TRADE AGREEMENT AND TRADE SPECIALIZATION BETWEEN COLOMBIA AND THE EU

*Carlos Alberto Abreo Villamizar**
Ricardo Bustillo Mesanza
Carlos Rodríguez González
Universidad del País Vasco (Spain)
* Corresponding author: cabreo001@ikasle.ehu.eus

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ABSTRACT

The study analyses the relevance of the trade agreement between Colombia and the European Union as a policy that promotes trade between them (export and import flows) and, subsequently, establishes its effectiveness in reducing the trade deficit of the former. Furthermore, the paper analyses the determinants of trade flows between the parties, emphasizing the effect of factor endowment on their bilateral trade. We use a panel data set from 2005 to 2019, wherein the export and import flows between Colombia and the countries of the European Union are considered. The findings indicate that the trade agreement between the two parties has deepened the Colombian trade deficit. Additionally, it is established that the parties share an inter-industry trade pattern based on their factor endowment. Consequently, the Colombian government should consider these findings to reorient its trade policy towards those European Union countries that have an opposite factor endowment.

Keywords: Colombia, European Union, trade agreement, factor endowment, trade gravity model.
JEL Classification: F13, F14, F15, F47, F53.

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RESUMEN

El estudio analiza la relevancia del acuerdo comercial entre Colombia y la Unión Europea como una política que promueve el comercio entre ellos (flujos de exportaciones e importaciones) y, subsecuentemente, establece su efectividad en la reducción del déficit comercial del primero. Adicionalmente, el artículo analiza los determinantes de los flujos comerciales entre las partes, destacando el efecto de la dotación de factores en su comercio bilateral. Utilizamos un conjunto de datos de panel de 2005 a 2019, en donde se cubren los flujos de exportación e importación entre Colombia y los países de la Unión Europea. Los hallazgos indican que el acuerdo comercial entre las dos partes ha profundizado el déficit comercial colombiano. Asimismo, se establece que las partes comparten un patrón de comercio interindustrial basado en su dotación de factores. En consecuencia, el gobierno colombiano debe considerar estos hallazgos para reorientar su política comercial hacia aquellos países de la Unión Europea que tienen una dotación de factores opuesta.

Palabras clave: Colombia, Unión Europea, acuerdo comercial, dotación de factores, modelo de gravedad del comercio.

Clasificación JEL: F13, F14, F15, F47, F53.

1. INTRODUCTION

Colombia, as one of the Latin American countries presenting the highest economic growth rates in the region in recent years, has developed a trade policy focused on openness in order to stimulate its trade flows. This trade policy is in line with that indicated by Egger *et al.* (2011), who affirm that trade agreements between associated countries increase their bilateral trade. In this sense, recent Colombian governments have signed a significant number of preferential trade agreements. However, the country's trade balance, structurally in deficit, has been negatively affected by trade liberalization. This fact poses significant questions regarding the focus of current Colombian trade policy on signing trade agreements.

This research aims, in particular, to evaluate the trade effects of the entry into force of the Free trade Agreement (FTA) between Colombia and the European Union (EU), using an empirical approach. Notably, the Colombia-EU agreement is one of the most important FTAs signed by Colombia after that signed with the United States of America (US), because of the trade amounts involved, and it offers Colombia preferential access to a large and attractive market. Furthermore, in our empirical approach, we include variables related to the factor endowment of the countries, which will provide evidence of the type of trade that has developed between them (inter- or intra-industry), as well as their effect on the commercial exchange. This will allow us to determine whether the Colombian trade pattern is in line with the Heckscher-Ohlin (H-O) model or the Linder hypothesis (Erdey and Pöstényi, 2017), and, therefore, whether the trade between the parties is related to inter-industry or intra-industry trade. Moreover, this assessment is developed through an empirical modelling strategy —the so-called trade gravity model— and we estimate the specifications through a more suitable approach than that of a traditional log-linear form; this approach is called the Poisson pseudo-maximum likelihood (PPML) (Santos Silva and Teneyro, 2006). Our findings indicate that, on the one hand, the FTA factor has a positive effect on Colombian imports from the EU but, on the other, it does not reflect any (statistically significant) effect on Colombian exports to the EU. Therefore, this suggests a deepening of the existing Colombian trade deficit. Additionally, the results related to the type of trade carried out between the parties show a clear and marked inter-industry pattern, suggesting that Colombia tends to trade (export and import flows) with EU countries that have different factor endowments. Consequently, trade between the parties is founded on the inter-industry trade pattern; they trade goods belonging to utterly different branches of activity.

In general, this empirical work is novel because it explores the nature of specialization in bilateral trade between an emerging South American country and a trading bloc such as the EU. The study is carried out within the framework of a bilateral trade agreement between the parties, measured through the trade gravity model and estimated through a more suitable method for these models called the PPML. Finally, the paper is organized as follows. The first section will describe the evolution of the Colombian trade liberalization strategy over the last few decades through

an international economic integration policy called *Apertura Comercial*. The second section of this paper will present the background and scope of the signed FTA between Colombia and the EU countries. The third section is concerned with the methodological approach, specification and data used for this study. The fourth section will offer the findings of the research, focusing on the effects of the variables involved in bilateral trade. As a final point, the last section focuses on discussion and includes additional concluding remarks.

2. COMMERCIAL AGREEMENT BETWEEN COLOMBIA AND THE EUROPEAN UNION

The existing literature on international trade is extensive and places particular emphasis on the effects of FTAs in promoting world trade by reducing trade barriers. In this regard, Lim and Breuer (2019) point out that in recent decades barriers to international trade have decreased significantly, especially in developing countries, as a measure to promote economic growth. This is the case of Colombia, a Latin American economy which, according to García *et al.* (2014), carried out a series of exceptional reforms in the early 1990s, aimed at promoting its trade openness and, subsequently, achieving a more productive and efficient economic system.

This study pays special attention to the Commercial Agreement struck between Colombia and the EU since the European Single Market offers remarkable opportunities for an economy that has been growing constantly over the last few decades. To ensure that continuous progress is maintained, the Colombian economy needs to expand into relevant markets, such as the EU bloc. The integration process with the EU is an opportunity for Colombia to access a market that, as a trade bloc, is the largest global commercial power with the second most traded currency in the world, the number one importer and exporter of goods worldwide and the largest buyer and seller of commercial services while also enjoying the highest Gross Domestic Product (GDP) [Procolombia, 2013a].

Therefore, the last decades have witnessed the rapid development of the trade relationship between Colombia and the EU. Structurally, more than half of Colombia's exports to the EU are mainly made up of coal, oil and their derivatives, respectively (MinCIT, 2018). The European

Single Market is one of the main destinations of Colombian exports, and it is characterized as an attractive, but unexploited, market for non-mining or oil exports and one of the most important consumers of oil and mining goods from Colombia. In this regard, it is important to note that Colombian exports to the EU amounted to 3,412,838,574 constant USD in 2019, which represented a decrease of 1.83% compared to the values exported to this market in 2018. Therefore, the signing of the trade agreement was strategic for all the countries involved.

According to the Organization of American States (OAS, 2019), negotiations for the signing of an agreement of common interest between the countries that belonged to the Andean Community (AC) (including Colombia) and the EU dated from 1993, when both sides signed a Framework Cooperation Agreement. Nevertheless, it was not until September 2007 that the first round of bloc-by-bloc negotiations was carried out in order to build an association agreement between the parties. The European Parliament (2018) highlights that, in May 2008, the EU and the AC reached a "Flexible Framework Agreement" for the association of the two blocs, in which each AC country could choose its level of participation. As a result, nine rounds of negotiations were carried out between the EU, Colombia and Ecuador after 2009. Consequently, the Trade Agreement was finally signed between the EU and Colombia and Peru in May 2010.

Simultaneously, Colombia and EU commercial relations had been framed under the Generalized System of Preferences (GSP) granted unilaterally by the EU since 2008 until the entry into force of the Commercial Agreement. According to the Andean Community (2008), the GSP has two regimes that granted preferential treatment to Colombian exports. The general regime granted the total suspension of tariffs for non-sensitive products, except for agricultural components, and reduced the *ad valorem* tariff of those classified as sensitive by 3.5 percentage points, except for textile and clothing products. Additionally, the specific tariffs on sensitive products were reduced by 30%. On the other hand, the special regime or GSP+ suspended all tariffs on sensitive and non-sensitive products covered by the GSP. This regime also established the suspension of all specific tariffs, except when the products also had an *ad valorem* tariffs.

This preferential treatment defined the trade between the parties until the trade agreement came into force in 2013. The agreement eliminated

the temporality of the preferential treatment, as well as the unilaterality of the tariff preferences, thereby creating a stable association. Finally, although the tariff preferences for Colombia granted by the EU improved with the entry into force of the FTA concerning those previously established by the GSP and GSP+, most of these preferences already existed. However, the commencement of the FTA granted preferential access into Colombia for goods from EU countries, which they did not previously have; this implies that bilateral preferences would be more relevant for the EU countries than for Colombia.

Regarding the different aspects that were negotiated, it is relevant to point out that the trade agreement between Colombia and the EU is not only a free trade agreement but means much more. It not only promotes free trade but also supports democracy and cooperation programmes, becoming an association agreement. According to Procolombia (2013b), the agreement covered the negotiation of 14 chapters, highlighting the reference to market access, wherein the tariff reduction in agricultural and industrial goods was negotiated. Other chapters, such as *Trade in Services*, *Technical Assistance and Strengthening of Commercial Capabilities*, *Dispute Resolution*, *Intellectual Property*, *Commercial Defence*, and *Sanitary and Phytosanitary Measures*, were also negotiated and agreed.

According to the MinCIT (2012b), the *Market Access* chapter established a classification of non-agricultural and agricultural goods. Regarding the first classification (industrial and fishing goods), a tariff reduction for 100% of the universe of these goods was defined for Colombian exports following the entry into force of the trade agreement. On the other hand, the agreement established a 10-year progressive tariff reduction for non-agricultural EU goods. In the case of agricultural goods, their trade was not completely liberalized due to the sensitivity of the issue for both parties. Colombian agricultural products obtained an immediate tariff reduction with the entry into force of the agreement with products such as flowers, coffee, palm oil, most fruits and vegetables, and most cocoa and tobacco products included. Nonetheless, a gradual quota liberalization was arranged for products the EU considered sensitive, such as bananas, sugar and beef, among others. Concerning EU agricultural goods, a series of products that Colombia considered sensitive were defined and subject to transitory and/or contingent tariffs. For instance, the dairy sector and its products were a special case in

the negotiation. Other sensitive products, such as rice, corn, pork and poultry products, were excluded from the agreement.

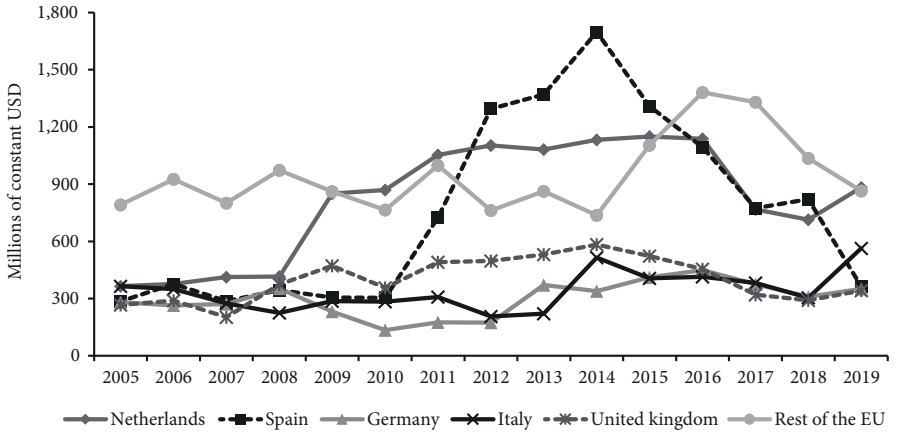
Furthermore, the agreement defined certain commercial defensive instruments, the aim of which was to avoid actions that might go against what was negotiated by the parties. These instruments included anti-dumping measures, subsidies and countervailing duties, and multilateral safeguard measures. These instruments are governed by the World Trade Organization's (WTO) multilateral agreements intended to solve this sort of dispute (MinCIT, 2019).

Finally, the agreement includes commitments regarding respect for human rights and the promotion of trade and sustainable development. According to the MinCIT (2012a), the agreement establishes respect for fundamental human rights as an essential element of the agreement, stating that, in the event of their violation, measures that comply with international law will be adopted. Similarly, in the case of trade and sustainable development, social clauses are included. This concerns the fulfilment of labour rights according to the definitions of the International Labour Organization (ILO), through the commitment of the parties involved to generate employment and decent work.

Figure 1 presents Colombian export performance in millions of constant USD to the main destination countries within the EU from 2005 to 2019.

Figure 1 illustrates the performance of Colombian exports to the main EU markets. One can observe two trends in most of the countries presented, excluding the Netherlands and Spain. The first trend can be observed between 2005 and 2016, where the evolution of Colombian exports to Germany, Italy, the United Kingdom (UK) and the Rest of the EU follows a pattern of moderate stability and there are no significant changes in export values. The other trend can be observed after 2016, when Colombian exports to these countries experienced a significant drop until 2018, although most countries show a slight recovery in 2019. In this group of countries, an outstanding level of exports is observed with Italy in 2014 (514,438,638 constant USD) and 2019 (571,633,289 constant USD) and with the United Kingdom in 2014 (582,987,237 constant USD). Concerning the Netherlands and Spain, which historically have been the main destinations of Colombian exports, the former exhibits a marked upward trend from 2008 to 2016 followed by

Figure 1. EU main destinations of Colombian exports in millions of constant USD

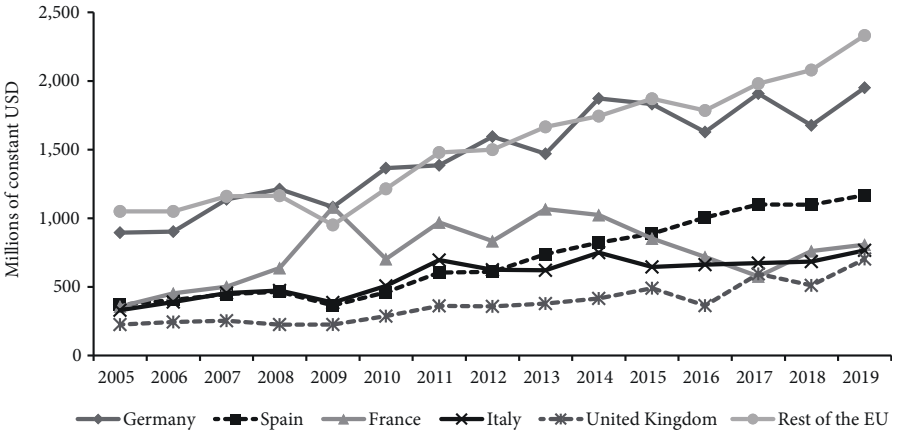


Source: Authors' elaboration based on Direction of Trade Statistics from the International Monetary Fund (IMF, 2021). Deflated values based on the Export Price Index (EPI) from Banco de la República (2020).

a significant drop until 2018 and a slight recovery in 2019. Regarding the performance of Colombian exports to the Netherlands, the highest amount of exports occurs in 2016 (1,149,773,480 constant USD) and one of the lowest is reached in 2018 (713,556,266 constant USD), only comparable with the performance of exports in the period before 2009. Concerning Spain, there is a prominent increase in Colombian exports from 2010 until 2014, followed by a dramatic decline until 2019, with export values similar to those of Germany and the UK. In particular, 2014 stands out as the year where the highest level of exports to Spain was reached (1,698,303,179 constant USD), as well as 2019 (368,224,379 constant USD), when the level of exports reached levels comparable to those presented before 2010. Overall, this indicates a general downward trend in the volume of Colombian exports to the EU in recent years, which calls into question the role of the trade agreement in boosting the country's exports to that market.

Additionally, Figure 2 presents Colombian import performance in millions of constant USD from the major economies of the EU from 2005 to 2019.

Figure 2. Origins of Colombian imports in millions of constant USD from the main EU markets



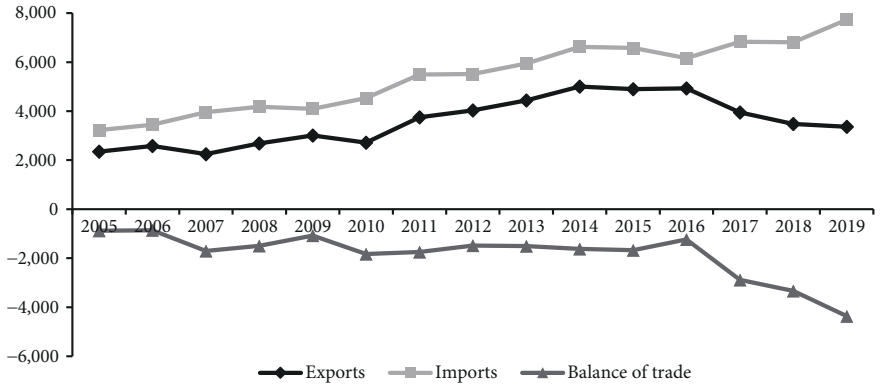
Source: Authors' elaboration based on Direction of Trade Statistics from the IMF (2021). Deflated values based on the Import Price Index (IPI) from Banco de la República (2020).

Figure 2 displays the evolution of Colombian imports from the EU countries, where Germany and Spain stand out as the main suppliers of Colombian imports. It is important to note that the highest level of exports from Germany and Spain was reached in 2019 (1,950,901,617 and 1,167,764,270 constant USD, respectively). Additionally, unlike Colombian exports to the EU, Colombian imports from most of the countries presented, show a sustained upward trend during the period analysed, slightly interrupted in 2009 as a consequence of the financial crisis. Conversely, Colombian imports from France have fluctuated significantly, reaching the highest amount imported in 2009 (1,080,381,150 constant USD), followed by the amounts reached in 2013 (1,066,511,862 constant USD) and 2014 (1,023,695,474 constant USD). This indicates that the trade agreement has been an incentive for the growth of Colombian imports from the EU.

Moreover, Figure 3 shows the Trade Balance of Colombia with the EU in millions of constant USD from 2005 to 2019.

Figure 3 indicates the performance of the Trade Balance of Colombia with the EU. It can be observed that in the period analysed, Colombia has

Figure 3. Trade balance of Colombia with the EU in millions of constant USD



Source: Authors' elaboration based on Direction of Trade Statistics from the IMF (2021). Deflated values based on the Export and Import Price Index from Banco de la República (2020).

a persistent deficit in its trade balance, with a significant widening of the gap from 2016. Additionally, in 2014, the beginning of a clear downward trend in Colombian exports to the EU is observed. This aspect coincides with the drop in international oil prices, which generated significant macroeconomic imbalances in Colombia due to the strong links between the oil sector and other economic sectors (Ramirez and Quintero, 2019). In this regard, it is relevant to note that Colombian exports to the world are mainly composed (63.3% in 2018) by oil and mining goods (Abreo, Bustillo, and Rodriguez, 2022). Furthermore, a marked upward trend in Colombian imports is observed, with a slight slowdown in 2009 and 2016. The slight drop in Colombian imports in 2009 coincides with the global debt crisis, which had effects on a global scale. Moreover, according to MinCIT (2016), the slight slowdown in Colombian imports in 2016 is due to the significant drop in imports of oil derivatives, an aspect that coincided with the start of operations of the most important oil refining plant in the country called Reficar. Finally, the evolution of the trade balance over the period analysed casts doubt on the effectiveness of the signing of the trade agreement between Colombia and the EU as a measure to balance the trade deficit of the former.

3. METHODOLOGICAL APPROACH AND DATA

The gravity model is a robust and effective econometric method implemented in order to explore the drivers of bilateral trade. The pioneers in the application of the gravity model to international trade were Tinbergen (1962) and Poyhonen (1963), who described an equivalent connection between bilateral trade flows and Newton's law of universal gravitation. The most basic economic expression of the gravity model applied to international trade suggests that bilateral trade flows are proportional to the domestic production of the countries involved and inversely proportional to their distance.

$$X_{ij} = \alpha_o Y_i^{(\alpha 1)} Y_j^{(\alpha 2)} D_{ij}^{(\alpha 3)} Z_{ij}^{(\alpha 4)} n_{ij} \quad [1]$$

The empirical and theoretical developments of the gravity model came from advances introduced by Anderson (1979) and Anderson and van Wincoop (2003), among other authors. The main developments are derived from the inclusion of additional variables that promote or restrict bilateral trade, as well as the implementation of the fixed effects of pairs of countries, fixed effects of individual countries and time fixed effects, which are used to control unobservable trade frictions (Gopinath, Helpman, and Rogoff, 2014).

Furthermore, our empirical study includes the 28 countries that belonged to the EU prior to the UK's departure, comprising data on trade between Colombia and the UK in 2019 as the commercial relationship governed by the pre-existing agreement between Colombia and the EU continued until 31 December 2020 (European Commission, 2019). The period analysed was between 2005 and 2019. This selection was made after taking into consideration a period before the FTA between Colombia and the EU was in force and also a period after the same.

The variables implemented in the models are shown in Table 1. Furthermore, Table 2 shows the descriptive statistics for the variables used in the empirical study.

Given this, four econometric specifications are proposed to explain the determinants of Colombian export levels to EU countries. The equations include control variables usually implemented in gravity models such as physical distance ($DIST_{Colj}$), common language ($COMLANG_{Colj}$), common

Table 1. Information of variables implemented in the model

Variable	Description	
Dependent variables		
X_{Colj}	Colombian exports to its EU partners in constant USD	
M_{Colj}	Colombian imports from its EU partners in constant USD	
Independent variables		
Log$DIST_{Colj}$	Log Distance in kilometres between Colombia and EU country *(j)*	
$COMLANG_{Colj}$	Colombia and EU country *(j)* share a primary or official language	
$COMLEG_{Colj}$	Colombia and EU country *(j)* share common legal origins	
$LANDLOCK_j$	EU country *(j)* is landlocked	
$EUROAREA_j$	EU country (*j*) is a member of the monetary union	
$OECD_j$	EU country (*j*) belongs to OECD	
FTA_{Colj}	Colombia and EU country *(j)* with Regional Trade Agreement in force	
LogGDP_{Colj}	Log of bilateral sum of the GDP of Colombia and the GDP of EU country *(j)* in constant USD	
LogRFE_{Colj}	Lof of Relative factor endowment between Colombia and EU country *(j)*	
LogHC_{Colj}	Log of differences in human capital between Colombia and EU country *(j)*	
LogPD_{Colj}	Log of differences in population density between Colombia and EU country *(j)*	

Source: Authors' elaboration.

	Update date	Source	Expected sign
	Dependent variables		
	January 19, 2021	IMF Deflected values based on EPI from Banco de la República	
	January 19, 2021	IMF Deflected values based on IPI from Banco de la República	
	Independent variables		
	January 30, 2021	Centre d' Etudes Prospectives et d'Informations Internationales (CEPII)	–
	January 30, 2021	CEPII	+
	January 30, 2021	CEPII	+
	January 30, 2021	CEPII	–
	January 30, 2021	European Commission	+
	March 30, 2021	Organisation for Economic Co-operation and Development (OECD)	+
	December 8, 2020	World Trade Organisation	+
	January 10, 2021	World Bank	+
	February 30, 2021	Calculated by authors with data from WB	+
	February 30, 2021	Penn World Table version 10.0	+
	February 30, 2021	Calculated by authors with data from CEPII	+

Table 2. Descriptive statistics of the data

Variable	Mean	Standard deviation	min	Max
X_{Colj}	127	244	0	1,700
M_{Colj}	193	344	0	1,950
$DIST_{Colj}$	9,422	811	7,506	11,268
$COMLANG_{Colj}$	0.036	0.186	0	1
$COMLEG_{Colj}$	0.321	0.468	0	1
$LANDLOCK_j$	0.179	0.383	0	1
$EUROAREA_j$	0.59	0.492	0	1
$OECD_j$	0.752	0.432	0	1
FTA_{Colj}	0.467	0.499	0	1
GDP_{Colj}	911,000	945,000	153,000	4,340,000
RFE_{Colj}	26,115	21,242	60	109,000
HC_{Colj}	0.794	0.283	0.030	1.350
PD_{Colj}	133	245	0.330	1,546
Observations	420			

Note: Exports, Imports and GDP data in millions of constant USD.
Source: Authors' elaboration.

legal origins ($COMLEG_{Colj}$) and whether the EU country is landlocked ($LANDLOCK_j$). We also include economic integration variables, whether the EU country is part of the Eurozone ($EUROAREA_j$), whether the EU country belongs to the Organisation for Economic Co-operation and Development ($OECD_j$) and a variable that denotes if Colombia and the EU country share a trade agreement (FTA_{Colj}). Additionally, as noted by Dixit and Stiglitz (1977), in the endowment-based new trade model,

bilateral trade is an increasing function of the sum of GDP at origin and GDP of destination (GDP_{Colj}), which is a proxy for the economic size of the countries. Moreover, estimations [2], [3] and [4] involve three different measures of factor endowment in each of those equations. The equations also include time fixed effects (δ_t) and time-invariant country fixed effects at the destination country (α_j).

The inclusion of relative factor endowment (*RFE*), human capital (*HC*) and population density (*PD*) variables in the equations proposed, which are measures of the differences between factor endowments of the countries involved, are an effort to determine whether the Heckscher-Ohlin (H-O) model or the Linder hypothesis elucidate the pattern of bilateral Colombian-EU trade. In this regard, the Heckscher-Ohlin (H-O) model suggests that countries with different factor endowments will trade more with each other (Frankel, 1997). Conversely, the Linder (1961) hypothesis states that countries with similar levels of factor endowments have similar preferences and will therefore trade more with each other. Therefore, a positive sign of the coefficient of the factor endowment variables will denote the presence of a bilateral trade pattern linked to the H-O model (inter-industry) and a negative sign of these variables will denote the presence of a bilateral trade pattern related to the Linder hypothesis (intra-industry).

Frankel, Stein, and Wei (1995), and later other authors, used these variables based on the differences between the countries involved in GDP per capita, schooling levels and population density to measure the differences in their factor endowments and, subsequently, determine their commercial patterns. According to Egger (2002), the *RFE* variable represents the factor endowment of production and it is denoted as the absolute value of the difference between the natural logarithms of the GDP per capita of the countries, which is commonly used as a proxy for the capital-labour ratio of those countries.

$$RFE = \left[Log\frac{GDP_{it}}{POP_{it}} - Log\frac{GDP_{jt}}{POP_{jt}} \right] \qquad [2]$$

In the same vein, Frankel and Rose (2002) state that the variables associated with educational levels are estimates of investment in human

capital and related to factor endowments. In this regard, Erdey and Pöstényi (2017) indicate that the *HC* variable, which is a factor related to average years of schooling and return to education, is another measure of factor endowment based on the index of human capital from the Penn World Table. This variable is calculated as the absolute value of the difference between the *HC* indexes of the countries.

$$HC = \left[LogHC_{it} - LogHC_{jt} \right] \quad [3]$$

Finally, Yamarik, Ghosh, and Yamarik Sucharita Ghosh (2005) point out that the variable *PD* indicates the relative endowment of land between the two countries. Moreover, Eicher, Henn, and Papageorgiou (2012) indicate that greater differences in population density are positively related to trade flow. Additionally, Greene (2013) defines this variable as a proxy for infrastructure development. Therefore, this variable is calculated as the population divided by the area of a country.

$$PD = \left[Log \frac{POP_{it}}{AREA_i} - Log \frac{POP_{jt}}{AREA_j} \right] \quad [4]$$

Based on the variables set out above, we present the following equations to explain the determinants of Colombian exports to the EU.

First model [1]:

$$\begin{aligned} X_{Colj} = exp(&\beta_0 + \beta_1 LogDIST_{Colj} + \beta_2 COMLANG_{Colj} + \\ &\beta_3 COMLEG_{Colj} + \beta_4 LANDLOCK_j + \beta_5 EUROAREA_{jt} + \\ &\beta_6 OECD_{jt} + \beta_7 FTA_{Coljt} + \beta_8 LogGDP_{Coljt} + \delta_t + \alpha_j) n_{Coljt} \end{aligned} \quad [5]$$

Second model [2]:

$$\begin{aligned} X_{Colj} = exp(&\beta_0 + \beta_1 LogDIST_{Colj} + \beta_2 COMLANG_{Colj} + \\ &\beta_3 COMLEG_{Colj} + \beta_4 LANDLOCK_j + \beta_5 EUROAREA_{jt} + \\ &\beta_6 OECD_{jt} + \beta_7 FTA_{Coljt} + \beta_8 LogGDP_{Coljt} + \beta_9 RFE_{Coljt} + \delta_t + \alpha_j) n_{Coljt} \end{aligned} \quad [6]$$

Third model [3]:

$$X_{Colj} = exp(\beta_0 + \beta_1 LogDIST_{Colj} + \beta_2 COMLANG_{Colj} + \beta_3 COMLEG_{Colj} + \beta_4 LANDLOCK_j + \beta_5 EUROAREA_{jt} + \beta_6 OECD_{jt} + \beta_7 FTA_{Coljt} + \beta_8 LogGDP_{Coljt} + \beta_9 HC_{Coljt} + \delta_t + \alpha_j) n_{Coljt} \quad [7]$$

Fourth model [4]:

$$X_{Colj} = exp(\beta_0 + \beta_1 LogDIST_{Colj} + \beta_2 COMLANG_{Colj} + \beta_3 COMLEG_{Colj} + \beta_4 LANDLOCK_j + \beta_5 EUROAREA_{jt} + \beta_6 OECD_{jt} + \beta_7 FTA_{Coljt} + \beta_8 LogGDP_{Coljt} + \beta_9 PD_{Coljt} + \delta_t + \alpha_j) n_{Coljt} \quad [8]$$

Similarly, four econometric specifications are also proposed to explain the determinants of Colombian imports from EU countries. The structures of these specifications are in line with those proposed to explain the determinants of Colombian exports.

Fifth model [5]:

$$M_{Colj} = exp(\beta_0 + \beta_1 LogDIST_{Colj} + \beta_2 COMLANG_{Colj} + \beta_3 COMLEG_{Colj} + \beta_4 LANDLOCK_j + \beta_5 EUROAREA_{jt} + \beta_6 OECD_{jt} + \beta_7 FTA_{Coljt} + \beta_8 LogGDP_{Coljt} + \delta_t + \alpha_j) n_{Coljt} \quad [9]$$

Sixth model [6]:

$$M_{Colj} = exp(\beta_0 + \beta_1 LogDIST_{Colj} + \beta_2 COMLANG_{Colj} + \beta_3 COMLEG_{Colj} + \beta_4 LANDLOCK_j + \beta_5 EUROAREA_{jt} + \beta_6 OECD_{jt} + \beta_7 FTA_{Coljt} + \beta_8 LogGDP_{Coljt} + \beta_9 RFE_{Coljt} + \delta_t + \alpha_j) n_{Coljt} \quad [10]$$

Seventh model [7]:

$$M_{Colj} = exp(\beta_0 + \beta_1 LogDIST_{Colj} + \beta_2 COMLANG_{Colj} + \beta_3 COMLEG_{Colj} + \beta_4 LANDLOCK_j + \beta_5 EUROAREA_{jt} + \beta_6 OECD_{jt} + \beta_7 FTA_{Coljt} + \beta_8 LogGDP_{Coljt} + \beta_9 HC_{Coljt} + \delta_t + \alpha_j) n_{Coljt} \quad [11]$$

Eighth model [8]:

$$M_{Colj} = exp(\beta_0 + \beta_1 LogDIST_{Colj} + \beta_2 COMLANG_{Colj} + \beta_3 COMLEG_{Colj} + \beta_4 LANDLOCK_j + \beta_5 EUROAREA_{jt} + \beta_6 OECD_{jt} + \beta_7 FTA_{Coljt} + \beta_8 LogGDP_{Coljt} + \beta_9 PD_{Coljt} + \delta_t + \alpha_j) n_{Coljt} \quad [12]$$

The specifications proposed, traditionally estimated in their log-linear form through the Ordinary Least Square (OLS), will be assessed in their multiplicative form following the Santos Silva and Teneyro (2006) proposal. The authors state that the PPML is the most appropriate estimator for gravitational models, mainly because the logarithmic linearization of the models in the presence of heteroscedasticity, endogeneity and other econometric drawbacks leads to inconsistent results. Additionally, the authors state that the removal of zeros through the logarithmic linearization of trade models provide unsatisfactory results. On the contrary, their inclusion in gravity models strengthens the outcomes. The authors also confirm that the PPML approach yields smaller and more suitable results than those obtained by conventional estimators, offering more adequate coefficients for variables such as distance, contiguity, colony tie, and those variables related to economic and trade integration. Furthermore, and based on Gopinath, Helpman, and Rogoff (2014), it is stated that these differences between the coefficients obtained by conventional estimators and PPML are due to the presence of a non-linear effect in the distance factor. Therefore, the OLS estimator reflects more trade for larger economies than for smaller ones. All these reasons explain why renowned authors such as Fally (2015) recommend relying more on gravitational models estimated using the PPML approach than those estimated using conventional approaches. In the same vein, Egger and Nigai (2015) affirm that the PPML estimator has been widely used for the estimation of gravitational models due to its adequate results in recent years. All in all, the PPML estimator is robust to diverse patterns of heteroscedasticity, providing a natural way to deal with zeros in the dependent variable and offering smaller and more consistent coefficients and, therefore, better results for the study (Santos Silva and Teneyro, 2006).

4. RESULTS

Tables 3 and 4 present the results of the proposed models.

Table 3. Regression results for Colombian exports

Variables	Models for Colombian exports			
	[1]	[2]	[3]	[4]
Log$DIST_{Colj}$	–3.348*	–3.238**	–7.710***	–3.520***
	(1.754)	(1.609)	(2.414)	(0.801)
$COMLANG_{Colj}$	0.462	0.770**	0.941***	1.541***
	(0.405)	(0.309)	(0.349)	(0.159)
$COMLEG_{Colj}$	0.912**	1.113**	1.966***	0.436***
	(0.448)	(0.515)	(0.368)	(0.136)
$LANDLOCK_j$	–3.592***	–4.237***	–4.439***	–3.569***
	(0.465)	(1.098)	(0.721)	(0.437)
$EUROAREA_j$	–0.169	–0.255	0.260	0.080
	(0.291)	(0.415)	(0.227)	(0.102)
$OECD_j$	1.617**	0.688	1.198	3.069**
	(0.716)	(0.812)	(0.763)	(1.226)
FTA_{Colj}	0.363	1.216**	0.967**	0.528*
	(0.279)	(0.586)	(0.403)	(0.281)
LogGDP_{Colj}	0.713***	0.606**	0.223	
	(0.232)	(0.246)	(0.277)	
LogRFE_{Colj}		1.210*		
		(0.624)		
LogHC_{Colj}			10.237***	
			(2.980)	

Table 3. Regression results for Colombian exports (continued…)

Variables	Models for Colombian exports			
	[1]	[2]	[3]	[4]
LogPD_{Colj}				0.498***
				(0.098)
Constant	27.461*	27.499**	75.763***	31.671***
	(15.311)	(12.914)	(22.884)	(6.806)
Observations	420	420	420	420
R-squared	0.566	0.626	0.771	0.852
Reset test	0.579	0.629	0.001	0.000
Time-invariant country fixed effects	X	X	X	X
Time fixed effects	X	X	X	X

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

By using the PPML estimator, we measure the effects of the proposed variables in Colombian exports. Model [1] shows a notable negative impact from distance in Colombian exports to the EU. In the same vein, if an EU country is landlocked, Colombian exports to them will be negatively affected. On the other hand, the results show that a rise in the GDP_{Colj} variable will have a positive effect on its exports. Additionally, variables that describe whether countries share common legal origins and whether the EU country is part of the OECD will also have a positive impact on Colombian exports. Conversely, variables such as $COMLANG_{Colj}$, $EUROAREA_j$ and FTA_{Colj} are statistically insignificant.

Regarding the effects of factor endowment variables on Colombian exports presented in models [2], [3] and [4], each is statistically significant and they all have a positive sign, whereby the human capital (HC_{Colj}) variable shows a prominent and positive effect on its exports. In particular, the *RFE* result indicates that the greater the difference in the capital-labour ratio between the countries, the greater the Colombian

exports to the EU. Similarly, the effect of the *HC* variable points out that the greater the difference in investment in human capital between the countries, Colombian exports to the EU will tend to grow. The effect of the *PD* variable is in line with the results of the previous variables, showing that a greater difference in population density between countries will increase Colombian exports to the EU. Consequently, founded on the results of the proposed regressions, we can confirm that the pattern of Colombian exports to EU countries is related to the Heckscher-Ohlin (H-O) model or an inter-industry trade pattern, whereby countries with different factor endowments will trade more with each other.

Table 4. Regression results for Colombian imports

Variables	Models for Colombian imports			
	[5]	[6]	[7]	[8]
Log$DIST_{Colj}$	0.045	1.317	–0.228	0.360
	(1.538)	(1.276)	(1.517)	(1.384)
$COMLANG_{Colj}$	0.559**	0.846***	0.799***	0.882***
	(0.257)	(0.203)	(0.173)	(0.132)
$COMLEG_{Colj}$	–0.026	0.061	0.433	–0.038
	(0.156)	(0.153)	(0.287)	(0.110)
$LANDLOCK_j$	–0.279	–0.360	–0.417	–0.244
	(0.354)	(0.382)	(0.473)	(0.375)
$EUROAREA_j$	0.689***	0.562***	0.771***	0.703***
	(0.201)	(0.184)	(0.230)	(0.240)
$OECD_j$	0.653	0.270	0.453	0.828
	(0.793)	(0.780)	(0.788)	(0.945)
FTA_{Colj}	0.327***	0.515**	0.577***	0.169
	(0.102)	(0.218)	(0.155)	(0.107)
LogGDP_{Colj}	1.414***	1.391***	1.277***	1.325***
	(0.155)	(0.142)	(0.173)	(0.131)

Table 4. Regression results for Colombian imports (continued…)

Variables	Models for Colombian imports			
	[5]	[6]	[7]	[8]
LogRFE_{Colj}		0.621**		
		(0.270)		
LogHC_{Colj}			3.557**	
			(1.793)	
LogPD_{Colj}				0.431**
				(0.188)
Constant	–21.819	–33.762**	–16.827	–23.045*
	(15.720)	(13.297)	(15.321)	(13.387)
Observations	420	420	420	420
R-squared	0.924	0.931	0.938	0.945
Reset test	0.283	0.897	0.777	0.574
Time-invariant country fixed effects	X	X	X	X
Time fixed effects	X	X	X	X

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Similarly, we measure the effects of the included variables on Colombian imports. Model [5] indicates, unlike what is reflected in model [1], that the variables distance and common legal origin are statistically insignificant, as well as the variables that indicate whether the country is landlocked and whether it belongs to the OECD. On the other hand, variables such as $COMLANG_{Colj}$ and $EUROAREA_j$ seemingly exert a positive effect on Colombian imports. In the same line, an increase in the GDP of the pair of economies will have a positive effect on Colombian imports. Furthermore, the FTA factor has a positive effect on Colombian imports, unlike the statistical insignificance that the same factor seemingly has for Colombian exports to the EU.

Concerning the effect of the factor endowment variables on Colombian imports shown in models [6], [7] and [8], considering them as regressions that estimate the effects on Colombian exports, these variables offer statistical significance and a positive sign. Consequently, the greater the difference between the countries in the capital-labour ratio, in investment in human capital and population density, the greater the amount of Colombian imports from the EU. Therefore, based on the results, we can confirm that the pattern of Colombian imports to EU countries is associated with the Heckscher-Ohlin (H-O) model or an inter-industry trade pattern.

5. DISCUSSION

The results obtained by the gravitational model approach yielded some interesting insights on the effects of the process of trade integration between Colombia and the EU, and how the trade pattern developed between the parties based on the differences between their factor endowments.

The models that estimate the determinants of Colombia exports to the EU illustrate a notable negative effect from the distance variable on Colombian exports. This suggests that despite the advances in freight transport and the processes related to this activity, these costs are a critical factor that notably affects Colombian exports to the EU. In the same vein, if the EU country is landlocked, Colombian exports to these destinations will be negatively affected, which explains why most of its exports reach the EU through countries with access to the sea (see Figure 1). Additionally, landlock variable affects Colombian exports to a greater extent when the *RFE* and *HC* variables are considered in the gravitational model (models [2] and [3]), which suggests that their inclusion notably increases the negative effect of the landlock variable on Colombian exports. In contrast, the growth of the sum of the GDP of the pairs of countries has a positive effect on Colombian exports to the EU, which is in line with most of the related empirical research. Similarly, if the EU country belongs to the OECD, Colombian exports tend to increase notably. This elucidates why the largest amount of Colombian exports go to EU countries that belong to the OECD. Nonetheless, the most striking result to emerge from the results is that the FTA variable is

statistically insignificant, which indicates that the entry into force of the trade agreement between Colombia and the EU countries has had no impact (neither positive nor negative) on national exports. This result calls into question the effectiveness of the trade agreement between the parties in force since 2013 as a measure to increase Colombian exports and, subsequently, reduce its trade deficit with EU countries.

The following models, wherein we include different factor endowment measures, provide clear evidence for the relationship between the pattern of Colombian exports to EU countries and the Heckscher-Ohlin (H-O) model. Concerning this, the *RFE* and *PD* variables suggest that an increase in the differences between these measures would have a notable positive effect on Colombian exports to the EU. Similarly, the effect of the *HC* factor on Colombian exports would be outstanding, suggesting that the complementary structure of trade between the parties benefits from this dissimilarity. Based on the results from the differences in the factor endowments between the parties, it is possible to corroborate that the pattern of Colombian exports to the EU is related to the Heckscher-Ohlin (H-O) model since 50.2% of these are made up of oil and mining goods. The remaining exports are mostly made up of goods from the agricultural sector (69.3%) [MinCIT, 2021], statistical information that collectively supports our findings.

On the other hand, the models that estimate the determinants of Colombian imports mostly show results opposite to those reflected by the regressions that estimate the determinants of exports. Firstly, the distance factor is statistically insignificant, which indicates that the cost of transport does not affect the flow of imports from the EU. Second, if Colombia and an EU country share the same language, as is the case with Colombia and Spain, imports of the former will grow. Moreover, it is important to mention that, unlike the models that estimate Colombian exports, the landlock variable is insignificant in each of the models that estimate Colombian imports, which suggests that this factor neither harms nor promotes Colombian imports from the EU. This finding is supported by the evolution of Colombian imports from Spain, where constant growth can be appreciated in the analysed period (see Figure 2). Similarly, if the EU country belongs to the Eurozone, Colombian imports from these countries will grow, which explains why most of these flows come from countries that have the euro as their currency. Furthermore,

as in the export models, the effect of the sum of the GDP of the pairs of countries is positive, and therefore, its growth generates a favourable effect on Colombian imports from EU countries, an effect that is greater than that observed in Colombian exports (see Tables 3 and 4). As a final point, the FTA factor yields a positive effect on Colombian imports, suggesting that a trade agreement between the parties will increase these flows. This finding is opposite to what is reflected in our results for the export models and in line with the positive effects of FTAS in promoting trade flows between countries established by several authors.

Consistent with the results of the models of Colombian exports to the EU, in which we include measures for factor endowment, the Colombian import models also exhibit solid evidence for the relationship between the pattern of Colombian imports from the EU countries and the Heckscher-Ohlin (H-O) model. Similarly, the *RFE* and *PD* variables suggest a positive impact on Colombian imports; however, the *HC* factor provides a greater effect on the same. These results show, as in the export models, that the pattern of Colombian imports from EU countries is related to the Heckscher-Ohlin (H-O) model since the vast majority of imports originating in the EU are made up of capital goods, construction materials, goods of consumption and intermediate goods (MinCIT, 2021), statistical information that once again confirms the existence of a complementary trade structure between the parties.

In summary, these results show that, on the one hand, the trade agreement between Colombia and the EU has no effect on Colombian exports and, on the other hand, promotes Colombian imports from that destination, increasing the deficit in the trade balance between the parties (see Figure 3). Furthermore, the pattern of export and import flows between Colombia and EU countries are strongly related to the Heckscher-Ohlin (H-O) model, which suggests that in a complementary trade structure their bilateral trade is more likely to grow through inter-industry trade (Kabir and Salim, 2010).

6. CONCLUDING REMARKS

The purpose of this research is to determine the factors that drive Colombian trade (export and import flows) with the EU countries. Therefore, the authors present the results of applying a gravity model approach

to foreign trade among the parties between 2005 and 2019. The study yields insights into the trade effects resulting from the entry into force of the FTA between the parties and the trade patterns established by the differences in their factor endowments.

The research identifies factors that generate a positive effect on Colombian exports to the EU, such as sharing a common legal origin or that the EU destination belongs to the OECD or the sum of the GDP of the pairs of countries. Conversely, the distance factor between countries has a notably negative effect on their exports as well as the country of destination does not have access to the sea. Surprisingly, the FTA factor is statistically insignificant, which suggests that this variable does not have any impact on Colombian exports to the EU. Furthermore, Colombian imports from the EU are promoted by factors such as having a common language, that the EU country has the euro as its currency, the sum of the GDP of the pairs of countries and having an FTA in force. Regarding this last factor, unlike Colombian exports, this variable promotes imports from the EU. Additionally, models for Colombian exports to the EU and imports from the EU in which we measure the effect of the differences in their factor endowments in order to recognize trade patterns indicate a clear connection with the Heckscher-Ohlin (H-O) model, thereby proving the relevance of inter-industry trade between the parties.

Finally, our research determines the factors that explain the deepening of the deficit in Colombia's trade balance with EU countries, among which we highlight the positive effect of the trade agreement on the increase in its imports from the EU and the statistical insignificance of this variable in its exports to the EU. Additionally, we identify that Colombia and the EU countries carry out inter-industry trade based on their factor endowments, which should be considered by the Colombian government as an instrument that allows it to focus its trade policy towards those EU countries with different factor endowments. ◄

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Appendix A. Correlation matrix

	Log$DIST_{Colj}$	$COMLANG_{Colj}$	$COMLEG_{Colj}$	$LANDLOCK_j$	
Log$DIST_{Colj}$	1.000				
$COMLANG_{Colj}$	–0.332	1.000			
$COMLEG_{Colj}$	–0.472	0.280	1.000		
$LANDLOCK_j$	0.070	–0.090	–0.121	1.000	
$EUROAREA_j$	–0.310	0.160	0.542	–0.042	
$OECD_j$	–0.503	0.110	0.218	0.268	
FTA_{Colj}	0.000	0.000	0.000	0.000	
GDP_{Colj}	–0.477	0.237	0.274	–0.208	
LogRFE_{Colj}	–0.510	0.039	0.329	0.078	
LogHC_{Colj}	0.182	–0.260	–0.508	0.326	
LogPD_{Colj}	–0.243	–0.086	0.511	0.011	

Appendix B. Sample countries

AUT	FIN	LVA
BEL	FRA	MLT
BGR	GBR	NLD
COL	GRC	POL
CYP	HRV	PRT
CZE	HUN	ROM
DEU	IRL	SVK
DNK	ITA	SVN
ESP	LTU	SWE
EST	LUX	

	$EUROAREA_j$	$OECD_j$	FTA_{Colj}	GDP_{Colj}	$\text{Log}RFE_{Colj}$	$\text{Log}HC_{Colj}$	$\text{Log}PD_{Colj}$
	1.000						
	0.330	1.000					
	0.139	0.061	1.000				
	0.243	0.485	0.139	1.000			
	0.414	0.559	–0.136	0.364	1.000		
	–0.345	0.229	–0.168	0.092	0.171	1.000	
	0.246	0.084	–0.026	0.265	0.357	0.063	1.000