https://doi.org/10.17221/405/2021-AGRICECON

Determinants of Latin American and the Caribbean agricultural trade: A gravity model approach

Jeremiás Máté Balogh, Giovanna Maria Borges Aguiar*

Department of Agribusiness, Institute for the Development of Enterprises, Corvinus University of Budapest, Budapest, Hungary

**Corresponding author: jeremias.balogh@uni-corvinus.hu*

Citation: Balogh J.M., Borges Aguiar G.M. (2022): Determinants of Latin American and the Caribbean agricultural trade: A gravity model approach. Agric. Econ. – Czech, 68: 127–136.

Abstract: Latin America and the Caribbean (LAC) region is one of the most important players in global agricultural trade. They have vast potential to strengthen their position as a result of the region's opportunities to increase agricultural production when combined with growing global demand, which could help the region's economy thrive. To discover the LAC potential agricultural trade pattern, this paper aims to analyse the determinants of LAC agricultural bilateral export for the period 1995–2019. The gravity model of trade was employed by estimating various Poisson pseudo-maximum likelihood (PPML) models including zero trade flows for panel data. The findings show that importers' GDP of LAC countries has a greater impact on agricultural trade compared to LAC exporters. Cultural similarities (common language) and countries' participation in Southern Common Market [Mercado Común del Sur (MERCOSUR)] stimulated agri-food export. Conversely, distance (transportation), past colonial links, and North American Free Trade Agreement (NAFTA) raised trade costs, having a negative impact on the export of agricultural products. The impacts of environmental regulations are ambiguous. This paper contributes to the literature by investigating the factors of agri-food export in LAC countries, which can be an important instrument for decision-makers adjusting agricultural trade policy.

Keywords: agri-food sector; climate agreement; cultural proximity; free trade agreements; international trade; South America

According to the recent food consumption forecasts, the demand for agricultural products will increase by 15% over the next decade, with approximately 70% more food required by 2050 globally (FAO 2009; OECD/FAO 2019). While the most agriculturally productive locations are often not the ones with the highest demand concentrations, agricultural trade has the capacity to balance markets by correcting production imbalances by transferring food from surplus to deficit regions. Since the early 2000s, agricultural trade development has been boosted, particularly between emerging and developing countries, whilst agri-food tariffs have dropped and many countries have reduced their use of trade-distorting policies as producer support (OECD 2019).

Agricultural commerce is expected to rise in the upcoming decade, although at a smaller rate, as global demand declines, and Latin America and the Caribbean (LAC), in particular have reinforced their position as global suppliers while its export rates are likely to continue to increase. The region has plenty of land and water; 38% of its accessible land is used for agriculture, and 46% is covered in forests, accounting for 14% of worldwide production and 23% of agricultural and fishery commodity exports. Although productivity is projected to drop over time, LAC is estimated to be responsible for more than 25% of global agriculture and fisheries exports by 2028, emphasizing the favorable influence of trade openness on the area (OECD/FAO 2019).

Supported by the National Research, Development and Innovation Office, Hungary (Project No. 128232 and No. 134668).

https://doi.org/10.17221/405/2021-AGRICECON

Despite the relevance of the topic, research on agri-food trade patterns and dynamics in developing regions, such as LAC, is scarce compared to industrial product analysis. Given the above, this study aims to investigate how LAC trading countries market size, geographical characteristics, free trade, and climate agreements affect LAC agri-food export. To examine the LAC trade pattern, a gravity model approach was employed and estimated with panel econometrics from 1995 to 2019.

Literature review. Over the past years, many studies utilized the gravity model in their analysis. This section overviews the recent empirical analysis on trade investigated by gravity approach focusing on emerging markets and the LAC region. The study of Figueiredo et al. (2014) confirmed the border effect for Brazilian commercial transactions in the 1998–1999 period with the use of the gravity model and suggested a negative link between geographic distance and commercial flow, which is strongly supported by the existing research. In addition, his work revealed that border regions had more trade between them. The supply determinants of coffee exports from Brazil, Colombia, and Peru, were examined by Arevalo et al. (2016) from 2000 to 2013. Authors discovered that a rise in the Brazilian GDP, and the increase in the world coffee prices, had a beneficial impact on its commerce. Business freedom had a favorable impact on exports, as well as currency rate appreciation. The distance between Brazil and its trading partners and their income demonstrated a negative link with the coffee trade. The estimation for Colombian and Peruvian coffee exports shows that the GDP of the exporting and destination country and the international price of coffee all had a positive impact on both nations' coffee exports. Nonetheless, the increase in distance between commercial partners had a negative impact on trade. Paula and Miranda (2017) compared the determinants and evolution of trade flows of the BRICS countries (Brazil, Russia, India, China, and South Africa) between 1997 and 2013. Findings suggested that cultural and geographic parameters have a beneficial effect on trade flows between Brazil and the BRICS countries. The authors also emphasized that the variable related to country's economy had a significant advantageous impact on trade.

Duarte et al. (2019) utilized the gravity equation to investigate the drivers of global virtual water trade (VWT) flows from 1965 to 2010. Their findings support the long-term economic and population expansion that resulted in a rise in VWT. Additionally, environmental circumstances have an impact on VWT, and commercial agreements boost commerce and water exchanges. To explain the determinants of EU intra-industry trade (IIT) in the period of 1996–2017, Balogh and Leitão (2019) employed the gravity model and analysed patterns of the agricultural trade between the EU and its African, Caribbean, and Pacific (ACP) trading partners. They found that agricultural export costs are significantly lower if the EU and its external export markets share comparable cultures, embrace the same religion, or have a regional trade agreement. The determinants of IIT between Brazil, EU, and China, from 2006 to 2017, were examined by Bobato et al. (2020) through the gravity model, by ordinary least squares (OLS) and Poisson pseudo-maximum likelihood (PPML). They found that Brazilian IIT with EU and China is small and has not shown a growth trend. On the contrary, it has decreased over the period under analysis. Regarding the determinants of IIT, it was discovered that the degree of openness of the partner, the economic size of nations, and the similarity of incomes are all favorable aspects. Nevertheless, the authors observed that Brazil continues to have significant trade costs, which constrain the expansion of commercial partnerships.

Despite the importance of the topic, the literature on LAC agri-food trade patterns is still limited compared to other regions of the world. The objective of this paper is to contribute to the empirical literature by providing a bilateral trade analysis of agricultural products in LAC with the gravitation model.

In this paper, four hypotheses are elaborated to discover for LAC agricultural trade pattern:

H_1: The higher the LAC exporters and their trading partners' economies are, the higher the agricultural export between them is.

Empirical research suggests that gravitational features (economic size) between the LAC region and their trading partners enhance trade flows of agricultural products between them. In turn, geographical distance is inversely proportional to agricultural trade. In this sense, sharing common geographical borders, as well as having a short geographic distance between trading partners can encourage bilateral agri-food trade (Head and Mayer 2014; Balogh and Leitão 2019; Borges Aguiar and Cossu 2019).

H_2: Cultural similarity between LAC exporters and their trading partners stimulate bilateral agricultural trade flows between them.

According to the literature (Braha et al. 2017), culturally similar nations with language commonalities and colonial ties tend to trade more with each other since

https://doi.org/10.17221/405/2021-AGRICECON

such characteristics could be linked with reduced information and trade costs.

H_3: Free trade agreements [North American Free Trade Agreement (NAFTA) and Southern Common Market (MERCOSUR)] are positively associated with agricultural export between LAC countries and their export destination markets by boosting agri-food export.

Trade agreements can reduce or even eliminate tariffs, quotas, and other barriers between involved partners, diminishing trade costs. In accordance with this statement, the literature reveals a positive connection between trade flows and free trade agreements, indicating that trade integration may lead to better economic outcomes (Lambert and Grant 2008; Korinek and Melatos 2009; World Bank 2019).

H_4: Environmental regulation (Paris Agreement) negatively influences the LAC bilateral agricultural export by restricting trade flow.

Recent literature (Drabo 2017; Balogh and Jámbor 2020) emphasized the detrimental effects of agricultural trade on the environment and stimulating climate change as a result of pollution. In that sense, stricter environmental regulation is associated with higher trade costs, with the ability to reduce both probability and volume of export (Jug and Mirza 2005; Kim 2016; Shi and Xu 2018).

MATERIAL AND METHODS

The econometric gravity model of trade is based on Newton's law of universal gravitation, which states that the attraction between two bodies is proportional to their mass and inversely proportional to the square of their distance (Baldy 2007). Tinbergen (1962) employed the method in economics, by applying the gravity equation structure to the analysis of trade flows, theorizing that commerce between two nations is proportional to their GDP and inversely proportionate to their geographical distance:

$$X_{ij} = \left(\beta_0 \frac{Y_i^{\beta_1} Y_j^{\beta_2}}{D_{ij}^{\beta_3}}\right)\mu_{ij} \qquad (1)$$

where: i – exporter country; j – importer country; Y_i – exporter country income; Y_j – importer country income; D – geographical distance between trading nations; X_{ij} – volume of trade between trading nations (proportional to Y_i and Y_j, and inversely proportional to D); β – model's estimated parameters; μ_{ij} – error term.

The following equation represents the relationship between international trade and Equation (1):

$$X_{ij} = \beta_0 \times Y_i^{\beta_1} \times Y_j^{\beta_2} \times D_{ij}^{\beta_3} \times \mu_{ij} \qquad (2)$$

The Equation (2) was transformed into a logarithm form with the goal of linearizing and correcting it. This was also advantageous because the angular coefficient now measures the percentage change in X_{ij} for a percentage change in Y_i, i.e. the elasticity of X_{ij} in relation to Y_i (Gujarati and Porter 2008). As a result, the following equation can be created:

$$\ln X_{ij} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \mu \qquad (3)$$

Binary variables, known as dummy variables, are used to categorize data into mutually exclusive groups by indicating the existence or absence of a 'quality' or feature (Gujarati and Porter 2008). Those types of variables were incorporated into gravity equations to maximize their performance by introducing qualitative characteristics to the model. Moreover, they can identify the existence or absence of a common language, contiguity, colonization, or other bilateral characteristics, which can have a positive or negative impact on the trade between regions (Azevedo 2004).

Estimation methods and econometric specification. Baldwin and Taglioni (2006) observed that several specification mistakes in the gravity model were caused by the removal of variables, which led the coefficients associated with trade cost variables to be overestimated. The authors criticized the use of averaged export values as the dependent variable, which is employed in many works, thus weakening the robustness of the results. They suggest that the omitted variables cause an erroneous correlation with the regressors, resulting in an endogeneity problem in which the coefficients linked with the cost variables are biased. In this sense, multilateral resistance terms, such as temporal and geographic dummies, must be incorporated to correct this concern. Accordingly, zero trade flows of agri-food products are included in our estimations, therefore, missing trade values are substituted with zero. In addition, time and country-pair fixed effects (Anderson and van Wincoop 2004) and the remoteness term (Head 2003; Baier and Bergstrand 2007) were applied to the model separately. Furthermore, Santos Silva and Tenreyro (2006) emphasize that, under heteroscedasticity, the estimated parameters of log-linearized models that use OLS may lead to biased estimations of elasticities. To address this issue, and handle zero trade flows in the

https://doi.org/10.17221/405/2021-AGRICECON

sample, they proposed the non-linear PPML estimator, which deviations are small due to its ease of implementation and reliability in a wide range of situations, making it relatively robust. Since PPML is the most consistent method, different techniques of this model were applied to estimate the gravity Equation (4).

The estimated model takes into account economic size (GDP of LAC exporters and importers' GDP from LAC), geographical distances (closest geographical distances between most populated cities in kilometres) and adjacency (sharing common border), cultural aspects (common official language, past colonial relationship), free trade agreements (NAFTA, MERCOSUR), and environmental regulation (Paris Agreement) (Table 1).

The dependent variable of the model (*LAC_agri_export*) is derived from World Bank (2021a) World Integrated Trade Solutions (WITS) Commodity Trade Statistics Database (COMTRADE). The LAC bilateral export data are downloaded for a total agricultural export under World Trade Organization (WTO) Multilateral Trade Negotiation aggregations at Harmonized System (HS) including raw, semi, and processed agricultural products expressed in USD [Table S1 in electronic supplementary material (ESM); for the ESM see the electronic version]. Tables S2, S3 in ESM (for the ESM see the electronic version) include the detailed description of the sample. The economic size of LAC countries and their partners ($GDP\_reporter_i$ and $GDP\_partner_j$) were collected from World Bank (2021b) World Development Indicators (WDI) database. The $dist_{ij}$ variable was retrieved from CEPII (2021) database and captures the distance between the most populated city of each country in kilometres. Other bilateral dummy variables such as $comlang\_off_{ij}$, $contig_{ij}$, and $comcol_{ij}$ were also collected from the CEPII (2021) database, while the dummies for $MERCOSUR_{ij}$, $NAFTA_{ij}$, and $Paris\_agreement_{ij}$ were created by the authors. As shown in Table 2, the panel dataset of this analysis contains 122 150 observations

$$LAC\_agri\_export_{ij} = \beta_0 + \beta_1 \ln\left(GDP_{reporter\,i}\right) + \beta_2 \ln\left(GDP_{partner\,j}\right) + \beta_3 \ln\left(dist_{ij}\right) + \beta_4\, comlang\_off_{ij} + \\ + \beta_5\, contig_{ij} + \beta_6\, colony_{ij} + \beta_7\, MERCOSUR_{ij} + \beta_8\, NAFTA_{ij} + \beta_9\, Paris\_Agreement_{ij} + \mu_{ij} \quad (4)$$

where: $LAC\_agri\_export_{ij}$ – agricultural export value from LAC to destination country; $GDP_{reporter\,i}$ – GDP of the LAC exporter country; $GDP_{partner\,j}$ – GDP of importer country from LAC; $dist_{ij}$ – geographic distance between trading country's most populated cities; $comlang\_off_{ij}$ – common official primary language in trading countries; $contig_{ij}$ – common borders of trading countries; $colony_{ij}$ – past common colonial relationship of trading countries; $MERCOSUR_{ij}$ – trading countries are members of the Southern Common Market; $NAFTA_{ij}$ – trading countries are members of the North American Free Trade Agreement; $Paris\_Agreement_{ij}$ – the Paris Agreement was ratified by trading countries.

Table 1 Description of variables

Variables	Description	Data source
Dependent		
LAC_agri_export	bilateral aggregated agricultural exports of LAC countries to its destinations (million USD)	World Bank (2021a)
Independent		
ln(*GDP_reporter*)	logarithm of LAC countries GDP (current USD)	World Bank (2021b)
ln(*GDP_partner*)	logarithm of agricultural importers' GDP from LAC (current USD)	
ln(*dist*)	logarithm of geographic distance between country's most populated cities (km)	CEPII (2021)
contig	1 if trading countries share common borders, 0 otherwise	
comlang_off	1 if trading countries have a common official primary language, 0 otherwise	
colony	1 for past common colonial relationship, 0 otherwise	
MERCOSUR	1 if trading countries are both the member of the MERCOSUR, 0 otherwise	authors' composition
NAFTA	1 if trading countries are both the member of NAFTA, 0 otherwise	
Paris_Agreement	1 if trading countries are both signed the Paris Agreement, 0 otherwise	

MERCOSUR – Southern Common Market (Mercado Común del Sur); NAFTA – North American Free Trade Agreement; LAC – Latin America and the Caribbean

Source: Authors' own composition

https://doi.org/10.17221/405/2021-AGRICECON

Table 2. Summary statistics

Variable	Observation	Mean	SD	Min.	Max.
LAC_agri_export	122 150	25 400 000	318 000 000	0	31 300 000 000
LAC agri_export zero values	63 562	0	0	0	0
ln(*GDP_reporter*)	121 346	23.942	2.087	19.430	28.592
ln(*GDP_partner*)	105 623	24.161	2.439	16.215	30.695
ln(*dist*)	114 600	8.787	0.825	–0.004	9.901
comlang_off	114 600	0.161	0.368	0	1
contig	114 600	0.009	0.093	0	1
colony	114 600	0.026	0.160	0	1
MERCOSUR	122 150	0.003	0.051	0	1
NAFTA	122 150	0.062	0.241	0	1
Paris_Agreement	122 150	0.151	0.358	0	1

For explanation of the variables see Table 1
Source: Own composition based on World Bank (2021a) World Integrated Trade Solutions (WITS) database

from 35 LAC nations and their bilateral agri-food trade data with 249 commercial partners from 1995 to 2019.

RESULTS AND DISCUSSION

Over the last decades, LAC countries have observed significant positive trends in the development of the agricultural sector, which has occurred particularly in the growth of agricultural trade, accompanied by adjustments in policy and production, as well as increasing global integration (OECD 2019).

LAC's agricultural trade surplus has steadily increased and has served as a kind of buffer against large economic contractions during periods of recession and times of economic crisis (Arias et al. 2017). Over the last ten years, Europe – Central Asia, East Asia – Pacific and North America have been the leading exporters worldwide. On the other hand, while pondering agricultural trade only, LAC was the third-largest agricultural exporter in the world between 1995 and 2019, accounting for 14.3% of all agricultural items shipped internationally on average (Figure 1).

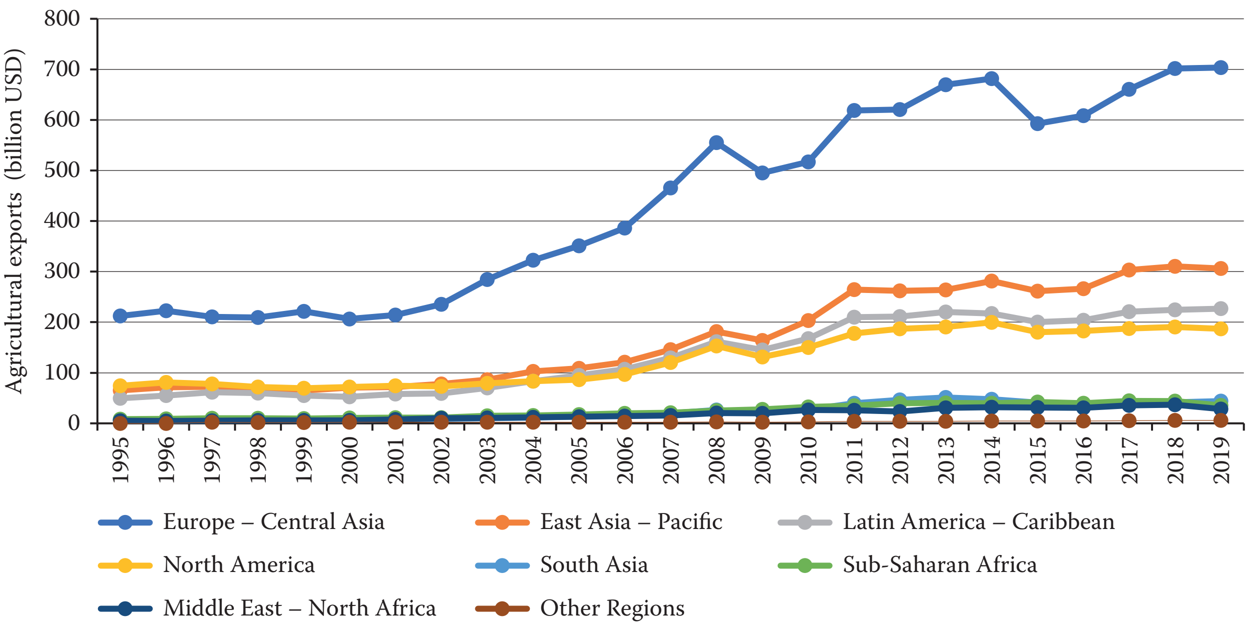

Figure 1. Evolution of agricultural exports in the world by region, 1995–2019

Source: Own composition based on World Bank (2021a) World Integrated Trade Solutions (WITS) database

https://doi.org/10.17221/405/2021-AGRICECON

In general, the agri-food trade has grown steadily in recent years, supplementing solid global economic development and commerce. LAC have strengthened their position in the international market as the world's third-largest agricultural exporter region, exporting an average of more than USD 124 billion in agricultural products between 1995 and 2019. In this same period, Brazil, Argentina, and Mexico were the top three exporters in the region, as Figure 2 suggests, contributing to an average of 70% of the LAC's agricultural exports.

The top ten exporters accounted for more than 90% of LAC total agri-exports during the analysed period. This high concentration persisted throughout the whole period, implying that the agricultural sector is highly concentrated in those nations.

It is crucial to emphasize Brazil's dominant role in the agri-food industry of LAC. Brazil has long been a key player in international commerce, with significant agricultural food export and market expansion, ranking as the LAC's largest one. Since 2011, it is the world fifth-largest agricultural and food exporter (World Bank 2021a).

The top ten LAC destination countries that imported the highest share of LAC agricultural products accounted for 56% of the total market share of agricultural products in the past 25 years. USA is the biggest trading partner of LAC agricultural products, with a share of 21% in the total destination market at the same period, as seen in Figure 3.

In 2019, the USA was the world's largest economy in terms of GDP (in current USD) and the largest importer in the world (OEC 2021). Since 2015, Mexico has surpassed Canada as the largest agricultural import partner of the USA (both countries share borders with the USA), boosting commerce with LAC as a whole. Brazil also strengths the LAC relation with the USA by exporting an average of USD 2 billion of agri-food products to the North American country, from 1995 to 2019, being its fifth-largest trading partner. Behind the USA, China is the second biggest importer of agricultural products from LAC.

Table 3 presents the gravity regression results for trade obtained using PPML calculations between LAC countries and their trading partners (export destinations) for the period of 1995–2019. The first and second column refers to PPML estimations that include zero trade flows. Time and country-pair fixed effects were also included in Model (1) whileModel (2) comprised the remoteness terms (*Remoteness_rep*, *Remoteness_part*) as GDP-weighted distance averages suggested by Head (2003), Baier and Bergstrand (2007). These remoteness terms are a linear approximation of the multilateral resistance terms.

Regarding the first hypothesis (H_1), the general gravity assumptions apply for LAC bilateral agri-food trade with positive values for LAC and partners' GDP and negative ones for geographical distance. In line with

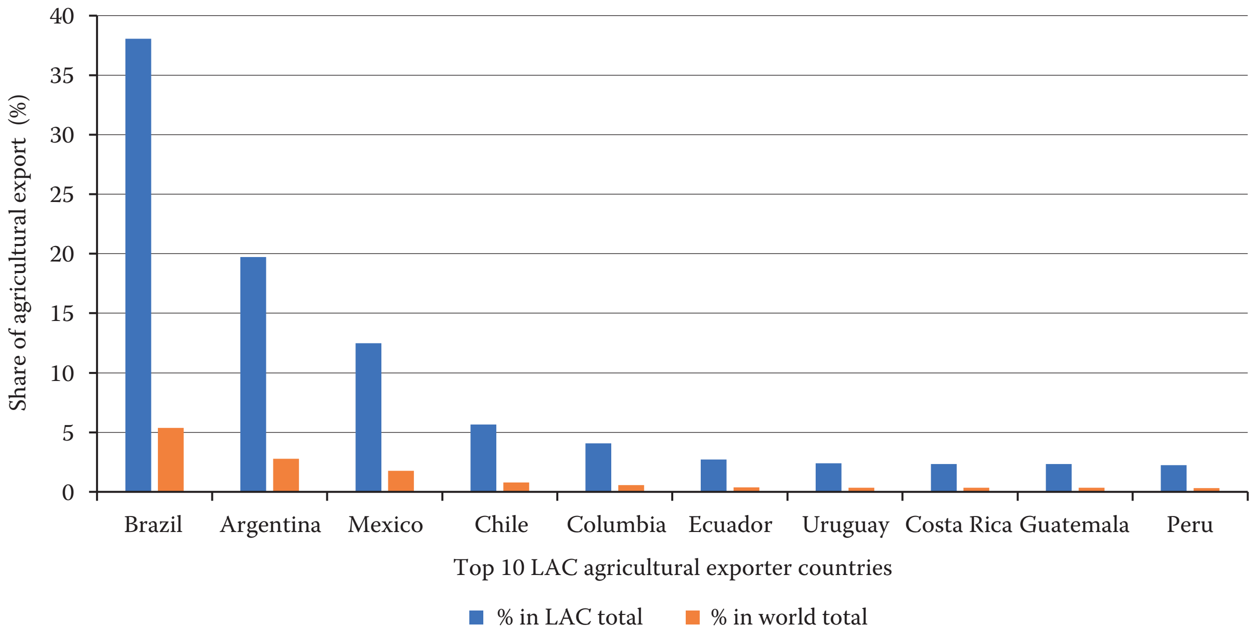

Figure 2. Share of the leading agricultural exporters of the LAC region in LAC total and world total exports, 1995–2019

LAC – Latin America and the Caribbean

Source: Own composition based on World Bank (2021a) World Integrated Trade Solutions (WITS) database

https://doi.org/10.17221/405/2021-AGRICECON

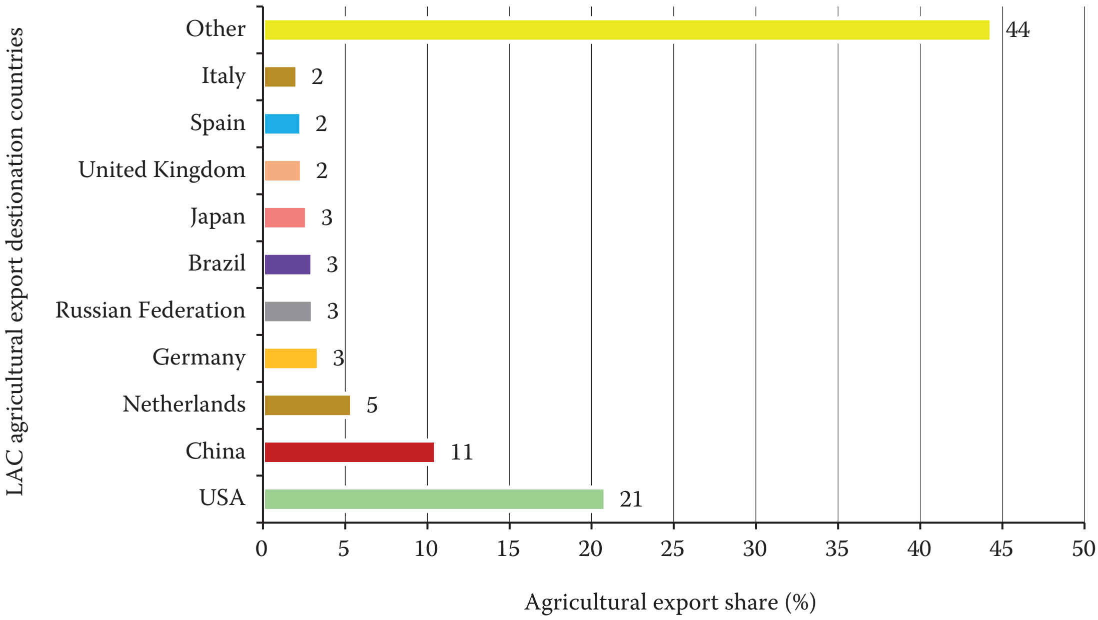

Figure 3. LAC destination agricultural export share in total LAC agricultural export by destination, 1995–2019

LAC – Latin America and the Caribbean

Source: Own composition based on World Bank (2021a) World Integrated Trade Solutions (WITS) database

the results, agri-food trade flows between LAC and their export destinations are directly proportional to the size of economies (*GDP_reporter*, *GDP_partner*) and inversely proportionate to the geographical distance (*dist*) between them.

The H_1 hypothesis on LAC bilateral agri-food trade is confirmed, implying that LAC trading partners' economy (*GDP_partner*) has a higher impact on agri-food trade than the size of the LAC economy (*GDP_reporter*) in Model (1). Besides, agri-food exports between LAC and its trading partners decline as the distance between their most populated cities increases.

The beneficial effect of a common official language (*comlang_off*) on LAC trade flow is observed in all estimation results, with a 1% significance level, demonstrating that cultural similarity between LAC and its trading partner appears to have a positive impact on trade flow, as it can reduce information and trade costs, confirming hypothesis H_2 in accordance with Braha et al. (2017). In contrast, Model (1) indicates that shared borders (*contig*) has a negative, and the former colonial relationship (*colony*) has a positive significant effect on agricultural export between LAC and its trading partners. It can be explained by the fact that main export destinations (USA, China, Netherland, Germany, and Spain) do not have common borders with LAC, and the export is realized on maritime transport.

In Model (2), common borders (*contig*), and the former colonial relationship (*colony*) have an inverse effect compared to Model (1), influenced by the effect of remoteness term.

Impacts of free trade were analysed by H_3. In this context, the influence of MERCOSUR was positive and significant, indicating that it increase the value of bilateral commerce between its member nations in line with World Bank (2019). According to Graf and Azevedo (2013), this was accomplished by the elimination of intra-bloc tariffs and non-tariff barriers, as well as the establishment of a common external tariff (CET) for most extra-bloc imported items. NAFTA had a negative impact on LAC agricultural export suggesting that it did not encourage agri-food export from Mexico to the USA and Canada (H_3 was only partly accepted).

The Paris Agreement, under which ratifying countries have decided to reduce their greenhouse gas emissions, including in the agricultural sector, was also added to the analysis in order to discover the effect of environmental regulation on LAC agri-food exports. The variable was positive significant [in Model (1)] or insignificant [in Model (2)] suggesting that it did not have a significant influence on LAC agri-food export (H_4 is rejected), however, Model (2) indicates a negative sign which is consistent with the previous empirical literature (De Santis 2012; Aichele and Felbermayr 2013; Kim 2016).

https://doi.org/10.17221/405/2021-AGRICECON

Table 3. Gravity estimation results for LAC region, 1995–2019

Variables	Model (1) *Agri_export*	Model (2) *Agri_export*
ln(*GDP_reporter*)	0.335*** (0.000)	0.914*** (0.0135)
ln(*GDP_partner*)	0.949*** (0.000)	0.848*** (0.0150)
ln(*dist*)	–0.008*** (0.000)	–0.146*** (0.0385)
comlang_off	0.097*** (0.000)	0.676*** (0.0604)
contig	–0.234*** (0.000)	0.793*** (0.133)
colony	0.081*** (0.000)	–0.613*** (0.0603)
MERCOSUR	2.191*** (0.718)	1.432*** (0.0832)
NAFTA	–1.142*** (0.155)	–0.974*** (0.0590)
Paris_Agreement	0.0003*** (0.000)	–0.0112 (0.0681)
Remoteness_exp	– –	–0.0007*** (0.000)
Remoteness_imp	– –	–0.00002*** (0.000)
Constant	1.820*** (0.017)	–23.88*** (1.052)
Observations	103 822	103 822
R-squared	0.824	0.534
Zero	yes	yes
Country pair fixed	yes	no
Time fixed	yes	no

*, **, ****P* < 0.05, *P* < 0.01, and *P* < 0.001, respectively; LAC – Latin America and the Caribbean; *Remoteness_exp* – multilateral resistance term for exporting countries; *Remoteness_imp* – multilateral resistance term for importing countries; for explanation of the variables see Table 1; robust standard errors in parenthesis; share of zero trade flows is 52% in the sample

Source: Own composition based on World Bank (2021a) World Integrated Trade Solutions (WITS) database

CONCLUSION

The agri-food trade has increased significantly in recent years, complementing strong demand, economic growth and expanding trade worldwide. The LAC region have cemented their position as the world's third-largest agricultural exporting region. From 1995 to 2019, the top ten nations in the LAC area accounted for more than 90% of total agri-exports, with Brazil in the first place, followed by Argentina and Mexico. The LAC trade statistics showed a strong concentration also on the import side, more specifically, the USA and China accounted for 31% of all agri-food products in total as LAC export destination markets. The paper employed the gravity model approach to analyse the main determinants of LAC bilateral agricultural export patterns. The study utilized an econometric approach using PPML estimation for LAC agri-food exports with all trading partners for the period 1995–2019, accounting for zero trade flows, time, and country fixed effect. The estimated models proved that the LAC trading partners' GDP and the geographic distance between them affect international commerce of agricultural products. Linguistic similarities (common official language spoken) have positive while border effects and past colonial links are ambiguous impacts on the LAC agri-food trade. Estimations explored the favorable impact of LAC involvement in MERCOSUR on agri-food commerce By contrast, the trade costs of shipping products from LAC (Mexico) to NAFTA destinations (USA and Canada) were higher, diminishing the value of export. It reveals that this trade relationship is not mutually advantageous for both partners in terms of agricultural products. Finally, the negative impact of environmental regulations (Paris Agreement) on agri-food export was not confirmed (H_4 is rejected). The conclusions of this study provide recommendations for LAC agricultural policymakers. Firstly, the export-oriented agricultural strategy should seek market diversification, as there is a high concentration at LAC destination markets in agri-food exports. Results imply that MERCOSUR appears to be favorable to LAC nations' agricultural trade. Moreover, LAC should expand market opportunities for regional trade integration, to make commerce more beneficial mutually, as well as strengthen commercial ties with its country peers, taking advantage that culturally similar nations might benefit from lower trade costs. Past colonial relationships with trading partners and the ratification of the Paris Agreement did not have a significant effect on LAC agricultural export. In conclusion, LAC have promising prospects to boost their agricultural production when combined with expanding global demand, which may help to stimulate the region's economic development. Additional research is needed, to take into account all aspects of free trade agreements on LAC trade relations at the product level.

https://doi.org/10.17221/405/2021-AGRICECON

REFERENCES

Aichele R., Felbermayr G. (2013): Estimating the effects of Kyoto on bilateral trade flows using matching econometrics. World Economy, 36: 303–330.

Anderson J.E., van Wincoop E. (2004): Trade costs. Journal of Economic Literature, 42: 691–751.

Arevalo J.L.S., de Andrade Á.M.F., e Silva G.A.B. (2016): A note on gravitational models applied to coffee exports from Brazil, Colombia and Peru (Uma Nota Sobre Modelos Gravitacionais Aplicados à Exportação de Café de Brasil, Colômbia e Peru). Revista Brasileira de Economia, 70: 271–280. (in Portuguese)

Arias D., Vieira P.A., Contini E., Farinelli B., Morris M. (2017): Agriculture Productivity Growth in Brazil: Recent trends and future prospects. Washington, D.C., US, World Bank: 55.

Baier S.L., Bergstrand J.H. (2007): Do free trade agreements actually increase members' international trade? Journal of International Economics, 71: 72–95.

Baldwin R., Taglioni D. (2006): Gravity for dummies and dummies for gravity equations. Centre for Economic Policy Research Discussion Paper, 5850: 1–23.

Baldy E. (2007): A new educational perspective for teaching gravity. International Journal of Science Education, 29: 1767–1788.

Balogh J.M., Jámbor A. (2020): The environmental impacts of agricultural trade: A systematic literature review. Sustainability, 12: 1–16.

Balogh J.M., Leitão N.C. (2019): A gravity approach of agricultural trade: The nexus of the EU and African, Caribbean and Pacific countries. Agricultural Economics – Czech, 65: 509–519.

Bobato A.M., Coronel D.A., Feistel P.R. (2020): The determinants of intra-industry trade between Brazil, the European Union and China, from 2006 to 2017: An application of the gravitational model. Geosul, 35: 695–731.

Borges Aguiar G.M., Cossu E. (2019): The gravity model for trade theory. Review of Economic Theory and Policy, 14: 293–299.

Braha K., Qineti A., Cupák A., Lazorčáková E. (2017): Determinants of Albanian agricultural export: The gravity model approach. AGRIS on-line Papers in Economics and Informatics, 09: 3–21.

CEPII (2021): Geography: Gravity Database. [Dataset]. CEPII – French center for research and expertise on the world economy. Available at http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=8 (accessed Sept 15, 2021).

De Azevedo A.F.Z. (2004): MERCOSUR: Ambitious policies, poor practices. Brazilian Journal of Political Economy, 24: 594–612.

De Paula J.S., Miranda M.I.C. (2017): Analysis of the trade pattern between the BRICS countries. Ensaios FEE, 37: 1005–1032.

De Santis R. (2012): Impact of environmental regulations on trade in the main EU countries: Conflict or synergy? The World Economy, 35: 799–815.

Duarte R., Pinilla V., Serrano A. (2019): Long term drivers of global virtual water trade: A trade gravity approach for 1965–2010. Ecological Economics, 156: 318–326.

Drabo A. (2017): Climate change mitigation and agricultural development models: Primary commodity exports or local consumption production? Ecological Economics, 137: 110–125.

FAO (2009): How to feed the world in 2050. In: Proceedings of the Expert Meeting on How to Feed the World in 2050, Rome, Italy, Food and Agriculture Organization of the United Nations (FAO) Headquarters, June 24–26, 2009: 3–4.

Figueiredo E., Lima L.R., Loures A. (2014): An analysis for the border effect in Brazil. Revista Brasileira de Economia, 68: 481–496.

Graf C.O., Azevedo A.F.Z. (2013): Bilateral trade among MERCOSUR member countries: A view of the bloc through the gravity model. Economia Aplicada, 17: 135–158.

Gujarati D.N., Porter D.C. (2008): Basic Econometrics. 5th Ed. London, United Kingdom, McGraw-Hill Inc.: 19.

Head K. (2003): Gravity for Beginners. Vancouver, Canada, UNCTAD Virtual Institute, University of British Columbia. Available at https://vi.unctad.org/tda/background/Introduction%20to%20Gravity%20Models/gravity.pdf (accessed Jan 20, 2022).

Head K., Mayer T. (2014): Gravity equations: Workhorse, Toolkit, and Cookbook appendix. Handbook of International Economics, 4: 131–195.

Jug J., Mirza D. (2005): Environmental regulations in gravity equations: Evidence from Europe. World Economy, 28: 1591–1615.

Kim H.S. (2016): The effect of the Kyoto Protocol on international trade flows: Evidence from G20 countries. Applied Economics Letters, 23: 973–977.

Korinek J., Melatos M. (2009): Trade Impacts of Selected Regional Trade Agreements in Agriculture. Paris, France, OECD Trade Policy Working Papers, No. 87: 59.

Lambert D.M., Grant J.H. (2008): Do regional trade agreements increase members' agricultural trade? American Journal of Agricultural Economics, 90: 765–782.

OEC (2021): United States Exports, Imports, and Trade Partners. The Observatory of Economic Complexity (OEC). Available at https://oec.world/en/profile/country/usa (accessed June 10, 2021).

OECD/FAO (2019): OECD-FAO Agricultural Outlook 2019–2028. Paris, France, OECD Publishing: 326.

https://doi.org/10.17221/405/2021-AGRICECON

OECD (2019): The Changing Landscape of Agricultural Markets and Trade: Prospects for Future Reforms. OECD Food, Agriculture and Fisheries Papers, No. 118. Paris, France, OECD Publishing: 23.

Santos Silva J.M.C., Tenreyro S. (2006): The log of gravity. The Review of Economics and Statistics, 88: 641–658.

Shi X., Xu Z. (2018): Environmental regulation and firm exports: Evidence from the eleventh Five-Year Plan in China. Journal of Environmental Economics and Management, 89: 187–200.

Tinbergen J. (1962): Shaping the World Economy; Suggestions for an International Economic Policy. New York, USA, Twentieth Century Fund: 330.

World Bank (2019): Trade Integration as a Pathway to Development? Semiannual Report of the Latin America and Caribbean region. Washington, D.C., USA, International Bank for Reconstruction and Development/The World Bank. Available at https://openknowledge.worldbank.org/handle/10986/32518 (accessed Sept 8, 2021).

World Bank (2021a): Commodity Trade Database. [Dataset]. World Integrated Trade Solution (WITS), The World Bank. Available at http://wits.worldbank.org/WITS/WITS/AdvanceQuery/RawTradeData/QueryDefinitionSelection.aspx?Page=RawTradeData&querytoken=2127572&selection=Existing (accessed May 19, 2021).

World Bank (2021b): World Development Indicators. [Dataset]. The World Bank. Available at https://databank.worldbank.org/source/world-development-indicators (accessed May 19, 2021).

Received: November 29, 2021
Accepted: February 22, 2022
Published online: April 7, 2022