UNIVERSIDAD DEL AZUAY

Faculty of Legal Sciences

School of International Studies

DETERMINANTS OF COCOA BEAN EXPORTS TO EUROPEAN UNION COUNTRIES: A GRAVITY MODEL FOR THE PERIOD 2010-2024

Project prior to obtaining the Bachelor´s Degree in
International Studies

Author:
Milena Vanessa Cuesta Miranda

Supervisor:
Econ. Luis Gabriel Pinos Luzuriaga

Cuenca – Ecuador

2025

DEDICATION

To my mother, for her unconditional love and support, and for never doubting me. This achievement is as much hers as it is mine.

ACKNOWLEDGMENTS

To God, for giving me wisdom and strength at every step; and to my supervisor, Economist Luis Pinos, for guiding me and teaching me with dedication and patience throughout this study. To my parents and friends, for their love, support, trust and for encouraging me, accompanying me, and never leaving me alone during this process.…

Table of Contents

List of Tables

List of Figures

Determinants of Cocoa Bean Exports to European Union countries: A Gravity Model for the Period 2010 - 2024

Abstract

Ecuadorian cocoa sustains one of the most important export chains in international trade. It is essential to understand which factors truly condition its exports in order to improve the competitiveness of the sector. The objective of this study is to estimate the determinants of cocoa bean exports to the countries of the European Union during the period 2010- 2024 through a gravity model. For this purpose, balanced panel data were used for 6 European Union countries: The Netherlands, Germany, Belgium, Spain, Italy, and France. Estimated through the fixed- effects method, the model includes variables such as GDP, distance, common language, price, transport costs and cultural ties. The results show that both Ecuador´s GDP and the GDP of the European Union countries are the main significant and positive determinants affecting exports behavior, indicating that economic growth in both the exporting and importing countries increases supply and demand. In contrast, the other variables are not relevant for this study. In conclusion, the development of Ecuadorian cocoa depends mainly on bilateral economic dynamism, which is why it is important to strengthen production and maintain the quality demanded by the European market.

Keywords: Ecuador, trade flow, gravity model, European union, GDP.

Determinantes de las exportaciones de cacao en grano a países de la Unión Europea: Un modelo gravitacional para el período 2010-2024

Resumen

El cacao ecuatoriano sostiene una de las cadenas exportadoras más importantes en el comercio internacional. Es fundamental entender que factores condicionan realmente sus exportaciones para mejorar la competitividad del sector. El objetivo de la investigación es estimar las determinantes de las exportaciones de cacao en grano hacia los países de la Unión Europea durante el periodo 2010-2024 mediante un modelo gravitacional. Para ello se emplearon datos de panel balanceado para 6 países de la Unión Europea: Países bajos, Alemania, Bélgica, España, Italia y Francia. Estimado a través del método de efectos fijos, se incluyeron variables como PIB, distancia, idioma común, precio, costos de transporte y lazos culturales. En los resultados se evidencia que tanto el PIB ecuatoriano como el de los países de la Unión Europea son las principales determinantes significativos y positivos que afectan el comportamiento de las exportaciones, mostrando que el crecimiento económico del país exportador e importador aumentan la oferta y la demanda. Y al contrario las otras variables no son relevantes para este estudio. En conclusión, el desarrollo del cacao ecuatoriano depende principalmente del dinamismo económico bilateral, por ello es importante fortalecer la producción y mantener la calidad que exige el mercado europeo.

Palabras clave: Ecuador, flujo comercial, modelo de gravedad, Unión Europea, PIB.

Determinants of Cocoa Bean Exports to European Union Countries: A Gravity Model for the Period 2010-2024

1. Introduction

Over the years, Ecuadorian cocoa has been one of the flagship products of the national economy. In the early twentieth century, the cocoa sector was among the main contributors to Ecuador's export revenues (Villacis et al., 2022). Although its percentage share within the trade balance has declined notably in recent decades, Ecuador continues to stand out in international markets due to the high-quality standards of its fine-flavor cocoa. Within this context, the country maintains a competitive position, which is essential to understanding cocoa trade flows and the integration of this product into the global market.

Nevertheless, the production and flow of Ecuadorian cocoa have faced several internal and external challenges, such as climate conditions associated with the El Niño phenomenon, labor availability, agricultural technification, national economic growth, trade barriers, logistical costs, and the dynamism of external markets. All these factors influence national supply. According to the International Cocoa Organization (2024), Ecuador produces between 330,000 and 360,000 tons of cocoa annually, placing the country in second place worldwide and positioning it as the leading producer of fine-flavor cocoa, which represents 75% of its total exports. Over the past ten years, between 110,000 and 150,000 tons have been shipped annually to the European Union, accounting for 60% of Ecuadorian cocoa. Therefore, this study seeks to identify the main determinants that influence exports to European market countries. The object of analysis focuses on the factors that affect Ecuador's cocoa-bean exports to the European Union between 2010 and 2024, evaluated through a gravity model that incorporates economic, geographic, and cultural variables.

The relevance of this study lies in understanding how variables such as economic size, trade logistics, and geographic distance can either limit or stimulate the country's export capacity. With this information, both producers and exporters will be able to adjust their strategies, identify opportunities to increase revenues, generate employment, and strengthen the cocoa value chain, thereby reducing vulnerabilities to external shocks such as price fluctuations in international cocoa markets. Likewise, the study aims to explore innovative options to maintain competitiveness within the global market and achieve greater international integration.

This research is organized sequentially. It begins with the general objective and continues with clearly defined specific objectives. This is followed by the literature review, which includes the theoretical framework containing the key concepts necessary for understanding the topic, and the state of the art, which cites various authors whose studies support or relate to this research. The methodology section then describes the tools and methods used, outlining the steps required to conduct the study. Here, the gravity model is presented and estimated using three different methods: Pooled OLS, Fixed Effects, and Random Effects. The results section is then introduced to present the data, values, and interpretations that support the analysis. Subsequently, the discussion section examines these results in relation to previous studies included in the state of the art, identifying similarities and differences. Finally, the conclusion and recommendations provide an overall synthesis, responding to each objective and offering suggestions derived from the study.

1.1. General Objective

Estimate the determinants of cocoa-bean exports to European Union countries through a gravity model during the period 2010–2024.

1.2. Specific Objectives

1. Review the state of the art related to the application of the gravity model in trade flows.
2. Contextualize Ecuador's domestic situation in the cocoa sector.
3. Contextualize Ecuador's trade relations with European Union countries.

4. Estimate the determinants of cocoa exports to the European Union.

2. Literature review

2.1. Theoretical Framework

Trade originated in basic markets, but it was the capitalist market that paved the way for commercial activity in Europe, later expanding globally. Within trade, three interdependent variables can be identified: material life, the market economy, and merchant capitalism. These variables became the fundamental drivers that stimulated European commercial growth. Additionally, the development of cities and financial institutions contributed to both local and international expansion (Braudel, 1985). Foreign trade refers to the exchange of products, goods, and services between different countries. International trade promotes development and fosters international relations, which in turn create economic growth opportunities and help improve quality of life (Suriaga & Hidalgo, 2021).

Foreign trade can be understood as an economic tool that encompasses a set of commercial relations among countries, through which goods and services are exchanged under a legal framework of national and international scope that transcends state borders. This activity generates employment and supports the formation of the global economy (González, 2011). It represents a fundamental axis of national economies, strengthening competition among local products and expanding the supply and demand of various national and international markets (Gómez, 2006). In this context, trade among countries is essential for developing nations because it enables them to increase their benefits, negotiate and access trade agreements, and ultimately become more competitive in the global market (Villacis et al., 2023). In conclusion, trade is a basic mechanism for generating employment opportunities and improving living conditions; it is the essential means for sustaining import and export operations, which drive economic progress (Valencia & Gallegos, 2014).

Among the main theories that explain foreign trade are the theory of absolute advantage, in which Smith (2005) argues that productivity increases due to specialization. Under this concept, he distinguishes between use value and exchange value, noting that while some goods have high utility and low exchange value, others have high exchange value and low utility. Another key theory is comparative advantage. Ricardo (1817) explains that even if a country does not have an absolute advantage in producing a good, countries can still benefit from trade by specializing in goods or services with lower production costs. He complements this with the labor theory of value, which states that the value of goods depends on the amount of labor used in their production. Finally, the theory of competitive advantage, proposed by Porter (1985), suggests that the profitability of a product depends on the structure of the industry. He introduces five forces: new entrants, substitutes, supplier power, buyer power, and rivalry among competitors, from which he develops three strategies: cost leadership, differentiation, and focus. Thus, competitive advantage is understood as the strategic construction of competitiveness and profitability.

Foreign trade generates flows of goods, services, and capital. Trade flows represent the movement of goods, services, and capital in an international context, creating networks of interdependence among the economies of different countries. These flows are dynamic, as they depend on changing factors such as the global economy, technological advances, transportation, and communication. They may take the form of exports or imports, not only bilaterally but also globally, depending on the degree of trade openness. As mentioned earlier, they are essential for strengthening national economies within the global landscape (Derbez & Usabiaga, 2002).

The indicator most commonly used to measure the degree of trade openness of an economy is considered a statistical tool. Over time, trade openness has become an important measure of integration into the global market. In this sense, authors such as Aronskind et al. (2004) state that the recent dynamics of global trade help accelerate output expansion and strengthen domestic activity and well-being.

The formula for trade openness is:

$$\text{Trade openness} = \frac{x+m}{PIB} \quad (1)$$

Where:

- X= Exports of goods and services
- M= Imports of goods and services
- GDP= Gross Domestic Product

Using formula one, it is possible to determine the degree to which an economy is connected or integrated into foreign trade. It allows us to understand the scale of a country's commercial exchange with others compared to the size of its economy (Carbaugh, 2009).

For a country to achieve greater trade openness, it must be competitive and improve its external performance. Commercial competitiveness is defined as the ability of a country to integrate and remain in international markets by innovating and adapting to the needs of diverse consumers as well as quality requirements. Competitiveness is not limited to cost reduction; it also involves incorporating sustainable advantages that benefit trade flows. The competitiveness of a country, industry, or company requires strategic mechanisms to position itself in markets surrounded by many competitors (Valencia & Gallegos, 2014). Additionally, other authors such as Bustillo (2001) explain that many people commonly believe competitiveness belongs only to large enterprises, when in reality it is present in everyday life. Being competitive is not merely about outperforming others, but about adopting a lifestyle focused on personal growth and collective well-being. Although often confused, competition and competitiveness are not the same: one may compete without being truly competitive if actions lack ethics or respect. True competitiveness involves constant improvement, coexisting with others in a fair environment, and making positive contributions to society. For a person, company, or country to be competitive, they must first desire to be so and commit to that objective, working consistently toward development (Mathews, 2009).

To understand international trade flows, several theoretical models have been developed, among which the gravity model stands out, popularized by Paul Krugman. This model is inspired by Newton's law of gravitation. It posits that bilateral trade between two countries is positively related to the economic size of both countries and negatively related to the geographical distance between them (Krugman & Wells, 2022). The gravity model has evolved into a key tool for analyzing international trade. It predicts that trade flows are directly related to the economic size of countries and inversely related to trade costs such as geographical distance or tariff barriers. For this reason, it serves as a useful tool for the present study and will be applied in the methods and materials section (Yotov et al., 2016).

2.2. State of art

Several authors have shown interest in explaining the causes behind commercial flows. Throughout history, since the creation of the gravity model, different researchers have contributed to its development, leading to a continuous evolution. For example, in the seminal work of Tinbergen (1962), the author transferred Newton's law analogy to the analysis of trade between two countries, proposing that trade flows between nations are related to their economic size and decrease with geographical distance. Similarly, Branson et al. (1981) strengthened the understanding of trade factors and relative prices by proposing a macroeconomic model that explains the dynamics of the real exchange rate based on the interaction between money supply, relative prices, and the current account balance. Their study demonstrated that in the short run, the exchange rate behaves as the price of a financial asset. Following this research, foreign trade movements could no longer be understood solely through economic size or distance, as other fundamental factors also influence the external competitiveness of countries.

Likewise, Bergstrand (1985) showed that the gravity equation could be derived from a general equilibrium model with goods differentiated by country of origin. Under this framework, consumers maximize their utility by distinguishing between domestic and imported products, while producers choose between staying in the domestic market or engaging in foreign trade. Based on this, he developed an extended version of the gravity equation, incorporating variables such as relative prices, unit value indices, and exchange rates, which allowed for a more accurate explanation of trade flows. Using data from 15 countries for the periods 1965–1966 and 1975–1976, estimated with OLS, he found that exports depended on GDP, distance, regional integration, and trade agreements. He concluded that higher exporter income increases trade, whereas high unit prices reduce it. It is worth noting that this study helped consolidate the gravity model as an empirical framework with strong explanatory power.

Similarly, Anderson & Wincoop (2003) marked a critical point in the evolution of the model. They resolved McCallum's (1985) "border puzzle," which questioned why national borders remain strong barriers to trade despite the existence of free trade agreements. They demonstrated that previous studies had overestimated results by failing to consider each country's relative position in the global trading system. By introducing the concept of multilateral resistance, they showed that trade does not depend solely on bilateral barriers but also on the barriers each country faces with its entire set of trading partners. Their structural general equilibrium model with CES preferences and iceberg costs confirmed that income and distance remain key factors, but with a lower magnitude than previously estimated. This study represented a methodological turning point, strengthening the structural gravity model and laying the foundation for modern estimations.

In one of the most recent versions, Head & Mayer (2013) built upon earlier studies such as Bergstrand (1985). Beyond acknowledging earlier versions of the gravity model, they emphasized the importance of adopting improved empirical practices and focused on consistent estimators such as fixed effects and PPML, which reduce heteroscedasticity and zero-trade problems. They highlight that the gravity model has improved the understanding of trade and can also be useful for analyzing foreign direct investment and global finance, given its versatility within international economics. The authors argue that, in addition to common variables like exporter and importer GDP and geographic distance, the model should incorporate other factors such as shared language, common currency, regional trade agreements, and shared borders.

Various studies have applied the gravity model to analyze the determinants of agricultural and food-product trade, identifying common patterns in the influence of macroeconomic and logistical variables. For example, Ayuda et al. (2022) examined Latin American agri-food exports from 1994 to 2019 using an extended gravity model that included exporter and importer GDP, geographic distance, exchange rates, and trade agreements, estimated through PPML, OLS, and the Heckman model. Their results indicate that exports respond more to importer demand than to exporter supply, and that regional trade agreements significantly foster sectoral growth, driven by economic reforms and regional integration. Similarly, Nisa et al. (2023) applied a gravity model estimated with OLS to analyze the export value of Indonesian cocoa relative to African competitors, considering variables such as production, productivity, exchange rates, population, free trade agreements, and global prices. They found positive effects for production and export volume, but negative effects for the real exchange rate and population, while GDP was not significant. They recommended allocating fiscal resources to strengthen cocoa-producing regions. Additionally, Vásquez & Tonon (2021) applied a modified gravity model with panel data to analyze Ecuador's cocoa-bean exports between 2004 and 2018, revealing that exports increase with higher GDP or agricultural production but decrease significantly due to higher trade costs, identifying these costs as the most detrimental factor to Ecuador's cocoa competitiveness. Overall, these studies confirm that external demand, domestic production, and especially logistical costs and trade agreements are decisive for export performance in Latin America. Furthermore, in Ecuador, Tonon et al. (2022) examined banana exports to 12 countries between 2000 and 2019 using random-effects panel models, showing that agricultural production and importer GDP positively affect exports, while agricultural trade costs have a stronger negative effect than geographic distance. They recommended reducing such costs through international agreements.

Multiple studies have used the gravity model to analyze the factors influencing international agricultural trade, highlighting structural and institutional variables. Tadesse & Abafita (2021) examined the determinants of global coffee trade between 2001 and 2015 using data from 18 exporting and 201 importing countries, estimated with OLS and PPML. Their results show that GDP, exchange-rate depreciation, arable land, common language, and historical ties increase coffee exports, while distance, tariffs, and regional trade agreements are not significant. They concluded that more targeted policies with country-level data are needed. Similarly, Ya & Pei (2022) studied the factors affecting agricultural trade between China and Africa using an extended gravity model with panel data from 2001 to 2020. They found positive effects for GDP, population, trade agreements, common language, and logistical infrastructure, suggesting high potential for growth if bilateral policies and institutional stability are strengthened. González et al. (2018) focused on Nicaragua, applying a gravity model estimated with OLS and Newey-West corrections on data from 20 years and 12 countries, finding that GDP per capita, population, and real exchange rates increased exports while distance reduced them. They concluded that understanding these factors is essential to strengthen the agricultural sector and mitigate economic risks. In another study, Adelina et al. (2020) examined the determinants of Indonesia's cocoa exports from 2009 to 2018 using a fixed-effects gravity model. They showed that destination-country GDP has a positive impact, while distance, exchange rates, and tariff barriers negatively affect exports. The model explained 89.12% of the variation in exports and was statistically validated, reinforcing the robustness of the results. Collectively, these studies highlight that macroeconomic variables such as GDP, infrastructure, exchange rates, and trade agreements play a central role in agricultural export performance worldwide.

Other studies have delved further into structural, regulatory, and regional determinants influencing agricultural trade, also through the application of the gravity model. Sapa & Droždz (2019) analyzed Poland's agri-food exports to non-EU countries between 2000 and 2016 using a Hausman-Taylor estimator. Their results show positive effects of exporter and importer GDP, while geographic distance and the post-socialist status of the importing country constrained exports. Additionally, agricultural value added, and preferential agreements promoted trade, although GDP per-capita differences were not significant. They conclude that prioritizing large, nearby markets with strong institutional linkages can optimize agri-food export performance. Grant & Lambert (2005) evaluated the impact of regional trade agreements on global agricultural trade between 1985 and 2002 using an extended gravity model with data from 86 countries and eight regional blocs. Their results showed significant positive effects in blocs such as NAFTA and CER, which increased trade without harming non-member countries. In contrast, blocs like the EU-15 and APEC generated trade diversion, mainly affecting exports of wheat and fruit. They concluded that regional agreements are effective instruments for trade liberalization, although their effects must be evaluated case by case. In a more regulatory approach, Balogh & Borges Aguiar (2022) analyzed agricultural trade between Latin America and the Caribbean using PPML on data from 16 countries, concluding that GDP, population, distance, and exchange rates are significant variables, and that improving infrastructure and expanding trade agreements is necessary to strengthen regional integration. Additionally, Soguero & Morales (2024) examined the impact of trade policies during the COVID-19 pandemic on international agricultural markets using a PPML-estimated gravity model for 97 importing countries, 176 trade partners, and around 1,000 agricultural products. Export and import flows were the dependent variables, while tariffs, distance, common language, regional agreements, and trade-facilitation measures were included as explanatory factors. Their results show that trade-facilitation measures significantly increased import flows, whereas restrictive policies reduced them, with strong effects on dairy, meat, and fruit markets. They concluded that during global crises, openness and cost reduction strengthen the resilience of agricultural systems, whereas trade barriers increase vulnerability, particularly for countries highly dependent on these exports.

Following a similar line of research, Krivko et al. (2024) examined the effects of the 2014 Russian embargo on food exports to neighboring countries such as Poland, Finland, Lithuania, Estonia, and Latvia, using the rebalancing coefficient method and structural-break tests for the period 2008–2020. In their model, the dependent variable included exports and imports, while destination-market characteristics and EU membership served as independent variables. Their results showed that the embargo caused severe losses, especially for Lithuania and Latvia. Dairy markets rebalance more quickly than fruit and vegetable markets. The authors conclude that although the embargo reduced sales to Russia, neighboring countries demonstrated adaptive capacity, highlighting both the resilience and vulnerability of the agri-food sector to geopolitical shocks. Continuing with a gravity-model methodology, Bueno Rezende de Castro & Kornher (2023) analyzed the effect of trade digitalization and customs modernization on agri-food flows using PPML and HDFE, with data from 200 countries for 2015, 2017, and 2019. The dependent variable was exports, while independent variables included traditional factors such as GDP, distance, language, and trade agreements, as well as PT indicators and digitalization of non-tariff border measures. Their results show that GDP increased exports by 0.58% in exporting countries and 0.13% in importing countries, while digitalization raised trade flows by 0.27% and 0.24%, respectively. They concluded that digitalization reduces transaction costs and facilitates entry into international markets.

Similarly, Shi et al. (2025) evaluated the patterns and export potential of China's agricultural products to RCEP countries using a static gravity model estimated through a one-step approach for 2009–2023. The dependent variable was export value, while the independent variables included GDP, population, distance, tariffs, free trade agreements, political stability, maritime connectivity, government efficiency, and economic freedoms. Their results indicate that export increases are driven by destination-country GDP and population, while exporter population and tariffs reduce trade. They conclude that although China accounts for 42% of exports within the bloc, markets such as Myanmar, Indonesia, and the Philippines show substantial growth potential. Strengthening institutional frameworks and reducing barriers is essential for sustaining competitiveness. Likewise, Tette et al. (2024) analyzed water use in the production of rice, maize, sorghum, and millet in Ghana through a gravity model estimated with MCOP. Exports and imports were the dependent variable, while GDP per capita, population, distance, production conditions per capita, and water use served as independent variables. Their results show that distance and Ghana's GDP reduce imports, while partner-country population and GDP increase them. They conclude that Ghana uses large volumes of water for agricultural production and, despite its abundant water resources, remains dependent on imports to meet domestic demand. They recommend prioritizing crops that require less water and expanding hydrological restoration projects.

3. Method and Materials

The present study is carried out using a mixed correlational–explanatory and inferential approach, as it seeks to describe the historical and structural behavior of cocoa-bean exports from Ecuador to the European Union, while simultaneously applying econometric techniques to estimate the gravity model. The research relies on secondary data obtained from official sources such as Trade Map, the European Central Bank, the World Bank, the Central Bank of Ecuador, CEPII, FAOSTAT, and Distance From To. The period of analysis covers 2010–2024 in order to obtain a broad and updated overview of cocoa trade. For this purpose, a balanced panel dataset is employed, taking into account the European Union countries that are most relevant for this study, specifically: Germany, Belgium, Spain, France, Italy, and the Netherlands, since the remaining countries either lack sufficient data or are not relevant for the analysis.

The analysis is composed of a set of European Union countries that maintain active trade relations with Ecuador. The data-processing procedure begins with the homogenization of monetary variables, followed by the construction of a balanced panel dataset, which ensures complete and uniform observations for each country throughout the study period. As a third step, the data are summarized, and once this is completed, graphs are created to show export trends. Finally, a statistical and econometric analysis based on the gravity model is conducted using three different estimation methods: Pooled OLS (Pool), Fixed Effects, and Random Effects. These estimations are carried out using R software, and in the final stage, several diagnostic tests are applied to determine which method is the most appropriate, thereby identifying the significant variables.

Silva & Tenreyro (2006) present the simple gravity equation, which explains trade flows in relation to the economic size of countries and the distance between them. The general formula used in this study, drawn from their model is:

$$FC_{\{ij\}} = A * \frac{\{\boldsymbol{PIB_i \cdot PIB_j}\}}{\{\boldsymbol{D_{\{ij\}}}\}} \quad \textbf{(2)}$$

Taking logarithms:

$$FC_{\{ijt\}} = \beta_0 + \beta_1 ln(PIB_{\{it\}}) + \beta_2 ln(PIB_{\{jt\}}) + \beta_3 ln(DIST_{\{ij\}}) + \varepsilon_{\{ijt\}} \quad (3)$$

Where:

- FCijt: represents the flow of cocoa-bean exports from Ecuador (country iii) to a European Union country (country jjj) in year t.
- PIBjt and PIBjt: denote the gross domestic products of the exporting and importing countries, respectively.
- DISTij: is the geographic distance between the two countries, measured in kilometers.
- εijt: is the stochastic error term.

There is also an extended version of the gravity equation, extracted from Yotov et al. (2016), which builds upon Tinbergen's (1962) original formulation but includes a greater number of variables. In addition to common variables such as GDP and distance, it incorporates factors such as common language, shared borders, membership in regional trade agreements, historical relations, and tariff barriers. For the present study, the variables used are those shown in Table 1.

Table 1.

Variables used in the estimation of the gravity model

Variable	Type	Notation	Concept	Expected Relationship
Trade Flows	Dependent	TF	Exports of Ecuadorian cocoa to European Union countries, expressed in millions of USD. This is the outcome the model seeks to explain.	

Ecuador´s GDP	Independent	PIBe	Reflects the country's productive capacity. A higher national GDP implies greater export supply and international competitiveness.	+
EU GDP	Independent	PIBue	Reflects the size and purchasing power of the importing countries. Higher GDP increases cocoa demand.	+
Distance	Independent	D	Measures the average geographic distance in kilometers between Quito and the capitals of EU countries.	-
Common Language	Independent	CL	Dummy variable: 1 = common language, 0 = no common language.	+
Trade Costs	Independent	TC	Represents costs associated with foreign trade: tariffs, insurance, logistics, and shipping time. These correspond to FOB values.	-
Price	Independent	P	Measures the annual average price of Ecuadorian cocoa in the international market (USD/ton). Higher prices may increase export value but reduce volume if demand is inelastic.	-
Cultural Ties	Independent	CT	Dummy variable: 1 = historical ties, 0 = no historical ties.	+

The econometric specification of the extended model is shown in Equation 4:

$$FC_{\{ijt\}} = \beta_0 + \beta_1 ln\left(PIBe_{\{it\}}\right) + \beta_2 ln\left(PIBue_{\{jt\}}\right) + \beta_3 ln\left(D_{\{ij\}}\right) + \beta_4 ln\left(IC_{\{it\}}\right) + \beta_5 ln\left(CTC_{\{jt\}}\right) + \beta_6 ln\left(P_{\{ij\}}\right) + \beta_7 ln\left(LC_{\{ij\}}\right) \varepsilon_{\{ijt\}} \quad (4)$$

The gravity model will be estimated using static panel-data models, including: Pooled OLS (Pool), Fixed Effects (FE), and Random Effects (RE). The Pooled OLS model is based on estimating a single linear regression and is attributed to Carl Friedrich Gauss. This approach focuses on determining the coefficients that minimize the distance to the dependent variable YYY. However, Gujarati (1997) notes that this method does not account for individual heterogeneity. Pooled OLS relies on three assumptions: (1) independence between regressors and errors; (2) homoscedasticity; and (3) no serial autocorrelation. One major limitation is that it ignores both cross-sectional and time variation, which may introduce bias when such characteristics correlate with independent variables (Wooldridge, 2010).

The Fixed Effects model controls for country-specific heterogeneity that remains constant over time. It incorporates a country-specific term capturing invariant characteristics potentially correlated with explanatory variables. Its advantage lies in offering stable estimators even in the presence of omitted-variable bias. In international trade analysis, it provides a robust assessment of the impact of macroeconomic variables across countries (Baltagi, 2005). This estimator requires strict exogeneity and is consistent but not efficient under RE assumptions because it does not consider the structure of the error term (Moral Arce & Pérez López, 2019).

The FE model is estimated as follows:

$$y_{\{it\}} = \alpha_i + \beta X_{\{it\}} + u_{\{it\}} \quad (5)$$

Where:

- yit: dependent variable for unit iii at time ttt (e.g., Ecuador's cocoa exports to country in year.
- αi: individual fixed effect capturing the country's time-invariant characteristics (e.g., geography, historical institutions).
- Xit: vector of independent variables (e.g., GDP, trade agreements, distance, tariffs).
- β: coefficients to be estimated.
- uit: idiosyncratic error term (unobserved factors varying across time).

Finally, the Random Effects model includes a composite error structure that separates unit-specific variation from idiosyncratic variation. In this method, it is necessary for the random effect to be uncorrelated with the regressors, allowing the estimation of coefficients for variables that do not vary over time, such as country of origin or population (Moral Arce & Pérez López, 2019). This approach captures correlation among observations belonging to the same country across time. Estimation is performed through Generalized Least Squares, yielding efficient coefficients under the assumption that individual effects are independent of explanatory variables. Its main advantage is that it allows the inclusion of time-invariant variables; however, its application is valid only if independence between random effects and regressors holds. Therefore, diagnostic tests, such as the F-test or the Hausman test, are recommended (Baltagi, 2005).

$$y_{\{it\}} = \alpha + \beta X_{\{it\}} + u_i + v_{\{it\}} \quad (6)$$

Where:

- yit: dependent variable for unit iii at time t.
- α: common intercept for all countries.
- Xit: vector of independent variables.
- β: coefficients to be estimated.
- ui: unit-specific error component, assumed random and uncorrelated with Xit.
- vit: idiosyncratic error.

To verify which method is most appropriate for estimating the gravity model, diagnostic tests such as the F-test and the Hausman test are applied, as they help determine whether the model should be estimated using Pool, Fixed Effects, or Random Effects, based on hypotheses that validate econometric assumptions.

Greene (2003) explains that the F-test is the basic procedure for examining linear hypotheses in regression models. It compares two models—one restricted and one unrestricted—adjusted according to their degrees of freedom, thereby assessing whether the imposed restrictions are valid. When comparing Pool versus Fixed Effects, the F-test examines the difference in model fit, determining whether the decrease in explanatory power is statistically significant. This allows for the identification of whether the gravity model should be estimated with or without restrictions.

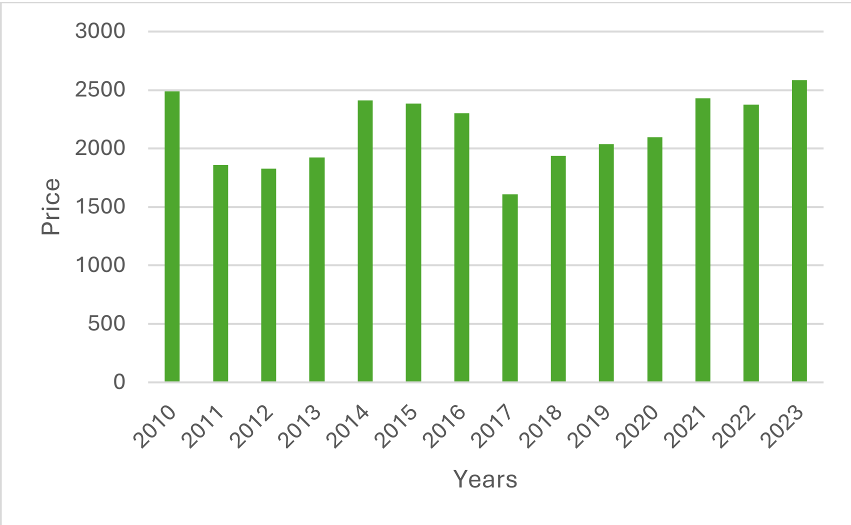
On the other hand, the Hausman test is applied to determine the most appropriate specification for a gravity model estimated with panel data. It compares the FE and RE estimators under the null hypothesis that there is no correlation between individual effects and explanatory variables. If this assumption holds, both estimators are consistent; however, if correlation exists, the RE estimator becomes inconsistent, while

FE remains valid. The Hausman statistic is constructed from the difference between both estimators and their variance–covariance structures. This test is essential because different datasets may alter results and lead to conflicting conclusions on model validity (Gallo et al., 2023).

4. Results

Ecuadorian cocoa has earned strong recognition worldwide. According to the International Cocoa Organization (2024), approximately 75% of Ecuador's exported cocoa belongs to the fine-flavor category, making the country the world's leading producer of fine-flavor cocoa. This recognition is attributed to several factors, including cultivation conditions, post-harvest practices, and the sensory profile of the plant. Among the main cocoa-exporting countries in the world are Côte d'Ivoire, Ecuador, Ghana, Nigeria, and Cameroon, while the principal importing countries include the Netherlands, Malaysia, Germany, the United States, and Indonesia. Moreover, the global cocoa price and its evolution are important factors for understanding supply and demand dynamics.

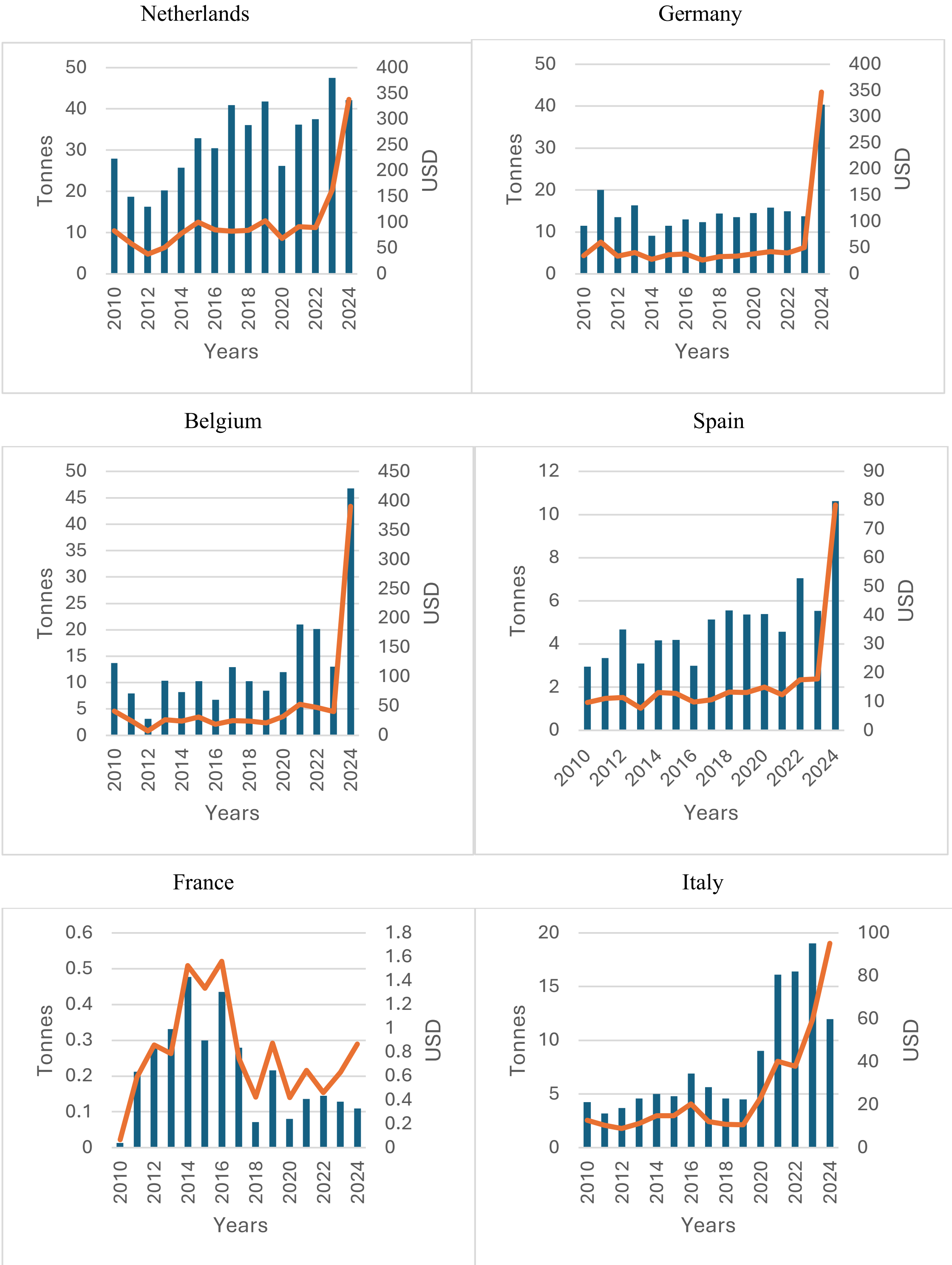
Figure 1.
Evolution of Ecuadorian cocoa prices in the international market, 2010–2023



Source: (Food and Agriculture Organization of the United Nations (FAO), 2025)

Between 2010 and 2023, cocoa prices experienced moderate fluctuations with notable improvements in recent years. Between 2010 and 2013, prices fluctuated between approximately USD 1,800 and USD 2,400 per ton, indicating stability in the international market. Following this period, a slight increase occurred until 2017, when prices declined due to excess supply. Beginning in 2018, prices rose again, reaching their highest point in 2023, at around USD 2,500 per ton—an outcome that benefits Ecuador and reflects recovering international demand. Overall, cocoa prices have remained stable, which translates into a higher valuation in international markets due to its high quality. Since 2020, international cocoa prices have shown an upward trend, increasing from USD 2,200 per ton to USD 3,100 per ton by June 2023. This reflects global supply-and-demand conditions and rising production and transport costs. Such increases represent a gap between local production conditions and international prices, highlighting the need to strengthen international trade mechanisms.

Figure 2.
Export trends of European Union countries in tons and U.S. dollars



Source: (World Bank, 2025)

Figure 2 presents cocoa-bean exports to European Union countries for the period 2010–2024. The Netherlands stands out significantly, with export values—both in tons and in USD—well above those of other countries, positioning it as Ecuador's most important trading partner in this market. Germany also shows steady and moderate growth until 2023, when exports rise sharply. Belgium exhibits a consistent upward trend, with notable changes in the last two years. Conversely, Spain shows gradual growth, with particularly important increases in 2017 and 2019, reaching its highest level in 2023—similar to the other countries—suggesting improved export prices or higher value added. France, by contrast, shows a slight downward trend in both variables. Italy displays gradual but modest growth compared to the other countries, reaching its peak in 2023 but still ranking among the countries with the lowest export volumes alongside France.

To estimate the determinants of Ecuadorian cocoa exports, the gravity model is applied, which requires the inclusion of variables such as trade flows (understood here as exports), Ecuador's GDP, the GDP of European Union countries, distance, common language, trade costs, price, and cultural ties. Within this framework, the variables included in the model are defined and classified as dependent or independent. Each variable is expected to have either a positive or negative relationship, and only those that result statistically significant will be considered (Anderson et al., 2003).

Based on the variables previously listed in Table 1, the gravity model was estimated to identify the determinants of Ecuador's cocoa exports to the European Union. Three econometric methods were used: Pooled OLS, Fixed Effects, and Random Effects. These allow analyzing the relationship between the dependent variable and the independent variables. The following table presents the coefficients obtained in each method, along with the R^2 and p-values, which help evaluate the consistency and influence of the variables within the model.

Table 2.
Results of the Gravity Model Estimation for Ecuadorian Cocoa Exports to the European Union (2010–2024)

Variables	Pool Method	Fixed Efects Method	Random Effects Method
Intercept	-117,1197*	-	-67,6931***
Log (Distance)	9,8871**	Not significant	Not significant
Log (GDP UE)	-1,0762***	1,9551*	0,9864
Log (GDP Ecu)	2,6253*	1,8699***	1,9621***
R2	0,2445	0,3533	0,2775
Trade costs	Not significant	Not significant	Not significant
Common Language	Not significant	Not significant	Not significant
Price	Not significant	Not significant	Not significant
P- Value (F)	0,0000	0,0000	0,0000

Note: Sig.<0.001(***), Sig.<0.01(**), Sig.<0.05(*)

Table 2 presents the estimation results for the gravity model using the three methods: Pooled OLS, Fixed Effects, and Random Effects. The estimation was carried out in two stages. First, a traditional gravity model was estimated in which the dependent variable is exports, and the independent variables include EU GDP, Ecuador's GDP, and distance. In the second stage, additional variables were included: common language, distance, trade costs, price, and cultural ties. Before selecting the most appropriate model, several tests were conducted to determine whether significant individual effects existed among countries. The first test was the F-test, which compares Pooled OLS versus Fixed Effects. The null hypothesis (H_0) states that individual effects are equal to zero, meaning no notable differences exist among countries, and therefore the pooled model would be preferable. In this case, the null hypothesis is rejected at a 0.05 significance level, indicating that the Fixed Effects model is better than the pooled model. Next, the Hausman test was applied to compare Fixed Effects versus Random Effects. Under the null hypothesis (H_0), there is no correlation between individual effects and explanatory variables, implying that Random Effects would be the most appropriate. The alternative hypothesis (H_1) states the opposite, indicating that Fixed Effects is preferable. Because the p-value is lower than 0.05, the null hypothesis is rejected, and both tests confirm that the Fixed Effects model provides the best specification, yielding more reliable results regarding the determinants of cocoa exports. Therefore, the other two methods are discarded, as they fail to capture unobserved heterogeneity among countries, making their results less representative.

The Fixed Effects results indicate that EU GDP has a positive and significant coefficient. Specifically, for every 1% increase in EU GDP, Ecuadorian cocoa exports rise by approximately 1.95%. This shows that the economic size and purchasing power of importing countries directly influence cocoa demand. In other words, higher income levels and economic growth in these countries increase their capacity to consume and import cocoa. Ecuador's GDP also shows a positive coefficient, indicating that a 1% increase in Ecuadorian GDP leads to a 1.86% rise in cocoa exports. This implies that national economic growth promotes export expansion, reflecting greater production capacity, export supply, and competitiveness in the cocoa sector. Overall, the Fixed Effects model shows the highest explanatory power, with an R^2 of 0.3533, compared to the other two methods.

The remaining variables in the extended model were not statistically significant because they do not exert a direct effect on export values. For example, distance does not influence results because it is constant over time. Other variables like trade costs, common language, cultural ties, and price—show little variation across European countries. However, they are included in the table because they help illustrate the direction and conceptual foundation of the model. These variables are not significant because the trade relationship between Ecuador and European countries is sustained mainly by product quality and institutional agreements rather than cultural or linguistic affinities. The significance markers (asterisks) next to the coefficients indicate each variable's level of statistical significance and how they influence cocoa exports. This allows identifying the p-value error level when determining whether to reject or accept the null hypothesis that the coefficient equals zero. In contrast, coefficients without asterisks are interpreted as non-significant, meaning they lack sufficient statistical relevance to influence the model during the study period.

The Fixed Effects estimation showed evidence of heteroscedasticity and contemporaneous correlation among observations, meaning that error variance is not constant, and that some correlation exists among country coefficients within the same period. This may affect estimator efficiency. To address this, robust standard errors were applied using an improved version of the White test, ensuring linear, unbiased, and consistent estimators (BLUE). As a result, the model maintains statistical validity, and the coefficients reflect the true effects of the variables.

5. Discussion

Based on the results obtained using the Fixed Effects model, it can be affirmed that the main determinants of Ecuador's cocoa exports to the European Union are the GDP of EU countries and Ecuador's GDP, both of which show positive and statistically significant effects. In contrast, variables such as distance, trade costs, price, common language, and cultural ties are not statistically relevant.

The dependent variable in this study is expressed in monetary values. The literature review shows that exports can be measured in different ways depending on the analytical approach—for example, export volumes in tons may be used to examine trade dynamics. Tinbergen (1962) demonstrated that trade flows increase with the economic size of countries, while Bergstrand (1985) showed that importer income boosts international trade. His study used FOB and CIF values to distinguish between transportation and insurance-related costs. Nisa et al. (2023) analyzed exports using non-deflated current dollars due to the time series structure and data availability. Similarly, in this study the dependent variable is expressed in nominal values because cocoa is a differentiated product whose export price reflects its quality. Furthermore, the Fixed Effects model captures macroeconomic variability and minimizes distortions related to prices.

Anderson et al. (2003), who incorporated the concept of multilateral resistance, also confirmed the relevance of partner-country income in determining the intensity of bilateral trade. Head & Mayer (2013) emphasized the income elasticity of importing countries, a finding consistent with this study, where EU GDP positively influences Ecuadorian cocoa exports. In contrast, studies such as Grant & Lambert (2005) show that the role of GDP can vary depending on the trade bloc due to integration effects. In this research, EU GDP exhibits a positive and significant effect of 1.95%, demonstrating that as European countries experience income growth and increased purchasing power, their demand for Ecuadorian cocoa also rises, reinforcing the hypothesis that external demand is a key driver of trade.

Similarly, Ecuador's GDP also shows a positive and significant effect, indicating that greater economic growth translates into higher production capacity and export supply. With an estimated effect of 1.86%, Ecuador's GDP suggests that national economic expansion strengthens export performance by enhancing productive capacity and increasing available supply. Growth in agricultural production and domestic income results in larger exportable volumes. These findings highlight the role of internal factors such as productivity, production costs, and logistical efficiency in shaping export competitiveness, reaffirming Ecuador's position as a global leader in fine-flavor cocoa. These results align with studies by Vásquez & Tonon (2021) and Tonon et al. (2022), which found that economic growth and domestic agricultural output determine export volumes in cocoa and bananas, respectively. Balogh & Borges Aguiar (2022) similarly argue that the macroeconomic performance of the exporting country strengthens agri-food competitiveness. This competitiveness is reflected in the consolidation of the agricultural sector, access to international certifications, and continuous improvements in the production of fine-flavor cocoa, which has increased both the volume and quality supplied to European markets. These results also align with Shi et al. (2025), who concluded that importer GDP is the main determinant of agricultural export growth in China, while exporter-country population tends to reduce exports a variable not included in this study.

Other variables, such as distance, were not significant in this study's Fixed Effects model. This contrasts with classic findings from Tinbergen (1962) and Bergstrand (1985), where distance was significant and negative due to transportation costs and physical barriers. González et al. (2018), in their study on Nicaraguan exports, also found that distance significantly reduces trade flows. Conversely, studies by Sapa & Droždz (2019) and Anderson et al. (2003) show that in modern economies with strong institutional frameworks, distance loses explanatory power because it is constant over time similar to this study, where distance showed no influence due to the high degree of differentiation in Ecuadorian cocoa. Trade costs were also not significant, similar to distance, which can be explained by the high quality of Ecuadorian cocoa and the efficient maritime logistics between Ecuador and the European Union. However, authors such as Soguero & Morales (2024) and Bueno Rezende De Castro & Kornher (2023) argue that the influence of trade costs depends on crises, regulatory reforms, or changes in commercial stability, which may render their effect irrelevant under certain conditions. Tette et al. (2024), who studied water use and agricultural productivity in Ghana, found the opposite: distance and domestic GDP were significant and negative, reducing trade, while foreign GDP increased export flows.

The price variable was also not significant in this study, consistent with the findings of Ayuda et al. (2022), who note that in agri-food products, importer demand and international agreements often exert greater influence on exports than price variations. In this study, price was not significant because the high quality of Ecuadorian cocoa outweighs price fluctuations, meaning that international demand does not respond strongly to price changes. This contrasts with Adelina et al. (2020), who analyzed Indonesian cocoa and found price to be significant. This difference reflects the distinct market positioning of Ecuadorian cocoa, which belongs to a specialized segment more dependent on quality than price. Similarly, variables such as common language, cultural ties, and trade agreements were not significant in this study. Their influence is minimal when analyzing export volumes. However, authors like Tadesse & Abafita (2021) found that historical ties and common language are important for certain agri-food products such as coffee. Balogh & Borges Aguiar (2022) and Nisa et al. (2023) argue that in today's agri-food markets, non-traditional variables have lost relevance, as they are overshadowed by stricter import standards, traceability requirements, and certification systems that dominate European import processes.

6. Conclusions and Recommendations

This study aimed to estimate the determinants of Ecuador's cocoa-bean exports to European Union countries during the period 2010–2024. Based on the results of the Fixed Effects model, the findings show that the GDP of European countries and Ecuador's GDP are the key determinants influencing cocoa-export performance. These results confirm the conceptual validity of the gravity model. In contrast, variables such as distance, price, trade costs, common language, and cultural ties were not statistically significant, suggesting that Ecuadorian cocoa exports respond primarily to economic factors and quality standards rather than to social or geographic characteristics.

With respect to the literature review, most of the previous studies—including those by Tinbergen (1962), Anderson et al. (2003), Ayuda et al. (2022), Balogh & Borges Aguiar (2022), and Head & Mayer (2013) support the use of the gravity model as an efficient framework for analyzing trade flows. In line with these authors, the results of this study confirm that the economic scale and income levels of countries are crucial in explaining agricultural exports, highlighting the relevance of the gravity model in analyzing Ecuador's agri-food trade flows. Nonetheless, unlike studies in which distance and trade costs are significant variables, in this research their effects were null. This suggests a structural shift in the commercial integration of Ecuadorian cocoa, which has become increasingly tied to institutional trade frameworks and product differentiation.

Regarding Ecuador's domestic cocoa situation, the study shows that the country maintains a leading global position, exporting approximately 75% of the world's fine-flavor cocoa, according to the International Cocoa Organization (2024). However, export volumes depend on internal factors such as labor availability, agricultural production, and logistics. The results confirm that each one-percentage-point increase in Ecuador's GDP leads to a direct increase in cocoa exports. This indicates that strengthening macroeconomic stability and the productive sector is essential for maintaining international competitiveness. These findings align with Vásquez & Tonon (2021), who showed that domestic economic growth boosts trade performance, particularly for agricultural products.

Trade between European Union countries and Ecuador reveals that the Netherlands, Germany, and Belgium are the main buyers of Ecuadorian cocoa, with considerably higher import levels than Spain, Italy, and France both in value and tonnage. The gravity model coefficients confirm that importer-country GDP is essential for determining trade flows, as higher purchasing power increases demand for Ecuadorian cocoa.

Through the gravity model, it was possible to estimate which factors positively influence or do not influence cocoa exports. The findings show that EU GDP and Ecuador's GDP are the most important and essential variables for maintaining trade flow stability. The other variables showed no relevance, as they did not statistically alter export behavior in the Fixed Effects model. This indicates that Ecuador and EU countries base cocoa trade primarily on economic size and product differentiation rather than on price changes, which in turn enhances Ecuador's international competitiveness.

In conclusion, this study demonstrates that Ecuador's cocoa exports to the European Union are determined primarily by economic factors, reaffirming the validity of the gravity model in its income-based formulation. The main limitation of the research was the limited availability and consistency of data for variables such as transportation costs and bilateral agreements, which constrained the inclusion of complementary variables such as exchange rate, population, or foreign investment. As a recommendation for future studies, the model could be expanded by incorporating additional non-traditional variables such as quality certifications or measures of trade openness that may provide a more comprehensive explanation of Ecuadorian cocoa's integration into the international market. The results of this study contribute to a better understanding of the elements that affect export performance and offer evidence for the design of public policies or economic improvements that may help strengthen competitiveness in this sector over the long term.

7. References

Adelina, S., Purnomo Wibowo, R., & Hasyim, H. (2020). Analysis of the Export Determinants of Indonesian Cocoa with a Gravity Model Approach. International Journal of Research and Review, 7(10), 10. https://doi.org/www.ijrrjournal.com

Anderson, J., Van Wincoop, E., Van Wincoop, N., Evans, C., Feenstra, R., Harrigan, J., Helliwell, J., Hillberry, R., Hummels, D., Rose, A., & Yi, K.-M. (2003). Gravity with Gravitas: A Solution to the Border Puzzle. https://doi.org/https://www.aeaweb.org/articles/pdf/doi/10.1257/000282803321455214

Aronskind, R., Braunsteni, D., & Schvarzer, J. (2004). Economic Openness: Variable, Tool, or Utopia? http://www.econ.uba.ar/cespa.htm

Ayuda, M. I., Belloc, I., & Pinilla, V. (2022). Latin American Agri-Food Exports, 1994–2019: A Gravity Model Approach. Mathematics, 10(3). https://doi.org/10.3390/math10030333

Balogh, J. M., & Borges Aguiar, G. M. (2022). Determinants of Latin American and Caribbean Agricultural Trade: A Gravity Model Approach. Agricultural Economics (Czech Republic), 68(4), 127–136. https://doi.org/10.17221/405/2021-AGRICECON

Baltagi, B. (2005). Econometric Analysis of Panel Data (3rd ed.). https://www.wiley.com/en-us/Econometric+Analysis+of+Panel+Data%2C+3rd+Edition-p-9780470014030

Bergstrand, J. H. (1985). The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence. The Review of Economics and Statistics, 67(3). https://doi.org/https://www.jstor.org/stable/1925976

Branson, W. H., School, W. W., & Branson, W. H. (1981). Macroeconomic Determinants of Real Exchange Rates.

Braudel, F. (2002). The Dynamics of Capitalism.

Bueno Rezende De Castro, A., & Kornher, L. (2023). The Effect of Trade and Customs Digitalization on Agrifood Trade: A Gravity Approach. Q Open, 3(1). https://doi.org/10.1093/qopen/qoac037

Bustillo, R. (2001). Foreign Trade: Theory and Exercises.

Carbaugh, R. J. (2009). International Economics (12th ed.). www.xlibros.com

Derbez, L., & Usabiaga, J. (2002). Official Gazette Publications Related to Foreign Trade. https://doi.org/http://www.apta.com.mx

Food and Agriculture Organization of the United Nations (FAO). (2025). International Cocoa Price. https://www.fao.org/home/es

Gallo, L., Sénégas, M.-A., & Le Gallo, J. (2023). On the Proper Computation of the Hausman Test Statistic in Standard Linear Panel Data Models: Some Clarifications and New Results. https://doi.org/10.3390/econometrics

Gómez, A. (2006). Globalization, Competitiveness, and Foreign Trade. https://analisiseconomico.azc.uam.mx/index.php/rae/article/view/1192/935

González, M., Campano, C., López, L., & Valdebenito, J. (2018). A Gravity Model of Trade for Nicaraguan Agricultural Exports. Cuadernos de Economía (Colombia), 37(74), 391–428. https://doi.org/10.15446/cuad.econ.v37n74.55016

González, R. (2011). Different Theories of International Trade. https://doi.org/https://revistasice.com/index.php/ICE/article/view/1393/1393

Grant, J., & Lambert, D. (2005). Lessons from Gravity Model Estimation. AgEcon Search. https://doi.org/https://ageconsearch.umn.edu/

Greene, W. H. (2003). Econometric Analysis. Prentice Hall.

Gujarati, D. (1997). Basic Econometrics (3rd ed.). McGraw-Hill.

Head, K., & Mayer, T. (2013). Gravity Equations: Workhorse, Toolkit, and Cookbook (No. 2013-27).

International Cocoa Organization. (2024a). Cocoa Market Report. https://www.icco.org/

International Cocoa Organization. (2024b). Production of Cocoa Beans. https://www.icco.org/fine-or-flavor-cocoa/?utm

Krivko, M., Czech, K., Wielechowski, M., Kotyza, P., & Smutka, L. (2024). Rebalancing Agri-Food Trade Flows Due to the Russian Import Ban: The Case of Direct Neighbors. Frontiers in Sustainable Food Systems, 8. https://doi.org/10.3389/fsufs.2024.1420945

Krugman, P., & Wells, R. (2022). Economics (4th ed.; 5th ed. original). https://doi.org/https://www.reverte.com/media/reverte/files/book-attachment-6807.pdf?utm

Mathews, C. (2009). Competitiveness. https://www.sciencedirect.com/science/article/abs/pii/S0165176509001554

McCallum, J. (1985). National Borders Matter: Canadian-U.S. Regional Trade Patterns. American Economic Review.

Moral Arce, I., & Pérez López, C. (2019). Panel Data Econometrics. https://www.jstor.org/stable/26967991?utm

Nisa, D. P. J. I. N., Darsono, & Antriyandarti, E. (2023). Determinants of Cocoa Bean Trade in the International Market: A Gravity Model Approach. International Journal of Sustainable Development and Planning, 18(10), 3347–3356. https://doi.org/10.18280/ijsdp.181035

Porter, M. E. (1985). Competitive Advantage: Creating and Sustaining Superior Performance. Free Press; Collier Macmillan.

Ricardo, D. (1817). On the Principles of Political Economy and Taxation.

Sapa, A., & Droždz, J. (2019). Polish Agri-Food Trade with Non-EU Countries: A Gravity Model Analysis. Annals of the Polish Association of Agricultural and Agribusiness Economists, XXI(4), 403–412. https://doi.org/10.5604/01.3001.0013.6006

Shi, L., Zhang, S., & Hashmi, S. M. (2025). Export Pattern and Export Potential of Chinese Agricultural Products to RCEP Countries: An Empirical Study Based on the Gravity Model. Frontiers in Sustainable Food Systems, 9. https://doi.org/10.3389/fsufs.2025.1492812

Silva, S., & Tenreyro, S. (2006). The Log of Gravity. https://doi.org/https://doi.org/10.1162/rest.88.4.641

Smith, A. (2005). An Inquiry into the Nature and Causes of the Wealth of Nations. https://www.econlib.org/library/Smith/smWN.html

Soguero, J., & Morales, C. (2024). Impact of Trade Policy Measures on Agricultural Markets During Global Disruptions: A Multicountry Analysis. http://ageconsearch.umn.edu

Suriaga, M., & Hidalgo, W. (2021). Brushstrokes of International Trade. E-IDEA Journal of Business Sciences, 3(13), 27–43. https://doi.org/10.53734/eidea.vol3.id142

Tadesse, T., & Abafita, J. (2021). Determinants of Global Coffee Trade: Do RTAs Matter? A Gravity Model Analysis. Cogent Economics and Finance, 9(1). https://doi.org/10.1080/23322039.2021.1892925

Tette, A. S. K., Odey, G., Ahmad, M. J., Adelodun, B., & Choi, K. S. (2024). Crop Water Use and a Gravity Model Exploration of Virtual Water Trade in Ghana's Cereal Agriculture. Water (Switzerland), 16(15). https://doi.org/10.3390/w16152077

Tinbergen, J. (1962). Shaping the World Economy (pp. 229–256).

Tonon, L., Vásquez, J., Armijos, A., & Altamirano, J. (2022). Analysis of Ecuadorian Exports Using the Gravity Model: The Case of Bananas. Revista Científica Eco Ciencia, 9(4), 77–110. https://doi.org/10.21855/ecociencia.94.699

Valencia, J., & Gallegos, E. (2014). Competitiveness and International Trade. https://dominiodelasciencias.com/ojs/index.php/es/article/view/57

Vásquez, J., & Tonon, L. (2021). Gravity Model of Ecuador's Cocoa Bean Exports. Innova Research Journal, 6(1), 235–250. https://doi.org/10.33890/innova.v6.n1.2021.1591

Villacis, A., Barrera, V., Alwang, J., Caicedo, C., & Quiroz, J. (2022). Strategies to Strengthen Ecuador's High-Value Cocoa Value Chain. http://www.iadb.org

Villacis, F., Andrade, J., Peréz, J., & Carrión, G. (2023). International Trade. www.casedelpo.com

Wooldridge, J. M. (2010). Econometric Analysis of Cross Section and Panel Data. https://mitpress.mit.edu/9780262232197/econometric-analysis-of-cross-section-and-panel-data/

World Bank. (2025). World Integrated Trade Solution (WITS): Exports (FOB).

Ya, Z., & Pei, K. (2022). Factors Influencing Agricultural Products Trade between China and Africa. Sustainability (Switzerland), 14(9). https://doi.org/10.3390/su14095589

Yotov, Y. V., Piermartini, R., Monteiro, J.-A., & Larch, M. (2016). An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model. https://unctad.org/publication/advanced-guide-trade-policy-analysis-