

FOOD EXPORTS AND FOOD SECURITY IN LATIN AMERICA AND CARIBBEAN: AN EMPIRICAL INVESTIGATION USING MULTIVARIATE REGRESSION ANALYSIS

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Abstract

This article intends to illustrate the effect of food exports on food security in Latin America and the Caribbean region. In this sense, undernourishment was used as a dependent variable in order to test if there is a positive correlation between the level of Food Security and food exports. The aim of this paper is to discuss this main hypothesis reconciling with other independent variables, such as agricultural land, and food production of each country from the period of 2000 – 2016. To attempt this aim, a group of databases was collected from FAO and the World Bank to be modeled by a Multivariate Regression through R program. The results observed shows that food exports and agricultural land have no positive effect on the improvement of undernourishment levels. Nevertheless, more studies must be done in order to get a broader overview of the food insecurity.

Keywords: Food Trade; Food Security; Multivariate Panel Regression; Latin America and the Caribbean.

1. Introduction

Factors such as food production and export can ensure better food security if analysed through a historical lens. However, external factors such as natural disasters and weather variation, as well as political and economic conditions must be considered when assessing how effective local food availability is. In this sense, that issue opens doors to a range of studies on how to deal with food production and distribution to meet individual needs around the world. However, while trade has benefited GDP growth, its distribution is problematic. There is enough food to feed the world, but basically, the main problem is how food is administered. This means that hunger is a problem of management, infrastructure, technology, political interests and, therefore, power.

According to 2018 reports by the UN², the number of food insecure individuals has increased for the third consecutive year in Latin America and the Caribbean. The economic

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² Available in: <http://www.fao.org/americas/noticias/ver/en/c/1152157/>

recession, the crisis in Venezuela and natural disasters have all contributed negatively on food distribution in the region. Given the importance of better understanding the factors that worsen or improve the level of food security, this paper proposes to test the existence of an effect on undernourishment level of each country caused by food exports in Latin America and the Caribbean during the time frame from 2000 to 2016.

The idea to bring exports as the main variable to explain the hypothesis is based on the relation between what is produced domestically and what flows into international market. It means a lot to consider in the calculation, but due to the limitations of the model, some independent variables were chosen to aggregate the study besides food exports, such as agricultural land and food production of each country. Taking this into account, this question suggests extensive quantitative research.

Considering the methodology, the present paper uses an empirical analysis with two multivariate regressions, a linear regression and panel data regression model, as the last one had the best fit. As a result, the numbers showed that there is a positive effect of domestic production of food on improvements in the level of undernourishment, while agricultural land and food exports have not, as will be better explored later. Throughout the paper, some approaches to the literature will be raised seeking to discuss the concept of food security and what other studies reveal about the effects of international trade on hunger. Afterwards, explanations about the data modelling and its results will be showed through tables and figures concluding with suggestions.

2. Literature Review

The whole society depends on what is available to eat in order to get the basic caloric intake per day, which guarantees energy for keeping our health. As explained by Escamilla and Correa (2008), “[...] nutrition security is a process that can be understood at the organism level as it is achieved when the cells and the tissues and organs that form the human body are properly nourished” (ESCAMILLA;CORREA, 2008, p. 16). Thus, food availability brings one of the biggest concerns of our time due to population growth and scarcity of resources. Each year the geopolitics of food changes in face of trade advances and market relation between country (THE HAGUE, 2013). Current needs differ greatly from those of the past years, and the dynamics between states are constantly adapting. New patterns of production emerge, new markets are established, and new centres of power correlate and compete with each other. Given the instability of a diverse and interdependent scenario on the International System, tensions and problems may eventually come on the scene.

Despite this trade dependency in an increasingly integrated world, most countries depend largely on domestic production. With this in mind, the variables food production and agricultural land come into the calculation as they are important factors to be considered beyond food export, which will be the focus of the research itself.

2.1 Food Security and Trade

Food Security studies emerge as a concept that, according to FAO, is measured by different indicators, which are highly related. Namely: availability, access, use and stability. Beyond that, food production and its consumption depend on a number of political, social, environmental factors to be sustainable. In this sense, the particular study of the whole problem involving the management of resources for implementation and guarantee of food for all became pertinent and emerged in the Social Sciences, obtaining importance as a study object. The logistics involved in food production depend, among other things, on the economic situation, being strongly linked to variations in trade.

Food security and trade have been closely related since the beginning. In order to balance and supply the absence or deficits of food, the trade relations between food producers and non-producers countries is necessary to ensure better food and nutrition quality globally. In a scenario where there is no international food trade, importing countries would suffer from rising food prices due to rising demand and the absence of domestic offerings, impacting on consumers accessibility to food. In the case of exporting countries, the price would fall given the surplus production, which could also result in several economic losses.

Countries are usually encouraged to integrate in regional trade agreements to capture faster economic growth for mitigate poverty, and therefore, hunger. The level of income, productivity of agriculture, and other factors, strongly impact on the four dimensions of food security (HERATH, 2014). Hence it is interesting to observe if other indicators such as food exports are capable of making an actual effect on food security index. Thus, several countries are in a position to influence international prices but none of them can, nor will, control them. According to Daviron and Douillet (2014) while large countries have an intentional influence on the food security of their own population, their influence on food security in the rest of the world is limited by the little degree of integration of domestic markets with international markets in most food-insecure countries.

Food diversification is also a key issue for food security from the point of view of international trade, as much of imported and exported products are needed for a complete nutrition intake. It can be said that there is no food security without the international food trade,

but to what extent are they really effective for the population? Some authors stresses about the importance of the open market as a facilitator, once it offers freedom to farmers around the world, helping them to have better prices, offering greater competitiveness for better products, technological advances within an integrated system.

According to some scholars in the field, it is claimed that producers, whether small or large, want to make a profit, which is the driving force behind food production activity. If there is no profit in return or no market, they may not produce enough to feed people. To this end, the government must follow in consonance through direct policies to stimulate these farmers, as a way out to increase food production and its better trade.

In the short term, we can see effects on how each individual is affected by trade. Firstly, consumers and producers feel the changing prices of goods consumed domestically. In the medium term, the work force responds to changes, shifting the economy to a new balance of employment, market, wage and other variables (IMF et al. 2011). The effects of trade dynamics and the production structure, land use, productivity, and other determinants may take a long time to stabilize.

2.2 The situation in Latin America and the Caribbean

The number of people with severe and moderate food insecurity in Latin Alerica and the Caribbean has reached 139 million in South America in 2016³. According to FAO report of 2017 on the Latin America and Caribbean food security situation, the region still has a good performance on its production, which indicates enough food for its total population, and with strong potential of promoting supply and growing international food trade, specially some countries such as Brazil and Argentina that are considered to be protagonists on primary commodities exportation.

Trade can have both negative and positive effects on each dimension of food security from an economic and social point of view. Even though, that not necessarily means healthy and nutritious food. With an socioeconomic point of view, the income distribution may not be following the rhythm of food production, taking longer to finally achieve food security. The same report also reveals the evidence of a big impact of natural disasters affecting agricultural production, especially on the Caribbean region which is mostly made up of islands.

As the largest country of the region, Brazil has become the larger producer of food in this current decade, an estimative that was expected by the tendency line according to analysts.

³ Available in: <<https://ourworldindata.org/hunger-and-undernourishment#the-global-hunger-index-ghi>>

Even though, that increase in agricultural production doesn't seem to be improving the number of people suffering from hunger on the country, contradicting the expectations regarding its population. That been said, there are a series of problems besides the production itself and access to food may be one of them, especially through the poorest population.

3. Theory

This section seeks to identify a causal relationship that connects our dependent variable with the independent variables. That is, whether malnutrition rates may change as the numbers of the other variables change or not. Primarily, as Tinta (2018) has showed in his research about the ECOWAS case, the relationship between market openness and growth is not consistent, while the trade integration inside the community seems to be a better option to boost food security. According to Trueblood and Shapouri (2001) "To improve food security by increasing food availability at the national level, countries have two options: accelerate domestic agricultural production or increase imports. Where agricultural growth is limited, commercial imports play a major role in improving a country's food security." (TRUEBLOOD; SHAPOURI, 2001, p. 1).

Normally, according to Martin (2017), four different channels of effect are considered in food security and market openness terms, namely: income changes, gains in productivity, substitution effects, food price volatility, and changes in individuals' diet. Regarding access to food, domestic prices of exportable products may rise for food-exporting countries, affecting the whole system. So, in this way, achieving a better level of food security means to ensure enough food to supply everyone.

The issue involves policymakers, specially in developing countries, in a way that they can develop a greater capacity for seeking to improve food security and food trade (UNNEVEHR, 2003). Historically, Laroche-Dupraz and Huchet says that,

In 2000, the downward trend in world agricultural prices started to shift. Global demand rose more sharply than supply, slowing the downward trend in agricultural prices from 2000 to 2007. Suddenly, agricultural prices spiralled in 2007-2008, triggering hunger riots in a number of developing countries in 2008. [...] The price volatility debate was reopened following the 2007-2008 price surge as farmers' earnings and consumer purchasing power suddenly looked uncertain, putting food security at risk. Recent years have seen two peaks in world prices for cereals and other major food commodities: once in 2007-2008 and again in 2010-2011. Prices have generally remained at a higher level than they were from the 1980s to the early 2000s. There may be a number of reasons for this trend, such as a growing imbalance between food demand and supply, the rise in oil prices, exchange rate movements and trade restrictions (LAROCHÉ-DUPRAZ; HUCHET, 2016, p.7).

In this sense, along the years we can see how prices and food are changing in correspondence. Bakari and Mabrouki (2017) affirms that the growth of agricultural trade has helped people regarding the quality of food and its abundance and variety, while promoting better prices. And indirectly or not, it is also a source of income for many individuals. As Diaz-Bonilla et al (2000) suggest though that it is important to see the food security issue in a broader way, considering financial and institutional concerns.

In Arowolo's (2016) survey, a panel model with 15 African countries that analyses food production found that the use of fertilizers on agricultural land has positive effects on the overall production level of that region of ECOWAS countries although it has few other political implications. Similarly, we still have to know how the level of malnutrition can be improved or not by other factors such as food exports. Hence, part of the scholars arguments towards a more open market regime in a way that it reduces the supply variability of food and can possibly lower domestic food prices.

In the other hand, Montalnano, Nenci and Salvatici (2015), and Martin (2017) says that trade openness must come with strong and sustainable policy instruments, offering opportunities for those countries in disadvantages. In Cuba case, domestic political force can slow down or even block the process of liberalization. In essence, open or not open market is a country's decision and must be negotiated in order to improve their own access to food and not be imposed (BROOKS; MATTHEWS, 2013). As Herath (2014) underlines,

Developing countries are inherited with low savings and investment due to lower income levels. Lower income again affects on savings and investment levels of these countries. As a result, these developing countries have being grown at a slower pace of economic growth. Low economic performance has kept people in severe poverty level. In developing countries, sizeable portion of people are suffering from severe poverty by exposing them to food insecurity (HERATH, 2014, p.62)

In accordance, Otero (2013) criticise the position of big organizations such as World Bank and United Nations Food and Agriculture Organization regarding their behaviour of supporting and overestimating the liberal perspective. It is argued that food dependency is stronger on basic foods in the developing countries while the developed countries dependency is restricted to a luxury range of food.

4. Research Design and Data

This research is configured as an observational study, as it aims to observe how the distribution of undernourishment levels occurs in a given region. Given the readings on the

subject of Food Security, the variables were chosen because they present, as seen in other works, some level of linkage.

All necessary data were collected through the World Bank website⁴ and by FAO indicators⁵. The survey collected 351 observations from four different variables, the dependent variable *undernourishment* was provided by FAO and *agricultural land*, *food exports*, *food production* from the World Bank. These variables are sectioned by year and by country from Latin America and the Caribbean. This region was chosen because it has a large population that remains stagnant with the problem of hunger, although the region has big food producers.

Regarding the indicators, “prevalence of undernourishment” is widely used to measure hunger and is the result of a proportion estimation of the population that normally has insufficient caloric intake indicating health risks. Their values are observed in percentages and measured at annual intervals.⁶ “Agricultural land” indicates the percentage of the amount of land in percentage of each country is available for agricultural production, “Food production” is the national food production itself and covers food crops considered to be edible. And finally, food exports are food in general, such as live animals, beverages and tobacco, vegetables, fats, oils and so on.⁷

The countries and dependencies used for the analysis were: Haiti, Bolivia, Nicaragua, Dominican Republic, Panama, Honduras, Peru, Ecuador, Paraguay, El Salvador Suriname, Trinidad and Tobago, Colombia, Guyana, Venezuela, Saint Vincent and the Grenadines, Jamaica, Belize, Dominican, Barbados, Mexico, Brazil, Argentina, Chile, Uruguay and Cuba. Some countries in the region for Latin America and the Caribbean were not added because of insufficient data for the analysis, namely Costa Rica, Guatemala, Grenada, Bahamas, Antigua and Barbuda, Saint Lucia, Saint Kitts and Nevis, and Saint Martin.

The empirical analysis is used in this study because it aims to test the scope of food trade and its effect on food security in the Latin American and Caribbean region, in order to prove or refute the positive effect of exports in the fight against undernourishment.

4.1 Data Processing

The data were processed through the program RStudio, a software widely used for statistical data proposes. Throughout the process, after collecting data with better frame, some

⁴ Available in: < <https://databank.worldbank.org/reports.aspx?source=world-development-indicators>>

⁵ Available in: <<https://unstats.un.org/sdgs/indicators/database/>>

⁶ Available in: <<http://www.fao.org/sustainable-development-goals/indicators/211/en/>>

⁷ Available in: < <https://data.worldbank.org/indicator?tab=all>>

treatments were needed in order to make them clean to visualize and, therefore, manipulate. During the modeling process, some charts were made to list countries and years for each variable. A matrix was also developed to better visualize the Pearson correlation coefficient, which aims to indicate whether there is correlation between each variable and whether it is positive or negative. Soon after, the regressions were modeled, the first as linear, obtaining a lower R^2 , and therefore, explaining less the hypothesis to be tested; and the second model, which is in panel data, as being the most suitable for the analysis because it considers the time and the countries in the best way.

4.2 Data Limitations

Regarding the limitations of data analysis, the raw database used needed to be modified in order to have a better fit and manipulation. In this sense, some of the values found in undernourishment variable had a repetition of the same value to indicate the minimum assumed to be 2.5. Also due to lack of appropriate data for all the Latin America and Caribbean for the selected time period, not all of the countries were used. Besides, in linear regression model, a few information is lost because of some error terms correlations that was not being taken into account. Also, as the database has temporal and transverse dimension, the Panel or longitudinal model is better suited to the research proposal. Beyond what was found, the interpretation of numbers obeys a lot of statistical conventions and other factors as well as other information are lost, being able only to indicate a level of influence, but not necessarily explaining the real issue completely.

5. Results

Given what was exposed in the section above, some correlations were made and evaluated through two different multivariate regression models. As stated, I first show the linear regression table, and then, the Panel Data regression. In order to choose what fits best, the Hausman test was applied. Also, the following tables and figures will facilitate the identification of other aspects that are worthwhile for this research findings.

Table 01 shows through statistic an individual overview of the sample. The first column shows the number of observations collected. Other interesting information to absorb is the Mean and Standard Deviation, as well as the Minimum and Maximum values of each variable.

Table 01 – Individual sample of descriptive statistics.

Statistic	N	Mean	St. Dev	Min	Pctl(25)	Pctl(75)	Max
Year	351	2,007.704	4.861	2,000	2,003.5	2,012	2,016
Agricultural Land	351	36.300	20.355	0.449	24.398	48.260	85.487
Food Exports	351	33.040	24.287	0.000	15.286	51.111	89.641
Food Production	351	107.265	17.906	69.990	95.845	116.660	183.720
Undernourishment	351	10.248	6.999	2.500	4.700	12.750	33.400

5.1 Regression Tables

The results of multivariate linear regression, as is shown in Table 02, corresponds to the first model. In this sense, it is important to see the value of R^2 , which is very low, indicating that this model is not appropriate to explain the variables.

Table 02 - Results from linear regression to show the effects of independent variables analysed on undernourishment.

	<i>Dependent variable:</i>
	Undernourishment
Agricultural Land	-0.060*** (0.018)
Food Exports	0.066*** (0.015)
Food Production	-0.021 (0.020)
Constant	12.530*** (2.306)
Observations	351
R^2	0.071
Adjusted R^2	0.063
Residual Std. Error	6.774 (df = 347)
F Statistic	8.883*** (df = 3; 347)
<i>Note:</i>	*p<0.1; **p<0.05; ***p<0.01

Differently, in the table below, an alternative presentation is showed with different result. In Panel Data regression technique, the results for R^2 are greater, indicating a better adjustment of the model. Other factor that should be observed is the p-value, which in both

tables are considered to be significant. Besides, Panel data gives more data variation, less collinearity and a better level of freedom as we are studying the dynamics of change along with food security levels in relation to trade.

Hausman's technique is one of the most popular for testing the empirical analysis model. The idea behind is to specify and choose the most appropriate model. As output, the chisq value was 0.65 and the p value was 0.88. This implies that one of the models is inconsistent. The Hausman test, therefore, shows that there are significant differences between the coefficients of the Linear Regression model and the Panel model, being the twoways effects within Panel model the best option.

Table 03 - Alternative presentation of the effects of independent variables on undernourishment in Panel Data.

	<i>Dependent variable:</i>
	Undernourishment
Agricultural Land	0.249*** (0.070)
Food Exports	0.106*** (0.010)
Food Production	-0.091*** (0.012)
Observations	351
R ²	0.301
Adjusted R ²	0.211
F Statistic	44.567*** (df = 3; 310)
<i>Note:</i>	*p<0.1; **p<0.05; ***p<0.01

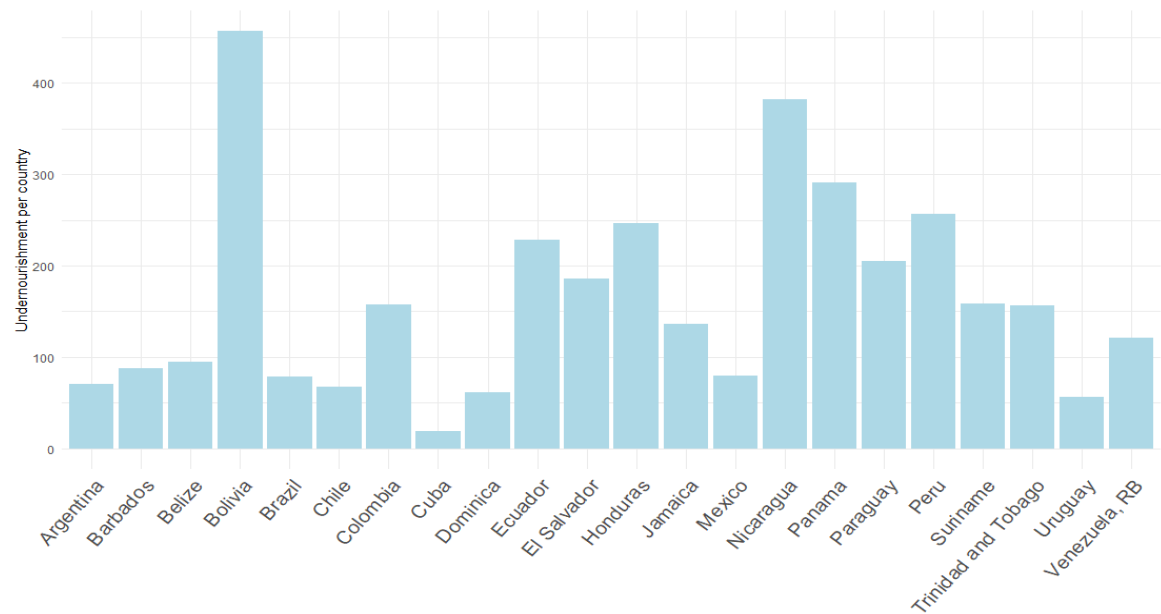
By looking at Table 03, the food exports had statistically more significant result showing a negative effect on undernourishment percentage. Differently, food production goes on the other way, showing to be improving undernourishment levels.

The R² shows that the within estimator can explain in 30% the fit to the model. For this reason, in comparison with the linear regression model, the results presented in panel data regression is going to be used for the analysis. Taking the hypothesis and results found, it is likely to explain in part that there is no positive effect between food exports and malnutrition, which means validating the null hypothesis.

5.2 Figures by Country

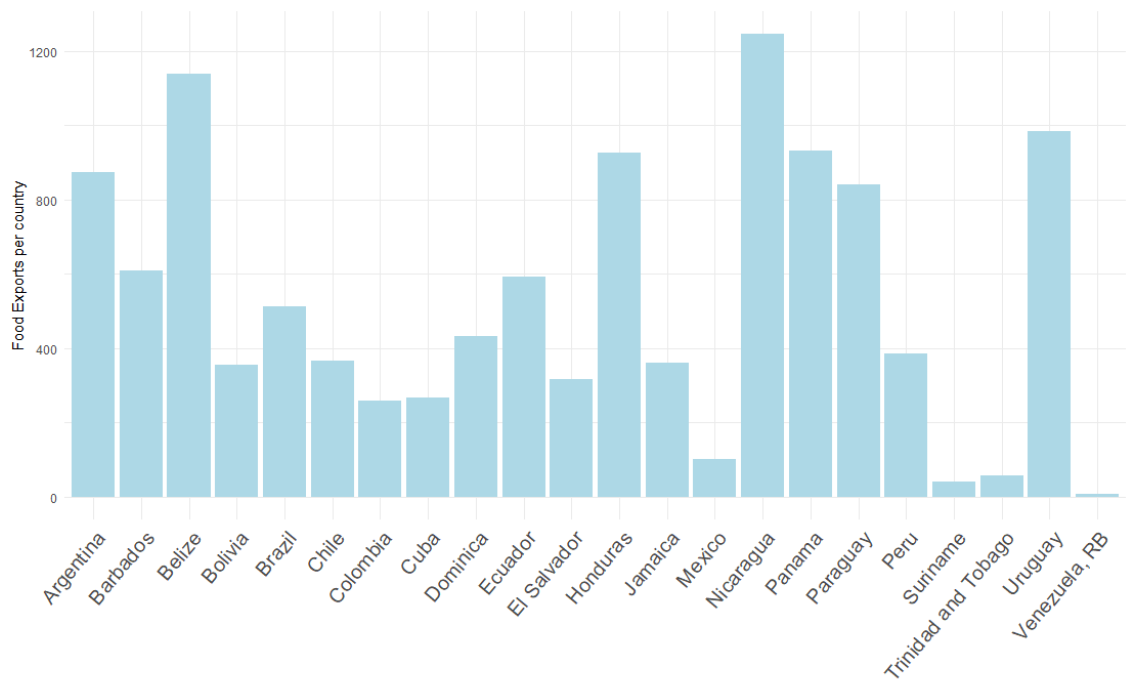
In this session, the variables are isolated to show the

Figure 01 – Undernourishment by country



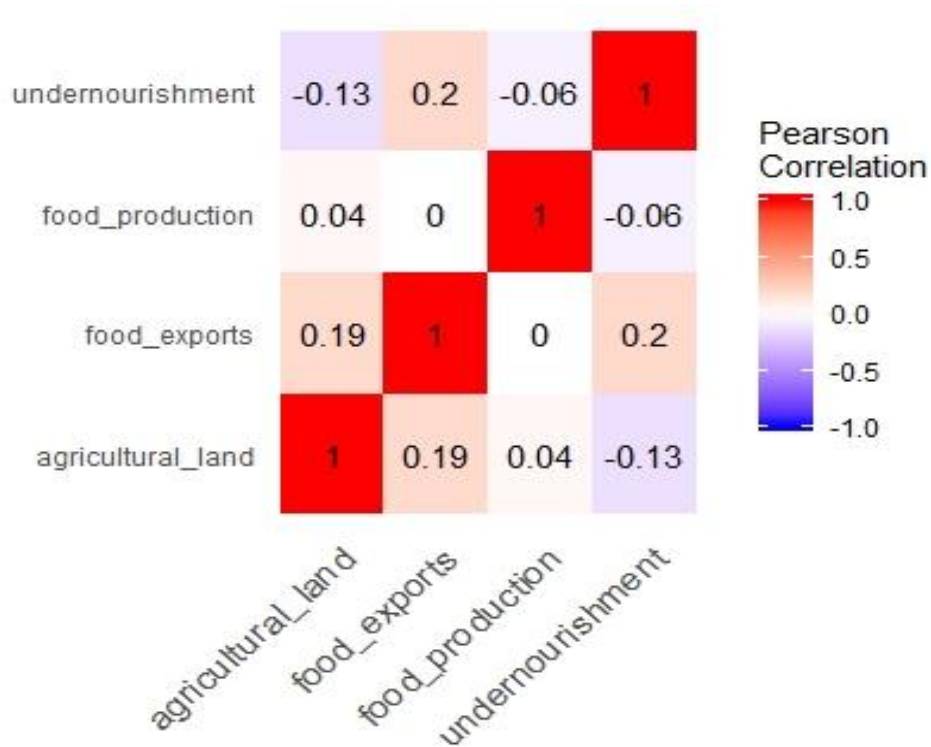
In this chart, each country in Latin America and the Caribbean is analysed in terms of its malnutrition index. It is possible to identify that Bolivia and Nicaragua had bigger problems within the analysed time interval. The lowest rates are in Cuba and Uruguay. In the case of Cuba, this value is possibly not credible given its government possible interference in making the data available or reliable.

Figure 02 – Food Exports by country



In this figure above, the food exports are showed by country and can reflect the level of dependency on food exports by each of them. Even though Brazil is a global player in food exports, its exports is more diversified, meaning that food exports corresponds only a part of its international trade. In the case of Venezuela, most of its exports are concentrated on crude and refined petroleum, indicating a small production of food intended for export. Other countries such as Trinidad and Tobago and Suriname are also small producers of food exports while Nicaragua, Uruguay, and Belize are one of the most dependent on foodstuffs international trade.

Figure 05 – Pearson Correlation of all variables



In this correlation matrix, it is possible to identify through red colour a higher correlation between the variables, while those in blue show a lower correlation. The correlation matrix facilitates the understanding of what we need to abstract from analysis.

6. Implications and Conclusions

Given the above, one possible explanation would be that export-produced food is designated for other regions, which implies that capital retained by exporting producers or production surpluses are not necessarily reinvested within the domestic market. Countries that do not have a good food reserve, such as developing countries, are usually the countries that import more than they export (SAMPAIO, 2005). Taking the case of Brazil, one of the largest players in the international food trade, according to its ministry of Livestock Agriculture and Supply (2017), about 70% of the food that reaches the population is produced by family farming. Thus, the more land cultivated for export, the less for family farming.

Accordingly, it is found no evidence to support the statement that food exports and food security is fully linked. The study found a weak relationship between those variables during the time period on Latin America and the Caribbean region. Also, the effects of trade on food security can be diverse according to idiosyncrasies of each country. Thus, the

agricultural land has no positive influence on food security. Notwithstanding, those arguments need to be validated by further investigations.

Despite the results presented, the importance of keep researching this issue of food security and trade is clear given the magnitude of their scope. From a more practical perspective, compressing such variables in mathematical models to explain social issues is indeed complicated, since many other issues are not taken into account in the equation, and further studies are needed to make it more comprehensive. That said, governments need greater integration and international assistance, as well as effective policies that reach more isolated regions, leading to an eradication of food insecurity. As suggestions, maintain a good level of food storage is important, and secondly, promote cooperation between different actors, such as farmers and the big industry. All this in consonance with facilitator policies while adopting fee reduction to make the small farmers more competitive by ensuring and stimulating the production of qualified and accessible food sustainably in order to change this food framework in Latin America and the Caribbean.

BIBLIOGRAPHY

AROWOLO, Olatunji Taofik; EKUM, Matthew Iwada. Food Production Modelling Using Fixed Effect Panel Data for Nigeria and Other 14 West African Countries. Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches" by Mitchell A. Petersen, 2009.

BAKARI, Sayef; MABROUKI, Mohamed. The Effect of Agricultural Exports on Economic Growth in South-Eastern Europe: An Empirical Investigation Using Panel Data. 2017.

BROOKS, Jonathan; MATTHEWS, Alan. Agricultural trade and food security: choosing between trade and non-trade policy instruments. 2013.

DAVIRON, Benoit; DOUILLET, Mathilde. **Major players of the international food trade and the world food security**. 2013.

DIAZ-BONILLA, Eugenio. Agricultural trade and food security: some thoughts about a continuous debate. **Strengthening the Global Trade System**, p. 39, 2013.

FAO and PAHO. *Panorama of Food and Nutrition Security in Latin America and the Caribbean*. Santiago de Chile. 2017.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. The State of Agricultural Commodity Markets 2015-16. 2015.

IMF, OECD; UNCTAD, WFP. Price volatility in food and agricultural markets: Policy responses. 2011.

KELLSTEDT, Paul M.; WHITTEN, Guy D. **The fundamentals of political science research**. Cambridge University Press, 2018.

LAROCHEZ-DUPRAZ, C.; HUCHET-BOURDON, Marilyne. Agricultural support and vulnerability of food security to trade in developing countries. **Food security**, v. 8, n. 6, p. 1191-1206, 2016.

MARTIN, Will. **Agricultural trade and food security**. ADBI Working Paper Series, 2017.

MONTALBANO, P.; NENCI, S.; SALVATICI, L. Trade, value chains and food security. **Background paper prepared for The State of Agricultural Commodity Markets**, v. 16, 2015.

NORD, M. Introduction to Item Response Theory Applied to Food Security Measurement: Basic Concepts, Parameters and Statistics. Roma, FAO. 2014.

OTERO, Gerardo; PECHLANER, Gabriela; GÜRCAN, Efe Can. The political economy of “food security” and trade: Uneven and combined dependency. **Rural Sociology**, v. 78, n. 3, p. 263-289, 2013.

PÉREZ-ESCAMILLA, Rafael; SEGALL-CORRÊA, Ana Maria. Food insecurity measurement and indicators. **Revista de Nutrição**, v. 21, p. 15s-26s, 2008.

SAMPAIO, Maria de Fátima Archanjo et al. Agricultura e segurança alimentar: análise da produção e da disponibilidade de alimentos na América Latina. 2005.

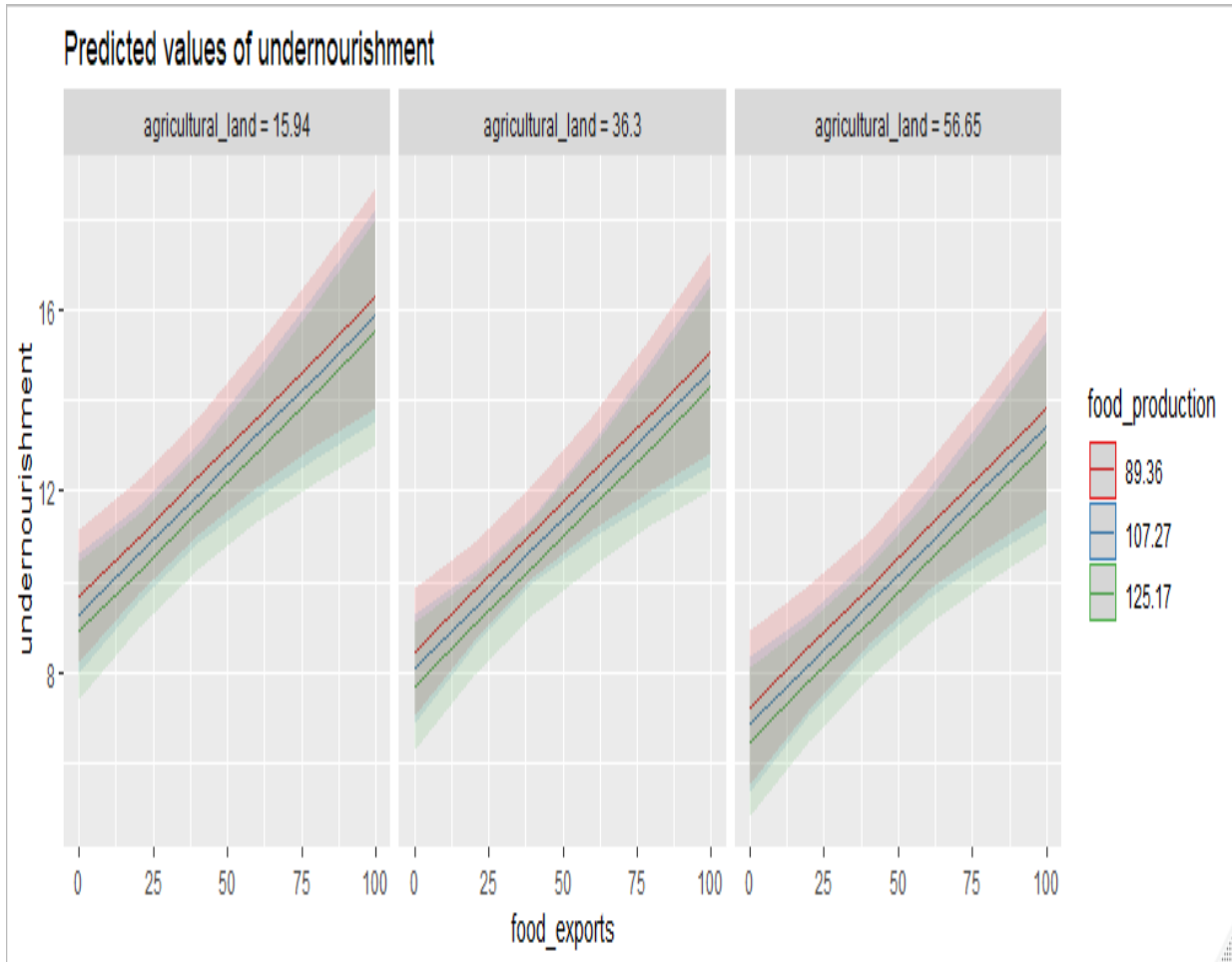
TINTA, Almame Abdouganior et al. The effect of integration, global value chains and international trade on economic growth and food security in ECOWAS. **Cogent Food & Agriculture**, v. 4, n. 1, p. 1465327, 2018.

TRUEBLOOD, Michael A.; SHAPOURI, Shahla. **Implications of trade liberalization on food security of low-income countries**. 2001.

UNNEVEHR, Laurian et al. (Ed.). **Food safety in food security and food trade**. Washington, DC: International Food Policy Research Institute, 2003.

Appendix A – Regression Figures

Figure I – Interactive Effect Regression from the alternative model



In Figure I the results were similar for the three food production categories. The bigger the exports scale, the bigger is the undernourishment percentage. On the other hand, the smaller the size of the agricultural land the larger the percentage of undernourishment.

Figure II - Scatterplot with Regression Line

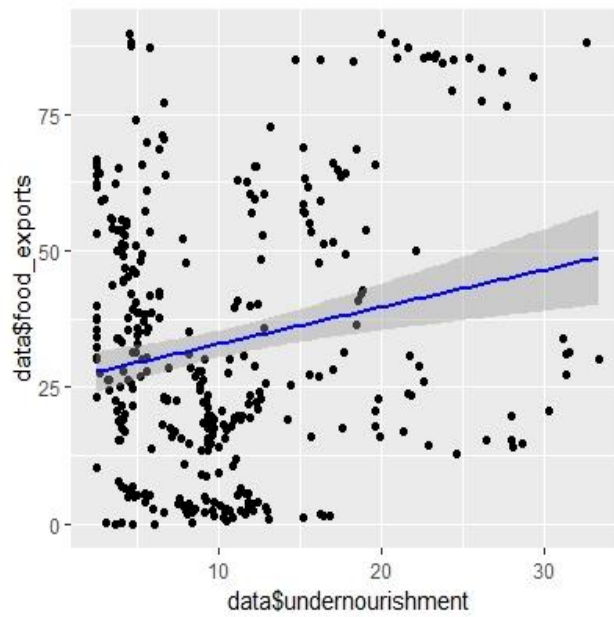
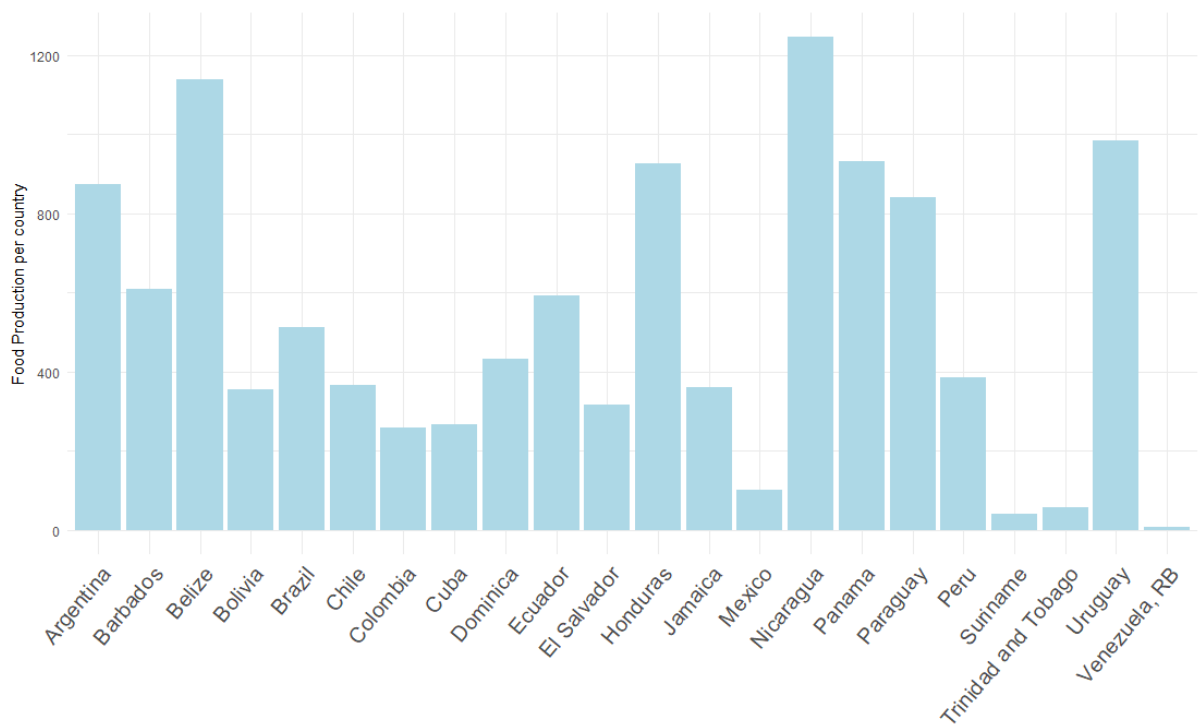


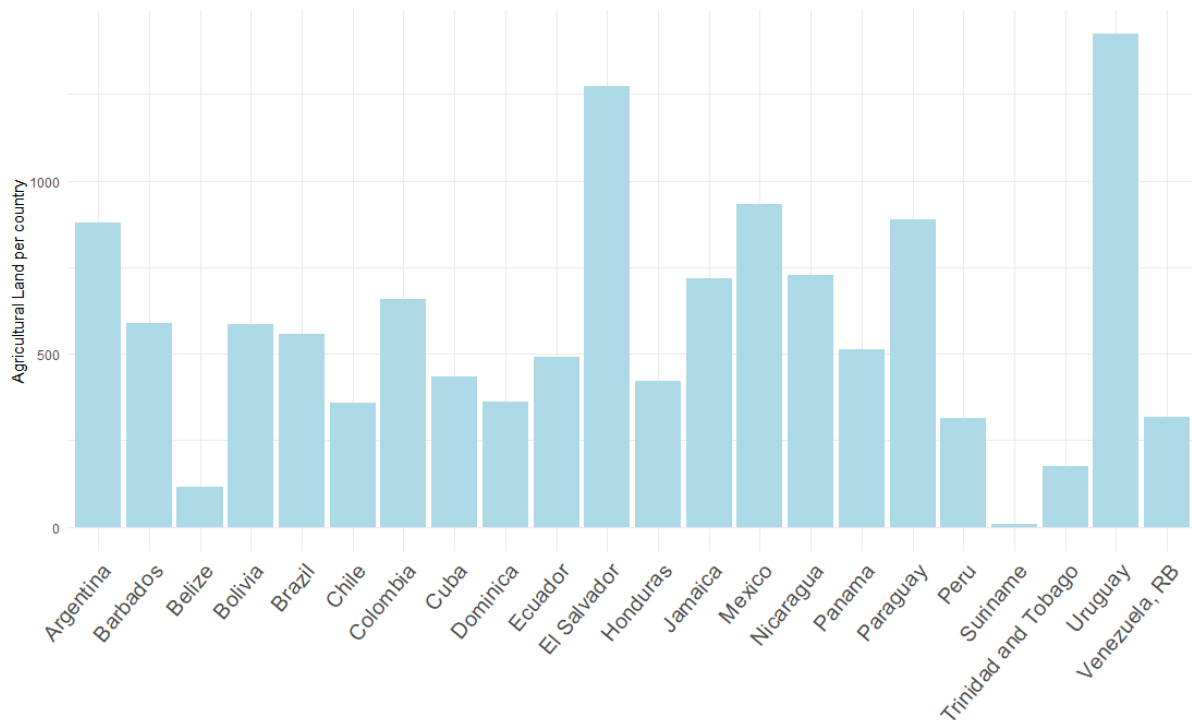
Figure I shows a correlation between undernourishment and food exports, indicating the dispersion of the residues, or the difference between the observed value and the estimated value. The blue line reveals a slight positive correlation between both variables. In this scatterplot, there are patterns that does not estimate in the best way to a purely linear regression, in because of this, the better model is Panel Regression model.

Figure III – Food production by country



In Figure III, countries such as Venezuela and Suriname, as well as Trinidad and Tobago seem to have a strong dependency on food imports. On the other hand, Uruguay, Nicaragua and Belize are great food producers.

Figure IV -Agricultural Land by country



The last Figure shows the agricultural land space for each country proportionally. It means that Uruguay and El Salvador have the greatest amount of arable land while Suriname and Belize are the ones with significantly least amount.