA's depth by region (OLS regression)

Dependent variable: *PCA top 5*	Asia	East Asia	European Union (27)	South and Central America	Africa
	(2)	(3)	(4)	(5)	(6)
Log Share PN Trade	0.0134*	0.0169**	-0.0001	0.0000	0.0015
	(0.006)	(0.007)	(0.000)	(0.000)	(0.001)
Importer fixed effects	yes	yes	yes	yes	yes
Exporter fixed effects	yes	yes	yes	yes	yes
R^2	0.925	0.948	0.980	1.000	0.962
Observations	201	142	643	61	234

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Other controls include: log distance , GDPSUM, GDPSIM, GDPDIF, SQGDPDIF, REMOTE. For North America and the Middle East regressions were not performed due to an insufficient number of observations.

APPENDIX

Table A.1: Effect of PTA's depth on production networks trade (2SLS) - first stage regression results

Dependent variable: dummy variable equal to one if trade flows are positive	Production network trade	Trade in final goods	Production network trade	Production network trade	Production network trade	Production network trade	Trade in final goods	Production network trade	Trade in final goods
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PTA_{ij}	0.045***	0.046***							
	(0.004)	(0.003)							
Total n. of $provisions_{ij}$			0.001***						
			(0.000)						
Total n. of WTO-X $provisions_{ij}$				0.000					
				(0.000)					
Total n. of WTO+ $provisions_{ij}$					0.004***				
					(0.000)				
PCA $aggregate_{ij}$						0.014***	0.022***		
						(0.003)	(0.002)		
PCA top 5_{ij}								0.021***	0.038***
								(0.005)	(0.004)
Dummy=1 if trade at time t-5 >0	0.097***	0.081***	0.098***	0.098***	0.097***	0.098***	0.081***	0.098***	0.081***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.00523)
Country pair fixed effects	yes	yes	yes	yes	yes	Yes	yes	yes	yes
Country-time fixed effects	yes	yes	yes	yes	yes	Yes	yes	yes	yes
Observations	87,837	87,837	87,837	87,837	87,837	87,837	87,837	87,837	87,837
R-squared	0.416	0.517	0.415	0.415	0.416	0.415	0.517	0.415	0.517
Number of id	3,819	3,819	3,819	3,819	3,819	3,819	3,819	3,819	3,820

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Effect of PTA's depth on production network trade (2SLS) - second stage regression results

	Production network trade	Trade in final goods	Production network trade	Production network trade	Production network trade	Production network trade	Trade in final goods	Production network trade	Trade in final goods
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PTA_{ij}	0.315***	0.294***							
	(0.031)	(0.024)							
Total n. of $provisions_{ij}$			0.019***						
			(0.001)						
Total n. of WTO-X $provisions_{ij}$				0.034***					
				(0.002)					
Total n. of WTO+ $provisions_{ij}$					0.033***				
					(0.003)				
PCA $aggregate_{ij}$						0.284***	0.253***		
						(0.023)	(0.017)		
PCA top 5 $provisions_{ij}$								0.416***	0.356***
								(0.038)	(0.0302)
Fit of the first stage regression	2.419***	2.979***	2.441***	2.463***	2.439***	2.427***	2.955***	2.446***	2.968***
	(0.325)	(0.372)	(0.323)	(0.323)	(0.325)	(0.323)	(0.372)	(0.323)	(0.372)
Country pair fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country-time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	56,113	56,113	56,113	56,113	56,113	56,113	56,113	56,113	56,113
R-squared	0.322	0.369	0.321	0.321	0.321	0.321	0.368	0.321	0.367
Number of id	3,601	3,601	3,601	3,601	3,601	3,601	3,601	3,601	3,601

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A.3: Estimation results for the propensity score (probability of sign an agreement)

	PTA_{ij}
$Distance_{ij}$ (ln)	-1.059***
	(0.080)
$GDPSUM_{ij}$	0.279***
	(0.019)
$GDPSIM_{ij}$	0.479***
	(0.023)
$GDPDIF_{ij}$	0.114
	(0.101)
$SQGDPDIF_{ij}$	-0.089***
	(0.026)
$REMOTE_{ij}$	0.064***
	(0.011)
Log likelihood	-957.5
Pseudo R^2	0.526
Observations	3,535

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.