Departamento de Economía

NEW DETERMINANTS OF BILATERAL TRADE: AN EMPIRICAL ANALYSIS FOR DEVELOPED AND DEVELOPING COUNTRIES

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A mis padres

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CHAPTER 1

INTRODUCTION AND OVERVIEW

1.1. MOTIVATION

The main aim of this dissertation is to investigate the effect of a number of factors on international trade flows in developed and developing countries.

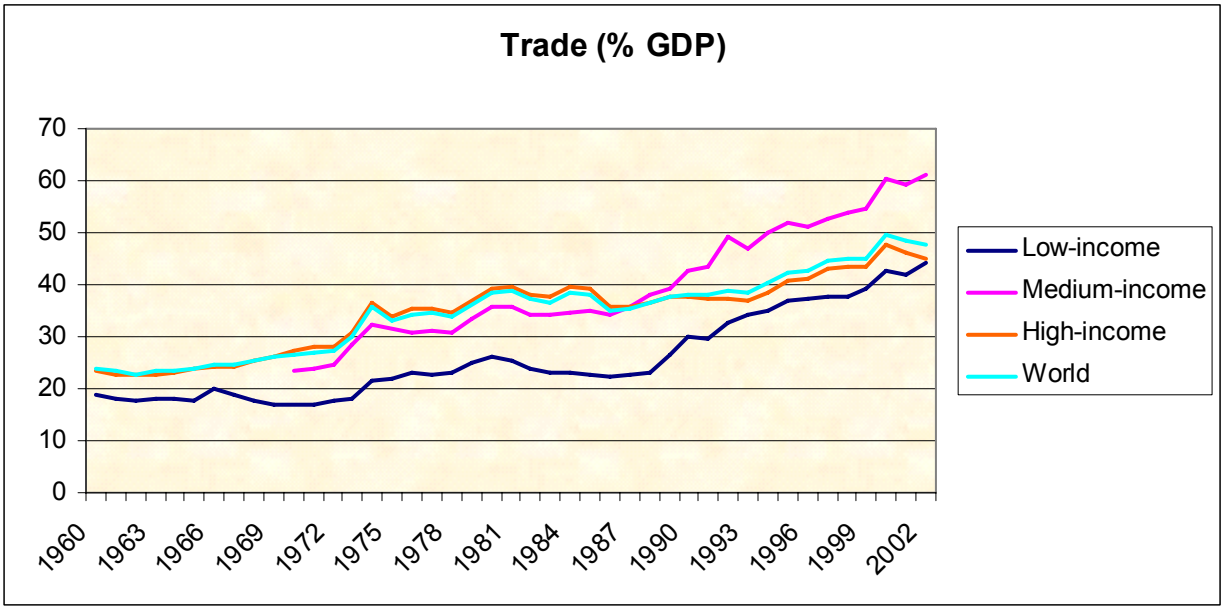
In today's global economy, international trade can play an important role in reducing poverty and income inequality in developing countries through its impact on economic growth.

There is a generalised belief that free trade establishes the best conditions for economic development and growth. However, since globalisation increases the costs of pro-poor policies, countries that fail to participate in the global economy run the risk of being marginalised. Therefore, to minimise the risks of marginalisation and to maximise the benefits stemming from globalisation could be considered as key challenges for developing countries. Marginalisation and the poor overall economic performance in developing countries may be partially due to a number of factors related to international trade issues such as barriers to trade imposed by developed countries and the dependence of developing countries on exports of primary products.

World trade has experienced huge growth in recent decades, a growth that has been higher in medium-income and low-income than in high-income economies. Hence, a number of developing countries have increased their trade shares in developed countries. Figure 1 shows the evolution of trade as a percentage of the GDP in the world and in

high-income, medium-income and low-income countries. World trade represented 23.95% of GDP in 1960 and 47.62% in the year 2002.

Figure 1. The growth of world trade.

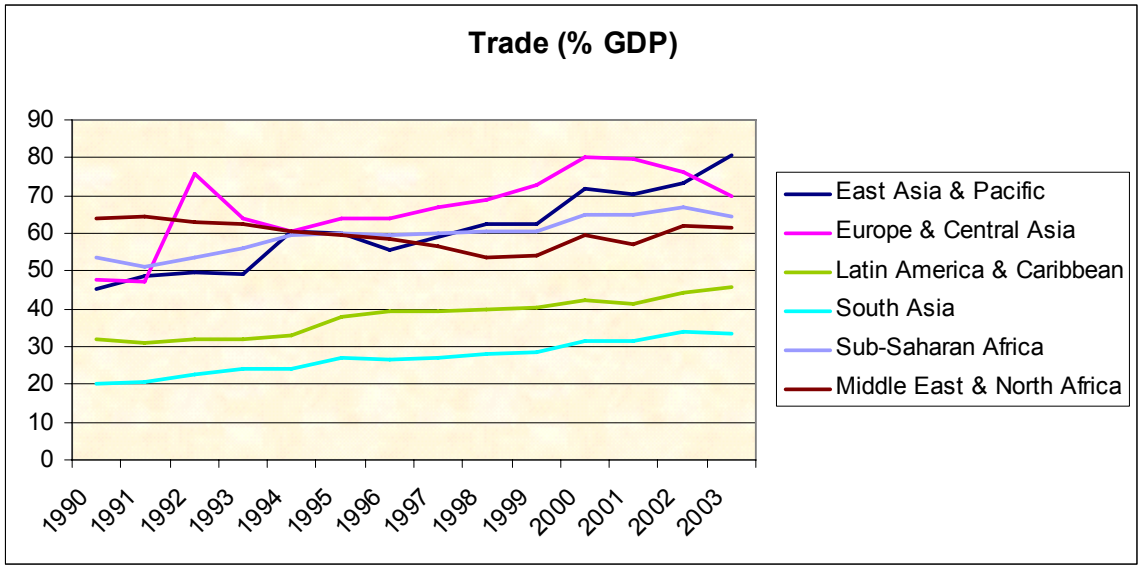


Source: World Bank (2005a)

According to Feenstra (1998), falling transport costs, trade liberalisation, economic convergence and the increase of intermediate goods trade are the main factors that explain the growth of world trade. In the same line, Baier and Bergstrand (2001) show that income growth, tariff rate reductions and lower transport costs have contributed to the growth of world trade. Income growth explains 67% of the growth of trade, tariff reductions 25% and transport cost reductions only 8%. However, these authors only use 16 OECD countries in their empirical analysis, all of which are high-income countries.

Figure 2 shows the evolution of trade as a percentage of GDP over the period 1990-2003 in different geographical areas. The highest increase of trade is observed in East Asia and Pacific countries, countries where extreme poverty has also decreased (see Figure 3).

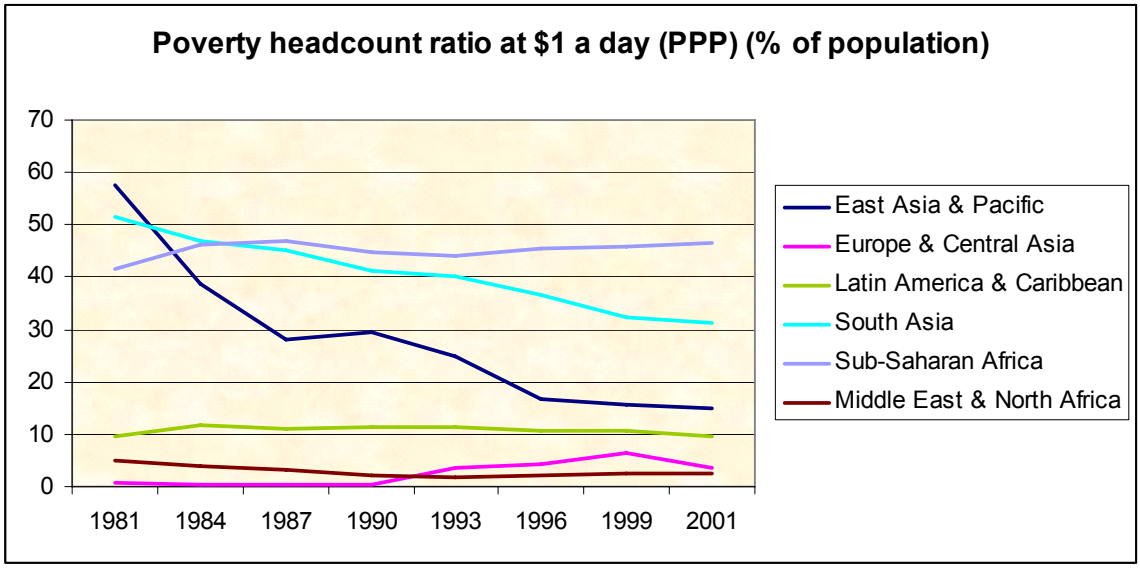
Figure 2. The growth of trade in different geographical areas.



Source: World Bank (2005a)

Although poverty exists everywhere in the world, it is in developing countries where more than one person in five subsists on less than $1 day. Figure 3 shows that some progress has been made in terms of economic inequality. Extreme poverty in developing countries has fallen from 28 percent to 21 percent since 1990. However, hundreds of millions of people are still trapped in poverty, especially in Sub-Saharan Africa and South Asia. Moreover, the decreasing tendency of extreme poverty has not been the same in all developing countries. While extreme poverty has decreased in South Asian, East Asian and Pacific countries, this is not the case in Sub-Saharan Africa, where extreme poverty is the highest.

Figure 3. The increase of economic inequality.



Source: World Bank (2005a)

Figure 3 shows that the largest decrease in extreme poverty has been in East Asia and Pacific countries, where the increase of trade has been more pronounced. Developed and developing countries face very different economic challenges and these may be playing a different role in the growth of international trade and hence, in economic growth. Thus, it is of great interest to investigate the determinants of international trade in developed and developing countries in order to derive economic policy recommendations that specifically apply to countries with different levels of development.

1.2. OBJECTIVES AND METHODOLOGY

In this dissertation, the pattern and direction of international trade flows will be analysed by taking into consideration different levels of development across countries in the world. A better understanding of the factors explaining trade will help authorities to define specific economic and industrial policies at macro and micro levels in order to promote

trade and subsequently economic development and growth in countries at different stages of development.

The dissertation analyses in greater detail the role of some of the variables recently considered as determinants of international trade flows. Technological innovation, geographical factors, cultural similarities and trade costs are the explanatory factors that will be investigated in depth.

First, aggregated trade flows are modelled as a function of incomes, distance, technological innovation, geography and cultural similarities. Second, a disaggregated analysis is performed to investigate the effect of tariffs and transport costs on bilateral trade flows.

One of the main devices used to analyse the determinants of international trade flows is the gravity model of trade. Recently, some authors have referred to this model as the "workhorse" of empirical trade studies (Eichengreen and Irwin, 1998; Cheng and Wall, 2005). In this dissertation, the gravity model is the main modelling framework used. Harrigan (2001) states that this approach is most suitable for aggregated data, although it does not perform so well with disaggregated data. According to Frankel (2000), data should be disaggregated to obtain better estimates, since not enough emphasis is placed on individual estimates that may be exposed to estimation error.

Determinants of international trade flows may differ across both countries and sectors. Country and sector heterogeneity issues will therefore be considered when analysing international trade patterns.

1.3. STRUCTURE OF THE DISSERTATION

This dissertation consists of six chapters, including this introductory chapter. In this section, a short description of the contents and main results of Chapters 2-6 are provided.

Chapter 2, "Literature Review", reviews the literature closely related to the gravity model of bilateral trade. Background and specification issues are also reviewed. Special attention is paid to a number of stylised facts of the "new" determinants of international trade, where heterogeneity is taken into account. The two types of heterogeneity considered are country-heterogeneity and sector-heterogeneity. The reason country-heterogeneity is taken into account is related to the economic differences existing between developed and developing countries that lead to differences in how the determinants of their bilateral trade flows behave. In relation to sector-heterogeneity, the search model should apply most strongly to differentiated products and most weakly to products traded on organised exchanges. Therefore, a number of variables such as distance, language and colonial ties should have the greatest effects on matching international buyers and sellers of differentiated products, and search costs should act as the greatest barrier to trade for differentiated products (Rauch, 1999).

In this chapter, a number of indicators of technological innovation are reviewed and two of them are selected for use in the empirical analysis. The stylised facts concerning geography focus on the negative correlation between geographical distance and international trade. Informational costs, tastes and preferences, and unfamiliarity are factors that may be behind this persistent negative correlation. Finally, the role of transport costs is considered to be of great importance nowadays due to the decreasing role of tariff barriers as an influencing factor on trade.

Chapter 3, "On the effect of technological innovation, cultural similarities and geography on international trade", presents the analysis of the role of technological innovation, geography and cultural similarities on international trade flows. The theoretical framework is derived from Helpman and Krugman (1996), and forms the base for the empirical analysis. A gravity equation augmented with technological innovation and transport infrastructure variables is estimated. Geographical and social variables are also considered. The results indicate that distance has a considerably low explanatory power on trade compared with transport infrastructure and technological innovation. Importers' technology has a lower effect on trade than exporters' technology and a higher technology endowment in the exporting country leads to greater exports. The development of technological innovation means that long distances are less important nowadays than in the past since the results indicate that technological innovation advances have lowered the effect of distance on trade. The hypothesis that countries tend to trade more when they are "closer" from a technological point of view is supported by the data.

Technological and transport infrastructures can be considered as a barrier to trade for countries with lower capital endowment level and, therefore, investing in them increases the participation of the poorest economies in the world economy. Finally, significant differences in the determinants of bilateral trade flows are found between developed and developing countries.

Chapter 4, "The role of geographical distance in gravity regressions: Is there really a missing globalisation puzzle?", analyses in depth the role of geographical distance on trade. The non-decreasing coefficient of distance commonly found in gravity regressions

has been considered puzzling since globalisation has decreased trade costs. In this chapter, a log-linear and a non-linear gravity equation are estimated in order to compare the evolution over time of the determinants of bilateral trade flows. Geographical, social and technological innovation variables are included in the model. Because the literature on gravity equations has highlighted the importance of relative trade barriers, remoteness variables are also included. The findings indicate that the distance coefficient increases over time for developing countries and decreases over time and is much lower in magnitude for developed countries. When non-linear and log-linear specifications are compared, the distance coefficient in non-linear regressions is clearly lower than that found in the linear estimations and decreases over time; nevertheless, opposite unexpected effects are found for a number of variables in the non-linear estimations. Although in terms of goodness of fit (high R-squared), the non-linear specification of the gravity equation seems to be a good approach to analyse the determinants of international trade, the log-linear specification of the gravity model shows better forecast accuracy on trade flows and a lower AIC value.

Chapter 5, "On the effect of tariffs and trade frictions on sectoral trade", presents the analysis of the effect of trade costs on international trade flows. An index of revealed comparative advantage of international trade is used to build a country-classification matrix. Thirteen exporting countries are chosen, according to their level of income and international specialisation. The effect of tariffs and transport costs is analysed from a sectoral perspective using two different specifications and two different estimation techniques, namely OLS and PPML. Regressions are run for different sub-samples to test the validity of the obtained results. Trade among countries with high and low levels of

development, and trade in differentiated, referenced and homogeneous goods are regressed on the determinants of international trade. Results support the evidence of country and sector-heterogeneity. Transport costs and tariffs seem to be less important for trade than distance and technological innovation. Nonetheless, when obtaining consistent estimates of the gravity model, distance coefficients present a lower magnitude (this result has already been found in previous literature) and tariffs and trade frictions present a higher effect on international trade flows.

Finally, Chapter 6 presents the final conclusions and makes some economic policy recommendations.

CHAPTER 2

LITERATURE REVIEW

Abstract

In the present chapter, the gravity equations literature related to its theoretical framework, estimation techniques, functional specification and the interpretation of variables traditionally included in this kind of model is reviewed. Heterogeneity issues are also introduced.

In a second step, stylised facts about the "new" determinants of bilateral trade flows are described; these are technological innovation, cultural similarities, geographical disadvantages, and trade costs.

2.1. THE GRAVITY MODEL OF BILATERAL TRADE

2.1.1. Background

The gravity model has been used as an empirical tool to analyse the determinants of bilateral trade flows. This model has been widely used since it provides a good fit to most data sets of regional and international trade flows. Nonetheless, the gravity model has also played a prominent role in areas other than international trade, such as foreign direct investments (Loungani, Modi and Razin, 2002) and income (Frankel and Romer, 1999).

The first authors to apply the gravity model to international trade flows were Tinbergen (1962) and Pöyhönen (1963). This model, in its basic form, assumes that trade between countries can be compared to the gravitational force between two objects: it is directly related to countries' size and inversely related to the distance between them. Exports from country *i* to country *j* are explained by their economic sizes, their populations, direct geographical distances and a set of dummies incorporating some characteristics common

to specific flows. Theoretical support for the research in this field was originally very poor but since the second half of the 1970s several theoretical developments have appeared in support of the gravity model. Anderson (1979) made the first formal attempt to derive the gravity equation from a model that assumed product differentiation. Bergstrand (1985, 1989) also explored the theoretical determination of bilateral trade, in which gravity equations were associated with simple monopolistic competition models. Helpman and Krugman (1996) used a differentiated product framework with increasing returns to scale to justify the gravity model. Deardorff (1995) has proven that the gravity equation characterises many trade models and can also be justified from standard trade theories. Anderson and van Wincoop (2003) support the idea that the key aspect of the gravity model is the dependence of trade on a bilateral and multilateral resistance factor. These authors refer to price indices as "multilateral resistance" variables, since they depend on all bilateral resistances, including those not directly involving the exporting country. Helpman, Melitz and Rubinstein (2007) develop a theory that generalises Anderson and van Wincoop's (2003) equation in two ways. First, it accounts for firm heterogeneity and fixed trade costs. Second, it accounts for asymmetries between the volume of exports of the trading partners. These authors develop a theory that enables bilateral trade flows to be equal to zero, in particular when there is productivity heterogeneity across firms and firms bear fixed costs of exporting. Then, only firms with the highest productivity export.

All these authors derive a gravity model from theories based on different foundations for trade. A common feature of these models is that they all assume complete specialisation. Therefore, each good is assumed to be produced in only one country. Feenstra, Markusen

and Rose (2001) and Haveman and Hummels (2004) examine a model with incomplete specialisation (multiple countries may produce each homogeneous good), where much lower trade volumes are expected than in the case of complete specialisation.

Additionally, the gravity approach has been furnished with better estimation techniques to deal with different biases. Recently, Santos-Silva and Tenreyro (2006) emphasise a heteroscedasticity bias stemming from the log-linearisation of the gravity equation. Log-linearisation raises the problem of how to deal with zero-value observations. These authors propose using Poisson pseudo-maximum likelihood (PPML) regression since it is easy to implement and reliable in a wide variety of situations. This method is robust to different patterns of heteroscedasticity and provides a natural way to deal with zeros in trade data. Issues about the model specification of the gravity equation are analysed in depth below.

2.1.2. Model specification

According to the generalised gravity model of trade (Deardorff, 1995) the volume of exports between pairs of countries, X_{ij}, is a function of their incomes, their populations, their geographical distance and a set of dummies,

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} P_i^{\beta_3} P_j^{\beta_4} D_{ij}^{\beta_5} A_{ij}^{\beta_6} u_{ij} \qquad (2.1)$$

where Y_i (Y_j) indicates the GDP of the exporter (importer), P_i (P_j) are populations of the exporter (importer), D_{ij} measures the distance between the two countries' capitals (or economic centres), A_{ij} represents any other factors aiding or preventing trade between pairs of countries and u_{ij} is the error term. For estimation purposes, model (2.1), in log-linear form for a single year, is expressed as

$$lX_{ij} = \beta_0 + \beta_1 lY_i + \beta_2 lY_j + \beta_3 lP_i + \beta_4 lP_j + \beta_5 lD_{ij} + \sum_h \delta_h P_{ijh} + u_{ij} \qquad (2.2)$$

where l denotes variables in natural logs, $\sum_h \delta_h P_{ijh}$ is a sum of preferential trade dummy variables and P_{ijh} takes the value one when a certain condition is satisfied (e.g. belonging to a trade bloc), zero otherwise. Research using the gravity model has evaluated the impact of various variables in addition to the basic gravity equation. Usually, the model includes dummy variables for trading partners sharing a common language, colonial ties and common border, as well as trading bloc dummy variables that evaluate the effects of preferential trading agreements. The coefficients of all these trade variables δ_h are expected to be positive. Additionally, landlocked and island dummies are included when one of the trading partners does not have direct access to the sea or is an island, respectively.

A high level of income in the exporting country indicates a high level of production, which increases the availability of goods for exports. Therefore, β_1 is expected to be positive. The coefficient of Y_j, β_2, is also expected to be positive since a high level of income in the importing country suggests higher imports. The coefficient estimated for population of the exporters, β_3, may be positively or negatively signed, depending on whether the country exports less when it is big (absorption effect) or whether a big country exports more than a small country (economies of scale). The coefficient of the importer population, β_4, also has an ambiguous sign, for similar reasons. The distance coefficient is expected to be negative since it is a proxy of all possible trade cost sources.

Finally, several authors have focussed on the specification of the gravity model. Some of them support the view that non-linear models are preferred to log-linear models. Coe, Subramanian, Tamirisa and Bhavnani (2002) refer to the failure of declining trade costs

as an important aspect of globalisation to be reflected in the estimates of the standard gravity model of bilateral trade. They estimate a non-linear specification of the gravity equation and find evidence of the declining importance of geography. These authors claimed that the non-falling distance coefficients over time in gravity regression is another puzzle that should have been added in Obstfeld and Rogoff's (2000) paper, in which six major puzzles in international macroeconomics were cited.[1] Coe et al. (2002) argue that the non-linear specification takes into account zero values for bilateral trade and the level of the estimated distance coefficients is more consistent with the theory. In this line, Croce, Juan-Ramón and Zhu (2004) also estimate a non-linear gravity model and claim that distance has become less relevant over time although the distance coefficient in their yearly regressions declines only slightly (0.06 percentage points in 23 years).

In a recent study, Santos-Silva and Tenreyro (2006) state that log-linearisation is not advisable, even assuming that all observations of the dependent variable are positive, since the expected value of the log-linearised error will in general depend on the covariates and hence Ordinary Least Squares (OLS) estimation will be inconsistent in the presence of heteroscedasticity. According to these authors, OLS estimation exaggerates the role of variables such as geographical distance and cultural similarities.

In this dissertation, different estimation techniques (Tobit and Poisson) are used in the empirical analysis to deal with the problems associated with the existence of zeros and the presence of heteroscedasticity. Additionally, a log-linear and a non-linear

[1] The six major globalisation puzzles considered by these authors are the home bias effect in trade, the Feldstein-Horioka saving-investment relationship, the home bias effect in equity portfolios, the international consumption correlations puzzle, the purchasing power parity puzzle and the exchange rate disconnect puzzle.

specification are compared to analyse whether there is really a missing globalisation puzzle.

2.1.3. Heterogeneity issues

Country-heterogeneity

There are clear economic differences between developed and developing countries that lead to differences in how the determinants of their bilateral trade flows behave. Many developing countries have substantial economic vulnerabilities, such as debt, high unemployment and inflation rates, poverty and unequal income distribution. Moreover, developing economies are characterised by higher levels of trade protection than developed countries and a number of them remain dependent on foreign aid. Thus, the pooling assumption may be rejected in a sample of countries with different levels of economic development, since the determinants of trade may have different coefficients for high and low-income countries.

Traditionally, few studies have attempted to identify the differential impact of the determinants of trade on various groups of countries (Balassa, 1979; Baldwin, 1979). However, in recent years, the amount of research that considers country-heterogeneity has increased, and a number of authors have examined the existence of different trade patterns for developed and developing countries using a gravity framework (Loungani et al. 2002). Other studies focus on heterogeneity in specific variables; for instance, Filippini and Molini (2003) show that the elasticity of demographic variables has different signs and magnitudes in developed and developing countries.

In this dissertation country-heterogeneity is taken into account from an empirical perspective when analysing the determinants of international trade in a gravity

framework in both aggregated and disaggregated analysis. Results point towards the importance of considering country-heterogeneity in this type of study.

Sector-heterogeneity

A classification that has been widely used in the literature on sector-heterogeneity is that introduced by Rauch (1999). This classification has been used in other empirical studies such as Feenstra et al. (2001), Tang (2006) and Giuliano, Spilimbergo and Tonon (2006). Rauch (1999) divides internationally traded commodities into three groups: those traded on organised exchanges, those not traded on organised exchanges but possessing what this author calls reference prices, and all other commodities. The conventional wisdom is that there is a cost to setting up organised exchange markets that is independent of the volume of transactions; this will not allow a market to open if the expected volume of transactions at the price expected to prevail in equilibrium is too small. Possession of a reference price distinguishes homogeneous from differentiated products. As far as empirical analysis of matching international buyers and sellers is concerned, the reason to treat commodities traded on organised exchanges differently from commodities that only have reference prices is that the former have specialised traders that centralise price information, while the same is only potentially true for the latter. Thus, homogeneous commodities can be further divided into those whose reference prices are quoted on organised exchanges and those whose reference prices are quoted only in trade publications. The search model should apply most strongly to differentiated products and most weakly to products traded on organised exchanges, with its applicability to other homogeneous products unclear. Proximity, common language and colonial ties should have the greatest effects on matching international buyers and sellers of differentiated

products, and search costs should act as the greatest barrier to trade for differentiated products.

Feenstra et al. (2001) finds that different estimates of the gravity equation pertain to types of goods, rather than being features of countries. However, these authors run gravity regressions in two groups of countries: exports within the OECD and exports between OPEC and non-OPEC countries. Country-heterogeneity (at least not by level of development) is therefore not really analysed, since in the former sample they are considering exports of goods from developed countries to developed countries, while in the latter, they are considering exports from heavily resource-dependent countries.

In this dissertation, sector-heterogeneity is taken into account from an empirical perspective when analysing the determinants of international trade in a disaggregated gravity framework. Results point towards the importance of considering sector-heterogeneity in this type of study since determinants of international trade differ among sectors.

2.2. STYLISED FACTS OF THE NEW DETERMINANTS OF INTERNATIONAL TRADE

2.2.1. Technological innovation

International trade theory highlights the importance of technological innovation in explaining the international competitiveness of a country (Fagerberg, 1997). Therefore, the development of relevant indicators to measure the level of technological innovation across countries is a matter of great interest in a knowledge-based economy, with a high and increasing dependence on information technology and human capital. Kuznets (1962) already noted the problems that the lack of appropriate innovation measures create in

economic research related to inventive activity. In recent years, important attempts have been made to measure technology creation and diffusion, and human skills across countries.

Wakelin (1997) classifies different proxies for technological innovation used in the literature and points out that the main choice of technological innovation proxies has been between using an input to the innovation process, such as R&D expenditure or the number of scientists and engineers employed in research departments, or an output, such as number of patents. In a more recent study, Keller (2004) points out that technology is an intangible that is difficult to measure directly and that three indirect approaches that can be used are the measurement of inputs (research and development), outputs (patents) and the effect of technology (higher productivity).

Table A shows some of the most relevant indicators (composite indices) that measure countries' endowment of technological innovation. The use of composite indices is criticised by Grupp and Mogee (2004), since composite scores and country rank positions can vary considerably depending on the selection process and alternative methods of calculation. However, when analysing the effect of technological innovation on trade flows, the negative impact of using this kind of indicators does not seem to be high since there is no direct link between such indicators and public policy. Table B shows single variables, mostly related to R&D, that have also been used in recent years to measure the effect of technological innovation in different countries and regions.

Table A. Measurement of technological innovation with composite indices.[2]

Variable	Description	Source
ArCo	This index takes into account three dimensions: **Creation of technology** *(number of patents*, *number of scientific papers)*, **diffusion of technology** *(Internet penetration*, *telephone penetration*, *electricity consumption*) and **development of human skills** *(gross tertiary science and engineering enrolment*, *mean years of schooling*, *adult literacy rate).*	Archibugi and Coco (2004)
European Innovation Scoreboard	This index takes 17 indicators into account. The aspects of the innovation process measured by the scoreboard are: **Availability and use of people with the right skills, creation of new ideas, innovation by firms** and a **range of issues**. From these indicators a so-called "tentative summary innovation index" (SII) is constructed. The index is normalised to the interval [-10, 10]. An index of zero represents the European Union average (Grupp and Mogee, 2004).	European Commission (2005)
ITR	The "Internet Traffic Report" monitors the flow of data around the world. The index takes values between zero and 100. Higher values indicate faster and more reliable connections.	ITR (2004)
ICT	The index of Information and Communication Technology (ICT) diffusion consists of two dimensions: **Connectivity** *(Internet hosts, PCs, telephone mainlines and cellular subscribers)* and **access** *(Internet users, literacy, GDP per capita and cost of a local call)*. Moreover, a third dimension (**policy**) is presented separately.	Phillippa Biggs, UNCTAD (2003)
TAI	The "Technology Achievement Index" is built up of four dimensions: **Creation of technology** *(number of patents granted to residents, receipts of royalty and license fees from abroad)*, **diffusion of recent innovations** *(Internet hosts, exports of high technology and medium technology products)*, **diffusion of old innovations** *(number of telephones, electricity consumption*) and **human skills** *(mean years of schooling*, *gross tertiary science enrolment ratio)*.	UNDP (2001)
NRI	The "Network Readiness Index" measures the degree of preparation of a nation or community to participate in and benefit from Information and Communication Technology (ICT) developments. It is built up of three dimensions: **Environment** offered by a country or community, the **readiness** of the community's key stakeholders, and the **usage** of ICT.	WEF, World Bank and INSEAD (2004)

[2] The "Technology Achievement Index" (TAI) (UNDP, 2001) and the ArCo technology index (Archibugi and Coco, 2004) are chosen for use in the empirical analysis.

Table B. Proxies for technological innovation.

Variable	Description	Source
Proportion of non-managers using computers	Measures the impact of computers on productivity	Black and Lynch (2004)
R&D expenditure Workers in R&D and innovation sectors Number of researchers	Indicators of R&D and innovation	Caballero, Coca and Escribano (2002)
Expenditure on innovation per worker	Indicators of innovation	Calvo (2002)
Imports of computer equipments	Proxy for technological adoption	Caselli and Coleman (2001)
Foreign R&D capital stock	R&D *spillovers*	Coe, Helpman and Hoffmaister (1997)
Variable related to the stock of past research effort and the stock of human capital in countries	Level of technology	Eaton and Kortum (2002)
R&D expenditure	Input measure of investments in new technologies	Fagerberg (1997)
Absolute difference between the ArCo of the two trade partners	Proxy for technological distance	Filippini and Molini (2003)
Internet *hosts*	Measures the Internet development in a country	Freund and Weinhold (2004)
International patents	National innovative output	Furman and Hayes (2004)
Telecommunications and Internet consumption	Indicators of Information and Communication Technology (ICT)	García Castillejo (2002)
Total factor productivity (TFP)	Output measure of investments in new technologies	Gustavsson, Hansson and Lundberg (1997)
Firms introducing an innovation (preceding year) Innovation expenditure	Indicators of innovation in firms	Lachenmaier and Wößmann (2006)
Average number of patents *per capita*	Proxy of innovative output	Moreno, Paci and Usai (2005)
R&D expenditure Inputs assigned for basic research Information and Communication Technology (ICT) expenditure	Indicators of R&D and ICT	Sánchez, López, Cervantes and Cañibano (2000)
R&D expenditure	Identifies industries where countries tend to have relatively efficient technology	Torstensson (1996)
R&D expenditure Number of patents	Input measure of investments in new technologies Output measure of investments in new technologies	Verspagen and Wakelin (1997)
Total factor productivity (TFP)	Output measure of investments in new technologies	Wolff (1997)
Equipment investment per person engaged in production	Proxy for technological change	Wolff (2002)
Telephone call traffic	Proxy for "disembodied" idea flows	Wong (2004)

Empirical applications show that heterogeneity matters in technological innovation. Loungani et al. (2002) distinguish between developed and developing countries when analysing whether better information can substitute for geographical distance. Their

results point towards the existence of country-heterogeneity in the different determinants of international trade since they show that technological innovation is a "substitute" for distance in developing countries (better information decreases the effect of distance), whereas technological innovation and distance are "complementary" in developed countries (better information magnifies the effect of distance). This may occur when trade in differentiated products dominates and physical proximity and high information technology reinforce each other in fostering trade. Developing countries can overcome the disadvantage of distance by investing in technological innovation. This result is in the same line as Freund and Weinhold (2004), who show the importance of new technologies on trade as measured by Internet hosts.

Fink, Mattoo and Neagu (2005) analyse the effect of communication costs on bilateral trade flows by taking into account sector-heterogeneity. Their results show that communication costs have a significant effect on international trade and that they are of greater importance for trade in differentiated products than for trade in homogeneous products. In this line, Tang (2006) analyses the contribution of technological innovation to the growth of United States imports. This author finds that technological innovation has a higher effect on the growth of trade in differentiated goods than in the growth of trade in referenced and homogeneous goods in the last two decades. Moreover, the impact of technological innovation is found to be higher for exports of differentiated goods from developing countries. Technological variables are therefore of great importance in increasing the participation of the poorest economies in the world economy.

2.2.2. Language and colonial ties as measures of cultural similarities

A number of international trade studies focus on the effect of a shared language (Frankel, Stein and Wei, 1998; Helliwell, 1999). Among them, Helliwell (1999) explores the economics of language in 22 OECD countries and 11 developing countries. The author finds that the general common language effect seems to be driven by the role of English. The other languages analysed, German, French and Spanish, are not found to be significant in the empirical regressions. However, language can be seen as a resource for future cooperation.

Country-heterogeneity in language is found by Guo (2004). This author shows that language influences on trade are more significant in China (a developing country) than in the United States (a developed country).

Rauch (1999) finds that sector-heterogeneity also matters in language and colonial ties. These variables are more important for differentiated products. This may be due to the effect of incomplete information, since differentiated products tend to be less traded because the demand for them is lower outside the country in which they are produced. A further reason may be similarity of foreign preferences, since trade in differentiated products increases with links. The author argues that this result implies that "firms develop their varieties of differentiated products to suit niches in their home markets. We suppose further that they do this (…) because positive transportation costs make this the best decision, ceteris paribus. This could explain why differentiated products tend to be less traded: there is less demand for them outside the country in which they are produced".[3]

[3] Rauch, 1999, page 31.

2.2.3. Geography and the role of distance

The negative correlation between geographical distance and bilateral trade volumes is one of the most robust empirical findings in economics (Leamer and Levinsohn, 1995). However, it is still unclear exactly what information is embodied in the distance coefficients that are estimated in gravity regressions. Filippini and Molini (2003) state that "distance is much more than geography: it is history, culture, language, social relations and many other things".[4] In recent studies, a number of authors have contributed to the debate on the interpretation of distance effects. Factors such as informational costs, tastes and preferences, unfamiliarity, and differences in factor endowments that provide opportunities for trade have been considered.

Loungani et al. (2002) show that distance involves more than just transport costs and that informational cost may be behind the impact of distance on trade. Blum and Goldfarb (2006) find that distance is a good proxy for differences in tastes and preferences. Their results provide a new explanation for the persistence effect of distance in gravity regressions. This suggests that the distance effect in gravity will persist for a number of products even if transport costs, search costs and other trade barriers associated with distance are reduced to zero, which is the case to some extent for Internet trade. For the distance effect to disappear there needs to be a homogenisation of cultures. Huang (2007) shows that unfamiliarity can explain part of the negative correlation between geographical distance and bilateral trade volumes. This author shows that higher uncertainty-aversion leads to lower trade flows to distant partners than gravity models predict. However, the author's interpretation of the distance coefficient (i.e. higher negative coefficients in the distance variable are interpreted to mean that trade is less

[4] Filippini and Molini, 2003, page 699.

likely to take place with more remote foreign countries) could be misleading. Melitz (2007) understands distance as a way to analyse the composition of international trade between different partners. Results show an increasing effect of distance on international trade. Furthermore, the impact of North-South distance has decreased over time. This author points out "at least half the rise in influence has a simple explanation, unrelated to transport costs. It flows from the shift in the composition of trade away from primary goods in agriculture and mining where differences in factor endowment are basic, toward sophisticated and highly differentiated products in manufacturing, where they are not. This shift in composition signifies a movement away from the sort of trade that rises with latitudinal distance and therefore can account for a good part of the rise in the negative coefficient of distance".[5]

Gravity models of trade use distance between countries as a proxy for transport costs, assuming that transport costs from the exporting country to the importing country are the same as transport costs from the importing to the exporting country ($t_{ij}=t_{ji}$). However, Anderson and van Wincoop (2004) emphasise the need to obtain better transport cost measures and to use these measures to expand gravity models. In spite of these limitations, distance variables are commonly used in gravity regressions as a proxy for transport costs with the implicit assumption that distance costs are a linear function of distance.

Buch, Kleinert and Toubal (2004) show that if distance costs decrease proportionally for all countries, no change should be found in the distance coefficient, since the distance coefficient measures the relative importance of economic relationships between trading partners located far away from each other, as opposed to those located nearby. An

[5] Melitz (2007), page 982.

increase in the constant term would indicate that the distance costs decrease; however, when applied to real data, this effect is mixed with an omitted variables effect also included in the constant term. Buch et al. (2004) distinguish three scenarios. First, when the distance costs decrease proportionally for all countries, all the information about the positive effect of decreasing distance costs is included in the constant term, which is larger. Second, when the distance costs decrease non-proportionally and the decrease is greater for smaller distances, the distance coefficient increases over time. Third, when the distance costs decrease non-proportionally and the decrease is smaller for smaller distances, the distance coefficient decreases over time in absolute terms. In other words, a decrease in the distance coefficient indicates that trade with countries that are far away from the home country increases with respect to trade with countries that are closer to the home country. Conversely, an increase indicates that trade with countries that are far away decreases with respect to trade with countries that are closer to the home country.

The evolution of the distance coefficient may differ between developed and developing countries; consequently country-heterogeneity is considered in the empirical analysis.

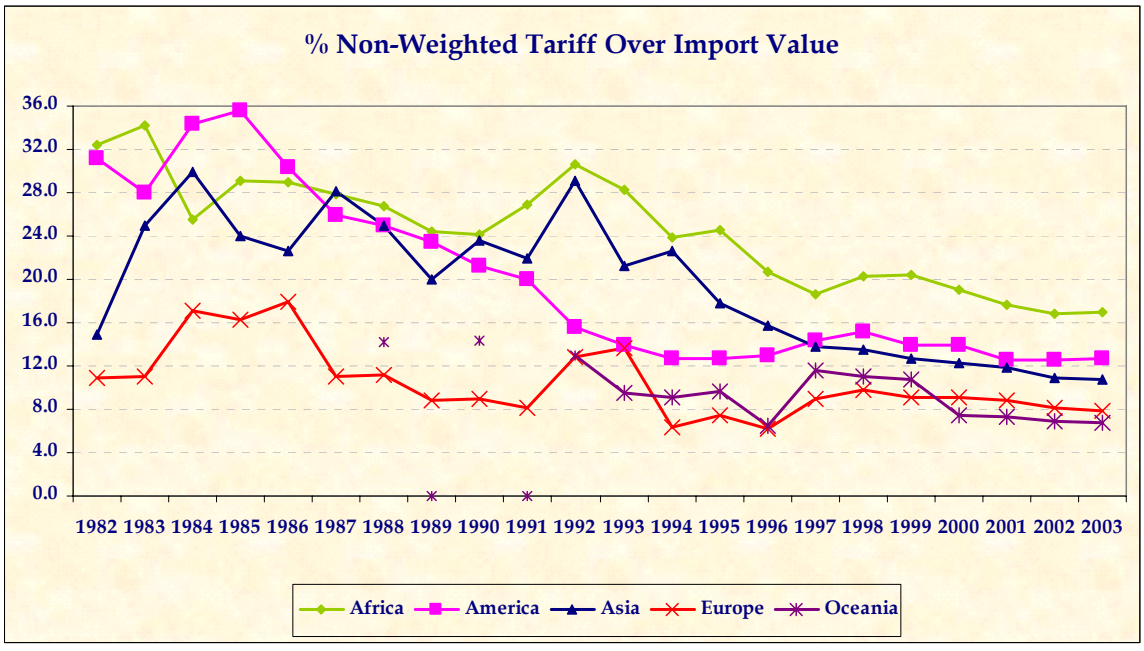
Heterogeneity in products also matters in distance. Rauch (1999) finds that proximity (when adjusted for distance effects and transportability) is more important for differentiated products. A possible reason for this may be that incomplete information matters since trade of differentiated products tends to be lower because there is less demand for these products outside the country in which they are produced. This result contrasts with that of Fink et al. (2005), who find that the distance coefficient is lower in absolute value for differentiated products. Therefore, the hypothesis that incomplete information on products matters is further analysed in the empirical analysis. If it does,

higher coefficients are expected in distance and socio-cultural links for differentiated goods.

2.2.4. Trade costs: tariffs and transport costs

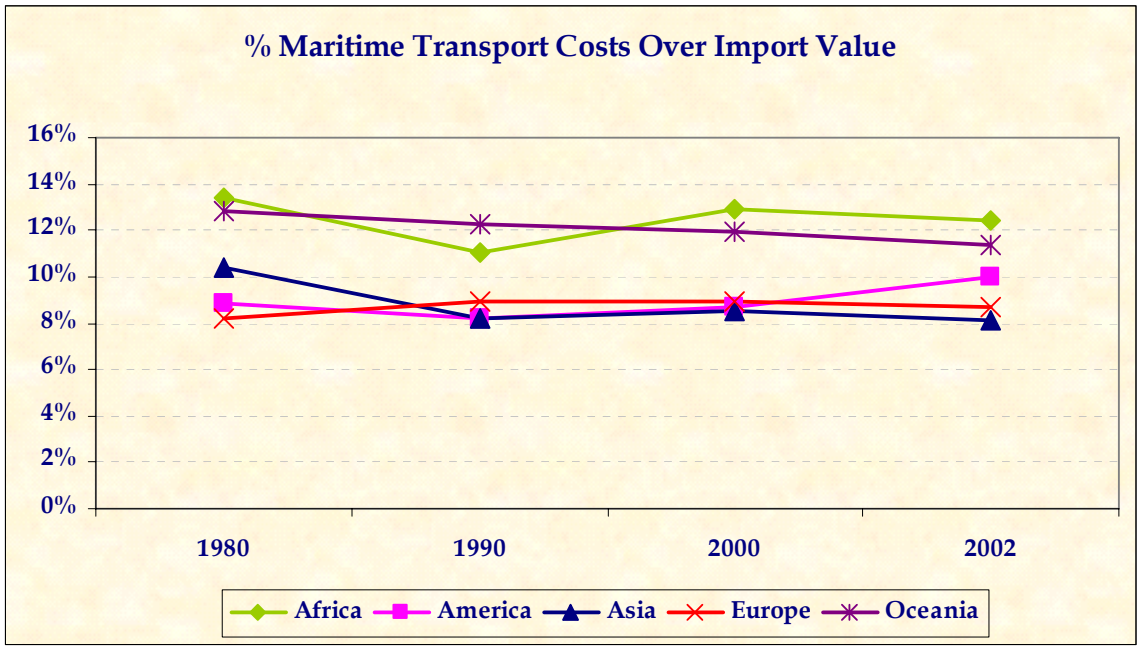
Trends towards geographical regionalisation and globalisation have led to the decreasing role of tariff barriers as an influencing factor on trade. As a result, the relative importance of transport costs has increased, and these costs have become a relevant determinant of trade patterns. Figure 5 shows the tendency of maritime transport costs to decrease. This tendency can be compared with the steeper decreasing slope shown in the tariff evolution graph (Figure 4). Depending on the continent, transport costs range between 8% and 13% of import values.

Figure 4. Percentage of non-weighted tariff over import value.



Source: World Bank (2005b)

Figure 5. Percentage of maritime transport costs over import value.



Source: UNCTAD, 2004 and own elaboration

Despite their importance, few studies have focussed on transport costs, and existing research has mainly been carried out at an aggregate level. As pointed out above, gravity models use distance between country capital cities as a proxy for transport costs.

In relation to artificial trade barriers, the impact of tariffs in the analysis of trade determinants is ambiguous. On the one hand, relatively high foreign tariffs would be associated with lower exports for an industry. In this case, tariffs increase costs and reduce trade. On the other hand, high foreign tariffs might be a response to countries' competition, indicating industries in which a country is comparatively strong.[6]

Lee and Swagel (1997) use disaggregated cross-country, cross-industry data of manufactured goods in 1988. These authors measure levels of protection by country and

[6] The theoretical framework derived in Chapter 3 supports the possibility that tariffs have a positive effect on trade since income increases due to tariff revenue.

industry and find that tariff and non-tariff barriers differ from one sector to another, and in general both of them are found to be lower between developed countries. The higher tariff levels in developing countries may reflect the greater importance of tariff revenue in government finance. Their measures of protection by industry indicate that antidumping practices and other non-tariff barriers apply overall to trade on sensitive commodities (food products, beverages, textiles, apparel, iron and steel). These authors only analyse data on total imports and exports for each country and their results indicate that trade barriers have a negative effect on imports, although there is no conclusive evidence of the relative importance of tariff and non-tariff barriers on trade. Using a different framework, Leamer (1990) finds that both tariff and non-tariff barriers have a large import-reducing effect. In contrast, Harrigan (1993) finds that tariffs and transport costs are a more substantial barrier to trade in manufactures between developed countries than non-tariff barriers using bilateral trade data.

Tang (2006) includes tariffs and transport costs measures in a gravity framework that considers sector-heterogeneity. Tariffs are measured as the effective tariff rate that the United States charges on imports from the exporting country for product group k and transport costs are measured as the total freight cost as a percentage of import value for product group k from the exporting country to the United States. Results show the expected ambiguous effect of tariffs on trade. For differentiated goods, tariffs have a positive effect on US imports, so US tariffs might be a response to countries' competition, indicating that these countries are comparatively strong in differentiated goods. For reference-priced and homogeneous goods, tariffs have a negative effect on US imports, so relatively high US tariffs are associated with lower imports for these

industries. Fink et al. (2005) also find that tariffs have a negative impact on trade for reference-priced and homogeneous goods; however, the tariff variable is not statistically different from zero in the case of differentiated goods. The reason for this could be that tariffs, in general, are low for differentiated products. In what follows, the role of tariff barriers is studied more deeply from an empirical point of view.

Tang (2006) shows that transport costs have a higher effect on trade for homogeneous goods. This result is also obtained in other studies considering sector-heterogeneity such as Giuliano et al. (2006), in line with the idea that homogeneous goods are on average heavier and more costly to move than other goods (Rauch, 1999) and that differentiated products generally have higher value-to-size or value-to-weight ratios, and thus they should be less affected by transport costs (Huang, 2007).

2.3. CONCLUDING REMARKS

In summary, this chapter highlights the importance of analysing the role of technological innovation, cultural factors, geographical characteristics and trade costs on international trade flows. Additionally, taking into account heterogeneity issues may lead to a better understanding of the effect of these "new" variables on trade patterns in developed and developing countries. Therefore, in this dissertation both country and sector heterogeneity are considered in a gravity framework.

CHAPTER 3

ON THE EFFECT OF TECHNOLOGICAL INNOVATION, CULTURAL SIMILARITIES AND GEOGRAPHY ON INTERNATIONAL TRADE[7]

Abstract

In this chapter, a gravity equation augmented with technological innovation and transport infrastructure variables is derived from a theoretical model based on Helpman and Krugman (1996). The effect of geographical (distance, adjacency, insularity and being landlocked) and social variables (regional integration agreements among countries and sharing a language) is also investigated in the empirical analysis. In addition, country-heterogeneity is considered since the determinants of trade may differ between developed and developing countries. With regard to the methodology, in a first step, the augmented gravity model is estimated by Ordinary Least Squares (OLS). Secondly, the endogeneity of two explanatory variables, technological innovation and income, is taken into account and the model is estimated by Instrumental Variables (IV). Finally, a Tobit estimation is performed to account for missing trade.

3.1. THEORY AND MODEL SPECIFICATION

In order to understand the role played by cross-country differences in relative factor endowments and relative country size in the determination of the volume of trade, a model based on Helpman and Krugman (1996) is built. One case developed by these authors is outlined and additional variables are included in a more realistic framework

[7] A different version of this chapter has been published as a book chapter:
Márquez-Ramos, L., Martínez-Zarzoso, I. and Suárez-Burguet, C. (2007), "Technological Innovation, Trade and Development". In: Hakikur Rahman, ed., Information and Communication Technologies for Economic and Regional Developments, IGI Publishing: 79-101.

with two differentiated goods in the market in order to obtain the final model, which supports the notion that comparative advantage determines international trade.

According to Helpman and Krugman (1996), in a world with two differentiated products every country imports from its trading partner a fixed share of the output of every commodity,

$$T = s(X_1 * + pX_2 *) + s *(X_1 + pX_2) \quad (3.1)$$

where outputs of differentiated, relatively labour-intensive goods are denoted by X_1 and $X_1 *$. As $(X_1 * + pX_2 *)$ is the whole output produced by the foreign country and $(X_1 + pX_2)$ is the whole output produced by the home country, then:

$$T = sGDP * + s * GDP \quad (3.2)$$

Equation (3.2) implies that with a constant GDP and $GDP *$, the volume of trade depends only on relative country size, and the more equal the size of the countries is, the larger it will be, regardless of the composition of factor endowments.

Extended Case

Based on Helpman and Krugman (1996), a theoretical framework, which introduces some increasing production factors, is developed: "hard" (transport infrastructure) and "soft" investment in infrastructure (technological innovation) as determinants of the volume of trade. Geographical barriers and technological innovation also determine countries' specialisation, trade flows and economic growth.

Following Deardorff (1995), Bougheas, Demetriades and Morgenroth (1999) and Eaton and Kortum (2002), transport costs are introduced by using the Samuelson "iceberg" type (1954), where only a fraction $\boldsymbol{g} = \frac{1}{\tau}$ of the quantity exported actually reaches the final

destination and delivering a unit from the home to the foreign country requires production of more than one unit. Transport costs can be determined by geographical factors, since positive geographical barriers mean that $\tau > 1$.

Limão and Venables (2001) investigated the dependence of transport costs on geography and infrastructure and showed that poor transport infrastructure damages trade. Bougheas et al. (1999) point out that "there is a simple way to introduce infrastructure in the above model. If the role of 'hard' infrastructure is to improve transportation conditions we can think of it as a cost-reducing technology".[8] Therefore, transport infrastructure is introduced by reducing transport costs (τ) and increasing the fraction of the goods shipped that actually reach the final destination. However, if one of the countries improves its transport infrastructure and the other does not improve it with the same intensity, *g* will change at a different rate. Therefore, τ is a measure of transport costs in the home country and τ^* is a measure of transport costs in the foreign one.

According to Deardorff (1995), trade can be valued either exclusive of transport costs (f.o.b) or inclusive of transport costs (c.i.f) for export flows. This author claims that trade flows must be reduced by the amount of the transport costs on an f.o.b. basis[9] and, hence, exports are assumed to be sold at f.o.b. prices and the greater part of transport costs are paid by the importing country.

[8] Bougheas et al., 1999, page 173.

[9] When the author considers a case of impeded trade, with Cobb-Douglas preferences, on a c.i.f basis the author obtains $\boldsymbol{T}_{ij}^{cif} = \beta_i \boldsymbol{Y}_j = \frac{\boldsymbol{Y}_i \boldsymbol{Y}_j}{\boldsymbol{Y}^w}$ and on an f.o.b basis the result is $\boldsymbol{T}_{ij}^{fob} = \frac{\boldsymbol{Y}_i \boldsymbol{Y}_j}{\boldsymbol{t}_{ij} \boldsymbol{Y}^w}$, where $\boldsymbol{T}_{ij}$ is the value of exports from country *i* to country *j*, β_i is a fixed share of their incomes that consumers spend on the product of country *i*. $\boldsymbol{Y}_i$ and $\boldsymbol{Y}_j$ are *i*'s and *j*'s income, $\boldsymbol{Y}^w$ is world income and $\boldsymbol{t}_{ij}$ are transport costs. For the CES case, relative distance from suppliers is considered and, therefore, bilateral trade flows are centred around the same values found in the Cobb-Douglas case, although they are smaller for countries that are further apart than the average distance and larger for countries that are closer than the average.

Technological innovation can be defined as the capacity in countries to bring new ideas into practice provided by the development of new products and processes. Then, "soft" infrastructure is included following Freund and Weinhold (2004). The authors include the effect of the Internet on trade in their model by assuming that the Internet reduces the fixed cost to enter a particular market and, as they point out, "the Internet is likely to reduce this type of entry cost since networks can expand and information can be more easily exchanged."[10] Hence, the richer the "soft" infrastructure is, the lower the fixed entry costs will be, and this effect can be reflected in the final price of goods (price changes from p to p' in the home country, being $p > p'$, and price changes from p to p'' in the foreign country, being $p > p''$) and the final price of goods changes their final demand and exports. β (β*) is used to represent the increase in trade as a consequence of lower final prices in the model ($\beta \geq 1$ and $\beta^* \geq 1$).

As a further step, integration agreements across countries are taken into account. Anderson and van Wincoop (2003) use a variable $\boldsymbol{b}_{ij}$ to reflect the existence of an international border between i and j. When $\boldsymbol{b}_{ij} = 1$, regions i and j are located in the same country. Otherwise, $\boldsymbol{b}_{ij}$ takes the value one plus the tariff equivalent of the border barrier between the countries in which the regions are located. The authors use this variable to model unobservable trade costs. In the present framework, a variable $I=I^*$ that takes a value of one when countries remove their barriers to trade or when they are integrated within the same economic area is considered. When tariff or non-tariff barriers deter trade because imports are burdened with taxes in the home country, then $I > 1$, and when

[10] Freund and Weinhold, 2004, page 174.

imports are burdened with taxes in the foreign country, then I^*> 1; thus, there are positive entry costs involved in entering foreign countries.

On the other hand, Samuelson (1954) states: "What does the government do with the tariff receipts?" (…) "The government is assumed to distribute the receipts to the (representative) consumer in a *lump-sum* fashion."[11] In accordance with Eaton and Kortum (2002), the revenue from generating barriers and the increase in intranational trade due to borders can be incorporated in this framework.

The home (foreign) country's imports from the foreign (home) country are subject to an *ad valorem* tariff t (t^*) on all imports, and therefore the result is an increase in income (as measured by GDP) due to tariff revenue.

Taking into account transport costs, "hard" and "soft" infrastructure and integration variables, the specification of the model is:

$$T = s\beta(X_1^* + p''X_2^*)(1+t)\frac{1}{\tau}\frac{1}{I} + s^*\beta^*(X_1 + p'X_2)(1+t^*)\frac{1}{\tau^*}\frac{1}{I^*} \qquad (3.3)$$

where $\boldsymbol{t} \geq 0$ and $\boldsymbol{t}^* \geq 0$.

Equation (3.3) shows that artificial barriers deter trade when $\boldsymbol{I} > (1+\boldsymbol{t})$, as a result of the existence of barriers other than an *ad valorem* tariff in the home country, and when $\boldsymbol{I}^* > (1+\boldsymbol{t}^*)$, there are barriers other than an *ad valorem* tariff in the foreign country.

When the additional variables are included in equation (3.2), the new specification becomes:

$$\boldsymbol{T} = \boldsymbol{s}\,\beta\,\boldsymbol{GDP}^*\frac{1}{\tau\,\boldsymbol{I}} + \boldsymbol{s}^*\beta^*\boldsymbol{GDP}\frac{1}{\tau^*\boldsymbol{I}^*} \qquad (3.4)$$

[11] Samuelson, 1954, page 274.

In this model, β and β* represent the increase in trade as a consequence of lower final prices for technological achievement and innovation activity ($\beta \geq 1$ and $\beta^* \geq 1$). An increase in these parameters will raise trade volumes.

Taking these considerations into account, since there are two differentiated goods, $\boldsymbol{X}_1$ and X_2, and both countries export varieties of these goods, β and β* are introduced as endogenous variables depending on the level of innovation and other factors related to the advances in technological innovation which are achieved in each country,

$$\beta = \ln \nu + \mu + \varepsilon$$

$$\beta^* = \ln \nu^* + \mu^* + \varepsilon^* \qquad (3.5)$$

where ν (ν*) is the innovation level in the home (foreign) country and μ (μ*) includes other factors related to the advance of technological innovation in the home (foreign) country; thus both reduce the final prices of the goods. Moreover, β and β* can foster trade due to the improved quality and greater variety of exported goods, so ε (ε*) indicates other reasons that lower the final prices of the goods.

Rewriting equation (3.4), the final model is obtained, where trade increases more slowly when innovation is higher, since innovation is more relevant at its earlier stages, whereas it could exceed the socially optimal level at a very advanced level (Gans and Stonecash, 2002). This is consistent with the two types of innovations (type A, hurt your country; type B, help your country) stated by Samuelson (2004).

$$\boldsymbol{T} = \boldsymbol{s}\,\boldsymbol{GDP}^* \frac{\ln \nu + \mu + \varepsilon}{\tau\, \boldsymbol{I}} + \boldsymbol{s}^*\boldsymbol{GDP} \frac{\ln \nu^* + \mu^* + \varepsilon^*}{\tau^*\, \boldsymbol{I}^*} \qquad (3.6)$$

3.2. DATA, SOURCES AND VARIABLES

Table A.1[12] shows a summary of the data used in the aggregated empirical analysis. Data on bilateral exports are obtained from Statistics Canada (2001), income and population variables are from the World Bank's World Development Indicators (2001). Finally, information about geographical and cultural dummies is from the CIA (2003).

With respect to technological variables, some additional explanations are needed. The *technology achievement index* (TAI) developed by the United Nations Development Programme (UNDP, 2001) and the *ArCo technology index* introduced by Archibugi and Coco (2004) are chosen. These indicators are more complete, compared to other variables, since they take into account a wider array of variables related to technological innovation. In what follows, a more detailed description of the components of the selected indices is presented.

The technology achievement index (TAI)

The TAI is a new measure introduced by the UNDP in its *Human Development Report* of 2001. It aims to capture how well a country as a whole is participating in creating, using and diffusing technology and in building a human skill base to acquire knowledge. A nation's technological achievements are very complex and therefore it is difficult to capture them in an index that reflects the full range of technologies and quantifies some aspects of technology creation, diffusion and human skills. In order to overcome these inconveniences, the TAI is constructed using indicators of a country's achievements in four dimensions, thus providing a summary of a society's technological achievements and allowing countries to be classified in four groups according to their level of

[12] Table A.1 in Appendix. The first column lists the variables used for empirical analysis; the second column outlines a description of the variables, and the third column shows the data sources.

technological innovation: Leaders, Potential Leaders, Dynamic Adopters and Marginalised. This classification could help policy-makers to define technology strategies. The four dimensions used in the construction of the TAI are: creation of technology, diffusion of recent innovations, diffusion of old innovations and human skills.

- The *creation of technology index* represents the capacity to innovate. It is relevant for all countries and constitutes the highest level of technological capacity. Two indicators are used to capture the level of innovation in a country. The first is the *number of patents granted to residents*, which reflects the current level of invention activities and represents a form of codified knowledge generated by research carried out in firms and organisations (Archibugi and Coco, 2004). The second indicator is *receipts of royalty and license fees from abroad*, which indicates the stock of successful innovations made in the past that are still useful.
- The *diffusion of recent innovations index* and the *diffusion of old innovations index* represent the importance that the adoption of new technologies and participation in the information and knowledge age has for countries. Since technological advance is a cumulative process, diffusion of older innovations is necessary in order to adopt later innovations. Two indicators measure the *diffusion of recent innovations*. The first, *Internet hosts*, reflects the diffusion of the Internet, which allows the fastest transfer of information and an easier adaptation of firms and organisations in a changing environment; the second is *exports of high technology and medium technology products*, illustrating the level of specialisation of the country in technologically intensive goods. The Internet

represents the newest form of technology diffusion and a key to participating in Information and Communication Technology. Two additional indicators measure the *diffusion of old innovations*, namely, *number of telephones* and *electricity consumption*, which are important since both are needed to be able to use new technologies and basic related activities. Electricity consumption is also a proxy for the use of machinery and equipment since most of it is run by electric power (Archibugi and Coco, 2004). Both indicators are expressed in logarithms with an upper level (the average in the OECD countries, allowing the elimination of useless differences among all countries whose telephony and electricity shares are above the average) since they are only relevant at earlier stages of technological advance. Expressing the index in logarithms ensures that as the level of the index increases its contribution to the composed index decreases, showing the idea that, beyond a certain level, neither telephones nor electricity consumption enrich the technological capacity of a country.

- The *human skills index*. Skills contribute to improve technological dynamism. This index is measured using two indicators, *mean years of schooling*, representing the fact that if people have a basic education on which to develop cognitive skills they can be users of technology, and *gross tertiary science enrolment ratio*, showing that, as the number of inhabitants with the ability to develop skills in science, mathematics and engineering increases, the number of technology creators also grows.

The ArCo technology index

The ArCo is a measure of the technological capabilities of a country and was introduced by Archibugi and Coco (2004). Their results do not differ too much from the UNDP study. One advantage of the ArCo index compared with the TAI index is that it is calculated for a higher number of countries and it allows comparisons over time.

The authors take three dimensions into account: creation of technology, diffusion of technology and development of human skills. It is calculated as a simple average of the three dimensions.

- The *creation of technology index* includes *number of patents* and *number of scientific papers,* which represent a form of codified knowledge generated in the country. Patents are a good proxy for commercially exploitable technological inventions and scientific literature represents the knowledge generated in the public sector.
- The *diffusion of technology index* is measured by three indicators, *Internet penetration*, *telephone penetration* and *electricity consumption.* The Internet represents the newest form of technology diffusion, and its penetration is measured by the data on users. *Telephone penetration* includes the number of telephones mainlines, which are a fundamental infrastructure for economic and social life, and the number of mobile phones, which are the natural evolution of telecommunications. *Electric power consumption* represents the diffusion of old innovations. Telephony and electricity indices are expressed in natural logarithms.
- The *development of human skills index* includes three indicators, *gross tertiary science and engineering enrolment*, *mean years of schooling* and *adult literacy*

rate in a country. The first indicator gives an idea of the formation of human capital in science and technology. It is obtained by multiplying gross tertiary enrolment in the population and the percentage of tertiary students in science and engineering. The *mean years of schooling* represents the average number of years of school completed in the population over 14 years old and it gives an indication of the level of human skills. *Adult literacy* is the percentage of people over 14 years old who can read and write. It is considered by the authors as a necessary condition for the development of human ability.

Values for the technological variable (TAI) have been calculated using the same criteria followed by the United Nations Development Programme. The value for each index is the simple average of the indicators described above and the value for TAI is the average of all four indices. The classification obtained is slightly different to the *Human Development Report* classification for 2001 because the arithmetic averages are calculated for OECD member country indicators and then they are used to fill the gaps of missing data for some OECD countries, thus increasing the sample size. Table A.2 shows the results that can be summarised in a ranking[13] that includes five additional countries compared with the United Nations Development Programme's ranking, these nations being Denmark, Iceland, Luxembourg, Switzerland and Turkey. These countries are OECD member countries and they increase the data available for technological innovation to 77 countries.[14] The countries are classified in four blocks as shown by the

[13] Table A.2 in Appendix. The three columns show the TAI ranking, the list of countries classified and the TAI value.

[14] In the empirical application, only 62 countries are used due to the existence of missing values for transport infrastructure variables.

existence of a gap between the last country in one group and the first in the next group (see UNDP, 2001 and Archibugi and Coco, 2004).

Scores are derived as an index relative to the maximum and minimum achieved by countries in any indicator of these dimensions. The performance of each index takes a value between 0 and 1 calculated according to equation (3.7).

$$\boldsymbol{I}1 = \frac{(\boldsymbol{actual\ value} - \boldsymbol{observed}\ \min \boldsymbol{value})}{(\boldsymbol{observed}\ \max\ \boldsymbol{value} - \boldsymbol{observed}\ \min \boldsymbol{value})} \tag{3.7}$$

The TAI is calculated as a simple average of the four dimension indices, based on the assumption that components play a comparable role in the technological achievement of a country.

Transport infrastructure variables are calculated with data on kilometres of paved roads and kilometres of motorways per square kilometre, taking into account the quality of the roads. Equation (3.8) is used to calculate the index.

$$\boldsymbol{Infrastructure\ \ variable} = \frac{((0.75 \cdot \boldsymbol{paved\ \ roads}(\boldsymbol{km})) + \boldsymbol{motorways}(\boldsymbol{km}))}{\boldsymbol{Land\ \ area}(\boldsymbol{km}^2)} \tag{3.8}$$

The geographical dummies considered in the empirical analysis are adjacency, being an island, being landlocked and geographical distance between countries. The cultural variable used in the aggregated analysis is sharing a common language. The effect of these variables on trade is analysed from an empirical point of view and country-heterogeneity is tested to analyse whether the coefficients of these variables are the same for all the trading patterns, or whether they behave differently in developed and developing countries, as expected.

3.3. EMPIRICAL ANALYSIS

3.3.1. Determinants of international trade. Ordinary Least Squares estimation

A gravity model augmented with technological variables and a transport infrastructure index from equation (3.6) is derived. Integration dummies are added in order to analyse the impact of trade agreements on international trade. A number of dummies representing geographical and cultural characteristics are also added. The model is expressed in additive form using a logarithmic transformation. The estimated equation is:

$$\begin{aligned}\ln X_{ij} &= \alpha_0 + \alpha_1 \cdot \ln Y_i + \alpha_2 \cdot \ln Y_j + \alpha_3 \cdot \ln P_i + \alpha_4 \cdot \ln P_j + \alpha_5 \cdot Adj_{ij} + \alpha_6 \cdot Isl + \alpha_7 \cdot Land + \\ &+ \alpha_8 \cdot CACM + \alpha_9 \cdot CARIC + \alpha_{10} \cdot MERC + \alpha_{11} \cdot NAFTA + \alpha_{12} \cdot CAN + \alpha_{13} \cdot EU + \\ &+ \alpha_{14} \cdot \ln Dist_{ij} + \alpha_{15} \cdot Lang_{ij} + \alpha_{16} \cdot TAI_i + \alpha_{17} \cdot TAI_j + \alpha_{18} \cdot Inf_i + \alpha_{19} \cdot Inf_j + u_{ij}\end{aligned} \qquad (3.9)$$

where *ln* denotes natural logarithms.

The model is estimated with data for 62 countries in 1999 and a total of 3782 (62*61) bilateral trade flows are obtained (Figure A.1, Appendix).[15] The presence of missing/zero values in the bilateral trade flows data reduces the sample to 3126 observations. OLS estimation is performed on the double log specification as given by equation (3.9).

X_{ij} denotes the value of exports from country i to j, Y_i and P_i are income and population in the exporter's market, Y_j and P_j are income and population in the destination market, Adj_{ij} is a dummy that takes a value of 1 when countries share the same border and zero otherwise, *Isl* takes a value of 1 when the exporter or the importer are islands, *Land* is a dummy for *landlocked* countries, CACM is a dummy that takes a value of 1 when both countries belong to the Central American Common Market, CARIC is a dummy that takes a value of 1 when both countries belong to the Caribbean Community, MERC is a dummy that takes a value of 1 when both countries belong to Mercosur, NAFTA takes a

[15] Excluding Bolivia, Ecuador and Venezuela for data availability reasons.

value of 1 when countries are members of the North American Free Trade Area, CAN is a dummy representing Andean Nations Community members and EU takes a value of 1 when countries are members of the European Union. Geographical distance between countries is often used as a proxy for transport costs in gravity equations, so $Dist_{ij}$ is the geographical great circle distance in kilometres between the capitals of country i and j. $Lang_{ij}$ is a dummy for countries sharing the same language, and TAI_i and TAI_j are technological variables measuring technological innovation in the exporting and the importing countries. Inf_i and Inf_j are infrastructure variables measuring the level of transport infrastructures in the exporting and the importing countries. Finally, $\boldsymbol{u_{ij}}$ is independently and identically distributed among countries. Table 1 shows the estimation results for the baseline model and the contribution of the dimensions considered in the TAI to trade flows.

Table 1. Determinants of international trade. Baseline model and augmented gravity model (technological innovation differentiated by 4 dimensions).

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Constant term	-10.42***	-10.84***	-11.62***	-22.8***	-16.69***
	(-11.94)	(-13.84)	(-17.64)	(-37.41)	(-26.49)
Exporter's income	0.27***	0.15***	0.08***	0.02**	0.06***
	(13.22)	(11.15)	(8.75)	(2.16)	(7.79)
Importer's income	0.22***	0.14***	0.09***	0.04***	0.07***
	(11.47)	(9.31)	(7.34)	(3.09)	(6.38)
Exporter's population	0.70***	0.71***	0.77***	1.03***	0.94***
	(23.08)	(29.37)	(39.42)	(57.95)	(48.66)
Importer's population	0.51***	0.53***	0.57***	0.77***	0.69***
	(15.79)	(21.36)	(26.41)	(37.38)	(34.71)
Adjacency dummy	-	0.44**	0.49***	0.37**	0.17
		(2.36)	(3.15)	(2.23)	(1.18)
Island dummy	-	-0.4***	-0.27***	-0.45***	-0.23***
		(-3.58)	(-3.01)	(-5.32)	(-2.61)
Landlocked dummy	-	-1.08***	-1.16***	-0.75***	-0.84***
		(-10.48)	(-13.47)	(-9.54)	(-10.21)
CACM dummy	-	0.93***	1.22***	2.38***	2.17***
		(2.89)	(4.92)	(9.96)	(8.04)
CARICOM dummy	-	2.99***	4.44***	2.88***	4.37***
		(2.91)	(4.65)	(2.86)	(4.65)
MERCOSUR dummy	-	2.52***	3.12***	1.74***	2.55***

		(8.56)	(10.09)	(5.54)	(5.81)
NAFTA dummy	-	3.07***	0.47	1.42***	1.53***
		(7.41)	(1.11)	(2.96)	(2.69)
CAN dummy	-	0.67	1.68***	0.71*	0.76
		(1.4)	(3.9)	(1.74)	(1.36)
EU dummy	-	0.51***	0.17*	-0.05	-0.17*
		(4.33)	(1.75)	(-0.53)	(-1.66)
Distance	-1.38***	-0.98***	-0.97***	-0.98***	-1.12***
	(-31.19)	(-20.82)	(-23.32)	(-26.53)	(-27.92)
Language dummy	-	0.67***	0.72***	0.88***	0.73***
		(6.12)	(7.43)	(10.58)	(8.51)
Exporter's creation of technology	-	4.89***	-	-	-
		(19.98)			
Importer's creation of technology	-	3.04***	-	-	-
		(10.59)			
Exporter's diffusion of recent innovations	-	-	5.78***	-	-
			(33.17)		
Importer's diffusion of recent innovations	-	-	3.88***	-	-
			(21.44)		
Exporter's diffusion of old innovations	-	-	-	7.07***	-
				(39.27)	
Importer's diffusion of old innovations	-	-	-	4.95***	-
				(30.38)	
Exporter's human skills	-	-	-	-	6.46***
					(41.31)
Importer's human skills	-	-	-	-	4.52***
					(27.35)
Exporter's infrastructure	-	1.23***	0.82***	0.72***	1.03***
		(24.21)	(17.18)	(19.31)	(26.6)
Importer's infrastructure	-	0.98***	0.72***	0.58***	0.83***
		(17.76)	(13.9)	(13.09)	(17.99)
R-squared	0.407	0.637	0.719	0.786	0.761
Number of observations	3126	3126	3126	3126	3126

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. The dependent variable is the natural logarithm of exports in value (current US$). Income, population and distance are also in natural logarithms. The estimation uses White's heteroscedasticity-consistent standard errors.

Model 1: *Baseline model;* ***Model 2:*** *Augmented gravity model. Contribution of the creation of technology dimension on trade****; Model 3:*** *Augmented gravity model. Contribution of the diffusion of recent innovations dimension on trade;* ***Model 4:*** *Augmented gravity model. Contribution of the diffusion of old innovations dimension on trade;* ***Model 5:*** *Augmented gravity model. Contribution of the human skills dimension on trade.*

Model 1 presents the OLS results for the baseline case, which excludes technological and transport infrastructure variables. The coefficients on income are both positive, as expected, and the income elasticities are below one for the exporter and the importer. Higher income economies tend to be more interested in product differentiation and specialisation, and therefore they trade more.

The coefficients on population are positive and significant, then a higher market fosters trade, thus indicating the presence of economies of scale. However, since countries with different levels of development are included, the elasticity of demographic variables might have a different sign and dimension across the two groups of countries. This will be further investigated.

Finally, the coefficient on distance has a negative sign, as expected, because lower distances imply a higher amount of goods traded.

Models 2, 3, 4 and 5 consider the gravity model augmented with technological variables: creation of technology, diffusion of recent innovations, diffusion of old innovations, and human skills. These variables are significant and have the expected sign, although some differences in the magnitudes of the coefficients and in the significance of variables can be observed, depending on the dimension included in the gravity equation. For example, adjacency is not significant when human skills are considered and some coefficients and signs on integration dummies are also different. Moreover, income coefficients are lower when technological diffusion or human skills are added than when the creation of technology index is added, the reason could be that the two former variables are capturing part of the positive effect of income on trade. Results show a higher explanatory power when including technological variables for exporting countries than when including them for importing countries. Then a higher technological innovation in the exporting country leads to greater exports. When the diffusion of old innovations index is included as a proxy for technological innovation, a higher variability of the bilateral export flows is experienced.

In the quest of the differential effect of investing on each one of the four dimensions, the variability between the maximum and the minimum values of the indices is analysed. It has been found that, the variability in the indices is 61.9% for creation of technology, 79.35% for diffusion of recent innovations, 87.86% for diffusion of old innovations and 89.72% for human skills. Therefore, those countries that do not reach a basic level of technological innovation should invest in old innovations and education for fostering international trade.

Table 2 shows estimation results when the technological variables included are the TAI index (Models 6, 7 and 10) and the ArCo index (Models 8, 9 and 11). Technological variables are found to be significant and positive, as expected. A higher technological innovation endowment fosters international trade, although the magnitude of the estimated coefficient for TAI (UNDP, 2001) is higher than the estimated coefficient for ArCo (Archibugi and Coco, 2004).

Table 2. Determinants of international trade. Augmented gravity model.

Variable	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Constant term	-15.38***	-15.72***	-19.24***	-19.36***	-14.37***	-17.01***
	(-25.71)	(-27.04)	(-31)	(-32.05)	(-21.18)	(-24.41)
Exporter's income	0.02***	0.02**	0.05***	0.04***	0.02**	0.04***
	(2.62)	(2.53)	(6.35)	(5.69)	(2.34)	(5.61)
Importer's income	0.04***	0.04***	0.06***	0.05***	0.04***	0.05***
	(3.72)	(3.61)	(5.21)	(4.64)	(3.51)	(4.65)
Exporter's population	0.89***	0.89***	0.97***	0.98***	0.89***	0.98***
	(49.34)	(51.41)	(53.45)	(55.1)	(49.5)	(53.6)
Importer's population	0.66***	0.67***	0.71***	0.72***	0.67***	0.72***
	(34.92)	(35.64)	(36.5)	(37.46)	(34.66)	(36.43)
Adjacency dummy	0.43***	0.32**	0.38**	0.24	0.31**	0.13
	(2.89)	(2.15)	(2.34)	(1.52)	(2.03)	(0.8)
Island dummy	-0.46***	-0.47***	-0.27***	-0.31***	-0.46***	-0.28***
	(-5.64)	(-5.77)	(-3.17)	(-3.72)	(-5.58)	(-3.26)
Landlocked dummy	-0.86***	-0.83***	-1.04***	-0.97***	-0.86***	-1.02***
	(-11.34)	(-10.99)	(-13.82)	(-12.92)	(-11.29)	(-13.68)
CACM dummy	1.95***	1.99***	2.41***	2.39***	1.74***	1.95***
	(8.08)	(8.56)	(9.27)	(9.55)	(6.96)	(7.22)
CARICOM dummy	4.29***	4.17***	4.07***	3.91***	4.24***	3.99***
	(4.49)	(4.38)	(4.03)	(3.89)	(4.44)	(3.95)
MERCOSUR dummy	2.58***	2.49***	2.91***	2.76***	2.56***	2.85***

	(7.66)	(7.73)	(8.72)	(8.5)	(7.18)	(7.62)
NAFTA dummy	0.71	0.83	1.12*	1.2	0.81	1.31*
	(1.16)	(1.36)	(1.65)	(1.51)	(1.31)	(1.85)
CAN dummy	1.22***	1.05**	1.06**	0.89*	1.26***	1.14**
	(2.61)	(2.24)	(2.22)	(1.87)	(2.69)	(2.4)
EU dummy	-0.24**	-0.35***	-0.11	-0.26**	-0.22**	-0.09
	(-2.54)	(-3.76)	(-1.1)	(-2.45)	(-2.36)	(-0.89)
Distance	-1***	-0.95***	-0.95***	-0.91***	-1.12***	-1.2***
	(-26.72)	(-25.44)	(-24.82)	(-24.13)	(-20.55)	(-21.8)
Language dummy	0.92***	0.87***	0.91***	0.83***	0.93***	0.93***
	(11)	(10.49)	(10.41)	(9.81)	(11.16)	(10.78)
Exporter's TAI	9.12***	9.17***	-	-	9.01***	-
	(46.46)	(47.61)			(42.97)	
Importer's TAI	6.39***	6.35***	-	-	6.2***	-
	(30.7)	(31.09)			(27.19)	
Technological distance (TAI)	-	-1.73***	-	-	-	-
		(-9.43)				
Exporter's ArCo	-	-	7.71***	8.04***	-	7.48***
			(46.75)	(48.74)		(43.72)
Importer's ArCo	-	-	5.44***	5.68***	-	5.21***
			(30.08)	(32.69)		(26.8)
Technological distance (ArCo)	-	-	-	-1.93***	-	-
				(-11.61)		
Exporter's infrastructure	0.68***	0.68***	0.91***	0.88***	0.67***	0.88***
	(17.65)	(18.26)	(25.06)	(24.89)	(17.34)	(23.63)
Importer's infrastructure	0.57***	0.57***	0.74***	0.71***	0.56***	0.71***
	(12.57)	(12.89)	(17.45)	(16.94)	(12.31)	(16.51)
LONGDISTi	-	-	-	-	0.21	0.59***
					(0.99)	(2.75)
LONGDISTj	-	-	-	-	0.36	0.59**
					(1.53)	(2.52)
R-squared	0.788	0.793	0.781	0.789	0.788	0.783
Number of observations	3126	3126	3126	3126	3126	3126

Notes: ***, **, * indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. The dependent variable is the natural logarithm of exports in value (current US$). Income, population and distance are also in natural logarithms. The estimation uses White's heteroscedasticity-consistent standard errors.

Model 6: *Augmented gravity model (technological innovation measured by TAI);* ***Model 7:*** *Augmented gravity model and estimation of the effect of technological distance on trade (technological innovation measured by TAI);* ***Model 8:*** *Augmented gravity model (technological innovation measured by ArCo);* ***Model 9:*** *Augmented gravity model and estimation of the effect of technological distance on trade (technological innovation measured by ArCo);* ***Model 10 and Model 11:*** *Augmented gravity model and estimation of the effect of technological innovation on geographical distance and therefore, on trade.*

Model 6 shows estimation results for equation (3.9). Geographical variables are important determinants of international trade, and variables other than distance are therefore included in order to analyse their effect on trade flows. The adjacency coefficient is expected to be positive since countries sharing a border trade more, and the

landlocked coefficient is expected to be negative, since countries without direct access to the sea trade less. History, culture, language and social relations are also expected to have important effects on trade. Language is included as a proxy for this type of relationship between countries. Its coefficient is expected to be positive. Integration dummies are also considered. Results show that income, population, geographical distance, technological innovation, transport infrastructure and all the dummies are significant and show the expected sign, excluding some integration dummies. The European Union dummy has a negative sign. This unexpected result has also been found by other authors (e.g. Cyrus, 2002) and several explain that the reason may be the heterogeneity in the sample or the existence of missing values in the dependent variable. This model has a high explanatory power given the high value of the R^2 (78.8%).

In Models 7 and 9 a different way to add technology in the trade equation is considered: the variable included is the technological distance between trading partners (Filippini and Molini, 2003). This is defined as the absolute difference between technological indicators in the exporting and the importing countries. This variable indicates that two countries can be far away from each other not only geographically, but also from a technological perspective. Technological gaps can deter trade since similar countries trade more. Therefore, a negative correlation between this new variable and the export flows is expected. In Models 7 and 9 the TAI and the ArCo indices respectively have been used to construct the technological distance variable. Technological distance has been found to be significant in both models and it increases the explanatory power of the regressions. Results support the view that countries tend to trade more when they are "closer" from a technological point of view. Moreover, when the coefficient of geographical distance is

compared in Models 6 and 7, and in Models 8 and 9, results show a lower magnitude of geographical distance when technological distance is considered. This result offers partial evidence proving that different technological endowments in countries are also beyond the persistent negative effect of geographical distance on trade.

Freund and Weinhold (2004) fail to show evidence of the role played by the Internet in altering the effect of geographical distance in trade patterns. They use a dummy variable (LONGDIST), which equals one if the distance between trade partners exceeds the average distance between all countries. Then, they interact it with the growth in the number of Internet hosts in each country. In the process of comparing the results in this research with those obtained by these authors, the same interaction variable is added in the estimated equation. As in Freund and Weinhold (2004), the coefficient of this variable is not significant. It could be that a more general proxy for technological innovation would be better to measure this effect. In Model 10, the technological variable TAI is interacted with the dummy LONGDIST, instead of using Internet hosts, obtaining LONGDISTi (LONGDIST*TAIi) and LONGDISTj (LONGDIST*TAIj). If technology and the advance of information and knowledge have reduced (increased) the impact of geographical distance on trade, then the coefficient on the interaction term should be positive (negative). However, although these coefficients have been found to be positive they seem to be non-significant.

ArCo is used instead of TAI in Model 11 to analyse the effect of the knowledge-based economies on trade (LONGDISTi and LONGDISTj are interacted with TAIi and TAIj). Since the coefficient of LONGDISTi and LONGDISTj are both positive and significant, results offer partial evidence showing that the information and knowledge advances have

reduced the effect of geographical distance on trade. This result supports the inference to take into account different dimensions of technology, such as creation and human capabilities, and not only diffusion.

In order to determine the relative importance of the different variables included in the augmented gravity model, the beta coefficients are calculated (see Table A.3 in Appendix). They are used by some researchers to compare the relative strength of the various predictors within the model. Since the beta coefficients are all measured in standard deviations they are comparable when the explanatory variables are expressed in different units. The estimates of Model 6 imply that the highest beta coefficients are, in absolute value, for technological variables (0.504 for TAI in the exporting country and 0.359 for TAI in the importing country). This means that a standard deviation increase in the endowment of technological innovation in the exporting country would lead to a 0.504 standard deviation increase in the logarithm of exports, whereas a standard deviation increase in the endowment of technological innovation in the importing country would enhance a 0.359 standard deviation in the logarithm of exports. Clearly, this indicates that technological variables are important determinants of international trade flows. Beta coefficients for technological innovation are also the highest in Model 7 (0.506 for TAI in the exporting country and 0.357 for TAI in the importing country). However, when beta coefficients for geographical and technological distance are compared, geographical distance appears to be a more important determinant of international trade flows since this variable may be capturing the effects of trade barriers other than transport costs, such as informational costs (Loungani et al., 2002), tastes and

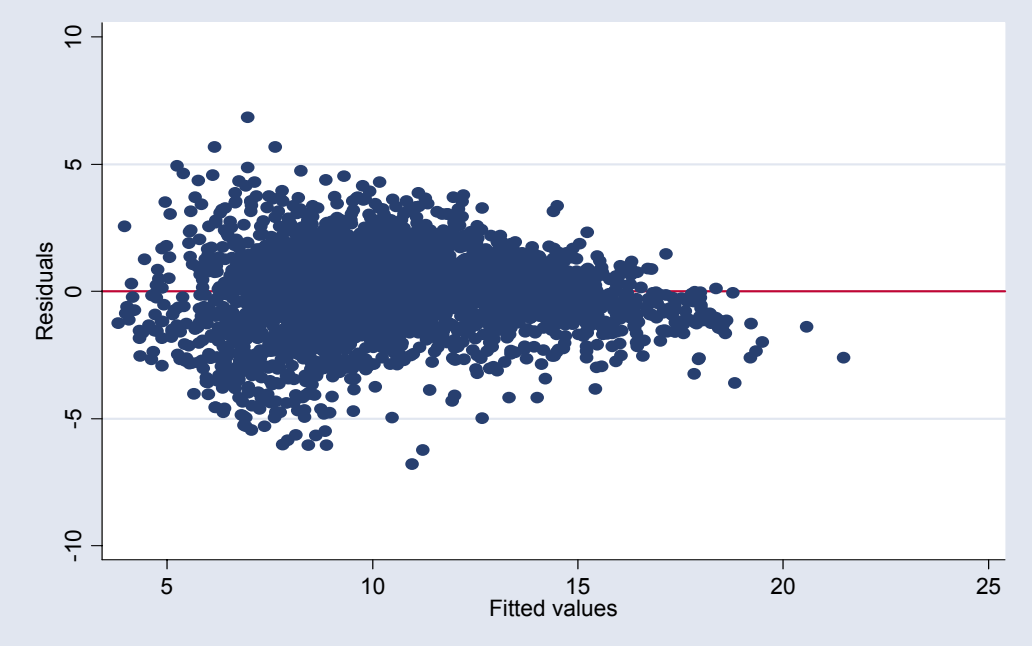
preferences (Blum and Goldfarb, 2006), unfamiliarity (Huang, 2007) and differences in factor endowments (Melitz, 2007).

3.3.2. Regression Diagnostics

In order to investigate the presence of multicollinearity, a correlation matrix is built among all the explanatory variables included in the model and any significant relations are found among them. The simple correlation coefficients are always below 60%. Moreover, the *variance inflation factor* (VIF) is obtained. Tolerance, defined as 1/VIF is used to check for the degree of collinearity. A tolerance value lower than 0.1 means that the variable could be considered as a linear combination of other independent variables. The tolerance values for variables used in the estimated gravity model are always higher than 0.1.

One of the main assumptions in ordinary least square regression is the homogeneity of variance of the residuals. If the variance of the residuals is non-constant, the residual variance is heteroscedastic. White's Test and the Breusch-Pagan/Cook-Weisberg Test indicate the presence of heteroscedasticity in the data. Moreover, in Graph 1 a graphical method is used to detect heteroscedasticity, where the residuals versus the predicted values are plotted. This graph shows that the pattern of the data points gets narrower towards the right end, which is an indication of heteroscedasticity. Therefore, all the equations in this dissertation are estimated using White's transformation to obtain consistent standard errors in the regressions.

Graph 1

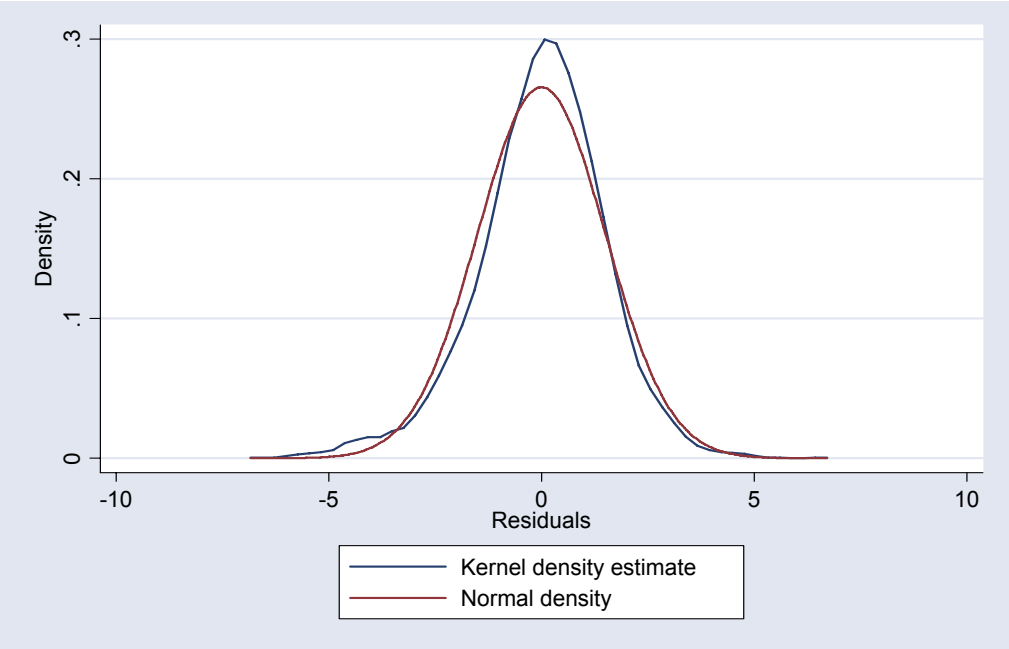


In order to check for the normality of the residuals, the predicted residuals and the Kernel density estimates are compared (Graph 2). Graph 3 shows skewness, kurtosis values and the Jarque-Bera statistic. Jarque-Bera is a statistical test for verifying whether the series are distributed normally. The test statistic measures the difference between the skewness and kurtosis of the series and those from the normal distribution. The null hypothesis is a normal distribution and the reported probability is the probability that a Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis. Therefore, a small probability value leads to the rejection of the null hypothesis of a normal distribution.

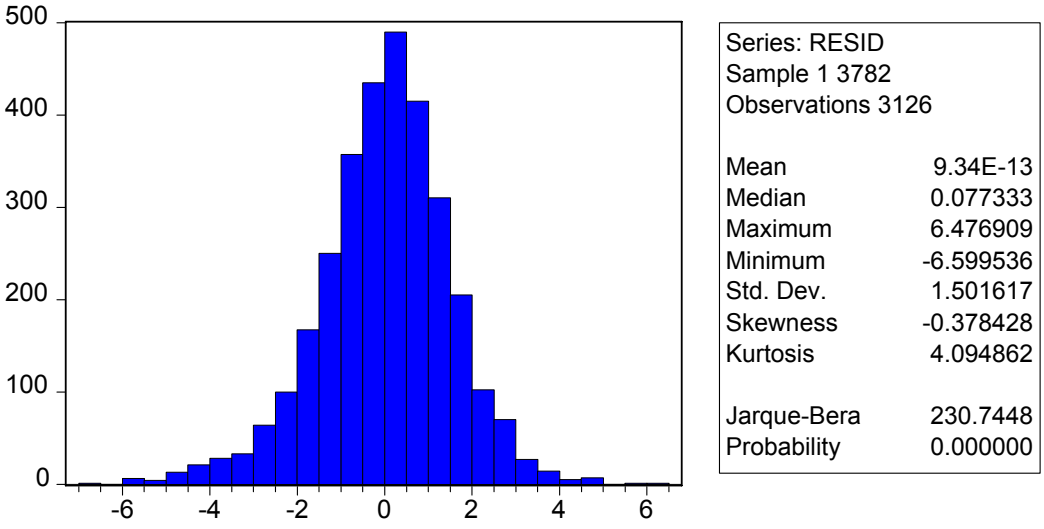
The results show a deviation from normality. However, normality of the residuals is only required for valid hypothesis testing, that is, the normality assumption ensures that the p-values for the t-test and F-test will be valid. Normality is not required in order to obtain

unbiased estimates of the regression coefficients. OLS regression merely requires that the residuals must be distributed identically and independently.

Graph 2



Graph 3



Finally, the model specification is also checked. A model specification error may occur when one or more relevant variables are omitted from the model, or one or more

irrelevant variables are included in the model. Model specification errors can substantially affect the estimated coefficients of regression. The *linktest* command in STATA is used and the Ramsey test to test for specification errors.

The *linktest* is based on the idea that if a regression is properly specified, it should not be possible to find any additional independent variables that are significant except by chance. The *linktest* creates two new variables, a variable of the prediction (_hat) and a variable of the square prediction (_hatsq). The model is then refitted using these new variables as predictors. The former should be significant since it is the predicted value. The latter should not because, if the model is correctly specified, the squared predictions should not have much explanatory power.

In a first step, the *linktest* is calculated for the baseline case of the gravity model, where only distance, exporter's and importer's income, and exporter's and importer's population are included as independent variables. In this case, the variable of prediction is not significant (_hat) and the variable of square prediction is significant (_hatsq). Moreover, the hypothesis that the model has no omitted variables is rejected with the Ramsey RESET test (a regression specification error test for omitted variables). In the augmented gravity model, both the variable of prediction (_hat) and the variable of square prediction (_hatsq) are significant. Additionally, the hypothesis that the model has no omitted variables is rejected with the Ramsey RESET Test. This indicates that further research is needed to improve the specification of the estimated model.

3.3.3. Determinants of international trade. Instrumental Variables estimation

Although gravity models are in most cases estimated using OLS, this specification does not account for the existence of causality between income and/or technological

innovation and trade. Since this is a potential problem that will lead to misspecification of the estimated model, in this chapter the possible endogeneity of technology and income variables in the gravity equation is analysed. In this case, income and/or technological innovation will be correlated with the error term and the OLS estimates would be biased and inconsistent.

In order to test for the presence of endogeneity, a Hausman test is performed. The purpose of this test is to indicate whether there is correlation between the regressors (income and technological innovation) and the error term in the augmented gravity model. The null hypothesis is that there is no correlation and therefore OLS provides consistent and efficient estimates; if this is true, the IV estimates should be similar to the OLS estimates.

To estimate by IV, the use of a set of instrumental variables that are correlated with technological innovation and income in countries, but not with the error term of equation (3.9) will be desirable. Total labour force in 1999 and land area in square kilometres are selected as instruments for income, and average research and development expenditure (% of GDP) and average public spending on education (% of GDP) in the period 1994–1998 are selected as instruments for technological innovation. The selection of the instrumental variables is based on Eaton and Kortum (2002). These authors suggest that a country's level of technology is related to its stock of past research effort, and that a higher stock of human capital allows a country to absorb more ideas from abroad, thus improving productivity and income in countries. Land area is used as an instrument for income, since a number of authors have shown that within-country trade increases income in countries (e.g. Frankel and Romer, 1999).

The version of the Hausman test proposed by Davidson and MacKinnon (1993) is also applied to validate the results. In a first step, technological innovation (TAI_i) and income ($logY_i$) measures are regressed on all exogenous variables and an instrument (since the selected instruments for income and technology are highly correlated) to obtain the residuals. Then, in a second step, the augmented gravity model is estimated including the residuals from the first regressions as an additional variable. The result differs depending on the instrument included. When labour force is included as an instrument for income and R&D expenditure is used for technological innovation, the residuals of those regressions are not significant in the augmented gravity model. Since the coefficients on the first stage residuals are not significantly different from zero for labour force and R&D expenditure, the test indicates that there is no endogeneity problem and, therefore, the OLS estimation is consistent. However, when land area is included as an instrument for income and public spending on education for technological innovation, the residuals of those regressions are significant in the augmented gravity model. Therefore, when land area and public spending on education are included as instruments, the test accepts the hypothesis of endogeneity.

Finally, whether the instrumental variables chosen are valid is determined. The first requirement of good instruments is that they must be highly correlated with the variable for which they are instrumenting. Table 3 shows that both land area and labour force are significant for income, and that the research and development expenditure and the public spending on education are highly significant in explaining technological innovation.

Table 3. First Stage Regression.

Variable	Model 3.A		Model 3.B	
Constant term	20.60*** (19.36)	22.33*** (69.04)	0.28*** (118.01)	0.21*** (17.55)
Labour force	0.29*** (4.25)	-	-	-
Land area	-	0.24*** (8.25)	-	-
Research and development expenditure	-	-	0.14*** (85.26)	-
Public spending on education	-	-	-	0.04*** (14.52)
R-squared	0.027	0.027	0.761	0.122
Number of observations	3782	3721	2867	3782

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. The dependent variable in Model 3.A is the exporter's income in natural logarithms, and the exporter's technological innovation in Model 3.B. Labour force and land area variables are also given in natural logarithms. The estimation uses White's heteroscedasticity-consistent standard errors.

The second requirement of good instruments is that they must be uncorrelated with the error term of the export equation. To determine this, the residual of the OLS regression are regressed on the instruments. The results show that the instruments used independently are indeed correlated with the error term (except labour force). This will in fact indicate that the instruments chosen are not the best. However, Cyrus (2002) points out that this test is a very difficult test to pass, and that it may be better to examine the R-squared of these regressions. Results show that the variables used as instruments for income and technology have a low explanatory power (all instruments have a R-squared value below 0.0063) in the error term regressions.

Since some of the results from the test accept the hypothesis of endogeneity, equation (3.9) has also been estimated by IV. The second column of Table 4 shows the OLS results of equation (3.9), the third and fourth columns the IV results, where income and technological innovation are considered respectively as endogenous. In the IV estimates, several differences from the OLS coefficients are obtained. In Model 4.B, where income

is considered as endogenous, exporter's income has a higher magnitude than by OLS and in Model 4.C, where technological innovation is considered as endogenous, the NAFTA dummy is significant and the EU dummy is not.

Table 4. Instrumenting for income and technological innovation.

Variable	Model 4.A	Model 4.B	Model 4.C
Constant term	-15.38***	-19.54***	-15.12***
	(-25.71)	(-14.32)	(-23.37)
Exporter's income	0.02***	0.25***	0.02***
	(2.62)	(3.52)	(2.76)
Importer's income	0.04***	0.05***	0.04***
	(3.72)	(4.13)	(3.81)
Exporter's population	0.89***	0.86***	0.84***
	(49.34)	(25.56)	(43.72)
Importer's population	0.66***	0.66***	0.66***
	(34.92)	(33.51)	(33)
Adjacency dummy	0.43***	0.35**	0.39***
	(2.89)	(2.29)	(2.73)
Island dummy	-0.46***	-0.15	-0.34***
	(-5.64)	(-1.63)	(-3.76)
Landlocked dummy	-0.86***	-0.81***	-0.73***
	(-11.34)	(10.11)	(-8.94)
CACM dummy	1.95***	2.06***	2.01***
	(8.08)	(8.41)	(6.39)
CARICOM dummy	4.29***	4.43***	5.36***
	(4.49)	(4.54)	(35.09)
MERCOSUR dummy	2.58***	2.41***	2.52***
	(7.66)	(6.93)	(6.24)
NAFTA dummy	0.71	0.48	0.92*
	(1.16)	(0.83)	(1.69)
CAN dummy	1.22***	1.08**	1.12**
	(2.61)	(2.55)	(2.36)
EU dummy	-0.24**	-0.26***	-0.02
	(-2.54)	(-2.68)	(-0.24)
Distance	-1***	-1.08***	-0.9***
	(-26.72)	(-27.89)	(-23.09)
Language dummy	0.92***	0.77***	0.99***
	(11)	(8.65)	(10.71)
Exporter's TAI	9.12***	7.35***	8.11***
	(46.46)	(12.69)	(30.07)
Importer's TAI	6.39***	6.32***	6.64***
	(30.7)	(28.21)	(29.77)
Exporter's infrastructure	0.68***	0.63***	0.69***
	(17.65)	(16.37)	(17.69)
Importer's infrastructure	0.57***	0.56***	0.47***
	(12.57)	(11.75)	(9.83)
R-squared	0.788	0.763	0.786
Number of observations	3126	3067	2481

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. The dependent variable is the natural logarithm of exports in value (current US$). Income, population and

distance are also in natural logarithms. The estimation uses White's heteroscedasticity-consistent standard errors.
Income instruments: Total labour force in the exporting country in 1999 (in logarithms) and land area in square kilometres in the exporting country (in logarithms). **Technology instruments**: Average research and development expenditure (% of GDP) and the average public spending on education (% of GDP) over the period 1994–1998.

3.3.4. Country-heterogeneity and Tobit estimation

Traditionally, when estimating a gravity model of trade, it is implicitly assumed that the coefficients of all the explanatory variables are the same for all the trading patterns. Empirically, this requires imposing the pooling assumption. In this chapter, the pooling assumption is tested with aggregated data. The magnitude and sign of the explanatory variables depend on certain characteristics of the trading partners. Thus, the 62-country sample is divided into two groups of countries according to their level of income. The richest countries in the sample are considered as developed while the poorest countries are considered as developing. The estimation results show important differences concerning the goodness of fit and the significance and magnitude of the variable coefficients.

In order to understand whether there exists a differential behaviour concerning the determinants of trade flows for developed and developing countries, equation (3.9) is estimated by interacting the exogenous variables (except integration dummies) with a dummy (DP) that takes the value of 1 when trading partners are richer than the simple average in the sample, zero otherwise. The Wald test is used in order to check whether each exogenous variable and its interaction with the dummy representing developed countries present a different coefficient. Finally, since almost 20% of the observations for bilateral trade flows are zeros, a Tobit model is estimated in order to take into account the missing trade. Table 5 shows results.

Table 5. Testing the pooling assumption and Tobit estimation.

Variable	Model 12	Model 13
Constant term	-22.11*** (-28.97)	-48.36*** (-32.6)
Exporter's income	0.04*** (5.01)	0.05** (2.3)
DP*Exporter's income	0.48*** (2.97)	1.61*** (3.29)
Importer's income	0.04*** (3.74)	0.06*** (2.73)
DP*Importer's income	0.57*** (3.6)	1.67*** (3.5)
Exporter's population	1.08*** (51.81)	1.64*** (36.1)
DP*Exporter's population	-0.76*** (-4.26)	-2.61*** (-5.1)
Importer's population	0.78*** (35.43)	1.15*** (26.72)
DP*Importer's population	-0.66*** (-3.89)	-2.27*** (-4.59)
Adjacency dummy	0.66*** (3.12)	1.45*** (3.01)
DP*Adjacency dummy	-0.45* (-1.76)	-0.78 (-1.01)
Island dummy	-0.38*** (-3.42)	0.12 (0.59)
DP*Island dummy	0.11 (0.79)	-0.71* (-1.84)
Landlocked dummy	-0.85*** (-8.98)	-1.29*** (-7.12)
DP*Landlocked dummy	0.12 (0.99)	-2.22*** (-6.28)
CACM dummy	2.24*** (7.72)	5.68*** (5.51)
CARICOM dummy	3.92*** (3.87)	6.24*** (2.59)
MERCOSUR dummy	2.16*** (5.55)	4.18*** (3.99)
NAFTA dummy	1.31*** (3.17)	1 (0.71)
CAN dummy	0.18 (0.38)	0.35 (0.14)
EU dummy	0.13 (1.56)	1.24*** (3.36)
Distance	-0.97*** (-19.55)	-0.47*** (-5.17)
DP*Distance	0.25*** (3.69)	0.29 (1.57)
Language dummy	1.04*** (10.63)	3.02*** (15.18)
DP*Language dummy	-0.53*** (-3.12)	-2.24*** (-5.11)
Exporter's ArCo	9.77*** (38.05)	14.43*** (29)
DP*Exporter's ArCo	-5.67*** (-12.46)	-8.53*** (-6.19)
Importer's ArCo	7.15*** (26.49)	9.97*** (20.15)
DP*Importer's Arco	-5.48*** (-12.12)	-6.25*** (-4.57)
Technological distance	-3.09*** (-13.82)	-2.76*** (-6.09)
DP*Technological distance	1.91*** (4.58)	2.18 (1.64)
Exporter's infrastructure	0.92*** (18.57)	1.38*** (11.27)
DP*Exporter's infrastructure	-0.24*** (-3.45)	-0.29 (-1.43)
Importer's infrastructure	0.8*** (12.62)	1.27*** (10.72)
DP*Importer's infrastructure	-0.41*** (-4.86)	-0.47** (-2.33)
R-squared	0.808	-
Log likelihood	-	-8938
Number of observations	3126	3782

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. The dependent variable is the natural logarithm of exports in value (current US$). Income, population and distance are also in natural logarithms. The estimation of Model 12 uses White's heteroscedasticity-consistent standard errors. DP is a dummy variable that takes the value one for developed countries, zero otherwise.

The results from the Wald test show that the poolability assumption is indeed rejected for bilateral exports and that the estimated parameters are not identical across bilateral relationships. Model 12 shows that both income variables are more relevant for

developed countries. A 1% increase in own GDP increases exports from developed countries by 0.52% (0.04+0.48), and by only 0.04% when exports are from developing countries. Very similar coefficients are obtained for foreign GDP.

The coefficients for population variables present positive signs, but of a very low magnitude for developed countries and a magnitude close to unity for developing countries. As developing countries are more specialised in labour intensive exports, the results indicate that greater availability of cheap labour force in developing countries fosters trade, whereas in developed the trend of population growth is stable and almost close to zero (see Filippini and Molini, 2003).

The magnitude of the distance coefficient is lower for developed, -0.72 (-0.97+0.25), than for developing countries (-0.97). The adjacency dummy coefficient falls 68% (-0.45/0.66) for developed countries and also the language dummy is reduced by 50% (-0.53/1.04) when countries are developed. Therefore, the responsiveness of trade to adjacency falls by about 36% {[exp(-0.45)-1]*100} and to language by 41% {[exp(-0.53)-1]*100}.

Model 13 reports the Tobit estimation of the gravity equation with the interactive terms included. The results show several distinctive features compared to those obtained in Model 12. Income variables for the exporter and the importer show a higher magnitude for developed countries (1.66 and 1.73 respectively) than in the OLS estimation. Population variables for developed countries now present negative coefficients (-0.97 and -1.12 respectively), indicating that an increase in population deters trade. This may be due to the richest countries in the sample exporting less when they are bigger (absorption effect) (see Martínez-Zarzoso and Nowak-Lehmann, 2003).

The adjacency dummy has a coefficient for developing countries that is more than double that in Model 12 and also the effect of some integration dummies is amplified (CACM, CARICOM and MERCOSUR). However, the NAFTA and CAN dummies are not significant and the EU dummy is now positive and significant. Geographical distance has a considerably lower effect on trade for developing countries and the coefficient for the interactive variable is positive but not significant, whereas language, technological innovation and transport infrastructure have a higher effect on trade flows, for both developed and developing countries, than in Model 12.

3.4. CONCLUDING REMARKS

This chapter presents an aggregated empirical analysis of the role of technological innovation, cultural similarities and geography on international trade flows. The estimated model is derived from a Helpman and Krugman (1996) framework.

The main economic policy recommendation that could be derived from the evidence is that investing in transport infrastructure and technological innovation leads to the improvement and maintenance of the level of competitiveness. These variables can be considered as a barrier to trade for countries with lower endowment levels and, therefore, investing in them increases the participation of the poorest economies in the world economy. Whether technology has any effect on geographical distance in a more globalised and integrated world is also analysed. The results indicate that the development of information technology has lowered the effect of distance on trade, since the development of technological innovation means that long distances are less important nowadays than in the past.

Finally, significant differences in the determinants of bilateral trade flows are found between developed and developing countries. Trade flows are more sensitive to geographical and cultural variables for developing than for developed economies and all the estimated coefficients for technological innovation and transport infrastructure variables are significant and higher in magnitude for developing countries.

CHAPTER 4

THE ROLE OF GEOGRAPHICAL DISTANCE IN GRAVITY REGRESSIONS: IS THERE REALLY A MISSING GLOBALISATION PUZZLE?[16]

Abstract

The main aim of this chapter is to investigate the role of geographical distance in gravity regressions in relation to the missing globalisation puzzle cited by Coe et al. (2002). These authors claimed that the fact that geographical distance coefficients do not fall over time is another puzzle that should have been added to Obsfeld and Rogoff's (2000) paper, in which six major puzzles in international macroeconomics were cited. In order to do so, a linear and a non-linear gravity model are estimated for a cross-section of 65 countries over the period 1980–1999. Non-linear specifications of the gravity model have been recently used in the literature to address the issue of non-declining transport costs over time (Coe et al., 2002 and Croce et al., 2004). However, results show that there is no missing globalisation puzzle once the linear specification results are correctly interpreted. The main findings are that distance has a different effect for developed and developing countries and that the grounds for using a non-linear specification are not clear since the linear specification, in general terms, shows better performance than the non-linear one.

4.1. ESTIMATION OF A LOG-LINEAR MODEL

4.1.1. 65-country sample

A log-linear version of the gravity model is estimated (Bergstrand, 1985, 1989; Deardorff, 1995). The model is augmented with technological innovation (ArCo index,

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Archibugi and Coco, 2004). Remoteness is also included since recent literature on gravity models of international trade has highlighted that, theoretically, these models are determined by relative trade barriers and not only by absolute trade barriers between the exporting and the importing country (Anderson and van Wincoop, 2003). The estimated equation is:

$$\begin{aligned}\ln \boldsymbol{X}_{ij} &= \alpha_0 + \alpha_1 \cdot \ln \boldsymbol{Y}_i + \alpha_2 \cdot \ln \boldsymbol{Y}_j + \alpha_3 \cdot \ln \boldsymbol{P}_i + \alpha_4 \cdot \ln \boldsymbol{P}_j + \alpha_5 \cdot \boldsymbol{Adj}_{ij} + \alpha_6 \cdot \boldsymbol{Isl}_i + \alpha_7 \cdot \boldsymbol{Isl}_j + \\ &+ \alpha_8 \cdot \boldsymbol{Land}_i + \alpha_9 \cdot \boldsymbol{Land}_j + \alpha_{10} \cdot \ln \boldsymbol{rem}_i + \alpha_{11} \cdot \ln \boldsymbol{rem}_j + \alpha_{12} \cdot \boldsymbol{CACM} + \alpha_{13} \cdot \boldsymbol{CARIC} + \\ &+ \alpha_{14} \cdot \boldsymbol{MERC} + \alpha_{15} \cdot \boldsymbol{NAFTA} + \alpha_{16} \cdot \boldsymbol{CAN} + \alpha_{17} \cdot \boldsymbol{EU} + \alpha_{18} \cdot \ln \boldsymbol{Dist}_{ij} + \alpha_{19} \cdot \boldsymbol{Lang}_{ij} + \\ &+ \alpha_{20} \cdot \boldsymbol{ArCo}_i + \alpha_{21} \cdot \boldsymbol{ArCo}_j + \boldsymbol{u}_{ij}\end{aligned} \tag{4.1}$$

where *ln* denotes natural logarithms. Rem_i and Rem_j measure the level of remoteness in the exporting and the importing countries. These variables are calculated according to equation (4.2) and (4.3), as in Coca-Castaño, Márquez-Ramos and Martínez-Zarzoso (2005). It is intended to measure the average distance of an exporting country from all its trading partners,

$$\mathrm{Re}\boldsymbol{m}_i = \sum_j \left(\frac{\boldsymbol{Y}_j}{\boldsymbol{Y}^w} \right) \boldsymbol{Dist}_{ij} \tag{4.2}$$

$$\mathrm{Re}\boldsymbol{m}_j = \sum_i \left(\frac{\boldsymbol{Y}_i}{\boldsymbol{Y}^w} \right) \boldsymbol{Dist}_{ij} \tag{4.3}$$

where Y_i and Y_j represent exporter's and importer's income and Y^w represents the world income.

The model is estimated with data for 65 countries in 1980, 1985, 1990, 1995 and 1999 and a total of 4160 (65*64) bilateral trade flows are obtained (Figure A.1, Appendix). The presence of missing/zero values in the bilateral trade flow data for different years

slightly reduces the sample (e.g. in 1999 there were 3347 observations). OLS estimation is performed on the double log specification as given by equation (4.1).

For comparison purposes the integration dummies are included over the entire period. In this way the same variables are included in all regressions. Frankel (1997) justifies the inclusion of Free Trade Agreement dummies even before a formal trading bloc has come into being by indicating that informal ties between the countries usually existed previously. Finally, transport infrastructure variables are not included since there are not available data for all the years considered.

Table 6 shows estimation results for equation (4.1) for different years.

Table 6. Determinants of international trade. Augmented log-linear gravity model, OLS estimation.

	1980	1985	1990	1995	1999
Constant term	-44.42***	-43.17***	-46.00***	-50.94***	-49.96***
	(-14.91)	(-13.96)	(-17.03)	(-22.80)	(-23.40)
Exporter's income	1.11***	1.54***	1.48***	1.52***	1.46***
	(13.63)	(16.59)	(17.89)	(23.46)	(22.69)
Importer's income	0.92***	0.85***	1.11***	1.23***	1.21***
	(10.54)	(9.13)	(13.72)	(18.81)	(19.02)
Exporter's population	-0.22***	-0.67***	-0.54***	-0.52***	-0.40***
	(-2.68)	(-6.98)	(-6.54)	(-7.71)	(-5.99)
Importer's population	-0.15*	-0.04	-0.32***	-0.41***	-0.42***
	(-1.79)	(-0.45)	(-3.92)	(-6.14)	(-6.44)
Adjacency dummy	0.37*	0.35**	0.59***	0.37***	0.31**
	(1.89)	(1.99)	(3.37)	(2.92)	(2.24)
Exporting island dummy	-0.02	-0.24**	-0.12	-0.30***	-0.22***
	(-0.14)	(-2.03)	(-1.21)	(-3.52)	(-2.63)
Importing island dummy	-0.05	0.20*	0.21**	-0.12	0.06
	(-0.46)	(1.75)	(2.44)	(-1.58)	(0.75)
Exporter landlocked dummy	-0.25**	-0.25**	-0.17	-0.47***	-0.42***
	(-2.03)	(-2.10)	(-1.49)	(-5.16)	(-4.85)
Importer landlocked dummy	-0.43***	-0.64***	-0.45***	-0.46***	-0.72***
	(-3.31)	(-5.08)	(-3.77)	(-4.87)	(-7.61)
Exporter's remoteness	1.47***	1.58***	1.45***	1.09***	1.19***
	(6.64)	(6.93)	(7.49)	(7.09)	(8.19)
Importer's remoteness	0.30	-0.29	-0.25	0.43***	0.29*
	(1.34)	(-1.26)	(-1.26)	(2.75)	(1.84)
CACM dummy	2.63***	1.45***	1.55***	1.69***	1.98***

	(10.95)	(4.41)	(5.83)	(7.01)	(9.03)
CARICOM dummy	4.79***	4.23***	4.42***	5.04***	4.89***
	(25.99)	(23.15)	(25.84)	(6.27)	(5.37)
MERCOSUR dummy	0.67*	0.11	0.50	0.61	0.73*
	(1.67)	(0.27)	(1.27)	(1.56)	(1.86)
NAFTA dummy	-0.47	-0.45	-0.56	-0.43	-0.17
	(-1.42)	(-1.40)	(-1.59)	(-0.79)	(-0.28)
CAN dummy	0.54***	0.26	0.45**	1.22***	1.50***
	(2.08)	(0.97)	(2.01)	(6.26)	(5.70)
EU dummy	0.18*	0.01	0.52***	0.10	-0.02
	(1.72)	(0.08)	(5.61)	(1.29)	(-0.20)
Distance	-0.98***	-1.06***	-0.95***	-1.08***	-1.18***
	(-16.11)	(-18.31)	(-19.27)	(-26.07)	(-28.47)
Language dummy	0.37***	0.33***	0.57***	0.65***	0.68***
	(3.39)	(2.88)	(5.65)	(7.30)	(7.84)
Exporter's ArCo	4.69***	3.00***	3.34***	3.18***	3.49***
	(10.62)	(6.23)	(7.35)	(10.60)	(12.10)
Importer's ArCo	2.59***	3.02***	1.95***	1.54***	1.46***
	(5.57)	(6.02)	(4.42)	(4.74)	(4.59)
R-squared	0.65	0.66	0.70	0.78	0.79
Number of observations	2440	2408	2926	3334	3347
Akaike Info Criterion	22.91	22.88	23.77	24.52	24.55
Root Mean Squared Error	1.76	1.75	1.69	1.52	1.49
Mean Absolute Error	1.33	1.31	1.26	1.13	1.11
Mean Absolute Percentage Error	20.9	20.73	18.66	15.69	15.52
S&J (1990) goodness of fit	0.91	0.91	0.92	0.93	0.93

Notes: ***, **, * indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. The dependent variable is the natural logarithm of exports in value (current US$). Income, population, distance and remoteness are also in natural logarithms. The estimation uses White's heteroscedasticity-consistent standard errors.

Income variables are significant and have the expected positive sign. Population variables are negative, thus indicating the existence of an absorption effect in the 65-country sample.

The importance of the adjacency dummy decreases over time, starting in 1980 with an estimated coefficient of 0.37 and ending in 1999 with a coefficient of 0.31. Landlockedness seems to have a higher negative effect on trade nowadays than in the past. Exporter's remoteness is significant and shows the expected positive sign, whereas importer's remoteness is significant and positively signed in 1995 and 1999. A positive sign is also found in other studies of trade such as Coca-Castaño et al. (2005).

Table 6 also shows how the impact of most Latin American agreements (CACM, CARICOM, MERCOSUR and CAN) on trade flows has increased since they came into force, whereas the NAFTA dummy is not significant and the European Union (EU) dummy is only significant in 1980 and 1990. A possible explanation for this result may be the existence of heterogeneity in the sample. Evidence of the existence of informal ties between the countries in the FTA is found before the formal trading bloc came into being, since FTA dummies are included over the entire period (Frankel, 1997).

Distance shows its expected puzzling result, that is, a slightly increasing negative impact on trade flows. The coefficients obtained for the language dummy increase over time, indicating that easier verbal communication between trading partners facilitates trade to a higher extent in the 90s than in the 80s. This model has a high explanatory power in terms of the R^2.

4.1.2. Sensitivity analysis

In Chapter 3, it was shown that the pooling assumption is rejected in a sample of countries with different levels of economic development, since the determinants of trade have different coefficients for high and low-income countries. As above, two groups of countries are considered. The DP dummy is used, which takes the value of one when the countries are richer than the average in the sample and zero otherwise. Table 7 shows final results.

Table 7. Determinants of international trade. Augmented log-linear gravity model with country-heterogeneity, OLS estimation.

	1980	1985	1990	1995	1999
Constant term	-40.18***	-36.05***	-45.21***	-49.05***	-46.68***
	(-11.69)	(-9.95)	(-14.52)	(-19.51)	(-18.97)
Exporter's income	1.11***	1.49***	1.31***	1.33***	1.23***
	(10.75)	(12.67)	(12.30)	(15.93)	(15.13)
DP*Exporter's income	**-0.48****	**-0.64*****	**0.33***	**0.28***	**0.33****
	(-2.24)	**(-2.75)**	**(1.67)**	**(1.76)**	**(2.02)**
Importer's income	0.81***	0.69***	0.95***	1.08***	1.07***
	(7.27)	(5.76)	(9.20)	(12.19)	(12.58)
DP*Importer's income	**0.24**	**0.42***	**0.79*****	**0.53*****	**0.29***
	(1.06)	**(1.78)**	**(3.88)**	**(3.35)**	**(1.82)**
Exporter's population	-0.22**	-0.60***	-0.32***	-0.25***	-0.08
	(-2.15)	(-5.00)	(-3.01)	(-2.89)	(-0.95)
DP*Exporter's population	**0.54****	**0.66*****	**-0.48****	**-0.49*****	**-0.58*****
	(2.34)	**(2.66)**	**(-2.25)**	**(-2.84)**	**(-3.39)**
Importer's population	-0.04	0.12	-0.15	-0.25***	-0.29***
	(-0.35)	(1.02)	(-1.41)	(-2.67)	(-3.17)
DP*Importer's population	**-0.24**	**-0.40**	**-0.84*****	**-0.58*****	**-0.28**
	(-0.99)	**(-1.61)**	**(-3.91)**	**(-3.49)**	**(-1.64)**
Adjacency dummy	0.56**	0.58**	0.64***	0.61***	0.56***
	(2.06)	(2.45)	(2.66)	(3.24)	(2.76)
DP*Adjacency dummy	**-0.42**	**-0.34**	**0.05**	**-0.26**	**-0.28**
	(-1.24)	**(-1.13)**	**(0.18)**	**(-1.19)**	**(-1.21)**
Exporting island dummy	-0.03	-0.35**	-0.15	-0.28**	-0.15
	(-0.18)	(-2.16)	(-1.11)	(-2.29)	(-1.24)
DP*Exporting island dummy	**0.17**	**0.59*****	**0.17**	**0.05**	**-0.05**
	(0.78)	**(2.67)**	**(0.92)**	**(0.33)**	**(-0.29)**
Importing island dummy	-0.11	0.14	0.13	-0.20*	0.08
	(-0.68)	(0.89)	(1.10)	(-1.83)	(0.82)
DP*Importing island dummy	**0.15**	**0.17**	**0.12**	**0.17**	**-0.02**
	(0.69)	**(0.78)**	**(0.71)**	**(1.13)**	**(-0.11)**
Exporter landlocked dummy	-0.20	-0.20	-0.17	-0.49***	-0.44***
	(-1.26)	(-1.23)	(-1.11)	(-3.95)	(-3.76)
DP*Exporter landlocked dummy	**0.08**	**0.14**	**0.12**	**0.22**	**0.26***
	(0.38)	**(0.70)**	**(0.64)**	**(1.44)**	**(1.75)**
Importer landlocked dummy	-0.40**	-0.60***	-0.50***	-0.43***	-0.73***
	(-2.37)	(-3.61)	(-3.24)	(-3.37)	(-5.73)
DP*Importer landlocked dummy	**0.12**	**0.17**	**0.29**	**0.09**	**0.27**
	(0.51)	**(0.76)**	**(1.42)**	**(0.54)**	**(1.56)**
Exporter's remoteness	1.44***	1.66***	1.83***	1.30***	1.35***
	(4.91)	(5.36)	(7.18)	(6.67)	(7.24)
DP*Exporter's remoteness	**-0.36**	**-1.04*****	**-1.28*****	**-0.75*****	**-0.68*****
	(-1.12)	**(-3.03)**	**(-4.42)**	**(-3.43)**	**(-3.17)**
Importer's remoteness	-0.03	-0.97***	-0.51**	0.20	-0.01
	(-0.10)	(-3.11)	(-1.98)	(1.01)	(-0.06)
DP*Importer's remoteness	**0.47**	**1.05*****	**0.36**	**0.28**	**0.30**

	(1.46)	**(3.14)**	**(1.26)**	**(1.29)**	**(1.33)**
CACM dummy	2.44***	1.06***	1.26***	1.34***	1.59***
	(8.69)	(2.79)	(4.11)	(4.66)	(6.26)
CARICOM dummy	4.77***	4.26***	4.53***	5.13***	4.81***
	(20.37)	(17.70)	(22.37)	(6.25)	(5.09)
MERCOSUR dummy	0.70*	0.21	0.69**	0.62**	0.79***
	(1.81)	(0.60)	(2.23)	(2.09)	(2.61)
NAFTA dummy	-0.34	-0.23	-0.24	-0.21	0.10
	(-1.39)	(-1.10)	(-1.22)	(-0.67)	(0.26)
CAN dummy	0.39	0.00	0.17	0.94***	1.16***
	(1.39)	(-0.01)	(0.72)	(4.26)	(3.94)
EU dummy	0.23*	0.15	0.50***	0.36***	0.28***
	(1.84)	(1.20)	(5.11)	(4.82)	(3.59)
Distance	-1.01***	-1.12***	-1.03***	-1.20***	-1.31***
	(-13.12)	(-15.49)	(-15.78)	(-21.15)	(-23.36)
DP*Distance	**0.10**	**0.25****	**0.34*****	**0.38*****	**0.43*****
	(0.91)	**(2.31)**	**(3.88)**	**(5.25)**	**(6.02)**
Language dummy	0.44***	0.47***	0.72***	0.77***	0.80***
	(3.09)	(3.24)	(5.65)	(6.87)	(7.41)
DP*Language dummy	**-0.16**	**-0.44***	**-0.64*****	**-0.41****	**-0.39****
	(-0.73)	**(-1.93)**	**(-2.99)**	**(-2.37)**	**(-2.31)**
Exporter's ArCo	4.63***	3.29***	4.38***	4.49***	4.87***
	(7.23)	(4.78)	(6.74)	(9.95)	(11.49)
DP*Exporter's ArCo	**0.44**	**-0.06**	**-2.60*****	**-2.64*****	**-2.68*****
	(0.51)	**(-0.06)**	**(-3.03)**	**(-4.49)**	**(-4.81)**
Importer's ArCo	3.07***	3.52***	2.37***	2.25***	1.91***
	(4.53)	(4.83)	(3.74)	(4.39)	(3.88)
DP*Importer's ArCo	**-1.49**	**-1.66***	**-1.85****	**-1.87*****	**-1.17***
	(-1.63)	**(-1.75)**	**(-2.20)**	**(-2.99)**	**(-1.91)**
R-squared	0.65	0.67	0.71	0.78	0.80
Number of observations	2440	2408	2926	3334	3347
Akaike Info Criterion	22.91	22.87	23.76	24.49	24.52
Root Mean Squared Error	1.75	1.73	1.67	1.49	1.46
Mean Absolute Error	1.32	1.29	1.24	1.11	1.09
Mean Absolute Percentage Error	20.76	20.41	18.36	15.33	15.11
S&J (1990) goodness of fit	0.91	0.91	0.92	0.93	0.93

Notes: ***, **, * indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. The dependent variable is the natural logarithm of exports in value (current US$). Income, population, distance and remoteness are also in natural logarithms. The estimation uses White's heteroscedasticity-consistent standard errors. DP is a dummy variable that takes the value one when the exporting country is a high-income country and zero otherwise.

Results of the interaction dummies (Table 7) show the existence of heterogeneity in the sample. The distance coefficient is statistically different for developed and developing countries. The positively signed coefficients when interacting with the DP dummy mean

that these variables are more important to foster trade in developing countries than in developed ones.

Other geographical variables do not show much evidence of heterogeneity. The adjacency coefficient has a similar magnitude for developed and developing countries. The coefficient of the exporter landlockedness variable is significant from 1995 onwards and differs significantly for developed and developing countries only in 1999, whereas the magnitude of the coefficient of the importer landlockedness variable increases over time.

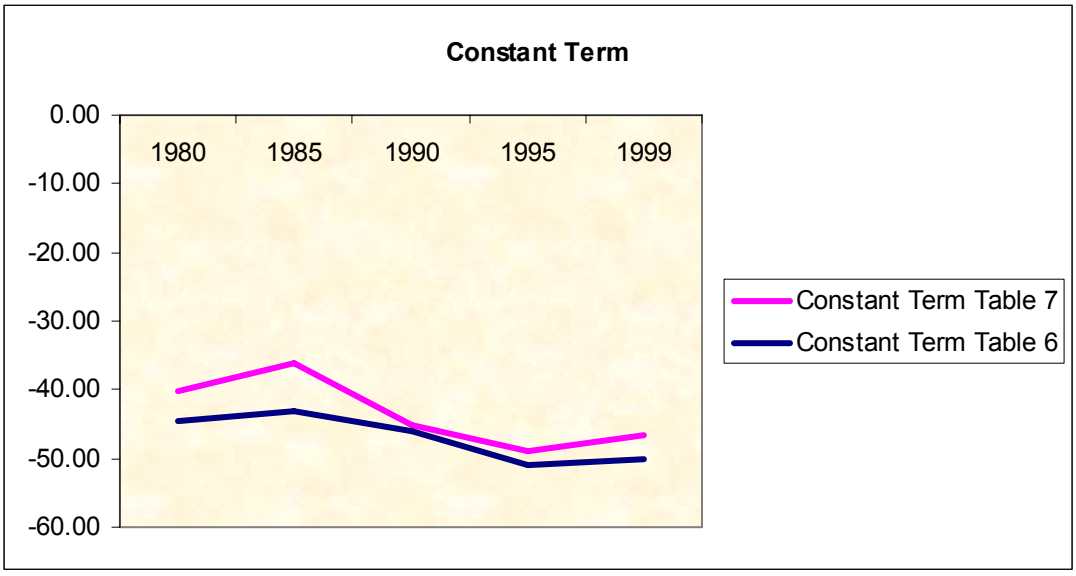
Language has a higher effect on trade flows in developing countries than in developed ones from 1985 onwards. Coefficient heterogeneity is also observed in the technological innovation variables, which show higher coefficients for developing countries.

In relation to the income coefficients, Garman, Petersen and Gilliard (1998) analyse economic integration in a number of developing countries and support the notion that the costs and benefits of integration are unevenly distributed among members of an integration agreement in favour of the richest countries. They find that the income coefficients obtained for Latin American countries have a smaller magnitude than those reported in other studies on European trade. Results in this chapter partially support this evidence, since the exporter income coefficients are higher for high-income economies from 1990 onwards (the interaction dummies take a positive value).

Going back to distance coefficients, the distance coefficient is considerably lower for developed countries and from the year 1985 onwards the differences are statistically significant with respect to developing countries. The magnitude of the coefficient shows an increase for both groups of countries from 1990 onwards. For the whole period 1980–

1999, a 13.55% decrease in the distance coefficient is observed for the developed countries, whereas a 29.7% increase in the distance coefficient is observed for developing countries. According to Buch et al. (2004) changes in the distance coefficient over time[17] cannot be interpreted in terms of rising or falling distance costs. Instead, this coefficient measures how important bilateral economic activities with partners that are far away in comparison to those with partners that are close to the home country. These authors show that the distance coefficient might remain unchanged and that changing distance costs is reflected in the constant term. In this line, the evolution of the constant term estimated in Tables 6 and 7 and the evolution of the distance coefficient for developed and developing countries are analysed. Figures 6 and 7 show the evolution over time according to the results of the OLS regressions.

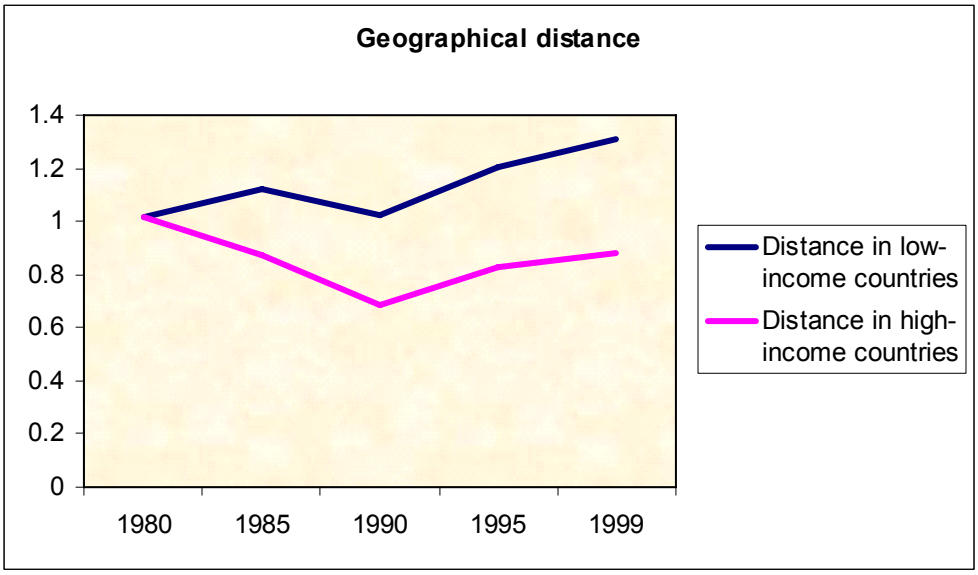
Figure 6. Evolution of the constant term (from Tables 6 and 7).



Source: Own Elaboration

[17] When the distance coefficient is obtained from the estimation of gravity equations using OLS at different points in time.

Figure 7. Evolution of the geographical distance in high and low-income countries in absolute value (from Table 7).



Source: Own Elaboration

The constant term is larger when heterogeneity is considered (Figure 6) and a slight increase in the constant term is observed from 1995 onwards. This effect could be a sign of a reduction in transport costs over time; however, this effect is mixed with an omitted variables effect which might also change the value of the constant term.

With respect to the distance coefficient, the different scenarios considered in Buch et al. (2004) are taken into account to classify each group of countries. The developing countries can be placed in scenario 2, since the magnitude of the distance coefficient increases over the period 1980–1999, whereas the developed countries can be placed in scenario 3, since the magnitude of the distance coefficient decreases over the period 1980–1999. For developing countries, export flows for small distances increase over time, whereas export flows for large distances decrease over time, and therefore trade

with countries far away decreases in relation to trade with nearby countries. The opposite applies to developed countries.

4.2. ESTIMATION OF A NON-LINEAR MODEL

Coe et al. (2002) estimate a non-linear specification of the gravity equation and find evidence for the declining importance of geography. They prefer the non-linear specification since it takes into account zero values for bilateral trade and the level of the estimated distance coefficients is more consistent with theory. Moreover, they point out that "the non-linear models do a much better job of explaining bilateral trade than do the log-linear models".[18] In a more recent paper, Croce et al. (2004) study the performance of four trading blocs (MERCOSUR, NAFTA, CACM and the Andean Community). They estimate a non-linear gravity equation by NLS for each year throughout the period 1978–2001 and find that it explains an important part of the determinants of trade flows: income, population, distance, adjacency, language and integration variables have the expected sign and are significant. These authors state that "in spite of the technological progress experienced in the last two decades, global economic geography is still relevant. This represents one of the puzzles of globalisation". [19] Both papers find that distance has become less relevant over time by using non-linear estimation techniques. The estimated coefficients fell over time, but their values still reveal the importance of geography on trade. Although Coe et al. (2004) mention on page 16 that they also ran regressions excluding developing countries from the sample, they did so to test the robustness of their results to potential data weaknesses and not to test for heterogeneity in the sample. They

[18] Coe et al. (2002), page 21.
[19] Croce et al. (2004), page 9.

say that the results, which are not reported, were "very similar" to those based on the full sample.

In order to compare log-linear and non-linear specifications, the empirical model to be estimated is derived, which is given by equation (4.4):

$$X_{ij} = \left(P_i^{c(1)} \cdot ArCo_i^{c(2)} \cdot Y_j^{c(3)} + P_j^{c(4)} \cdot ArCo_j^{c(5)} \cdot Y_i^{c(6)}\right) \cdot \frac{rem_i^{c(8)} \cdot rem_j^{c(9)} \cdot e^{\mu ij}}{Dist_{ij}^{c(7)}} + \varepsilon_{ij}$$
$$\mu_{ij} = \alpha_1 \cdot CACM + \alpha_2 \cdot CARIC + \alpha_3 \cdot MERC + \alpha_4 \cdot NAFTA + \alpha_5 \cdot CAN + \quad (4.4)$$
$$+ \alpha_6 \cdot EU + \alpha_7 \cdot Adj_{ij} + \alpha_8 \cdot Lang_{ij} + \alpha_9 \cdot Land_i + \alpha_{10} \cdot Land_j + \alpha_{11} \cdot Isl_i + \alpha_{12} \cdot Isl_j$$

where bilateral export flows between countries is the dependent variable, and the explanatory variables are the same as those included in the log-linear model. Variables representing integration agreements, adjacency, language, landlocked and island dummies are included in the non-linear model by means of an exponential function, as in Croce et al. (2004).

The optimisation process to estimate a non-linear model has three main parts: obtaining the starting parameter values, updating the candidate parameter vector at each interaction, and determining when the optimum is reached. If the objective function is globally concave, there is a single maximum and any algorithm that improves the parameter vector at each iteration will eventually find this maximum. If the objective function is not globally concave, different algorithms may find different local maxima. However, all iterative algorithms suffer from the same problem of being unable to distinguish between local and global maxima. Eviews uses the Marquardt algorithm to solve by NLS. This algorithm modifies the Gauss-Newton algorithm by adding a correction matrix to the Hessian approximation.

Iterative estimation procedures require starting values for the coefficients of the model and the closer to the true values they are, the better. However, there are no general rules

for selecting them. In this chapter, the simple average of the values obtained in Croce et al. (2004) and Coe et al. (2002) are used as the starting values of income, population and distance.[20] For the CAN, CACM, MERC and NAFTA dummies, adjacency and language variables, the coefficients obtained in Croce et al. (2004) are included as starting values. For remoteness, the values of the coefficient obtained in Coe et al. (2002) are used. Finally, the OLS coefficients are used as starting values for the rest of the explanatory variables.

The estimation process achieves convergence if the maximum change in the coefficients is below the specified value. A convergence criterion of 0.001 has been used. When a non-linear model converges, the standard statistical results and tests are asymptotically valid.

Table 8 shows final results and allows non-linear estimations to be compared with the linear estimations obtained in Table 6.

Table 8. Determinants of international trade. Augmented non-linear gravity model, NLS estimation.

	1980	1985	1990	1995	1999
Exporter's income	0.69***	0.81***	0.96***	0.62***	0.56***
	(11.10)	(15.55)	(11.20)	(6.56)	(5.96)
Importer's income	0.76***	0.93***	1.00***	0.72***	0.70***
	(16.29)	(20.41)	(13.45)	(8.91)	(10.25)
Exporter's population	1.08***	1.14***	0.86***	0.75***	0.83***
	(11.32)	(9.73)	(9.85)	(12.70)	(15.50)
Importer's population	1.16***	1.32***	0.92***	0.93***	1.10***
	(10.87)	(11.42)	(8.08)	(10.88)	(11.65)
Adjacency dummy	1.14***	1.13***	2.07***	1.19***	1.12***
	(5.68)	(6.16)	(9.82)	(6.04)	(6.29)
Exporting island dummy	1.31***	1.54***	0.63***	0.53***	0.59***
	(7.49)	(8.57)	(4.21)	(2.78)	(3.32)
Importing island dummy	0.89***	1.05***	0.57***	0.44***	0.49***
	(5.74)	(6.63)	(3.08)	(2.71)	(3.86)

[20] Distance is included with a positive sign because, in the non-linear specification estimated in this paper, it enters in the denominator.

Exporter landlocked dummy	-0.43*	-0.29	-0.72**	-0.02	0.17
	(-1.84)	(-1.14)	(-2.43)	(-0.09)	(0.88)
Importer landlocked dummy	0.17	0.22	-0.20	0.37**	0.42**
	(0.90)	(1.09)	(-0.88)	(1.98)	(2.07)
Exporter's remoteness	-1.18***	-0.83**	-0.45	-0.24	-0.41
	(-3.62)	(-2.29)	(-1.02)	(-0.67)	(-1.35)
Importer's remoteness	-0.99***	-1.92***	-2.22***	-1.51***	-1.50***
	(-3.30)	(-5.88)	(-5.40)	(-3.08)	(-3.74)
CACM dummy	4.96***	5.75***	4.03***	2.55***	3.43***
	(5.00)	(5.20)	(3.25)	(2.73)	(4.33)
CARICOM dummy	4.96***	5.84***	6.31***	4.03***	4.17***
	(6.01)	(5.42)	(5.12)	(4.03)	(3.94)
MERCOSUR dummy	2.72***	3.00***	1.58**	1.99***	2.15***
	(4.97)	(4.27)	(2.36)	(4.66)	(5.55)
NAFTA dummy	-0.69***	-0.55**	-0.89***	0.40**	0.90***
	(-3.08)	(-2.29)	(-3.05)	(2.21)	(4.95)
CAN dummy	2.92***	3.95***	2.24***	2.01***	1.68***
	(4.36)	(4.54)	(2.60)	(3.18)	(3.00)
EU dummy	1.02***	1.05***	0.19	0.59***	0.82***
	(5.35)	(5.12)	(0.75)	(3.99)	(5.31)
Distance	0.65***	0.77***	0.43***	0.23***	0.18***
	(7.04)	(8.13)	(4.86)	(3.58)	(2.75)
Language dummy	0.05	-0.12	-0.48***	-0.11	-0.26**
	(0.30)	(-0.91)	(-3.00)	(-0.76)	(-2.20)
Exporter’s ArCo	5.87***	6.43***	5.54***	3.44***	3.17***
	(5.98)	(5.41)	(4.29)	(5.54)	(6.96)
Importer’s ArCo	5.66***	6.99***	6.14***	6.16**	8.45***
	(4.92)	(5.50)	(3.34)	(2.15)	(2.91)
R-squared	0.92	0.95	0.86	0.83	0.87
Number of obs	2999	2997	3447	3689	3692
Number of iterations	62	51	60	39	28
Akaike Info Criterion	28.89	29.26	31.02	32.23	32.34
Root Mean Squared Error	419152.1	533166	1367821	2397003	2529591
Mean Absolute Error	124008.2	132031.3	308903.2	605801.6	660928.4
Mean Absolute Percentage Error	1259.01	812.14	1079.99	3746.58	4054.8
S&J (1990) goodness of fit	0.86	0.89	0.81	0.79	0.82

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. The dependent variable is exports in value (current US$). The estimation uses White’s heteroscedasticity-consistent standard errors.

Income variables are significant and have the expected positive sign. Population variables are positive, thus indicating the existence of scale economies in the 65-country sample; this result is the opposite of that obtained in the log-linear estimation. The magnitude of the adjacency coefficient decreases over time in the 90s. Unexpected signs are found for island and remoteness. Decreasing evidence of the importance of being an island is

found. Remoteness has a negative sign indicating that more remote countries trade less; the opposite (expected) sign was obtained in log-linear regressions. Landlocked has a positive (unexpected) effect on trade in 1995 and 1999 for the importing country. Table 8 shows a decreasing positive effect of three Latin American agreements (CACM, CARICOM and CAN) on trade flows, and an increasing positive effect of Mercosur, from 1990 onwards, and NAFTA from 1995 onwards. According to the non-linear results, the European Union agreement (EU dummy) has a decreasing positive effect on trade flows. The results show that there are informal ties between the countries before the agreements came into force, as was shown in the log-linear regressions.

Finally, a greater technological innovation endowment in both the exporting and the importing country leads to higher international trade flows. The coefficient for the exporter's technological innovation decreases over time, whereas it increases for the importer. This result is also different to the one obtained in the log-linear regressions, where the coefficients of both variables decrease over time, and the importers' technological innovation has a lower effect on trade than the exporters' technological innovation.

4.3. LOG-LINEAR AND NON-LINEAR MODEL COMPARISON

When non-linear and log-linear models are compared, the adjusted R-squared is not a good indicator since it depends on the selected dependent variable and different scales are used in both specifications.[21] Coe et al. (2002) use the exponentials of the predicted values in the log-linear regression to calculate an adjusted R-squared transformed so as to be comparable to the adjusted R-squared in the non-linear model. However, the non-

[21] In the log-linear model the dependent variable is lnX, whereas in the non-linear is X.

linear specification does not include a constant term and this should be considered for the purpose of comparing models.

In this chapter, the forecast accuracy of log-linear and non-linear models are compared. Henderson and Millimet (2006) compare different specifications of the gravity model, i.e. parametric (linear and non-linear) and non-parametric. The authors compute four measures of forecast accuracy: the squared correlation coefficient between the actual value and the predicted value, the predicted mean squared error, the predicted mean absolute error and the predicted mean absolute percentage error. Their results indicate that, regardless of the accuracy measure used, parametric estimations are preferred to non-parametric ones and, within the parametric models, log-linear models present a better forecasting accuracy than non-linear models.

The predicted root mean squared error, the predicted mean absolute error and the predicted mean absolute percentage error are chosen to allow comparison between log-linear and non-linear models. According to these forecasting measures, the log-linear model outperforms the non-linear model and the non-linear model underpredicts the volume of trade in the sample.

Another way to compare both specifications is to use the estimation results to generate predictions in order to compare the forecast evaluation of the linear and non-linear models. Stavins and Jaffe (1990) use a goodness of fit statistic equal to one minus Theil's U-statistic based on comparing predicted and actual values for the dependent variable (S&J goodness of fit). The Theil inequality coefficient lies between 0 and 1 and a value of zero indicates a perfect fit. Log-linear and non-linear models can be compared with this measure since it is scale invariant. The S&J (1990) goodness of fit values are shown

at the bottom of Tables 6, 7 and 8. The values obtained are always higher in log-linear models, thus indicating that these models offer a better forecast accuracy than non-linear models.

Finally, both models (Table 6 and 8) are also compared with the Akaike Info Criterion (AIC). In order to do so the AIC obtained into log-linear specifications are transformed, since in the log-linear model the dependent variable is the natural logarithm of exports whereas in the non-linear model it is the exports themselves.[22] Smaller values of the AIC indicate that one particular model is preferred. According to this criterion, the linear gravity model is a better alternative.

4.4. CONCLUDING REMARKS

This chapter goes beyond the role of geographical distance on trade to analyse whether there is really a "missing globalisation puzzle" since the non-decreasing coefficient of distance has been considered puzzling since globalisation has reduced trade costs.

According to the obtained results, the magnitude of distance increases over the period 1980-1999 for developing countries, whereas it decreases over the period 1980-1999 for developed countries.

Overall, the results in this chapter indicate that the linear gravity model is still a very good technique to estimate gravity equations and, although one of the main criticisms against using linear gravity equations to estimate trade flows is the failure to reflect declining trade costs, evidence of declining trade costs can also be shown in linear gravity estimations when the results are correctly interpreted. Therefore, it is not clear why a non-linear estimation should resolve this puzzle in a better way than a linear

[22] $\boldsymbol{AIC}_{\log} = \boldsymbol{AIC} + 2 \cdot \overline{\ln \boldsymbol{Y}}$

estimation. Opposite effects are found for a number of variables in the non-linear estimations and the log-linear model outperforms the non-linear one in terms of accuracy and AIC criteria.

CHAPTER 5

ON THE EFFECT OF TARIFFS AND TRADE FRICTIONS ON SECTORAL TRADE

Abstract

This chapter aims to analyse the effect of trade costs on international trade flows. First, the performance of the gravity model in a disaggregated analysis is evaluated. Second, a revealed comparative advantage index is used to select the sectors and countries for the empirical analysis. Data, sources and variables used in the empirical study are then described. In the empirical analysis, the effect of tariffs and transport costs is analysed from a sectoral perspective. Two different specifications are considered. First, income and income per capita, geographical dummies concerning exporters and importers, and technological innovation are included in the regression to analyse their effect on international trade flows. Second, exporter and importer dummies are included to take into account relative trade barriers. Additionally, two different estimation techniques are used, namely OLS and PPML. PPML estimates have recently been suggested to obtain consistent estimates of the gravity model (Santos-Silva and Tenreyro, 2006). The gravity model is estimated for different sub-samples to test the robustness of the results obtained. In a first step, the effect of trade determinants is analysed for developed and developing countries. In a second step, the effect of trade determinants is analysed for differentiated, referenced and homogeneous goods. Finally, the performance of the OLS and PPML techniques is compared.

5.1. AGGREGATED VERSUS DISAGGREGATED DATA

The impressive goodness of fit of the gravity model applied to bilateral trade flows is widely recognised. Harrigan (2001) analyses the reasons that justify the good performance of the gravity model in empirical analysis of international trade. This author differentiates between aggregated and disaggregated studies and states that "most of the evidence that gravity works comes from aggregated data (…) it is surprising how little work has been done on examining disaggregated gravity equations".[23] Feenstra et al. (2001) and Haveman and Hummels (2004) analyse the effect of determinants of international trade in gravity equations with disaggregated data.

Haveman and Hummels (2004) state that the common elements contributing to the theoretical foundation of gravity models (Anderson, 1979; Bergstrand, 1985) are complete specialisation and identical preferences. Under these assumptions each good is produced only in one country and consumers, who value variety, import all the goods that are produced. In a world with two countries, these models would be useful to make clear predictions about bilateral trade patterns. However, in a multi-country world, the gravity model says little about the pattern of bilateral trade other than predicting the set of partners a country trades with. As Haveman and Hummels (2004) point out, this does not mean that it is impossible to distinguish the sources of specialisation. For example, Feenstra et al. (2001) show that theories of specialisation can be differentiated, since income elasticities in gravity equations should be different depending on whether or not entry barriers are in place. Models with free entry, including monopolistic competition and reciprocal dumping with free entry, predict larger exporter than importer income elasticities. Models with restricted entry, including Armington national product

[23] Harrigan, 2001, page 41.

differentiation and reciprocal dumping with no entry, predict lower exporter than importer income elasticities. These authors find evidence for free-entry models in differentiated goods and for restricted entry models in homogeneous goods.

Haveman and Hummels (2004) examine a model with incomplete specialisation (multiple countries may produce each homogeneous good), where much lower trade volumes are expected than in the case of complete specialisation. These authors analyse bilateral trade flows at the 4-SITC level and show that countries do not buy all available goods. A large number of zero observations and the fact that the volume of trade is underpredicted at sectoral level are the main reasons why the gravity model performs better in aggregated than in disaggregated analysis.

5.2. REVEALED COMPARATIVE ADVANTAGE

A revealed comparative advantage (RCA) index is calculated according to Balassa's measure of relative export performance by country and industry (1965) to determine in which goods the countries considered in the analysis are specialised. The index is defined as country's share of world exports of a good divided by its share of total world exports, as expressed in equation (5.1):

$$\boldsymbol{RCA_{ik}} = \frac{\boldsymbol{X_{ik}} / \boldsymbol{X_{wk}}}{\boldsymbol{X_{iN}} / \boldsymbol{X_{wN}}} \cdot 100 \qquad (5.1)$$

where RCA_{ik} is the revealed comparative advantage index of commodity k for country i, X_{ik} is the value of exports of commodity k by country i, X_{wk} is the value of world exports of commodity k, X_{iN} is the value of exports of all commodities by country i and X_{wN} is the value of world exports of all commodities. A ranking of the first ten industries with

the highest positive RCA values is drawn up for each country in the year 2000.[24] Rauch classification is used to determine whether countries are specialised in goods traded on an organised exchange (homogeneous), reference-priced or differentiated goods (Rauch, 1999).

According to equation (5.1), country i has a comparative advantage in exporting commodity k when RCA_{ik} is greater than one. Table A.6[25] in Appendix shows the main sectors in which the 65-country sample used in Chapters 3 and 4 are specialised (see Figure A.1, Appendix).

The patterns of specialisation are as follows. Developing Asian countries (China, India, Nepal and Pakistan) are mainly specialised in differentiated products, whereas developing African countries (Egypt, Mozambique and Sudan) are specialised in homogeneous goods. A number of high-income countries are mainly specialised in differentiated and reference-priced products, whereas others, Canada, France, Ireland, Hong Kong, Japan, Singapore, Switzerland-Liechtenstein, United Kingdom, and the United States tend to be specialised in high-technology sectors.

Finally, a number of medium-income countries, mainly Mediterranean, Central-Eastern European and Latin American countries, are specialised in differentiated and reference-priced goods.

[24] Suárez, Fernández and García (1996) point out that this index indicates an "exporting advantage" more than a comparative advantage since imports are not taken into account.

[25] Table A.6 in Appendix. The second column of the table lists the ranking of the ten industries in which each country is highly specialised; the third column outlines a description of the sectors, and the fourth column shows the corresponding Rauch conservative classification (1999). Bold sectors are high-technology sectors according to OECD (2001) and Eurostat (1999) classification.

5.3. CLASSIFICATION MATRIX

A classification matrix is constructed to choose a representative sample for the sectoral analysis. Classifications by country (developed and developing countries) and by commodity (Rauch, 1999: differentiated, reference-priced and homogeneous) are considered. Information in Table A.6 is used to determine whether countries are specialised in differentiated, reference-priced or homogeneous goods. For example, when a country is more specialised[26] in differentiated goods (ranked in the 10 most exported goods) than in reference-priced or homogenous goods, then it is considered to be specialised in differentiated goods.[27] A representative country is chosen from each group (in bold in Table 9). When a high number of countries is classified in the same group, two representative countries are chosen for the empirical analysis. In Latin-America, Bolivia, Brazil and Chile are chosen; North America is represented by the United States; Asia, by China and Japan; Europe by the Czech Republic, Germany, Spain and the United Kingdom; Africa by Ghana and South Africa and Oceania is represented by Australia.

[26] Specialisation can be defined as "producing more than you need of some things, and less of others, hence specialising in the first". Definition obtained from Deardorff's Glossary of International Economics (http://www-personal.umich.edu/~alandear/glossary/).

[27] When a country has the same number of differentiated, reference-priced and homogeneous commodities in the ranking, it is included in more than a group (e.g. Finland).

Table 9. Classification matrix.

	Differentiated	Reference-priced	Homogeneous
High-income	Austria Belgium, Luxembourg Finland France, Monaco **Germany** Hong Kong Ireland Italy **Japan** Sweden Switzerland, Liechtenstein	**Australia** Belgium, Luxembourg Canada Denmark Finland Iceland Ireland Netherlands Norway **United Kingdom** United States	France, Monaco Singapore **United States**
Medium-income	Bulgaria Colombia Costa Rica **Czech Republic** Dominican Republic Greece Mexico Panama Paraguay Portugal El Salvador Slovak Republic South Korea **Spain** Turkey	**Chile** Costa Rica Croatia Cyprus Israel Peru Poland **South Africa** Spain Syrian Arab Republic Trinidad and Tobago Turkey Venezuela	Algeria Argentina **Brazil** Bulgaria Uruguay
Low-income	**China** Honduras India Jamaica Kenya Nepal Nicaragua Pakistan Tanzania	Ecuador **Ghana** Nicaragua Senegal	**Bolivia** Egypt Mozambique Nicaragua Sudan

Note: Countries are classified in three groups as follows: countries are ordered from higher to lower income levels (GDP per capita, PPP in 1999. Source: WDI, 2005), then an upper level of GDP is composed by calculating the average of the first half of the sample, and an inferior level by calculating the average of the second. Commodities are classified according to Rauch (1999).

5.4. DATA, SOURCES AND VARIABLES

Bilateral trade data by commodity were obtained from Feenstra, Lipsey, Deng, Ma and Mo (2005). The level of disaggregation chosen is 4-digit SITC. The sample of countries considered includes 13 exporters and 167 importers in the year 2000 (Table A.4, Appendix). Table A.5 in Appendix lists the codes of the sectors used in the final sample,

which includes 146 sectors with homogeneous goods, 349 sectors with reference-priced goods, and 694 sectors with differentiated goods.

The databases used to construct the exogenous variables for the regression analysis are World Development Indicators (2005) for incomes and population, World Integrated Trade Solution (WITS) for tariffs, and the Doing Business (2006) database for transport costs. This database was recently created by the World Bank and it compiles procedural requirements for exporting and importing a standardised cargo of goods. Distance between capitals, common official language and the colonial dummy were taken from CEPII.[28]

Two types of variables are used. Income, population, technological innovation, transport costs, geographical, cultural and integration dummies vary across countries, whereas tariffs, high-technology and sectoral dummies vary across sectors. Technological innovation is proxied using the TAI described in Chapter 3 (UNDP, 2001). This indicator takes into account a wide array of variables related to technological innovation. The high-technology dummy is based on the OECD (2001) and Eurostat (1999) classifications. The OECD's classification is based on R&D intensities and Eurostat suggests a higher disaggregation level and defines commodities using the Standard International Trade Classification (SITC), revision 3 at 4-digit level. Concordances from the Centre for International data at UC Davis between SITC revision 2 and revision 3 are used, since trade data are defined according to SITC revision 2. Table A.7 presents the list of high-technology sectors considered in the empirical analysis. Finally, sectoral dummies are

[28] The dist_cepii file was taken from http://www.cepii.fr/anglaisgraph/bdd/distances.htm. The language variable is based on the fact that two countries share a common official language (comlang_off) and simple distances are calculated following the great circle formula, which uses latitudes and longitudes of the most important cities/agglomerations (in terms of population).

based on Rauch (1999) and were obtained from Jon Haveman's International Trade data webpage.[29]

Table A.8[30] shows a summary of the data and sources used in this chapter.

5.5. EMPIRICAL ANALYSIS

5.5.1. Determinants of sectoral trade

In order to analyse the effect of trade barriers on sectoral trade, a gravity equation is specified and estimated for disaggregated data. Sectoral dummies for high-technology sectors and for referenced and homogeneous goods are also included in the regression. The *DP* dummy is included in the regression to take into account country-heterogeneity. The estimated equation is:

$$\begin{aligned}\ln X_{ijk} &= \alpha_0 + \alpha_1 \cdot \ln Y_i + \alpha_2 \cdot \ln Y_j + \alpha_3 \cdot \ln YH_i + \alpha_4 \cdot \ln YH_j + \alpha_5 \cdot Adj_{ij} + \\ &+ \alpha_6 \cdot Land_i + \alpha_7 \cdot Land_j + \alpha_8 \cdot MERC + \alpha_9 \cdot NAFTA + \alpha_{10} \cdot CAN + \alpha_{11} \cdot EU + \\ &+ \alpha_{12} \cdot EMU + \alpha_{13} \cdot ECOWAS + \alpha_{14} \cdot CEFTA + \alpha_{15} \cdot \ln Dist_{ij} + \alpha_{16} \cdot Lang_{ij} + \\ &+ \alpha_{17} \cdot Colony_{ij} + \alpha_{18} \cdot TAI_i + \alpha_{19} \cdot TAI_j + \alpha_{20} \cdot \ln Tariffs_{ik} + \alpha_{21} \cdot TC_i + \alpha_{22} \cdot TC_j + \\ &+ \alpha_{23} \cdot hightech_k + \alpha_{24} \cdot \hom_k + \alpha_{25} \cdot ref_k + \alpha_{26} \cdot DP + \varepsilon_{ijk}\end{aligned} \tag{5.2}$$

where *ln* denotes natural logarithms.

Income per capita in the exporting and importing country is included instead of population, following Martínez-Zarzoso and Nowak-Lehmann's (2003) observation that a specification including income per capita is preferred when the gravity model is applied to estimate bilateral exports for specific products.

X_{ijk} denotes the value of exports of commodity k from country i to j; Y_i and YH_i are income and income per capita in the exporter's market; Y_j and YH_j are income and income per capita in the destination market; Adj_{ij} is a dummy that indicates whether the

[29] http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeData.html

[30] Table A.8 in Appendix. The first column lists the variables used for empirical analysis; the second column outlines a description of the variables, and the third column shows the data sources.

trading partners are contiguous; $Land_i$ and $Land_j$ take the value of 1 when the exporting or importing countries are landlocked, respectively, and zero otherwise.

MERC is a dummy that takes a value of 1 when both exporting and importing countries belong to Mercosur; NAFTA takes a value of 1 when countries are members of the North American Free Trade Area, and CAN is a dummy representing Andean Community members. EU takes a value of 1 when countries are members of the European Union. Additionally, EMU takes a value of 1 when countries are members of the Economic and Monetary Union;[31] ECOWAS takes a value of 1 when countries are members of the Economic Community of West African States. Finally, CEFTA takes a value of 1 when countries are members of the Central European Free Trade Agreement.

$Dist_{ij}$ is the geographical great circle distance in kilometres between the most important cities (in terms of population) of country *i* and *j*. $Lang_{ij}$ is a dummy for countries sharing a common official language. $Colony_{ij}$ is a dummy that takes the value of 1 when trading partners have had a colonial link at any time.

The technological achievement index is used to measure technological innovation in country *i* and *j*. Then, TAI_i and TAI_j are technological variables measuring technological innovation in the exporting and importing country.

$Tariff_{ik}$ is the simple average effectively applied tariff for all countries importing each commodity from the 13 exporters. TC_i and TC_j are transport costs of the exporting and importing country respectively.

$High\text{-}tech_k$ is a dummy that takes the value of 1 when the commodity is a high-technology commodity (Table A.7, Appendix). Hom_k takes the value of 1 when a

[31] Greece is also considered, since the Greek government announced on 15 January 2000 the drachma-euro exchange rate with which Greece would enter the third stage of EU Economic and Monetary Union (EMU) on 1 January 2001.

commodity is homogeneous, zero otherwise, whereas ref_k takes the value of 1 when a commodity is reference-priced, according to the conservative Rauch classification (1999).[32] Finally, ε_{ijk} is the error term, which is assumed to be independently and identically distributed.

Equation (5.2) is estimated using Ordinary Least Squares (OLS) and Pseudo Poisson Maximum Likelihood (PPML) methods. The PPML method is used following observations by Santos-Silva and Tenreyro (2006) that the standard empirical methods are not appropriate to estimate gravity equations. Log-linearisation leads to inconsistent estimates when observations with heteroscedasticity are present. In addition, the zero values in the dependent variable cannot be considered in the OLS estimation. Moreover, Santos-Silva and Tenreyro (2006) state that OLS estimation of the gravity model exaggerates the role of geographical proximity and links. Their results suggest that heteroscedasticity is responsible for the main differences. To address these estimation problems, these authors propose using the PPML method.

In this empirical analysis, since the problem of zeros in the dependent variable is not relevant, only sectors with positive trade volumes are considered; however, the presence of heteroscedasticity could bias coefficients obtained in OLS regressions. In fact, the results of the White's Test indicate that the error term is heteroscedastic.

Table 10 shows the results of the OLS and PPML estimations in columns 2 and 3, respectively.

[32] The "conservative" classification minimises the number of 4-digit commodities that are classified as either organised-exchange or reference-priced.

Table 10. Determinants of international trade with sectoral data.

	OLS	PPML
Constant term	-3.60***	0.33
	(-8.66)	(0.16)
Exporter's income	0.27***	0.24***
	(33.03)	(5.54)
Importer's income	0.35***	0.60***
	(100.51)	(23.39)
Exporter's income per capita	-0.40***	-1.72***
	(-12.37)	(-7.17)
Importer's income per capita	0.03***	0.13**
	(3.70)	(2.41)
Adjacency dummy	0.55***	1.15***
	(26.94)	(10.02)
Exporter's Landlocked dummy	-0.48***	-1.26***
	(-16.21)	(-8.39)
Importer's Landlocked dummy	-0.14***	-0.09
	(-9.83)	(-1.39)
MERCOSUR dummy	0.13**	0.14
	(2.51)	(0.86)
NAFTA dummy	1.01***	0.29*
	(14.78)	(1.67)
CAN dummy	1.03***	1.06**
	(3.96)	(2.04)
EU dummy	0.02	0.18*
	(0.71)	(1.73)
EMU dummy	0.29***	0.07
	(10.07)	(0.61)
ECOWAS dummy	-0.76*	0.02
	(-1.96)	(0.02)
CEFTA dummy	0.22***	0.64***
	(5.52)	(4.63)
Distance	-0.36***	-0.22***
	(-55.14)	(-6.19)
Language dummy	0.28***	0.06
	(19.06)	(0.90)
Colonial dummy	-0.03*	-0.17**
	(-1.76)	(-2.22)
Exporter's TAI	2.54***	8.51***
	(17.46)	(7.68)
Importer's TAI	0.68***	1.20***
	(20.73)	(5.63)
Tariffs	0.10***	0.23***
	(12.12)	(3.05)
Exporter's transport costs	-0.04	0.13

	(-1.56)	(0.79)
Importer's transport costs	-0.17***	-0.48***
	(-17.68)	(-9.81)
High-tech dummy	0.39***	0.69***
	(34.71)	(17.86)
Homogeneous goods dummy	-0.04**	-0.17**
	(-1.97)	(-2.16)
Referenced goods dummy	-0.07***	-0.63***
	(-7.25)	(-16.53)
DP dummy	0.06***	0.25**
	(4.59)	(2.53)
R-squared	0.25	-
Pseudo R-squared	-	0.36
Akaike Info Criterion	570244.8	7.65e+09
_hatsq coefficient	0.11***	0.05***
Number of observations	149 840	149 847

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics and z-statistics are in brackets. The OLS estimation uses White's heteroscedasticity-consistent standard errors and the dependent variable is the natural logarithm of exports in value (thousands of US$). Income, income per capita, distance, tariffs and transport costs are also in natural logarithms.

The OLS results show that geographical variables, distance, adjacency and landlocked, are significant and present the expected sign. Sharing a language increases exports. The estimated coefficients for technological innovation are significant and the coefficient of the TAI is higher in magnitude for exporters than for importers, as obtained in the aggregated analysis.

With regard to regional integration, membership of Mercosur, NAFTA, the Andean Community, the European Economic and Monetary Union and CEFTA has a positive effect on exports. The positive and significant high-tech dummy shows that technologically intensive sectors are highly exported.

In relation to trade costs, results show a positive and significant effect of tariff variables on trade flows. This result is unexpected. A possible explanation may be that the structure of world tariffs benefits exports from the 13 exporting countries included in the regression. A second explanation could be that the exporters (developing countries) are

using tariffs as a source of revenue and therefore they set up high tariffs in the products that are exported.[33]

Transport cost variables present the expected negative sign, although it is only significant in the case of importer's transport costs. The exporting countries export less to countries with higher transport costs.

The beta coefficients are calculated to determine the relative importance of the different variables included in the model (see Table A.9 in Appendix). The highest beta coefficients are, in absolute value, for income in the exporting and importing countries, exporter's income per capita, exporter's technological innovation and geographical distance. Trade barriers show a low beta coefficient that varies between -0.04 (importer's transport costs) and 0.03 (tariffs). Therefore, they do not seem to have a relevant impact on the pattern of exports in the sample. Finally, the R-squared is significantly lower than that obtained when estimating aggregated data. This is in line with the previous literature.

The third column of Table 10 shows the PPML results.[34] The distance variable presents a lower negative coefficient than when using OLS and the language variable is not

[33] This is investigated by restricting the sample to developing countries as exporters to all the other countries. In this case, results show that the tariff coefficient takes a value of 0.42 in the OLS estimation and a value of 0.75 in the PPML estimation. When restricting the sample to developed countries as exporters to all the other countries, results show that the tariff coefficient takes a value close to zero (0.04) in the OLS estimation and is not significant in the PPML estimation.

[34] Knowledge about the parameters allows us to know the influence of an explicative variable on the expected value of the dependent variable. For example, when the Poisson regression model gives

$$\boldsymbol{E}\left[\boldsymbol{Y}_i|\boldsymbol{x}_i\right] = \exp\left[\beta_1 \boldsymbol{x}_{i1} + \beta_2 \boldsymbol{x}_{i2} + \beta_3\right]$$

The marginal effect of the first explicative variable on the expected value of Y_i, keeping the other variables constant, is given by

$$\partial \boldsymbol{E}\left[\boldsymbol{Y}_i|\boldsymbol{x}_i\right] \Big/ \partial \boldsymbol{x}_{i1} = \beta_1 \exp\left[\beta_1 \boldsymbol{x}_{i1} + \beta_2 \boldsymbol{x}_{i2} + \beta_3\right]$$

β_1 has the same sign as this marginal effect, but the numerical value of the effect depends on the value of $\boldsymbol{x}_{i1}$. The marginal effects can be summarised by replacing in the above equation $\boldsymbol{x}_{i1}$ and $\boldsymbol{x}_{i2}$ by average values of the explicative variables over the whole sample. Moreover, it is also possible to interpret β_1 as a

significant. In contrast to Rauch (1999), OLS and PPML estimates show that countries sharing colonial ties trade less. Higher magnitudes are found in the coefficients of technological innovation and trade costs variables. In this case, the coefficients on tariffs and importer's transport costs are higher than when using OLS. Importer's transport costs are found to have a greater deterrent effect on where to export to. Finally, country-heterogeneity is more pronounced since the DP dummy is higher in magnitude, thus indicating that developed countries trade more among themselves. The results obtained can be compared to other studies that use disaggregated trade data such as Siliverstovs and Schumacher (2006). These authors also find that geographical distance coefficients are significantly lower in magnitude in PPML estimates than in OLS estimates.

In order to uncover any multicollinearity problems, the *variance inflation factor* (VIF) is obtained. Tolerance, defined as 1/VIF, is used to check for the degree of collinearity. All the tolerance values for variables used in the estimated gravity model are higher than 0.1, with the exception of the exporter's income per capita (tolerance of 0.03) and exporter's technological innovation (tolerance of 0.04) which present a high degree of correlation (92%).

To validate results obtained when estimating equation (5.2) and to eliminate multicollinearity problems, country dummies for exporters and importers are included in the disaggregated model (not reported) since the effects of origin-specific and destination-specific unobservable market characteristics or multilateral resistance terms from both the exporting and importing countries are considered. Anderson and van Wincoop (2003) highlight that the key aspect of the gravity model is the dependence of

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semi-elasticity: $\partial \log \boldsymbol{E}\left[\boldsymbol{Y}_i \middle| \boldsymbol{x}_i\right] \Big/ \partial \boldsymbol{x}_{i1} = \beta_1$. Interpretation obtained from the webpage of the Faculteit Economische en Toegepaste Economische Wetenschappen (http://www.econ.kuleuven.be).

trade on a bilateral and multilateral resistance factor since, theoretically, these models are determined by relative trade barriers and not only by absolute trade barriers between the exporting and importing countries. The estimated equation is:

$$\begin{aligned}\ln X_{ijk} &= \delta_i + \lambda_j + \alpha_0 + \alpha_1 \cdot Adj_{ij} + \alpha_2 \cdot MERC + \alpha_3 \cdot NAFTA + \alpha_4 \cdot CAN + \\ &+ \alpha_5 \cdot EU + \alpha_6 \cdot EMU + \alpha_7 \cdot ECOWAS + \alpha_8 \cdot CEFTA + \alpha_9 \cdot \ln Dist_{ij} + \\ &+ \alpha_{10} \cdot Lang_{ij} + \alpha_{11} \cdot Colony_{ij} + \alpha_{12} \cdot \ln Tariffs_{ik} + \alpha_{13} \cdot hightech_k + \alpha_{14} \cdot \hom_k + \\ &+ \alpha_{15} \cdot ref_k + \alpha_{16} \cdot DP + \varepsilon_{ijk}\end{aligned} \tag{5.3}$$

where ln denotes natural logarithms, δ_i denotes exporter dummies and λ_j importer dummies. Table 11 shows the final results.

Table 11. Determinants of international trade with sectoral data, exporter and importer dummies.

	OLS	PPML	OLS with transport costs	PPML with transport costs
Adjacency dummy	0.41***	0.91***	0.41***	0.91***
	(17.99)	(8.74)	(17.97)	(8.72)
MERCOSUR dummy	0.17***	0.84***	0.17***	0.84***
	(2.67)	(4.73)	(2.68)	(4.75)
NAFTA dummy	1.09***	0.72***	1.07***	0.72***
	(14.95)	(4.19)	(14.70)	(4.19)
CAN dummy	1.50***	3.95***	1.50***	3.95***
	(5.58)	(8.38)	(5.54)	(8.38)
EU dummy	0.28***	0.81***	0.28***	0.81***
	(9.84)	(6.10)	(9.58)	(6.09)
EMU dummy	0.08***	-0.18	0.08**	-0.18
	(2.64)	(-1.48)	(2.46)	(-1.48)
ECOWAS dummy	-1.21***	0.71	-1.23***	0.71
	(-2.99)	(0.80)	(-3.04)	(0.80)
CEFTA dummy	0.32***	0.49***	0.32***	0.49***
	(7.24)	(3.62)	(7.32)	(3.63)
Distance	-0.43***	-0.27***	-0.43***	-0.27***
	(-54.43)	(-8.12)	(-54.61)	(-8.10)
Language dummy	0.16***	-0.03	0.17***	-0.03
	(9.57)	(-0.49)	(9.83)	(-0.49)
Colonial dummy	0.17***	0.10	0.16***	0.10
	(8.76)	(1.21)	(8.43)	(1.22)
Tariffs	0.11***	0.24***	0.11***	0.24***
	(13.70)	(3.22)	(13.31)	(3.22)
Transport costs	-	-	-0.27**	-0.46**
			(-2.15)	(-2.06)
High-tech dummy	0.39***	0.70***	0.40***	0.70***

	(37.14)	(18.32)	(37.58)	(18.34)
Homogeneous goods dummy	-0.05**	-0.20***	-0.06***	-0.20***
	(-2.28)	(-2.67)	(-2.87)	(-2.70)
Referenced goods dummy	-0.06***	-0.62***	-0.07***	-0.62***
	(-6.82)	(-16.84)	(-6.93)	(-16.82)
DP dummy	-0.20***	-0.69***	-0.20***	-0.69***
	(-9.22)	(-5.62)	(-9.25)	(-5.62)
R-squared	0.28	-	0.28	-
Pseudo R-squared	-	0.39	-	0.39
Akaike Info Criterion	603617	7.50e+09	590653.9	7.48e+09
_hatsq coefficient	0.11***	0.04***	0.08***	0.06***
Number of observations	160 321	160 335	156 379	156 393

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics and z-statistics are in brackets. The OLS estimation uses White's heteroscedasticity-consistent standard errors and the dependent variable is the natural logarithm of exports in value (thousands of US$). Distance and tariffs are also in natural logarithms.

The OLS results show that all the variables included in the regression are significant and present the expected sign (that obtained when estimating equation (5.2)), with the exception of the colonial and DP dummies. When calculating beta coefficients (see Table A.9 in Appendix), the highest value is for geographical distance. The beta coefficient for tariffs is also low when considering multilateral resistance (0.03).

According to the PPML results, EMU, ECOWAS, language and colonial dummies are not significant. The result that socio-cultural links have no effect on trade flows is unexpected since it has been shown that trade increases with links (Rauch, 1999). This result is further analysed below, where regressions for differentiated, referenced and homogeneous goods are estimated.

A comparison of the performance of equation (5.2) and (5.3) shows a higher goodness of fit value in the latter, in both the OLS and PPML estimations. Additionally, the Akaike Info Criterion (AIC) is usually used to compare models. Smaller values of the AIC indicate that one particular model is preferred. According to this criterion, equation (5.3)

is a better alternative when estimating by PPML. Therefore, equation (5.3) is used in the estimation for different types of goods.

Finally, columns 4 and 5 in Table 11 include an additional variable, $ln\ (TC_i*TC_j)$, to consider transport costs in equation (5.3). Results show that coefficients in variables do not change when transport costs are included and that the coefficient of this variable is higher in the PPML than in the OLS regression. The corresponding beta coefficient of this additional variable is –0.08, which is higher than the beta coefficients obtained when estimating equation (5.2) by OLS (see Table A.9, Appendix), but still low compared to geographical distance. The result that distance coefficients do not change when estimating equation (5.3) and equation (5.3) with transport costs, supports the hypothesis that geographical distance indicate factors other than transport costs.

5.5.2. Robustness tests

In this section a number of robustness checks are presented. First, based on Santos-Silva and Tenreyro (2006), a heteroscedasticity-robust RESET test is performed. The authors show that only the models estimated using the PPML regressions pass the RESET test. This test is performed by checking the significance of an additional regressor constructed as $(x'b)^2$, where b is the vector of estimated parameters. Their results show that in the OLS regression the test rejects the hypothesis that the coefficient on the test variable is zero. Nonetheless, the PPML regressions pass the test since there is no evidence of misspecification of the gravity equations. The *linktest* in STATA is used to test for specification errors. Tables 10 and 11 show that the variable of square prediction (_hatsq) is significant in all cases, that is, equation (5.2) and equation (5.3) estimated by both OLS and PPML. The coefficient of (_hatsq) is lower in all cases in PPML regressions, thus

indicating that the specification error is less important. Further research is needed to improve the specification of the estimated model with sectoral data. Second, separated regressions are estimated for equations (5.2) and (5.3) for sectoral trade flows among developed and among developing countries. Table 12 and Table 13 show results for OLS and PPML estimations in developed and developing countries, respectively.

Table 12. Determinants of international trade with sectoral data. International trade flows among developed countries.[35]

	Equation (5.2)		Equation (5.3)	
	OLS	PPML	OLS	PPML
Adjacency dummy	0.65***	0.69***	0.53***	0.55***
	(23.61)	(5.99)	(17.03)	(4.54)
NAFTA dummy	0.65***	0.63***	0.96***	0.92***
	(9.17)	(4.20)	(12.25)	(4.76)
EU dummy	-0.03	0.26**	0.32***	0.73***
	(-0.97)	(2.16)	(9.17)	(4.58)
EMU dummy	0.31***	0.35***	0.07**	0.09
	(10.48)	(3.03)	(1.99)	(0.75)
CEFTA dummy	0.43***	0.45***	0.39***	0.47***
	(8.61)	(2.75)	(7.21)	(3.10)
Distance	-0.40***	-0.28***	-0.42***	-0.31***
	(-43.05)	(-6.89)	(-36.03)	(-6.89)
Language dummy	0.24***	-0.02	0.17***	-0.02
	(11.77)	(-0.25)	(6.93)	(-0.24)
Colonial dummy	-0.02	-0.15*	0.18***	0.06
	(-0.85)	(-1.86)	(7.21)	(0.63)
Tariffs	0.05***	0.18*	0.07***	0.18*
	(4.37)	(1.73)	(6.09)	(1.85)
Exporter's transport costs	-0.35***	-0.07	-	-
	(-7.08)	(-0.33)		
Importer's transport costs	-0.33***	-0.66***	-	-
	(-19.82)	(-7.36)		
High-tech dummy	0.60***	0.78***	0.59***	0.78***
	(36.04)	(16.97)	(37.27)	(17.19)
Homogeneous goods dummy	-0.33***	-0.28***	-0.35***	-0.32***
	(-10.80)	(-2.61)	(-11.87)	(-3.09)
Referenced goods dummy	-0.09***	-0.62***	-0.08***	-0.60***
	(-6.17)	(-13.09)	(-6.24)	(-13.07)

[35] In Table 12, both the exporters and the importers are restricted to be developed countries and in Table 13, both the exporters and the importers are restricted to be developing countries.

R-squared	0.24	-	0.27	-
Pseudo R-squared	-	0.33	-	0.35
Akaike Info Criterion	302913.4	5.41e+09	320565.2	5.44e+0.9
_hatsq coefficient	0.07***	0.05***	0.07***	0.05***
Number of observations	77443	77445	82748	82750

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics and z-statistics are in brackets. The OLS estimation uses White's heteroscedasticity-consistent standard errors and the dependent variable is the natural logarithm of exports in value (thousands of US$). Distance and tariffs are also in natural logarithms. For the purposes of comparison, only the variables included in both equations (5.2) and (5.3) are reported.

Table 13. Determinants of international trade with sectoral data. International trade flows among developing countries.

	Equation (5.2)		Equation (5.3)	
	OLS	PPML	OLS	PPML
Adjacency dummy	0.32***	1.61***	0.04	0.62***
	(10.57)	(12.31)	(1.14)	(4.07)
MERCOSUR dummy	0.22***	-0.25	0.25***	0.89***
	(3.88)	(-1.40)	(3.56)	(3.65)
CAN dummy	0.42*	0.90**	1.32***	3.81***
	(1.71)	(1.98)	(5.27)	(7.68)
ECOWAS dummy	-0.94**	0.72	-1.27***	0.44
	(-2.43)	(0.81)	(-3.15)	(0.50)
CEFTA dummy	-0.18**	1.05***	0.04	0.35**
	(-2.40)	(3.95)	(0.56)	(2.25)
Distance	-0.35***	-0.35***	-0.48***	-0.40***
	(-36.19)	(-5.83)	(-38.66)	(-7.29)
Language dummy	0.32***	0.77***	0.17***	-0.07
	(14.90)	(7.46)	(6.16)	(-0.48)
Colonial dummy	-0.16***	-0.09	0.12***	0.56**
	(-6.65)	(-0.38)	(4.24)	(2.36)
Tariffs	0.17***	0.41***	0.17***	0.41***
	(14.11)	(5.91)	(14.85)	(5.97)
Exporter's transport costs	-0.05	-0.24	-	-
	(-1.54)	(-1.18)		
Importer's transport costs	-0.17***	-0.35***	-	-
	(-13.92)	(-7.47)		
High-tech dummy	0.19***	0.49***	0.20***	0.49***
	(12.94)	(6.92)	(14.55)	(7.01)
Homogeneous goods dummy	0.30***	0.11	0.32***	0.14
	(8.93)	(1.16)	(9.99)	(1.62)
Referenced goods dummy	-0.05***	-0.68***	-0.04***	-0.67***
	(-3.89)	(-11.38)	(-3.16)	(-11.69)
R-squared	0.20	-	0.23	-
Pseudo R-squared	-	0.42	-	0.46

Akaike Info Criterion	264221.5	2.03e+09	279916.2	1.96e+0.9
_hatsq coefficient	0.29***	0.11***	0.09***	0.06***
Number of observations	72397	72402	77573	77585

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics and z-statistics are in brackets. The OLS estimation uses White's heteroscedasticity-consistent standard errors and the dependent variable is the natural logarithm of exports in value (thousands of US$). Distance and tariffs are also in natural logarithms. For the purposes of comparison, only the variables included in both equations (5.2) and (5.3) are reported.

Results show that for developed countries (Table 12) important biases are found in the European Union dummy. When estimating by PPML, this variable is significant and has the right sign. The importance of distance is lower when using the PPML regression since the coefficients are lower in both equation (5.2) and equation (5.3) than when OLS is used. The language dummy is not significant for developed countries when using PPML and the colonial dummy has a negative sign. The importance of distance and links is found to be lower when estimating by PPML, as has been evidenced by other authors (Santos-Silva and Tenreyro, 2006; Siliverstovs and Schumacher, 2006). Additionally, the coefficients of the tariff variable and importer's transport costs are higher in the PPML regression.

In relation to developing countries, results in Table 13 show that the differences in the magnitude of coefficients and signs are considerable in integration dummies. Distance is only slightly lower in PPML than in OLS when estimating equation (5.3). When estimating by PPML, the magnitude of distance is lower for developed than for developing countries. The language variable is significant, excluding the estimation of equation (5.3) using PPML, and colonial ties are of greater importance for developing countries. The coefficient of tariffs is higher when estimating by PPML and it has an unexpected positive sign. This persistent result points towards the idea that tariffs may be

determined to a greater extent by sector and not by country of destination; consequently sector-heterogeneity must be considered when analysing the effect of tariffs.

In the case of trade among developing countries, transport costs have the expected negative sign and the effect of this variable is higher when estimating by PPML.

When comparing regressions between developed and developing countries, the goodness of fit shows that a higher pseudo R-squared is obtained with PPML methodology for developing countries, whereas a higher R-squared is obtained with OLS methodology for developed countries. The small values of the dependent variable and a lower quality of the data may be driving this result in the sectoral analysis of the determinants of bilateral trade among developing countries. All AIC values are lower for developing countries, thus showing evidence that equation (5.2) and equation (5.3) are preferred in the case of trade among developing countries than in the case of trade among developed countries.

Finally, when using the *linktest* command in STATA, the variable of square prediction (_hatsq) is significant in regressions for both developed and developing countries. The coefficient of (_hatsq) is lower in all cases in PPML regressions, thus indicating that the specification error is smaller.

Third, the gravity model is also estimated for each type of good separately. Equation (5.3) is estimated for differentiated, reference-priced and homogeneous goods. Table 14 shows the OLS results.

Table 14. Determinants of international trade for different types of goods. OLS estimation.

	Differentiated	Referenced	Homogeneous
Adjacency dummy	0.45***	0.40***	0.37***
	(16.06)	(9.52)	(3.90)
MERCOSUR dummy	0.24***	0.19	-0.54*
	(3.16)	(1.59)	(-1.66)
NAFTA dummy	0.94***	1.20***	1.31***
	(9.91)	(9.94)	(4.82)
CAN dummy	0.60**	0.27	1.86***
	(1.98)	(0.63)	(4.66)
EU dummy	0.18***	0.38***	0.62***
	(5.11)	(6.97)	(4.71)
EMU dummy	0.06	0.12**	0.16
	(1.60)	(2.15)	(1.35)
ECOWAS dummy	-0.83**	-0.87	-2.89***
	(-2.53)	(-0.89)	(-8.34)
CEFTA dummy	0.18***	0.67***	0.12
	(3.44)	(7.70)	(0.49)
Distance	-0.51***	-0.39***	-0.22***
	(-53.88)	(-26.60)	(-5.76)
Language dummy	0.28***	0.05	0.02
	(13.18)	(1.55)	(0.22)
Colonial dummy	0.13***	0.18***	0.24**
	(5.61)	(5.06)	(2.57)
Tariffs	0.14***	0.13***	-0.11***
	(12.50)	(10.27)	(-4.17)
High-tech dummy	0.46***	0.10***	-0.07
	(38.95)	(3.99)	(-0.84)
DP dummy	-0.26***	-0.01	-0.23*
	(-10.38)	(-0.27)	(-1.96)
R-squared	0.32	0.27	0.19
Akaike Info Criterion	404699	148288.1	33156.35
_hatsq coefficient	0.07***	0.03***	0.05***
Number of observations	111 006	40 915	8 400

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics are in brackets. The dependent variable is the natural logarithm of exports in value (thousands of US$). Distance and tariffs are also in natural logarithms. The estimation uses White's heteroscedasticity-consistent standard errors.

Results show that heterogeneity matters in the tariff variable. This variable only shows the expected negative sign in homogeneous goods. Higher importer tariffs in homogeneous goods are associated with lower exports.

Different effects of the integration agreements on trade are also found. In the case of Latin American regional agreements, trade in homogeneous goods has increased to a higher extent among Andean Community members, whereas trade in differentiated goods has increased among members of Mercosur. Different results are found in European agreements. Countries that have adopted the euro and the members of CEFTA have experienced an increase of trade in reference-priced goods. According to these results, ECOWAS has a negative effect on trade among members. Finally, trade among the United States, Canada and Mexico (NAFTA) has increased to a higher extent in homogeneous goods.

The importance of distance and language is higher for differentiated goods, as expected. As in Rauch (1999), this result supports the hypotheses that proximity and common language are more important in matching international buyers and sellers of differentiated products than of homogeneous products. Nonetheless, colonial links seem to have a greater impact on fostering trade in homogeneous goods. Finally, the model seems to perform better for the case of differentiated goods since the coefficient of determination is 32%.

In order to correct for heteroscedasticity, equation (5.3) is also estimated using PPML for different types of goods. Table 15 shows final results.

Table 15. Determinants of international trade for different types of goods. PPML estimation.

	Differentiated	Referenced	Homogeneous
Adjacency dummy	0.99***	0.31***	0.23
	(7.94)	(3.26)	(0.85)
MERCOSUR dummy	1.27***	0.76***	0.68
	(5.21)	(3.16)	(1.16)
NAFTA dummy	0.57***	1.15***	0.11
	(2.86)	(6.41)	(0.16)
CAN dummy	2.06***	0.87	2.52***
	(4.65)	(1.62)	(3.97)
EU dummy	0.75***	0.48***	0.99**
	(4.65)	(2.86)	(2.49)
EMU dummy	-0.23	0.25	-0.05
	(-1.55)	(1.63)	(-0.13)
ECOWAS dummy	0.57	0.68	-4.11***
	(1.17)	(0.80)	(-5.67)
CEFTA dummy	0.33**	0.89***	0.18
	(2.02)	(6.38)	(0.44)
Distance	-0.32***	-0.41***	-0.17
	(-7.55)	(-10.02)	(-1.51)
Language dummy	0.07	-0.12	0.37*
	(0.84)	(-1.22)	(1.68)
Colonial dummy	0.00	0.30***	0.57*
	(-0.04)	(3.11)	(1.76)
Tariffs	0.50***	0.06	-0.44***
	(4.26)	(1.41)	(-6.06)
High-tech dummy	0.87***	-0.12**	-1.04***
	(23.74)	(-2.20)	(-6.86)
DP dummy	-0.94***	-0.10	0.15
	(-6.37)	(-1.09)	(0.60)
Pseudo R-squared	0.44	0.37	0.32
Akaike Info Criterion	5.76e+09	8.58e+08	4.25e+08
_hatsq coefficient	0.03***	0.004***	0.02***
Number of observations	111 015	40 918	8 402

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. Z-statistics are in brackets. Distance and tariffs are in natural logarithms.

When estimating by PPML, evidence of country-heterogeneity is remarkably higher in the case of differentiated products (the magnitude of DP dummy is higher in PPML than in OLS regression). Magnitudes in distance, sharing a common language and colonial ties

are found to be lower for differentiated products than for referenced and homogeneous goods. This is an unexpected result; however some of the links (Rauch, 1999) can be explained by the adjacency dummy since trading partners sharing a common border trade more with each other. Results show that sharing a border is of greater importance for trade in differentiated products.

Distance is not significant for homogeneous goods, supporting the view that incomplete information is of greater importance for trade in differentiated products (Rauch, 1999). Moreover, a number of differences are found in the magnitude of the coefficients obtained for integration agreements, thus showing that the coefficients of integration dummies may be biased in OLS regression.

As in the OLS estimation, a negative effect of tariff barriers is only found in the case of homogeneous goods although the magnitude is considerably higher than in the OLS regression.

Similarly to the OLS result, the pseudo R-squared obtained shows that a higher variability is explained for exports of differentiated goods.

Finally, the variable $ln\ (TC_i*TC_j)$ is included when estimating equation (5.3) for trade among countries with high and low levels of development, and trade in differentiated, referenced and homogeneous goods. Table 16 shows the obtained coefficients in this variable in both OLS and PPML estimation.

*Table 16. Transport costs coefficients, ln (TC_i*TC_j).*

	OLS	PPML
All countries, all goods (from Table 11)	-0.27**	-0.46**
	(-2.15)	(-2.06)
Developed countries	0.78***	1.08***
	(19.45)	(1201.35)
Developing countries	-0.16	No convergence
	(-1.15)	
Differentiated goods	-0.16	No convergence
	(-1.08)	
Referenced goods	-0.48***	No convergence
	(-2.94)	
Homogeneous goods	-1.38***	-1.69***
	(-3.35)	(-47.74)

Notes: ***, **, *, indicate significance at 1%, 5% and 10%, respectively. T-statistics and z-statistics are in brackets. The OLS estimation uses White's heteroscedasticity-consistent standard errors and the dependent variable is the natural logarithm of exports in value (thousands of US$).

Results show that transport cost variable presents the expected negative sign and is significant in the case of the thirteen exporting countries to the 167 importing countries. This variable is also negative and significant when estimating the determinants of trade for referenced and homogeneous goods. A higher magnitude is found for homogeneous than for referenced goods. Additionally, transport costs are of greater importance in PPML than in OLS regressions since the obtained coefficients are higher. Finally, STATA does not find convergence when estimating equation (5.3) with the variable *ln (TC_i*TC_j)* for trade among developing countries, and for differentiated and reference-priced goods.

5.6. CONCLUDING REMARKS

In this chapter, the effect of tariffs and transport costs is added to the list of the new determinants of international trade flows and analysed from an empirical perspective with sectoral data. Two different specifications and two different estimation techniques,

namely OLS and PPML, are used. Regressions are run for different sub-samples to test the validity of the obtained results.

When trade among developed and developing countries is analysed, results support the evidence of country-heterogeneity since distance and sharing a language have a higher effect on trade flows for developing than for developed countries. A higher effect of tariffs on trade flows is obtained for trade among developing than for trade among developed countries and importer's transport costs deter to a higher extent trade among developed than among developing countries.

When different regressions are estimated for different types of goods, OLS results show that the importance of distance and language is higher for differentiated goods, as expected. Otherwise, when estimating by PPML, magnitudes in distance, sharing a common language and colonial ties are found to be lower for differentiated products than for referenced and homogeneous goods. This is an unexpected result.

Overall, results show that transport costs and tariffs have a lower effect on trade flows than distance and technological innovation. However, when estimating by PPML techniques, distance coefficients present a lower magnitude and trade barriers present a higher effect on international trade flows.

Finally, a comparison of OLS and PPML techniques shows PPML regressions to perform better as the specification error is of lower importance. Nonetheless, according to AIC criterion, OLS regressions are preferred since smaller values of the AIC are found in OLS than in PPML regressions. Further research is needed to improve the specification of the estimated model with sectoral data.

CAPÍTULO 6

CONCLUSIONES Y RECOMENDACIONES

El comercio internacional es un factor clave para el crecimiento económico de las naciones, así como también una vía para lograr, junto a otros factores, la disminución de las desigualdades económicas y una reducción significativa de la pobreza en los países más desfavorecidos. Por este motivo, el objetivo principal de esta tesis es analizar el efecto diferencial que una serie de factores tiene sobre el comercio internacional considerando diferentes niveles de desarrollo económico entre países.

Factores como la innovación tecnológica, las características geográficas, las similitudes culturales existentes entre los socios comerciales o las barreras de comercio que dificultan la libre circulación de bienes entre las distintas economías, son de crucial importancia puesto que determinan los patrones de comercio así como también la dirección y sentido de los flujos de comercio entre países.

Aunque a estos determinantes del intercambio se les haya prestado una atención más limitada en la literatura económica sobre el comercio mundial, en las últimas décadas un número creciente de estudios han incorporado dichas variables como factores explicativos de los patrones de la especialización productiva internacional. Concretamente, los desarrollos en el ámbito de los modelos de gravedad han incentivado un creciente interés acerca de la influencia de estas variables.

Si bien es cierto que la distancia geográfica se ha incluido tradicionalmente en los modelos de gravedad como variable aproximativa de los costes de transporte, a ella se han unido otras características geográficas, como la insularidad de los países, la

disponibilidad de fachada marítima o la existencia de fronteras comunes; elementos todos ellos estrechamente relacionados con los costes de transporte de las mercancías. En este sentido, cuanto mayor sea dicho coste, menos se comerciará, justificando el signo negativo que muestran variables como la distancia geográfica al llevar a cabo las correspondientes estimaciones econométricas.

Por otro lado, los factores culturales, tales como compartir un idioma común o haber tenido lazos coloniales, incentivan en términos sociales el comercio internacional. Estas variables están estrechamente vinculadas con similitudes en gustos y preferencias, así como con un mejor conocimiento de los mercados de los países que comparten características sociales y culturales, disminuyendo en consecuencia, los costes asociados a la hora de disponer de una mejor información de estos mercados.

Recientemente se han incluido variables tecnológicas en el contexto de los modelos de gravedad, como puede observarse en los estudios de Filippini y Molini (2003) y de Freund y Weinhold (2004). Estos trabajos constatan que el estado de la tecnología se configura como un factor de especial relevancia para determinar el patrón de comercio de los países. El primero probando la importancia de la distancia tecnológica entre países en la determinación de los flujos de comercio. El segundo demostrando la capacidad de Internet para fomentar el comercio. Por un lado, una mayor distancia tecnológica entre países perjudica en gran medida que los mismos comercien, por otra parte una mayor difusión tecnológica fomenta el intercambio de bienes entre ellos.

En lo referente a los costes comerciales, mientras que las barreras arancelarias y la participación en acuerdos de integración han sido tradicionalmente incorporados en los análisis empíricos de comercio internacional (Harrigan, 1993; Frankel, Stein y Wei,

1995), hasta finales de la década de los 90 los costes de transporte no se incluían, debido a la dificultad de conseguir datos fiables. En estos estudios, era la distancia geográfica la que aproximaba el impacto de dichos costes. Hay que tener en cuenta, sin embargo, que diversos estudios han demostrado que la distancia geográfica no sólo está relacionada con los costes directos de transporte, sino que se vincula también con los costes de información (Loungani et al., 2002), las diferencias en gustos y preferencias del mercado exterior (Blum y Goldfarb, 2006), la mayor o menor similitud cultural con los socios comerciales (Huang, 2007) y también, lógicamente, con diferencias en las dotaciones factoriales (Melitz, 2007). En definitiva, estos trabajos refuerzan la intuición de que detrás del persistente efecto negativo de la distancia sobre el comercio, se articulan otros factores bastante heterogéneos que van más allá de los costes del transporte.

Como ya se ha señalado, el efecto de las variables analizadas sobre el comercio internacional difiere en los distintos países. En esta tesis, se consideran dos grupos de países, desarrollados y en vías de desarrollo, con características económicas y sociales diversas y en los que los factores geográficos también introducen peculiaridades y diferencias. La clasificación de los países en desarrollados y en vías de desarrollo se realiza a partir de sus niveles de renta per capita, por lo que los países con mayores niveles de renta per capita se consideran desarrollados y los países con una renta per capita más baja se consideran en vías de desarrollo.

Sin embargo, no sólo se considera la heterogeneidad entre países, sino también la heterogeneidad entre sectores. Los determinantes de comercio tienen efectos distintos cuando los bienes tienen el carácter de diferenciados, referenciados u homogéneos. La lógica que hay en detrás de esta clasificación fue introducida por Rauch (1999). Los

bienes diferenciados están asociados a mayores costes de búsqueda de información que pueden significar importantes barreras comerciales. Además, este autor diferencia aquellos bienes que se comercian en intercambios organizados de los bienes cuyos "precios de referencia" aparecen citados en publicaciones de comercio, debido a que los primeros centralizan la información de precios. Así, en los capítulos 3 y 4 se considera una muestra de datos agregados, mientras que en el capítulo 5 se introduce una sectorialización de los flujos de comercio.

Los principales resultados que se han obtenido en esta tesis se pueden resumir como sigue. En el capítulo 3, se analiza el efecto de la innovación tecnológica, las similitudes culturales y una serie de factores geográficos sobre el comercio internacional. El modelo a estimar se deriva del marco teórico de Helpman y Krugman (1996). El efecto de las similitudes culturales y de la geografía es el esperado y, en este capítulo, se presta especial atención al efecto de la innovación tecnológica sobre el comercio. Mayores dotaciones de innovación tecnológica fomentan el comercio internacional. Los resultados obtenidos demuestran que los coeficientes beta más altos de las variables incluidas en la ecuación de gravedad son los de los factores tecnológicos, por lo que son estas variables las que tienen una mayor influencia sobre las exportaciones. El coeficiente beta del índice de adelanto tecnológico en el país exportador (TAIi) es de 0,504, mientras que el de la dotación de innovación tecnológica en el país importador (TAIj) es de 0,359. Además la existencia de mayores distancias tecnológicas entre países hace que el comercio entre ellos sea menor, indicando que no solo la distancia geográfica es relevante en la determinación de los flujos comerciales, sino también la distancia tecnológica. Si bien es cierto que el efecto de la distancia geográfica es mucho mayor (el coeficiente beta de la

distancia geográfica es de -0,25 y el de la distancia tecnológica de -0,08). Por último, el avance de la innovación tecnológica, es de gran relevancia a la hora de disminuir las desventajas geográficas de los países. El efecto de la innovación tecnológica sobre las desventajas geográficas se ve reflejado en la obtención de un signo positivo de la interacción entre una variable dicotómica representativa de largas distancias geográficas y la variable de innovación tecnológica, el índice de adelanto tecnológico (TAI). El TAI es un indicador introducido por Naciones Unidas en su *Human Development Report* de 2001. Representa el logro de los países en participar, crear, usar y difundir tecnología, teniendo en cuenta las capacidades humanas como un elemento clave para la consecución del conocimiento que permita y facilite el adelanto tecnológico. Los resultados obtenidos avalan la idea de que con los avances tecnológicos aumenta la transmisión de información, disminuyen los costes de información de los mercados extranjeros y los países se familiarizan más los unos con los otros, comenzando a compartir gustos y a tener preferencias y necesidades similares.

Además, los resultados demuestran que el efecto de la dotación de innovación tecnológica del país exportador sobre el comercio es un 42 por cien superior en los países pobres que en los países ricos, mientras que el efecto de la innovación tecnológica del país importador sobre el comercio es un 23 por cien superior para los países en desarrollo. Estos resultados constatan que los países más pobres se beneficiarían del desarrollo de las nuevas tecnologías al aumentar su participación en el comercio mundial. En este sentido, factores tecnológicos como la inversión en capital humano y la difusión tecnológica disminuirían su marginalización en el marco de las relaciones comerciales internacionales.

En este capítulo se demuestra que los efectos de otros determinantes del comercio internacional también difieren según el nivel de desarrollo de los países. Los factores geográficos y culturales resultan de mayor importancia en la determinación de los flujos de comercio internacional en el caso de los países en desarrollo. El efecto positivo de las dotaciones de infraestructura de transporte sobre el comercio también destaca en el caso de estos países. Por tanto, las desventajas que los países más pobres tienen en el comercio internacional se reducirían a través de adecuadas inversiones en infraestructura, tanto de transporte como tecnológicas. Puesto que una correcta actuación sobre las desventajas geográficas y un adecuado estímulo en las dotaciones de infraestructuras desembocarían en mayores exportaciones por parte de los países más desfavorecidos económicamente y, dado que el comercio es una vía para lograr la disminución de las desigualdades económicas y de los niveles de pobreza, los países más pobres convergerían hacia estadios superiores de desarrollo económico.

En el capítulo 4, se analiza en profundidad el papel de la distancia geográfica en los modelos de gravedad. Varios autores han señalado que la especificación lineal de una ecuación de gravedad conduce a la obtención de coeficientes sesgados (Coe et al., 2002; Croce et al., 2004) y, en este caso, la distancia geográfica reduce los flujos de comercio de manera acusada y su efecto no disminuye en el tiempo como cabría esperar debido a la disminución de los costes de transporte. Esto es lo que se ha denominado en la literatura como "missing globalisation puzzle". Sin embargo, la importancia de los costes de transporte no se ha visto especialmente reducida en las últimas décadas. Por el contrario, su importancia relativa ha aumentado si se compara con la pronunciada caída de otras barreras comerciales, como es el caso de los aranceles.

En este capítulo se comparan los resultados obtenidos en una especificación lineal y en una especificación no lineal de la ecuación de gravedad, puesto que comparativas en la literatura previa (Coe et al., 2002) afirman que la estimación de una especificación no lineal es más apropiada. Se interpreta el resultado económico de la variable distancia, que está lejos de representar únicamente el efecto de los costes de transporte. Cuando el coeficiente de la distancia aumenta a lo largo del tiempo, lo que sucede en el caso de los países en desarrollo, el efecto distancia se interpreta como un aumento de comercio con los socios que están más cerca con respecto a los socios que están geográficamente más alejados. Mientras que cuando el coeficiente de la distancia disminuye a lo largo del tiempo, lo que sucede en el caso de los países desarrollados, se interpreta como un aumento de comercio con los países que están más lejos respecto a los que están más cerca (Buch et al., 2004). Este resultado está en línea con los resultados que ya se obtenían en el capítulo 3, y es que son los países más ricos los que han alcanzado mayores dotaciones tecnológicas y, por tanto, los que más han disminuido los costes asociados a la información imperfecta de los mercados exteriores. Se ha producido un incremento en su familiaridad con los importadores potenciales. En consecuencia, su participación en el comercio mundial ha aumentado. Además, estos resultados prueban que las dotaciones factoriales de los países más ricos son cada vez más similares, de manera que estos países tienden a la especialización en productos manufacturados diferenciados (Melitz, 2007).

Los resultados obtenidos demuestran que no existe un "missing globalisation puzzle" una vez se interpreta de manera adecuada el efecto de la distancia geográfica sobre el comercio. Además, en este capítulo se demuestra que la especificación lineal es superior

a la no lineal, debido a que en la especificación no lineal se han obtenido signos no esperados en varias variables y a que la especificación lineal predice mejor y se obtienen menores valores en el criterio de selección de modelos de Akaike. Por último, se observa un efecto diferencial en la evolución de las variables para los países desarrollados y en vías de desarrollo, constando la importancia de considerar la heterogeneidad de los países cuando se analiza la evolución del efecto que estos factores tienen sobre el comercio.

El análisis de los capítulos 3 y 4 se ha realizado con datos agregados de 65 países que representan más del 75% del comercio internacional. Con el fin de considerar también la heterogeneidad entre sectores, en el capítulo 5, se analizan los determinantes de las exportaciones sectoriales para una muestra de 13 países exportadores y 1189 sectores. Se toma como referencia la clasificación de Rauch (1999) que distingue tres tipos de sectores: diferenciados, con precios referenciados y homogéneos. En el análisis empírico se utilizan dos metodologías: Mínimos Cuadrados Ordinarios (MCO) y Poisson (PPML). PPML es la metodología propuesta por Santos-Silva y Tenreyro (2006) para corregir la heteroscedasticidad y la existencia de ceros en la variable dependiente. Las principales diferencias entre los coeficientes de los resultados obtenidos con ambas metodologías radican en las variables geográficas (distancia geográfica) y las variables socio-culturales (hablar un mismo idioma y compartir lazos coloniales), cuyo efecto estimado es mayor cuando se utiliza MCO.

En este capítulo, se presta especial atención al efecto de los aranceles y de los costes de transporte sobre el comercio y se demuestra la importancia de considerar la heterogeneidad entre sectores puesto que las variables difieren en signo y en significación según se estime el comercio entre países de bienes diferenciados, con precios

referenciados u homogéneos. De nuevo, los resultados indican la importancia de considerar la heterogeneidad entre países con diferentes niveles de desarrollo económico.

Para el caso de los costes de transporte, con las estimaciones por PPML se obtienen mayores coeficientes que por MCO. Lo mismo sucede para el caso de los aranceles. Cuando se estima por PPML la ecuación de gravedad incluyendo los costes de transporte para los distintos tipos de bienes, el resultado sólo converge para el caso de bienes homogéneos, donde se observa que el efecto de esta variable es mucho más elevado que al estimar por MCO. Además, los aranceles tienen un efecto negativo sobre el comercio internacional únicamente para el caso de bienes homogéneos. Este efecto negativo es mucho mayor al estimar por PPML. Por tanto, es en los sectores homogéneos donde las barreras al comercio consideradas juegan un papel más importante.

Los resultados obtenidos en el análisis sectorial prueban que los costes de transporte y las barreras arancelarias son de menor importancia en la determinación de los flujos de comercio internacional que otras "nuevas" variables como la distancia geográfica y la innovación tecnológica, aunque la magnitud de los coeficientes cambia al estimar con las distintas metodologías. Por ejemplo, al estimar por PPML se obtienen coeficientes en la distancia geográfica más bajos, mientras que los coeficientes de las variables de innovación tecnológica, costes de transporte y barreras arancelarias son más altos que al estimar con MCO.

Sin embargo, desde el punto de vista econométrico, tanto la estimación por MCO como por PPML sufren problemas de especificación, aunque de acuerdo con el criterio de selección de modelos de Akaike (es menor para las estimaciones por MCO que para PPML), MCO sería el modelo preferido. Por tanto, no está claro que la estimación

mediante Poisson sea la mejor cuando se utilizan datos sectoriales. Al comparar si la ecuación de gravedad funciona mejor con datos agregados o sectoriales, los resultados demuestran que este modelo funciona mejor cuando se analizan los determinantes de comercio en términos agregados. Además, al distinguir entre sectores, se prueba que una mayor variabilidad del modelo viene explicada para el caso de bienes diferenciados. Futuras investigaciones deberían ir encaminadas en la búsqueda del método más adecuado para estimar modelos de gravedad considerando tanto la heterogeneidad entre países como la heterogeneidad entre sectores.

Las recomendaciones de política económica que se desprenden de este estudio apuntan a que las acciones reguladoras y decisiones estratégicas en el ámbito comercial deberían considerar la especialización internacional de cada país y el nivel de desarrollo en el que se encuentra. La correcta actuación en política tecnológica, geoestratégica, social y económica es la clave para mantener y aumentar la participación de los países más pobres en el comercio mundial. No se debe olvidar que los objetivos y retos a los que se enfrentan los líderes políticos no son los mismos en países ricos y pobres. En cualquier caso, cuando se trata de política comercial se requiere un riguroso análisis de la situación en el que se analice en qué sectores los países tienen mayor presencia internacional, para de este modo tener la posibilidad de explotar esta ventaja comparativa, siempre que sea consistente con su estrategia económica a largo plazo.

Los resultados empíricos de esta tesis demuestran que si un país tiene mayor presencia internacional en el comercio de bienes diferenciados, por un lado, debe de tener en cuenta que, para este tipo de bienes, el efecto negativo de las barreras comerciales, tales como los aranceles y costes de transporte, es menor que en el caso de bienes homogéneos. Por

otro lado, los factores geográficos y socio-culturales afectan crucialmente al comercio de estos bienes debido a que están relacionados con los gustos y preferencias de los consumidores de los países importadores, así como también al conocimiento que se tiene de los mercados de estos países. En las estimaciones por MCO se obtiene un coeficiente de -0,51 en la variable de distancia geográfica cuando se analizan las exportaciones de bienes diferenciados. Hablar un mismo idioma se traduce en un aumento del volumen de comercio del 32 por cien {[exp(0,28)-1]*100}. En este caso, cuando se trata de mantener o aumentar la participación en los mercados internacionales por medio del comercio de bienes diferenciados, políticas que fomenten la innovación tecnológica ayudarían a disminuir la importancia de la distancia geográfica y, en consecuencia, el efecto de la información imperfecta de los mercados exteriores más alejados. La participación en acuerdos de integración regional también contribuiría a un mejor conocimiento de otros mercados, disminuyendo el coste de información incompleta y los costes de búsqueda de información.

Por el contrario, si un país tiene mayor presencia internacional en el comercio de bienes homogéneos y quiere explotar esta ventaja exportadora, debería centrarse en mayor medida en la disminución de las barreras comerciales, tales como los aranceles y los costes de transporte. Las estimaciones por MCO demuestran un efecto menor de la distancia geográfica (-0,22) y hablar un mismo idioma (no significativo) sobre las exportaciones de bienes homogéneos que sobre las exportaciones de bienes diferenciados. En este sentido, la interpretación correcta de la variable distancia geográfica es que los bienes homogéneos se comercian relativamente más con países más alejados.

Los resultados demuestran que un aumento del 10 por cien en las tasas arancelarias disminuye las exportaciones de bienes homogéneos en 1,1 por cien y que un aumento del 10 por cien en los costes de transporte disminuye un 13,8 por cien las exportaciones de este tipo de bienes. Adicionalmente, con las estimaciones con PPML se obtiene que el efecto de las barreras comerciales pudiera ser aún mayor. Una reducción de los aranceles del 10 por cien podría significar un aumento en el volumen exportado del 4,4 por cien al país de destino. En lo referente al efecto que los costes de transporte tienen sobre el comercio, una reducción de los mismos de un 10 por cien se podría ver reflejada en un aumento del volumen exportado del 17 por cien al país de destino.

Estos resultados constatan que los costes de transporte suponen una barrera clave sobre la que se debe actuar. Adecuadas inversiones en infraestructuras de transporte, así como la participación en acuerdos de integración regional, ampliarían la proyección exterior de aquellas economías especializadas en la exportación de bienes homogéneos.

De nuevo, debe resaltarse la necesidad de considerar el nivel de desarrollo económico en el que se encuentran los países a la hora de plantear objetivos alcanzables. Las economías más pobres se ven más afectadas por factores sobre los que es más difícil actuar, es decir, por sus desventajas geográficas y sus características socio-culturales. Si bien es cierto que sobre las desventajas geográficas se puede influir con adecuadas inversiones en infraestructuras de transporte y tecnológicas.

Por último, la toma de decisiones para fomentar las exportaciones de aquellos sectores en los que se tiene ventaja comparativa, va a resultar un factor clave en la participación de los países en lo referente a comercio mundial en las próximas décadas y, en última

instancia, va a ayudar a mayores cotas de equidad económica y a la disminución de los niveles de pobreza de los países más desfavorecidos.

REFERENCES

- Anderson, J. E. (1979), "A theoretical foundation for the gravity equation", *American Economic Review* 69(1), 106-116.
- Anderson, J. E. and Van Wincoop, E. (2003), "Gravity with gravitas: A solution to the border puzzle", *American Economic Review* 93(1), 170-192.
- Anderson, J. E. and Van Wincoop, E. (2004). "Trade Costs", *Journal of Economic Literature* 42(3), 691-751.
- Archibugi, D. and Coco, A. (2004). "A new indicator of technological capabilities for developed and developing countries (ArCo)", *World Development* 32 (4), 629-654.
- Baier, S. L. and Bergstrand, J. H. (2001), "The Growth of World Trade: Tariffs, Transport. Costs, and Income Similarity", *Journal of International Economics* 53(1), 1-27.
- Balassa, B. (1965). "Trade Liberalization and 'Revealed' Comparative Advantage," *Manchester School* 33, 99-123.
- Balassa, B. (1979). "The changing pattern of comparative advantage in manufactured goods", *The Review of Economics and Statistics* 61(2), 259-266.
- Baldwin, R. E, (1979). "Determinants of Trade and Foreign Investment: Further Evidence," *The Review of Economics and Statistics* 61(1), 40-48.
- Bergstrand, J. H. (1985), "The gravity equation in international trade: Some microeconomic foundations and empirical evidence", *The Review of Economics and Statistics* 67(3), 474-481.

- Bergstrand, J. H. (1989), "The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade", *The Review of Economics and Statistics* 71(1), 143-153.
- Biggs, P. (2003), "Information and Telecommunication Technology (ICT) development indices" (Document: WICT-40E). Paper presented at the 3rd World Telecommunication/ICT Indicators Meeting. UNCTAD.
- Black, S. E. and Lynch, L. M. (2004), "What's driving the new economy?: The benefits of workplace innovation", *The Economic Journal* 114 (493), 97-116.
- Blum, B. S. and Goldfarb, A. (2006), "Does the internet defy the law of gravity?", *Journal of International Economics* 70(2), 384-405.
- Bougheas, S., Demetriades, P. O. and Morgenroth, E. (1999), "Infrastructure, transport costs and trade", *Journal of International Economics* 47(1), 169-189.
- Buch, C. M., Kleinert, J. and Toubal, F. (2004), "The distance puzzle: on the interpretation of the distance coefficient in gravity equations", *Economics Letters* 83, 293-298.
- Caballero, M., Coca, P. and Escribano, R. (2002), "La transferencia de tecnología al tejido empresarial valenciano: Diagnóstico de la situación", *Revista Valenciana de Economía y Hacienda* 5, 47-63.
- Calvo, J. L. (2002), "Innovación tecnológica y convergencia regional. ¿Se amplía o se cierra la brecha tecnológica entre las CCAA españolas?", *Economía Industrial* 347, 33-40.
- Caselli, F. and Coleman W. J. (2001), "Cross-country technology diffusion: the case of computers", *American Economic Review* 91(2), 328-335.

- Central Intelligence Agency (CIA), (2003), *The World Factbook.* Retrieved June 17, 2006, from http://www.odci.gov/cia/publications/factbook
- Cheng, I-H. and Wall, H. J. (2005), "Controlling for heterogeneity in gravity models of trade and integration," *Review*, Federal Reserve Bank of St. Louis, 49-63.
- Coca-Castaño, P., Márquez-Ramos, L. and Martínez-Zarzoso, I. (2005), "Infraestructuras, costos de transporte y flujos de comercio", *Revista de Análisis Económico* 20(1), 3-22.
- Coe, D. T., Helpman, E. and Hoffmaister A. W. (1997), "North-South R&D *spillovers*", *The Economic Journal* 107(440), 134-149.
- Coe, D. T., Subramanian, A., Tamirisa, N. T. and Bhavnani, R. (2002), "The missing globalization puzzle", IMF Working Paper No. 02/171.
- Croce, E., Juan-Ramón, V. H. and Zhu, F. (2004), "Performance of Western Hemisphere Trading Blocs: A Cost-Corrected Gravity Approach", IMF Working Paper No. 04/109.
- Cyrus, T. L. (2002), "Income in the gravity model of bilateral trade: Does Endogeneity Matter?", *The International Trade Journal* 16(2), 161-180.
- Davidson, R. and MacKinnon, J. G. (1993), *Estimation and Inference in Econometrics*, New York, Oxford University Press, Inc.
- Deardorff, A. V. (1995), "Determinants of bilateral trade: Does gravity work in a Neo-classical word?", NBER Working Paper 5377.
- Eaton, J. and Kortum, S. (2002), "Technology, geography and trade", *Econometrica* 70(5), 1741-1779.

- Eichengreen, B. and Irwin, D. (1998), "The Role of History in Bilateral Trade Flows." In: Jeffrey A. Frankel, ed., *The Regionalization of the World Economy*, Chicago, The University of Chicago Press.
- European Commission (2005): European Innovation Scoreboard. Retrieved June 17, 2006, from http://www.cordis.lu/innovation-smes/scoreboard/home.html
- EUROSTAT (1999), Répartition régionale de l'emploi dans les secteurs de Haute Technologie. Serie 'Statistiques en Bref'.
- Fagerberg, J. (1997), "Competitiveness, scale and R&D". In: Fagerberg, J., Hansson, P., Lundberg, L. and Melchior, A., eds., *Technology and International Trade*. Cheltenham, UK, Edward Elgar: 38-55.
- Feenstra, R. C. (1998), "Integration of Trade and Disintegration of Production in the Global Economy," *Journal of Economic Perspectives* 12(4), 31-50.
- Feenstra, R. C., Markusen, J. R. and Rose, A. K. (2001), "Using the Gravity Equation to Differentiate among Alternative Theories of Trade", *Canadian Journal of Economics* 34 (2), 430–447.
- Feenstra, R. C., Lipsey, R. E., Deng, H., Ma, A. C. and Mo, H. (2005), "World Trade Flows, 1962-2000". NBER-United Nations Trade Data, NBER Working Paper No. 11040.
- Filippini, C. and Molini, V. (2003), "The determinants of East Asian trade flows: a gravity equation approach", *Journal of Asian Economics* 14(5), 695-711.
- Fink, C., Mattoo, A. and Neagu, I. C. (2005), "Assessing the impact of communication costs on international trade," *Journal of International Economics* 67(2), 428-445.

- Frankel, J. (1997), *Regional Trading Blocs in the Wold Economic System,* Washington, DC: Institute for International Economics.
- Frankel, J. (2000), "Integrating transportation costs and geography into trade analysis". In: Coyle and Ballenger, eds., *Technological changes in the transport sector,* Washington, DC: 5-20.
- Frankel, J., Stein, E. and Wei, S-J. (1995), "Trading Blocs and the Americas: The Natural, the Unnatural and the Supernatural", *Journal of Development Economics* 47(1), 61-95.
- Frankel, J., Stein, E. and Wei, S-J. (1998), "Continental Trading Blocs: Are They Natural or Supernatural?". In: Jeffrey Frankel, ed., *The Regionalisation of the World Economy*. Chicago: University of Chicago Press: 91-113.
- Frankel, J. A. and Romer, D. (1999), "Does trade cause growth?", *American Economic Review* 89(3), 379-399.
- Freund, C. L. and Weinhold, D. (2004), "The effect of the Internet on international trade", *Journal of International Economics* 62(1), 171-189.
- Furman J. L. and Hayes, R. (2004), "Catching up or standing still? National innovative productivity among "follower" countries, 1978-1999", *Research Policy* 33 (9), 1329-1354.
- Gans, J. S. and Stonecash, R. (2002), "The Innovation and Market Structure in General Equilibrium". In: A.D. Woodland, ed., *Economic Theory and International Trade. Essays in Honour of Murray C. Kemp*. UK, Edward Elgar.
- García Castillejo, A. (2002), "El consumo de servicios de telecomunicaciones e Internet por las empresas españolas", *Economía Industrial* 343, 111-130.

- Garman, G., Petersen J., and Gilliard, D. (1998), "Economic integration in the Americas: 1975-1992". *Journal of Applied Business Research* 14(3), 1-12.
- Giuliano, P., Spilimbergo, A. and Tonon, G. (2006), "Genetic, Cultural and Geographical Distances". CEPR Discussion Paper no. 5807. London, Centre for Economic Policy Research. http://www.cepr.org/pubs/dps/DP5807.asp
- Great circle distances between cities (2003). Retrieved June 17, 2006, from http://www.wcrl.ars.usda.gov/cec/java/lat-long.htm
- Grupp, H. and Mogee, M. E. (2004), "Indicators for national science and technology policy: how robust are composite indicators?", *Research Policy* 33 (9), 1373-1384.
- Guo, R. (2004), "How culture influences foreign trade: evidence from the U.S. and China", *The Journal of Socio-Economics* 33 (6), 785-812.
- Gustavsson, P., Hansson, P. and Lundberg, L. (1997), "Technical progress, capital accumulation and changing international competitiveness." In: Fagerberg, J., Hansson, P., Lundberg, L. and Melchior, A., eds., *Technology and International Trade*. Cheltenham, UK, Edward Elgar: 20-37.
- Harrigan, J. (1993), "OECD imports and trade barriers in 1983," *Journal of International Economics* 35(1-2), 91-111
- Harrigan, J. (2001), "Specialization and the Volume of Trade: Do the Data Obey the Laws?", NBER Working Paper No. 8675.
- Haveman, J. and Hummels, D. (2004), "Alternative hypotheses and the volume of trade: the gravity equation and the extent of specialization", *Canadian Journal of Economics/Revue canadienne d'économique* 37 (1), 199-218.

- Helliwell, J. F. (1999), "Language and trade". In *Exploring the economics of language,* edited by Albert Breton, Department of Economics, University of Toronto. http://www.pch.gc.ca/offlangoff/perspectives/english/explorer/page_01.html
- Helpman, E. and Krugman, P. R. (1996), *Market Structure and Foreign Trade. Increasing Returns, Imperfect Competition, and the International Economy,* Cambridge, MA: MIT Press.
- Helpman, E., Melitz, M. and Rubinstein, Y. (2007), "Estimating Trade Flows: Trading Partners and Trading Volumes", NBER Working Paper No. 12927.
- Henderson, D. J. and Millimet, D. L. (2006), "Is gravity linear?", Working Paper Series 2006: 0603, Department of Economics at Binghamton University, New York.
- Huang, R. R., (2007), "Distance and trade: Disentangling unfamiliarity effects and transport cost effects", *European Economic Review* 51(1), 161-181.
- ITR- Internet Traffic Report (ITR), (2004). Retrieved June 17 from http://www.internettrafficreport.com/main.htm
- Keller, W. (2004), "International Technology Diffusion", *Journal of Economic Literature* 42 (3), 752-782.
- Kuznets, S. (1962). "Inventive activity: Problems of definition and measurement". In: Richard R. Nelson (ed.), *The rate and direction of inventive activity: Economic and social factors*, Princenton: Princenton University Press: 19-43.
- Lachenmaier, S. and Wößmann, L. (2006), "Does innovation cause exports? Evidence from exogenous innovation impulses and obstacles using German micro data," *Oxford Economic Papers* 58(2), 317-350.

- Leamer, E. E. (1990), "Latin America as a target of trade barriers erected by the major developed countries in 1983," *Journal of Development Economics* 32(2), 337-368.
- Leamer, E. E. and Levinson, J. (1995), "International Trade Theory: The Evidence". In: G. Grossman and K. Rogoff, eds., *Handbook of International Economics*, vol. 3, Elsevier: 1339-1394.
- Lee, J-W. and Swagel, P. (1997), "Trade Barriers And Trade Flows Across Countries And Industries," *The Review of Economics and Statistics* 79(3), 372-382.
- Limão, N. and Venables, A. J. (2001), "Infrastructure, geographical disadvantage, transport costs and trade", *The World Bank Economic Review* 15, 451-479.
- Loungani, P., Mody, A., and Razin, A. (2002), "The Global Disconnect: The Role of Transactional Distance and Scale Economies in Gravity Equations", *Scottish Journal of Political Economy* 49(5), 526-543.
- Martínez-Zarzoso, I. and Nowak-Lehmann, F. (2003), "Augmented Gravity Model: An empirical application to Mercosur-European Union trade flows", *Journal of Applied Economics* 6 (2), 291-316.
- Melitz, J. (2007), "North, South and distance in the gravity model", *European Economic Review* 51 (4), 971–991
- Moreno, R., Paci, R. and Usai, S. (2005), "Spatial spillovers and innovation activity in European regions", *Environment and Planning A* 37(10), 1793–1812.
- Obstfeld, M., and K. Rogoff (2000), "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?", NBER Working Paper Series, Working Paper 7777.

- OECD (2001). Classification des secteurs et des produits de haute technologie.
- Pöyhönen, P. (1963), "A tentative model for the volume of trade between countries", *Weltwirtschaftliches Archiv* 90, 93-99.
- Rauch, James E. (1999). "Networks versus markets in international trade," *Journal of International Economics* 48(1), 7-35.
- Samuelson, P. A. (1954), "The transfer problem and transport costs", *The Economic Journal* 64, 264-289.
- Samuelson, P. A. (2004), "Where Ricardo and Mill Rebut and Confirm Arguments of Mainstream Economists Supporting Globalization," *Journal of Economic Perspectives* 18(3), 135-146.
- Sánchez, M. P., López, A. Cervantes, M. and Cañibano, C. (2000), *El capital humano en la nueva sociedad del conocimiento*. VI Premio Círculo de Empresarios. Madrid: Círculo de Empresarios.
- Santos-Silva, J. and Tenreyro, S. (2006), "The Log of Gravity," *The Review of Economics and Statistics* 88(4), 641-658.
- Siliverstovs, B. and Schumacher, D. (2006), "To log or not to log, or how to estimate a gravity model?". Paper presented at the ETSG 2007. Vienna.
- Suárez, C., Fernández, I. and García, L. (1996), "Patrón de intercambios y evolución de los flujos de comercio". In: Velarde, J., García Delgado, J. L. and Pedreño, A., dir., *España en la Unión Europea: Balance de un decenio*. Madrid, Editorial Civitas: 183-199.
- Statistics Canada (2001), *World Trade Analyzer*. http://www.statcan.ca/

- Stavins, R. N. and Jaffe, A. B. (1990), "Unintended Impacts of Public Investments on Private Decisions: The Depletion of Forested Wetlands", *American Economic Review* 80(3), 337-352.
- Tang, L. (2006), "What accounts for the growth of trade in differentiated goods: Economic causes or technological imperatives?", *Economics Letters* 91, 204-209.
- Tinbergen, J. (1962), "Shaping the world economy. Suggestions for an international economic policy", The Twentieth Century Fund, New York.
- Torstensson, J. (1996), "Technical Differences and Inter-industry Trade in the Nordic Countries", *Scandinavian Journal of Economics* 98 (1), 93-110.
- UNCTAD (2004), *Review of Maritime Transport 2004,* UNCTAD, Geneva.
- United Nations Development Programme (UNDP), (2001), *Human Development Report,* New York, Oxford University Press.
- Verspagen, B. and Wakelin, K. (1997), "Technology, employment and trade: perspectives on European integration." In: Fagerberg, J., Hansson, P., Lundberg, L. and Melchior, A., eds., *Technology and International Trade*. Cheltenham, UK, Edward Elgar: 56-74.
- Wakelin, K. (1997), *Trade and Innovation. Theory and Evidence*, Cheltenham, UK, Edward Elgar.
- Wolff, E. N. (1997), "Productivity growth and shifting comparative advantage on the industry level". In: Fagerberg, J., Hansson, P., Lundberg, L. and Melchior, A., eds., *Technology and International Trade*. Cheltenham, UK, Edward Elgar: 1-19.
- Wolff, E. N. (2002), "The impact of IT investment on income and wealth inequality in the postwar US economy", *Information Economics and Policy* 14 (2), 233-251.

- Wong, W. K. (2004), "How good are trade and telephone call traffic in bridging income gaps and TFP gaps?", *Journal of International Economics* 64 (2), 441-463.
- World Bank (2001), *World Development Indicators*, Washington, DC.
- World Bank (2005a), *World Development Indicators*, Washington, DC.
- World Bank (2005b), "Data on Trade and Import Barriers". Retrieved June 17, 2006, from http://www.worldbank.org/
- World Economic Forum (WEF), World Bank and INSEAD (2004), *The Global Information Technology Report 2003-2004: Towards an Equitable Information Society*, New York, Oxford University Press.

APPENDIX

Figure A.1. Selected countries.

Algeria
Argentina
Australia
Austria
Belgium-Luxembourg
Bolivia
Brazil
Bulgaria
Canada
Chile
China
Colombia
Costa Rica
Croatia
Cyprus
Czech Republic
Denmark
Dominican Republic
Ecuador
Egypt, Arab Rep.
El Salvador
Finland
France
Germany
Ghana
Greece
Honduras
Hong Kong, China
Iceland
India
Ireland
Israel
Italy
Jamaica
Japan
Kenya
Korea, Rep.
Mexico
Mozambique
Nepal
Netherlands
Nicaragua
Norway
Pakistan
Panama
Paraguay
Peru
Poland
Portugal
Senegal
Singapore
Slovak Republic
South Africa
Spain
Sudan
Sweden
Switzerland
Syrian Arab Republic
Tanzania
Trinidad and Tobago
Turkey
United Kingdom
United States
Uruguay
Venezuela

Table A.1: Variable descriptions and sources of data. Aggregated analysis.

Variable	Description	Source
X_{ij} : Exports from i to j	Nominal value of bilateral exports	Statistics Canada (2001)
Y_i : Exporter's income	Exporter's GDP, PPP (current international $)	World Bank (2001)
Y_j : Importer's income	Importer's GDP, PPP (current international $)	World Bank (2001)
P_i : Exporter's population	Total population in the exporter's market	World Bank (2001)
P_j : Importer's population	Total population in the importer's market	World Bank (2001)
Adj_{ij} : Adjacency dummy	Dummy variable = 1 if the trading partners share a border, 0 otherwise	CIA (2003)
Isl: Island dummy	Dummy variable = 1 if the country is an island, 0 otherwise	CIA (2003)
Land: Landlocked dummy	Dummy variable = 1 if the country is landlocked, 0 otherwise	CIA (2003)
CACM dummy	Dummy variable = 1 if the trading partners are members of CACM, 0 otherwise	
CARICOM dummy	Dummy variable = 1 if the trading partners are members of CARICOM, 0 otherwise	
MERCOSUR dummy	Dummy variable = 1 if the trading partners are members of MERCOSUR, 0 otherwise	
NAFTA dummy	Dummy variable = 1 if the trading partners are members of NAFTA, 0 otherwise	
CAN dummy	Dummy variable = 1 if the trading partners are members of CAN, 0 otherwise	
EU dummy	Dummy variable = 1 if the trading partners are members of European Union, 0 otherwise	
$Dist_{ij}$: Distance	Great circle distances between country capitals of trading partners (km)	Great circle distances between cities (2003)
$Lang_{ij}$ *:* Language dummy	Dummy variable = 1 if the trading partners share the same official language, 0 otherwise.	CIA (2003)
TAI_i : Exporter's TAI	Technological variable	UNDP (2001), author's calculations
TAI_j : Importer's TAI	Technological variable	UNDP (2001), author's calculations
$ArCo_i$: Exporter's ArCo	Technological variable	Archibugi and Coco (2004)
$ArCo_j$: Importer's ArCo	Technological variable	Archibugi and Coco (2004)
Inf_i : Exporter's infrastructure	Transport infrastructure variable	CIA (2003), authors' calculations
Inf_j *:* Importer's infrastructure	Transport infrastructure variable	CIA (2003), authors' calculations

Note: UNDP denotes United Nations Development Programme and CIA denotes Central Intelligence Agency.

Table A.2. The Technology Achievement Index.

Technological Leaders		
1	Finland	0.745
2	United States	0.733
3	Sweden	0.704
4	Japan	0.697
5	Rep. of Korea	0.664
6	Luxembourg	0.634
7	Netherlands	0.628
8	United Kingdom	0.604
9	Singapore	0.595
10	Switzerland	0.595
11	Canada	0.589
12	Australia	0.587
13	Germany	0.581
14	Norway	0.580
15	Ireland	0.564
16	Belgium	0.551
17	New Zealand	0.548
18	Denmark	0.547
19	Austria	0.542
20	Iceland	0.540
21	France	0.534
22	Israel	0.513
Potential Technological Leaders		
23	Spain	0.479
24	Italy	0.470
25	Czech Republic	0.462
26	Hungary	0.461
27	Slovenia	0.456
28	Hong Kong, China	0.453
29	Slovakia	0.444
30	Greece	0.436
31	Portugal	0.418
32	Bulgaria	0.408
33	Poland	0.402
34	Malaysia	0.392
35	Croatia	0.388
36	Cyprus	0.384
37	Mexico	0.383
38	Argentina	0.376
39	Rumania	0.365
40	Turkey	0.355
41	Costa Rica	0.354
42	Chile	0.353
Dynamic Technological Adopters		
43	Uruguay	0.339
44	South Africa	0.335
45	Thailand	0.330
46	Trinidad and Tobago	0.323
47	Panama	0.317
48	Brazil	0.306
49	China	0.293
50	Philippines	0.292
51	Bolivia	0.270
52	Colombia	0.270
53	Peru	0.265
54	Jamaica	0.256
55	Iran	0.253
56	Paraguay	0.248
57	Tunisia	0.248
58	El Salvador	0.248
59	Ecuador	0.247
60	Dominican Republic	0.238
61	Syrian Arab Republic	0.233
62	Egypt	0.228
63	Algeria	0.212
64	Zimbabwe	0.210
65	Indonesia	0.202
66	Honduras	0.199
67	Sri Lanka	0.194
68	India	0.191
Technologically Marginalised		
69	Nicaragua	0.175
70	Pakistan	0.156
71	Senegal	0.148
72	Ghana	0.127
73	Kenya	0.116
74	Nepal	0.070
75	Tanzania	0.066
76	Sudan	0.058
77	Mozambique	0.053

Notes:

Technological Leaders (above 0.5). This group includes countries with a high capability to create and sustain technological innovation.

Potential Technological Leaders (from 0.35 to 0.49). This group includes countries that have invested in all four dimensions, but have been less innovative.

Dynamic Technological Adopters (from 0.19 to 0.34). Countries in this group try to achieve growth in their technology content and in their level of development.

Technologically Marginalised (below 0.19). The last group consists of marginalised countries: many African countries belong to this block. It is difficult for them to gain access even to the oldest technologies and a low technological level is associated to low income levels. The relative position is not particularly meaningful due to the lack of adequate data.

Table A.3. "Beta coefficients" of the variables included in the augmented gravity model. Aggregated analysis.

	Beta coefficients in Model 6	*Beta coefficients in Model 7*
Exporter's income	0.0183443	0.016847
Importer's income	0.0385702	0.037293
Exporter's population	0.4261248	0.4307026
Importer's population	0.3156517	0.3216922
Adjacency dummy	0.0245367	0.0180214
Island dummy	-0.0533542	-0.054391
Landlocked dummy	-0.0967349	-0.0929241
CACM dummy	0.0370647	0.0379439
CARICOM dummy	0.0333055	0.0323905
MERCOSUR dummy	0.0489882	0.0473729
NAFTA dummy	0.0095025	0.0111667
CAN dummy	0.0094735	0.0081441
EU dummy	-0.0172897	-0.0255349
Distance	-0.2706165	-0.2572081
Language dummy	0.1000771	0.0942539
Exporter's TAI	0.5036714	0.5065245
Importer's TAI	0.359052	0.3571144
Technological distance	-	-0.0817619
Exporter's infrastructure	0.1562054	0.1565873
Importer's infrastructure	0.1290454	0.1297312

Table A.4. Importing countries.

	Country	Code		Country	Code		Country	Code		Country	Code
1	Afghanistan	AFG	43	Denmark	DNK	85	Kuwait	KWT	127	Rwanda	RWA
2	Albania	ALB	44	Djibouti	DJI	86	Kyrgyzstan	KGZ	128	Samoa	WSM
3	Algeria	DZA	45	Dominican Rep.	DOM	87	Lao P. Dem. Rep.	LAO	129	Saudi Arabia	SAU
4	Angola	AGO	46	Ecuador	ECU	88	Latvia	LVA	130	Senegal	SEN
5	Argentina	ARG	47	Egypt	EGY	89	Lebanon	LBN	131	Seychelles	SYC
6	Armenia	ARM	48	El Salvador	SLV	90	Liberia	LBR	132	Sierra Leone	SLE
7	Australia	AUS	49	Eq.Guinea	GNQ	91	Libya	LBY	133	Singapore	SGP
8	Austria	AUT	50	Estonia	EST	92	Lithuania	LTU	134	Slovakia	SVK
9	Azerbaijan	AZE	51	Ethiopia	ETH	93	Madagascar	MDG	135	Slovenia	SVN
10	Bahamas	BHS	52	Fiji	FJI	94	Malawi	MWI	136	Somalia	SOM
11	Bahrain	BHR	53	Finland	FIN	95	Malaysia	MYS	137	South Africa	ZAF
12	Bangladesh	BGD	54	France,Monac	FRA	96	Mali	MLI	138	Spain	ESP
13	Barbados	BRB	55	Gabon	GAB	97	Malta	MLT	139	Sri Lanka	LKA
14	Belarus	BLR	56	Gambia	GMB	98	Mauritania	MRT	140	St.Kt-Nev An	KNA
15	Belgium-Lux	BEL	57	Georgia	GEO	99	Mauritius	MUS	141	Sudan	SDN
16	Belize	BLZ	58	Germany	DEU	100	Mexico	MEX	142	Suriname	SUR
17	Benin	BEN	59	Ghana	GHA	101	Mongolia	MNG	143	Sweden	SWE
18	Bermuda	BMU	60	Gibraltar	GIB	102	Morocco	MAR	144	Switz.Liecht	CHE
19	Bolivia	BOL	61	Greece	GRC	103	Mozambique	MOZ	145	Syria	SYR
20	Bosnia Herzg	BIH	62	Greenland	GRL	104	Myanmar	MMR	146	TFYR Macedonia	MKD
21	Brazil	BRA	63	Guatemala	GTM	105	Nepal	NPL	147	Taiwan	TWN
22	Bulgaria	BGR	64	Guinea	GIN	106	Neth.Ant.Aruba	ANT	148	Tajikistan	TJK
23	Burkina Faso	BFA	65	GuineaBissau	GNB	107	Netherlands	NLD	149	Tanzania	TZA
24	Burundi	BDI	66	Guyana	GUY	108	New Calednia	NCL	150	Thailand	THA
25	Cambodia	KHM	67	Haiti	HTI	109	New Zealand	NZL	151	Togo	TGO
26	Cameroon	CMR	68	Honduras	HND	110	Nicaragua	NIC	152	Trinidad Tobago	TTO
27	Canada	CAN	69	Hungary	HUN	111	Niger	NER	153	Tunisia	TUN
28	Cent.Afr.Rep	CAF	70	Iceland	ISL	112	Nigeria	NGA	154	Turkey	TUR
29	Chad	TCD	71	Indonesia	IDN	113	Norway	NOR	155	Turkmenistan	TKM
30	Chile	CHL	72	Iran	IRN	114	Oman	OMN	156	UK	GBR
31	China	CHN	73	Iraq	IRQ	115	Pakistan	PAK	157	USA	USA
32	China HK SAR	HKG	74	Ireland	IRL	116	Panama	PAN	158	Uganda	UGA
33	China MC SAR	MAC	75	Israel	ISR	117	Papua N.Guinea	PNG	159	Ukraine	UKR
34	Colombia	COL	76	Italy	ITA	118	Paraguay	PRY	160	United Arab Em	ARE
35	Congo	COG	77	Jamaica	JAM	119	Peru	PER	161	Uruguay	URY
36	Costa Rica	CRI	78	Japan	JPN	120	Philippines	PHL	162	Uzbekistan	UZB
37	Cote d'Ivoire	CIV	79	Jordan	JOR	121	Poland	POL	163	Venezuela	VEN
38	Croatia	HRV	80	Kazakhstan	KAZ	122	Portugal	PRT	164	Viet Nam	VNM
39	Cuba	CUB	81	Kenya	KEN	123	Qatar	QAT	165	Yemen	YEM
40	Cyprus	CYP	82	Kiribati	KIR	124	Rep Moldova	MDA	166	Zambia	ZMB
41	Czech Rep	CZE	83	Korea D P Rep.	PRK	125	Romania	ROM	167	Zimbabwe	ZWE
42	Dem.Rep.Congo	ZAR	84	Korea Rep.	KOR	126	Russian Fed	RUS			

Exporting countries.

Australia
Bolivia
Brazil
Chile
China
Czech Republic
Germany
Ghana
Japan
South Africa
Spain
United Kingdom
United States

Table A.5. List of 4-digit SITC sectors (conservative classification).

Differentiated sample (694 sectors)

0015	2230	5332	6114	6533	6618	6935	7161	7311	7444	7621	7810
0115	2235	5334	6115	6535	6620	6940	7162	7312	7447	7622	7812
0118	2237	5335	6116	6536	6623	6941	7163	7313	7448	7628	7820
0141	2238	5410	6117	6538	6624	6942	7164	7314	7450	7630	7821
0342	2330	5413	6118	6539	6630	6943	7165	7315	7451	7631	7822
0460	2331	5414	6120	6540	6631	6944	7180	7316	7452	7633	7830
0461	2332	5415	6130	6541	6632	6950	7188	7317	7453	7638	7831
0480	2440	5416	6131	6542	6633	6951	7189	7331	7456	7640	7832
0483	2450	5417	6132	6543	6638	6952	7210	7339	7459	7641	7840
0484	2480	5419	6133	6544	6640	6953	7211	7360	7461	7642	7849
0485	2481	5510	6210	6549	6641	6954	7212	7361	7462	7643	7850
0488	2482	5513	6213	6550	6642	6955	7213	7362	7463	7648	7851
0560	2483	5530	6214	6552	6643	6956	7219	7367	7464	7649	7852
0565	2484	5534	6250	6553	6644	6957	7220	7369	7465	7710	7853
0567	2672	5540	6251	6560	6645	6960	7224	7370	7468	7711	7860
0576	2683	5541	6252	6561	6646	6963	7230	7371	7471	7712	7861
0580	2685	5542	6253	6562	6647	6964	7231	7372	7472	7720	7862
0581	2686	5543	6254	6563	6648	6965	7232	7373	7473	7721	7863
0582	2690	5720	6255	6564	6649	6966	7233	7374	7474	7722	7868
0583	2711	5721	6259	6565	6650	6968	7234	7410	7478	7725	7910
0589	2731	5722	6280	6570	6651	6970	7240	7411	7483	7730	7912
0619	2770	5723	6282	6571	6658	6973	7243	7412	7490	7731	7920
0712	2771	5821	6289	6572	6659	6974	7244	7413	7491	7732	7923
0724	2772	5822	6292	6573	6660	6975	7245	7414	7492	7740	7925
0730	2784	5824	6330	6574	6664	6978	7246	7415	7493	7741	7928
0731	2789	5829	6332	6575	6665	6990	7247	7416	7499	7742	7930
0733	2910	5836	6344	6576	6666	6991	7248	7417	7510	7750	7931
0739	2911	5838	6350	6577	6674	6992	7250	7418	7511	7751	7932
0742	2919	5839	6351	6578	6720	6993	7251	7420	7512	7752	7937
0914	2920	5841	6353	6579	6724	6995	7252	7421	7513	7753	7938
0980	2922	5842	6359	6580	6725	6996	7259	7422	7518	7754	7939
0984	2923	5850	6419	6581	6733	6997	7260	7423	7519	7757	8120
0985	2924	5852	6420	6582	6780	6998	7263	7424	7520	7758	8121
0986	2926	5910	6424	6583	6781	6999	7264	7425	7522	7760	8122
0989	2927	5912	6428	6584	6782	7110	7265	7426	7523	7761	8124
1110	2929	5913	6511	6585	6783	7111	7266	7427	7525	7762	8131
1122	3221	5914	6518	6589	6785	7112	7267	7428	7526	7763	8132
1213	3224	5921	6519	6590	6790	7120	7268	7430	7527	7764	8210
2112	3231	5980	6520	6591	6791	7130	7269	7431	7528	7768	8211
2114	3350	5982	6522	6592	6793	7132	7270	7434	7529	7780	8212
2116	3354	5983	6523	6593	6794	7133	7271	7435	7590	7781	8213
2117	3359	5986	6524	6594	6795	7138	7272	7436	7591	7782	8215
2120	4313	5988	6525	6595	6910	7139	7280	7440	7610	7783	8217
2121	4314	5989	6526	6596	6920	7140	7281	7441	7611	7784	8219
2122	5241	6110	6529	6597	6930	7149	7283	7442	7612	7786	8310
2123	5330	6112	6530	6613	6931	7160	7284	7443	7620	7788	8311

8312	8423	8435	8452	8465	8512	8740	8813	8854	8933	8959	8993
8313	8424	8437	8453	8469	8513	8741	8820	8855	8939	8960	8994
8319	8425	8438	8454	8470	8514	8742	8822	8857	8940	8970	8996
8411	8426	8439	8455	8471	8515	8744	8830	8859	8941	8972	8997
8412	8427	8440	8456	8472	8517	8745	8831	8920	8942	8980	8998
8413	8428	8441	8458	8480	8710	8746	8840	8921	8943	8981	8999
8414	8429	8442	8459	8481	8711	8747	8841	8922	8944	8982	9110
8415	8430	8443	8460	8482	8719	8748	8842	8925	8946	8983	9310
8416	8431	8447	8461	8483	8720	8749	8843	8928	8947	8984	9410
8420	8432	8448	8462	8484	8730	8810	8850	8930	8950	8986	9510
8421	8433	8450	8463	8510	8731	8811	8851	8931	8951	8990	
8422	8434	8451	8464	8511	8732	8812	8852	8932	8952	8991	

Reference-priced sample (349 sectors)

0019	0344	0622	2470	2734	3250	5146	5240	5754	5922	6545	6755
0112	0345	0720	2471	2740	3345	5147	5243	5755	5931	6551	6757
0114	0360	0722	2472	2741	3351	5148	5249	5759	5972	6610	6760
0129	0361	0723	2474	2780	3352	5150	5251	5791	5977	6611	6761
0140	0362	0750	2475	2782	3353	5154	5259	5792	5981	6612	6762
0142	0363	0752	2479	2783	3410	5155	5310	5793	6113	6670	6763
0149	0370	0811	2510	2785	3413	5156	5311	5799	6340	6672	6764
0161	0371	0812	2511	2786	3425	5157	5312	5811	6341	6710	6768
0168	0372	0814	2512	2851	3510	5158	5320	5812	6342	6712	6770
0171	0470	0819	2516	2852	4111	5160	5322	5813	6343	6713	6822
0172	0471	1120	2517	2860	4310	5161	5323	5816	6345	6714	6832
0173	0481	1121	2518	2870	4311	5162	5331	5817	6410	6715	6842
0174	0540	1123	2519	2871	4312	5163	5411	5820	6411	6716	6852
0175	0542	1124	2632	2872	5110	5169	5620	5823	6412	6730	6863
0176	0544	1210	2633	2873	5111	5220	5621	5825	6413	6731	6880
0179	0545	1220	2650	2874	5112	5221	5622	5826	6414	6732	6890
0220	0546	1222	2657	2875	5113	5223	5623	5827	6415	6734	6898
0221	0547	1223	2658	2876	5114	5224	5629	5830	6416	6740	6899
0222	0548	2110	2659	2877	5119	5225	5711	5831	6417	6741	6932
0223	0561	2111	2660	2878	5120	5226	5712	5832	6418	6742	
0224	0564	2119	2665	2879	5121	5230	5719	5833	6421	6743	
0230	0571	2221	2666	2880	5122	5231	5729	5834	6510	6744	
0240	0572	2223	2667	2881	5123	5232	5731	5835	6514	6745	
0250	0574	2224	2670	2882	5124	5233	5739	5837	6515	6746	
0251	0575	2225	2671	2890	5130	5234	5741	5840	6516	6747	
0252	0579	2226	2687	2925	5137	5235	5742	5843	6517	6748	
0253	0586	2232	2712	3211	5138	5236	5743	5849	6521	6749	
0340	0616	2234	2730	3220	5139	5237	5751	5851	6531	6750	
0341	0620	2460	2732	3230	5140	5238	5752	5911	6532	6751	
0343	0621	2462	2733	3232	5145	5239	5753	5920	6534	6753	

Homogeneous sample (146 sectors)

0010	0741	4113
0011	0743	4212
0012	0751	4213
0013	0810	4215
0014	0813	4216
0110	0910	4217
0111	0913	4218
0113	1211	4222
0116	1212	4225
0120	2220	4229
0121	2222	4230
0122	2227	4232
0123	2311	4234
0125	2312	4236
0350	2320	4239
0351	2321	4240
0352	2322	4241
0410	2610	4242
0411	2613	4243
0412	2614	4245
0420	2630	4249
0421	2631	5222
0422	2640	6512
0423	2641	6513
0430	2649	6810
0440	2651	6811
0449	2654	6812
0450	2680	6820
0451	2681	6821
0452	2682	6823
0453	2710	6824
0459	2721	6825
0541	2722	6826
0570	2810	6827
0573	2814	6830
0577	2815	6831
0585	2816	6840
0591	2820	6841
0592	2821	6850
0599	2822	6851
0610	2823	6860
0611	3330	6861
0612	3340	6870
0615	3341	6871
0710	3342	6872
0711	3343	6891
0713	3344	9610
0721	4110	9710
0740	4112	

Table A.6. Revealed Comparative Advantage in the year 2000.

		International Specialisation Index-SICT rev. 2, 4 digit[36]	Rauch classification[37]
		South Africa	
1	2877	MANGANESE ORES AND CONCENTRATES	reference priced
2	6812	PLATINUM AND OTHER METALS OF THE PLATINUM GROUP	homogeneous goods
3	2786	SLAG, DROSS, SCALINGS AND SIMILAR WASTE, N.E.S.	reference priced
4	2516	CHEMICAL WOOD PULP, DISSOLVING GRADES	reference priced
5	6716	FERRO-ALLOYS	reference priced
6	2879	ORES & CONCENTRATES OF OTHER NON-FERROUS BASE METAL	reference priced
7	5721	PROPELLANT POWDERS AND OTHER PREPARED EXPLOSIVES	differentiated goods
8	2890	ORES & CONCENTRATES OF PRECIOUS METALS; WASTE, SCRAP	reference priced
9	2687	SHEEP'S/LAMBS' WOOL/OTHER ANIMAL HAIR, CARDED/COMBED	reference priced
10	2117	SHEEP & LAMB SKINS WITHOUT THE WOOL, RAW (FRESH ETC)	differentiated goods
		Algeria	
1	3413	PETROLEUM GASES AND OTHER GASEOUS HYDROCARBONS	reference priced
2	3414	PETROLEUM GASES AND OTHER GASEOUS HYDROCARBONS N	#N/A
3	3345	LUBRICATING PETROL. OILS & OTHER HEAVY PETROL. OILS	reference priced
4	2440	CORK, NATURAL, RAW & WASTE (INCLUDING BLOCKS/SHEETS)	differentiated goods
5	3341	MOTOR SPIRIT AND OTHER LIGHT OILS	homogeneous goods
6	2713	NATURAL CALCIUM PHOSPHATE., NATURAL ALUMINIUM C. PHOS.	#N/A
7	3344	FUEL OILS, N.E.S	homogeneous goods
8	3342	KEROSENE AND OTHER MEDIUM OILS	homogeneous goods
9	3343	GAS OILS	homogeneous goods
10	3352	MINERAL TARS AND PRODUCTS OF THEIR DISTILLATION	reference priced
		Argentina	
1	742	MATE	differentiated goods
2	4232	SOYA BEAN OIL	homogeneous goods
3	813	OIL-CAKE & OTHER RESIDUES (EXCEPT DREGS)	homogeneous goods
4	4234	GROUNDNUT (PEANUT) OIL	homogeneous goods
5	4236	SUNFLOWER SEED OIL	homogeneous goods
6	115	MEAT OF HORSES, ASSES, ETC., FRESH, CHILLED, FROZEN	differentiated goods
7	616	NATURAL HONEY	reference priced
8	2221	GROUNDNUTS (PEANUTS), GREEN, WHETHER OR NOT SHELLED	reference priced
9	440	MAIZE (CORN), UNMILLED	homogeneous goods
10	412	OTHER WHEAT (INCLUDING SPELT) AND MESLIN, UNMILLED	homogeneous goods
		Australia	
1	2860	ORES AND CONCENTRATES OF URANIUM AND THORIUM	reference priced
2	2681	SHEEP'S OR LAMBS' WOOL, GREASY OR FLEECE-WASHED	homogeneous goods
3	2873	ALUMINIUM ORES AND CONCENTRATES (INCLUDING ALUMINA)	reference priced
4	2682	SHEEP'S OR LAMBS' WOOL, DEGREASED, IN THE MASS	homogeneous goods
5	2223	COTTON SEEDS	reference priced
6	2815	IRON ORE AND CONCENTRATES, NOT AGGLOMERATED	homogeneous goods
7	3222	OTHER COAL, WHETHER/NOT PULVERIZED, NOT AGGLOMERATE	#N/A
8	2874	LEAD ORES AND CONCENTRATES	reference priced
9	2116	SHEEP & LAMB SKINS WITH WOOL ON, RAW (FRESH, SALTED)	differentiated goods
10	2876	TIN ORES AND CONCENTRATES	reference priced

[36] Bold sectors are high-technology sectors, according to OECD (2001) and Eurostat (1999) classification.
[37] Conservative classification. #N/A indicates that this code is not classified by Rauch.

		Austria	
1	6658	ARTICLES MADE OF GLASS, N.E.S	differentiated goods
2	6760	RAILS AND RAILWAY TRACK CONSTRUCTION MATERIAL	reference priced
3	7915	RAIL & TRAMWAY FREIGHT AND MAINTENANCE CARS	#N/A
4	6129	OTHER ARTICLES OF LEATHER OR OF COMPOSITION LEATHER	#N/A
5	1110	NON ALCOHOLIC BEVERAGES, N.E.S.	differentiated goods
6	2671	REGENERATED FIBRES SUITABLE FOR SPINNING	reference priced
7	2734	PEBBLES AND CRUSHED OR BROKEN STONE. GRAVEL, MACADAM	reference priced
8	2481	RAILWAY OR TRAMWAY SLEEPERS (TIES) OF WOOD	differentiated goods
9	7913	RAILWAY & TRAMWAY COACHES, VANS, TRUCKS ETC.	#N/A
10	6631	HAND POLISHING STONES, WHETSTONES, OILSTONES, HONES	differentiated goods
		Belgium-Luxembourg	
1	2651	FLAX & RAMIE, FLAX TOW, RAMIE NOILS, & WASTE OF FLAX	homogeneous goods
2	6595	CARPETS, RUGS ETC. OF MAN-MADE TEXTILE MATERIALS N.E.S.	differentiated goods
3	2771	INDUSTRIAL DIAMONDS, SORTED, WHETHER OR NOT WORKED	differentiated goods
4	6611	QUICKLIME, SLAKED LIME AND HYDRAULIC LIME	reference priced
5	6539	PILE & CHENILLE FABRICS, WOVEN OF MAN-MADE FIBRES	differentiated goods
6	4241	LINSEED OIL	homogeneous goods
7	6594	CARPETS, CARPETING, RUGS, MATS & MATTING, OF WOOL ETC.	differentiated goods
8	6672	DIAMONDS, UNWORKED. CUT/OTHERWISE WORKED. NOT MOUNTED/SET	reference priced
9	6852	LEAD AND LEAD ALLOYS, WORKED	reference priced
10	5835	COPOLYMERS OF VINYL CHLORIDE AND VINYL ACETATE	reference priced
		Bolivia	
1	2876	TIN ORES AND CONCENTRATES	reference priced
2	6871	TIN AND TIN ALLOYS, UNWROUGHT	homogeneous goods
3	2239	FLOURS OR MEALS/OIL SEEDS/OLEAG. FRUIT NON DEFATTED	#N/A
4	2874	LEAD ORES AND CONCENTRATES	reference priced
5	2875	ZINC ORES AND CONCENTRATES	reference priced
6	4232	SOYA BEAN OIL	homogeneous goods
7	813	OIL-CAKE & OTHER RESIDUES (EXCEPT DREGS)	homogeneous goods
8	914	MARGARINE, IMITATION LARD & OTHER PREPARED EDIBLE FATS	differentiated goods
9	577	EDIBLE NUTS (EXCL. NUTS USED FOR THE EXTRACT. OF OIL)	homogeneous goods
10	4236	SUNFLOWER SEED OIL	homogeneous goods
		Brazil	
1	742	MATE	differentiated goods
2	4314	WAXES OF ANIMAL OR VEGETABLE ORIGIN	differentiated goods
3	2816	IRON ORE AGGLOMERATES (SINTERS, PELLETS, BRIQUETTES)	homogeneous goods
4	2654	SISAL & OTHER FIBRES OF AGAVE FAMILY, RAW OR PROCESSED.	homogeneous goods
5	2815	IRON ORE AND CONCENTRATES, NOT AGGLOMERATED	homogeneous goods
6	6712	PIG IRON, CAST IRON AND SPIEGELEISEN, IN PIGS, BLOCKS	reference priced
7	585	JUICES; FRUIT & VEGETABLES (INCL. GRAPE MUST) UNFERMENTED	homogeneous goods
8	813	OIL-CAKE & OTHER RESIDUES (EXCEPT DREGS)	homogeneous goods
9	7923	**AIRCRAFT NOT EXCEEDING AN UNLADEN WEIGHT OF 15000 KG**	differentiated goods
10	2222	SOYA BEANS	homogeneous goods
		Bulgaria	
1	1211	TOBACCO, NOT STRIPPED	homogeneous goods
2	5622	MINERAL OR CHEMICAL FERTILISERS, PHOSPHATIC	reference priced
3	2450	FUEL WOOD (EXCLUDING WOOD WASTE) AND WOOD CHARCOAL	differentiated goods
4	6821	COPPER AND COPPER ALLOYS, REFINED OR NOT, UNWROUGHT	homogeneous goods
5	6851	LEAD AND LEAD ALLOYS, UNWROUGHT	homogeneous goods

6	6861	ZINC AND ZINC ALLOYS, UNWROUGHT	homogeneous goods
7	2238	OIL SEEDS AND OLEAGINOUS FRUIT. N.E.S.	differentiated goods
8	8122	SINKS, WASH BASINS, BIDETS, WATER CLOSET PANS, ETC	differentiated goods
9	3510	ELECTRIC CURRENT	reference priced
10	2924	PLANTS, SEEDS, FRUIT USED IN PERFUMERY, PHARMACY	differentiated goods
		Canada	
1	9610	COIN (OTHER THAN GOLD) NOT BEING LEGAL TENDER	homogeneous goods
2	2234	LINSEED	reference priced
3	2519	OTHER CELLULOSIC PULPS	reference priced
4	452	OATS, UNMILLED	homogeneous goods
5	6411	NEWSPRINT	reference priced
6	2512	MECHANICAL WOOD PULP	reference priced
7	2482	WOOD OF CONIFEROUS SPECIES, SAWN, PLANED, TONGUED ETC.	differentiated goods
8	2226	RAPE AND COLZA SEEDS	reference priced
9	7928	**AIRCRAFT, N.E.S. BALLOONS, GLIDERS ETC AND EQUIPMENT**	differentiated goods
10	411	DURUM WHEAT, UNMILLED	homogeneous goods
		Chile	
1	2712	SODIUM NITRATE, NATURAL. CONTAINING <16.3% OF NITROGEN	reference priced
2	2871	COPPER ORES & CONCENTRATES; COPPER MATTE	reference priced
3	6821	COPPER AND COPPER ALLOYS, REFINED OR NOT, UNWROUGHT	homogeneous goods
4	575	GRAPES, FRESH OR DRIED	reference priced
5	343	FISH FILLETS, FRESH OR CHILLED	reference priced
6	814	FLOURS	reference priced
7	574	APPLES, FRESH	reference priced
8	2460	PULPWOOD (INCLUDING CHIPS AND WOOD WASTE)	reference priced
9	579	FRUIT, FRESH OR DRIED, N.E.S.	reference priced
10	342	FISH, FROZEN (EXCLUDING FILLETS)	differentiated goods
		China	
1	2613	RAW SILK (NOT THROWN)	homogeneous goods
2	8994	**UMBRELLAS, PARASOLS, WALKING STICKS, PARTS**	differentiated goods
3	5723	PYROTECHNIC ARTICLES:(FIREWORKS, RAILWAY FOG ETC.)	differentiated goods
4	7622	RADIO-BROADCAST RECEIVERS PORTABLE, INCL. SOUND REC.	differentiated goods
5	6597	PLAITS AND SIMILAR PRODUCTS OF PLAITING MATERIALS	differentiated goods
6	8999	**MANUFACTURED GOODS, N.E.S.**	differentiated goods
7	8941	BABY CARRIAGES AND PARTS	differentiated goods
8	8942	CHILDREN'S TOYS, INDOOR GAMES, ETC.	differentiated goods
9	6576	HAT SHAPES, HAT-FORMS, HAT BODIES AND HOODS	differentiated goods
10	2614	SILK WORM COCOONS SUITABLE FOR REELING & SILK WASTE	homogeneous goods
		Colombia	
1	573	BANANAS, FRESH OR DRIED	homogeneous goods
2	711	COFFEE, WHETHER OR NOT ROASTED OR FREED OF CAFFEINE	homogeneous goods
3	2927	CUT FLOWERS AND FOLIAGE	differentiated goods
4	3231	BRIOUET. OVOIDS & SIMILAR SOLID FUELS, OF COAL PEAT LIGNITE	differentiated goods
5	3221	ANTHRACITE, WHETHER/NOT PULVERIZED, NOT AGGLOMERATE	differentiated goods
6	6673	OTHER PRECIOUS & SEMI-PRECIOUS STONES, UNWORKED, CUT ETC	#N/A
7	712	EXTRACTS, ESSENCES/CONCENTRATE OF COFFEE & CHICORY	differentiated goods
8	3222	OTHER COAL, WHETHER/NOT PULVERIZED, NOT AGGLOMERATE	#N/A
9	2119	HIDES AND SKINS, N.E.S WASTE AND USED LEATHER	reference priced
10	611	SUGARS, BEET AND CANE, RAW, SOLID	homogeneous goods
		Costa Rica	

1	573	BANANAS, FRESH OR DRIED	homogeneous goods
2	2232	PALM NUTS AND PALM KERNELS	reference priced
3	548	VEGETABLE PRODUCTS, ROOTS & TUBERS, FOR HUMAN FOOD	reference priced
4	579	FRUIT, FRESH OR DRIED, N.E.S.	reference priced
5	711	COFFEE, WHETHER OR NOT ROASTED OR FREED OF CAFFEINE	homogeneous goods
6	2927	CUT FLOWERS AND FOLIAGE	differentiated goods
7	8442	UNDER GARMENTS, EXCL. SHIRTS OF TEXTILE FABRICS	differentiated goods
8	589	FRUIT OTHERWISE PREPARED OR PRESERVED, N.E.S.	differentiated goods
9	2926	BULBS, TUBERS & RHIZOMES OF FLOWERING OR OF FOLIAGE	differentiated goods
10	343	FISH FILLETS, FRESH OR CHILLED	reference priced
		Croatia	
1	8424	JACKETS, BLAZERS OF TEXTILE FABRICS	differentiated goods
2	2734	PEBBLES AND CRUSHED OR BROKEN STONE. GRAVEL, MACADAM	reference priced
3	2512	MECHANICAL WOOD PULP	reference priced
4	5413	**ANTIBIOTICS N.E.S., NOT INCL. IN 541.7**	differentiated goods
5	2483	WOOD OF NON-CONIFEROUS SPECIES, SAWN, PLANED, TONGUED	differentiated goods
6	8422	SUITS, MEN'S, OF TEXTILE FABRICS	differentiated goods
7	6123	PARTS OF FOOTWEAR	#N/A
8	6341	WOOD SAWN LENGTHWISE, SLICED/PEELED, BUT NOT PREPARED	reference priced
9	5113	HALOGENATED DERIVATIVES OF HYDROCARBONS	reference priced
10	6612	PORTLAND CEMENT, CIMENT FONDU, SLAG CEMENT ETC.	reference priced
		Cyprus	
1	541	POTATOES	homogeneous goods
2	2114	GOAT & KID SKINS, RAW (FRESH, SALTED, DRIED, PICKLED)	differentiated goods
3	572	OTHER CITRUS FRUIT, FRESH OR DRIED	reference priced
4	6724	PUDDLED BARS AND PILINGS; INGOTS, BLOCKS, LUMPS ETC.	differentiated goods
5	571	ORANGES, MANDARINS, CLEMENTINES AND OTHER CITRUS	reference priced
6	7932	SHIPS, BOATS AND OTHER VESSELS	differentiated goods
7	6612	PORTLAND CEMENT, CIMENT FONDU, SLAG CEMENT ETC.	reference priced
8	2732	GYPSUM, PLASTERS, LIMESTONE FLUX & CALCAREOUS STONE	reference priced
9	548	VEGETABLE PRODUCTS, ROOTS & TUBERS, FOR HUMAN FOOD	reference priced
10	8933	ORNAMENTAL ART. AND OBJECTS OF MAT. OF DIV. 58	differentiated goods
		Denmark	
1	2120	FURSKINS, RAW (INCLUDING ASTRAKHAN, CARACUL, ETC.)	differentiated goods
2	113	MEAT OF SWINE, FRESH, CHILLED OR FROZEN	homogeneous goods
3	121	BACON, HAM & OTHER DRIED, SALTED, SMOKED MEAT OF SWINE.	homogeneous goods
4	5169	ORGANIC CHEMICALS, N.E.S	reference priced
5	7213	DAIRY MACHINERY AND PARTS	differentiated goods
6	350	FISH, DRIED, SALTED OR IN BRINE; SMOKED FISH	homogeneous goods
7	343	FISH FILLETS, FRESH OR CHILLED	reference priced
8	4111	FATS AND OILS OF FISH AND MARINE MAMMALS	reference priced
9	4312	ANIMAL/VEGETABLE OILS & FATS, WHOLLY/PARTLY HYDROGENATED	reference priced
10	240	CHEESE AND CURD	reference priced
		Dominican Republic	
1	1221	CIGARS AND CHEROOTS; CIGARILLOS	#N/A
2	8423	TROUSERS, BREECHES ETC. OF TEXTILE FABRICS	differentiated goods
3	6716	FERRO-ALLOYS	reference priced
4	8465	CORSETS, BRASSIERES, SUSPENDERS AND THE LIKE	differentiated goods
5	8442	UNDER GARMENTS, EXCLUDING SHIRTS, OF TEXTILE FABRICS	differentiated goods
6	6123	PARTS OF FOOTWEAR	#N/A

7	8424	JACKETS, BLAZERS OF TEXTILE FABRICS	differentiated goods
8	615	MOLASSES, WHETHER OR NOT DECOLOURISED	homogeneous goods
9	1211	TOBACCO, NOT STRIPPED	homogeneous goods
10	8462	UNDER GARMENTS, KNITTED OF COTTON	differentiated goods
		Ecuador	
1	2655	MANILA HEMP, RAW OR PROCESSED, NOT SPUN; TOW & WASTE	#N/A
2	573	BANANAS, FRESH OR DRIED	homogeneous goods
3	2927	CUT FLOWERS AND FOLIAGE	differentiated goods
4	371	FISH, PREPARED OR PRESERVED, N.E.S. INCLUDING CAVIAR	reference priced
5	6576	HAT SHAPES, HAT-FORMS, HAT BODIES AND HOODS	differentiated goods
6	721	COCOA BEANS, WHOLE OR BROKEN, RAW OR ROASTED	homogeneous goods
7	723	COCOA BUTTER AND COCOA PASTE	reference priced
8	360	CRUSTACEANS AND MOLLUSCS, FRESH, CHILLED, FROZEN ETC	reference priced
9	343	FISH FILLETS, FRESH OR CHILLED	reference priced
10	712	EXTRACTS, ESSENCES/CONCENTRATE OF COFFEE & CHICORY	differentiated goods
		Egypt	
1	615	MOLASSES, WHETHER OR NOT DECOLOURISED	homogeneous goods
2	2652	TRUE HEMP, RAW OR PROCESSED, NOT SPUN; TOW AND WASTE	#N/A
3	2651	FLAX & RAMIE, FLAX TOW, RAMIE NOILS, & WASTE OF FLAX	homogeneous goods
4	2731	BUILDING AND MONUMENTAL STONE NOT FURTHER WORKED	differentiated goods
5	2631	COTTON (OTHER THAN LINTERS), NOT CARDED OR COMBED	homogeneous goods
6	541	POTATOES	homogeneous goods
7	3232	COKE AND SEMI-COKE OF COAL OF LIGNITE OR OF PEAT	reference priced
8	6513	COTTON YARN	homogeneous goods
9	7933	SHIPS, BOATS AND OTHER VESSELS FOR BREAKING UP	#N/A
10	6595	CARPETS, RUGS ETC. OF MAN-MADE TEXTILE MATERIALS NES	differentiated goods
		Slovak Republic	
1	6745	SHEETS & PLATES, RLD. THICKNESS. 3MM TO 4,75MM IRN/STL.	reference priced
2	7751	HOUSEHOLD TYPE LAUNDRY EQUIPMENT	differentiated goods
3	7911	RAIL LOCOMOTIVES, ELECTRIC	#N/A
4	8424	JACKETS, BLAZERS OF TEXTILE FABRICS	differentiated goods
5	7915	RAIL & TRAMWAY FREIGHT AND MAINTENANCE CARS	#N/A
6	482	MALT, ROASTED OR NOT (INCLUDING MALT FLOUR)	#N/A
7	6747	TINNED SHEETS AND PLATES OF STEEL	reference priced
8	6623	REFRACTORY BRICKS & OTHER REFRACT. CONSTRUCTION MATERIAL	differentiated goods
9	6519	YARN OF TEXTILE FIBRES, N.E.S, INCLUDING YARN OF GLASS FIBRE	differentiated goods
10	6611	QUICKLIME, SLAKED LIME AND HYDRAULIC LIME	reference priced
		Finland	
1	2742	IRON PYRITES, UNROASTED	#N/A
2	2814	ROASTED IRON PYRITES, WHETHER OR NOT AGGLOMERATED	homogeneous goods
3	2120	FURSKINS, RAW (INCLUDING ASTRAKHAN, CARACUL, ETC.)	differentiated goods
4	6412	PRINTING PAPER & WRITING PAPER, IN ROLLS OR SHEETS	reference priced
5	6415	PAPER AND PAPERBOARD, IN ROLLS OR SHEETS, N.E.S.	reference priced
6	7251	MACH. FOR MAK./FINIS. CELLUL. PULP, PAPER, PAPERBOARD	differentiated goods
7	7259	PARTS OF THE MACH. OF 725--	differentiated goods
8	5849	OTHER CHEMICAL DERIVATIVES OF CELLULOSE	reference priced
9	6418	PAPER & PAPERBOARD, IMPREGNATED COAT. SURFACE-COLOURED	reference priced
10	7111	STEAM & OTHER VAPOUR GENERATING BOILERS	differentiated goods
		France, Monaco	
1	6352	CASKS, BARRELS, VATS, TUBS, BUCKETS & OTHER COOPERS' PRODUCTS	#N/A

2	2651	FLAX & RAMIE, FLAX TOW, RAMIE NOILS, & WASTE OF FLAX	homogeneous goods
3	1121	WINE OF FRESH GRAPES (INCLUDING GRAPE MUST)	reference priced
4	2652	TRUE HEMP, RAW OR PROCESSED, NOT SPUN; TOW AND WASTE	#N/A
5	7924	**AIRCRAFT EXCEEDING AN UNLADEN WEIGHT OF 15000 KG**	#N/A
6	7914	RAILWAY & TRAMWAY PASSENGER COACHES & LUGGAGE VAN	#N/A
7	5530	PERFUMERY, COSMETICS AND TOILET PREPARATIONS	differentiated goods
8	11	ANIMALS OF THE BOVINE SPECIES, INCL. BUFFALOES, LIVE	homogeneous goods
9	5842	CELLULOSE NITRATES	differentiated goods
10	7911	RAIL LOCOMOTIVES, ELECTRIC	#N/A
		Germany	
1	451	RYE, UNMILLED	homogeneous goods
2	7264	PRINTING PRESSES	differentiated goods
3	7753	DISH WASHING MACHINES OF HOUSEHOLD TYPE	differentiated goods
4	3231	BRIOUET. OVOIDS & SIMILAR SOLID FUELS, OF COAL PEAT LIGNITE	differentiated goods
5	9310	SPECIAL TRANSACTIONS & COMMODITIES, NOT CLASSIFIED TO KIND	differentiated goods
6	7233	ROAD ROLLERS, MECHANICALLY PROPELLED	differentiated goods
7	7822	SPECIAL PURPOSE MOTOR LORRIES AND VANS	differentiated goods
8	5837	POLYVINYL ACETATE	reference priced
9	6591	LINOLEUM AND SIMILAR FLOOR COVERINGS	differentiated goods
10	7421	RECIPROCATING PUMPS, OTHER THAN 742.81	differentiated goods
		Ghana	
1	721	COCOA BEANS, WHOLE OR BROKEN, RAW OR ROASTED	homogeneous goods
2	2877	MANGANESE ORES AND CONCENTRATES	reference priced
3	723	COCOA BUTTER AND COCOA PASTE	reference priced
4	6341	WOOD SAWN LENGTHWISE, SLICED/PEELED, BUT NOT PREPARED.	reference priced
5	2771	INDUSTRIAL DIAMONDS, SORTED, WHETHER OR NOT WORKED	differentiated goods
6	371	FISH, PREPARED OR PRESERVED, N.E.S. INCLUDING CAVIAR	reference priced
7	2483	WOOD OF NON-CONIFEROUS SPECIES, SAWN, PLANED, TONGUED	differentiated goods
8	2659	VEGETABLE TEXTILE FIBRES, N.E.S. AND WASTE	reference priced
9	2223	COTTON SEEDS	reference priced
10	548	VEGETABLE PRODUCTS, ROOTS & TUBERS FOR HUMAN FOOD	reference priced
		Greece	
1	2114	GOAT & KID SKINS, RAW (FRESH, SALTED, DRIED, PICKLED)	differentiated goods
2	1211	TOBACCO, NOT STRIPPED	homogeneous goods
3	8483	FUR CLOTHING, ARTICLES MADE OF FURSKINS	differentiated goods
4	4235	OLIVE OIL	#N/A
5	2223	COTTON SEEDS	reference priced
6	2633	COTTON WASTE (INCLUDING PULLED OR GARNETTED RAGS)	reference priced
7	576	FIGS, FRESH OR DRIED	differentiated goods
8	4233	COTTON SEED OIL	#N/A
9	589	FRUIT OTHERWISE PREPARED OR PRESERVED, N. E.S.	differentiated goods
10	575	GRAPES, FRESH OR DRIED	reference priced
		China Hong Kong SAR	
1	6671	PEARLS, UNWORKED/WORKED, NOT MOUNTED, SET OR STRUNG	#N/A
2	6673	OTHER PRECIOUS & SEMI-PRECIOUS STONES, UNWORKED CUT ETC	#N/A
3	8435	BLOUSES OF TEXTILE FABRICS	differentiated goods
4	8851	WATCHES, WATCH MOVEMENTS AND CASES	differentiated goods
5	8451	JERSEYS, PULLOVERS, TWINSETS, CARDIGANS, KNITTED	differentiated goods
6	8973	JEWELLERY OF GOLD, SILVER OR PLATINUM	#N/A
7	6515	YARN CONTAINING 85% BY WGT. OF SYNTH. FIBRES, FOR SALE	reference priced

8	8441	SHIRTS, MEN'S, OF TEXTILE FABRICS	differentiated goods
9	8443	UNDER GARMENTS, WOMEN'S, OF TEXTILE FABRICS	differentiated goods
10	8842	**SPECTACLES AND SPECTACLE FRAMES**	differentiated goods
		Honduras	
1	1221	CIGARS AND CHEROOTS; CIGARILLOS	#N/A
2	8462	UNDER GARMENTS, KNITTED, OF COTTON	differentiated goods
3	8463	UNDER GARMENTS, KNITTED, OF SYNTHETIC FIBRES	differentiated goods
4	711	COFFEE, WHETHER OR NOT ROASTED OR FREED OF CAFFEINE	homogeneous goods
5	573	BANANAS, FRESH OR DRIED	homogeneous goods
6	8465	CORSETS, BRASSIERES, SUSPENDERS AND THE LIKE	differentiated goods
7	8442	UNDER GARMENTS, EXCL. SHIRTS, OF TEXTILE FABRICS	differentiated goods
8	8451	JERSEYS, PULLOVERS, TWINSETS, CARDIGANS, KNITTED	differentiated goods
9	8441	SHIRTS, MEN'S, OF TEXTILE FABRICS	differentiated goods
10	8423	TROUSERS, BREECHES ETC. OF TEXTILE FABRICS	differentiated goods
		Iceland	
1	350	FISH, DRIED, SALTED OR IN BRINE; SMOKED FISH	homogeneous goods
2	344	FISH FILLETS, FROZEN	reference priced
3	4111	FATS AND OILS OF FISH AND MARINE MAMMALS	reference priced
4	343	FISH FILLETS, FRESH OR CHILLED	reference priced
5	814	FLOURS	reference priced
6	372	CRUSTACEANS AND MOLLUSCS, PREPARED OR PRESERVED	reference priced
7	2814	ROASTED IRON PYRITES, WHETHER OR NOT AGGLOMERATED	homogeneous goods
8	342	FISH, FROZEN (EXCLUDING FILLETS)	differentiated goods
9	6841	ALUMINIUM AND ALUMINIUM ALLOYS, UNWROUGHT	homogeneous goods
10	341	FISH, FRESH (LIVE/DEAD)OR CHILLED, EXCL. FILLETS	reference priced
		India	
1	2235	CASTOR OIL SEEDS	differentiated goods
2	4245	CASTOR OIL	homogeneous goods
3	6545	FABRICS, WOVEN, OF JUTE OR OF OTHER TEXTILE BAST FIB	reference priced
4	6593	KELEM, SCHUMACKS AND KARAMANIE RUGS AND THE LIKE	differentiated goods
5	6592	CARPETS, CARPETING AND RUGS, KNOTTED	differentiated goods
6	421	RICE IN THE HUSK OR HUSKED, BUT NOT FURTHER PREPARED.	homogeneous goods
7	6596	CARPETS, RUGS ETC. OF OTHER TEXTILE MATERIALS N.E.S.	differentiated goods
8	741	TEA	homogeneous goods
9	2731	BUILDING AND MONUMENTAL STONE NOT FURTHER WORKED	differentiated goods
10	6541	FABRICS, WOVEN, OF SILK, OF NOIL OR OTHER WASTE SILK	differentiated goods
		Ireland	
1	5148	OTHER NITROGEN-FUNCTION COMPOUNDS	reference priced
2	2772	NATURAL ABRASIVES, N.E.S.	differentiated goods
3	5156	HETEROCYCLIC COMPOUNDS; NUCLEIC ACIDS	reference priced
4	7521	**ANALOGUE & HYBRID DATA PROCESSING MACHINES**	#N/A
5	5155	OTHER ORGANO-INORGANIC COMPOUNDS	reference priced
6	5514	MIXTURES OF TWO OR MORE ODORIFEROUS SUBSTANCES	#N/A
7	5413	**ANTIBIOTICS N.E.S., NOT INCL. IN 541.7**	differentiated goods
8	5841	REGENERATED CELLULOSE	differentiated goods
9	230	BUTTER	reference priced
10	15	HORSES, ASSES, MULES AND HINNIES, LIVE	differentiated goods
		Israel	
1	6672	DIAMONDS, UNWORKED CUT/OTHERWISE WORKED. NOT MOUNTED/SET	reference priced
2	5622	MINERAL OR CHEMICAL FERTILISERS, PHOSPHATIC	reference priced

3	7263	MACH., APPAR., ACCESS. FOR TYPE FOUNDING OR SETTING	differentiated goods
4	7922	**AIRCRAFT NOT EXCEEDING AN UNLADEN WEIGHT 2000 KG**	#N/A
5	5623	MINERAL OR CHEMICAL FERTILISERS POTASSIC	reference priced
6	2713	NATURAL CALCIUM PHOSPHATE, NATURAL. ALUMINIUM C. PHOS.	#N/A
7	6891	TUNGSTEN, MOLYBDENUM, TANTALUM & MAGNESIUM, UNWROUGHT	homogeneous goods
8	572	OTHER CITRUS FRUIT, FRESH OR DRIED	reference priced
9	5914	**DISINFECT., ANTI-SPROUTING PROD. ETC. PACKED FOR SALE**	differentiated goods
10	5123	PHENOLS & PHEN.-ALCO.& THEIR HALOGENATED DERIVATIVES	reference priced
		Italy	
1	6543	FABRICS, WOVEN, OF WOOL OR OF FINE ANIMAL HAIR N.E.S	differentiated goods
2	7248	MACH. FOR PREPARING, TANNING OR WORKING HIDES	differentiated goods
3	6624	NON-REFRACT. CERAMIC BRICKS, TILES, PIPES & SIMILAR PRODUCTS.	differentiated goods
4	483	MACARONI, SPAGHETTI AND SIMILAR PRODUCTS	differentiated goods
5	6542	FABRICS, WOVEN, CONTAIN. 85% OF WOOL/FINE ANIMAL HAIR	differentiated goods
6	6118	LEATHER, SPECIALLY DRESSED OR FINISHED	differentiated goods
7	4235	OLIVE OIL	#N/A
8	6613	BUILDING & MONUMENTAL STONE, WORKED,& ARTICLES. THEREOF	differentiated goods
9	6115	SHEEP AND LAMB SKIN LEATHER	differentiated goods
10	6112	COMPOSITION LEATHER FIBRE, IN SLABS ETC., SHEETS, ETC	differentiated goods
		Jamaica	
1	2873	ALUMINIUM ORES AND CONCENTRATES (INCLUDING ALUMINA)	reference priced
2	6623	REFRACTORY BRICKS & OTHER REFRACT. CONSTRUCT. MATERIALS	differentiated goods
3	8463	UNDER GARMENTS, KNITTED, OF SYNTHETIC FIBRES	differentiated goods
4	611	SUGARS, BEET AND CANE, RAW, SOLID	homogeneous goods
5	548	VEGETABLE PRODUCTS, ROOTS & TUBERS, FOR HUMAN FOOD	reference priced
6	1221	CIGARS AND CHEROOTS; CIGARILLOS	#N/A
7	7932	SHIPS, BOATS AND OTHER VESSELS	differentiated goods
8	8442	UNDER GARMENTS, EXCL. SHIRTS, OF TEXTILE FABRICS	differentiated goods
9	8462	UNDER GARMENTS, KNITTED, OF COTTON	differentiated goods
10	573	BANANAS, FRESH OR DRIED	homogeneous goods
		Japan	
1	7851	MOTORCYCLES, AUTO-CYCLES AND CYCLES WITH AN AUX. MOTOR	differentiated goods
2	7933	SHIPS, BOATS AND OTHER VESSELS FOR BREAKING UP	#N/A
3	6253	TYRES, PNEUMATIC, NEW, OF A KIND USED ON AIRCRAFT	differentiated goods
4	8821	CHEMICAL PRODUCTS & FLASHLIGHT MATERIALS	#N/A
5	8813	**PHOTOGRAPHIC & CINEMATOGRAPHIC APPARATUS N.E.S**	differentiated goods
6	7133	INT. COMBUSTION PISTON ENGINES FOR MARINE PROPULSION.	differentiated goods
7	7638	**OTHER SOUND RECORDERS AND REPRODUCERS**	differentiated goods
8	7591	**PARTS OF AND ACCESSORIES SUITABLE FOR 751.1-,751.8**	differentiated goods
9	7367	**OTHER MACH.-TOOLS FOR WORKING METAL OR MET. CARBIDE**	differentiated goods
10	7243	SEWING MACHINES, FURNITURE FOR SEWING MACH.& PARTS	differentiated goods
		Kenya	
1	2654	SISAL & OTHER FIBRES OF AGAVE FAMILY, RAW OR PROCESSED.	homogeneous goods
2	741	TEA	homogeneous goods
3	2114	GOAT & KID SKINS, RAW (FRESH, SALTED, DRIED, PICKLED)	differentiated goods
4	2927	CUT FLOWERS AND FOLIAGE	differentiated goods
5	2112	CALF SKINS, RAW (FRESH, SALTED, DRIED, PICKLED/LIMED)	differentiated goods
6	711	COFFEE, WHETHER OR NOT ROASTED OR FREED OF CAFFEINE	homogeneous goods
7	2785	QUARTZ, MICA, FELSPAR, FLUORSPAR, CRYOLITE & CHIOLITE	reference priced
8	545	OTHER FRESH OR CHILLED VEGETABLES	reference priced

9	589	FRUIT OTHERWISE PREPARED OR PRESERVED N. E.S.	differentiated goods
10	344	FISH FILLETS, FROZEN	reference priced
		South Korea	
1	7762	**OTHER ELECTRICAL VALVES AND TUBES**	differentiated goods
2	7938	TUGS, SPECIAL PURPOSE VESSELS, FLOATING STRUCTURES	differentiated goods
3	6531	FABRICS, WOVEN OF CONTINUOUS SYNTHETIC TEXTILE MATERIALS	reference priced
4	6532	FABRICS, WOVEN CONTAINING 85% OF DISCONTINUOUS SYNTHETIC FIBRES.	reference priced
5	6552	KNITTED/CROCHETED FABRICS OF FIBRES OTHER THAN SYNTHETIC	differentiated goods
6	7932	SHIPS, BOATS AND OTHER VESSELS	differentiated goods
7	2665	SYNTHETIC FIBRES NOT CARDED, COMBED OR OTHERWISE PREPARE	reference priced
8	7612	TELEVISION RECEIVERS, MONOCHROME	differentiated goods
9	5138	POLYCARBOXYLIC ACIDS & THEIR ANHYDRIDES, ETC.	reference priced
10	6115	SHEEP AND LAMB SKIN LEATHER	differentiated goods
		Mexico	
1	7912	OTHER RAIL LOCOMOTIVES; TENDERS	differentiated goods
2	8732	REVOLUTION COUNTERS, TAXIMETERS AND THE LIKE	differentiated goods
3	7621	RADIO-BROADCAST RECEIVERS FOR MOTOR VEHICLES	differentiated goods
4	7611	TELEVISION RECEIVERS, COLOUR	differentiated goods
5	1123	BEER MADE FROM MALT (INCLUDING ALE, STOUT AND PORTER)	reference priced
6	6932	WIRE, TWISTED HOOP FOR FENCING OF IRON OR STEEL	reference priced
7	7731	**INSULATED, ELECT. WIRE, CABLE, BARS, STRIP AND THE LIKE**	differentiated goods
8	544	TOMATOES, FRESH OR CHILLED	reference priced
9	2783	COMMON SALT; ROCK SAT, SEA SALT; PURE SODIUM CHLORIDE	reference priced
10	6994	SPRINGS & LEAVES FOR SPRINGS, OF IRON/STEEL/COPPER	#N/A
		Mozambique	
1	2231	COPRA	#N/A
2	360	CRUSTACEANS AND MOLLUSCS, FRESH, CHILLED, FROZEN ETC	reference priced
3	2472	SAWLOGS AND VENEER LOGS, OF NON CONIFEROUS SPECIES	reference priced
4	611	SUGARS, BEET AND CANE, RAW, SOLID	homogeneous goods
5	2731	BUILDING AND MONUMENTAL STONE NOT FURTHER WORKED	differentiated goods
6	2631	COTTON (OTHER THAN LINTERS), NOT CARDED OR COMBED	homogeneous goods
7	577	EDIBLE NUTS (EXCL. NUTS USED FOR THE EXTRACTION OF OIL)	homogeneous goods
8	812	BRAN, SHARPS & OTHER RESIDUES DERIVED FROM SIFTING	reference priced
9	2481	RAILWAY OR TRAMWAY SLEEPERS (TIES) OF WOOD	differentiated goods
10	1212	TOBACCO, WHOLLY OR PARTLY STRIPPED	homogeneous goods
		Netherlands	
1	2926	BULBS, TUBERS & RHIZOMES OF FLOWERING OR OF FOLIAGE	differentiated goods
2	2927	CUT FLOWERS AND FOLIAGE	differentiated goods
3	722	COCOA POWDER, UNSWEETENED	reference priced
4	251	EGGS IN SHELL	reference priced
5	564	FLOURS, MEALS & FLAKES OF POTATOES. FRUITS & VEGETABLES.	reference priced
6	7754	SHAVERS & HAIR CLIPPERS WITH MOTOR AND PARTS	differentiated goods
7	723	COCOA BUTTER AND COCOA PASTE	reference priced
8	252	EGGS NOT IN SHELL	reference priced
9	6591	LINOLEUM AND SIMILAR FLOOR COVERINGS	differentiated goods
10	541	POTATOES	homogeneous goods
		Nicaragua	
1	2221	GROUNDNUTS (PEANUTS), GREEN, WHETHER OR NOT SHELLED	reference priced
2	711	COFFEE, WHETHER OR NOT ROASTED OR FREED OF CAFFEINE	homogeneous goods

3	1221	CIGARS AND CHEROOTS; CIGARILLOS	#N/A
4	611	SUGARS, BEET AND CANE, RAW, SOLID	homogeneous goods
5	360	CRUSTACEANS AND MOLLUSCS, FRESH, CHILLED, FROZEN ETC	reference priced
6	8423	TROUSERS, BREECHES ETC. OF TEXTILE FABRICS	differentiated goods
7	8465	CORSETS, BRASSIERES, SUSPENDERS AND THE LIKE	differentiated goods
8	8441	SHIRTS, MEN'S, OF TEXTILE FABRICS	differentiated goods
9	2225	SESAME (SESAMUM) SEEDS	reference priced
10	573	BANANAS, FRESH OR DRIED	homogeneous goods
		Norway	
1	350	FISH, DRIED, SALTED OR IN BRINE; SMOKED FISH	homogeneous goods
2	341	FISH, FRESH (LIVE/DEAD)OR CHILLED, EXCLUDING FILLETS	reference priced
3	2734	PEBBLES AND CRUSHED OR BROKEN STONE. GRAVEL, MACADAM	reference priced
4	2814	ROASTED IRON PYRITES, WHETHER OR NOT AGGLOMERATED	homogeneous goods
5	3414	PETROLEUM GASES AND OTHER GASEOUS HYDROCARBONS N	#N/A
6	4111	FATS AND OILS OF FISH AND MARINE MAMMALS	reference priced
7	342	FISH, FROZEN (EXCLUDING FILLETS)	differentiated goods
8	344	FISH FILLETS, FROZEN	reference priced
9	6716	FERRO-ALLOYS	reference priced
10	6831	NICKEL & NICKEL ALLOYS, UNWROUGHT (INGOTS, PIGS, ETC)	homogeneous goods
		Nepal	
1	6592	CARPETS, CARPETING AND RUGS, KNOTTED	differentiated goods
2	8471	CLOTHING ACCESSORIES OF TEXTILE FABRICS	differentiated goods
3	6593	KELEM, SCHUMACKS AND KARAMANIE RUGS AND THE LIKE	differentiated goods
4	8442	UNDER GARMENTS, EXCLUDING SHIRTS, OF TEXTILE FABRICS	differentiated goods
5	8433	DRESSES, WOMEN'S, OF TEXTILE FABRICS	differentiated goods
6	4249	FIXED VEGETABLE OILS, N.E.S	homogeneous goods
7	8435	BLOUSES OF TEXTILE FABRICS	differentiated goods
8	8441	SHIRTS, MEN'S, OF TEXTILE FABRICS	differentiated goods
9	8434	SKIRTS, WOMEN'S, OF TEXTILE FABRICS	differentiated goods
10	8423	TROUSERS, BREECHES ETC. OF TEXTILE FABRICS	differentiated goods
		Panama	
1	573	BANANAS, FRESH OR DRIED	homogeneous goods
2	7932	SHIPS, BOATS AND OTHER VESSELS	differentiated goods
3	7938	TUGS, SPECIAL PURPOSE VESSELS, FLOATING STRUCTURES	differentiated goods
4	7631	GRAMOPHONES & RECORD PLAYERS, ELECTRIC	differentiated goods
5	611	SUGARS, BEET AND CANE, RAW, SOLID	homogeneous goods
6	7933	SHIPS, BOATS AND OTHER VESSELS FOR BREAKING UP	#N/A
7	2873	ALUMINIUM ORES AND CONCENTRATES (INCLUDING ALUMINA)	reference priced
8	3343	GAS OILS	homogeneous goods
9	8812	**CINEMATOGRAPHIC CAMERAS, PROJECTORS, SOUND-REC, PARTS**	differentiated goods
10	341	FISH, FRESH(LIVE/DEAD) OR CHILLED, EXCLUDING FILLETS	reference priced
		Peru	
1	814	FLOURS	reference priced
2	4111	FATS AND OILS OF FISH AND MARINE MAMMALS	reference priced
3	2876	TIN ORES AND CONCENTRATES	reference priced
4	2874	LEAD ORES AND CONCENTRATES	reference priced
5	2687	SHEEP'S/LAMBS' WOOL/OTHER ANIMAL HAIR, CARDED/COMBED	reference priced
6	2875	ZINC ORES AND CONCENTRATES	reference priced
7	6871	TIN AND TIN ALLOYS, UNWROUGHT	homogeneous goods
8	6811	SILVER, UNWROUGHT, UNWORKED OR SEMI-MANUFACTURED	homogeneous goods

9	6821	COPPER AND COPPER ALLOYS, REFINED OR NOT, UNWROUGHT	homogeneous goods
10	6851	LEAD AND LEAD ALLOYS, UNWROUGHT	homogeneous goods
		Pakistan	
1	6513	COTTON YARN	homogeneous goods
2	6521	COTTON FABRICS, WOVEN, UNBLEACHED, NOT MERCERISED	reference priced
3	615	MOLASSES, WHETHER OR NOT DECOLOURISED	homogeneous goods
4	2633	COTTON WASTE (INCLUDING PULLED OR GARNETTED RAGS)	reference priced
5	6592	CARPETS, CARPETING AND RUGS, KNOTTED	differentiated goods
6	6584	BED LINEN, TABLE LINEN, TOILET & KITCHEN LINEN ETC.	differentiated goods
7	422	RICE SEMI-MILLED OR WHOLLY MILLED, BROKEN RICE	homogeneous goods
8	2632	COTTON LINTERS	reference priced
9	8991	**ART. & MANUF. OF CARVING OR MOULDING MATERIALS**	differentiated goods
10	8481	ARTICLES OF APPAREL & CLOTHING ACCESSORIES, OF LEATHER	differentiated goods
		Poland	
1	586	FRUIT, TEMPORARILY PRESERVED	reference priced
2	6349	WOOD, SIMPLY SHAPED, N.E.S.	#N/A
3	3232	COKE AND SEMI-COKE OF COAL OF LIGNITE OR OF PEAT	reference priced
4	6351	WOODEN PACKING CASES, BOXES, CRATES, DRUMS ETC.	differentiated goods
5	6359	MANUFACTURED ARTICLES OF WOOD, N.E.S.	differentiated goods
6	2741	SULPHUR OF ALL KINDS	reference priced
7	6760	RAILS AND RAILWAY TRACK CONSTRUCTION MATERIAL	reference priced
8	7119	PARTS OF BOILERS & AUX. PLANT OF 711.1-/711.2-	#N/A
9	2450	FUEL WOOD (EXCLUDING WOOD WASTE) AND WOOD CHARCOAL	differentiated goods
10	615	MOLASSES, WHETHER OR NOT DECOLOURISED	homogeneous goods
		Portugal	
1	6330	CORK MANUFACTURES	differentiated goods
2	2440	CORK, NATURAL, RAW & WASTE (INCLUDING IN BLOCKS/SHEETS)	differentiated goods
3	6121	ARTICLES OF LEATHER OR OF COMPOSITION LEATHER	#N/A
4	7621	RADIO-BROADCAST RECEIVERS FOR MOTOR VEHICLES	differentiated goods
5	6584	BED LINEN, TABLE LINEN, TOILET & KITCHEN LINEN ETC.	differentiated goods
6	6575	TWINE, CORDAGE, ROPES & CABLES. & MANUFACTURE THEREOF	differentiated goods
7	6665	TABLEWARE & OTHER ARTICLES OF OTHER KINDS OF POTTERY	differentiated goods
8	6576	HAT SHAPES, HAT-FORMS, HAT BODIES AND HOODS	differentiated goods
9	7268	BOOKBINDING MACHINERY AND PARTS	differentiated goods
10	2239	FLOURS OR MEALS/OIL SEEDS/OLEAG. FRUIT NON DEFATTED	#N/A
		Paraguay	
1	2685	HORSEHAIR & OTHER COARSE ANIMAL HAIR (EXCLUDING WOOL)	differentiated goods
2	2222	SOYA BEANS	homogeneous goods
3	3510	ELECTRIC CURRENT	reference priced
4	2450	FUEL WOOD (EXCLUDING WOOD WASTE) AND WOOD CHARCOAL	differentiated goods
5	2631	COTTON (OTHER THAN LINTERS), NOT CARDED OR COMBED	homogeneous goods
6	4232	SOYA BEAN OIL	homogeneous goods
7	2235	CASTOR OIL SEEDS	differentiated goods
8	813	OIL-CAKE & OTHER RESIDUES (EXCEPT DREGS)	homogeneous goods
9	5513	ESSENTIAL OILS, CONCRETES & ABSOLUTES: RESINOIDS	differentiated goods
10	6511	SILK YARN & YARN SPUN FROM NOIL/OTHER SILK WASTE	differentiated goods
		Czech Republic	
1	3223	LIGNITE, WHETHER OR NOT PULVERIZED, NOT AGGLOMERATED	#N/A
2	6576	HAT SHAPES, HAT-FORMS, HAT BODIES AND HOODS	differentiated goods
3	2518	CHEMICAL WOOD PULP, SULPHITE	reference priced

4	3231	BRIOUET. OVOIDS & SIMILAR SOLID FUELS, OF COAL PEAT LIGNITE	differentiated goods
5	6658	ARTICLES MADE OF GLASS, N.E.S	differentiated goods
6	3353	PITCH & PITCH COKE OBTAINED FROM COAL TAR/MINERAL TARS	reference priced
7	2238	OIL SEEDS AND OLEAGINOUS FRUIT. N.E.S.	differentiated goods
8	6794	CASTINGS OR IRON OR STEEL, IN THE ROUGH STATE	differentiated goods
9	6351	WOODEN PACKING CASES, BOXES, CRATES, DRUMS ETC.	differentiated goods
10	6664	TABLEWARE & OTHER ARTICLES OF PORCELAIN OR CHINA	differentiated goods
		El Salvador	
1	8463	UNDER GARMENTS, KNITTED, OF SYNTHETIC FIBRES	differentiated goods
2	8442	UNDER GARMENTS, EXCLUDING SHIRTS, OF TEXTILE FABRICS	differentiated goods
3	711	COFFEE, WHETHER OR NOT ROASTED OR FREED OF CAFFEINE	homogeneous goods
4	8462	UNDER GARMENTS, KNITTED OF COTTON	differentiated goods
5	611	SUGARS, BEET AND CANE, RAW, SOLID	homogeneous goods
6	8433	DRESSES, WOMEN'S, OF TEXTILE FABRICS	differentiated goods
7	615	MOLASSES, WHETHER OR NOT DECOLOURISED	homogeneous goods
8	8441	SHIRTS, MEN'S, OF TEXTILE FABRICS	differentiated goods
9	8451	JERSEYS, PULLOVERS, TWINSETS, CARDIGANS, KNITTED	differentiated goods
10	8459	OTHER OUTER GARMENTS & CLOTHING, KNITTED	differentiated goods
		Senegal	
1	4234	GROUNDNUT (PEANUT) OIL	homogeneous goods
2	2922	SHELLAC, SEED LAC, STICK LAC, RESINS, GUM-RESINS, ETC.	differentiated goods
3	343	FISH FILLETS, FRESH OR CHILLED	reference priced
4	341	FISH, FRESH (LIVE/DEAD) OR CHILLED, EXCLUDING FILLETS	reference priced
5	2114	GOAT & KID SKINS, RAW (FRESH, SALTED, DRIED, PICKLED)	differentiated goods
6	360	CRUSTACEANS AND MOLLUSCS, FRESH, CHILLED, FROZEN ETC	reference priced
7	615	MOLASSES, WHETHER OR NOT DECOLOURISED	homogeneous goods
8	344	FISH FILLETS, FROZEN	reference priced
9	371	FISH, PREPARED OR PRESERVED, N.E.S. INCLUDING CAVIAR	reference priced
10	350	FISH, DRIED, SALTED OR IN BRINE; SMOKED FISH	homogeneous goods
		Singapore	
1	5157	SULPHONAMIDES, SULTONES AND SULTAMS	reference priced
2	7524	**DIGITAL CENTRAL STORAGE UNITS, SEPARATELY CONSIGNED**	#N/A
3	3343	GAS OILS	homogeneous goods
4	2714	POTASSIUM SALTS, NATURAL, CRUDE	#N/A
5	3344	FUEL OILS, N.E.S	homogeneous goods
6	5982	ANTI-KNOCK PREPARATIONS, OXIDATION INHIBITORS ETC.	differentiated goods
7	5154	ORGANO-SULPHUR COMPOUNDS	reference priced
8	2923	VEGETABLE MATERIAL OF A KIND USED PRIMARILY FOR PLAITING	differentiated goods
9	3342	KEROSENE AND OTHER MEDIUM OILS	homogeneous goods
10	8974	OTHER ARTICLES OF PRECIOUS METAL	#N/A
		Spain	
1	571	ORANGES, MANDARINS, CLEMENTINES AND OTHER CITRUS	reference priced
2	2440	CORK, NATURAL, RAW & WASTE (INCLUDING IN BLOCKS/SHEETS)	differentiated goods
3	4235	OLIVE OIL	#N/A
4	544	TOMATOES, FRESH OR CHILLED	reference priced
5	2114	GOAT & KID SKINS, RAW (FRESH, SALTED, DRIED, PICKLED)	differentiated goods
6	6624	NON-REFRACT. CERAMIC BRICKS, TILES, PIPES & SIMILAR PRODUCTS.	differentiated goods
7	572	OTHER CITRUS FRUIT, FRESH OR DRIED	reference priced
8	545	OTHER FRESH OR CHILLED VEGETABLES	reference priced
9	6330	CORK MANUFACTURES	differentiated goods

10	7914	RAILWAY & TRAMWAY PASSENGER COACHES & LUGGAGE VAN	#N/A
		Sudan	
1	2225	SESAME (SESAMUM) SEEDS	reference priced
2	2922	SHELLAC, SEED LAC, STICK LAC, RESINS, GUM-RESINS, ETC.	differentiated goods
3	12	SHEEP AND GOATS, LIVE	homogeneous goods
4	4234	GROUNDNUT (PEANUT) OIL	homogeneous goods
5	615	MOLASSES, WHETHER OR NOT DECOLOURISED	homogeneous goods
6	2114	GOAT & KID SKINS, RAW (FRESH, SALTED, DRIED, PICKLED)	differentiated goods
7	459	BUCKWHEAT, MILLET, CANARY SEED, GRAIN SORGHUM ETC	homogeneous goods
8	548	VEGETABLE PRODUCTS, ROOTS & TUBERS, FOR HUMAN FOOD	reference priced
9	2924	PLANTS, SEEDS, FRUIT USED IN PERFUMERY, PHARMACY	differentiated goods
10	112	MEAT OF SHEEP AND GOATS, FRESH, CHILLED OR FROZEN	reference priced
		Sweden	
1	6413	KRAFT PAPER AND PAPERBOARD, IN ROLLS OR SHEETS	reference priced
2	7213	DAIRY MACHINERY AND PARTS	differentiated goods
3	7842	BODIES FOR THE MOTOR VEHICLES OF 722/781/782/783	#N/A
4	7233	ROAD ROLLERS, MECHANICALLY PROPELLED	differentiated goods
5	6713	IRON OR STEEL POWDERS, SHOT OR SPONGE	reference priced
6	5838	ION EXCHANGERS OF POLYMERIZATION/COPOLYMERIZ.TYPE	differentiated goods
7	7251	MACH. FOR MAK./FINIS. CELLUL. PULP, PAPER, PAPERBOARD	differentiated goods
8	7451	TOOLS FOR WORKING IN THE HAND, PNEUMATIC, PARTS	differentiated goods
9	2512	MECHANICAL WOOD PULP	reference priced
10	7841	CHASSIS FITTED WITH ENGINES FOR MOTOR VEHICLES	#N/A
		Syrian Arab Republic	
1	12	SHEEP AND GOATS, LIVE	homogeneous goods
2	2632	COTTON LINTERS	reference priced
3	4233	COTTON SEED OIL	#N/A
4	2631	COTTON (OTHER THAN LINTERS), NOT CARDED OR COMBED	homogeneous goods
5	6115	SHEEP AND LAMB SKIN LEATHER	differentiated goods
6	752	SPICES (EXCEPT PEPPER AND PIMENTO)	reference priced
7	2713	NATURAL CALCIUM PHOSPHATE, NATURAL ALUMINIUM C. PHOS.	#N/A
8	2633	COTTON WASTE (INCLUDING PULLED OR GARNETTED RAGS)	reference priced
9	544	TOMATOES, FRESH OR CHILLED	reference priced
10	6513	COTTON YARN	homogeneous goods
		Switzerland, Liechtenstein	
1	8851	WATCHES, WATCH MOVEMENTS AND CASES	differentiated goods
2	7268	BOOKBINDING MACHINERY AND PARTS	differentiated goods
3	129	MEAT& EDIBLE OFFALS, N.E.S. SALTED. IN BRINE DRIED/SMOKED	reference priced
4	7271	MACH. FOR WORKING OF CEREALS OR DRIED VEGETABLES	differentiated goods
5	5411	**PROVITAMINS & VITAMINS, NATURAL OR REPRODUCED BY SYNTHESIS**	reference priced
6	6674	SYNTHETIC/RECONSTRUCTED PRECIOUS/SEMI-PRECIOUS STONES	differentiated goods
7	8996	**ORTHOPAEDIC APPLIANCES, SURGICAL BELTS AND THE LIKE**	differentiated goods
8	7252	PAPER & PAPERBOARD CUTTING MACHINERY OF ALL KINDS	differentiated goods
9	5312	**SYNTHETIC ORGANIC LUMINOPHORES; OPTIC. BLEACHING AGENTS**	reference priced
10	2771	INDUSTRIAL DIAMONDS, SORTED, WHETHER OR NOT WORKED	differentiated goods
		Tanzania	
1	2654	SISAL & OTHER FIBRES OF AGAVE FAMILY, RAW OR PROCESSED.	homogeneous goods
2	343	FISH FILLETS, FRESH OR CHILLED	reference priced
3	2225	SESAME (SESAMUM) SEEDS	reference priced

4	4314	WAXES OF ANIMAL OR VEGETABLE ORIGIN	differentiated goods
5	2235	CASTOR OIL SEEDS	differentiated goods
6	1213	TOBACCO REFUSE	differentiated goods
7	6673	OTHER PRECIOUS & SEMI-PRECIOUS STONES, UNWORKED CUT ETC	#N/A
8	2112	CALF SKINS, RAW (FRESH, SALTED, DRIED, PICKLED/LIMED)	differentiated goods
9	1212	TOBACCO, WHOLLY OR PARTLY STRIPPED	homogeneous goods
10	711	COFFEE, WHETHER OR NOT ROASTED OR FREED OF CAFFEINE	homogeneous goods
		Trinidad and Tobago	
1	5225	**OTHER INORGANIC BASES & METALLIC OXID., HYDROXIDE& PEROXIDE**	reference priced
2	6713	IRON OR STEEL POWDERS, SHOT OR SPONGE	reference priced
3	5121	ACYCLIC ALCOHOLS & THEIR HALOGENATED DERIVATIVES	reference priced
4	6731	WIRE ROD OF IRON OR STEEL	reference priced
5	3413	PETROLEUM GASES AND OTHER GASEOUS HYDROCARBONS	reference priced
6	3342	KEROSENE AND OTHER MEDIUM OILS	homogeneous goods
7	3344	FUEL OILS, N.E.S	homogeneous goods
8	5621	MINERAL OR CHEMICAL FERTILISERS, NITROGENOUS	reference priced
9	611	SUGARS, BEET AND CANE, RAW, SOLID	homogeneous goods
10	6732	BARS & RODS, OF IRON/STEEL; HOLLOW MINING DRILL ST.	reference priced
		Turkey	
1	576	FIGS, FRESH OR DRIED	differentiated goods
2	1211	TOBACCO, NOT STRIPPED	homogeneous goods
3	2633	COTTON WASTE (INCLUDING PULLED OR GARNETTED RAGS)	reference priced
4	6581	SACKS AND BAGS, OF TEXTILE MATERIALS	differentiated goods
5	6515	YARN CONTAINING 85% BY WGT. OF SYNTHETIC FIBRES, FOR SALE	reference priced
6	577	EDIBLE NUTS (EXCLUDING NUTS USED FOR THE EXTRACTION OF OIL)	homogeneous goods
7	6593	KELEM, SCHUMACKS AND KARAMANIE RUGS AND THE LIKE	differentiated goods
8	2785	QUARTZ, MICA, FELSPAR, FLUORSPAR, CRYOLITE & CHIOLITE	reference priced
9	2632	COTTON LINTERS	reference priced
10	6584	BED LINEN, TABLE LINEN, TOILET & KITCHEN LINEN ETC.	differentiated goods
		United Kingdom	
1	3415	COAL GAS, WATER GAS, PRODUCER GAS & SIMILAR GASES	#N/A
2	9510	ARMOURED FIGHTING VEHICLES, ARMS OF WAR & AMMUNITION	differentiated goods
3	1124	SPIRITS; LIQUEURS, OTHER SPIRITUOUS BEVERAGES, N.E.S	reference priced
4	7929	**PARTS OF HEADING 792--,EXCLUDING TYRES, ENGINES**	#N/A
5	481	CEREAL GRAINS, WORKED/PREPARED, (BREAKFAST FOODS)	reference priced
6	2116	SHEEP & LAMB SKINS WITH WOOL ON, RAW (FRESH, SALTED)	differentiated goods
7	7921	**HELICOPTERS**	#N/A
8	5233	SALTS OF METALLIC ACIDS; ETC.	reference priced
9	2687	SHEEP'S/LAMBS' WOOL/OTHER ANIMAL HAIR, CARDED/COMBED	reference priced
10	8830	CINEMATOGRAPH FILM, EXPOSED-DEVELOPED, NEG. OR POS.	differentiated goods
		Uruguay	
1	421	RICE IN THE HUSK OR HUSKED, BUT NOT FURTHER PREPARED.	homogeneous goods
2	2686	WASTE OF SHEEP'S/LAMBS' WOOL OR OF OTHER ANIMAL HAIR	differentiated goods
3	115	MEAT OF HORSES, ASSES, ETC., FRESH, CHILLED, FROZEN	differentiated goods
4	482	MALT, ROASTED OR NOT (INCLUDING MALT FLOUR)	#N/A
5	6512	YARN OF WOOL OR ANIMAL HAIR (INCLUDING WOOL TOPS)	homogeneous goods
6	111	MEAT OF BOVINE ANIMALS, FRESH, CHILLED OR FROZEN	homogeneous goods
7	129	MEAT& EDIBLE OFFALS, N.E.S. SALT. IN BRINE DRIED/SMOKED	reference priced
8	422	RICE SEMI-MILLED OR WHOLLY MILLED, BROKEN RICE	homogeneous goods
9	2687	SHEEP'S/LAMBS' WOOL/OTHER ANIMAL HAIR, CARDED/COMBED	reference priced

10	6114	LEATHER OF OTHER BOVINE CATTLE AND EQUINE LEATHER	differentiated goods
		USA	
1	6344	WOOD-BASED PANELS, N.E.S.	differentiated goods
2	6553	KNITTED/CROCHETED FABRICS ELASTIC OR RUBBERISED	differentiated goods
3	459	BUCKWHEAT, MILLET, CANARY SEED, GRAIN SORGHUM ETC	homogeneous goods
4	6880	URANIUM DEPLETED IN U235 & THORIUM, & THEIR ALLOYS	reference priced
5	2222	SOYA BEANS	homogeneous goods
6	7131	INTERNAL COMBUSTION PISTON ENGINES FOR AIRCRAFT	#N/A
7	5843	CELLULOSE ACETATES	reference priced
8	440	MAIZE (CORN), UNMILLED	homogeneous goods
9	7144	**REACTION ENGINES**	#N/A
10	2511	WASTE PAPER, PAPERBOARD; ONLY FOR USE PAPER-MAKING	reference priced
		Venezuela	
1	6713	IRON OR STEEL POWDERS, SHOT OR SPONGE	reference priced
2	3345	LUBRICATING PETROL. OILS & OTHER HEAVY PETROL. OILS	reference priced
3	2789	MINERALS, CRUDE, N.E.S.	differentiated goods
4	2239	FLOURS OR MEALS/OIL SEEDS/OLEAG. FRUIT NON DEFATTED	#N/A
5	3342	KEROSENE AND OTHER MEDIUM OILS	homogeneous goods
6	6932	WIRE, TWISTED HOOP FOR FENCING OF IRON OR STEEL	reference priced
7	3354	PETROLEUM BITUMEN, PETROL. COKE & BITUMEN. MIXTURE NES	differentiated goods
8	2225	SESAME (SESAMUM) SEEDS	reference priced
9	3341	MOTOR SPIRIT AND OTHER LIGHT OILS	homogeneous goods
10	6724	PUDDLED BARS AND PILINGS; INGOTS, BLOCKS, LUMPS ETC.	differentiated goods

Source: Feenstra, Lipsey, Deng, Ma and Mo (2005) and own elaboration.

Table A.7. High-technology sectors.

SITC4, rev. 2	DESCRIPTION
5221	CHEMICAL ELEMENTS
5222	INORGANIC ACIDS AND OXYGEN COMPOUNDS OF NON-METAL
5223	HALOGEN AND SULPHUR COMPOUNDS OF NON-METALS
5224	METALLIC OXIDES OF ZINC, CHROMIUM, MANGANESE, IRON,
5225	OTH.INORG.BASES & METALLIC OXIDE, HYDROXIDE.& PEROXIDE.
5241	FISSILE CHEMICAL ELEMENTS AND ISOTOPES
5249	OTHER RADIO-ACTIVE AND ASSOCIATED MATERIALS
5311	SYNTHETIC ORGANIC DYESTUFFS
5312	SYNTH. ORGANIC LUMINOPHORES; OPTIC. BLEACHING AGENTS
5411	PROVITAMINS & VITAMINS, NARURAUREPROD. BY SYNTHESIS
5413	ANTIBIOTICS N.E.S., NOT INCL. IN 541.7
5414	VEGETABLE .ALKALOIDS, NATURAL/REPRODUCED BY SYNTHESIS
5415	HORMONES, NATURAL OR REPRODUCED BY SYNTHESIS
5416	GLYCOSIDES; GLANDS OR OTHER ORGANS & THEIR EXTRACTS
5417	MEDICAMENTS(INCLUDING VETERINARY MEDICAMENTS)
5419	PHARMACEUTICAL GOODS, OTHER THAN MEDICAMENTS
5823	ALKYDS AND OTHER POLYESTERS
5911	INSECTICIDES PACKED FOR SALE ETC.
5912	FUNGICIDES PACKED FOR SALE ETC.
5913	WEED KILLERS (HERBICIDES)PACKED FOR SALE ETC.
5914	DISINFECT., ANTI-SPROUTING PROD. ETC. PACKED FOR SALE
7144	REACTION ENGINES
7148	GAS TURBINES, N.E.S.
7149	PARTS OF THE ENGINES & MOTORS OF 714-AND 718.8-
7187	NUCLEAR REACTORS AND PARTS
7188	ENGINES & MOTORS, N.E.S. SUCH AS WATER TURBINES ETC.
7281	MACH. TOOLS FOR SPECIALISED PARTICULAR INDUSTRIES
7283	MACH. FOR SORTING, SCREENING, SEPARATING, WASHING ORE
7284	MACH.& APPLIANCES FOR SPECIALISED PARTICULAR IND.
7361	METAL CUTTING MACHINE-TOOLS
7362	METAL FORMING MACHINE TOOLS
7367	OTHER MACH.-TOOLS FOR WORKING METAL OR MET. CARBIDE
7371	CONVERTERS, LADLES, INGOT MOULDS AND CASTING MACH.
7372	ROLLING MILLS, ROLLS THEREFOR AND PARTS
7373	WELDING, BRAZING, CUTTING, SOLDERING MACHINES & PARTS
7511	TYPEWRITERS; CHEQUE-WRITING MACHINES
7512	CALCULATING MACHINES, CASH REGISTERS. TICKET & SIM.
7518	OFFICE MACHINES, N.E.S.
7521	ANALOGUE & HYBRID DATA PROCESSING MACHINES
7522	COMPLETE DIGITAL DATA PROCESSING MACHINES
7523	COMPLETE DIGITAL CENTRAL PROCESSING UNITS
7524	DIGITAL CENTRAL STORAGE UNITS, SEPARATELY CONSIGNED
7525	PERIPHERAL UNITS, INCL. CONTROL & ADAPTING UNITS
7528	OFF-LINE DATA PROCESSING EQUIPMENT. N.E.S.
7591	PARTS OF AND ACCESSORIES SUITABLE FOR 751.1-,751.8
7599	PARTS OF AND ACCESSORIES SUITABLE FOR 751.2-,752-
7638	OTHER SOUND RECORDERS AND REPRODUCERS
7641	ELECT. LINE TELEPHONIC & TELEGRAPHIC APPARATUS
7642	MICROPHONES, LOUDSPEAKERS, AMPLIFIERS
7643	RADIOTELEGRAPHIC & RADIOTELEPHONIC TRANSMITTERS
7648	TELECOMMUNICATIONS EQUIPMENT

7649	PARTS OF APPARATUS OF DIVISION 76-
7722	PRINTED CIRCUITS AND PARTS THEREOF
7723	RESISTORS, FIXED OR VARIABLE AND PARTS
7731	INSULATED ELECT. WIRE, CABLE, BARS, STRIP AND THE LIKE
7732	ELECTRIC INSULATING EQUIPMENT
7741	ELECTRO-MEDICAL APPARATUS
7742	APP. BASED ON THE USE OF X-RAYS OR OF RADIATIONS
7762	OTHER ELECTR. VALVES AND TUBES
7763	DIODES, TRANSISTORS AND SIM. SEMI-CONDUCTOR DEVICES
7764	ELECTRONIC MICROCIRCUITS
7768	PIEZO-ELECTRIC CRYSTALS, MOUNTED PARTS OF 776-
7781	BATTERIES AND ACCUMULATORS AND PARTS
7782	ELECT. FILAMENT LAMPS AND DISCHARGE LAMPS
7783	ELECTR. EQUIP. FOR INTERNAL COMBUSTION ENGINES, PARTS
7784	TOOLS FOR WORKING IN THE HAND WITH ELECT. MOTOR
7788	OTHER ELECT. MACHINERY AND EQUIPMENT
7921	HELICOPTERS
7922	AIRCRAFT NOT EXCEEDING AN UNLADEN WEIGHT 2000 KG
7923	AIRCRAFT NOT EXCEEDING AN UNLADEN WEIGHT OF 15000 KG
7924	AIRCRAFT EXCEEDING AN UNLADEN WEIGHT OF 15000 KG
7925	AIRCRAFT EXC GLIDERS, AIRSHIPS ETC
7928	AIRCRAFT, N.E.S. BALLOONS, GLIDERS ETC AND EQUIPMENT
7929	PARTS OF HEADING 792--,EXCL. TYRES, ENGINES
8710	OPTICAL INSTRUMENTS AND APPARATUS
8720	MEDICAL INSTRUMENTS AND APPLIANCES
8741	SURVEYING, HYDROGRAPHIC, COMPASSES ETC.
8742	DRAWING, MARKING-OUT, DISC CALCULATORS AND THE LIKE
8743	NON ELECTRICAL INSTR., FOR MEASURING, CHECKING FLOW
8744	INSTR.& APP. FOR PHYSICAL OR CHEMICAL ANALYSIS
8745	MEASURING, CONTROLLING & SCIENTIFIC INSTRUMENTS
8748	ELECTRICAL MEASURING, CHECKING, ANALYSING INSTRUM.
8749	PARTS, N.E.S. ACCESSORIES FOR 873-,8743-,87454,8748
8811	PHOTOGRAPHIC, CAMERAS, PARTS & ACCESSORIES
8812	CINEMATOGRAPHIC CAMERAS, PROJECTORS, SOUND-REC, PAR
8813	PHOTOGRAPHIC & CINEMATOGRAPHIC APPARATUS N.E.S
8841	LENSES, PRISMS, MIRRORS, OTHER OPTICAL ELEMENTS
8842	SPECTACLES AND SPECTACLE FRAMES
8946	NON-MILITARY ARMS AND AMMUNITION THEREFOR
8981	PIANOS AND OTHER STRING MUSICAL INSTRUMENTS
8982	OTHER MUSICAL INSTRUMENTS OF 898.1-
8983	GRAMOPHONE RECORDS AND SIM. SOUND RECORDINGS
8989	PARTS OF AND ACCESSORIES FOR MUSICAL INSTRUMENTS
8991	ART.& MANUF. OF CARVING OR MOULDING MATERIALS
8993	CANDLES, MATCHES, PYROPHORIC ALLOYS ETC.
8994	UMBRELLAS, PARASOLS, WALKING STICKS, PARTS
8996	ORTHOPAEDIC APPLIANCES, SURGICAL BELTS AND THE LIKE
8997	BASKETWORK, WICKERWORK ETC. OF PLAITING MATERIALS
8998	SMALL-WARES AND TOILET ART., FEATHER DUSTERS ETC.
8999	MANUFACTURED GOODS, N.E.S.

Source: OECD (2001) and Eurostat (1999). Own elaboration.

Table A.8. Variable descriptions and sources of data. Disaggregated analysis.

Variable	Description	Source
X_{ijk} : Exports from i to j of the commodity k	Value of exports from the 13-country selected countries to 167 countries, in thousands of US dollars in the year 2000	Feenstra et al. (2005)
Y_i : Exporter's income	Exporter's GDP, PPP (current international $)	World Bank (2005)
Y_j : Importer's income	Importer's GDP, PPP (current international $)	World Bank (2005)
YH_i : Exporter's income per capita	Exporter's GDP per capita, PPP (current international $)	World Bank (2005)
YH_j : Importer's income per capita	Importer's GDP per capita, PPP (current international $)	World Bank (2005)
Adj_{ij} : Adjacency dummy	Dummy variable = 1 if the trading partners share a common border, 0 otherwise.	CEPII (2006)
$Land_i$: Landlocked dummy	Dummy variable = 1 if the exporting country is landlocked, 0 otherwise.	CEPII (2006)
$Land_j$: Landlocked dummy	Dummy variable = 1 if the importing country is landlocked, 0 otherwise.	CEPII (2006)
MERC dummy	Dummy variable = 1 if the trading partners are members of Mercosur, 0 otherwise	
NAFTA dummy	Dummy variable = 1 if the trading partners are members of NAFTA, 0 otherwise	
CAN dummy	Dummy variable = 1 if the trading partners are members of CAN, 0 otherwise	
EU dummy	Dummy variable = 1 if the trading partners are members of European Union, 0 otherwise	
EMU dummy	Dummy variable = 1 if the trading partners are members of Economic and Monetary Union, 0 otherwise	
ECOWAS dummy	Dummy variable = 1 if the trading partners are members of ECOWAS, 0 otherwise	
CEFTA dummy	Dummy variable = 1 if the trading partners are members of CEFTA, 0 otherwise	
$Dist_{ij}$: Distance	Great circle distances between the most important cities in trading partners	CEPII (2006) http://www.cepii.fr/anglaisgraph/bdd/distances.htm
$Lang_{ij}$: Language dummy	Dummy variable = 1 if the trading partners share the same official language, 0 otherwise.	CEPII (2006)
$Colony_{ij}$: Colony dummy	Dummy variable = 1 if the trading partners have ever had a colonial link, 0 otherwise.	CEPII (2006)
TAI_i : Exporter's TAI	Technological variable	UNDP (2001), author's calculations
TAI_j : Importer's TAI	Technological variable	UNDP (2001), author's calculations
$Tariffs_{ik}$	Effectively applied rates in sector k	WITS (2006) http://wits.worldbank.org/witsnet/StartUp/Wits_Information.aspx
TC_i: Exporter's transport costs	Transport costs (US$ per container)	Doing Business (2006)
TC_j: Importer's transport costs	Transport costs (US$ per container)	Doing Business (2006)
High-tech dummy	Dummy variable = 1 when commodity is a high-technology commodity, 0	

	otherwise	
Hom_k dummy	Dummy variable = 1 when a commodity k is homogeneous, according to Rauch classification (1999), 0 otherwise	Jon Haveman's International Trade Data webpage http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeData.html
Ref_k dummy	Dummy variable = 1 when a commodity k is reference-priced, according to Rauch classification (1999), 0 otherwise	Jon Haveman's International Trade Data webpage

Table A.9. "Beta coefficients" of the variables included in the gravity model. Disaggregated analysis.

	Beta coefficients equation (5.2)-OLS	Beta coefficients equation (5.3)-OLS
Exporter's income	0.16	-
Importer's income	0.30	-
Exporter's income per capita	-0.15	-
Importer's income per capita	0.02	-
Adjacency dummy	0.08	0.06
Exporter's Landlocked dummy	-0.05	-
Importer's Landlocked dummy	-0.02	-
MERCOSUR dummy	0.01	0.01
NAFTA dummy	0.05	0.05
CAN dummy	0.01	0.01
EU dummy	0.00	0.05
EMU dummy	0.03	0.01
ECOWAS dummy	0.00	-0.01
CEFTA dummy	0.01	0.02
Distance	-0.19	-0.23
Language dummy	0.05	0.03
Colonial dummy	0.00	0.03
Exporter's TAI	0.20	-
Importer's TAI	0.08	-
Tariffs	0.03	0.03
Exporter's transport costs	-0.01	-
Importer's transport costs	-0.04	-
Transport costs	-	-0.08
High-tech dummy	0.08	0.08
Homogeneous goods dummy	-0.01	-0.01
Referenced goods dummy	-0.02	-0.01
DP dummy	0.02	-0.05