Gravity Models for Latin American Economies

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Abstract. This research seeks to estimate a gravity model that allows to characterize trade between Latin American economies. An indexed triple gravity model is proposed, which considers fixed effects of time, exporting country and importing country. The gravity equations have been widely used for the prediction of international trade flows, but many of the models used for these purposes have problems of poor specification from an econometric point of view. Thus, the proposed model seeks to include simultaneously new variables or variables that have been consider independently, as well as, to provide a correct economic inference of the Latin American regional trade flows.

Keywords: Gravity models · Econometric modeling · Latin American · International trade

1 Introduction

The gravity equations have been widely used for the prediction of international trade flows, but many of these models have problems of poor specification from an econometric point of view. This investigation attempts to provide a correct economic inference of Latin American regional trade flows. Thus, this research aims to estimate a gravity model that allows to characterize trade between Latin American economies. To this end, we propose an indexed triple gravity model, which considers fixed effects of time, exporter and importer countries [1].

The objective is to determine the main variables that impact the volume of trade in the region of Latin America, identifying the reasons that explain the amounts of trade between each pair of countries. Simultaneously, the research considers the major economic integration issues for Latin America and the evolution of intra and inter industrial trade.

The sample includes twenty Latin American countries, primarily from the continent, and the islands of Cuba, Haiti and Dominican Republic. Therefore, the sample considers 20 economic units, observed over a period of 25 years (1990–2014), elaborating a database by gathering the information related to the variables define to integrate the economic model and to be tested in the econometric one. Furthermore, the panel data model seeks to estimate the parameters of interest, the temporal and transversal variability of data. This application allows to characterize trade within the region and to determine the relevant variables for intraregional commerce, comparing with the different studies that have been conducted on the subject and the behavior of the new parameters include in this study.

The analysis focuses on bilateral trade in Latin America, pondering intraregional exports. The study contains and applies the econometric model to identify the significant variables, acknowledging their impact on regional commerce.

This research ultimately presents the findings of the application of the indexed triple gravity model and the recommendations for subsequent studies. The extended propose model is validated in relation to the classic gravity model, including additional explanatory variables such as the level of integration, women participation in labor force, the index of Intraindustrial Commerce, amongst others. The idea is to determine which ones are the ones that generates the gravitational force and, therefore, effect trade volumes in the region. Subsequently, the significance within the region of the variables traditional used in the literature is also validated. The findings highlight that the distance still a significant factor to explain the volumes of trade in Latin America and correctly represents the transport costs associated with international trade.

2   Methodology

The research analyzes the trade within the Latin American region using a gravitational model. A correlational model is formulated to clarify bilateral trade with explanatory variables according to the revision of the theoretical models. Then we proceed to formulate the model and describe each of the relevant variables that would explain Latin America regional trade between 1990 and 2014, the period under study.

This investigation considers as a core the role of the gravity model variables. The use of different indicators captures their potential influence on trade exchange by pairs of countries, as a first exploratory measurement. This is the reason why bilateral trade is the dependent variable, taking each pair of countries as two observations, exports from country I to j and then form country j to I since the variables of the gravity model effect both, the demand for imports as well as the export supply of the economies, becoming a measurement of bilateral trade as gravity models stipulate. The equation in its general form is as follows (ec. 1).

$$LnComBil_{ijt} = \alpha_i + \gamma_j + \lambda_t + + \beta_1 LnR\_tcambio_{it} + \beta_2 LnR\_tcambio_{jt}$$
$$+ \beta_3 Lnreserv\_ext_{it} + \beta_4 Lnreserv\_ext_{jt} + \beta_5 nivel\_integ_{ijt}$$
$$+ \beta_6 Lnpib_{it} + \beta_7 Lnpib_{jt} + \beta_8 Lnpobl_{it} + \beta_9 Lnpobl_{jt}$$
$$+ \beta_{10} Lnarea_i + \beta_{11} Lnarea_j + \beta_{12} Lnpart\_muj_{it}$$
$$+ \beta_{13} Lnpart\_muj_{jt} + \beta_{14} Lnescolaridad_{it}$$
$$+ \beta_{15} Lnescolaridad_{jt} + \beta_{16} infla_{it} + \beta_{17} infla_{jt}$$
$$+ \beta_{18} com\_intra_{ijt} + \beta_{19} front\_comun_{ij} + \beta_{20} leng\_comun_{ij}$$
$$+ \beta_{21} Lndist_{ij} + \beta_{22} colonia_{ij} + \beta_{23} salida\_mar_i$$
$$+ \beta_{24} salida\_mar_j + \beta_{25} isla_i + \beta_{26} isla_j + \mu_{ijt}$$

(ec. 1)

The data use in this study was elaborated from information obtain from different sources, such as the World Bank, CEppi, the International Monetary Fund, COMTRADE from the United Nations, among other.

3   Results

The database consists of a total of 20 countries acting as exporter and importers in a time horizon of 25 years, forming a balance data panel with 9500 observations.

When comparing the models obtain by applying the different methodologies for panel data, the results show that the consistent estimator to explain the volume of trade between countries is the application is a fixed-triple-index OLS model [1] for country of origin, country of destination and time, correcting with robust standardized errors clustered, finally obtaining a R^2 of 69,07%. The equation applied to the Latin America region is shown in Eq. 2 (ec. 2)

$$LnComBil_{ijt} = \alpha_i + \gamma_j + \lambda_t - \underset{(0,029)}{0,584 LnR\_tcambio_{it}}^{**} + \underset{(0,007)}{0,427 LnR\_tcambio_{jt}}^{***}$$

$$+ \underset{(0,001)}{0,309 Lnreserv\_ext_{it}}^{***} + \underset{(0,010)}{0,238 Lnreserv\_ext_{jt}}^{**} + \underset{(0,000)}{0,409 nivel\_integ_{ijt}}^{***}$$

$$- \underset{(0,284)}{0,255 Lnpib_{it}} + \underset{(0,000)}{0,807 Lnpib_{jt}}^{***} + \underset{(0,009)}{3,144 Lnpobl_{it}}^{***} - \underset{(0,502)}{1,305 Lnpobl_{jt}}$$

$$- \underset{(0,025)}{2,387 Lnpart_{muj_{it}}}^{**} - \underset{(0,059)}{2,222 Lnpart_{muj_{jt}}}^{*} + \underset{(0,000)}{2,540 Lnescolaridad_{it}}^{***}$$

$$+ \underset{(0,104)}{1,080 Lnescolaridad_{jt}} + \underset{(0,628)}{0,000038 infla_{it}} - \underset{(0,276)}{0,00011 infla_{jt}}$$

$$+ \underset{(0,000)}{1,620 Lncom\_intra_{ijt}}^{***} - \underset{(0,784)}{0,065 front\_comun_{ij}} + \underset{(0,060)}{1,186 leng\_comun_{ij}}^{*}$$

$$- \underset{(0,000)}{1,784 Lndist_{ij}}^{***} - \underset{(0,817)}{6,807} + \mu_{ijt}$$

(ec. 2)

*significativa al 10%; ** significativa al 5%; *** significativa al 1%*

The Real Exchange Rate for the exporting country was found to be significant at 5% and consistent with the findings stated by [2]. Thus, a 1% increase in the Real Exchange Rate of, which means an appreciation of the local currency, implies a decrease of 0.584%

in the exports of local producers, as exports are less competitive in the international arena due to the appreciation of the national currency. Likewise. The Real Exchange Rate of the importing country is significant at 1% with a coefficient of 0.427, which means that by increasing by 1% of the Real Exchange Rate of the importing country, its imports will increase by 0.427%, as the export currency depreciates in relation with domestic currency, becoming their goods and services relatively cheaper.

Regarding the amounts of Reserves that the countries hold to address their international commitments, the variable prove to be very significant, for both, exporting and importing countries. In the case of the exporting country, the variable represents the ability to defend exchange rate of this economy and maintain its competitiveness in the international markets. If the Reserves of the exporting country increases in 1% its exports increase by 0.309%. In turn, for the importing country the Reserves represents the capacity to finance its imports, consequently if the Reserves increase by 1%, its imports increase by 0.238%. The results are coherent with the literature [1].

The variable that represents the Level of Integration between pairs of countries is define as follows:

- Level 1 Partial Agreement between the pair of economies.
- Level 2 Free Trade Agreement (FTA) between the pair of economies.
- Level 3 Customs Union between the pair of economies.

This variable is highly significant and with a positive coefficient. In this regard, integration efforts in the region cause a greater volume of intraregional trade. This is in line with the proposal of [3], they declare that tariff preferences have been a stimulus for the application of trade agreements in intraregional commerce, despite the deficiencies that the regional integration processes present. Notwithstanding, the result is contrary to other authors proposals [4–7] who question the ability of integration to generate trade or who postulate that the tariff preferences negotiated in the region have been of little coverage or shallow to generate greater trade volume among the economies involved [8].

The GDP variable was not significative for the exporting country and, on the other hand, strongly significant for the importing countries. The coefficient of the importing country shows that in the region imports increase in 0.807% when GDP increases by 1%; thus, a higher income level increases imports demand, however this rise is inferior to the income surge.

The population variable proves to be significant only for the exporting country. A 1% increase in the population would cause an increase of 3.14% in exports volume. This may be explained by the fact that a larger population also implies a greater availability of the labor factor of production and, therefore, greater export supply.

Participation of Women in the labor force, usually considered as an indicator of economic openness, is significant at 5% for the exporting country and weakly significant for the importing country (significant at 10%). In the case of the exporting country, the coefficient shows that for a 1% increase in the Participation of Women in the labor force, export would decrease by 2.387%. Meanwhile, for the importing country an increase of 1% in the Participation of Women in the labor force would produce a decrease of 2,222% of imports. These findings imply that the postulate by [9] could be confirmed;

they point out a "resistance" of women to the effects of the opening of markets, causing a division between economic-political spaces. This resistance could be explained by the participation of the female workforce in import substituting or non-traditional sectors. As consumers, they may prefer domestic products.

The Schooling variable was strongly significant for the exporting economy and not significant for the importing economy. In the case of the exporting country, a 1% increase in schooling generates an increase of 2.540% in exports. These results coincide with those presented by [10], who understand Schooling as a way to measure the skills of human capital that produces export supply, a factor that enhances competitiveness and promotes the augment of exports because the economy is able to produce a higher export supply.

The Inflation was not significant in the application of the model, for either country. This is consistent with the macroeconomic premise that money or monetary parameters have no effect on the real sector. Thus, considering such period of analysis, this result could be expected.

The index of Intraindustrial Commerce (IIC) is significant with a coefficient of 1.62, so an increase of 1% of this Index would provoke a 1.62 increase on bilateral trade. This coincide with [11] findings, in the sense that product differentiation, economies of scale and product varieties would generate higher levels of trade. Furthermore, pertaining to [12], similar factor endowments, which induces economies convergence, would be a factor that would promote trade between pairs of countries.

Regarding the index of Intra-industrial Commerce (IIC), at regional level, defining as intra-industrial trade an index equal or greater than 0.3 because the index was calculate using customs classification at the level of chapter, it shows that only few relationships among pairs reach the category of intra-industrial commerce. The ones that surpass this level are the ones that belong to the same customs union or have a higher level of integration that the rest of the countries, such as Argentina, Brazil and Uruguay; likewise, the economies belonging to the Central American Central Market (Costa Rica, Guatemala, Honduras and El Salvador). Uttermost, the CII indicates intra-industrial trade for the larger economies in terms of income and greater participation in regional commerce, being the most important the pairs Brazil – Argentina and Mexico – Brazil.

The variables Seaside, Insularity and Area are omitted because they are invariant along time and only explain the situation of the economies i or j, but bilateral trade was defined as an ij variable, so the estimates that considers fix effects disregard this kind of parameters.

The Common Border is not significant. The geographical complexity of the Latin American area should be contemplated, because it could cause ambiguous relative transportation costs depending more on the difficulty of the access than the distance between two points. For example, transportation costs may be higher between bordering countries with an important geographical complexity than non-border countries with easy access for merchandise transportation, amongst all other combinations that may occur in the region.

Common Language is significant at 10% with a coefficient of 1.186, implying that pairs of economies that speaks the same language have greater trade than pairs of economies that do not have the same language. This result suggests an important role of cultural affinities on trade flows [13–15]. This factor could explain why Brazil is not

such a gravitating country in generating intra-regional trade despite its large economic size.

Distance is one of the fundamental variables for the model, since it represents the effect gravity produces by the proximity of the countries. In the intraregional model for Latin America, this variable is strongly significant nd consistent with the postulate by the gravity model. Pairs of countries that are 1% closer to each other have 1.784% more trade.

4   Conclusions

The present research responds to the objectives established, which sought to characterize intra-regional trade in Latin American, determining the relevance of the variables incorporated in the model according to the theoretical review of trade and gravity models applies in previous studies.

According to the model elaborated for trade within the region, trade would be affected by macroeconomic variables, in agreement with the findings presented in the literature [16–19].

Within the region, the Real Exchange Rate seems to be the factor that would effect both exporting and importing economies, reflecting their dependence on foreign currency, especially the ones use as international currencies over the domestic ones, the latter not being a referent for international markets. Another monetary variable that is relevant for trade is Reserves, which illustrates the economy capacity to maintain an stable Balance of Payments and impact also to importing and exporting economies. One characteristic of Latin American commerce is that Reserves influence more exports than imports; consequently, we infer that countries that export generate more confidence in the international markets and contribute more to transactions in the regional markets.

Related to macroeconomic variables, they behaved according to what it is expected from literature. Nevertheless, they have different behavior depending whether the economy is an exporting one or an importing one. Meanwhile GDP and inflation are not significant for the exporting country, his population increase export supply. On the other hand, importing economies' GDP increases the demand for foreign goods, whereas population and inflation are not relevant for the importing country. Therefore, the macroeconomic variables that promote trade are population of the exporting economies and GDP of importing countries. Considering the fundamental and basic variables of the gravity model, it would be expected that the economic size of the countries would be significant for importing and exporting country, not only for importer, likewise for population. Hence trade intraregional does not complies with all the results or findings obtained for other areas.

For future studies should be considered that gravity model may attain better or clearer results for economies that share some indicators and that in the long run may converge, thus, economies more homogenous. Consequently, the option of omitting certain countries with unique characteristic should be considered in comparison to the whole block, to estimate more reliable coefficients for the basic variables.

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