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Foreign Direct Investment and Trade:
A Bi-directional Gravity Approach

by

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Abstract

This paper compares the traditional gravity model with a bidirectional approach when multilateral resistance is implemented to analyze the effect of inward foreign direct investment (FDI) on exports. We use cross-sectional HS trade data disaggregated at a 6-digit level in 2010 with controls for HS 2-digit level. Our results show that FDI increases exports only in the in the direction of exporter-importer, and the effect is higher when multilateral resistance is implemented and the effect is different across sections. Our robustness checks show that when FDI is removed, the coefficients and the effect on sectors are similar (*JEL codes: C21, F14, F15, F21*).

Keywords: FDI, bilateral trade, gravity model, cross-section data, Harmonized System 2-digit code

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1.Introduction

International trade and foreign direct investment are remarkable economic activities that cause fast growth. Parallel to this, gravity models have become the main method to explain bilateral trade flows. Interactions between FDI and exports have been considered previously under a gravity approach since the Helpman and Krugman (1985) model.

One of the key drivers in the world economy is the remarkable dynamic increase in trade between the United States and the rest of the world. The objective of this paper is to analyze the effect of FDI and exports using the well-known traditional gravity approach for cross-section data from 2010 for a representative sample of North and South America countries. However, while North America is mainly developed due to large economies (the United States and Canada), South America is defined as emerging. Our study is based on the BACI-CEPII bilateral database of highly disaggregated trade flows by 2-digit Harmonized System (HS code).

Although gravity models have been successfully augmented with FDI, it is necessary to place emphasis on other aspects, which we develop directly in our approach and represent our value added. Firstly, gravity models have only focused on one direction of trade flows (exporter to importer), but do not consider the other direction (importer to exporter). Following Novy (2013), we combine both trade directions, but incorporate FDI to the transport cost to derive a new bi-directional gravity equation, which is completely new in the literature. We also model the multilateral resistance by considering domestic trade, which is compared with the traditional exporter and importer effects used as proxies for multilateral resistance.

We consider the following research questions: (1) What effect does FDI have on exports? (2) What are the sectors most sensitive to FDI? (3) Do the results change when we consider the bi-directional gravity approach? (4) What happens if we model the multilateral resistance rather than adding exporter and importer-fixed effects?

Our results show that FDI increases exports, but only in the direction of exporter-importer. The effect is asymmetric between HS sections because some sections present a positive coefficient and other a negative coefficient. Generally, for sections with high value added, the effect is higher, but there are some outlier sections. The FDI coefficient increases when multilateral resistance is modeled, which also shows the importance of considering domestic trade. The three equations present the same R2 coefficient. We also do some robustness checks by varying the transport cost function and show that when FDI is not a transport cost component, the results do not change.

The plan of this paper is as follows. Section 2 sketches the theoretical framework which links gravity and FDI. Section 3 derives the alternative explanations for the traditional and augmented gravity model. Section 4 presents the methodology and data. Section 5 shows the results. Section 6 presents some robustness checks. Section 7 presents conclusions.

2. Theoretical Framework

A large literature regarding international trade and FDI shows that the relationship of inward FDI and the exports of host countries mainly concentrate on complementarity and substitution, usually with exports regressed on some measure of FDI and some other control variables. FDI can also affect the breakdown of exports by industry and geographical area. The main analysis on the effects of FDI on exports is based on the Heckscher (1919)-Ohlin (1933) model and it's extensions (Mundell (1968); Kojima (1975, 1977, 1982); Krugman (1983); Helpman (1984); Horstmann and Markusen (1984); Helpman and Krugman (1985); Blomström (1990); Markusen (1992); Brian, Hanson, and Harrison (1997); Lipsey (1998, 2000, 2002); Helpman, Melitz, and Yeaple (2003); Barrios, Görg and Strobl (2005)).

FDI As A Factor That Replaces Exports

Some studies find FDI to have a positive affect on trade and others a negative impact. It depends on the type of FDI stimulated (Markusen 1997, 1998, 2002; Markusen and Maskus, 2002). A positive influence of FDI on trade is shown by the experience of Taiwan, Mexico, and India, as well as Japanese investment in the countries of South-Eastern Asia. German investment in most EU countries and Central and Eastern Europe indicates that FDI and exports complement each other.

Markusen (1997, 2002) provides a model where both horizontal and vertical FDI arise endogenously and depend on country characteristics (differences between country size, relative skilled labor endowments, level of trade costs, etc.). When FDI is horizontal FDI and trade are substitutes. Investment liberalization stimulates trade (Carr et.al., 2001) if FDI is vertical, and substitutes for trade if FDI is horizontal (Markusen and Maskus, 2002). Investment liberalization stimulates exports when countries differ in relative skill endowments provided trade costs are low, but investment liberalization reduces exports when countries are similar in relative skill endowments, and trade costs are high (Amiti and Wakelin, 2002).

According to concepts based on the Heckscher (1919)-Ohlin (1933) model, in which trade substitutes production factor flows, inflowing FDI replaces trade. The host country has a relative edge in the production and exportation of those goods, the manufacture of which requires a high supply of a factor that occurs in such a country (capital, workforce). Similar to trade, international capital mobility tends to equalize prices of goods on an international scale, so trade and FDI can be considered substitutes (Mundell, 1968). Kojima has completed this theory already at the country level by stating that labor-intensive goods manufactured in developing countries, where comparative edges occur, return to FDI's country of origin (Kojima 1975, 1977, 1982).

FDI As A Factor That Stimulates Exports

When FDI is vertical (multinational firms geographically split stage of production) FDI stimulates trade. Vertical multinationals are firms, which geographically fragment the production process by stages (Markusen, 1998).

The outsourcing of production to developing countries is related to the manufacture of goods intended for export (Blomström, 1990). According to Kojima's classification, trade-oriented and anti-trade-oriented investment can be distinguished. Most research aimed at determining FDI's impact on exports from host countries goes into the behaviors of multinational corporations as such and the reasons behind investing in a specific country. The findings of such research confirm that multinationals are more oriented to exports than to the internal market. Access to the international networks of parent companies is important for export promotion (Lipsey, 1998).

FDI As A Factor That Affects the Structure of Exports

Multinational firms can influence changes in the production structure and help increase exports of local businesses, especially in developing countries. The inflow of FDI may make new local businesses open in the host country, but also those that already exist there may change the scope of their production, which implies that FDI also affects the breakdown of exports by industry and geographical area. Multinational firms expand and integrate production networks, while delivering technologies necessary for the growth of a given industry (Dobson and Chia, 1997). The activities of multinational firms urge local business to export (Brian, Hanson and Harrison, 1997). A greater production and export activity of multinational firms in a specific industry makes domestic companies in the same industry more willing to export (Lipsey, 2002). In addition, the share of labor-intensive goods in exports is diminishing with time, unlike that in the production and exportation of capital-intensive goods, which is on the rise (Lipsey, 2000). Some countries see new industries and product variants, which are increasingly more often intended for export and born due to inflowing FDI (Frances and Görg, 1999).

However, the long-term effects of FDI's inflow may also prove negative for the host country. Countries that are hosts FDI may lose their edge, among other things, due to increases in their pay levels (Lipsey, 2002), as is especially the case in developing countries, which affects the activities of local businesses and their willingness to export.

To sum up, the hitherto research into FDI's influence on the host country's exports does not provide a clear answer to the question about the strength and directions of these relationships. Most empirical studies suggest that an increase in FDI's inflow may have a positive effect on the host country's exports, especially as regards investment that is not oriented to the internal market. In fact, FDI's impact on exports depends on the confluence of many factors, which affect both the investor's country of origin and the host country of FDI.

The New Trade Theory (henceforth, NTT) emphasized the role of differences in technology between countries (Grossman and Helpman, 1994), by taking into account the Ricardo (1818) framework that countries will specialize in trading goods that are cheap to produce. This production of different goods is based on Krugman's (1980) monopolistic competition model and the concept of love of variety. This framework for the production of different varieties states that it is necessary to distinguish the different country industries those produce varieties in order to explain trade flows, as we do in our model. However, NTT assumes firm homogeneity, which means that all the firms are equal. The New New Trade Theory (NNTT) solves this problem with the Melitz (2003) model, which incorporates firm heterogeneity into the Krugman (1980) model, stating that only the most productive firms will engage in exports. This imperfect competition framework has been augmented with technology diffusion and multinational production (Eaton and Kortum, 2001).

The Eaton and Kortum (2002) model follows a Ricardian framework to derive a gravity equation that considers technology in a multi-industry framework. Chen and Novy (2011) study trade integration for each different industry under a gravity approach. Also, Chaney (2008) has derived a gravity equation that successfully incorporates the Melitz (2003) firm heterogeneity. However, the studies that explain the effects of FDI on exports under a gravity approach are scarce.

The gravity equation is one of the most often applied empirical techniques to analyze bilateral trade. Since 1962, the gravity model is one of the most frequently applied empirical methods to explain international trade flows (Tinbergen 1962; Poyhonen 1963). The gravity equations have been derived in Ricardian (1818), Heckscher (1918)-Ohlin (1933) and Helpman and Krugman (1985) models. Gravity models have dealt with this multi-industry approach. Eaton and Kortum (2002) follow a Ricardian framework to derive a gravity equation that considers technology in a multi-industry framework. Gravity models have introduced FDI to explain multinational production.

In models by Eaton and Kortum (2002) and Anderson and van Wincoop (2003), the conventional wisdom that gravity equations lacked micro-foundations was finally dismissed. Importer and exporter fixed effects could be used to capture the multilateral resistance terms that emerged in different theoretical models (Feenstra 2002; Redding and Venables, 2004).

Helpman, Melitz and Rubinstein (2008), Melitz and Ottaviano (2008) found a useful tool to measure the new distinction between intensive and extensive margins of adjustment to trade shocks Bernard et al. (2007), Mayer and Ottaviano (2007), Chaney (2008). Heterogeneous firms models are compatible with gravity. Processes of economic integration also seem to influence the patterns of FDI dispersion (for a discussion on this issue, see Blomström and Kokko, 1997). Regional integration has typically been thought of as producing two types of effects: static and dynamic (de Mello-Sampayo, 2007). Regional integration is also likely to generate dynamic effects that will positively affect FDI inflows.

Gravity models have been used frequently in empirical work to assess trade flows and most recently to assess FDI (Brainard, 1997; Lipsey, 1999; Anderson and Wincoop, 2003). The theoretical underpinnings of trade under the classical gravity model suggest that transport costs and trade barriers should discourage trade since they raise import prices. These two variables are thought to have the opposite effect on FDI, implying that FDI and trade can be seen as alternative modes of foreign market penetration (Horst, 1972; Caves, 1974; Brainard, 1997).

The inclusion of product heterogeneity in our model is based on Krugman's (1980) monopolistic competition model and the concept of love of variety, where consumers can allocate their consumption preferences to certain varieties. Melitz (2003) model incorporates firm heterogeneity into Krugman's (1980) model, stating that only the most productive firms will engage in exports. The research has focused on the exports of differentiated goods.

Gravity models have dealt with this multiproduct approach. Mayer et al (2014) incorporate multiproduct firms to Melitz's (2003) firm heterogeneity model. Industry heterogeneity leads to product varieties, which present differences in value added amongst each other. When countries trade, this heterogeneity framework motivates the specialization in the production of goods that can be produced less costly. This argument was initially proposed by Smith (1776) but not demonstrated. Ricardo (1818) defined the gains for trade when countries produce different goods. Gravity models have dealt with this multi-industry approach. Eaton and Kortum (2002) follow a Ricardian framework to derive a gravity equation that considers technology in a multi-industry framework.

3. Empirical model

By using a gravity approach, we test the impact of FDI on bilateral exports in cross-section sectorial data. Following Anderson and Van Wincoop (2003), we derive a first gravity equation consistent with the Helpman and Krugman (1985) framework, which augments transport costs with FDI. Our expected value added consists of using the transport cost expression in the bidirectional gravity equation proposed by Novy (2013). We model multilateral resistance explicitly from domestic trade.

We now detail the equations to be used in our study. The gravity methodology used to explain bilateral trade flows started in the early 60s (Tinbergen, 1962; Pöyhonen, 1963). However, the first gravity equations lacked microeconomic foundations until the study of Anderson and Van Wincoop (2003), which has become a global reference in economic research. The Anderson and Van Wincoop (2003) gravity equation can be seen as follows:

$$x_{ij} = \frac{y_i y_j}{y^w} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma}, \sigma > 1 \qquad (1)$$

Where x_{ij} represents the bilateral exports from the exporter country i to the importer country j, y_i is the nominal income for residents in country i, y_j is the nominal income for residents in country j, $y^w = \sum_j y_j$ is the world nominal income, t_{ij} is the transport cost between i and j, $\Pi_i P_j$ is the unobservable multilateral resistance term, which reflects third-country effects. Finally, σ is a parameter greater than 1 that denotes the constant elasticity of substitution between varieties of countries i and j.

The Anderson and Van Wincoop (2003) gravity equation considers the following expression for the transport cost: $\mathrm{t}_{\mathrm{ij}}^{\mathrm{AvW}} = d_{ij}^{\delta_1} e^{\delta_2 b_{ij}}$, where d_{ij} is the bilateral distance between the exporter and importer country. b_{ij} is a dummy variable that takes value 1 for international trade and 0 in other case. We go beyond and augment the transport cost expression with FDI and, following Head, Mayer and Ries (2010), other variables related to contiguity, institutions and colonial linkages. Equation (2) is our expression for the transport cost:

$$t_{ij} = dist_{ij}^{\rho_1} {FDI_{ij,t-1}}^{-\rho_2} e^{-(\delta_3 adj_{ij} + \delta_4 colony_{ij} + \delta_5 comlang_{ij} + \delta_6 agreem_{ij})} \quad (2)$$

The transport cost is an increasing function in the bilateral distance ($dist_{ij}$). In contrast, the transport cost is a decreasing function in $FDI_{ij,t-1}$, which is the lagged bilateral FDI. Following Helpman, Melitz and Yeaple (2004), FDI saves transport costs because multinational firms can easily export to the foreign affiliates, so transport costs fall with FDI. The transport cost function is also decreasing at other dummy variables which distribute exponentially: adjacency (adj_{ij}), which takes value 1 if countries share a common border and 0 otherwise; colony ($colony_{ij}$) which takes value 1 if countries shared colonial linkages in the past and 0 otherwise; membership of trade agreements ($agreem_{ij}$), which takes value 1 if both countries are members of a trade agreement[2] and 0 otherwise. Finally common language ($comlang_{ij}$), takes value 1 if at least 10% of the people in both countries speak the same language. The introduction of FDI in the transport cost motivates that transport costs become asymmetric ($t_{ij} \neq t_{ji}$) because $FDI_{ij} \neq FDI_{ij}$, but the other transport cost components are symmetric.

We plug the transport cost expression of (2) in (1), under the Helpman and Krugman (1985) framework and take logarithms to make it linear OLS. This equation can be easily derived from Anderson and Van Wincoop (2003)[3].

$$\log x_{ij} = \beta_0 + \beta_1 \log GDP_i + \beta_2 \log GDP_j + \beta_3 \log POP_i + \beta_4 \log POP_j - \beta_5 \log dist_{ij} + \beta_6 \log FDI_{ij,t-1} + \beta_7 adj_{ij} + \beta_8 colony_{ij} + \beta_9 comlang_{ij} + \beta_{10} agreem_{ij} + \gamma_s + \mu_i + \delta_j + \varepsilon_{ij} \quad (3)$$

Where GDP_i and GDP_j denote the GDP for the exporter and importer country, and GDP are the variables that explain the income for countries i and j. POP_i and POP_j denote the

[2] We consider the following trade agreements: NAFTA, CAN and MERCOSUR.
[3] This is the standard gravity equation specified at the literature. It has been widely derived in several studies.

population for the exporter and importer country. After that, following Feenstra (2002) and Redding and Venables (2004), we incorporate exporter (μ_i) and importer (δ_j) fixed effects to control for the multilateral resistance. We also include controls for HS2 products (γ_s).

We are going to expand this equation to consider the total volume of trade ($x_{ij}x_{ji}$) and create a bidirectional gravity equation from 1 following Novy (2013) by defining a symmetric gravity equation for x_{ji}. Now we start our contribution when we include the FDI in the transport cost expression, which has never been tested in the bidirectional approach.

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^w}\right)^2 \left(\frac{t_{ij}t_{ji}}{\Pi_i \Pi_j P_i P_j}\right)^{1-\sigma} \quad (4)$$

This equation (4) allows us to reallocate all the unobservable multilateral resistance terms ($\Pi_i \Pi_j P_i P_j$) all together. There are two ways of dealing with these unobservable terms:

After taking the logarithms, the first approach is equivalent to the one expressed in equation 2, so we introduce the controls for the exporter and importer together with the sectorial dummy variable.

$$\log(x_{ij}x_{ji}) = \log\left(\frac{y_i}{y^w}\right)^2 + \log\left(\frac{y_j}{y^w}\right)^2 - (\sigma - 1)\log t_{ij} - (\sigma - 1)\log t_{ji} + \log(1 + FDIij,t-1) + \log(1+FDIji,t-1) + \mu i + \delta j + \gamma s \quad (5)$$

Bi-directional transport costs are symmetric in the following components: $dist_{ij} = dist_{ij}$, $adj_{ij} = adj_{ji}$, $colony_{ij} = colony_{ji}$, $comlang_{ij} = comlang_{ji}$, $agreem_{ij} = agreem_{ji}$. The resultant expression can be seen as follows, given that the square of a dummy variable D is idempotent, so it is equivalent to the initial dummy variable at the power of 1 ($D^2 = D$).

$$t_{ij}t_{ji} =$$
$$dist_{ij}^{\rho_1}\, FDI_{ij,t-1}{}^{-\rho_2}\, e^{-(\delta_3 adj_{ij}+\delta_4 colony_{ij}+\delta_5 comlang_{ij}+\delta_6 agreem_{ij})} *$$
$$dist_{ij}^{\rho_7}\, FDI_{ij,t-1}{}^{-\rho_8} e^{-(\delta_9 adj_{ij}+\delta_{10} colony_{ij}+\delta_{11} comlang_{ij}+\delta_{12} agreem_{ij})} =$$
$$dist_{ij}^{2\rho_1} FDI_{ij,t-1}{}^{-\rho_2} * FDI_{ij,t-1}{}^{-\rho_8} * e^{(\delta_3 adj_{ij}+\delta_4 colony_{ij}+\delta_5 comlang_{ij}+\delta_6 agreem_{ij})} \quad (6)$$

In (4) we plug the expression for the transport cost obtained at (6) and take logarithms to make it linear:

$$\log(x_{ij}x_{ji}) = \alpha_0 + \alpha_1 \log \mathrm{GDP}_i^2 + \alpha_2 \log \mathrm{GDP}_j^2 + \alpha_3 \log \mathrm{POP}_i^2 + \alpha_4 \log \mathrm{POP}_j^2 + \alpha_5 \log(1 + FDI_{ij,t-1}) + \alpha_6 \log(1 + FDI_{ji,t-1}) - \alpha_7 logd_{ij}^2 + \alpha_8 adj_{ij} + \alpha_9 colony_{ij} + \alpha_{10} comlang_{ij} + \alpha_{11} agreem_{ij} + \alpha_{12} \log \Pi_i \Pi_j P_i P_j + \gamma_s + \varepsilon_{ij} \ (7)$$

The first bidirectional gravity equation deals with the term $\Pi_i \Pi_j P_i P_j$, which is not observable, by adding the exporter and importer fixed effects (μ_i, δ_j), as in equation (3).

$$\log(x_{ij}x_{ji}) = \alpha_0 + \alpha_1 \log(GDP_i)^2 + \alpha_2 \log(GDP_j)^2 + \alpha_3 \log(POP_i)^2 + \alpha_4 \log(POP_j)^2 + \alpha_5 \log(1 + FDI_{ij,t-1}) + \alpha_6 \log(1 + FDI_{ji,t-1}) - \alpha_7 logd_{ij}^2 + \alpha_8 adj_{ij} + \alpha_9 colony_{ij} + \alpha_{10} comlang_{ij} + \alpha_{11} agreem_{ij} + \mu_i + \delta_j + \gamma_s + \varepsilon_{ij} \ (8)$$

The other way consists of measuring directly the unobservable multilateral resistance. Although proxies for exporter and importer effects have demonstrated to be effective (Baldwin and Taglioni, 2006), some studies have started to model multilateral resistance explicitly. Behrens, Ertur and Koch (2012) model the multilateral resistance from a spatial autoregressive model. We follow Novy (2013) to define a new gravity equation that considers domestic trade flows for the exporter country (x_{ii}) consistent with the approach by Anderson and Van Wincoop (2003).

$$x_{ii} = \frac{y_i^2}{y^w}\left(\frac{t_{ii}}{\Pi_i P_i}\right)^{1-\sigma} \qquad (9)$$

As direct data for x_{ii} does not exist, we consider an expression consistent with the approach used by Wei (1996) to estimate these domestic flows as follows: $x_{ii} = \left|GDP_i - \sum_i x_{i,ROW} - x_{ij,c}\right|$, where $x_{i,ROW}$ is total exports from country i to the rest of the world, including country j. $x_{ij,c}$ is exports from country i to country j of a product category c. t_{ii} is domestic transport costs, which depend only on the domestic distance $t_{ii} = dist_{ii}^{\delta_1}$. The same expression can be applied to country j: $x_{jj} = \left|GDP_j - \sum_j x_{j,ROW} - x_{ij,c}\right|, t_{jj} = dist_{jj}^{\delta_2}$ [4]. This equation allows us to determine an expression for the multilateral resistance term for i ($\Pi_i P_i$).

$$\Pi_i P_i = t_{ii}\left(\frac{x_{ii}y^w}{y_i^2}\right)^{\left(\frac{1}{\sigma-1}\right)} \qquad (10)$$

Analogously, we repeat the same procedure for country j. We define the same term ($\Pi_j P_j$) for country j.

$$\Pi_j P_j = t_{jj}\left(\frac{x_{jj}y^w}{y_j^2}\right)^{\left(\frac{1}{\sigma-1}\right)} \qquad (11)$$

If we plug both multilateral resistance expressions obtained in equation (10) and (11) into equation (4), then we get:

$$x_{ij}x_{ji} = x_{ii}x_{jj}\,\frac{\left(t_{ij}t_{ji}\right)^{1-\sigma}}{\left(t_{ii}t_{jj}\right)^{1-\sigma}} \qquad (12)$$

We take logarithms so that we get a gravity equation that depends on the multilateral resistance terms instead of considering dummy variables, and plug the transport cost expression obtained at (6) can linearize equation (12):

$$\log\left(x_{ij}x_{ji}\right) = \log x_{ii} + \log x_{jj} - (\sigma-1)\log t_{ij} - (\sigma-1)\log t_{ji} + (\sigma-1)\log t_{ii} + (\sigma-1)\log t_{jj} \quad (13)$$

We substitute domestic transport cost by the expression dependent on domestic distance expressed before:

$$\log\left(x_{ij}x_{ji}\right) = \gamma_0 + \gamma_1\log x_{ii} + \gamma_2\log x_{jj} - \gamma_3\log d_{ij}^2 + \gamma_4\log FDI_{ij,t-1} + \gamma_5\log FDI_{ji,t-1} + \gamma_6\log d_{ii} + \gamma_7\log d_{jj} + \gamma_s + \varepsilon_{ij} \quad (14)$$

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[4] For the sake of simplicity, we make domestic FDI flows non-relevant, so $FDI_{ii,t-1} = 1$ and $FDI_{jj,t-1} = 1$.

4. Methodology, variables, and Data

We have created a bilateral database at the HS 2-digit level from BACI-CEPII, which is perfectly consistent with the multi-product literature. In order to analyze the impact of FDI on exports, we have included aggregated FDI data. Our database contains 95726 observations. This classification allows distinguishing between low-value added and high value added products. The different HS sections can be checked in the annex (table 9.2).

We provide the list of variables, as well as the description, the units of measure and the different sources below. All the variables contain data for the year of 2010 except FDI that has been lagged one year and contains data for 2009. A table in the annex (9.1) shows the descriptive statistics.

TABLE 4.1: Variables and sources

Variable	Description / Units	Source
X_{ij} , X_{ji}	Bilateral sectorial exports from country i to country j at HS2 code (mln USD)	BACI-CEPII
FDI_{ij} , FDI_{ji}	Bilateral Foreign Direct Investment flows from country i to country j (mln USD)	UNCTAD
GDP_i, GDP_j	Gross Domestic Product for exporter and importer country (mln USD)	IMF
POP_i, POP_j	Population for exporter and importer country (mln)	IMF
$dist_{ij}$	Bilateral distance between the capitals for the exporter and importer country (kilometers)	CEPII
$X_{ij,ROW}$, $X_{j,ROW}$	Total exports from exporter and importer country	IMF
$x_{ij,c}$	Exports from country i to country I of a product category c	BACI-CEPII
$comlang_{ij}$	Dummy variable that takes value 1 if at least 10% of population in both countries speak the same language and 0 otherwise	CEPII
$colony_{ij}$	Dummy variable that takes value 1 if countries share a colonial past and 0 otherwise	CEPII
adj_{ij}	Dummy variable that takes value 1 if countries share a common border and 0 otherwise	CEPII
$agreem_{ij}$	Dummy variable that takes value 1 if countries are members of a regional trade agreement and 0 otherwise	Own elaboration
d_{ii} , d_{jj}	Internal distance within a country	CEPII

Source: authors' calculations

This is the list of countries used for the analysis. We include a list of North, Central and South America, which can be seen as follows.

TABLE 4.2: List of North, Central and South America countries included in the analysis

Argentina	Ecuador
Brazil	Mexico
Canada	Peru
Chile	United States
Colombia	Uruguay
Costa Rica	Venezuela

Source: own elaboration

We do two steps to homogenize the database. First, we avoid losing observations due to taking logarithms of negative FDI flows by considering absolute values. Second, we have values for exports at HS2 code, but not for imports. We do the following operation to homogenize, by estimating HS2 imports (M_{HS2}) from HS6 exports (X_{HS6}) and imports (M_{HS6}): $\frac{X_{HS6}}{M_{HS6}} = R$; $M_{HS2} = \frac{X_{HS2}}{R}$.

5. Results

The table 5.1 below shows the results for the cross-section OLS regressions. Each column represents an equation the first column contains bilateral exports as a dependent variable, and the second column uses FDI as the dependent variable. Column 1 is the Helpman and Krugman (1985) gravity equation incorporating FDI in the transport cost. Column 2 is the first bidirectional gravity equation, with proxies for the multilateral resistance. Finally, column 3 is the gravity equation with the multilateral resistance modeled. We have added three rows at the end of the table that indicate whether we consider controls for the exporter, importer or HS2 chapter or not. In order to simplify the number of rows, we have added the GDP, Population and distance squared together with the single one, which we indicate with or. Squared variables can be found in equations (8) and (14), while single variables are in equation (3).

TABLE 5.1: Cross-section estimation

Column	**1**	**2**	**3**
Equation	**3**	**8**	**14**
Dep. variable	$\boldsymbol{log(x_{ij})}$	$\boldsymbol{log\ (x_{ij} * x_{ji})}$	$\boldsymbol{log\ (x_{ij} * x_{ji})}$
$\log(1 + FDI_{ij,t-1})$	0,187	4,396	2,983
	(29,45)**	(28,81)**	(36,04)**
$\log(1 + FDI_{ji,t-1})$		-1,062	0,038
		(9,34)**	(0,53)
$\log GDP_i$ *or* $\log \mathrm{GDP}_i^2$	0,155	-10,091	
	(4,81)**	(26,05)**	
$\log GDP_j$ *or* $\log \mathrm{GDP}_j^2$	0,667	15,752	
	(31,08)**	(61,25)**	
$\log POP_i$ *or* $\log \mathrm{POP}_i^2$	0,964	19,160	
	(21,76)**	(36,02)**	
$\log POP_j$ *or* $\log \mathrm{POP}_j^2$	-0,037	-6,210	
	(1,19)	(16,50)**	
$\log x_{ii}$			3,134
			(35,45)**
$\log x_{jj}$			13,110
			(196,78)**
$\log d_{ii}$			4,783
			(48,87)**
$\log d_{jj}$			-1,045
			(10,58)**
$\log d_{ij}$ *or* $log d_{ij}^2$	-0,893	-8,479	-5,594
	(44,43)**	(34,78)**	(37,21)**
adj_{ij}	-0,097	14,983	34,789
	(2,52)*	(16,01)**	(48,70)**
$comlang_{ij}$	0,1	4,711	2,846
	(3,57)**	(6,29)**	(8,18)**
$colony_{ij}$	-0,457	-11,604	9,980
	(10,12)**	(10,01)**	(21,05)**
$agreem_{ij}$	0,961	26,283	17,045
	(37,27)**	(40,65)**	(33,70)**
constant	-8,751	-282,186	-116,731
	(45,32)**	(57,17)**	(32,45)**
Exporter effect	Yes	Yes	No
Importer effect	Yes	Yes	No
Chapter HS2 control	Yes	Yes	Yes
Section control	Yes	Yes	Yes
R2	0,79	0,79	0,79
N	95726	95726	95726

Source: authors' calculations (* p<0.05; ** p<0.01)

Although the coefficient R2 is the same for all the equations (0,79) there are some disparities with the other coefficients, which we explain as follows.

We can see how, in all the cases, FDI fosters exports. The effect is positive in all the equations, but exponentially increases when we jump to the bidirectional gravity equation (columns 2 and 3) from 0,18 to 2,9 and 4.3 (when the multilateral resistance is modeled). However, when we introduce the bidirectional approach, the variable $\log(FDI_{ji,t-1})$ is negative (column 2) or is non-significant (column 3), which suggests that only in the flows direction from the exporter to the importer country are significant.

In relation to the variables of the basic gravity model, the GDP and population are positive and significant in all cases except two: in column 2, GDP for the exporter country ($\log GDP_i$) and population for the importer country ($\log POP_j$) are negative but significant, which clearly suggests that the international trade is being substituted by domestic trade. The distance coefficient is negative, which is consistent with the literature, and significant for all the equations.

The third equation (column 3) does not contain GDP and Population as explanatory variables to model the multilateral resistance. The domestic trade, given by the variables $\log x_{ii}$ and $\log x_{jj}$, increases exports because both variables are positive and significant (3,1 and 13). Referring to the domestic distance, the coefficient is only negative for the importer country (-1,045), which suggests that distance is only a trade impediment for the importer country rather than the exporter country.

Referring to the factor variables that are transport cost components, only the existence of a common language and a trade agreement fosters exports in all the equations. The contiguity reduces trade for the first equation (column 1) but increases exports highly in the bidirectional equation (14 and 34). The colonial linkages reduce trade in the first (-0,457) and second (-11,980) equation.

To sum up, FDI fosters trade and the implementation of the multilateral resistance shows how domestic trade fosters exports, but in terms of R2 the three equations are equal. One of the major issues of this paper is the introduction of controls for HS sections. We expect from the literature that only some sectors are sensitive to exports. We show the coefficients of the controls for the 22 chapters of HS at the three equations, which we can see below in the table 5.2.

TABLE 5.2: Estimation results disaggregated by HS sections

Column	1	2	3
Equation	3	8	14
Dep. variable	$log(x_{ij})$	$log\ (x_{ij} * x_{ji})$	$log\ (x_{ij} * x_{ji})$
Section			
1			
2	-2,110	-30,826	-25,813
	(10,48)**	(6,39)**	(5,36)**
3			
4	2,136	27,290	29,296
	(16,04)**	(8,55)**	(9,20)**
5	0,951	8,624	11,161
	(7,17)**	(2,71)**	(3,52)**
6	-0,039	1,305	1,627
	(0,24)	(0,34)	(0,43)
7	4,608	90,908	87,448
	(42,73)**	(35,17)**	(33,93)**
8	-2,110	-32,771	-32,982
	(13,00)**	(8,42)**	(8,50)**
9	-3,751	-34,504	-32,137
	(20,67)**	(7,93)**	(7,41)**
10	1,857	19,920	19,196
	(13,18)**	(5,90)**	(5,70)**
11	-3,736	-47,588	-47,079
	(19,10)**	(10,15)**	(10,07)**
12	-2,796	-27,083	-26,458
	(17,47)**	(7,06)**	(6,92)**
13	1,524	27,235	28,083
	(13,43)**	(10,01)**	(10,35)**
14			
15	-0,223	-4,655	-2,031
	(1,36)	(1,19)	(0,52)
16	5,153	109,179	99,915
	(48,25)**	(42,65)**	(39,14)**
17	2,547	40,801	39,598
	(19,04)**	(12,73)**	(12,39)**
18	-0,656	-2,028	-0,915
	(5,55)**	(0,72)	(0,32)
19			
20	1,453	36,543	35,208
	(12,45)**	(13,06)**	(12,62)**
21		-15,840	
		(4,51)**	
22			

Source: authors' calculations (* p<0.05; ** p<0.01)

We can see how the results vary per section. For the section 2, which contains the low value, added, the results are highly negative. As a general pattern, the coefficients are higher in the bidirectional gravity equations.

We have a negative effect for the following sections: 6, 8, 9, 11, 12, 15, 18 and 21. The results are extremely negative at section 11 for the bidirectional gravity equations (-47) and section 9 (-34). It is remarkable because they are febrile articles and contain some value added.

The effect is positive for these sections: 4, 5, 7, 10, 13, 16, 17 and 20. The highest coefficients are for section 16 (109) and section 17 (40,8) at the bidirectional gravity equation. Section 16 implies manufacturing activities and contains high value added, which is perfectly consistent with the literature.

However, there is a section in which coefficients change: number 6 changes from negative (-0,334) to positive (more than 1) when the bidirectional gravity equations are considered.

To sum up, our results are consistent with the literature because a high number of high values added sectors have a positive coefficient when FDI is included, but there are other high value added sectors whose coefficient is negative. The coefficients greatly change when we move from one functional form to another, so the domestic trade that means the multilateral resistance is key element to explain this effect.

6. Robustness

The objective of this point is to see how our results vary when we change some elements from the gravity equation. We change the transport cost and create two alternative specifications, given the baseline specification at equation (2).

The first specification considers the transport cost dependent only on bilateral distance and FDI, so all the factor variables are omitted:

$$t_{ij} = dist_{ij}^{\rho_1} {FDI_{ij,t-1}}^{-\rho_2} \qquad (15)$$

The second specification omits FDI from the transport cost, so now transport costs are symmetric ($t_{ij} = t_{ji}$).

$$t_{ij} = dist_{ij}^{\rho_1} e^{-(\delta_2 adj_{ij} + \delta_3 colony_{ij} + \delta_4 comlang_{ij} + \delta_5 agreem_{ij})} \quad (16)$$

The following tables show how the results change when we change the transport cost function. We show the coefficients for the variables and sections, as before.

TABLE 6.1: Robustness for equation 3 with different transport cost functions

Column	**1**	**2**	**3**
Transport cost	**Baseline**	**15**	**16**
Dep. variable	$\boldsymbol{log(x_{ij})}$	$\boldsymbol{log\ (x_{ij} * x_{ji})}$	$\boldsymbol{log\ (x_{ij} * x_{ji})}$
$\log(1 + FDI_{ij,t-1})$	0,187	0,163	
	(29,45)**	(28,60)**	
$\log(GDP_i)$	0,155	0,511	0,643
	(4,81)**	(25,02)**	(23,27)**
$\log(GDP_j)$	0,667	0,579	0,553
	(31,08)**	(28,02)**	(26,08)**
$\log(POP_i)$	0,964	0,763	0,527
	(21,76)**	(26,71)**	(12,57)**
$\log(POP_j)$	-0,037	0,129	0,224
	(1,19)	(4,25)**	(7,45)**
$\log(dist_{ij})$	-0,893	-1,335	-1,049
	(44,43)**	(123,65)**	(53,89)**
adj_{ij}	-0,097		-0,079
	(2,52)*		(2,03)*
$comlang_{ij}$	0,1		0,427
	(3,57)**		(16,43)**
$colony_{ij}$	-0,457		-0,077
	(10,12)**		(1,77)
$agreem_{ij}$	0,961		0,985
	(37,27)**		(38,04)**
constant	-8,751	-7,654	-9,690
	(45,32)**	(37,02)**	(50,66)**
Exporter effect	Yes	Yes	Yes
Importer effect	Yes	Yes	Yes
Chapter HS2 control	Yes	Yes	Yes
R2	0,79	0,78	0,78
N	95726	95726	95726

Source: authors' calculations (* p<0.05; ** p<0.01)

In the first gravity equation, the changes are not significant. The coefficient of distance increases when we change the transport cost specification and the population becomes significant, so regional trade does not substitute the international trade.

We now present the robustness for equation 8 (table 6.2).

TABLE 6.2: Robustness for equation 7 with different transport cost functions

Column	**1**	**2**	**3**
Transport cost	**Baseline**	**15**	**16**
Dep. variable	$\boldsymbol{log(x_{ij})}$	$\boldsymbol{log\ (x_{ij} * x_{ji})}$	$\boldsymbol{log\ (x_{ij} * x_{ji})}$
$\log(1 + FDI_{ij,t-1})$	4.396	3.861	
	(28.81)**	(27.08)**	
$\log(1 + FDI_{ji,t-1})$	-1.062	0.13	
	(9.34)**	(1.35)	
$\log \mathrm{GDP}_i^2$	-10.091	-1.007	0.643
	(26.05)**	(4.09)**	(23.27)**
$\log \mathrm{GDP}_j^2$	15.752	15.333	0.553
	(61.25)**	(60.97)**	(26.08)**
$\log \mathrm{POP}_i^2$	19.160	13.223	0.527
	(36.02)**	(38.43)**	(12.57)**
$\log \mathrm{POP}_j^2$	-6.210	-4.828	0.224
	(16.50)**	(13.22)**	(7.45)**
$logd_{ij}^2$	-8.479	-17.667	-1.049
	(34.78)**	(135.17)**	(53.89)**
adj_{ij}	14.983		-0.079
	(16.01)**		(2.03)*
$agreem_{ij}$	26.283		0.427
	(40.65)**		(16.43)**
$comlang_{ij}$	4.711		-0.077
	(6.29)**		(1.77)
$colony_{ij}$	-11.604		0.985
	(10.01)**		(38.04)**
constant	-282.186	-246.183	-9.690
	(57.17)**	(48.85)**	(50.66)**
Exporter effect	Yes	Yes	Yes
Importer effect	Yes	Yes	Yes
Chapter HS2 control	Yes	Yes	Yes
R2	0.79	0.78	0.78
N	95726	95726	95726

Source: authors' calculations (* p<0.05; ** p<0.01)

In the first bidirectional gravity equation, the results do not change so much when we consider alternative transport cost functions. The variable $\log(FDI_{ji,t-1})$ becomes positive when we remove the factor variables. When FDI is removed, GDP and

Population coefficients become positive, so domestic trade does not substitute international trade.

TABLE 6.3: Robustness for equation 13 with different transport cost functions

Column	**1**	**2**	**3**
Transport cost	**Baseline**	**15**	**16**
Dep. variable	$\boldsymbol{log(x_{ij})}$	$\boldsymbol{log\ (x_{ij} * x_{ji})}$	$\boldsymbol{log\ (x_{ij} * x_{ji})}$
$\log(1 + FDI_{ij,t-1})$	2,983	4,644	
	(36,04)**	(57,92)**	
$\log(1 + FDI_{ji,t-1})$	0,038	2,055	
	(0,53)	(30,12)**	
$\log x_{ii}$	3,134	2,681	5,303
	(35,45)**	(30,77)**	(75,90)**
$\log x_{jj}$	13,110	14,204	13,369
	(196,78)**	(219,28)**	(218,80)**
$\log d_{ii}$	4,783	-14,052	-4,321
	(48,87)**	(155,29)**	(31,05)**
$\log d_{jj}$	-1,045	3,444	5,047
	(10,58)**	(40,27)**	(52,27)**
$logd_{ij}^2$	-5,594	-1,853	0,075
	(37,21)**	(21,46)**	(0,81)
adj_{ij}	34,789		46,321
	(48,70)**		(73,06)**
$comlang_{ij}$	2,846		3,180
	(8,18)**		(9,08)**
$colony_{ij}$	9,980		10,610
	(21,05)**		(22,69)**
$agreem_{ij}$	17,045		19,291
	(33,70)**		(38,90)**
constant	-116,731	9,425	-156,300
	(32,45)**	(2,97)**	(46,47)**
Exporter effect	No	No	No
Importer effect	No	No	No
Chapter HS2 control	Yes	Yes	Yes
R2	0,79	0,77	0,78
N	95726	95726	95726

Source: authors' calculations (* p<0.05; ** p<0.01)

We can see how the coefficients for the FDI increase. In fact, the variable $\log(FDI_{ij,t-1})$ becomes significant when control variables are removed from the transport cost. When FDI is removed, the results do not change so much.

Now we compare the coefficients for the HS sectors when we do the robustness checks with the transport cost.

TABLE 6.4: Robustness for equation 3 with different transport cost functions

Column	**1**	**2**	**3**
Transport cost	**Baseline**	**15**	**16**
Dep. variable	$log(x_{ij})$	$log\ (x_{ij} * x_{ji})$	$log\ (x_{ij} * x_{ji})$
Section			
1			
2	-2,110	-2,110	-2,123
	(10,48)**	(10,39)**	(10,50)**
3			
4	2,136	2,140	2,127
	(16,04)**	(15,94)**	(15,90)**
5	0,951	0,934	0,939
	(7,17)**	(6,99)**	(7,05)**
6	-0,039	-0,047	-0,048
	(0,24)	(0,29)	(0,3)
7	4,608	4,603	4,597
	(42,73)**	(42,34)**	(42,44)**
8	-2,110	-2,115	-2,114
	(13,00)**	(12,92)**	(12,96)**
9	-3,751	-3,788	-3,767
	(20,67)**	(20,70)**	(20,67)**
10	1,857	1,853	1,852
	(13,18)**	(13,05)**	(13,09)**
11	-3,736	-3,748	-3,733
	(19,10)**	(19,00)**	(18,99)**
12	-2,796	-2,799	-2,803
	(17,47)**	(17,35)**	(17,44)**
13	1,524	1,511	1,523
	(13,43)**	(13,20)**	(13,36)**
14			
15	-0,223	-0,217	-0,23
	(1,36)	(1,32)	(1,4)
16	5,153	5,141	5,142
	(48,25)**	(47,74)**	(47,93)**
17	2,547	2,537	2,533
	(19,04)**	(18,81)**	(18,85)**
18	-0,656	-0,668	-0,663
	(5,55)**	(5,60)**	(5,58)**
19			-0,028
			(0,2)
20	1,453	1,444	1,445
	(12,45)**	(12,27)**	(12,32)**
21			-1,323
			(8,99)**
22			

Source: authors' calculations (* p<0.05; ** p<0.01)

We can see that the coefficients for all the sections are very similar between the three transports cost functions. The only difference is the existence of results for sections 19 and 21 when FDI is removed. The coefficient for section 19 is not significant and the coefficient for section 21 is the opposite of the expected sign from the literature.

TABLE 6.5: Robustness for equation 8 with different transport cost functions

Column	**1**	**2**	**3**
Transport cost	**Baseline**	**15**	**16**
Dep. variable	$log(x_{ij})$	$log\ (x_{ij} * x_{ji})$	$log\ (x_{ij} * x_{ji})$
Section			
1			
2	-30,826	-30,553	-31,139
	(6,39)**	(6,25)**	(6,42)**
3			
4	27,290	27,451	27,117
	(8,55)**	(8,49)**	(8,46)**
5	8,624	8,271	8,379
	(2,71)**	(2,57)*	(2,62)**
6	1,305	0,947	1,062
	(0,34)	(0,25)	(0,28)
7	90,908	90,845	90,657
	(35,17)**	(34,70)**	(34,91)**
8	-32,771	-32,925	-32,832
	(8,42)**	(8,35)**	(8,40)**
9	-34,504	-35,702	-34,889
	(7,93)**	(8,10)**	(7,98)**
10	19,920	19,799	19,785
	(5,90)**	(5,79)**	(5,83)**
11	-47,588	-47,533	-47,359
	(10,15)**	(10,01)**	(10,05)**
12	-27,083	-27,081	-27,252
	(7,06)**	(6,97)**	(7,07)**
13	27,235	26,795	27,200
	(10,01)**	(9,72)**	(9,95)**
14			
15	-4,655	-4,595	-4,797
	(1,19)	(1,16)	(1,22)
16	109,179		108,893
	(42,65)**		(42,34)**
17	40,801	108,786	40,401
	(12,73)**	(41,95)**	(12,54)**
18	-2,028	40,392	-2,155
	(0,72)	(12,44)**	(0,76)
19			
20	36,543	-2,403	36,293
	(13,06)**	(0,84)	(12,91)**
21	-15,840	36,305	-15,797
	(4,51)**	(12,81)**	(4,48)**
22			

Source: authors' calculations (* p<0.05; ** p<0.01)

We can see how coefficients differ in sections 20 and 21, when transport cost is symmetric (column 2), the coefficient for section 20 becomes irrelevant and the one for section 21 increases to a high amount.

TABLE 6.6: Robustness for equation 13 with different transport cost functions

Column	**1**	**2**	**3**
Transport cost	**Baseline**	**15**	**16**
Dep. variable	$log(x_{ij})$	$log\ (x_{ij} * x_{ji})$	$log\ (x_{ij} * x_{ji})$
Section			
1			
2	-25,813 (5,36)**	-25,361 (5,13)**	-26,696 (5,50)**
3			
4	29,296 (9,20)**	29,100 (8,90)**	28,904 (9,01)**
5	11,161 (3,52)**	10,973 (3,37)**	11,636 (3,64)**
6	1,627 (0,43)	0,907 (0,23)	1,264 (0,33)
7	87,448 (33,93)**	86,893 (32,81)**	87,069 (33,51)**
8	-32,982 (8,50)**	-32,830 (8,23)**	-33,010 (8,44)**
9	-32,137 (7,41)**	-33,175 (7,44)**	-32,217 (7,37)**
10	19,196 (5,70)**	18,542 (5,36)**	19,482 (5,74)**
11	-47,079 (10,07)**	-47,113 (9,80)**	-46,603 (9,88)**
12	-26,458 (6,92)**	-26,977 (6,86)**	-26,537 (6,88)**
13	28,083 (10,35)**	27,487 (9,86)**	28,096 (10,27)**
14			
15	-2,031 (0,52)	-3,298 (0,82)	-1,903 (0,48)
16	99,915 (39,14)**	98,641 (37,60)**	99,558 (38,68)**
17	39,598 (12,39)**	38,952 (11,86)**	39,441 (12,24)**
18	-0,915 (0,32)	-1,220 (0,42)	-1,009 (0,35)
19			-1,735 (0,53)
20	35,208 (12,62)**	34,345 (11,98)**	35,107 (12,48)**
21			-15,411 (4,36)**
22			

Source: authors' calculations (* p<0.05; ** p<0.01)

The pattern is very similar to the cases before: the coefficients do not differ much between them. The only difference is the existence of coefficients for sections 19 (negative and non-significant) and 21 (negative and significant).

In summary the coefficients for the sections are similar for all the transport cost functions and when FDI is not included in the transport cost, there are not significant differences between the sections. The changes in the parameters for the variables are not very significant because only GDP and Population change.

7. Conclusions

According to our results, we can indicate some important ideas that might be taken into account. First, the introduction of direction of the importer-exporter does not reflect significant parameters, so direction of the exporter-importer, which has been traditionally used by the literature, is enough to determine the trade pattern. Another issue refers to the multilateral resistance, as we provided a version for the gravity equation when we explicitly model multilateral resistance. Although some coefficients are larger when we model multilateral resistance, the effect across sectors is very similar. It suggests that the use of exporter and importer fixed effects are enough to explain the effects of FDI on exports and should be used by the sake of simplicity. The last issue refers to the role of FDI, which is clearly subject to discussion. We can see that the effects of FDI are higher for the bidirectional gravity equations, which contains higher coefficients. However, when we look across sectors, the results do not differ so much between themselves. That makes us wonder if the variable FDI is relevant in our gravity equation, we confirm in the robustness checks that when FDI is not a part of the transport cost, the results are very similar to the baseline transport cost functional form.

This study presents some problems that should be addressed in future research. First, we only consider American countries, which only explain one world continent and not the world economy. We use cross-sectional data, which only shows the effect in one concrete year. As we can expect the existence of heterogeneity across years, panel data techniques should be implemented, which allows using a wide range of techniques. Another issue is that our study uses only OLS estimator. Although we report directly the coefficients of elasticity, according to Santos Silva and Tenreyro (2006) OLS is biased. These authors propose a new methodology whose results would be highly relevant for our approach.

Future research could use this study as a base to include more countries from other continents, develop alternative ways to estimate domestic trade and use other methodologies different from OLS.

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9. Annex

TABLE 9.1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
x_{ij}	95726	1042959	4707289	1	8.43E+07
x_{ji}	95726	9,94E+07	6,58E+09	0,0000622	1,88E+12
FDI_{ii}	95726	22328,37	58193,9	-256	276144
FDI_{ji}	95726	21585,24	66597,31	-17384	285974
GDP_i	95726	5864864	6563706	36217,5	1.45E+07
GDP_j	95726	2782079	5144444	36217,5	1.45E+07
POP_i	95726	158350.4	122672.4	3368,8	309349.7
POP_j	95726	94239.98	106392.2	3368,8	309349.7
$dist_{ij}$	95726	4633,176	2575,169	3084,921	9291,209
x_{ii}	95726	5259419	6050425	-53315,13	1.32E+07
x_{jj}	95726	2464447	4721402	-53315,13	1.32E+07
d_{ii}	95726	2031,935	5162,409	10	2089,281
d_{jj}	95726	2173,051	5437,798	10	2089,281

Source: authors' calculations

TABLE 9.2: HS Sections

Number of HS Section	Meaning
1	Live Animals; Animal Products
2	Vegetable Products
3	Animal or Vegetable Fats and Oils and Their Cleavage Products; Prepared Edible Fats; Animal or Vegetable Waxes
4	Prepared Foodstuffs; Beverages, Spirits, and Vinegar; Tobacco and Manufactured Tobacco Substitutes
5	Mineral Products
6	Products of the Chemical or Allied Industries
7	Plastics and Articles Thereof Rubber and Articles Thereof
8	Raw Hides and Skins, Leather, Furskins and Articles Thereof; Saddlery and Harness; Travel Goods, Handbags and Similar Containers; Articles of Animal Gut (Other Than Silkworm Gut)
9	Wood and Articles of Wood; Wood Charcoal; Cork and Articles of Cork; Manufacturers of Straw,of Esparto or of Other Plaiting Materials; Basketware and Wickerwork
10	Pulp of Wood or of Other Fibrous Cellulosic Material; Waste and Scrap of Paper or Paperboard; Paper and Paperboard and Articles Thereof
11	Textile and Textile Articles
12	Footwear, Headgear, Umbrellas, Sun Umbrellas, Walking Sticks, Seatsticks, Whips, Riding-Crops and Parts Thereof; Prepared Feathers and Articles Made Therewith; Artificial Flowers; Articles of Human Hair
13	Articles of Stone, Plaster, Cement, Asbestos, Mica or Similar Materials; Ceramic Products; Glass and Glassware
14	Natural or Cultured Pearls, Precious or Semiprecious Stones, Precious Metals, Metals Clad With Precious Metal, and Articles Thereof; Imitation Jewelry; Coin
15	Base Metals and Articles of Base Metal
16	Machinery and Mechanical Appliances; Electrical Equipment; Parts Thereof; Sound Recorders and Reproducers, Television Image and Sound Recorders and Reproducers, and Parts and Accessories of Such Articles
17	Vehicles, Aircraft, Vessels and Associated Transport Equipment
18	Optical, Photographic, Cinematographic, Measuring, Checking, Precision, Medical or Surgical Instruments and Apparatus; Clocks and Watches; Musical Instruments; Parts and Accessories Thereof
19	Arms and Ammunition; Parts and Accessories Thereof
20	Miscellaneous Manufactured Articles
21	Works of Art, Collectors' Pieces and Antiques
22	Special Classification Provisions; Temporary Legislation; Temporary Modifications Proclaimedpursuant to Trade Agreements Legislation; Additional Import Restrictions Proclaimed Pursuant to Section 22 of the Agricultural Adjustment Act, As Amended

Source: Own elaboration from UN Comtrade