Trade and Global Value Chains in the EU: a Dynamic Augmented Gravity Model

FIRST DRAFT

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Abstract

Focusing on the so-called "Factory Europe" we assess the empirical importance of the supply chains connection for the elasticity of bilateral trade flows across European member countries by using an augmented specification of the gravity equation both in a static and in a dynamic setting. Specifically, we add to the standard gravity equation measures of production fragmentation, GVC involvement and trade interdependence and we account for endogeneity by using dynamic panel techniques to obtain unbiased estimates. Preliminary results show that the impact of the EU trade integration process is better specified and soundly interpretable when regressions properly account for the amount of vertical specialization and the effects of other countries on each bilateral trade relation.

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1. Introduction

The increasing fragmentation of production registered during the last decades has deeply changed trade flows by emphasizing the importance of trade in intermediate inputs and triadic flows as well as the concept of added value. Being the gravity equation typically employed to explain bilateral trade flows, its use in this new context requires further investigation. As underlined also by Baldwin and Taglioni (2014), when parts and components are important, as it especially happens for regional trade, the traditional gravity model needs to be enhanced. This analysis goes in this direction by presenting an augmented version of the gravity equation (both static and dynamic) in order to capture some features of the new globally integrated production and trade system.

The focus of this paper is Factory Europe, an hub and spoke system centered on Germany and characterized by strong supply chain connections between countries (Baldwin and Lopez-Gonzalez, 2014). In order to investigate trade implications of country production fragmentation, triadic or higher dependence, and trade in added value in the EU, this paper proposes an augmented gravity equation by adding proxies for supply chain interdependence and fragmentation. To this end, we use indices derived from the Koopman *et al.* (2014)' decomposition to control for value chain fragmentation, while we use network centrality measures to control for the effects of other countries on each bilateral relation (Anderson and van Wincoop, 2003).

We carry out our empirical exercise both in a static and in a dynamic setting, in line with the growing interest for the persistence of trade (Head and Mayer, 2013) as well as to face the issue of endogeneity that arises when the traditional equation is augmented with variables that are determined simultaneously along with the dependent variable. Both difference and system GMM estimates are presented in the empirical section.

Trade data used in this analysis come from the new World Input Output Database WIOD (Timmer *et al.*, 2012). WIOD provides bilateral trade flows at the industry level distinguished according to their final and intermediate use - for 40 countries from 1995 to 2011.

Preliminary results show that the impact of the EU trade integration process is better specified and soundly interpretable when regressions properly account for the amount of vertical specialization and the effects of other countries on each bilateral trade relation. However, some additional efforts are required in order to improve estimation results, especially solving the well known trade-off between the endogeneity of supply chain variables, on one hand, and the issue of instrument proliferation, on the other hand (Roodman, 2009).

The work is organized as follows: Section 2 introduces the new indicators of global value chains and value added trade as well some network centrality measures; Section 3 presents a descriptive analysis of the EU global value chains and some useful visualizations of the "Factory Europe" trade network; Section 4 shows all the regression results; Section 5 presents the conclusions.

2. Trade implications of GVCs: trade in value added and network interdependence

The availability of global input-output matrices led to methodological contributions on new metrics of GVCs. Several recent articles generalise the concept of vertical specialisation and capture different dimensions of value added embedded in trade (see for instance Johnson and Noguera (2012), Daudin et al. (2011) and Koopman et al. (2014)). The aim of this section is to introduce new data sets and approaches to describe the network of trade relations among EU member countries by accounting for their actual involvement in global value chains. This is done by presenting both some indices derived from the decomposition of gross exports into value-added components developed by Koopman et al. (2010 and 2014) that measure trade in value added and involvement in GVCs, and some indices derived from network analysis that measure the level of trade interdependence across EU member countries. These measures are then employed to describe supply chain patterns in Europe (see section 3) as well as to provide evidence of their relevance in assessing regional bilateral trade (see section 4).

2.1. GVC and Trade in value added: new indicators

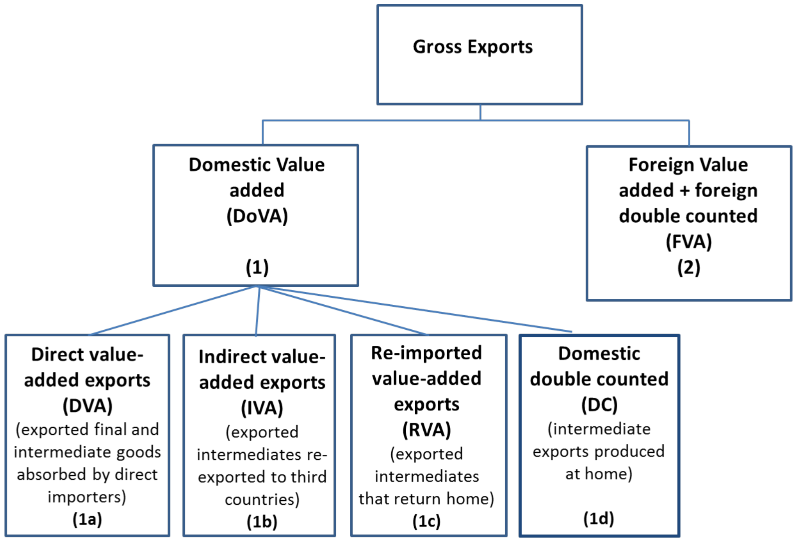
In a world characterized by the development of value chains, traditional trade statistics tend to overestimate the value created in each country in the production of its exports (Amador *et al.* (2014)). As argued by Cappariello and Felettigh (2014), there are two main reasons why gross exports need to be integrated with value added data: first of all, when processing trade is relevant, a decrease in the domestic share of gross exports is explained by an increase in both the foreign and the double counted components. Traditional statistics do not allow to capture this effect since they double count goods that cross international borders more than once; secondly, triangular production sharing prevent identifying the final demand that activates a country's exports. A new literature has emerged recently with the idea of tracing the value added of a country's trade flows by combining input-output tables with bilateral trade statistics and proposing new indicators (Hummels et al., 2001; Johnson and Noguera, 2012a, 2012b; Miroudot and Ragoussis, 2009; Koopman et al., 2011 and 2014; De La Cruz et al., 2011; Stehrer, 2013). In addition, advanced research on constructing appropriate databases is also being conducted by several institutions and research groups (see Johnson, 2014). As pointed out by Koopman *et al.* (2014), in order to decompose gross exports, input-output tables have to include three main elements: data distinguishing intermediate and final flows at the industry level within and between each country; the direct value added in production of each industry in all countries; the gross output of each industry in all countries. Data with these features are available in WIOD[1] [2]. They provide global input output tables with transactions at industry level specifying origin and destination. WIOD provides all the essential information to decompose gross exports: bilateral trade flows (including domestic transactions) at the industry level are distinguished according to their final and intermediate use; moreover, the dataset provides data concerning gross output by industries. WIOD concerns 40 countries (all the EU members included) together with a residual group (called Rest of the World) and 35 industries; it allows to identify the full gross export decomposition for a large period, from 1995 to 2011. All data collected form national sources are converted into US dollars.

By using these new data, scholars can now face the challenge of defining GVCs and trade in added value in statistically measurable elements and try to answer to some important research questions, such as: to what extent countries are involved in a vertically fragmented production? What is the position of a country/industry in the value chain? What is the actual production of value added of a country/industry? To this end, we apply the decomposition of the value added embodied in national gross exports proposed by Koopman *et al.* (2014).

[1] World Input Output Database, `http://www.wiod.org/new_site/data`. See Timmer *et al.* (2012) for details.

[2] Another possibility is to use data from GTAP, Global Trade Analysis Project, `https://www.gtap.agecon.purdue.edu/`. However, GTAP seems to be less appropriate for the aim of this essay because, even though it is a global database with Multi-Country Input-Output (MCIO) tables, it does not distinguish intermediate and final use of trade flows, requiring additional data manipulation (see Koopman *et al.* (2014) for details.)

Figure 1: Koopman et al. (2014)'s Gross Export Decomposition



Source: Elaboration of the authors from Koopman al. (2014)

The components derived from the above decomposition can be combined to derive other useful indices that help studying the involvement of each country in cross-border production chains. Two important measures can be derived to assess the involvement of a country/industry into a GVC: the GVC participation index and the GVC position index. The GVC participation indicator takes into account the indirect domestic value added exports (IVA)[3] and the foreign value-added exports (FVA)[4] to summarize the importance of global production chains in country (or industry) exports. Specifically, the GVC participation index for country i and industry k is:

$$GVCpar_{ik} = \frac{FVA_{ik}}{E_{ik}} + \frac{IVA_{ik}}{E_{ik}}$$

where E stands for gross exports, FVA is foreign VA and IVA is the domestic VA embodied in third countries' gross exports. The higher (lower) the value of the index, the larger (lower) is the participation of a country in GVCs.

The GVC position indicator is given by the ratio of the IVA exports and the FVA exports and measures the level of involvement of a country (or industry) in vertically fragmented production. It helps us to gauge whether a country is likely to be in the upstream or downstream of GVCs. Since at the global level IVA

[3]IVA reflects the indirect contribution of domestic supplier industries of intermediate goods or services used in other countries exports (i.e. value added exported in intermediates re-exported to third countries)

[4]FVA reflects the foreign value added content of intermediate imports embodied in gross exports (i.e., other countries domestic value added in intermediates used in exports).

and FVA equal each other, the higher (lower) the value of the index, the more upstream (downstream) the country exporters are situated in global value chain. The country lies upstream in the GVC, either by producing inputs and raw materials for others, or by providing manufactured intermediates or both; it lies downstream if it is a downstream processor or assembler adding inputs and value towards the end of the production process. Following Koopman et al. (2010) the GVC position index for country i and industry k is:

$$GVCpos_{ik} = \frac{IVA_{ik}}{E_{ik}} / \frac{FVA_{ik}}{E_{ik}}$$

2.2. GVC and trade interdependence: network measures

In order to measure the interactions between countries and their effect on bilateral trade relations we resort to Network analysis (NA). NA enables to represent the network of trade flows by giving emphasis to the relationship between the countries in the network and the structure of the network itself. The specificity of networks is that the relation between two nodes (i.e. countries in our case) is not analyzed in isolation, but it is studied focusing on its structural dimension, that is taking into account the 'effect of others' in the relation between them (i.e. taking into account the set of all possible trade relations with other partners that affect a dyadic flow) (De Benedictis *et al.*, 2014). NA provides several indicators to assess the importance of a node, capturing different aspects of its position (Borgatti, 2005). In this work, to take into account the 'interdependence' issue, we focus on centrality measures or 'ego' measures that give information about how and how much each single country is relatively positioned in the overall network, considering the trade relations with all countries inside and outside the geographical region to which it belongs (see De Benedictis *et al.* (2014) for more details on application of NA to international trade). Jackson (2010) classifies centrality measures into four main groups: 1) degree centrality, that measures how a node is connected to others; 2) closeness centrality, that shows how easily a node can be reached by other nodes; 3) betweenness centrality, that describes how important a node is in terms of connecting other nodes; 4) and eigenvector centrality , that associates a node's centrality to its neighbours' characteristics, directly referring to how important, central, influential or tightly clustered the neighbours are. In this first version of the paper we focus on two of these indices, namely the degree and the eigenvector centrality measures, as examples of local (the degree centrality) and global (the eigenvector centrality) measures. Degree centrality is the simplest measure of the position of a node (a country in our case) in a network . If the network is unweighted, it measures the centrality of a node by the number of connections (trade links here) the node has. If the network is weighted (i.e. trade volumes are considered instead of trade partnerships), the centrality (here called strength centrality) is given by the aggregate of the weights of trade flows connected to the country The strength centrality is essentially a local centrality measure as it takes into consideration only the direct links of a node, its nearest neighborhood, regardless of the position of the node in the network's structure. In a directed network, where the link (trade flows) go from the source country to the target country, there are two measures of degree centrality: in-degree centrality, measuring the links (import flows) pointing to ego, and out-degree centrality, measuring the links (export flows) pointing away from ego.

We use here both out-strength and in-strength centrality measures. They measure the total strength of the arcs exiting from a given country (out) / and the total strength of the arcs pointing to a given country (in), in terms of trade volumes. The measure is normalized by the number of possible trade partners.

(formula to be inserted here)

Moving from local centrality to global centrality we take into consideration the eigenvector centrality measure. It provides an indication of how important a node is by having the property of being large if a vertex has many neighbours, important neighbours, or both. Also in this case we refer to a weighted version of the out- and in-eigenvector centrality measures. The node's eigenvector centrality is determined by the eigenvector centrality of its neighbours (i.e., the country's centrality is given by the position of the countries linked to him). Here we use the weighted eigenvector centrality that is measured weighting the unweighted eigenvector centrality with the average bilateral trade volume in the Dijkstra (1959) algorithm.

(formula to be inserted here).

3. The EU global value chains: a descriptive analysis

By using the basic decomposition proposed by Koopman *et al.* (2014) and the indicators deriving from the same decomposition we can draw some insights about the value chain patterns for the EU member countries. Figure A.1 shows the average evolution of the DVA and FVA components for the EU member countries from 1995 to 2011. DVA still represents the main component of the EU gross exports even if during the last years the share of FVA has increased up to near 40 percentage points. This shows the tendency - with a break because of the crisis in 2008 - of the EU countries to increase their degree of vertical specialization over time. The average picture can be further investigated looking at the heterogeneous behaviour of individual EU members. Tables A.1 and A.2 show the domestic and the foreign value added shares for each EU country (and the average share for the EU-27) in four years, 1995, 2000, 2005 and 2010. As it is apparent from the tables, the main Eurozone economies (such as Italy, Germany and France) together with United Kingdom present the highest levels of DVA component. Conversely, the Central Eastern European countries (CEECs), with the relevant exception of Poland and Romania, show high shares of FVA (above the EU-27 average).

Also the share of IVA has increased from 1995 to 2008 while it has slightly declined from 2009. It gives relevant information about a country's upstream activities relative to its trade partners. The re-imported share appears to be of modest importance for total exports, apart from Germany and, to a lower extent, Italy, France and Spain. Even if this value is small in absolute term, it is of main importance implying the existence of supply chain connections where some intermediates are sent abroad to be processed before the final stage of production in the initial country (Amador *et al.* (2014)). Returning flows for advanced EU economies mainly comes from countries that joined the EU after 2004 (Koopman *et al.* (2010)); the re-imported share is particularly high for Germany: according to Amador *et al.* (2014) this depends on the German specialization in transport equipment, a sector characterized by a spider-shaped production process[5] in which both the most upstream stages and the final assembly remain in the home country. Even if the domestic component accounts for the largest part of gross exports, the data also testify the growing backward integration of the production process for advanced Eurozone economies. Finally, also the double counting component has increased, even though the share is modest relative to both the direct domestic value added and the foreign one; for the majority of EU countries it accounts on average for the 5 per cent of gross exports. Poland and Romania share with main Eurozone economies the importance of upstream activities: their share of indirect value added is on average, around 10 per cent. United Kingdom seems to represent a specific case in which the direct domestic component has remained around 70 percentage points for the whole period and its share of foreign value added is very small with respect to the other countries. Moreover, it has a significant share of both indirect domestic and re-imported value added. As suggested by Rahman and Zhao (2013), while the direct domestic value added (i.e. the first two items in the basic decomposition) is created outside the value chain, both the indirect and the re-imported domestic value added, together with the foreign component and the double counted items concern exports generated through the participation in global value chains. A combination of these items gives a measure of the international fragmentation of

[5] Baldwin and Venables (2010) define spider the production process in which separate parts are assembled into a final good without a specific order; on the contrary, the snake is a vertical flow of production in which the sequence of stages is determined by the engineering.

production. The data show that the dispersion of the production process has increased a lot in each EU country leading to a strong integration in the international production network. However, even if the share of international fragmentation for advanced EU members is rising, it is small relative to both partners in Central Eastern Europe and other advanced economies such as Belgium and Ireland.

To identify both the involvement of each country in the value chain and the role that EU members play in the production network, identifying upstream and downstream economies, figures A.2 - A.5 show participation and position index for each EU country in 4 reference years (1995, 2000, 2005 and 2010). Each figure reports the GVC participation index on the left axis and the GVC position index on the right one. Countries are ordered according to the position: countries on the right side are the most downstream producers while those on the left side are upstream economies. As expected, countries with the highest shares of FVA are the most downstream economies. Conversely, the index has larger values for countries with a relative high share of indirect value added such as United Kingdom that is the most upstream country in Europe, Romania and advanced Eurozone economies (mainly Germany, France, Italy and Finland). The position of these countries as upstream producers has increased during the analysed period even if for the majority of them, it has reduced during the crisis. Romania is an exception since its position as input supplier kept growing during the last years. On the contrary, for Poland the index has gradually decreased meaning that the country has changed its role in the value chain specializing in downstream activities. European Union countries are increasingly backward integrated; this is confirmed by the increase in the participation index that is larger for countries with the highest shares of FVA. For some EU members, the index has increased a lot: for Czech Republic and Hungary, for instance, it has risen from 30 to almost 50 per cent.

Recent analyses (Baldwin and Lopez-Gonzalez (2014), Iossifov (2014), Koopman *et al.* (2010), Miroudot *et al.* (2009)) have shown that there is a pan-European cross-border value chain characterized by large flows of intermediate goods and services that joins advanced EU economies (mainly Germany but also France, Italy and United Kingdom) and Central Eastern European countries. Based on this framework, we can also analyse connections between EU countries within cross border production chains. This is done using data and statistics from Trade in Value Added (TiVA) that provide detailed information at the bilateral level.[6]

Based on Iossifov (2014), interdependence has been analysed by looking at the participation of world

[6]TiVA dataset covers 57 countries and 18 industries that traces the sources and uses of value-added in international trade, also showing connections between countries along the chains. It allows to compute value added components for aggregate exports, but also at the bilateral and sector level. However, the dataset prevents distinguishing all the items identified in equations 8 and 10 since it has been built according to the 2010 decomposition (Koopman *et al.* (2010)). Moreover, data availability is restricted to 5 years (1995, 2000, 2005, 2008 and 2009). For additional details see `http://www.oecd.org/industry/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm`.

partners in value chains for both main Eurozone economies[7] and Central Eastern European countries showing, for each reference country, the rank of its first 15 partners. Results are shown in table A.3. A number of considerations arise. First, top partners for Eurozone countries are other EMU members. This is consistent with Amador and Cabral (2014)[8] who find that global value chains are very relevant for Eurozone countries taken as a whole; this system has shown a strong resilience also during the trade collapse. Germany lies in the first position for the majority of Eurozone countries: this confirms its role of manufacturing giant in the European value chain (Baldwin and Lopez-Gonzalez (2014)). Amador and Cabral (2014) compute a measure of trade in value added balance finding that Germany shows a surplus with respect to its Eurozone partners. Also United Kingdom plays an important role together with some Central Eastern EU countries (i.e. Czech Republic and Poland). CEE economies have gradually become sources of value added for the euro area, maintaining this role also during the trade collapse (Amador and Cabral (2014)). From the other side, when CEE economies are taken as reference, table A.4) shows that Eurozone countries, especially Germany, France and Italy account for a great amount of their supply chain trade. Even though some extra-EU countries occupy main positions in the ranks of both Eurozone and CEE economies (Russia, United States, Switzerland, China and Japan are usually in the top 15 positions), it is straightforward that EU countries are strongly integrated in their regional supply chain. Moreover, for both Eurozone and CEE economies, the residual group "rest of the world" usually lies in the first positions of the rank; it mainly refers to oil producers. An interesting point that comes from the data is that CEE economies share strong connections in terms of participation with each other: as suggested by Iossifov (2014), they are setting up their own production chain.

Interconnections between EU countries have also been analysed looking at the relative position of Eurozone and CEE countries[9] with respect to EU partners (A.5). The index is defined as the ratio of foreign and indirect domestic value added, i.e. as the share of value added from a trade partner embodied in reference country total exports on the domestic value added from reference country exported and then embodied in trade partner exports. Values of the index above 1 suggests that the trade partner is situated more upstream in the chain relative to the reference country, providing production inputs for exports; the opposite holds for values lower than 1. When the index is equal to 1, it means that the trade partner and the reference

[7] Main Eurozone countries are those who adopted the euro before 2002: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain.

[8] They analyze supply chain connections in the euro area employing the same decomposition we use in this section (Koopman *et al.* (2010)) but for a longer period (from 2000 to 2011)

[9] The countries considered are the same as for the participation index. Measures in tables A.3 and A.4 are computed taking reference country's total exports as denominator.

country play a similar role in the value chain. Focusing on EMU countries, it is possible to identify at least three groups in terms of position: first of all, there are some countries relative to which their partners are mainly located in downstream positions; this happens for Italy, France, Spain, Germany, Greece and Netherlands suggesting that these economies provide large amount of production inputs to other EU members. This results is consistent with the relative low share of foreign value added found for these countries and described above. The third group refers to remaining EU countries with respect to which their partners are located both upstream and downstream. In some cases, main upstream positions are occupied by CEE economies: Romania and Poland lie upstream with respect to Germany indicating that they act as input supplier for German producers; Latvia, Lithuania and Romania are located upstream with respect to Spain. When taking CEE economies as reference countries, four different situations appear: as for Luxembourg, each EU country is located upstream with respect to Hungary; the majority of EU partners are located upstream also with respect to Bulgaria, Slovak Republic and Slovenia. This is in line with the high shares of foreign value added found when decomposing gross trade confirming the dependence of these countries on imported inputs to produce goods for exports. On the contrary, there are many EU members that lie downstream with respect to Romania and Poland: differently form their partner in Central Eastern Europe, these two economies mainly act as input providers in the European production chain. Finally, the amount of EU partners located upstream and downstream relative to Czech Republic is balanced. Indeed, the basic decomposition shows that this country has both a significant and increasing share of foreign value added and a relatively high share of the indirect component; he acts as both an upstream and downstream producer in the European value chain. Apart from some exceptions[10], Euro area countries and United Kingdom lie upstream relative to each CEE country indicating that there are intense flows of intermediate inputs from the original EU members to them. As pointed out by Iossifov (2014), CEE economies mainly buy industrial equipment and value added components from euro area partners to produce both intermediate and final goods that are sold to final consumers worldwide through the value chain. Moreover, this could also be explained by the activity of multinational corporations that have offshored some production stages there.

In order to describe also the structure dimension of the EU countries trade, we use sociograms as a visual tool that allows to capture the multilateral effect on bilateral flows. It gives a visual representation of the network considering the relative position of each country in the European trading system based on the topological space rather than the geographical one. This choice gives a representation in which countries that

[10] As seen before, Germany lies downstream relative to both Poland and Romania.

are more connected tend to stay close, while those less connected are at the edges of the figure. However, the position in the figure is also influenced by the indirect effect of others because the position of each country also depends on that of the partners of its partners. Countries are represented by vertices or nodes and their trade relations by links. The strength of the flows is represented on a grey scale (only flows higher than 10th percentile are represented). Figure A.6 presents the European FVA network in 2009 where the size of the nodes are proportional to the weighted in-degree (VA import market share). The graph confirms the stylized facts described so far: i) the EU economies are deeply connected to each other in terms of input supply; ii) the role of Germany, France and Italy as main European buyers clearly emerges.

4. Empirical analysis

The aim of this analysis is to assess the empirical importance of the supply chains connection in Europe for the elasticity of bilateral trade flows across European member countries. To this end, the usual dummy strategy to assess the policy impact of the European membership using the baseline gravity equation has been augmented with new indices of global value chains and network centrality measures.

4.1. Model specification: static gravity equation

The specification of our gravity equation takes the usual log-linear form, where small letters denote variables in natural logarithms as follows:

$$x_{ijt} = \beta_0 + \beta_1 gdp_{it} + \beta_2 gdp_{jt} + \beta_3 ETA_{ijt} + \beta_4 gvc_{it} + \beta_5 gvc_{jt} - p_{it}^{1-\sigma} - p_{jt}^{1-\sigma} + \epsilon_{ijt} \quad (1)$$

where x_{ij} are export flows from country i to country j; gdp_i and gdp_j indicate, respectively, the GDP of countries i and j; ETA_{ij} is a set of dummies for controlling for the presence of European trade agreements (i.e., EMU, EU and others regional memberships); gvc_i and gvc_j are international fragmentation of production and other indices of global value chains; $p_i^{1-\sigma}$ and $p_j^{1-\sigma}$ are time varying multilateral (price) resistance terms (Anderson and van Wincoop, 2003); ϵ_{ij} is the error term and t denotes time. Following Koopman *et al.* (2014)'s framework, as global value chains' indices we use here the FVA indicator, which measure the degree of vertical specialization in gross exports (i.e., the sum of the foreign value added in a country's gross exports, included the double counted item) and the GVC position indicator computed as in section 2 .

It is common practice to proxy the multilateral (price) resistance term by using country-time fixed effects (Head and Mayer, 2013) and use also a set of country pair fixed effects as follows: θ_{jt}; ω_{ij}; ϕ_{it}. Country pair fixed effects control for the omitted variables bias due to the presence of possible other events specific to the country pair and contemporaneous to the treatment as well as the likely selection-bias of countries that join ETAs that can be explained by the same characteristics used by the gravity equations to explain trade flows (Persson, 2001; Baier and Bergstrand, 2004; De Benedictis and Taglioni, 2011). This omitted variable effects are specific to each trade flow and time invariant. Country time fixed effect proxy for time-varying multilateral resistance factors. Since both the mass variables and our GVC proxing factors are time varying for the exporter and/or the importer dimensions, they cannot be identified with country time fixed effects because of collinearity constraints (Head and Mayer, 2013). To overcome this constraint time varying network indices (η_{it}; η_{jt}) are here used as an alternative empirical approach to control for the *effects of third countries* ((De Benedictis and Tajoli, 2011) and (De Bruyne *et al.*, 2013)). Ward *et al.* (2013) recognize that while the network of world trade is highly interdependent, all the techniques employed to capture MR terms can be viewed as attempts to hold the rest of the world constant, assuming conditional independence at the dyadic level. On the contrary, the logic behind network is that having information about the relationship between i and j and between j and k may reveal something more about the relationship between i and k, even when we do not observe it. It means that in our estimates we proxy the multilateral (price) resistance term by using alternative network measures referred to the position in the world trade network of both the exporter and importer countries. In that case country pair and time fixed effects are kept to control for possible endogeneity in the dyadic relations and cyclical components. In this analysis we use the out-strength/in-strength degree centrality and the weighted out-eigenvector/in-eigenvector centrality measures provided by (De Benedictis *et al.*, 2014).

Since the attempt to overcome these problems by entering dummies and estimating a LSDV specification cannot be sufficient to take into account for possible endogeneity bias induced by both network and GVC statistics, we also apply a first difference transformation of the eq. 1 and estimate it by using both the one-step and two-step Arellano and Bond (1991) GMM estimators built on Holtz-Eakin et al. (1988). In this latter case also country pair fixed effects cancel out. Possible dyadic endogeneity is control for by GMM estimation technique. This also helps to control for other potential sources of unobserved heterogeneity which may be correlated with the other explanatory variables (including measurement errors, see Ponomareva and Katayama, 2010).

4.2. Model specification: dynamic gravity equation

To take into account the issue of persistence (Head and Mayer, 2013) we present also a dynamic version of eq. 1. In this specification, bilateral trade is explained also by its past levels and by the past levels of all the explanatory variables (Olivero and Yotov, 2012) and (Baldwin *et al.*, 2008) as follow:[11].

$$
\begin{aligned}
x_{ijt} = \alpha_0 + \alpha_1 x_{ijt-1} + \alpha_2 gdp_{it} + \alpha_3 gdp_{it-1} + \alpha_4 gdp_{jt} + \alpha_5 gdp_{jt-1} + \alpha_6 ETA_{ijt} + \alpha_7 ETA_{ijt-1} + \\
+ \alpha_8 gvc_{it} + \alpha_9 gvc_{it-1} + \alpha_{10} gvc_{jt} + \alpha_{11} gvc_{jt-1} + \alpha_{12} \eta_{it} + \alpha_{13} \eta_{it-1} + \\
+ \alpha_{14} \eta_{jt} + \alpha_{15} \eta_{jt-1} + \gamma_t + \mu_{ijt}
\end{aligned}
\quad (2)
$$

where η_i and η_j are network centrality measures for the exporter and the importer countries, respectively; γ_t is a time fixed effects; and the rest of the variables are the same as in eq. 1. Small letters denote, as usual, variables in natural logarithms and t denotes time.

This dynamic specification of our gravity equation keeps possible sources of endogeneity too: first, estimating it with OLS faces the traditional *dynamic panel bias* since the lagged dependent variable is correlated with the error term; second, it keeps additional endogeneity bias since the gravity equation is still augmented with variables that are determined simultaneously along with the dependent variable (i.e., GVC proxies and network indices); third, the presence of the policy variables (ETAs) induce the usual sources of possibile omitted variable endogeneity. Also in this case, LSDV estimates cannot be sufficient to remove such bias and risk to produce downward bias estimates. We have in fact a few time periods[12] and independent variables that are not strictly exogenous. To remove the bias we use in this case the Arellano-Bover/Blundell-Bond system generalised method of moments (SGMM) estimator (Arellano and Bover 1995; Blundell and Bond 1998). The Arellano-Bover/Blundell-Bond SGMM estimator augments the Arellano and Bond (1991) GMM estimator by including lagged level as well as lagged difference in a system of two equations (the original and the transformed ones). The first difference transformation is applied also here since our panel is strongly balanced (Roodman, 2009). The SGMM estimator increases dramatically the efficiency of the Arellano-Bond Difference GMM by involving a set of additional restrictions on the initial conditions of the process generating the dependent variable. It relies on the assumption that the first level lags of the variables in levels should be uncorrelated with observed country fixed effects (i.e., countries are not too far from steady states, in the sense that deviations from long-run means are not systematically related to fixed effects). The motivation for using the SGMM estimator instead of the GMM one, stands in the recognition that lags are likely to

[11] Olivero and Yotov (2012) also differentiate between time-varying trade costs and barriers that are constant over time. Since time varying barriers within the European Single Market are virtually absent we do not include this term in our specification. We believe this does not determine any serious bias

[12] The need to instrument the lagged dependent variable disappears when T is large enough that averaging over time yields stable results, Roodman, 2009

be weak instruments in the context of the Arellano and Bond (1991) GMM estimator if trade is expected to be persistent (past levels convey little information about future changes). Since in this case we should control for other possible sources of endogeneity other than the standard dynamic panel bias, we include in our estimation also instruments for both fragmentation and network indices. In the SGMM estimates one can also include time-invariant regressors, but time-invariant fixed effect dummies especially for short time series. Hence pair dummies are dropped from our estimates. The likely endogeneity of the ETAs is here controlled through the SGMM. Also in this case time fixed effects are kept to control for cyclical components.

4.3. Estimation results

Our gravity equations have been estimated for the period 1995-2009 for the 25 EU exporter countries and the 37 reporting countries for which WIOD trade value added data are available[13].

Tables 1 and 2 report LSDV and GMM estimates (both one-step and two-step) for different gravity specifications of eq. 1.

Recalling that in our empirical exercise we proxy the multilateral (price) resistance term by using alternative network measures, we can identify with our estimates also factors that vary only in the exporter or the importer dimensions (i.e., both mass variables and gvc indices). As apparent from the table, in all specifications the mass variable parameters are positive and significant. Conversely, EMU and EU membership show weak significance in LSDV estimates (Table 1) and mostly significant negative in GMM estimates (Table 2. The striking feature of our empirical exercise is that the indices of fragmentation and GVC position keep significance in almost all the specifications for both the importer and the exporter countries. Specifically, the positive coefficient for the importing countries (j) shows an apparent high correlation, on average, between intermediates and final imports, while the negative coefficient for the exporting countries (i) suggests a possible negative elasticity, on average, of bilateral exports to both fragmentation of production and upstreamness of the exporting countries. It is worth noting that these coefficients keep significance controlling for alternative centrality measures suggesting both the reliability of network measures to get rid the bilateral relations from the structure of the world trade network and the likely presence of a significant omitted variable bias in the gravity estimates that do not control for this. This latter evidence is emphasized by the fact that GVC and network controls come along with a strong reduction in magnitude of the euro

[13]Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia Republic, Slovenia, Spain, Sweden, United Kingdom, Canada, United States, China, India, Japan, South Korea, Australia, Brazil, Mexico, Taiwan, Turkey, Indonesia. Russia, Belgium and Luxembourg have been dropped in the estimates because of data availability

Table 1: Static augmented LSDV gravity model estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log GDP exporter		0.374***	0.595***	0.633***	0.481***	0.322***	0.533***	0.651***	0.523***
		(0.001)	(0.000)	(0.000)	(0.001)	(0.004)	(0.000)	(0.000)	(0.000)
Log GDP importer		0.616***	0.728***	0.657***	0.749***	0.726***	1.012***	0.837***	1.008***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
EMU (yes=1)	0.0255	-0.0237	-0.0280	-0.0347	-0.0275	-0.0628**	-0.0582*	-0.0771**	-0.0493+
	(0.612)	(0.464)	(0.386)	(0.280)	(0.390)	(0.046)	(0.066)	(0.015)	(0.118)
EU (yes=1)	-0.0678	-0.000498	0.0115	0.00773	0.0134	-0.00741	0.0216	0.000207	0.0311
	(0.305)	(0.990)	(0.777)	(0.848)	(0.739)	(0.859)	(0.590)	(0.996)	(0.432)
Log FVA exporter			0.416**		-0.735***		0.386**		-0.671**
			(0.019)		(0.008)		(0.021)		(0.026)
Log FVA importer			0.173		0.347+		0.428***		0.850***
			(0.174)		(0.106)		(0.001)		(0.000)
Log Pos exporter				-0.403***	-0.774***			-0.422***	-0.746***
				(0.000)	(0.000)			(0.000)	(0.000)
Log Pos importer				-0.0566	0.126			-0.130+	0.332**
				(0.471)	(0.345)			(0.134)	(0.017)
Log outdregree strength$_i$		1.051***	0.979***	0.914***	0.910***				
		(0.000)	(0.000)	(0.000)	(0.000)				
Log indregree strength$_i$		0.0872	-0.0477	0.00434	0.168				
		(0.533)	(0.751)	(0.976)	(0.236)				
Log outdregree strength$_j$		-0.154	-0.193*	-0.176*	-0.187*				
		(0.152)	(0.071)	(0.098)	(0.077)				
Log indregree strength$_j$		0.678***	0.605***	0.653***	0.586***				
		(0.000)	(0.000)	(0.000)	(0.000)				
Log outdegree eigenvector centrality$_i$						0.464***	0.442***	0.430***	0.431***
						(0.000)	(0.000)	(0.000)	(0.000)
Log indegree eigenvector centrality$_i$						0.564***	0.416***	0.350***	0.456***
						(0.000)	(0.001)	(0.003)	(0.000)
Log outdegree eigenvector centrality$_j$						-0.201**	-0.247***	-0.217***	-0.257***
						(0.016)	(0.003)	(0.009)	(0.002)
Log indegree eigenvector centrality$_j$						0.466***	0.276**	0.383***	0.302***
						(0.000)	(0.011)	(0.000)	(0.005)
cons.	5.039***	-28.38***	-30.25***	-29.16***	-28.34***	-4.392**	-14.11***	-11.37***	-12.14***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.047)	(0.000)	(0.000)	(0.000)
country pair dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes
*Exporter*time dummy*	yes	no	no	no	no	no	no	no	no
*Importer*time dummy*	yes	no	no	no	no	no	no	no	no
No Obs	15355	13469	13469	13469	13469	13469	13469	13469	13469
AB test (AR2)									
No Instr.									
R-sq	0.967	0.964	0.964	0.964	0.964	0.963	0.963	0.963	0.964
adj. R-sq	0.962	0.961	0.961	0.961	0.961	0.960	0.961	0.961	0.961

* In xtabond2 the R-squared is not available. It is computed as the squared correlation coefficient between actual and fitted values.

Robust s.e. clustered by pair in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Static augmented GMM gravity model estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log GDP exporter	0.898***	1.192***	1.088***	0.796***	0.776***	1.175***	1.323***	1.138***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log GDP importer	0.799***	0.747***	0.367***	0.520***	1.745***	1.966***	1.623***	1.790***
	(0.000)	(0.000)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
EMU (yes=1)	-0.0763**	-0.0849***	-0.0689**	-0.0755***	-0.0758**	-0.0684**	-0.0767**	-0.0865***
	(0.014)	(0.003)	(0.019)	(0.005)	(0.025)	(0.032)	(0.024)	(0.003)
EU (yes=1)	-0.107***	-0.100***	-0.0975***	-0.0740***	-0.0281	-0.0180	-0.0277	0.0325+
	(0.000)	(0.000)	(0.000)	(0.001)	(0.245)	(0.418)	(0.222)	(0.122)
Log FVA exporter		0.458**		-0.995***		0.705***		-0.443+
		(0.010)		(0.000)		(0.001)		(0.103)
Log FVA importer		-0.0106		0.972***		0.540***		0.802***
		(0.949)		(0.000)		(0.005)		(0.002)
Log Pos exporter			-0.378***	-1.032***			-0.570***	-0.939***
			(0.001)	(0.000)			(0.000)	(0.000)
Log Pos importer			0.410***	0.856***			-0.184+	0.121
			(0.001)	(0.000)			(0.134)	(0.436)
Log outdregree strength$_i$	0.461***	0.680***	0.518***	0.684***				
	(0.003)	(0.000)	(0.000)	(0.000)				
Log indregree strength$_i$	-0.421**	-0.755***	-0.402***	-0.0968				
	(0.014)	(0.000)	(0.007)	(0.409)				
Log outdregree strength$_j$	0.320*	0.267*	0.161	0.645***				
	(0.068)	(0.084)	(0.313)	(0.000)				
Log indregree strength$_j$	0.0707	0.102	0.496***	0.0663				
	(0.643)	(0.456)	(0.001)	(0.593)				
Log outdegree eigenvector centrality$_i$					-0.0522	0.281***	0.195**	0.461***
					(0.573)	(0.002)	(0.035)	(0.000)
Log indegree eigenvector centrality$_i$					0.132	-0.295**	-0.335***	-0.230**
					(0.276)	(0.018)	(0.005)	(0.028)
Log outdegree eigenvector centrality$_j$					0.226+	0.115	0.192	0.392***
					(0.122)	(0.372)	(0.156)	(0.000)
Log indegree eigenvector centrality$_j$					-0.797***	-0.898***	-0.696***	-0.914***
					(0.000)	(0.000)	(0.000)	(0.000)
cons.								
country pair dummy	no	no	no	no	no	no	no	no
Time dummy	yes	yes	yes	yes	yes	yes	yes	yes
*Exporter*time dummy*	no	no	no	no	no	no	no	no
*Importer*time dummy*	no	no	no	no	no	no	no	no
No Obs	12559	12559	12559	12559	12559	12559	12559	12559
AB test (AR2)	0.002	0.002	0.002	0.001	0.002	0.003	0.002	0.002
No Instr.	88	116	116	144	88	116	116	144
R-sq	0.599	0.656	0.680	0.666	0.493	0.600	0.604	0.628
adj. R-sq								

* In xtabond2 the R-squared is not available. It is computed as the squared correlation coefficient between actual and fitted values.

Robust s.e. clustered by pair in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

dummy (and partially also of the EU dummy). This is in line with the emerging strand of the literature that explains the "euro effects" by the increasing relevance of the supply chain links among European countries (Flam and Nordström, 2006).

However, the p-value of the Arellano-Bond test is strongly against the null hypothesis of no AR(2) errors.[14] It denounces the presence of additional serial correlation in the first-differenced errors for our GMM empirical estimates suggesting to move on to the dynamic model. Tables 3 and 4 reports both LSDV and SGMM estimates for different gravity specifications of eq. 2.

Empirical results show, firstly, that introducing the lagged level of both dependent and independent variables the explanatory power of the model significantly improves (this is supported by the higher values of the R^2 coefficients). Moreover, as largely expected, the coefficients of LSDV estimates are usually downward bias with respect to SGMM ones. Second, the strong significance of the coefficient of the lagged dependent variable (which lies in the usual range (Olivero and Yotov, 2012)); third, the mass variable parameters keep significance and show the expected signs in the dynamic model when we control for alternative centrality measures; fourth, the coefficients of alternative network centrality measures keep significance, generally speaking, also in the dynamic estimates, included the SGMM ones. This confirms the key role of the structure of the world trade network in our estimates. Specifically, as expected, while there is, on average, a positive association between the magnitude of bilateral flows and the out-degree centrality in the world network of the exporter countries (i), the opposite relation is in place in the case of the importer countries (j). Similarly for the in-degree centrality, a significant positive association with bilateral trade flows is in place for the importing countries while the in-degree centrality of the exporters is not significant. It is worth mentioning that both signs and significance of network centrality measures keep consistency in both static and dynamic estimates (we can see this confronting results in tables 1 and in table 2 with 3 and in table 4). Turning to the key variables of our analysis (i.e., supply chain connection), it is interesting to see that the SGMM estimates show, on average, a strong positive relation between the foreign value added content of the exporting countries and the magnitude of their exports of final goods (this effect is partially reduced by controlling for the past level of the same foreign value added content). This suggests the relevance within

[14] The presence of autocorrelation in the idiosyncratic disturbance term would render some lags invalid as instruments. Of course, the full disturbance is presumed to be autocorrelated because it contains fixed effects. Hence rejecting the null hypothesis of first-order serial correlation in the first-differenced errors does not imply model misspecification because the first-differenced errors are serially correlated even if the idiosyncratic errors are independent and identically distributed (and the GMM estimation procedure is specifically designed to eliminate this source of trouble). It is only rejection of the null hypothesis of no serial correlation in the first-differenced errors at an order greater than one which implies model misspecification. In fact, if some instruments are endogenous to the error term in differences they become potentially invalid instruments after all (Roodman, 2009).

Table 3: Dynamic augmented LSDV gravity model estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
L. Log exports	0.470***	0.466***	0.466***	0.464***	0.463***	0.473***	0.472***	0.471***	0.467***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log GDP exporter		0.148	0.324**	0.264**	0.287**	0.129	0.350***	0.321**	0.365***
		(0.218)	(0.019)	(0.046)	(0.032)	(0.283)	(0.008)	(0.012)	(0.005)
L. Log GDP exporter		0.0418	0.0587	0.100	0.0282	-0.0113	-0.0716	0.000646	-0.0819
		(0.702)	(0.625)	(0.395)	(0.810)	(0.922)	(0.569)	(0.996)	(0.508)
Log GDP importer		0.366***	0.424***	0.396***	0.447***	0.417***	0.534***	0.494***	0.535***
		(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
L. Log GDP importer		0.0264	0.0996	0.0203	0.128	0.0284	0.126	0.0147	0.122
		(0.831)	(0.410)	(0.867)	(0.289)	(0.839)	(0.363)	(0.914)	(0.379)
EMU (yes=1)	0.0406	0.0179	0.0243	0.0250	0.0299	0.0285	0.0326	0.0314	0.0365+
	(0.338)	(0.461)	(0.326)	(0.315)	(0.231)	(0.236)	(0.181)	(0.200)	(0.140)
Lagged EMU (yes=1)	-0.0145	-0.00734	-0.0193	-0.0234	-0.0118	-0.0446*	-0.0451*	-0.0592**	-0.0346+
	(0.735)	(0.758)	(0.417)	(0.336)	(0.625)	(0.054)	(0.052)	(0.012)	(0.142)
EU (yes=1)	-0.0852*	0.0311	0.0357	0.0305	0.0378	0.0275	0.0387	0.0248	0.0379
	(0.088)	(0.289)	(0.223)	(0.301)	(0.205)	(0.361)	(0.190)	(0.405)	(0.207)
Lagged EU (yes=1)	0.0914*	-0.0489*	-0.0401	-0.0441+	-0.0330	-0.0506*	-0.0369	-0.0451+	-0.0257
	(0.077)	(0.092)	(0.166)	(0.128)	(0.260)	(0.084)	(0.208)	(0.121)	(0.381)
Log FVA exporter			0.414***		0.227		0.469***		0.225
			(0.002)		(0.285)		(0.000)		(0.288)
L. Log FVA exporter			-0.104		-0.492**		-0.217*		-0.475**
			(0.401)		(0.021)		(0.082)		(0.027)
Log FVA importer			0.0831		0.122		0.179+		0.184
			(0.472)		(0.506)		(0.116)		(0.325)
L. Log FVA importer			0.107		0.453**		0.126		0.537***
			(0.304)		(0.016)		(0.218)		(0.005)
Log Pos exporter				-0.246***	-0.167			-0.291***	-0.210*
				(0.002)	(0.185)			(0.000)	(0.083)
L. Log Pos exporter				0.00748	-0.220*			0.0697	-0.145
				(0.913)	(0.065)			(0.324)	(0.229)
Log Pos importer				-0.0435	0.0426			-0.0998+	0.0421
				(0.524)	(0.686)			(0.140)	(0.693)
L. Log Pos importer				0.0201	0.238**			0.0404	0.296***
				(0.740)	(0.029)			(0.494)	(0.007)
Log outdregree strength$_i$		0.448***	0.420***	0.434***	0.430***				
		(0.000)	(0.000)	(0.000)	(0.000)				
Log indregree strength$_i$		-0.235***	-0.257***	-0.240***	-0.269***				
		(0.004)	(0.002)	(0.003)	(0.001)				
Log outdregree strength$_j$		0.184+	0.112	0.152	0.162				
		(0.115)	(0.355)	(0.214)	(0.183)				
Log indregree strength$_j$		0.664***	0.641***	0.648***	0.613***				
		(0.000)	(0.000)	(0.000)	(0.000)				
L. Log outdregree strength$_i$		0.141	0.107	0.0561	0.0464				
		(0.178)	(0.306)	(0.601)	(0.665)				
L. Log indregree strength$_i$		0.156*	0.133*	0.150*	0.160**				
		(0.051)	(0.095)	(0.055)	(0.043)				
L. Log outdregree strength$_j$		-0.0872	-0.122	-0.0915	-0.0277				
		(0.508)	(0.359)	(0.499)	(0.841)				
L. Log indregree strength$_j$		-0.322***	-0.385***	-0.318***	-0.405***				
		(0.000)	(0.000)	(0.000)	(0.000)				
Log outdegree eigenvector centrality$_i$						0.202**	0.197**	0.212***	0.213***
						(0.010)	(0.012)	(0.006)	(0.006)
Log indegree eigenvector centrality$_i$						-0.179***	-0.197***	-0.176**	-0.212***
						(0.010)	(0.005)	(0.011)	(0.003)
Log outdegree eigenvector centrality$_j$						0.228**	0.110	0.136	0.134
						(0.015)	(0.250)	(0.157)	(0.168)
Log indegree eigenvector centrality$_j$						0.481***	0.410***	0.431***	0.407***
						(0.000)	(0.000)	(0.000)	(0.000)
L. Log outdegree eigenvector centrality$_i$						0.0384	0.0226	0.00484	-0.00279
						(0.633)	(0.779)	(0.953)	(0.973)
L. Log indegree eigenvector centrality$_i$						0.0979+	0.0827	0.0853	0.0875
						(0.114)	(0.175)	(0.157)	(0.153)
L. Log outdegree eigenvector centrality$_j$						0.163*	0.184**	0.139+	0.188**
						(0.082)	(0.050)	(0.146)	(0.046)
L. Log indegree eigenvector centrality$_j$						-0.282***	-0.354***	-0.274***	-0.323***
						(0.000)	(0.000)	(0.000)	(0.000)
cons.	-0.842***	-17.42***	-19.16***	-18.22***	-19.36***	-2.313+	-9.779***	-6.589***	-9.362***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.132)	(0.000)	(0.001)	(0.000)
country pair dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes
*Exporter*time dummy*	yes	no	no	no	no	no	no	no	no
*Importer*time dummy*	yes	no	no	no	no	no	no	no	no
No Obs	14318	12559	12559	12559	12559	12559	12559	12559	12559
AB test (AR2)									
No Instr.									
R-sq	0.978	0.975	0.975	0.975	0.975	0.975	0.975	0.975	0.975
adj. R-sq	0.974	0.973	0.973	0.973	0.973	0.973	0.973	0.973	0.973

* In xtabond2 the R-squared is not available. It is computed as the squared correlation coefficient between actual and fitted values.

Robust s.e. clustered by pair in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Dynamic augmented SGMM gravity model estimates

	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
L. Log exports	0.533***	0.549***	0.597***	0.570***	0.602***	0.647***	0.647***	0.617***	0.678***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log GDP exporter		0.113	0.375**	0.145	0.324**	0.280*	0.609***	0.421***	0.586***
		(0.499)	(0.017)	(0.365)	(0.031)	(0.091)	(0.000)	(0.009)	(0.000)
L. Log GDP exporter		0.0216	-0.108	-0.0798	-0.0843	-0.144	-0.286**	-0.225+	-0.293**
		(0.868)	(0.459)	(0.573)	(0.561)	(0.274)	(0.037)	(0.105)	(0.029)
Log GDP importer		-0.219	0.127	-0.161	-0.00509	0.518***	0.383**	0.600***	0.306*
		(0.224)	(0.485)	(0.381)	(0.977)	(0.001)	(0.016)	(0.000)	(0.056)
L. Log GDP importer		-0.413***	-0.304**	-0.506***	-0.350***	0.0965	0.180	0.207	0.0436
		(0.002)	(0.025)	(0.000)	(0.005)	(0.559)	(0.288)	(0.201)	(0.784)
EMU (yes=1)	0.0725+	-0.0422	-0.0448+	-0.0463+	-0.0288	-0.0357	-0.0457+	-0.0529*	-0.0549*
	(0.112)	(0.176)	(0.124)	(0.133)	(0.324)	(0.270)	(0.130)	(0.099)	(0.065)
Lagged EMU (yes=1)	0.0681	0.0700**	0.0317	0.0833**	0.0479+	0.0407	-0.0136	0.00699	-0.00682
	(0.167)	(0.038)	(0.297)	(0.016)	(0.137)	(0.163)	(0.625)	(0.818)	(0.812)
EU (yes=1)	-0.00164	0.254***	0.256***	0.251***	0.199***	0.336***	0.248***	0.331***	0.171***
	(0.976)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Lagged EU (yes=1)	0.0605	0.0500	0.0559+	0.0719**	0.0610*	0.0640*	0.0306	0.0575*	0.00850
	(0.322)	(0.166)	(0.111)	(0.045)	(0.082)	(0.070)	(0.378)	(0.094)	(0.804)
Log FVA exporter				0.814***		1.014***	0.768***		0.954***
				(0.000)		(0.000)	(0.000)		(0.000)
L. Log FVA exporter				-0.331**		-0.596**	-0.454***		-0.518**
				(0.031)		(0.011)	(0.003)		(0.029)
Log FVA importer				0.175		0.197	0.0776		0.278
				(0.170)		(0.422)	(0.586)		(0.275)
L. Log FVA importer				0.0410		0.856***	0.543***		1.025***
				(0.797)		(0.001)	(0.000)		(0.000)
Log Pos exporter					-0.401***	0.163		-0.307***	0.103
					(0.000)	(0.274)		(0.001)	(0.425)
L. Log Pos exporter					0.146*	-0.180		0.213**	-0.0518
					(0.081)	(0.161)		(0.014)	(0.688)
Log Pos importer					0.109	0.418**		-0.232***	0.216+
					(0.262)	(0.015)		(0.008)	(0.150)
L. Log Pos importer					0.179**	0.524***		-0.192**	0.379**
					(0.028)	(0.000)		(0.023)	(0.011)
Log outdregree strength$_i$		0.513***	0.346***	0.444***	0.351***				
		(0.000)	(0.002)	(0.000)	(0.001)				
Log indregree strength$_i$		-0.271**	-0.296***	-0.288***	-0.488***				
		(0.015)	(0.005)	(0.005)	(0.000)				
Log outdregree strength$_j$		0.0892	0.0623	0.216	0.0881				
		(0.588)	(0.704)	(0.207)	(0.553)				
Log indregree strength$_j$		1.271***	1.011***	1.193***	1.129***				
		(0.000)	(0.000)	(0.000)	(0.000)				
L. Log outdregree strength$_i$		-0.0673	-0.125	-0.200*	-0.149+				
		(0.610)	(0.261)	(0.096)	(0.148)				
L. Log indregree strength$_i$		0.138	0.0350	0.162+	0.186**				
		(0.203)	(0.726)	(0.128)	(0.049)				
L. Log outdregree strength$_j$		-0.119	-0.0255	0.0786	-0.00270				
		(0.451)	(0.872)	(0.613)	(0.987)				
L. Log indregree strength$_j$		0.114	-0.0985	0.145	0.0141				
		(0.247)	(0.406)	(0.195)	(0.893)				
Log outdegree eigenvector centrality$_i$						0.356***	0.313***	0.376***	0.254***
						(0.000)	(0.000)	(0.000)	(0.003)
Log indegree eigenvector centrality$_i$						-0.154**	-0.280***	-0.129*	-0.441***
						(0.037)	(0.000)	(0.081)	(0.000)
Log outdegree eigenvector centrality$_j$						0.101	-0.165	0.00926	-0.0959
						(0.491)	(0.213)	(0.945)	(0.424)
Log indegree eigenvector centrality$_j$						0.384***	0.651***	0.315***	0.861***
						(0.001)	(0.000)	(0.003)	(0.000)
L. Log outdegree eigenvector centrality$_i$						-0.0885	-0.0928	-0.126	-0.140*
						(0.367)	(0.299)	(0.157)	(0.073)
L. Log indegree eigenvector centrality$_i$						-0.112	-0.0420	-0.131*	0.0417
						(0.150)	(0.562)	(0.100)	(0.570)
L. Log outdegree eigenvector centrality$_j$						-0.109	0.0341	-0.0110	0.0854
						(0.320)	(0.750)	(0.922)	(0.402)
L. Log indegree eigenvector centrality$_j$						-0.574***	-0.599***	-0.629***	-0.489***
						(0.000)	(0.000)	(0.000)	(0.000)
cons.	-0.403+	-12.71***	-12.85***	-13.79***	-15.68***	-8.043***	-12.58***	-12.08***	-10.70***
	(0.146)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
country pair dummy	no	no	no	no	no	no	no	no	no
Time dummy	no	yes	yes	yes	yes	yes	yes	yes	yes
*Exporter*time dummy*	yes	no	no	no	no	no	no	no	no
*Importer*time dummy*	yes	no	no	no	no	no	no	no	no
No Obs	14318	12559	12559	12559	12559	12559	12559	12559	12559
AB test (AR2)	0.810	0.948	0.840	0.928	0.860	0.747	0.794	0.795	0.792
No Instr.	928	100	132	132	164	100	132	132	164
R-sq	0.954	0.930	0.944	0.938	0.945	0.942	0.952	0.942	0.955

* In xtabond2 the R-squared is not available. It is computed as the squared correlation coefficient between actual and fitted values.

Robust s.e. clustered by pair in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

the Factory Europe of the increasing fragmentation of production and the emergence in the average bilateral flows of final goods of the so-called “factory countries”. It should be noted, however, that this positive relation is not apparent in the static analysis that does not properly account for the persistent nature of trade and the dynamic nature of the other variables in the gravity equation. Conversely, the relationship between the magnitude of imports of final goods and the upstream position of the importing countries is ambiguous. Finally, it is worth mentioning that while the “euro effect” is not significant (or even negative) in SGMM estimates, the EU dummy confirms its positive and statistical significant effect and lies in the usual range.

The consistency of the SGMM estimates cannot be taken for granted and depends strictly on the validity of the moment conditions used. As shown in table 2 the null hypothesis of no AR(2) errors this time is strongly supported by the p-value of the Arellano-Bond test, giving ground to the hypothesis of no serial correlation in the first-differenced errors for our SGMM empirical estimates.[15]

5. Conclusions

This work is an attempt to assess the empirical importance of the supply chains connection in Europe for the elasticity of bilateral trade flows across European member countries by using an augmented specification of the gravity equation in both a static and a dynamic setting. The main finding is that estimating a dynamic gravity equation augmented with indices that take into account for production fragmentation, GVC involvement and trade interdependence we can derive a better specified and soundly interpretable modelling of the EU trade linkages. Notwithstanding additional efforts could be made to improve estimation results, especially solving the trade-off between the endogeneity of supply chain variables from one hand, and instrument proliferation from the other hand, some conclusive remarks can be drawn. First, along with the deepening of the European integration, and the adoption of a common currency, an increasing process of production unbundling seems to be currently in place in the EU. This is consistent with predictions of the new economic geography (Hummels *et al.* (2001)). Second, the ability of the gravity equation to explain

[15] Arellano and Bond demonstrated that this test has greater power than the Sargan and the Hansen tests to detect lagged instruments when they are invalid because of autocorrelation. The test is valid for any GMM regression using panel data and it is based on the assumption that errors are not correlated across individuals; this explains why it is important to use time dummies: removing time related shocks from the errors, time fixed effects prevent the contemporaneous correlation. On the contrary, the validity of both the Sargan and the Hansen tests in gravity estimates is limited by two main problems: first of all, the Sargan test requires homoskedastic errrors for consistency (Roodman (2009a)). Therefore, since the log-linear gravity equation is characterized by heteroskedasticity, the Sargan test becomes inconsistent. Moreover, the Hansen test is vitiated by instrument proliferation. When there are many instruments, they can overfit the number of instrumented variables making the test misleading. Since sometimes the bias is present also with few instruments, it is not possible to define when the instruments are ”too many” (Roodman (2009b)).

the properties of the international trade network is to be tested. This is also consistent with the strand of the literature that highlights how the performance of the gravity model actually decreases when it is used to estimate higher order statistics such as triadic structures comparing the topological properties of the observed international trade network to the ones estimated through a gravity equation (Dueñas and Fagiolo (2013); Ward *et al.* (2013)).

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Appendix A. Tables & Figures

Figure A.1: Basic decomposition, EU27 as a group

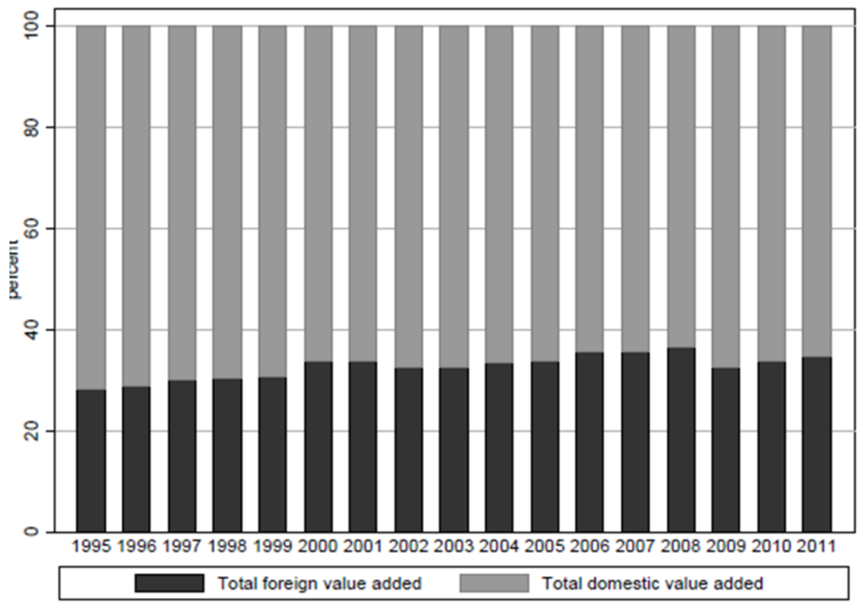


Table A.1: Domestic value added by country (1995-2000-2005-2010).

1995		2000		2005		2010	
DEU	82.90	GBR	81.08	GBR	82.30	GBR	79.62
POL	82.78	ITA	79.18	ITA	77.85	ROM	75.95
ITA	81.30	DEU	77.80	CYP	77.62	GRC	75.78
GRC	80.90	FRA	75.58	DEU	75.81	LVA	75.39
GBR	80.72	LVA	73.83	FRA	75.22	ITA	74.46
FRA	80.50	POL	73.73	GRC	73.80	DEU	73.91
ESP	79.44	ROM	73.29	ESP	73.61	FRA	73.19
ROM	76.68	ESP	72.78	ROM	70.45	CYP	72.86
FIN	76.59	FIN	72.45	SWE	69.92	ESP	72.69
AUT	76.14	AUT	71.81	LVA	69.83	PRT	72.46
LVA	74.91	SWE	70.17	POL	69.83	SWE	68.35
SWE	74.34	DNK	70.02	FIN	69.63	AUT	67.81
DNK	73.71	PRT	69.98	PRT	69.29	POL	67.63
CYP	73.15	GRC	69.34	AUT	68.29	FIN	67.32
PRT	72.45	CYP	67.73	DNK	67.53	EST	66.81
EU27	**71.65**	LTU	66.06	NLD	66.36	LTU	66.15
HUN	71.18	**EU27**	**66.15**	**EU27**	**66.18**	**EU27**	**66.14**
CZE	70.10	NLD	65.54	BGR	65.60	BGR	65.32
NLD	68.60	BGR	63.47	LTU	63.68	DNK	64.46
SVK	68.46	SVN	63.11	EST	60.27	SVN	63.50
BGR	67.56	CZE	61.63	SVN	59.67	NLD	62.35
LTU	67.07	BEL	58.48	BEL	59.35	MLT	60.38
SVN	66.15	SVK	57.29	IRL	57.93	SVK	58.09
EST	62.08	EST	55.46	CZE	56.77	BEL	56.80
IRL	61.46	IRL	55.21	MLT	56.05	IRL	56.27
BEL	61.30	HUN	52.00	HUN	54.78	CZE	54.88
LUX	54.85	MLT	47.43	SVK	54.26	HUN	54.53
MLT	49.17	LUX	41.68	LUX	41.13	LUX	38.76

Source: Author's calculations from WIOD

Table A.2: Foreign value added by country (1995-2000-2005-2010).

	1995		2000		2005		2010
MLT	50.83	LUX	58.36	LUX	58.88	LUX	61.24
LUX	45.14	MLT	52.57	SVK	45.74	HUN	45.47
BEL	38.70	HUN	48.00	HUN	45.22	CZE	45.12
IRL	38.54	IRL	44.79	MLT	43.95	IRL	43.73
EST	37.92	EST	44.54	CZE	43.23	BEL	43.21
SVN	33.85	SVK	42.71	IRL	42.07	SVK	41.91
LTU	32.93	BEL	41.53	BEL	40.65	MLT	39.62
BGR	32.44	CZE	38.37	SVN	40.33	NLD	37.65
SVK	31.54	SVN	36.89	EST	39.73	SVN	36.50
NLD	31.40	BGR	36.53	LTU	36.32	DNK	35.54
CZE	29.90	NLD	34.46	BGR	34.40	BGR	34.69
HUN	28.82	LTU	33.94	**EU27**	**33.82**	**EU27**	**33.86**
EU27	**28.35**	**EU27**	**33.85**	NLD	33.65	LTU	33.85
PRT	27.55	CYP	32.27	DNK	32.47	EST	33.19
CYP	26.85	GRC	30.66	AUT	31.71	FIN	32.68
DNK	26.29	PRT	30.02	PRT	30.71	POL	32.37
SWE	25.66	DNK	29.99	FIN	30.37	AUT	32.19
LVA	25.09	SWE	29.83	LVA	30.17	SWE	31.66
AUT	23.86	AUT	28.19	POL	30.17	PRT	27.54
FIN	23.41	FIN	27.55	SWE	30.08	ESP	27.31
ROM	23.32	ESP	27.22	ROM	29.55	CYP	27.14
ESP	20.56	ROM	26.71	ESP	26.39	FRA	26.81
FRA	19.50	POL	26.27	GRC	26.20	DEU	26.09
GBR	19.28	LVA	26.17	FRA	24.78	ITA	25.54
GRC	19.10	FRA	24.42	DEU	24.19	LVA	24.61
ITA	18.70	DEU	22.20	CYP	22.38	GRC	24.22
POL	17.22	ITA	20.82	ITA	22.15	ROM	24.06
DEU	17.10	GBR	18.92	GBR	17.70	GBR	20.39

Source: Author's calculations from WIOD

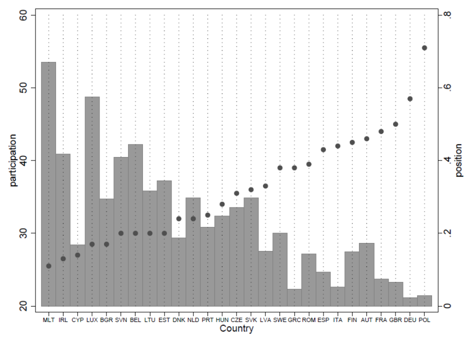


Figure A.2: Participation and Position (1995), EU countries

Source: Author's calculations from WIOD

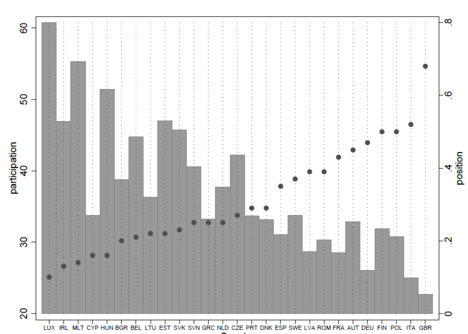


Figure A.3: Participation and Position (2000), EU countries

Source: Author's calculations from WIOD

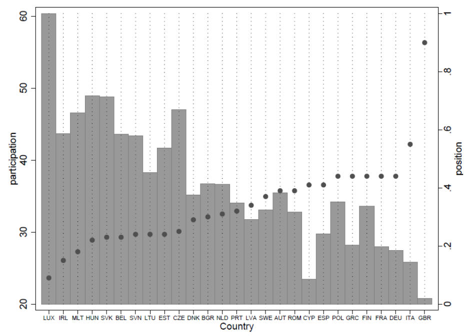


Figure A.4: Participation and Position (2005), EU countries

Source: Author's calculations from WIOD

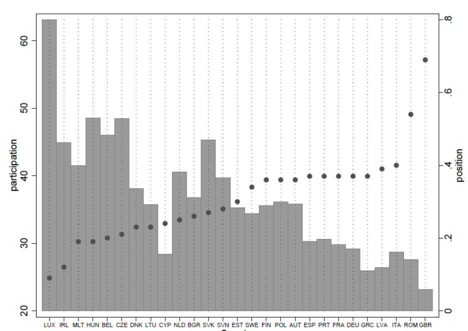


Figure A.5: Participation and Position (2010), EU countries

Source: Author's calculations from WIOD

Table A.3: Top 15 trade partners of Eurozone countries in cross-border production chains (2009)

Austria		**Belgium**		**Finland**		**France**	
Germany	16.88	Germany	8.16	Germany	7.63	Germany	7.58
Italy	3.57	France	6.23	Russian Fed.	6.71	United States	3.74
Switzerland	2.99	Netherlands	6.14	Sweden	4.21	Rest of the World	3.35
RoW	2.96	USA	3.84	China	4.06	Italy	3.11
USA	2.84	UK	3.09	USA	4.04	Belgium	2.71
China	2.28	RoW	2.96	UK	2.59	China	2.30
France	2.25	Italy	2.25	RoW	2.08	Spain	2.15
Czech Rep.	1.54	China	2.20	France	1.84	United Kingdom	2.10
UK	1.54	Ireland	1.92	Netherlands	1.80	Netherlands	1.76
Hungary	1.37	Luxembourg	1.82	Italy	1.53	Switzerland	1.38
Netherlands	1.35	Russian Fed.	1.52	Norway	1.40	Russian Fed.	1.37
Belgium	1.22	Spain	1.45	Belgium	1.39	Ireland	0.97
Russian Fed.	1.17	Sweden	1.27	India	1.37	Sweden	0.94
Poland	1.04	Japan	1.26	Spain	1.25	Japan	0.90
Spain	1.03	Norway	1.10	Denmark	1.19	Norway	0.69
Japan	0.91	Switzerland	0.97	Japan	1.12	Poland	0.66

Germany		**Greece**		**Ireland**		**Italy**	
France	3.82	RoW	4.85	USA	13.70	Germany	6.71
USA	3.47	Germany	3.99	UK	7.29	RoW	4.31
Italy	2.89	Russian Fed.	3.16	Germany	5.63	France	3.63
UK	2.83	USA	2.78	Netherlands	3.55	USA	2.10
China	2.73	Italy	2.25	RoW	3.52	Switzerland	1.91
Netherlands	2.70	Singapore	1.82	France	2.88	China	1.88
Switzerland	2.55	China	1.61	Belgium	2.48	Russian Fed.	1.60
Austria	2.40	UK	1.58	China	2.21	UK	1.52
RoW	2.33	France	1.55	Italy	2.00	Spain	1.40
Belgium	1.79	Turkey	1.15	Switzerland	1.93	Netherlands	1.26
Spain	1.63	Belgium	1.11	Spain	1.48	Austria	1.18
Russian Fed.	1.63	Denmark	1.07	Japan	1.15	Belgium	1.14
Poland	1.53	Spain	0.94	Singapore	0.93	Poland	0.98
Czech Rep.	1.51	Netherlands	0.92	Luxembourg	0.93	Ireland	0.79
Sweden	1.21	Japan	0.84	India	0.87	Sweden	0.65
Japan	1.12	Korea	0.83	Norway	0.80	Japan	0.62

Luxembourg		**Netherlands**		**Portugal**		**Spain**	
Germany	10.94	Germany	8.61	Spain	8.98	Germany	6.06
UK	7.82	RoW	4.68	Germany	7.04	RoW	4.07
USA	7.00	USA	4.62	RoW	4.15	France	4.01
Switzerland	6.98	UK	4.40	France	4.01	UK	2.46
Belgium	5.81	Belgium	4.29	Italy	2.53	Italy	2.24
France	3.88	Russian Fed.	2.92	UK	2.18	USA	2.13
Italy	3.55	France	2.83	USA	2.02	Portugal	1.78
Netherlands	2.97	Norway	2.09	China	1.95	China	1.61
Singapore	2.85	China	1.94	Netherlands	1.54	Netherlands	1.47
Spain	2.67	Ireland	1.92	Singapore	1.33	Belgium	1.18
Ireland	2.30	Italy	1.74	Belgium	1.20	Russian Fed.	1.16
Hong Kong	2.25	Spain	1.26	Russian Fed.	1.10	Switzerland	0.93
RoW	2.10	Switzerland	1.14	Sweden	0.83	Ireland	0.93
China	1.58	Sweden	1.03	Japan	0.82	Sweden	0.74
Austria	1.20	Japan	1.02	Norway	0.78	Luxembourg	0.68
India	1.12	Brazil	0.77	Hong Kong	0.77	Japan	0.63

Source: Author's calculations from TIVA

Table A.4: Top 15 trade partners of CEE countries in cross-border production chains (2009)

Czech Rep.		**Poland**		**Hungary**		**Bulgaria**		**Slovak Rep.**		**Slovenia**		**Romania**	
Germany	15.56	Germany	10.96	Germany	12.32	Russian Fed.	5.95	Germany	11.61	Germany	9.07	Germany	7.31
China	3.39	Russian Fed.	3.45	China	3.47	RoW	5.41	Russian Fed.	6.96	Italy	5.66	Italy	4.59
Russian Fed.	3.28	Italy	3.03	USA	3.41	Germany	4.61	Czech Rep.	5.47	RoW	5.66	RoW	3.29
Poland	3.15	France	2.39	Russian Fed.	2.95	Italy	3.13	Korea	3.03	France	3.63	France	3.07
Slovak Rep.	2.97	China	2.26	France	2.63	USA	2.18	France	3.03	Austria	3.60	Hungary	2.57
France	2.82	RoW	2.19	Austria	2.54	Turkey	2.07	Italy	2.85	USA	2.31	Russian Fed.	2.21
Italy	2.69	Czech Rep.	2.18	Italy	2.53	China	1.93	Poland	2.57	Russian Fed.	1.95	China	1.85
USA	2.46	USA	2.02	RoW	2.43	Greece	1.91	RoW	2.37	China	1.76	USA	1.68
RoW	2.28	UK	1.64	Japan	2.01	France	1.85	China	2.36	Japan	1.27	Turkey	1.59
Austria	2.26	Netherlands	1.41	Netherlands	1.85	Romania	1.45	Austria	2.21	Czech Rep.	1.24	UK	1.38
Japan	2.13	Sweden	1.36	UK	1.77	Belgium	1.33	USA	2.20	Spain	1.22	Austria	1.31
UK	1.85	Austria	1.06	Korea	1.45	Japan	1.24	Hungary	2.10	Poland	1.03	Spain	1.15
Netherlands	1.74	Belgium	1.04	Czech Rep.	1.45	Spain	1.00	UK	2.05	Netherlands	0.99	Netherlands	1.12
Belgium	1.37	Japan	1.01	Slovak Rep.	1.44	UK	0.95	Japan	1.72	Hungary	0.93	Poland	1.01
Spain	1.31	Spain	0.99	Poland	1.42	Netherlands	0.92	Netherlands	0.98	UK	0.90	Belgium	1.01
Switzerland	1.18	Korea	0.97	Romania	1.38	Singapore	0.86	Spain	0.94	Switzerland	0.89	Czech Rep.	0.92

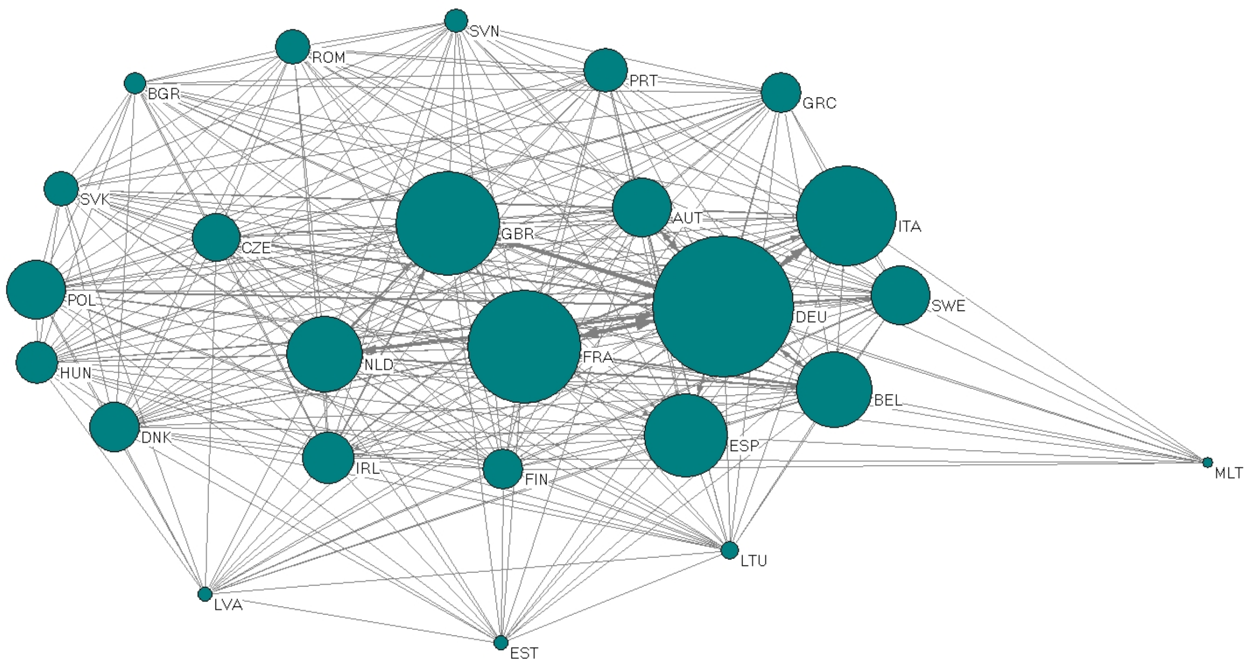
Source: Author's calculations from TIVA

Table A.5: Relative positions of EU trade partners for Eurozone and CEE countries (2009) (1/2)

Germany		**Austria**		**Belgium**		**Finland**		**France**		**Italy**		**Greece**		**Portugal**		**Spain**		**Ireland**	
GRC	1.80	GBR	2.31	GBR	2.76	MLT	3.46	ITA	1.42	NLD	1.02	ESP	1.56	ESP	2.94	LVA	2.28	GBR	4.31
GBR	1.74	GRC	1.91	BGR	2.65	GBR	1.98	ESP	1.20	GBR	0.95	NLD	1.38	ITA	2.76	LTU	1.56	NLD	4.05
ESP	1.58	ESP	1.73	LVA	2.42	PRT	1.84	GBR	1.15			ITA	1.28	ROM	2.02	ROM	1.48	GRC	3.43
ITA	1.41	ITA	1.58	IRL	2.23	EST	1.69	DEU	1.01	FIN	0.84	FRA	1.18	GBR	1.89	EST	1.45	DNK	2.50
IRL	1.35	FRA	1.29	ESP	1.99	ESP	1.68	ROM	0.98	GRC	0.78	FIN	1.09	NLD	1.73	ITA	1.30	LVA	2.23
ROM	1.23	PRT	1.27	ROM	1.78	DEU	1.51			ESP	0.77	GBR	1.05	LTU	1.69	BGR	1.03	ESP	1.94
POL	1.11	CZE	1.18	NLD	1.58	LVA	1.28	FIN	0.91	BGR	0.72	PRT	0.97	DEU	1.36	MLT	0.98	AUT	1.56
FRA	0.99	DEU	1.14	GRC	1.50	ITA	1.19	GRC	0.85	ROM	0.71			FRA	1.27			SWE	1.51
		NLD	1.14	FRA	1.46	ROM	1.18	NLD	0.81	DEU	0.71	LVA	0.83	IRL	1.12	GBR	0.88	FRA	1.48
NLD	0.88	BEL	1.14	ITA	1.46	IRL	1.18	PRT	0.79	FRA	0.71	CZE	0.71	LVA	1.09	FRA	0.83	LTU	1.47
SVN	0.88	SVK	1.14	LTU	1.21	FRA	1.09	AUT	0.78	IRL	0.69	ROM	0.68	EST	1.08	HUN	0.72	ITA	1.45
AUT	0.88	SWE	1.09	PRT	1.17	BGR	1.06	POL	0.77	BEL	0.69	POL	0.68	GRC	1.03	POL	0.69	POL	1.44
BEL	0.86	POL	1.04	DEU	1.17	AUT	1.02	SWE	0.76	SWE	0.66	BEL	0.67	HUN	1.02	NLD	0.65	EST	1.37
CZE	0.85	FIN	0.98	EST	1.13	SWE	0.96	DNK	0.71	AUT	0.63	EST	0.64	POL	1.00	GRC	0.64		
LVA	0.80			FIN	1.04	BEL	0.96	LTU	0.70	LVA	0.63	DEU	0.55	SVN	0.96	DEU	0.63	HUN	0.90
BGR	0.75	SVN	0.80	MLT	1.03	LTU	0.96	LVA	0.69	POL	0.50	HUN	0.53	CZE	0.95	FIN	0.59	PRT	0.89
SWE	0.75	LTU	0.78	CZE	1.00	CZE	0.95	BEL	0.69	DNK	0.47	AUT	0.52			AUT	0.58	FIN	0.85
PRT	0.73	ROM	0.77	SWE	0.98			IRL	0.68	LTU	0.46	LUX	0.50	MLT	0.86	CZE	0.55	DEU	0.74
FIN	0.66	LVA	0.75			GRC	0.91	CZE	0.67	CZE	0.46	SWE	0.48	BEL	0.85	IRL	0.51	MLT	0.74
DNK	0.62	EST	0.74	POL	0.91	DNK	0.84	SVN	0.65	HUN	0.45	BGR	0.43	AUT	0.79	BEL	0.50	ROM	0.71
EST	0.61	DNK	0.73	AUT	0.88	SVN	0.80	BGR	0.52	EST	0.43	IRL	0.29	BGR	0.75	SWE	0.50	BGR	0.65
SVK	0.59	IRL	0.64	DNK	0.82	POL	0.75	EST	0.47	SVN	0.39	DNK	0.29	SWE	0.65	DNK	0.44	LUX	0.52
HUN	0.49	HUN	0.59	SVK	0.82	SVK	0.62	MLT	0.38	PRT	0.36	LTU	0.28	FIN	0.54	SVN	0.39	CZE	0.50
MLT	0.38	MLT	0.53	SVN	0.80	NLD	0.60	HUN	0.35	SVK	0.34	MLT	0.19	SVK	0.53	PRT	0.34	SVN	0.48
LTU	0.32	BGR	0.51	HUN	0.74	HUN	0.45	LUX	0.28	LUX	0.26	SVK	0.18	LUX	0.52	SVK	0.32	BEL	0.45
LUX	0.26	LUX	0.17	LUX	0.28	LUX	0.43	SVK	0.28	MLT	0.09	SVN	0.15	DNK	0.48	LUX	0.12	SVK	0.43

Source: Author's calculations from TIVA

Figure A.6: The EU FVA network: the main buyers



Authors' elaboration from WIOD
Only flows higher than 10th percentile are represented

Table 3.6 (2/2)

Luxembourg		Netherlands		Czeck Rep.		Poland		Hungary		Romania		Slovak Rep.		Slovenia		Bulgaria	
GBR	13.03	GBR	3.18	ITA	2.19	ITA	2.02	FRA	2.87	MLT	1.68	GRC	5.50	GRC	6.50	GRC	2.35
ESP	8.53	EST	2.30	GBR	2.08	GRC	1.47	NLD	2.68	GRC	1.46	GBR	5.41	ITA	2.57	AUT	1.98
AUT	5.87	FIN	1.66	IRL	2.00	ESP	1.44	GBR	2.27	IRL	1.42	FRA	3.61	ESP	2.56	FRA	1.93
ITA	3.87	ESP	1.54	POL	1.90	GBR	1.44	ITA	2.23	ITA	1.41	ESP	3.17	SWE	2.37	ROM	1.85
DEU	3.85	LVA	1.53	ESP	1.81	MLT	1.35	FIN	2.23	AUT	1.29	ITA	2.93	NLD	2.28	LTU	1.56
FRA	3.61	FRA	1.24	MLT	1.63	FIN	1.34	DEU	2.06	GBR	1.28	IRL	2.33	ROM	2.27	IRL	1.55
BEL	3.60	DEU	1.13	ROM	1.63	FRA	1.31	GRC	1.90	POL	1.06	DNK	2.14	IRL	2.09	POL	1.51
NLD	3.41	LTU	1.12	NLD	1.61	NLD	1.25	AUT	1.70	FRA	1.02	NLD	1.90	GBR	1.97	ITA	1.39
LVA	2.45	ROM	1.04	FRA	1.49	BEL	1.10	MLT	1.61	NLD	0.97	PRT	1.89	FRA	1.54	PRT	1.33
EST	2.36	BGR	1.02	GRC	1.40	PRT	1.00	SWE	1.60			DEU	1.68	SVK	1.41	DEU	1.33
FIN	2.33	ITA	0.98	DEU	1.18	SVN	0.97	ROM	1.56	SVK	0.87	FIN	1.61	LTU	1.40	GBR	1.32
GRC	2.01			LVA	1.09	AUT	0.96	DNK	1.55	FIN	0.85	EST	1.51	FIN	1.26	CZE	1.28
IRL	1.93	AUT	0.88	FIN	1.06			POL	1.55	DEU	0.81	MLT	1.43	AUT	1.25	SVN	1.20
PRT	1.91	DNK	0.84	PRT	1.06	ROM	0.94	LTU	1.52	LUX	0.78	POL	1.36	BEL	1.25	MLT	1.07
BGR	1.73	MLT	0.81	BEL	1.00	DEU	0.90	SVK	1.48	SWE	0.71	CZE	1.27	DEU	1.14	SVK	1.05
CZE	1.71	POL	0.80			SVK	0.73	EST	1.43	LVA	0.71	BEL	1.22	CZE	1.13	NLD	0.98
SVK	1.71	SWE	0.75	HUN	0.89	LUX	0.72	ESP	1.39	ESP	0.68	SWE	1.17	PRT	1.04	ESP	0.97
MLT	1.64	GRC	0.72	SVN	0.89	IRL	0.69	BEL	1.36	LTU	0.64	ROM	1.15	POL	1.03	FIN	0.95
SWE	1.50	BEL	0.63	SWE	0.86	DNK	0.67	BGR	1.18	HUN	0.64	BGR	0.96	EST	1.00		
LTU	1.46	CZE	0.62	AUT	0.85	BGR	0.66	CZE	1.12	CZE	0.61			HUN	0.98	DNK	0.86
POL	1.39	PRT	0.58	EST	0.81	HUN	0.65	IRL	1.12	BEL	0.56	AUT	0.88			HUN	0.85
ROM	1.28	SVK	0.53	SVK	0.79	LTU	0.64	SVN	1.02	BGR	0.54	LTU	0.82	LUX	0.93	EST	0.75
SVN	1.08	SVN	0.44	BGR	0.78	SWE	0.58	LUX	1.00	EST	0.54	LVA	0.77	DNK	0.90	SWE	0.71
HUN	1.00	HUN	0.37	DNK	0.78	EST	0.54	PRT	0.98	PRT	0.49	SVN	0.71	BGR	0.83	LUX	0.58
		LUX	0.29	LTU	0.68	CZE	0.53			SVN	0.44	HUN	0.68	LVA	0.71	LVA	0.51
DNK	0.68	IRL	0.25	LUX	0.58	LVA	0.49	LVA	0.90	DNK	0.44	LUX	0.58	MLT	0.60	BEL	0.38

Source: Author's calculations from TIVA

Table A.6: Origin of the FVA incorporated in exports of manufacturing goods (2009)

	AUT	BEL	CZE	DNK	EST	FIN	FRA	DEU	GRC	HUN	IRL	ITA	LUX	NLD	POL	PRT	SVK	SVN	ESP	SWE	GBR	BGR	CYP	LVA	LTU	MLT	ROM
Austria		2.0	2.7	0.6	0.0	0.5	4.1	29.1	0.3	1.6	0.7	7.0	0.2	2.3	1.7	0.4	1.5	0.9	2.0	1.5	3.1	0.1	0.0	0.0	0.1	0.0	0.5
Belgium	1.0		0.9	0.7	0.1	0.6	9.9	13.0	0.3	0.4	4.3	3.7	0.8	11.8	0.9	0.4	0.3	0.1	2.4	1.9	6.3	0.3	0.0	0.1	0.1	0.0	0.3
Finland	1.0	2.0	0.7	1.5	1.3		2.9	13.7	0.3	0.3	0.9	2.5	0.2	2.0	1.2	0.5	0.2	0.1	2.3	6.0	5.0	0.1	0.1	0.3	0.2	0.1	0.2
France	1.1	4.5	0.9	0.7	0.1	0.5		15.7	0.3	0.4	1.6	7.5	0.4	3.2	1.2	0.7	0.3	0.3	4.6	1.6	4.4	0.1	0.0	0.1	0.1	0.1	0.5
Germany	4.1	3.2	2.6	1.1	0.1	0.9	7.2		0.4	1.2	2.1	6.5	0.5	4.7	3.1	0.6	0.9	0.4	3.6	1.9	6.7	0.1	0.0	0.1	0.0	0.0	0.6
Greece	0.8	1.7	0.4	0.5	0.0	0.4	3.1	5.9		0.3	0.8	6.2	0.3	2.0	0.5	0.2	0.2	0.1	2.2	0.6	2.8	1.3	0.3	0.0	0.0	0.0	0.8
Ireland	0.7	2.1	0.2	1.2	0.1	0.4	4.6	5.9	0.4	0.3		2.4	0.3	6.2	0.8	0.2	0.1	0.0	2.3	1.1	15.2	0.0	0.0	0.1	0.1	0.0	0.1
Italy	2.3	2.3	1.0	0.6	0.0	0.6	7.5	14.1	0.6	0.7	1.5		0.5	3.2	1.6	0.4	0.5	0.4	3.0	1.3	3.6	0.3	0.0	0.0	0.1	0.0	0.9
Luxembourg	1.2	11.5	1.2	0.4	0.1	0.7	11.2	21.2	0.2	0.3	1.1	3.1		6.2	1.2	0.3	0.4	0.1	2.1	1.6	5.4	0.1	0.0	0.0	0.0	0.0	0.1
Netherlands	0.8	4.5	0.6	1.0	0.1	0.8	4.2	12.8	0.2	0.4	1.0	2.3	0.3		0.8	0.0	0.2	0.1	1.9	1.3	9.0	0.1	0.0	0.1	0.1	0.0	0.2
Portugal	0.9	1.8	0.7	0.6	0.0	0.4	7.1	13.8	0.3	0.5	0.9	6.3	0.2	3.2	0.8		0.2	0.1	21.6	1.1	4.1	0.1	0.0	0.0	0.1	0.0	0.5
Spain	1.0	1.9	0.9	0.7	0.1	0.6	9.2	11.7	0.3	0.6	1.5	6.3	0.3	2.8	1.1	2.2	0.2	0.1		1.1	4.9	0.2	0.1	0.1	0.1	0.0	0.5
Czech Rep.	2.6	1.7		0.6	0.0	0.5	4.3	21.8	0.3	1.4	0.7	4.8	0.2	2.8	5.3	0.3	3.3	0.4	2.1	1.1	3.1	0.1	0.0	0.1	0.1	0.0	0.6
Hungary	3.9	1.4	1.9	0.8	0.0	0.5	4.9	21.6	0.2		0.6	4.4	0.1	3.3	2.2	0.2	2.2	0.4	1.6	1.0	3.0	0.2	0.0	0.0	0.1	0.0	2.2
Poland	1.9	2.0	2.7	1.1	0.1	1.0	4.9	19.1	0.3	1.1	0.7	7.4	0.2	2.8		0.3	1.5	0.3	2.1	1.8	3.4	0.1	0.0	0.1	0.3	0.0	0.5
Slovak Rep.	2.3	1.1	6.8	0.7	0.0	0.4	5.4	16.6	0.4	1.9	0.5	4.8	0.1	1.4	3.3	0.2		0.3	1.6	0.8	4.0	0.1	0.0	0.0	0.1	0.0	0.5
Slovenia	5.9	1.4	2.0	0.5	0.0	0.5	6.5	14.7	0.7	1.3	0.6	12.1	0.2	2.0	1.6	0.2	1.3		2.5	1.2	1.8	0.2	0.0	0.0	0.1	0.0	1.1
Bulgaria	1.6	1.1	0.9	0.7	0.0	0.3	3.7	8.1	3.8	0.7	0.7	5.8	0.1	1.4	1.3	0.3	0.4	0.3	1.4	0.9	1.5		0.1	0.0	0.1	0.0	2.5
Romania	3.0	1.5	1.5	0.6	0.0	0.4	6.4	13.8	1.4	4.1	0.8	11.6	0.2	2.2	2.2	0.4	1.1	0.4	1.9	0.9	3.1	0.9	0.1	0.0	0.0	0.1	

Source: Author's calculations from TIVA