ESTIMATING THE EFFECT OF TRADE COSTS ON SECTORAL TRADE USING "GOOD OLD" OLS

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Abstract

This paper uses sectoral trade data to compare and quantify the impact that a number of institutional and geographical trade barriers have on bilateral trade flows. Data on distance, tariffs, inland cost of importing and exporting, the number of documents required for trade, time and information technology are used as proxies for trade barriers. A gravity model of trade is estimated using bilateral data for 13 exporters and 167 importers and sectoral data at 4-digit of the SITC classification. Results of the estimation indicate that trade barriers related to the number of days, the number of documents required for trade and technological innovation achievements have a greater impact on trade flows than tariff barriers. This result also holds when the gravity model is estimated for different sectors and for individual countries. According to these findings, trade policy negotiation efforts should be focused on facilitating trade processes and should be in the forefront of multilateral negotiations.

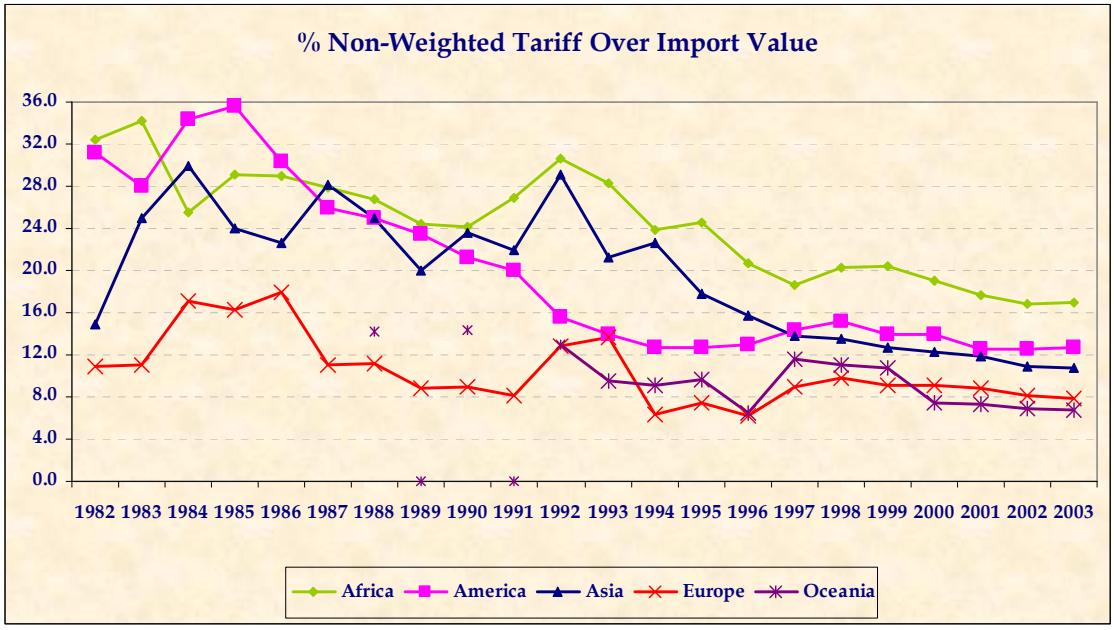
Keywords: tariff barriers, trade facilitation, sectoral trade.

JEL classification: F14.

1. Introduction

Trends towards geographical regionalisation and globalisation have led to a decreasing role for tariff barriers as a factor influencing trade. Figure 1 shows a clear decreasing trend over time in the development of tariffs in different regional areas in the world.

Figure 1. Tariff barriers and trade. A world perspective 1982-2003.



Source: World Bank (2005b)

Nonetheless, trade policy could still be a key issue in some countries. In addition, transport costs and technological innovation have become an important determinant of trade patterns worldwide. A number of studies have studied on the importance of technological innovation on international trade (Freund and Weinhold, 2004; Fink et al., 2005). Other studies have focused on several aspects of trade facilitation (Wilson et al., 2005; Martínez-Zarzoso and Márquez-Ramos, 2008). The issue of trade facilitation is of growing interest in the trade policy debate as it has been included in the Doha

Development Agenda. However, the measurement and quantification of the potential benefits of trade facilitation have only recently been investigated. Martínez-Zarzoso and Márquez-Ramos (2008) analyse the effect of trade facilitation on trade volumes at a disaggregated level. They focus on the simplification of "at the border procedures" comprising the number of documents and time involved in crossing the border, as well as the transaction cost incurred. Their results support multilateral initiatives which encourage countries to assess their trade facilitation needs and priorities and to improve them.

This paper aims to quantify and compare the effect of tariff barriers and trade facilitation measures on international trade flows at sectoral level. We consider the role of tariffs, cost, time and number of documents required for trade and information technology as factors influencing disaggregated trade flows. As there are clear economic differences between developed and developing countries leading to differences in the way the determinants of bilateral trade flows behave, different groups of countries will be analysed. A large number of developing countries have substantial economic vulnerabilities, such as external debt, high unemployment and inflation rates, poverty and unequal income distribution. Therefore, developing economies are characterised by higher levels of trade protection than developed countries, and a significant group of them remain dependent on foreign aid. Taking a sample of countries, with different levels of economic development, as and homogeneous group may no be the right approach to follow. Country-heterogeneity is therefore taken into account when analysing international trade determinants. Moreover, in line with previous research pointing out

the fact that trade determinants differ among sectors (Rauch, 1999), sector-heterogeneity is considered in the analysis.

The impressive goodness of fit of the gravity model applied to bilateral trade flows is widely recognised. Some authors have referred to this model as the "workhorse" of empirical trade studies (Eichengreen and Irwin, 1998; Cheng and Wall, 2005). In the context of the gravity model, Anderson and van Wincoop (2003) emphasise the dependence of trade on a bilateral and multilateral resistance factor. These authors refer to price indices as "multilateral resistance" variables that depend on all bilateral resistances, including those not directly involving the exporting country.

A gravity equation is estimated in this paper using the method recently proposed by Baier and Bergstrand (2007). They suggest using a linear approximation to all influences on the multilateral trade resistance and then proceeding with OLS estimates. The advantage of using this method instead of the traditional log-linear OLS approach is that we are able to properly model and break down the influences of multilateral resistance on trade flows.

The main results can be summarised as follows. Firstly, a reduction in the number of days and the number of documents needed for trade promotes international trade to a greater extent than equivalent reductions in tariff barriers. Secondly, the former effect is comparable to the effect of distance on trade. Finally, information technology will also play an important role in promoting trade.

The paper is organised as follows. In Section 2, data, sources and variables used are presented. A detailed description of the trade facilitation and tariff data collection is presented. Section 3 presents the model specification, the main results and a number of robustness tests. Finally, Section 4 contents concluding remarks.

2. Data, sources and variables

Bilateral trade data by commodity were obtained from Feenstra et al. (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.1, Appendix). The 13 exporters are chosen according to the classification matrix constructed in Martínez-Zarzoso and Márquez-Ramos (2008). The sectors under analysis include 146 sectors with homogeneous goods, 349 sectors with reference-priced goods, and 694 sectors with differentiated goods.

The databases used to construct the explanatory variables for the regression analysis are the World Development Indicators (2005) for income, the World Integrated Trade Solution (WITS) for tariffs, and the Doing Business (2006) database for trade facilitation variables.[1] 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 is taken from CEPII.[2] Technological innovation is proxied using the Technological Achievement Index (TAI) computed by UNDP (2001). This indicator takes into account a broad array of variables related to technological innovation. Tariff data comes from the Trade Analysis Information System (TRAINS) and have been extracted using WITS. Tariffs faced by each of the 13 exporting countries are collected by using the importing countries as reporting countries. We obtain tariffs weighted by their corresponding trade values at one digit SITC classification in the year 2000. In

[1] Arruñada (2007) states that the priority should not only be simplifying the procedures, but also, restructuring formalities and enhancing the value of institutions to generate reliable information which is essential for reducing transaction costs.

[2] 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 the latitudes and longitudes of the most important cities/agglomerations (in terms of population).

TRAINS there are three types of tariffs for each product: bound rate, preferential and Most-Favoured Nation tariffs (MFN). Bound tariffs are specific commitments made by individual WTO members. The bound rate is the maximum MFN tariff level for a given product line. When WTO members negotiate tariff levels, they make agreements about bound tariff rates, but these are not necessarily the rate that a WTO member applies to other WTO members' products.[3] The preferential rate is the lowest one. Under a preferential trade agreement, one country imposes lower tariffs on another country's products than their MFN rate. Then, exporting countries may have access to several different preference programs from a given importing partner and for a given product. MFN tariffs are what countries promise to impose on imports from other members of the World Trade Organisation, unless the country is part of a preferential trade agreement.

WITS uses the concept of effectively applied tariffs, defined as the lowest tariff granted by an importer to an exporter for a particular product.[4] The rates used in this paper are weighted average effectively applied tariffs for each country importing each product from the 13 exporters in the sample. Table 1 shows weighted average tariffs imposed on imports from the 13-country sample to all importing countries in the year 2000 for the different sections of the Standard International Trade Classification (SITC, revision 2). Overall, protection is greater on sensitive products such as food and live animals, beverages and tobacco and animal and vegetable oils, fats and waxes.

[3] Countries can break a commitment (i.e. raise a tariff above the bound rate), but only with difficulty. To do so they have to negotiate with the countries most closely concerned and that could result in compensation for trading partners' loss of trade.

[4] UNCTAD and the World Bank have computed ad valorem equivalents (AVEs) of non ad valorem tariffs, which are included when average tariff rates are computed. A three-step method for estimating unit values is used: (1) from tariff line import statistics of the market country available in TRAINS; then (if (1) is not available) (2) from the HS 6-digit import statistics of the market country from COMTRADE; then (if (1) and (2) are not available) (3) from the HS 6-digit import statistics of all OECD countries. Once a unit value is estimated, then it is used for all types of rates (MFN, preferential…).

As trade facilitation variables are of great interest for this research, we considered it appropriate to present a more detailed description of the data collection. Doing Business compiles procedural requirements for exporting and importing a standardised cargo of goods. Every official procedure for exporting and importing the goods is recorded (from the contractual agreement between the two parties to the delivery of goods) along with the time and cost necessary for completion. All documents required for the clearance of the goods across the border are also recorded. For exporting goods, procedures range from packing the goods at the factory to their departure from the port of origin. For importing goods, procedures range from the vessel's arrival at the port of entry to the delivery of the cargo to the factory warehouse. Local freight forwarders, shipping lines, customs brokers and port officials provide information on required documents and costs, as well as the time for completing each procedure. To make the data comparable across countries, several assumptions about the business and the traded goods are made. The main assumptions refer to the business and types of goods traded. The business has to be located in the country's most populous city, and it must have 200 employees or more. It is assumed to be a private, limited liability company that does not operate within an export processing zone, or an industrial estate with special export or import privileges. The business must be domestically owned with no foreign ownership and exports more than 10% of its sales.

The traded product must travel in a dry-cargo, 20-foot, full container load, not be hazardous, and not include military items. In addition, it must not require special conditions for transport, like refrigeration, and does not require any special plant health or environmental safety standards other than accepted international standards. Finally, the

product falls under the following Standard International Trade Classification (SITC) Revision categories: SITC 65 (textile yarn, fabrics and made-up articles); SITC 84 (articles of apparel and clothing accessories) or SITC 07 (coffee, tea, cocoa, spices and manufactures thereof).

The cost is recorded as the fees levied on a 20-foot container in US dollars. All the fees associated with completing the procedures to export or import goods are included. These, in turn, include costs of documents, administrative fees for customs clearance and technical control, terminal handling charges and inland transport. The cost measurement does not include tariffs or trade taxes. Only official costs are recorded.

Table 1. Average effectively applied tariffs (expressed in weighted terms) imposed on imports from the 13-country sample by all countries in the year 2000.

Product	Product Name	South Africa	Australia	Bolivia	Brazil	Chile	China	Czech Republic
0	Food and live animals	9.92	18.41	12.92	9.30	7.20	7.33	17.61
1	Beverages and tobacco	12.90	6.93	15.23	25.30	7.21	5.04	34.26
2	Raw materials, inedible, except fuels	1.68	3.11	4.28	5.85	1.15	2.32	1.99
3	Mineral fuels, lubricants and related materials	3.38	1.47	0.66	1.56	6.61	2.61	1.40
4	Animal and vegetable oils, fats and waxes	10.42	11.27	19.54	17.19	9.66	1.97	17.06
5	Chemicals and related products, n.e.s.	6.04	3.56	7.07	3.69	5.95	4.68	4.36
6	Manufactured goods classified chiefly by material	2.17	3.11	3.49	3.54	3.55	4.77	5.79
7	Machinery and transport equipment	6.65	3.99	2.67	4.57	13.66	2.58	6.33
8	Miscellaneous manufactured articles	4.68	5.32	6.12	5.82	7.78	4.64	4.83
9	Commodities and transactions, n.e.s.	14.72	1.54	0.00	2.86	0.68	7.30	10.90

Product	Product Name	Germany	Ghana	Japan	Spain	United Kingdom	United States
0	Food and live animals	14.16	1.65	10.46	12.19	13.75	18.70
1	Beverages and tobacco	16.25	7.45	21.31	14.70	23.83	30.22
2	Raw materials, inedible, except fuels	4.17	1.53	4.76	5.25	6.15	6.75
3	Mineral fuels, lubricants and related materials	2.67	2.80	7.36	14.50	1.33	5.13
4	Animal and vegetable oils, fats and waxes	13.53	0.75	6.73	8.72	10.83	12.38
5	Chemicals and related products, n.e.s.	4.28	6.43	5.70	7.35	4.15	4.55
6	Manufactured goods classified chiefly by material	5.52	1.45	8.32	11.43	8.35	7.49
7	Machinery and transport equipment	5.54	1.92	5.27	8.23	3.71	4.07
8	Miscellaneous manufactured articles	4.07	3.56	4.29	10.05	4.30	5.99
9	Commodities and transactions, n.e.s.	3.23	0.00	0.23	4.44	11.42	1.32

Source: WITS (2008) and authors' calculations.

3. Empirical analysis

3.1. Model specification and main results

The theoretical background for our study is provided by the model of Baier and Bergstrand (2007), which is a generalisation of previous work on the gravity equation, in which special attention is given to modelling the so-called "multilateral resistance" terms (RM). Baier and Bergstrand (2007) demonstrated that a first-order log-linear Taylor series expansion of the nonlinear system of price equations provides an alternative OLS log-linear specification that introduces theoretically-motivated RM. This methodology has two basic advantages with respect to the other approaches recently proposed to estimate a "theoretically motivated" gravity equation. Firstly, it is simpler than the custom nonlinear least squares (CNLS) program proposed by Anderson and van Wincoop (2003), which has scarcely been applied by empirical researchers. Secondly, it makes it possible to estimate the comparative static effects of a trade costs. The most commonly applied approach to estimate potentially unbiased gravity equation coefficients since Anderson and van Wincoop (2003) is to use region-specific fixed effects, as already suggested by the authors and by Feenstra (2004). Although this method is very simple and avoids the measurement error associated with measuring regions' "internal distances" (as in CNLS), it does not allow to estimate the comparative static effects of trade costs. Moreover, Anderson and van Wincoop (2003) approach is only valid in a world with symmetrical bilateral trade costs ($t_{ij}=t_{ji}$), whereas the RM approximation terms also work under asymmetrical bilateral trade costs[5].

[5] See Addendum to "Bonus Vetus OLS" (B-B, 2007) in http://www.nd.edu/~jbergstr/working_papers.html.

Baier and Bergstrand (2007) suggest applying a first-order Taylor expansion to the explanatory variables and estimating the gravity model specified with the transformed variables using OLS. By using this methodology, the independent variables are transformed as follows:

$$(x_{ijk})_{P_iP_j} = \frac{1}{N_i}\sum_{i=1}^{N_i} x_{irk} + \frac{1}{N_j}\sum_{j=1}^{N_j} x_{jsk} - \frac{1}{N_i}\sum_{i=1}^{N_i} x_{irk}\,\frac{1}{N_j}\sum_{j=1}^{N_j} x_{jsk} \qquad (1)$$

$$(x_{ik}x_{jk})_{P_iP_j} = \frac{1}{N_i}\sum_{i=1}^{N_i} x_{ik} + \frac{1}{N_j}\sum_{j=1}^{N_j} x_{jk} - \frac{1}{N_i}\sum_{i=1}^{N_i} x_{ik}\,\frac{1}{N_j}\sum_{j=1}^{N_j} x_{jk} \qquad (2)$$

where r is an index of the country partners of i and s is an index of the country partners of j. Equation (1) refers to variables with bilateral variability (e.g. distance), whereas Equation (2) indicates the transformation required for variables with country or sectoral variability, but which are common for all the trading partners. The estimated equation is:

$$\begin{aligned}\ln X_{ijk} &= \alpha_0 + \alpha_1 \ln(Y_i Y_j) + \alpha_2(\ln Dist_{ij} - \ln Dist_{P_iP_j}) + \\ &+ \alpha_3(\ln Tariffs_{ijk} - \ln Tariffs_{P_iP_j}) + \alpha_4(\ln ET_i \ln ET_j)_{P_iP_j} + \varepsilon_{ijk}\end{aligned} \qquad (3)$$

where *ln* denotes natural logarithms. X_{ijk} denotes the value of exports of commodity k from country i to j; Y_i and Y_j are incomes in the origin and destination market respectively;

$Dist_{ij}$ is the geographical great circle distance in kilometres between the most important cities (in terms of population) of country i and j. $Tariff_{ijk}$ is the weighted average effectively applied tariff for each country importing each commodity from the 13 exporters.[6] ET_i and ET_j are easy to trade variables (technological innovation, transport costs, time and number of documents required to trade) for the exporting and importing

[6] This variable is disaggregated at 1 digit level (SITC classification).

country respectively. Finally, ε_{ijk} is the error term, which is assumed to be independently and identically distributed.

Table 2 shows the results obtained for the full sample. Models 1-4 include different trade facilitation variables, namely technological innovation, transport costs, number of days and number of documents required to trade, respectively.

Our results show the expected negative effect of distance on trade. Additionally, tariff barriers are also negative and significant, as expected, although the coefficients obtained for trade facilitation variables are higher. On one hand, technological innovation is positive and significant, indicating that improving service infrastructure fosters international trade. On the other hand, inland transport costs, the number of documents and days required to export deter international trade flows. This deterrent effect is greater for variables related to bureaucratic procedures and waiting time at the border.

These results were similar to those found in the estimates with exporter and importer fixed effects. In particular, the elasticity for distance was -0.54 (0.006), for tariff barriers was -0.02 (0.001) and for time delays was -0.32 (0.06).[7]

The beta coefficients are calculated to determine the relative importance of the different variables included in the model (Table A.2, Appendix). The highest beta coefficients are, in absolute value, for distance, income and trade facilitation variables, whereas tariff barriers show lower beta coefficients. These results indicate that trade facilitation variables play a more important role as determinants of the pattern of trade than tariff barriers.

[7] Robust standard errors in brackets.

Table 2. Determinants of bilateral trade.

Variables	Model 1	Model 2	Model 3	Model 4
Income	0.32*** (119.90)	0.36*** (169.64)	0.31*** (143.62)	0.34*** (162.69)
Distance	-0.50*** (-72.22)	-0.48*** (-75.38)	-0.50*** (-78.71)	-0.51*** (-80.91)
Tariffs	-0.03*** (-18.87)	-0.03*** (-17.49)	-0.03*** (-18.22)	-0.02*** (-14.90)
Technological innovation	0.57*** (69.16)	-	-	-
Transport costs	-	-0.04*** (-6.07)	-	-
Time	-	-	-0.39*** (-81.47)	-
Documents	-	-	-	-0.52*** (-65.65)
Number of observations	153,289	183,422	183,422	183,422
R-squared	0.21	0.20	0.22	0.22
RMSE	1.72	1.69	1.67	1.67

Notes: ***, **, * indicate significance at 1%, 5% and 10%, respectively. T-statistics are given in brackets. The dependent variable is the natural logarithm of exports in value (thousands of US$) of commodity k from country i to j. The estimation uses White's heteroscedasticity-consistent standard errors. Data is for the year 2000.

3.2. Robustness

3.2.1. The effect of tariff barriers and trade facilitation measures on imports from different countries

The level of protection for goods coming from developing countries face lower average weighted tariffs in developed countries that in developing countries; however, developing countries face higher tariffs in developed countries than in trade among developed countries themselves (Table A.4). Average weighted tariffs which are equal to 0 are more frequent among developed countries. Moreover, the second part of Table A.4 shows that the mean of the effectively applied weighted tariffs among developed countries is 4.5%, while it is higher when one (or both) of the trading partners is a developing country (10.6%). This phenomenon is known as "tariff bias" against developing countries.

To focus on the effect of trade barriers on imports from different countries, we estimate a separated regression for the case of each of the 13 exporters included in the sample. We analyse the extent to which imports from developed and developing countries are deterred by tariffs and by trade facilitation barriers.

Results of estimating equation (3) are shown in Table 3. With respect to the trade facilitation variables, the coefficients present the expected sign and are significant for China, Germany, Japan, United Kingdom and the United Stated. Imports from the UK, Germany and China face the largest elasticity with respect to number of documents needed to import. A possible explanation could be that more complicated procedures are required for goods coming from larger exporters whose exports are very competitive as a means of deterring stronger competitors from accessing the market.

Moreover, trade facilitation variables are of greater importance than tariff barriers, although these variables present lower elasticity for goods coming from Australia and Spain, and excluding the United States, which shows an elasticity of –0.15 in the tariff variable.

Additionally, the magnitude of the coefficient of the transport cost variable for exporters located far away from the main markets (Australia, China and Japan) is considerably higher than the average value obtained in Table 2. As the transport cost variable includes only internal transport costs, and we are controlling for distance in the model, the question that arises is why products imported from Australia, China and Japan face greater elasticity with respect to internal transport costs. A possible explanation is that importers easily substitute goods coming from those locations with goods coming from nearer exporters with lower internal transport costs.

Otherwise, unexpected results are obtained in medium-income and low-income countries such as Bolivia, Brazil, Chile, Czech Republic and Ghana. Trade facilitation variables are not significant or do not show the expected sign, while tariff barriers are not significant. This result could indicate that the model we are estimating does not perform well for developing exporters, for which other factors, such as exchange rates or infrastructures, could be the main determinants of exports.

Table 3. Determinants of exports from each of the 13 exporting countries.

	Tariffs	Technological innovation	Transport costs	Time	Documents	Observations	R-squared	RMSE
Australia	-0.06*** (-4.87)	0.36*** (7.54)	-0.49*** (-12.80)	-0.20*** (-7.82)	0.06* (1.78)	7150	0.02	1.70
Bolivia	-0.02 (-0.88)	-0.76** (-2.05)	-0.11 (-0.50)	0.47** (2.14)	0.44** (2.03)	301	0.02	1.52
Brazil	-0.01 (-0.73)	0.02 (0.27)	0.11*** (2.94)	0.00 (0.01)	0.01 (0.37)	8559	0.05	1.63
Chile	0.01 (0.57)	0.14 (1.18)	-0.02 (-0.33)	-0.05 (-0.90)	0.01 (0.07)	2775	0.07	1.59
China	0.04*** (3.73)	0.66*** (23.51)	-0.62*** (-25.87)	-0.59*** (-33.64)	-0.67*** (-23.35)	18495	0.17	1.77
Czech Republic	-0.02*** (-3.00)	0.51*** (7.43)	0.30*** (7.43)	0.07** (2.34)	0.08 (1.56)	3939	0.03	1.41
Germany	-0.06*** (-11.81)	1.21*** (47.81)	-0.16*** (-8.25)	-0.58*** (-43.94)	-0.76*** (-36.63)	26547	0.21	1.73
Ghana	0.03 (1.63)	0.29 (0.78)	-0.03 (-0.15)	-0.22 (-1.53)	-0.19 (-1.05)	306	0.03	1.66
Japan	0.01 (0.60)	0.53*** (14.47)	-0.63*** (-21.35)	-0.50*** (-23.80)	-0.34*** (-11.19)	15901	0.14	1.94
South Africa	-0.05*** (-3.77)	-0.15*** (-3.90)	0.12*** (4.18)	0.02 (0.84)	0.11*** (2.90)	6326	0.03	1.57
Spain	0.02*** (3.53)	0.41*** (13.02)	0.07*** (3.51)	-0.21*** (-12.78)	-0.12*** (-5.05)	16043	0.13	1.55
United Kingdom	-0.03*** (-4.43)	0.86*** (35.27)	-0.24*** (-12.66)	-0.54*** (-39.49)	-0.71*** (-33.63)	22004	0.18	1.62
United States	-0.15*** (-10.50)	0.87*** (22.88)	-0.24*** (-8.07)	-0.37*** (-19.35)	-0.43*** (-17.07)	21539	0.17	1.93

Notes: ***, **, * indicate significance at 1%, 5% and 10%, respectively. T-statistics are given in brackets. The dependent variable is the natural logarithm of exports in value (thousands of US$) of commodity k from country i to j. The estimation uses White's heteroscedasticity-consistent standard errors. Data is for the year 2000. Number of observations, R-squared and RMSE correspond to regression including technological innovation as a trade facilitation measure.

3.2.2. The effect of tariff barriers and trade facilitation measures in different sectors

The effect of trade barriers and trade facilitation variables on imports are analysed and compared for different sectors. Two classifications are considered. Firstly, the model is estimated for each of the sections of the SITC (Sections 0-9). Secondly, the model is estimated for differentiated, reference priced and homogeneous goods according to the Rauch classification. High-technology goods, as defined in the OECD (2001) and Eurostat (1999) classifications are also considered as a separate category. Table 4 shows main results.

The coefficient of tariffs is negative and significant (excluding Sections 2 and 9) and shows elasticity between -0.01 and –0.05. According to the results obtained, the greatest tariff elasticities are found in sensitive products such as food and live animals; mineral fuels, lubricants and related materials; and animal and vegetable oils, fats and waxes.

These results can be compared with those obtained by other authors. For example, Fink et al. (2005) also estimate a sectoral gravity equation using trade flows classified according to Rauch classification. These authors find that the estimated coefficient for the tariff variable is not statistically different from zero in the case of differentiated goods, whereas it is negative and statistically significant in the case of reference-priced and homogeneous goods. Along the same lines, Tang (2006) analyses the factors that contribute to the growth of US imports in differentiated, referenced and homogeneous goods. Although US tariffs on differentiated goods have been reduced by 2.25% in the period 1975-2000, this reduction explains only 0.2% of the growth in US imports of differentiated goods. Meanwhile, the contribution of decreasing tariff barriers on the growth of US imports is

about 8% for referenced and 13.7% homogeneous goods. Tariff barriers therefore play a more important role for trade in reference-priced and homogeneous goods.

In relation to trade facilitation variables, results show that improvements in service infrastructure (measured as the technological achievement in countries), and reducing the number of days and documents required for trade are of greater importance than transport costs (which includes all the official fees associated with completing the procedures to export or import goods). Nonetheless, transport costs play an important role in the case of trade of goods included in Section 8 and high-technology goods. Finally, equation (3) is estimated for differentiated, referenced and homogeneous goods (Rauch, 1999) and for high-technology sectors.[8] Results show that trade facilitation procedures would benefit differentiated, referenced and high-technology sectors to a greater extent than in the case of trade in homogeneous goods. This result is in line with the assumption that the search model applies most strongly to differentiated products and most weakly to products traded on organised exchanges (Rauch, 1999). Therefore, trade facilitation variables 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 in differentiated products.

[8] Based on 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 goods using the Standard International Trade Classification (SITC) Revision 3 at the 4-digit level. Table A.3, in Appendix, shows the list of high-technology sectors considered in the regressions.

Table 4. Determinants of bilateral trade. Different sectors.

	Tariffs	Technological innovation	Transport costs	Time	Documents	Observations	R-squared	RMSE
Section 0	-0.04*** (-8.25)	0.24*** (7.68)	0.05** (2.14)	-0.23*** (-14.17)	-0.35*** (-13.23)	12364	0.12	1.71
Section 1	-0.02* (-1.72)	0.51*** (5.99)	-0.03 (-0.52)	-0.29*** (-6.82)	-0.35*** (4.95)	1688	0.09	1.79
Section 2	-0.01 (-1.4)	0.21*** (5.48)	0.04 (1.49)	-0.14*** (-6.5)	-0.01 (-0.44)	9307	0.09	1.75
Section 3	-0.05*** (-3.14)	0.61*** (6.39)	-0.06 (-0.81)	-0.37*** (-6.84)	-0.53*** (-6.08)	1994	0.15	2.09
Section 4	-0.05*** (-2.87)	0.21** (2.23)	0.28*** (3.65)	-0.22*** (-4.22)	-0.28*** (-3.58)	1249	0.06	1.45
Section 5	-0.03*** (-6.52)	0.72*** (37.16)	0.06*** (4.09)	-0.45*** (-38.84)	-0.53*** (-27.91)	23423	0.30	1.54
Section 6	-0.04*** (-13.43)	0.50*** (33.83)	-0.01 (-0.48)	-0.36*** (-42.06)	-0.53*** (-37.52)	39650	0.22	1.57
Section 7	-0.02*** (-5.11)	0.82*** (50.49)	-0.08*** (-5.83)	-0.53*** (-56.07)	-0.69*** (-44.05)	41575	0.29	1.7
Section 8	-0.01*** (-3.10)	0.48*** (22.49)	-0.28*** (-14.72)	-0.41*** (-33.60)	-0.65*** (-32.15)	21528	0.26	1.69
Section 9	-0.02 (-0.75)	1.03*** (4.96)	-0.01 (-0.08)	-0.42*** (-3.66)	-0.39** (-2.17)	468	0.23	2.25
Differentiated	-0.02*** (-12.15)	0.63*** (62.53)	-0.06*** (-7.24)	-0.43*** (-72.72)	-0.61*** (-61.49)	95856	0.24	1.69
Referenced	-0.04*** (-12.31)	0.57*** (34.44)	0.04*** (2.91)	-0.36*** (-37.62)	-0.48*** (-30.86)	36178	0.19	1.62
Homogeneous	-0.05*** (-6.87)	0.11** (2.56)	0.04 (1.20)	-0.15*** (-6.23)	-0.11*** (-2.80)	7700	0.08	1.92
High-technology	-0.02*** (-5.05)	0.94*** (48.06)	-0.15*** (-8.69)	-0.59*** (-51.32)	-0.76*** (-39.90)	27776	0.34	1.70

Notes: ***, **, * indicate significance at 1%, 5% and 10%, respectively. T-statistics are given in brackets. The dependent variable is the natural logarithm of exports in value (thousands of US$) of commodity k from country i to j. The estimation uses White's heteroscedasticity-consistent standard errors. Data is for the year 2000. Number of observations, R-squared and RMSE correspond to regression including technological innovation as a trade facilitation measure.

4. Conclusions

In this paper, the effect of trade barriers is analysed using sectoral data as disaggregion allows a more accurate analysis of policies for different products. Then, the effect of tariff protection and trade facilitation measures on trade flows is compared. Time, number of documents and cost of trade as well as information technology achievements are used as proxies for trade facilitation, while tariffs are measured as the weighted

average effectively applied tariffs for each country importing each product from the 13 exporters in the sample.

Overall, the main results indicate that trade facilitation variables are, in relative terms, much more important than tariffs, and this result is also obtained when country and sector-heterogeneity are considered.

The single-exporter regressions indicate that our model performs better for developed countries than for developing exporters, for which other factors, such as exchange rates, market access or infrastructures, could be the main determinants of exports.

The results for specific type of goods indicate that trade facilitation improvements would benefit trade in differentiated and high-technology sectors to a greater extent than trade in homogeneous goods, basically due to the different weight of fixed costs that both groups of products are assuming.

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APPENDIX

Table A.1. 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, Monaco	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	Guinea Bissau	GNB	107	Netherlands	NLD	149	Tanzania	TZA
24	Burundi	BDI	66	Guyana	GUY	108	New Caledonia	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	Côte 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, and the United States.

Table A.2. Beta coefficients.

Variables	Table 2
Income	0.32
Distance	-0.20
Tariffs	-0.05
Technological innovation	0.16
Transport costs	-0.01
Time	-0.17
Documents	-0.14

Table A.3. 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. FROM 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.4. Average weighted tariffs. Summary statistics.

	Observations	Mean	Std. Dev.	Observations	Mean	Std. Dev.
Exporter	The importing country is developed			The importing country is developing		
Australia	5725	3.84	7.86	2532	10.60	11.71
Bolivia	224	5.64	11.83	93	12.57	5.46
Brazil	6013	4.81	6.51	3806	10.79	8.59
Chile	1677	6.87	9.10	1391	12.31	5.97
China	13915	5.09	5.76	9717	15.40	8.83
Czech Republic	2996	5.81	6.83	2208	10.33	10.72
Germany	21380	3.74	7.27	13849	11.02	8.22
Ghana	303	0.69	2.26	53	17.55	13.09
Japan	11893	5.73	16.30	7365	13.99	10.34
South Africa	4358	5.28	11.54	4052	12.41	8.51
Spain	12691	3.75	6.54	6980	14.29	9.84
United Kingdom	18659	3.71	10.03	9754	12.43	18.44
United States	17320	5.44	21.38	7349	11.71	7.74

Both trading partners are developed			
Observations	Mean	Std. Dev.	Equal to 0
96699	4.48	12.83	33.19%
One or both trading partners are developing			
Observations	Mean	Std. Dev.	Equal to 0
94414	10.59	10.42	4.11%