Fecha de recepción: 13/02/ 2019
Fecha de aprobación: 26/03/2019

Casa Editora
UNIVERSIDAD DEL AZUAY 50 AÑOS

05

APPLICATION OF A GRAVITY MODEL TO THE BILATERAL TRADE BETWEEN ECUADOR AND GERMANY

Casa Editora | UNIVERSIDAD DEL AZUAY 50 AÑOS

Abstract

Paulo García[1]
Luis Tonón[2]

The objective of this research is to determine the influence of the main factors that affect bilateral trade between Ecuador and Germany through the application of a gravity model, seeking to answer the question: how does the bilateral trade flows between Ecuador and Germany affect the size of their economies and the costs of trade? To solve it, an analysis of the bilateral trade flows between Ecuador and Germany in relation to the GDP of each country and the trade costs generated will be carried out. The study covers the period 2002 - 2017 and the information was obtained from official data bases of both countries and the United Nations. For the calculations, the linear regression using least squares was used with the software Microsoft Excel. The findings make it possible to show that Ecuador's GDP is the most influential factor in bilateral trade flows, while Germany's GDP has an opposite effect to that expected, decreasing trade when the GDP increases. Likewise, it is determined that, although total trade flows decrease with increasing trade costs, Ecuadorian imports do not decrease in this increase.

1
Licenciado en Estudios Internacionales, Universidad del Azuay. Email: paulogarcia-flores@ec.uazuay.edu.ec

2
Magister Luis Tonón Profesor de la Universidad del Azuay. Email: ltono@uzuay.edu.ec

UNIVERSIDAD DEL AZUAY 50 AÑOS | Casa Editora

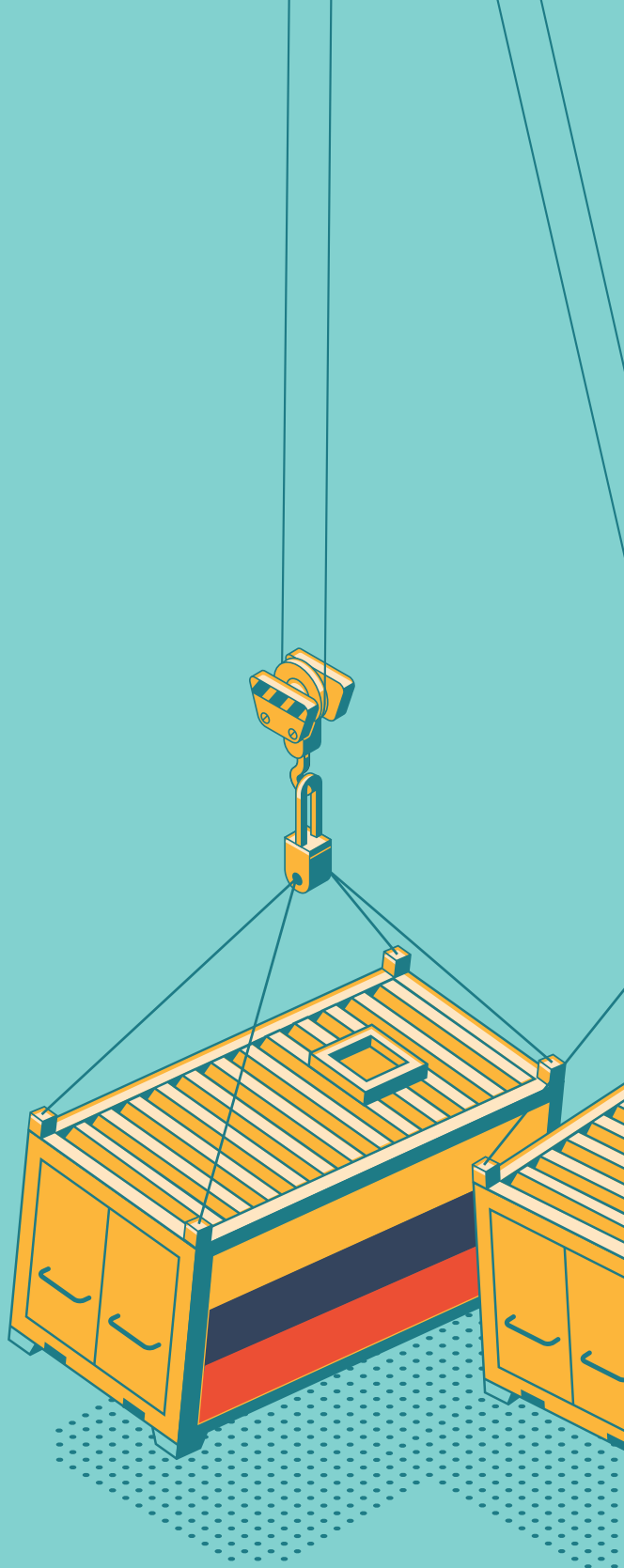
Resumen

El objetivo de esta investigación es determinar la influencia de los principales factores que afectan el comercio bilateral entre Ecuador y Alemania mediante la aplicación de un modelo de gravedad, buscando responder la pregunta ¿cómo afecta a los flujos comerciales bilaterales entre Ecuador y Alemania el tamaño de sus economías y los costos de comercio? Para resolverla, se realizar un análisis de los flujos comerciales bilaterales entre Ecuador y Alemania en relación al PIB de cada país y los costos de comercio generados. El estudio comprende el periodo 2002 – 2017 y se obtuvo la información de bases de fuentes oficiales de ambos países y de Naciones Unidas. Para los cálculos se utilizó la regresión lineal mediante mínimos cuadrados empleando el programa Microsoft Excel. Los hallazgos permiten evidenciar que el PIB de Ecuador es el factor más influyente en los flujos comerciales bilaterales mientras que el PIB de Alemania presenta un efecto inverso al esperado, al disminuir el comercio cuando aumenta el PIB. De igual forma se llega a determinar que, aunque los flujos comerciales totales disminuyen al aumentar los costos de comercio, las importaciones ecuatorianas no disminuyen con este aumento.

Keywords

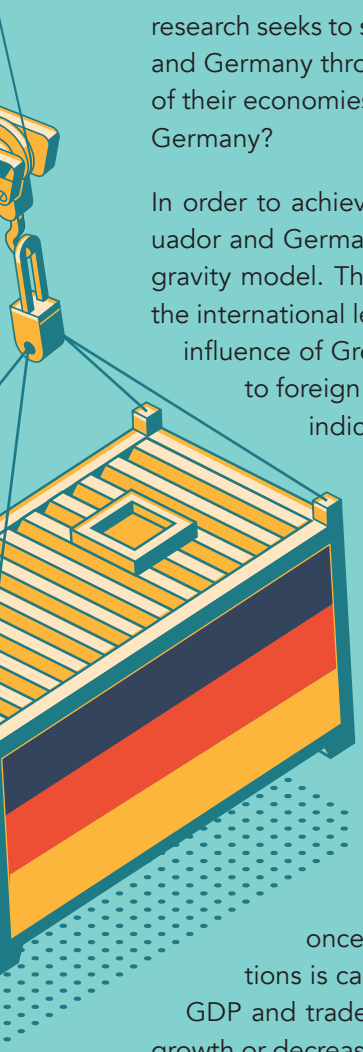
Germany, trade, Ecuador, gravity, Model.

Alemania, comercio, Ecuador, gravedad, modelo.



Introduction

Ecuador is currently in a process of commercial opening with several countries and trade blocs, including the European Union. Within this bloc, Germany was Ecuador's main trade partner between 2002 and 2017. At first glance this may seem strange, since within the European Union itself there are countries that are closer in terms of language, culture and physical distance, such as Spain, but which, although they have come closer, have not become as relevant to Ecuador as Germany has been. However, when a deeper analysis is made it can be noticed that the characteristics of Germany, such as being the largest and most populous economy in the whole of the European Union, seem to show that it is natural to have higher trade flows than with other countries. Thus, this research seeks to study the influence of the main factors in bilateral trade between Ecuador and Germany through a gravity model in order to answer the question: How does the size of their economies and the costs of trade affect bilateral trade flows between Ecuador and Germany?



In order to achieve the above objective, an analysis of bilateral trade flows between Ecuador and Germany in the period 2002 - 2017 is carried out through the application of a gravity model. This model has been chosen for this study due to its wide acceptance at the international level for analyzing trade flows and its ability to provide information on the influence of Gross Domestic Product (GDP) and trade costs. The gravity model applied to foreign trade is based on the same logic as Isaac Newton's Law of Gravity, which indicates that the attraction generated by one body with respect to another varies according to the size and distance of the bodies. This, applied to countries and their trade, means that the size of an economy, measured by its Gross Domestic Product (GDP), directly affects trade flows, increasing the larger the economy; while trade costs affect inversely, indicating that when trade costs are larger, the size of trade flows should decrease. With this, the model allows to obtain information related to the influence of these factors on bilateral trade flows.

With this theoretical background, the document analyses the GDPs of Germany and Ecuador and the trade flows, consisting of imports and exports, between the countries. The data is obtained from various official sources and then transformed into U.S. dollars and then the regression is performed using least squares in Microsoft Excel. Finally, once the results of the model have been obtained, an analysis of its implications is carried out. In this way, it is possible to see the influence of each country's GDP and trade costs on bilateral trade flows and to understand the way in which the growth or decrease of any of the economies or the increase or decrease of trade costs may affect trade between the two countries.

Development

Historically, the gravity model has been widely used to analyze international trade flows (Krugman, Obstfeld, & Melitz, International Economics, 2018). It has come a long way since it was first used almost sixty years ago by (Timberger, Shaping the World Economy; Suggestions for an International Economic Policy, 1960). It became very popular with the passage of time with studies that confirmed its empirical usefulness and that were later based theoretically (Brakman & van Bergeijk, The Gravity Model in International Trade: Advances and Applications, 2010). For this reason, the gravity model is ideal to be applied in this case.

The equation used for the model of gravity presented in this study was the one indicated by the authors (Krugman, Obstfeld, & Melitz, 2018), which is explained below:

$$T_{ij} = \frac{A * Y_i * Y_j}{D_{ij}}$$

Where:

- **A** is a constant. This includes other variables that influence trade flows.
- **T_{ij}** is the value of trade between country i and country j.
- **Y_i** is the GDP of country i.
- **Y_j** is the GDP of country j.
- **D_{ij}** is the distance between the two countries, which in this case is considered as trade costs (C), as explained later in this document.

Subsequently, the different values were converted to logarithms to simplify the equation as follows based on the properties of the logarithms:

$$\ln(T_{ij}) = \beta_0 + \beta_1 \ln(Y_i) + \beta_2 \ln(Y_j) - \beta_3 \ln(C_{ij}) + \beta_4 \text{Dummy}$$

The gravity model applied to foreign trade has similarities with that used by Isaac Newton (Krugman, Obstfeld, & Melitz, International Economics, 2018). In its application to foreign trade, size is represented by Gross Domestic Product (GDP) while distance is maintained as a proxy of the trade costs needed to carry out the commercial exchange. The higher the GDP, the higher the trade flows; and the higher the trade costs, the lower the trade flows. This configures the relationship between the two main factors of the equation.

This is because, on the one hand, the size of GDP, as indicated by (Yotov, Piermartini, Monteiro, & Larch, An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model, 2016), carries useful information about the relationship between the size of the country, its purchasing power and bilateral trade flows: large and rich markets import more from all sources, have greater purchasing power and trade flows will increase the more similar in size are the trading partners.

The distance, on the other hand, serves to observe the difficulty of trading between countries. If the distance is less than the average barriers the country faces in trading with others, known as multilateral resistance term, trade will be easier. Instead, if it is greater than this term, trade will be more complicated for the countries (Anderson & van Wincoop, Gravity with Gravitas: A Solution to the Border Puzzle, 2003). This is due to the reality of international trade, where choices are made on the basis of opportunity cost. This, being done at the same time by all the countries, generates an overall balance at the international level (Krugman, Obstfeld, & Melitz, 2018). The distance was originally obtained from the geographical distance between the capitals or the borders of the countries, but then it went on to include many other factors, such as transportation costs, the time spent during shipping, taxes, communication costs and even the cultural distance; that allowed to understand the difficulty of a bilateral trade between two countries (De Benedictis & Taglioni, The Gravity Model in International Trade, 2011). Because obtaining these factors with accuracy is very complicated, distance is used as an approximation to them (De Benedictis & Taglioni, The Gravity Model in International Trade, 2011).

In turn, in this document distance is replaced by trade costs. This is because distance, being constant every year, would become zero at the moment of being transformed into logarithms. Similarly, because distance is an approximation, the use of trade costs can fulfill the same function within the gravity model. Thus, assuming that trade costs can be considered as all the costs incurred in bringing a good to an end user, with the exception of the cost of producing the good itself (De, Why Trade Costs Matter?, 2006); it is noted that they fit into the paper on which distance is usually used if values are calculated from the time the product leaves the first country to the time it arrives in the other country (De, Why Trade Costs Matter?, 2006). In addition, generating a model based on these values is a method that has already been used previously by authors such as (Limão & Venables, Infrastructure, Geographical Disadvantage, Transport Costs, and Trade, 2001).

Precisely, the values of exports and imports in FOB and CIF were used to approximate trade costs. The acronyms FOB and CIF are derived from the Terms of International Trade (INCOTERMS) created by the International Chamber of Commerce. These are used to know the value, responsibilities and risks involved in the transport of goods at different stages of their journey (International Chamber of Commerce, 2010). Therefore, FOB means "free on board", indicating that this value includes the cost of goods, cargo and transport in the country of origin, costs of customs formalities and cargo handling costs in the port of origin (International Chamber of Commerce, 2010). Also, CIF means "cost, insurance and freight" and that, in other words, includes in addition to what is already included in the INCOTERM FOB, transport or freight and cargo insurance (International Chamber of Commerce, 2010). Thus, the FOB values are a good approximation to know the costs of the products in the country of origin while the CIF values allow to have an idea of the values that those products would have when arriving at the destination country, thus being able to infer the cost of sending the different products from one country to another. Based on the above, as these terms are widely used in international trade, including within the databases used, and taking into account their relationship with the costs generated during the process of exporting or importing a product, the values indicated in these terms can be used to calculate trade costs (Limão & Venables, Infrastructure, Geographical Disadvantage, Transport Costs, and Trade, 2001).

For this model, data were obtained from the following sources:

- **GDP of Ecuador:** (Central Bank of Ecuador, 2018).
- **GDP of Germany:** (Federal Statistical Office, 2018).
- **Imports CIF and FOB from Ecuador:** (Central Bank of Ecuador, 2018).
- **FOB exports from Ecuador:** (Central Bank of Ecuador, 2018).
- **CIF imports from Germany:** (United Nations, 2017).

For the conversion of the German GDP values from euros to US dollars, the averages of each year of the official exchange rate reflected by the Central Bank of Ecuador were used. CIF values relating to imports by Germany did not need to be converted into dollars because the United Nations database already shows them converted into dollars.

In addition, a dummy variable was used to indicate the presence of safeguards in 2015, 2016 and 2017. This type of variable is used to represent the existence or not of a particular element in the statistical calculation and only has two possible values (Gujarati & Porter, Econometría, 2010). In this case the two values were: zero (0) in the moments in which the safeguards were not present and one (1) when they were present. This, in order to increase the accuracy of the model by taking into account a factor that increased trade barriers.

The trade costs were obtained as follows: First, Ecuador's FOB imports were subtracted from Ecuador's CIF imports. Second, FOB exports from Ecuador were subtracted from CIF imports from Germany, as it did not have the data on German imports in FOB from the same source. Third, the two values resulting from the previous steps were added to obtain the costs of trade.

> With the information obtained to calculate the model, a regression was carried out using Microsoft Excel. This was done using the least squares method. In addition, the model was applied as follows. First, individually to the flows of imports and exports. Second, to the total flows. This in order to better identify the importance of each part of the flow and to perform a more complete analysis.

The results of the application of the gravity model are shown in Table 1:

Table 1. Results of the application of the regression to the trade flows between Ecuador and Germany from 2002 to 2017

Type	R^2	Adjusted R^2	Ecuation
Exports	0.8713	0.8392	$\ln(X_{Ecuador\ Germany}) = -24{,}2890 + 1{,}7886\ln(Y_{Germany}) - 0{,}1840\ln(D_{Ecuador\ Germany}) + 0{,}0301 Dummy$
Imports	0.9908	0.9885	$\ln(M_{Ecuador\ Germany}) = -3{,}7310 + 0{,}5347\ln(Y_{Ecuador}) + 0{,}7021\ln(D_{Ecuador\ Germany}) - 0{,}0766 Dummy$
Total trade flows	0.9811	0.9743	$\ln(T_{Ecuador\ Germany}) = -2{,}7047 + 1{,}0567\ln(Y_{Ecuador}) - 0{,}0463\ln(Y_{Germany}) - 0{,}1448\ln(D_{Ecuador\ Germany}) - 0{,}3459 Dummy$

Author: García, Paulo.

Results of the application of the gravity model in exports, imports and total flows. Imports and exports are considered from Ecuador's point of view. The results reflect the influence of different factors on trade between the two countries.

The following information can be interpreted from these results:

The effect of Ecuador's GDP increase is positive on the trade flows, in other words, for every 1% increase in GDP, the trade flows increase by 1.0567%. In contrast, for every 1% increase in Germany's GDP, trade flows decrease by 0.0463%. Additionally, trade costs also influence with a decrease in trade flows of 0.1448% for each 1% increase in costs. Safeguards also have a negative effect, with a 0.3459% decrease in trade flow.

The value of $R^{2,}$ which explains how well the data are adjusted to the regression line (Gujarati & Porter, Econometría, 2010), indicates that the reliability is close to 98%, however, it is necessary to make the following precisions. The values of GDP Ecuador and Safeguards individually speaking are statistically significant. The German GDP and Total Cost of Trade values are not statistically significant The latter is due to a problem of multicollinearity, a high linear relationship between variables that affects the correct performance of the regression (Gujarati & Porter, Econometría, 2010), between the GDPs of the countries. However, this drawback goes beyond the limits proposed for this analysis, and therefore requires more future research to improve model accuracy and avoid multicollinearity.

The precision of the model seems to be due in particular to the behavior of imports. Applying the model only to imports, the values of R2 and adjusted R2, reach 99.08% and 98.85% respectively, while in the case of applying it only to exports, the values are 87.13% and 83.92% respectively. These values, which are more accurate for imports than for exports, explain why Ecuador's GDP is the least likely to cause an error: because of its influence on what Ecuadorians buy from Germany. Therefore, Ecuador's GDP has a greater influence than Germany's GDP and it is evident that the Ecuadorian economy and buyers are the most influential in the total trade flows.

In addition, it can be seen that trade costs do not have a negative effect on imports. Thus, despite the increase in trade costs in the case of imports, imports do not decrease but increase. This means that the increase in trade costs on imports does not matter because Ecuadorian consumers will continue to buy German products.

Conclusions

As noted, the application of the gravity model provides information on the influence of GDPs and trade costs on trade flows. On the one hand, Ecuador's growth is positive for the increase in trade flows, which means that by increasing the size of the economy, the country can import and export more products. On the other hand, the growth of the German GDP seems to affect the opposite of the Ecuadorian GDP, reducing the commercial flow, which indicates that, as the German economy grows, the consumption of Ecuadorian products does not necessarily increase. Likewise, trade costs have a negative influence, as expected, on the behavior of commercial flows, decreasing their quantity. Also, as expected, safeguards negatively affect flows.

Another point to highlight is the influence of the Ecuadorian GDP on the results. While it can be seen that the German GDP has a lesser influence, the Ecuadorian GDP is the most important factor to explain the increases or decreases in trade between the two countries. This seems to be especially related to the flow of imports, which has a greater adjustment than that of exports. In other words, the Ecuadorian economy is the one that most influences trade between the two countries because of the products that are purchased by Ecuadorians.

It can also be seen that imports have a behavior contrary to that expected with the increase in trade costs. Precisely, imports behave like luxury goods or goods without easy substitutes in other markets. This means that when trade costs increase, imports also increase, rather than decrease. Thus, despite rising costs, Ecuador continues to import products from Germany.

The model explained in this article is a first approximation that requires further and deeper analysis in the future. The model has a multicollinearity problem so it needs more research. However, this does not prevent it from presenting useful information for a first analysis. In the future, it would be ideal to continue with the analysis by also reviewing the impact generated by the Multiparty Agreement with the European Union as gravity models are ideal for conducting research on the impact of trade agreements and could allow for a quantitative perception of the impact, whether positive or negative, of the agreement. For this reason, this first approach presents useful information for the present and future analysis of bilateral trade with the European Union.

Annexes

Annex 1

Table 2. GDPs and exchange rates for transformation into US dollars

Year	GDP Ecuador	GDP Germany		
	In thousands of US dollars	Thousands of euros	Exchange rate	In thousands of US dollars
2002	28,548,945	2,209,290,000	0.9452	2,088,220,908
2003	32,432,858	2,220. 080,000	1.1303	2,509,356,424
2004	36,591,661	2,270,620,000	1.2435	2,823,515,970
2005	41,507,085	2,300,860,000	1.2445	2,863,420,270
2006	46,802,044	2,393,250,000	1.2556	3,004,964,700
2007	51,007,777	2,513,230,000	1.3701	3,443,376,423
2008	61,762,635	2,561,740,000	1.4711	3,768,575,714
2009	62,519,686	2,460,280,000	1.3946	3,431,106,488
2010	69,555,367	2,580,060,000	1.3261	3,421,417,566
2011	79,276 .664	2,703,120,000	1.3917	3,761,932,104
2012	87,924,544	2,758,260,000	1.2847	3,543,536,622
2013	95,129,659	2,826,240,000	1.3279	3,752,964,096
2014	101,726,331	2,932,470,000	1.3291	3,897,545,877
2015	99,290,381	3,043,650,000	1.1100	3,378,451,500
2016	98,613,972	3,144,050,000	1.1569	3,637,351,445
2017	103,056,619	3,263,350,000	1.1297	3,686,606,495

Source: www.bce.fin.ec and www.destatis.de.

Author: García, Paulo.

Table showing the Gross Domestic Products (GDPs) of Ecuador and Germany, including the annual exchange rates at which the values of Germany's GDP were converted into U.S. dollars.

Annex 2

Table 3. Data used for regression in thousands of US dollars

Year	GDP Ecuador	GDP Germany	FOB Imports	CIF Imports	Imports Trade Costs	FOB Exports	CIF Exports	Export Trade Costs	FOB Trade Flows	Trade Costs	Safeguards
2002	$ 28.548.945,00	$ 2.086.740.683,70	$ 170.255,36	$ 181.497,79	$ 11.242,43	$ 172.165,76	$ 323.902,00	$ 151.736,24	$ 342.421,12	$ 162.978,67	0
2003	$ 32.432.859,00	$ 2.502.096.762,40	$ 167.172,64	$ 178.100,53	$ 10.927,89	$ 215.687,08	$ 403.910,00	$ 188.222,92	$ 382.859,72	$ 199.150,81	0
2004	$ 36.591.661,00	$ 2.823.243.495,60	$ 195.689,91	$ 206.554,22	$ 10.864,31	$ 198.204,34	$ 453.173,00	$ 254.968,66	$ 393.894,25	$ 265.832,97	0
2005	$ 41.507.085,00	$ 2.864.478.665,60	$ 219.158,46	$ 232.161,60	$ 13.003,14	$ 201.374,47	$ 537.430,00	$ 336.055,53	$ 420.532,93	$ 349.058,67	0
2006	$ 46.802.044,00	$ 3.007.166.490,00	$ 223.306,43	$ 237.301,58	$ 13.995,15	$ 223.224,11	$ 473.810,00	$ 250.585,89	$ 446.530,54	$ 264.581,04	0
2007	$ 51.007.777,00	$ 3.445.512.668,50	$ 272.692,19	$ 288.396,13	$ 15.703,94	$ 247.630,28	$ 518.003,00	$ 270.372,72	$ 520.322,47	$ 286.076,66	0
2008	$ 61.762.635,00	$ 3.767.192.374,40	$ 354.300,80	$ 375.738,50	$ 21.437,70	$ 314.976,96	$ 665.362,00	$ 350.385,04	$ 669.277,76	$ 371.822,74	0
2009	$ 62.519.686,00	$ 3.428.769.222,00	$ 365.379,81	$ 384.293,20	$ 18.913,39	$ 326.865,48	$ 558.857,00	$ 231.991,52	$ 692.245,29	$ 250.904,91	0
2010	$ 69.555.367,00	$ 3.426.526.084,80	$ 451.743,34	$ 475.646,65	$ 23.903,31	$ 320.263,71	$ 519.883,23	$ 199.619,52	$ 772.007,05	$ 223.522,83	0
2011	$ 79.276.664,00	$ 3.765.094.754,40	$ 539.405,58	$ 568.468,78	$ 29.063,20	$ 492.588,10	$ 700.540,66	$ 207.952,56	$ 1.031.993,68	$ 237.015,76	0
2012	$ 87.924.544,00	$ 3.545.963.890,80	$ 563.932,62	$ 592.207,54	$ 28.274,92	$ 376.784,02	$ 682.651,91	$ 305.867,89	$ 940.716,64	$ 334.142,81	0
2013	$ 95.129.659,00	$ 3.752.172.748,80	$ 626.845,00	$ 655.895,10	$ 29.050,10	$ 410.662,30	$ 651.529,71	$ 240.867,41	$ 1.037.507,30	$ 269.917,51	0
2014	$ 101.726.331,00	$ 3.895.773.198,89	$ 629.361,20	$ 657.452,20	$ 28.091,00	$ 525.637,40	$ 704.536,33	$ 178.898,93	$ 1.154.998,60	$ 206.989,93	0
2015	$ 99.290.381,00	$ 3.382.834.356,00	$ 525.933,90	$ 546.316,30	$ 20.382,40	$ 548.916,50	$ 555.816,49	$ 6.899,99	$ 1.074.850,40	$ 27.282,39	1
2016	$ 98.613.972,00	$ 3.479.677.337,50	$ 422.430,20	$ 438.224,50	$ 15.794,30	$ 530.651,50	$ 572.045,57	$ 41.394,07	$ 953.081,70	$ 57.188,37	1
2017	$ 103.056.619,00	$ 3.685.105.354,00	$ 511.215,40	$ 530.473,50	$ 19.258,10	$ 502.227,70	$ 571.879,35	$ 69.651,65	$ 1.013.443,10	$ 88.909,75	1

Author: García, Paulo.

Table indicating the values, prior to being converted to logarithms, used for the calculation of the regression.

Annex 3

Table 4. Data used for regression in logarithms

Year	GDP Ecuador	GDP Germany	FOB Imports	CIF Imports	Imports Trade Costs	FOB Exports	CIF Exports	Export Trade Costs	FOB Trade Flows	Trade Costs	Safeguards
2002	17,16713054	21,4588692	12,04505471	12,10899876	9,327450292	12,05621301	12,68819628	11,92989903	12,7437966	12,00137461	0
2003	17,29468263	21,64039492	12,02678233	12,09010345	9,299073516	12,28158393	12,90894736	12,14538228	12,85542393	12,20181766	0
2004	17,41533093	21,76115224	12,18428659	12,23831822	9,293238384	12,1970538	13,02402923	12,44889591	12,88383775	12,49062346	0
2005	17,54137469	21,7756522	12,29755031	12,35518896	9,472946146	12,21292149	13,1945538	12,72503169	12,94927807	12,7629953	0
2006	17,66143744	21,82426411	12,31630023	12,3770871	9,54646612	12,31593152	13,06856168	12,43155701	13,00926308	12,48590287	0
2007	17,74748867	21,96033855	12,51609893	12,57209027	9,661666915	12,41969211	13,15773631	12,50755673	13,16220403	12,5640151	0
2008	17,93880913	22,04959583	12,77790155	12,8366487	9,972906333	12,66025477	13,40808653	12,76678794	13,41395444	12,82617251	0
2009	17,95099204	21,95546721	12,80869267	12,85916108	9,847625416	12,69730399	13,23364891	12,3544561	13,44769564	12,4328293	0
2010	18,05763364	21,95481278	13,02086947	13,07243053	10,08177222	12,67690003	13,16135951	12,20416843	13,55674896	12,31726883	0
2011	18,18845437	22,04903887	13,19822303	13,25070167	10,27722805	13,10742861	13,45960769	12,24506526	13,8470031	12,37588192	0
2012	18,29198955	21,98907586	13,24269006	13,29161243	10,24973047	12,83942741	13,43374036	12,63090857	13,75439725	12,71932376	0
2013	18,37075135	22,04560091	13,34845458	13,39375615	10,2767772	12,9255265	13,38707827	12,39200189	13,85233157	12,50587167	0
2014	18,43779674	22,08315801	13,35246062	13,39612734	10,24320452	13,1723669	13,46529518	12,09457629	13,95960969	12,24042542	0
2015	18,41355926	21,94197976	13,17293082	13,21095339	9,922427062	13,21570161	13,22819347	8,839275386	13,88769205	10,21399675	1
2016	18,40672351	21,97020541	12,95377951	12,99048662	9,667404394	13,18186078	13,25697394	10,63089294	13,76745591	10,95410585	1
2017	18,45078909	22,02756495	13,14454631	13,18152528	9,86568703	13,12680888	13,25668332	11,15126165	13,8288641	11,39537708	1

Author: García, Paulo.

Table that indicates the values, already converted into logarithms, entered into Microsoft Excel to calculate the regression.

Annex 4

Table 5. Summary table of the regression of total flows

Regression Statistics	
Multiple R	0.990514341
R Square	0.981118659
Adjusted R Square	0.974252717
Standard Error	0.069525479
Observations	16

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	2.762926768	0.690731692	142.8964367	2.10911E-09
Residual	11	0.053171715	0.004833792		
Total	15	2.816098483			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-2.704707054	4.312619814	-0.627161023	0.543351749	-12.19671927	6.787305158	-12.19671927	6.787305158
GDP Ecuador	1.056672732	0.131461188	8.037906451	6.24494E-06	0.767328608	1.346016857	0.767328608	1.346016857
GDP Germany	-0.046288656	0.31307683	-0.147850789	0.885135852	-0.735366113	0.6427888	-0.735366113	0.6427888
Trade costs	-0.144805212	0.072128354	-2.00760456	0.069887049	-0.303558648	0.013948224	-0.303558648	0.013948224
Safeguards	-0.345892437	0.117065142	-2.954700525	0.013098828	-0.603551077	-0.088233796	-0.603551077	-0.088233796

Author: García, Paulo.

Table summarizing the data obtained by the regression applied to the total flows in Microsoft Excel. The same format of the program is maintained for ease of reading.

Annex 5

Table 6. Summary table of the regression of exports

Regression Statistics	
Multiple R	0.93345435
R Square	0.871337024
Adjusted R Square	0.83917128
Standard Error	0.161972687
Observations	16

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	2.132050042	0.710683347	27.08897472	1.25483E-05
Residual	12	0.314821814	0.026235151		
Total	15	2.446871856			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-24.28903094	5.468527347	-4.441603635	0.000804592	-36.20392849	-12.3741334	-36.20392849	-12.3741334
GDP Germany	1.788556346	0.257117593	6.956180353	1.52532E-05	1.228345237	2.348767456	1.228345237	2.348767456
Trade costs	-0.184048807	0.086944378	-2.1168569	0.055846422	-0.373484333	0.00538672	-0.373484333	0.00538672
Safeguards	0.030114404	0.221348571	0.136049689	0.894037695	-0.452162703	0.512391511	-0.452162703	0.512391511

Author: García, Paulo.

Table summarizing the data obtained by the regression applied to exports in Microsoft Excel. The same format of the program is maintained for ease of reading.

Annex 6

Table 7. Summary table of the regression of imports

Regression Statistics	
Multiple R	0.99539226
R Square	0.990805751
Adjusted R Square	0.988507188
Standard Error	0.051006654
Observations	16

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	3.364396278	1.121465426	431.0545432	1.76455E-12
Residual	12	0.031220144	0.002601679		
Total	15	3.395616422			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-3.731008318	1.124694776	-3.31735187	0.006140217	-6.181507725	-1.28050891	-6.181507725	-1.28050891
GDP Ecuador	0.534692379	0.133632679	4.001209759	0.001757866	0.243531784	0.825852975	0.243531784	0.825852975
Trade costs	0.702121752	0.139520291	5.032398865	0.000292999	0.398133153	1.006110351	0.398133153	1.006110351
Safeguards	0.076633478	0.082343323	0.930658075	0.370375366	-0.10277721	0.256044166	-0.10277721	0.256044166

Author: García, Paulo.

Table summarizing the data obtained by the regression applied to imports in Microsoft Excel. The same format of the program is maintained for ease of reading.

Bibliography

Anderson, J., & van Wincoop, E. (2003). Gravity with Gravitas: A Solution to the Border Puzzle. *The American Economic Review, 93*(1), 170-192.

Brakman, S., & van Bergeijk, P. (Eds.). (2010). *The Gravity Model in International Trade: Advances and Applications.* New York: Cambridge University Press.

Central Bank of Ecuador. (2018). *Cuestiones económicas.* Retrieved may 1, 2018, from https://www.bce.fin.ec/cuestiones_economicas/

De Benedictis, L., & Taglioni, D. (2011). The Gravity Model in International Trade. In L. De Benedictis, & L. Salvatici (Eds.), *The Trade Impact of European Union Preferencial Policies.*

De, P. (2006). *Why Trade Costs Matter?*

Federal Statistical Office. (2018). *National Accounts.* Retrieved may 1, 2018, from https://www.destatis.de/EN/FactsFigures/NationalEconomyEnvironment/NationalAccounts/NationalAccounts.html

Gujarati, D., & Porter, D. (2010). *Econometría* (Fifth ed.). México, D.F. Retrieved may 23, 2018

International Chamber of Commerce. (2010). *ICC TRANSPORT GUIDE and Incoterms®* 2010 .

Krugman, P., Obstfeld, M., & Melitz, M. (2018). *International Economics* (Eleventh ed.). Pearson Education.

Limão, N., & Venables, A. (2001). Infrastructure, Geographical Disadvantage, Transport Costs, and Trade. *The World Bank Economic Review, 15*(3), 451-479.

Timberger, J. (1960). *Shaping the World Economy; Suggestions for an International Economic Policy.* New York: Twentieth Century Fund. Retrieved from https://repub.eur.nl/pub/16826

United Nations. (2017). *United Nations International Trade Statistics Database.* Retrieved may 1, 2018, from https://comtrade.un.org/data/

Yotov, Y., Piermartini, R., Monteiro, J.-A., & Larch, M. (2016). *An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model.* World Trade Organization.