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ECONOMIC GROWTH IN LATIN AMERICA AND THE ROLE OF CHINA. AN ANALYSIS OF LATIN AMERICAN NEOSTRUCTURALISM

RAFAEL GUSTAVO MIRANDA DELGADO

rafaelgustavomd@hotmail.com

Professor and co-founding director of the Research Group on Development Studies and Democracy (GISEDD) at the Universidad de Los Andes Venezuela (Venezuela). Post-doctorate in Social Sciences from the Universidad Central de Venezuela, PhD in Political Science and International Relations from the Universidad Ricardo Palma de Perú, MA in International Relations from the Universidad Andina Simón Bolívar de Ecuador, Economist from the Universidad de los Andes Venezuela. Author of more than thirty articles on Latin America published in Latin America, Europe, Asia and North Africa.

ANTONIO AZUAJE

antonioaz28061@gmail.com

Guest researcher at the Research Group on Development Studies and Democracy (GISEDD) at the Universidad de Los Andes Venezuela (Venezuela). Economist from the Universidad de Los Andes Venezuela, Master in Economic Development from the Universidad Estadual de Campinas Brazil and MBA in Data Science and Analytics from the University of São Paulo.

Abstract

This research aims is to analyze the role that the Chinese economy has had in the economic growth of Latin America. The methodology used consists of a multivariate approach for time series, and causal relationships are obtained through the impulse response analysis functions. It is stated that China's economic growth, in general, has been positive for the region but it has also had negative effects, such as the re-primarization of Latin American economies. For this reason, for Latin America to realize the full potential that Chinese economic growth has for the region, it must apply policies that generate structural change.

Keywords

Economic growth; Neo–structuralism; Latin America; China; Global economy

Resumen

El objetivo de esta investigación es analizar el rol que ha tenido la economía china en el crecimiento económico de América Latina. La metodología utilizada consiste en un enfoque multivariado para series de tiempo, y se obtienen relaciones de causalidades a través del análisis de las funciones impulso respuesta. Se afirma que el crecimiento económico de China en general ha sido positivo para la región, pero este también ha tenido efectos negativos, como la re – primarizacion de las economías latinoamericanas. Por ello, para que América Latina haga efectivo todo el potencial que tiene para la región el crecimiento económico chino, debe aplicar políticas que generen un cambio estructural.

Palabras claves

Crecimiento económico; Neo–estructuralismo; América Latina; China; Economía global

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Introduction

The analysis of economic growth consists of identifying, within the simultaneous evolution of variables which are the ones that play the leading role and those that are modified laggardly. The neo-structuralist school represents a reflexive effort that offers a theoretical and analytical framework to understand economic growth, its explanatory variables, and the policies that promote it.

Nowadays, one of the most interesting phenomena at a global level is the pluralization of the centers of economic growth, with China being one of the most relevant emerging economies. China has had significant economic growth in recent years, which has also been able to improvement the entire global economy with its trade, investment, and changes in the international political economy.

Therefore, the aim of this research is to analyze the role that the Chinese economy has had in the economic growth of Latin America. The methodology used consists of a multivariate approach for time series. It seeks to estimate cointegration vectors between the variables studied that signify a stable relationship between them, interpreting such relationships as long-term connections. Additionally, causal relationships are obtained through the impulse response function analysis.

The research is presented in three parts. In analytical elements, it reflects Latin American neo-structuralism on the influence of the Chinese economy in Latin America, emphasizing the main channels of influence: investment, trade, and terms of trade. In the second part, descriptive analysis, we seek to measure the associations between Latin America economic growth and China economic growth, choosing as explanatory variables of the Gross Domestic Product (GDP) of Latin America and the Caribbean, the Gross Domestic Product (GDP) per capita of China, Foreign Direct Investment, Gross Fixed Capital Formation and the economic openness index. Finally, in econometric analysis, the multivariate analysis for time series is presented to estimate the degree of association between the GDP of Latin America and the Caribbean with the GDP of China and the other selected variables, and causal relationships are obtained through the impulse response functions analysis.

Analytical elements

The Latin American structuralism and neo-structuralism schools represent a reflexive effort that offers a theoretical, analytical, and categorical framework. From the Latin American particularities look forward to the generation of knowledge that responds to the main economic challenges of the region, is one of the contributions distinctive the idea of structural change.

The fundamental argument that distinguishes the structuralism and neo-structuralism schools is the warning that economic growth is not indifferent to the economic structure. There are productive sectors that have a greater capacity to generate economic growth, and structural change precedes economic growth.

For Ocampo (2005), economic growth in developing countries is intrinsically linked to the dynamics of productive structures and the policies and institutions created specifically to support them. The dynamics of production structures play a fundamental role in changing the pace of economic growth. Economic growth is an essentially mesoeconomic process determined by the dynamics of production structures. This dynamic of productive structures depends on the interaction between innovation, understood as all kinds of new activities and new ways of carrying out existing activities, and the complementarities, linkages, and networks between companies and productive activities and their respective learning processes. The State with the economic policy can affect the productive structure and create comparative advantages. To generate growth must be constantly created dynamic productive activities.

The productive structure is configured by market incentives and by the policies that countries may adopt. The international economy plays a fundamental role due to the forces of its incentives.

Nowadays, China rise.is one of the most significant variables to understand the economic world. Since the end of the 1970s, began to implement strategies of economic reform and opening, promoting an average annual growth of 9.9 percent and an annual increase in international trade of 16.3 percent over the next thirty years. China overtook Japan in 2010 as the world's second-largest economy and replaced Germany as the world's largest exporter. Since 2010, China has contributed nearly 1 percentage point per year to the global GDP growth rate. In 2016, China contributed more than 15 percent of the world's GDP, ranking as the second largest economy after the United States. It also has the largest industrial GDP in the world with 22.5 percentage points; it is the largest agricultural producer in the world with 30 percent of the value added of world agricultural activity; it is the second economy in terms of final consumption of households with 9.6 percent. China is the world's leading exporter and the second largest importer. And in 2018, it contributed 15.8 percent of world GDP (World Bank, 2020).

Chinese economic growth has been especially resilient. For example, during the global financial crisis of 2008, China had ample fiscal space and abundant foreign exchange reserves. China's economy started to recover in the first quarter of 2009, its growth rate for this year reaching 9.1 percent and 10.1 percent in 2010. China's solid growth during the crisis was the strongest driving force for global recovery (Lin, 2010). At the time of writing this article, China is the country that has presented the best recovery after the COVID-19 crisis, and once again, it is emerging with the potential to drive world economic growth.

China's economic growth since its reform and opening has had a significant impact at the global level, benefiting economies with an abundance of natural resources, such as those of Latin America, via Foreign Direct Investment, terms of trade, and international trade.

Currently, China is the second largest investing country in the region and Latin America is the second region recipient of Chinese Foreign Direct Investment (FDI), receiving around 15 percent of total FDI from this country. Of this FDI received, 80 percent is concentrated in Brazil, Peru, and Argentina. China has also become the leading banker in Latin America. The China Development Bank and the China Export-Import Bank have overtaken the World Bank and the Inter-American Development Bank in the region. The accumulated loans in the period 2005 - 2017 have reached 150 billion dollars (MMDD), highlighting those received by Venezuela, Brazil, Ecuador, and Argentina. On the other hand, a diversified set of cooperation mechanisms has been created, such as the Infrastructure Fund, the Special Fund for Agriculture, and the Program for Scientific-Technological Associations. It should be noted, that more than two thousand Chinese companies have been founded in Latin America. (Berjano, 2019; Rios, 2018; Gallagher and Myers, 2017; Chen and Li, 2017; Detsch, 2018).

FDI has been concentrated on projects and acquisitions in natural resource-intensive sectors such as mining, oil, and gas. The composition of Chinese FDI in the region shows that in the period 2010-2014, almost 90 percent was directed to natural resources, in oil and gas extraction. China is among the most important foreign investors in Argentina, Brazil, Colombia, Ecuador, Peru, and Venezuela. In mining, China has concentrated its investments in Peru and a lesser extent in Brazil. Chinese FDI in the agricultural field remains limited but shows a growing trend and the consolidation of large global players operating in the region, such as the Chongqing group (GGG), is observed. Finally, in recent years, Chinese investments have been increasingly directed towards telecommunications, the automotive industry, and non-conventional energies (CEPAL, 2018).

The oil absorbs most of the Chinese financing in Latin America and its main instruments to guarantee the supply of oil are direct investments by Chinese public companies and the financing of Chinese public banks with a counterpart in oil. Next, copper and iron are the sectors with the highest Chinese FDI in Latin America. In the case of soybeans, due to legal difficulties in purchasing land, the strategy was to acquire two international trading companies already present in the region and that control almost the entire value chain, to seek to transform them into a large Latin American operator (Gallagher, Irwin, and Koleski, 2013; Cheny Perez - Ludeña, 2014).

Additionally, the most significant project worldwide is the one promoted by China called the Belt and Road initiative, which is of strategic importance to Latin America. This initiative has important complementarities and spaces for cooperation. China has a special interest in guaranteeing access to the region's natural resources and Latin America in attracting FDI in strategic areas such as infrastructure and communication.

To realize the full Chinese FDI potential to generate growth in the region, the Latin American economies must promote projects that allow the region's economies to join the productive chains promoted by China; not only as suppliers of raw materials but also identify activities with the highest added value, which promote investments and technological alliances. Otherwise, the logic of the market and the reprimarization of Latin American economies will continue to prevail.

The rise of China in the world economy has also affected the terms of trade, increasing the prices of raw materials and energy resources, and reducing the prices of simple manufacturers, which has had diametrically different effects in the Latin American sub regions. South America has benefited from the high demand for raw materials, minerals, and energy products, and the high supply of manufactured goods, which has improved its terms of trade. For their part, the Central American countries have been affected by the deterioration in the terms of trade due to this same situation; since they are net importers of oil and net exporters of manufacturing. While Mexico was surpassed by China as the second trading partner of the United States; especially due to the displacement of its manufacturers. Central American manufacturers have also not been able to compete with Chinese manufacturers in the US market (Berjano, 2019; Caputo, 2005; CEPAL, 2004).

Miranda (2021) warns that increases in the prices of natural resources produce incentives for the re-primarization of productive structures; via international prices and the real exchange rate. Economic growth is anchored on the volatility of international prices of natural resources. Thus, the abundance of natural resources, as is the case in most of Latin America, is an additional argument in favor of policies for structural change.

For his part, Palma (2005) points out that the process of early deindustrialization in Latin America has been generated by changes in industrial policies and the drastic process of trade and financial liberalization that brought economies back to their traditional comparative advantages, to their natural Ricardian position. And Ocampo (2005) highlights, that the Latin American economic growth of the 2000s was driven by the increase in the prices of raw materials, especially hydrocarbons and mining products, and by the massive inflow of capital during two periods of exuberance in international financial markets, between mid-2004 and April 2006, and especially between mid-2006 and mid-2007; which allowed rapid growth and simultaneously generated a current account surplus, but without structural change.

This economic growth does not possess the qualities of growth during the period of state-led development between the end of World War II and 1980, which was driven by manufacturing and increased productivity.

For this reason, Ocampo (2005) distinguishes between deep structural change and superficial structural change. The first is characterized by an intense learning process and a high degree of development of complementarities, and therefore, by strong dynamic economies of scale of a microeconomic and mesoeconomic nature. While the second is characterized, by a low level of learning and a scarce development of productive complementarities, such as the development of enclaves dedicated to natural resource export activities.

For example, between the end of World War II and 1980, Latin America grew more than the world average, achieving the highest growth in the entire history of the region: 5.5 percent per year and 2.7 percent per capita. The engine of economic growth was the manufacturing industry sector; productivity also reached the highest levels in history, estimated that the GDP per worker increased by 2.7 percent per year between 1950 and 1980, and it was a period of greater economic stability. The model of economic policies for growth in this period was characterized by being a mixed model. Combined import substitution with export promotion and regional integration, due to the growing attention to industrialization, the significant expansion of the spheres of action of the State in economic life; through the creation of public companies and in the development of some industrial sectors (Bértola and Ocampo, 2014).

Thus, it can be affirmed that productive development policies for structural change have been essential for economic growth. Incentives must be generated to channel investments where the long-term benefits are strongest and change the structure of relative returns in favor of more complex sectors. Productive diversification and complexity allow the reallocation of productive factors to new activities, the addition of value to production processes, and the promotion of productive chains, that allow the diffusion of technology, the homogenization of productivity, and the reduction of inequality and poverty.

Productive development policies consist of a particular way of affecting the economic structure, a selective way, which intentionally seeks to favor, over others, a particular industry. Successful productive development policies have included assistance in capturing and adapting foreign technology, creating comparative advantages, protecting international competition, promoting exports, coordinating and complementing financial markets, promoting economies of scale, and regulating foreign direct investment (Chang, 2012; Rodrik, 2013).

In commercial matters, although South America presented a complementary productive structure with China and have a trade surplus; Mexico and Central America presented a competitive structure and maintained trade deficits.

Bilateral Chinese-Latin American trade in 2017 totaled 257.8 million dollars, exports to China were 130.8 million dollars, and imports from China were 127 million dollars. China is the first commercial partner of Brazil, Chile, and Peru; and the second of most of the countries in the region. Exports to China are focused on raw materials, almost exclusively energy and mining for manufacturers. China's degree of dependence on imports of natural resources from Latin America, measured as a ratio between net imports and consumption, already reaches 60 percent in the case of major commodities, such as oil, copper, iron, and in the case of soy rising to 85 percent (Berjano, 2019; Rios, 2018; Rosales and Kuwayana, 2012).

Latin America is relevant to China in the supply of various metallic minerals. Exports of Latin American minerals to China increased from 1.7 million tons in 2000 to almost 220 million tons in 2015. Of this amount, Brazil's contribution was 192 million tons, Peru's 11 million tons, and Chile's 10 million tons. Additionally, it is estimated that the Chinese demand for minerals will continue to increase since it is especially tied to the urbanization process of the Asian country, which is estimated to increase by 70 percent by the year 2030. In terms of oil, exports to China reached 854,000 barrels per day in 2015, figures corresponding to 13 percent of the continent's total exports to China and 8 percent of Chinese oil consumption. About 91 percent of this amount originated in Venezuela (CEPAL, 2018; World Bank, 2016).

Sustained economic growth requires structural change and a productive transformation that incorporates and spreads technological progress. For this, the primary sector must not only transfer income to other sectors but must also articulate productive linkages with the industrial and service sectors. However, these synergies do not occur spontaneously or due to market dynamics. So, specific policies are needed for the generation, dissemination, and incorporation of knowledge into production. Policies for the selective promotion of exports, granting of government incentives to those who undertake innovative activities, support for the creation of high-tech companies, and completion and adapt the technological infrastructure in the less advanced priority sectors (CEPAL, 1995; CEPAL, 1996).

Trade with China is persistently in deficit for the majority of the region, which has worsened since 2011, especially in Mexico and Central America. Only three countries in the region register a surplus with China, Brazil, Venezuela, and Chile. It is an inter-industrial exchange where the Latin American region practically exclusively exports unprocessed natural resources and imports a wide range of manufactured goods. There is a marked deficit with China in the manufacturing market since manufacturing exports to China are very low, except in the case of Costa Rica and Mexico. The most exported products to China from the region are oil, iron, copper in different forms, soybeans, metals, wood, and sugar (CEPAL, 2018; CEPAL, 2016).

As the pioneering works of Prebisch (1973) already warned, in Latin America, there is an asymmetry between the low dynamism of the demand for primary products that it exports, compared to the wide demand for imported industrial products. This damages the terms of trade and generates a structural imbalance in the balance of payment.

Additionally, China is substituting the import of processed goods with its capacity, which has eroded the contribution of Latin American countries to the value chain. Economies such as Bolivia, Ecuador, and Uruguay practically do not add value to their main products exported to China: precious metals, fruits, and soybeans, respectively. In the case of Argentine and Brazilian exports of soybeans and their derivatives, the percentage of exported products with some level of processing fell significantly from 2004 to 2014. For its part, the percentage of Venezuelan refined oil has decreased notably in total exports of petroleum products. Only in the case of copper, the percentage of exported refined material has remained stable for Chile and Peru. (CEPAL, 2016).

Sustained economic growth requires a structural change, a basket of varied exports that are positioned in more complex sectors. Exports to China do not meet these conditions. On the contrary, they accentuate the re-primarization of the region's economy. Processed products have a minimal share in the current export basket of the region to China, and the manufacturing sector has been reduced in the domestic market by international competition, particularly Chinese competition. For Latin America to take advantage of the potential of trade with China, it must apply productive development policies that do not follow the short-term incentives of the market.

In agriculture, Latin America has significantly increased its weight as China's agricultural supplier. The region's portion of Chinese imports of agricultural products went from 16 percent in 2000 to 27 percent in 2015. In this year, 2015, the region surpassed the joint share of the United States as a supplier of Chinese imports. The United States and Canada reached 26 percent which was much higher than the shares obtained by other relevant competitors such as the Association of Southeast Asian nations with 15 percent, and Austria and New Zealand with 11 percent. However, although the region as a whole has increased its weight as an agricultural supplier to China, the growth of regional exports has been represented almost entirely by a single basic product and a single supplier, soybeans from Brazil (CEPAL, 2016).

Agricultural exports to China have significant potential to add value. For this, it is necessary to know and satisfy the requirements of the Chinese consumer and the regulatory requirements to access the market, such as sanitary and phytosanitary requirements, and quality standards. This may represent a barrier to entry due to high costs. However, States can offer industries and companies this information and support as a public good.

It should be noted, that the technological and structural complexity gap between China and Latin America has been widening. From 1995 - 2014, the complexity of China's economic structure increased significantly. Industrial policy strategy focused on investment in new technological sectors and areas of greater demand for knowledge such as the digital economy. This has made it possible to reduce the productivity gap with the most advanced economies and to develop new technological capabilities in areas such as the Internet, data storage, metadata analysis, robotics, and artificial intelligence. While in the principal economies of Latin America, such as Brazil, Mexico, and Argentina, the complexity of the productive structure lagged, and this behavior has spread to the rest of the countries of the region (CEPAL, 2018).

As Chang (2020) warns, economic theories and empirical evidence show that although in the short term there is a certain probability that free trade allows all partners to maximize their production and income, in the long term it harms the economic development of the less developed partners, for whom it is impossible to establish technologically advanced and highly productive industries if they have to compete with the most advanced producers in the most economically developed countries. In the long run, free trade between countries at different stages of economic development is detrimental to less developed countries.

Thus, what intrinsically hinder sustained economic growth in the region is not the incentives generated by FDI, the terms of trade or trade with China, but rather the lack of productive development and foreign trade policies that generate structural change with greater diversity and technological content.

Additionally, it is often sought to measure the associations between Latin America's economic growth and China's economic growth.

Descriptive analysis

For the economic growth of Latin America and the Caribbean, the Gross Domestic Product (GDP) per capita of all the countries that make up the region was considered as an aggregate; this was obtained by dividing the GDP by the population at mid-year. GDP is the sum of the gross value added of all resident producers in the economy plus all taxes on products, less any subsidies not included in the value of products. The data was obtained from the World Bank (2022) and is expressed in current dollars. In addition, the natural logarithm was applied to statistically improve the model and observe the convergence of growth between the countries of Latin America and the Caribbean as an aggregate. The economic growth of Latin American countries is our variable to analyze or the dependent variable.

Broadly, Latin America and the Caribbean countries present an average of 4,383 million dollars in the selected period (1970-2020). This period is divided into half, where the GDP registered its lowest values: 613 million dollars in 1970 to 3,760 billion in 2002. In the second half (2002-2020), the region registered the highest levels of GDP; reaching the figure of 10,433 billion dollars in 2014. The coefficient of variation is 70 percent, indicating that there is a high degree of dispersion in what refers to the distribution of GDP in the region in the period under study.

Table 1. Gross Domestic Product of Latin America and the Caribbean (GDP-LATAM)

Average	Deviation padron	CV%	Minimum	Quartil 1	Median	Quartil 3	Maximum
4.383	3.065	70%	613	1.889	3.760	7.089	10.433

For Chinese economic growth, China's Gross Domestic Product (GDP) per capita was considered. The data was obtained from the World Bank (2021) and is expressed in current dollars. Additionally, the logarithm was applied to improve the model statistically.

Broadly, China presents an average of 3,026 trillion dollars in the selected period (1970-2020). This period is divided into half where the GDP registered its lowest values of 92,602 billion dollars in 1970 to 734,547 billion in 1995. The second half (1995-2020) registered the highest levels of China's GDP, reaching the figure of 14.279 trillion dollars in the 2019. The coefficient of variation is 144 percent, indicating that there is a high degree of dispersion in what refers to the distribution of GDP in China during the period under study.

Table 2. Gross Domestic Product of China (GDP-CHINA)

Average	Deviation padron	CV%	Minimum	Quartil 1 1	Median	Quartil 3	Maximum
3.026.912.246.789	4.351.030.925.221	144%	92.602.973.434	17.888.223.506	734.547.898.221	4.072.324.884.836	14.279.937.467.431

Foreign Direct Investment (FDI) is the sum of equity capital, reinvested earnings, other forms of long-term capital, and short-term capital as described in the balance of payments. This series reflects the net total, that is, net FDI in the reporting economy from foreign sources less net FDI of the reporting economy in the rest of the world. This series reflects net inflows into the economy report and is divided by GDP. The data is expressed in dollars at current prices. The variable was obtained from the World Bank (2022) and is the aggregate of Latin America. Additionally, the logarithm was applied to improve the model statistically.

Broadly, Latin America and the Caribbean countries present an average of 87.365 billion dollars of FDI in the selected period (1970-2020). This period is divided into half where FDI registered its lowest values, 918,606 million dollars in 1972, up to 30,168 billion in 1995. The second half (1995-2020) saw the region register its highest levels of FDI, reaching the figure of 343.499 billion dollars in 2013. The coefficient of variation is 119 percent, indicating that there is a high degree of dispersion in what refers to the distribution of FDI in the region in the period under study.

Table 3. Foreign Direct Investment in Latin America and the Caribbean (FDI)

Average	Deviation padron	CV%	Minimum	Quartil 1	Median	Quartil 3	Maximum
87.365.222.156	107.594.401.387	119%	918.606.901	5.439.428.290	30.168.276.207	160.087.884.767	343.499.295.040

Gross Fixed Capital Formation includes land improvements, the acquisition of facilities, machinery, and equipment, and the construction of roads, railways, and related works, including schools, offices, hospitals, private residences, and buildings of commercial and industrial. Data is in US dollars at current prices. The variable was obtained from the World Bank (2021) for Latin America as an aggregate. Additionally, the logarithm was applied to improve the model statistically.

Broadly, Latin America and the Caribbean countries present an average of 469,220 billion dollars, referring to FBC in the selected period (1970-2020). This period is divided into half where the FBC registered its lowest value of 35,504 billion dollars in 1970 to 365,494 billion in 1995. In the second half (1995-2020), the region registered its highest FDI levels, reaching the figure of 1,314 trillion dollars in the 2013. The coefficient of variation is 85 percent, indicating that there is a high degree of dispersion in what refers to the FBC distribution in the region in the period under study.

Table 4. Gross Capital Formation in Latin America and the Caribbean (FBC)

Average	Deviation padron	CV%	Minimum	Quartil 1	Median	Quartil 3	Maximum
469.220.807.100	400.501.398.655	85%	35.504.768.350	146.236.493.229	365.494.167.637	812.474.693.594	1.314.006.550.235

The economic openness index is an indicator that measures the degree of openness of a country's economy, considering its foreign trade to its global economic activity as a whole. It is the result of the sum of imports of goods and services plus exports of goods and services, divided by GDP at buyer's prices, all at current prices in dollars. The variable was obtained from the World Bank (2021) for Latin America as an aggregate. Additionally, the logarithm was applied to improve the model statistically.

Broadly, Latin America and the Caribbean countries present an average of 0.38 points regarding economic openness in the selected period (1970-2020). This period is divided into half, where economic openness registered its lowest values, 0.27 points in 1970, down to 0.34 points in 1988. The second half (1988-2020) saw the region register its highest levels. of economic openness reaching the figure of 0.51 points in 2018. The coefficient of variation is 21 percent, indicating that there is a relatively stable degree of dispersion in what refers to the distribution of economic openness in the region during the study period.

Table 5. Economic Opening of Latin America and the Caribbean (APERT-ECO)

Average	Deviation padron	CV%	Minimum	Quartil 1	Median	Quartil 3	Maximum
0,38	0,08	21%	0,27	0,31	0,34	0,45	0,51

Econometric analysis

The methodology used consists of a multivariate approach for time series. It seeks to estimate cointegration vectors between the variables studied that signify a stable relationship, interpreting such relationships as long-term connections. Cointegration is a multivariate procedure suitable for the time series treatment, considering the possibility of stochastic trend's existence in the series because it results in a relational equation of magnitudes in level.

With this approach, it will be possible to estimate the degree of association between the GDP of Latin America and the Caribbean (our target variable) with the GDP of China, Foreign Direct Investment in the region, Gross Capital Formation in the region, and finally the Economic Opening in the region, during the period 1970-2020.

With this methodology, it is also possible to estimate the short-term adjustment dynamics resulting from variations in the GDP of Latin America and the Caribbean and the other variables under study, leaving visible the short- and long-term impacts on variables of interest derived from standardized exogenous shocks, through the analysis of impulse response functions.

Before applying the time series cointegration methods, it is essential to verify certain characteristics, such as the homoscedasticity and stationarity of the variables and their degree of integration. The verification of the heteroscedasticity pattern of the series was carried out by graphical inspection of the series in second difference (See Appendix 1). Additionally, cointegration methods can only be applied to stationary or first-order integrated variables, so the unit root test was applied to each of the variables and the complete model, to know their integration properties (See appendix 2). Finally, the methodology of Johansen (1991) is used to perform a test to calculate the rank of matrix II = 〚αβ〛^´. Cointegration tests allow for verifying the long-term relationship between economic variables. Johansen's (1991) cointegration test has been used because it determines the number of cointegration vectors (See Appendix 3). By complying with these elements; it was possible to move on to time series analysis.

To decide to work with the Vector Error Correction Model (VEC-M), we first analyzed the behavior of the variables through the analysis of the Vector Autoregressive Model (VAR). It should be noted that the VEC-M model is developed as an evolution of such a VAR model. For this reason, it is essential to observe the behavior in the first instance through the said model. The order of the VAR model was chosen by analyzing the Final Prediction Error (FPE) information criterion, through which it was concluded that it is of order 2; that is, this VAR model has 2 lags (see Appendix 3).

Having determined the number of unit roots and the order of the VAR model, Johansen's (1991) methodology was applied to obtain the number of cointegration vectors. Considering the behavior of the variables under study in the VAR model, and based on it, the decision was made to work with the VEC-M model, through which a better adaptation of the variables to the selection of the economic theory. We were able to observe that using the VEC-M model, the result of the maximum eigenvalue was 3 cointegration vectors, with a significance of 5% for all models. The VEC-M model was chosen, with equal linear trends, within the cointegration vector; since it is the most parsimonious and includes less rigidity than the other candidate models. For this reason, it was chosen.

$$Log(diff1(PIB\ LATAM\ Y\ CARIBE_t)) = \beta_0+\beta_1+\beta_2+\beta_3(Log(Diff2(PIB\ CHINA_t)) + \beta_4(Log(Diff2(Inversión\ Extranjera\ Directa_t)) + \beta_5 Log(Diff2((Formación\ Bruta\ de\ Capital_t)) + \beta_6(Log(Diff2(Apertura\ Económica_t)) = 0$$

```
## Response PIB.LATAM.d :
##
## Call:
## lm(formula = PIB.LATAM.d ~ ect1 + ect2 + ect3 + PIB.LATAM.dl1 +
##     PIB.CHINA.dl1 + investimento.estrangeiro.direto.dl1 + Formação.bruta.de.capital.dl1 +
##     APERT.ECO.dl1 - 1, data = data.mat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.19482 -0.04408  0.02539  0.06535  0.17145
##
## Coefficients:
##                                      Estimate Std. Error t value Pr(>|t|)
## ect1                                 -0.77254    0.39187  -1.971   0.0555 .
## ect2                                  0.04356    0.01858   2.345   0.0240 *
## ect3                                  0.05821    0.03627   1.605   0.1162
## PIB.LATAM.dl1                        -0.12473    0.44972  -0.277   0.7829
## PIB.CHINA.dl1                         0.30757    0.19659   1.564   0.1254
## investimento.estrangeiro.direto.dl1   0.04172    0.06125   0.681   0.4996
## Formação.bruta.de.capital.dl1         0.26660    0.33863   0.787   0.4356
## APERT.ECO.dl1                        -0.38534    0.28942  -1.331   0.1904
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.09461 on 41 degrees of freedom
## Multiple R-squared:  0.4248, Adjusted R-squared:  0.3125
## F-statistic: 3.784 on 8 and 41 DF,  p-value: 0.002102
```

$$0{,}78 PIB\ LATAM\ Y\ CARIBE = -0{,}55 + 0{,}02 + 0{,}11 - 0{,}12 PIB\ CHINA + 0{,}49\ Inversión\ Extranjera\ Directa + 0{,}43\ Formación\ Bruta\ de\ Capital + 0{,}19 Apertura\ Económica = 0$$

With the model offered, a stable relationship between the variables studied can be observed. However, it is not yet possible to define causal relationships. These relations are obtained through the analysis of the impulse response functions that will be developed later.

The VEC-M model complied with the stability condition. The roots of the characteristic polynomial and its modules are all less than unity. The model is stationary; it does not have unit roots and therefore the estimators are consistent (see Appendix 4).

The correlogram (see Appendix 5) shows good behavior of the residual correlations. The residuals normality analysis the of the VEC-M model showed that with a significance level of 5%, the residuals have a normal distribution. The normality of the residuals is verified in all the joint and individual tests of asymmetry and kurtosis. The normality of the residuals for the VEC-M model only gives more confidence for the hypothesis tests of the coefficients, but it is not fundamental.

The LM (see Appendix 6) and Portmanteau (see Appendix 7) tests corroborate the absence of serial autocorrelation. Since this bloom is the best fit for these aspects, we will keep and assume that the non-contemporary residual autocorrelation is resolved.

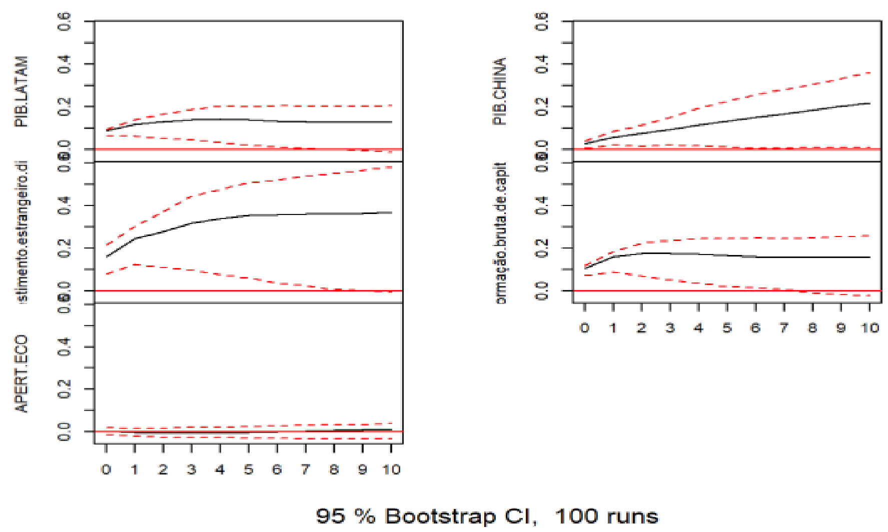
Finally, impulse response functions help to quantify how much an impact on one variable affects the others over time. This impulse response analysis is used to investigate the dynamic interactions between endogenous variables and is based on the Wold moving average representation of a VAR(p) process. On the other hand, the impulse response function is used to describe the reaction of the system of equations under study as a function of time or as a function of some other independent variable that parameterizes the dynamic behavior of the system (Pfaff, 2011).

Next, the impulse response function is presented graphically, through which we can observe how the variations or shocks of each of the series under study have influenced the GDP of Latin America and The Caribbean, where the red lines represent the confidence interval estimated for each of them.

A shock on the GDP of Latin America and the Caribbean determines a behavior on the FDI series in the region that begins at a high level; over the years, the influence grows positively until it stabilizes in period 8. We can observe that the GDP of Latin America and the Caribbean influences positively and in a large proportion on the growth of FDI in the region.

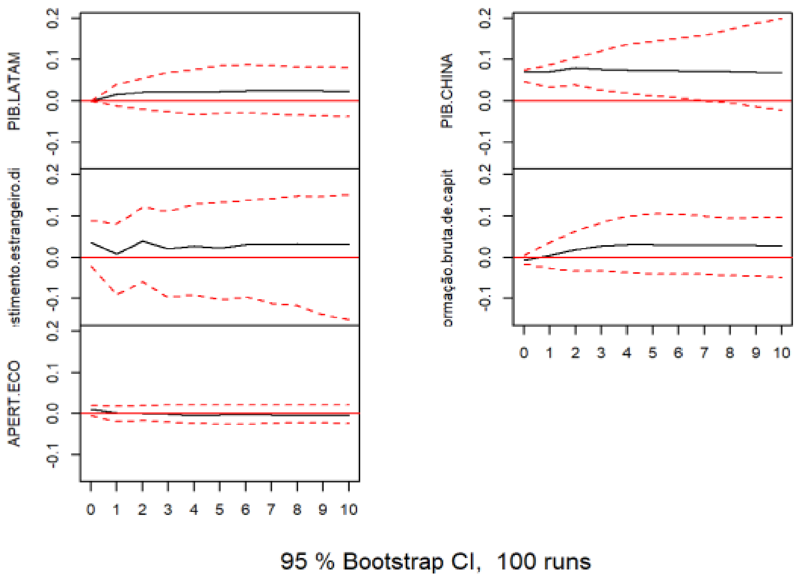
The impact of a shock on the GDP of Latin America and the Caribbean determines a behavior on the economic opening series in the region that is practically non-existent, the confidence interval is around zero, that is to say, an increase or a fall in the region GDP does not directly influence the rise or fall of economic openness. On the other hand, a shock on the GDP of Latin America and the Caribbean determines a behavior on the GDP series of China that at the beginning of our series is at a low level; but with time, its influence increases, maintaining a growing trend, indicating that an increase in the region's GDP contributes to an increase in China's GDP.

Graph 1. PIB-LATAM



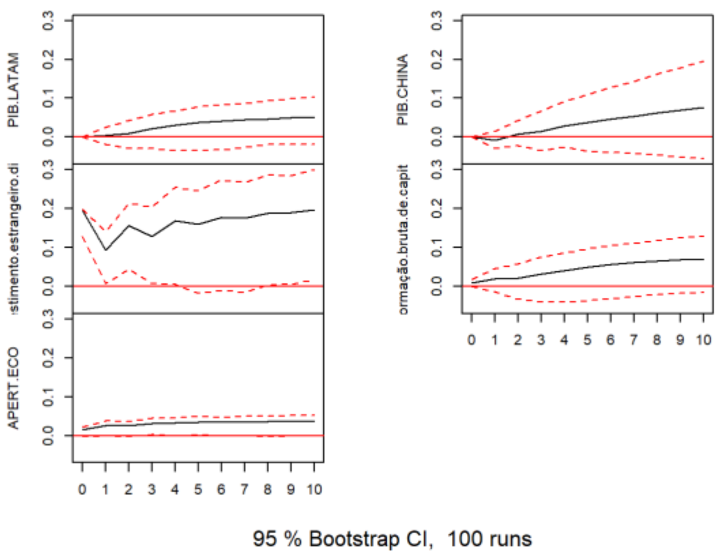
Finally, a shock on the GDP of Latin America and the Caribbean determines a behavior on the gross capital formation series of the region, that begins at a high level, tends to decrease over time, and then tends to stabilize, we can highlight that throughout our series under study, a positive but not directly proportional relationship has been established between both indicators, that is, large variations in the region's GDP will not have the same proportionality in an increase or decrease in the region's gross capital formation.

Graph 2. PIB-CHINA



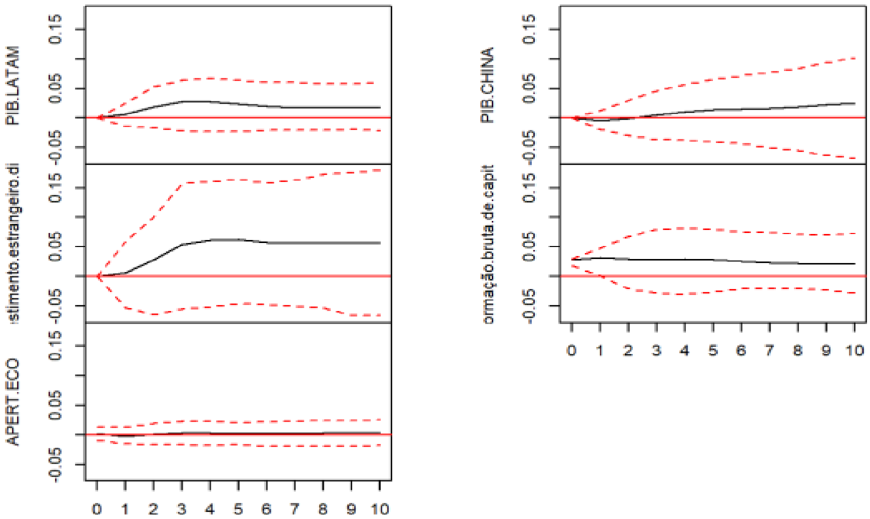
A shock on theChina GDP determines a behavior on the GDP series of Latin America and the Caribbean. Initially begins at a very low level, but over the years that influence takes on a more relevant character; that is, as the years have passed in the period 1970-2020, China's GDP growth has positively influenced the region's GDP growth..

Graph 3. IED



A shock on IED determines a behavior on the GDP of Latin America and the Caribbean that begins at a low level. With the passing of the periods, its influence becomes increasingly important, that is to say, as the years pass in the period under study, IED has had a positive impact on the region's GDP growth.

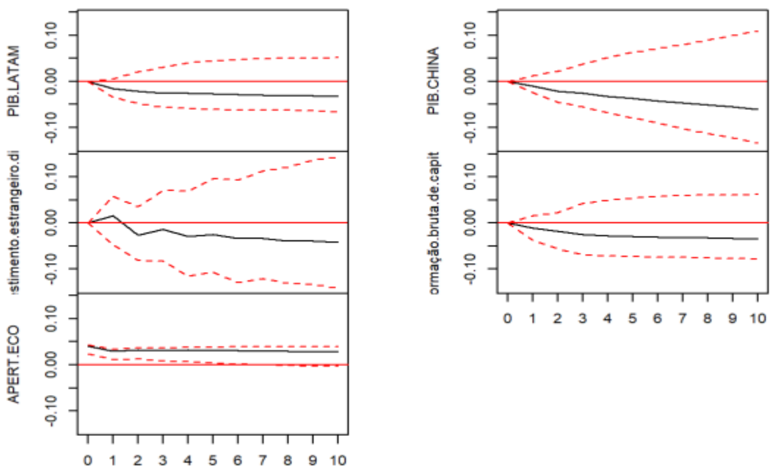
Graph 4. FORMACIÓN BRUTA DE CAPITAL



95 % Bootstrap CI, 100 runs

A shock on the region's gross capital formation determines a behavior on its GDP series that begins at a low level, as the periods go by it is influence begins to increase, and from period 6 it tends to stabilize. In other words, over the years a positive and stable influence between both indicators has been established..

Graph 5. APERT ECO



95 % Bootstrap CI, 100 runs

A shock on the economic opening of the region determines a negative behavior on its GDP series, highlighting that it remains constant over the years in the same patamar. In other words, throughout the period under study, the economic opening of the region has not played a determining role in terms of its growth.

Next, the variance decomposition function is worked on. Pfaff (2011) explains the decomposition function as a matrix-based method of the orthogonal impulse response coefficient Ψn, where the variance indicates in what proportion of the variability of each of the variables that are part of the proposed model explains the variability of the variable under study.

In this case, it is observed in what proportion the variation of the variables PIB LATAM, PIB CHINA, IED, FBC, and APERT ECO explain the variability of PIB LATAM at the moment in which our model tends to stabilize.

The variance decomposition function of the model is presented below:

	PIB-LATAM	PIB-CHINA	IED	FBC	APERT-ECO
[1,]	100.00000	0.000000	0.0000000	0.0000000	0.000000
[2,]	97.32913	1.254403	0.1055683	0.1986666	1.112232
[3,]	95.30587	1.701930	0.2472509	1.0282216	1.716732
[4,]	93.24048	1.790305	0.9522151	1.8502439	2.166754
[5,]	91.82951	1.793198	1.7331249	2.2591686	2.385003
[6,]	90.54741	1.890795	2.6317185	2.3252724	2.604805
[7,]	89.43252	2.033440	3.4559772	2.2618833	2.816177
[8,]	88.32551	2.173595	4.2902205	2.1730465	3.037627
[9,]	87.32573	2.264763	5.0801057	2.0939306	3.235471
[10,]	86.42426	2.308325	5.8330627	2.0248340	3.409514
[11,]	85.66063	2.314235	6.5067540	1.9629737	3.555409
[12,]	85.01495	2.296414	7.1006195	1.9067798	3.681232
[13,]	84.48187	2.261847	7.6091856	1.8577556	3.789345
[14,]	84.03860	2.215641	8.0454752	1.8167381	3.883543
[15,]	83.67276	2.161062	8.4176644	1.7836314	3.964881
[16,]	83.36816	2.101492	8.7376066	1.7571891	4.035554
[17,]	83.11383	2.039552	9.0134526	1.7360525	4.097114
[18,]	82.89853	1.977266	9.2537681	1.7190194	4.151419
[19,]	82.71436	1.915837	9.4648482	1.7052418	4.199711
[20,]	82.55461	1.855999	9.6522762	1.6940559	4.243059

At instant 1, the variation in LATAM PIB is fully explained by its variation. The model tends to stabilize at instant 18 where the variation of the Latin America and the Caribbean PIB is explained in 82.9% by its variation; 2% by the variation in the China PIB; 9.3% by the IED variation; 4.2% due to the variation in economic openness and finally 1.7% due to the variation in gross capital formation.

Conclusions

China's economic growth has had a positive impact on Latin America's economic growth. Through the analysis of the impulse response functions, it can be stated that during the period 1970-2020, China's GDP growth has positively influenced the region's GDP growth and that this influence has been greater over the years. According to the results of the variance decomposition function of the model, the variation of Latin America and the Caribbean GDP is explained by 2 percent of the GDP China variation.

Broadly, China's economic growth has been positive for the region; but it has had adverse effects, too. The main adverse effect is the re-primarization of Latin American economies. Which inhibits sustained growth, and that has been a consequence of the concentration of Chinese Foreign Direct Investment in natural resource-intensive sectors such as mining, oil, and gas; of price increases of natural resources and their short-term incentives; and of trade where the region practically exclusively exports unprocessed natural resources.

For this reason, for Latin America to realize the full potential that Chinese economic growth has for the region; it must apply policies that generate structural change with greater diversity and technological content. Incentives must be generated to channel investments where the long-term benefits are strongest, and that allow the productive factors reallocation to more complex activities; and with better incorporation into the global production chains promoted by China.

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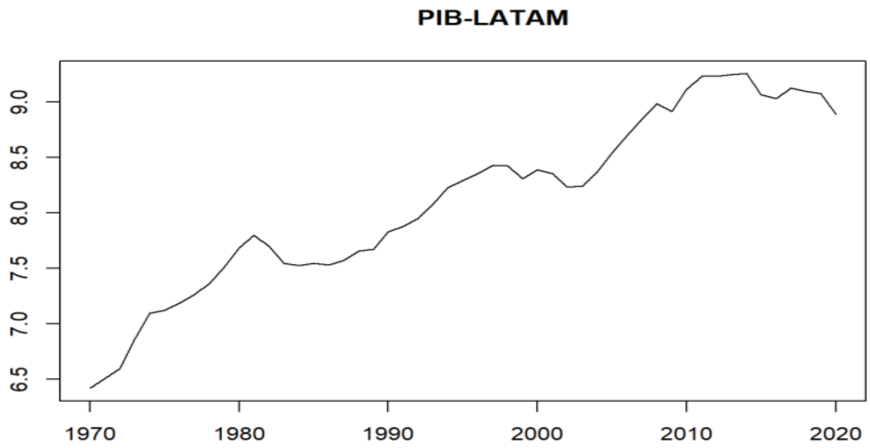
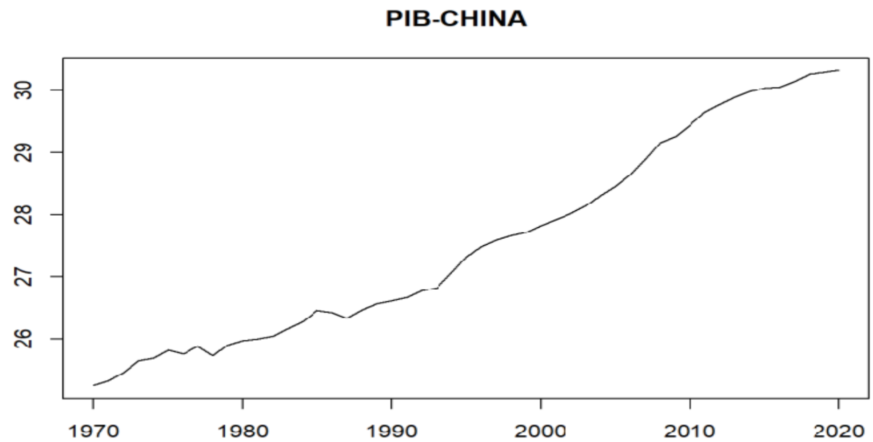
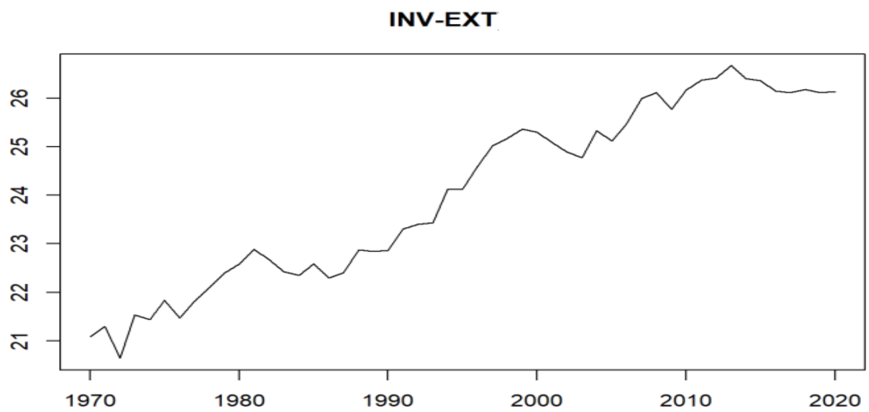
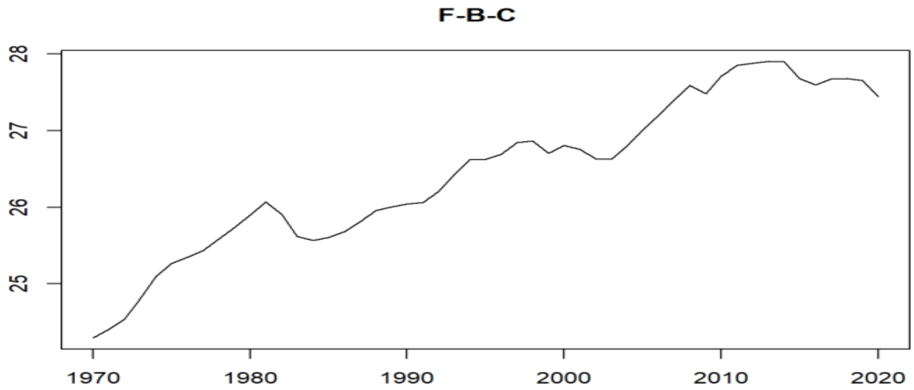
Appendix

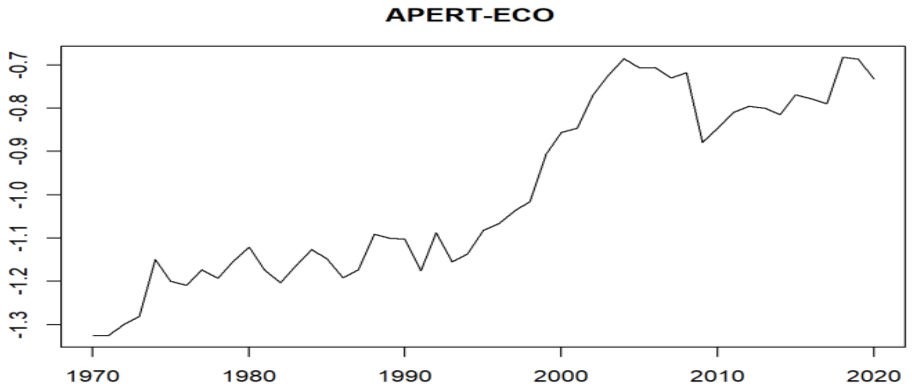
1. Verification of the heteroscedasticity pattern of the series



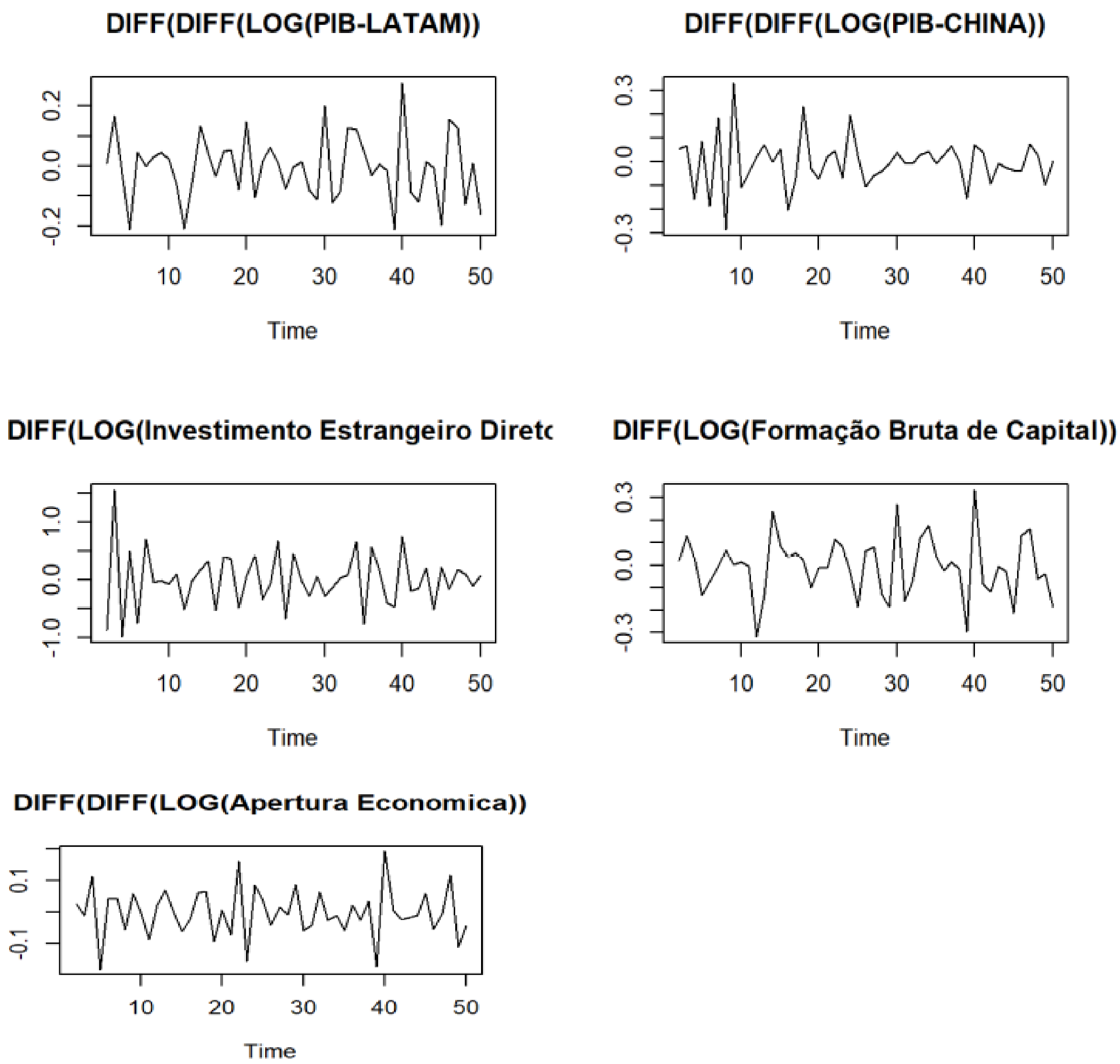








The graphical analysis carried out on the variables under study determined the presence of a trend in each of them. To continue with the analysis, it is necessary to eliminate its presence. Hence, after several econometric devices application, the logarithm and second difference were applied to the PIB-LATAM, PIB-CHINA, and APERTURA ECONOMICA variables; for the variables INVERSION EXTRANGERA DIRECTA and APERTURA ECONOMICA. It was not necessary to apply a second difference to control this problem.



After applying logarithms and differences to the series under study, we should not have unit root problems, and we can also rule out the application of a model with a deterministic trend.

2. Unit root test

A maximum of three-unit roots were assumed for each variable used in the model: PIB-LATAM, PIB-CHINA, APERTURA ECONOMICA, INVERSION EXTRANGERA DIRECTA, and FORMACÍON BRUTA DE CAPITAL. All variables have been linearly transformed by applying logarithms and differences. It is highly unlikely that there are more than three roots in the economic variables, hence the choice; also, because graphical inspection does not show a stochastic trend of such magnitude.

Dickey & Pantula's (1987) tests for three-unit roots consist of three steps. First, the existence of three-unit roots is analyzed. By rejecting this hypothesis, two-unit roots are tested. Finally, a third step is to verify the presence of a single root, in case the hypothesis of two-unit roots is rejected.

By using the LAPPLY function available in the R studio software, we can perform the unit root test on all variables using a single algorithm.

```
## $`PIB-LATAM`
##                  tau1
## statistic -7.296875
##
## $`PIB-CHINA`
##                  tau1
## statistic -7.763024
##
## $`investimento estrangeiro direto
##                  tau1
## statistic -9.550469
##
## $`Formação bruta de capital`
##                  tau1
## statistic -4.978879
##
## $`APERT-ECO`
##                  tau1
## statistic -7.797777
 adf[[1]]@cval

##        1pct  5pct 10pct
## tau1 -2.62 -1.95 -1.61
```

Having ruled out the presence of 3-unit roots, we proceed directly to testing the presence of 2 unit roots, where we will test the hypothesis of the existence of two unit roots under the alternative existence hypothesis of only one. The lags of the dependent variable should also be included to remove the correlation of the residuals; observed by the correlogram analysis. The number of lags is defined by the Akaike (1985) and Schwarz (1978) criteria; to guarantee the appropriate choice of the lag number.

The tested models have the following structural forms:

$$\begin{aligned}
\nabla^3 y_t &= \beta_1 \nabla^2 y_{t-1} + \beta_2 \nabla y_{t-1} + \sum_{i=1}^{m} \gamma_i \nabla^3 y_{t-i} + \varepsilon_t \\
\nabla^3 y_t &= \alpha + \beta_1 \nabla^2 y_{t-1} + \beta_2 \nabla y_{t-1} + \sum_{i=1}^{m} \gamma_i \nabla^3 y_{t-i} + \varepsilon_t \\
\nabla^3 y_t &= \alpha + \beta t + \beta_1 \nabla^2 y_{t-1} + \beta_2 \nabla y_{t-1} + \sum_{i=1}^{m} \gamma_i \nabla^3 y_{t-i} + \varepsilon_t
\end{aligned}$$

Dickey and Pantula's (1987) individual hypothesis test for the second is as follows:

$$\begin{cases} H_0 & : & \beta_1 < 0, \beta_2 = 0 \\ H_A & : & \beta_1 < 0, \beta_2 < 0 \end{cases}$$

The test statistics are $t_1 = \hat{\beta}_1 / s_{\beta_1}$ e $t_2 = \hat{\beta}_2 / s_{\beta_2}$. Critical values that were calculated by Dickey and Pantula (1987) and simulated using the R study software. The decision criterion defines if $\hat{t_1} < \tau^{crit}$ the null hypothesis is rejected.

Critical values are available in Dickey and Fuller (1981), according to the model used, the level of significance, and the size of the sample. The decision criterion defines that if: $\hat{t_{\alpha\tau}} < \tau^{crit}_{\alpha\tau}$ the null hypothesis that the model has a constant is rejected, if $\hat{t_{\alpha\tau}} < \tau^{crit}_{\alpha\tau}$, the null hypothesis that the model has a trend is rejected.

The tests were initially executed for each of the variables and then for the complete model, obtaining that the *Tau1* statistic belongs to the critical region for each of the series (the values of each of the roots are greater in modulus), which means that we do not have unit roots for each of the series studied in log and with a first and second difference, which is why we reject *Ho*. Our series is second (2) order integrated, that is, they have two-unit roots and a constant.

3. Cointegration

The cointegration by the procedure of Johansen (1991) is based on the Grainger Representation Theorem. This theorem states that if a group of variables cointegrates with each other, then the cointegration vector has a representation in the form of an error correction model. The error correction model is a variation of the VAR methodology. By applying this methodology, we establish the order of the Var model.

```
m2=VARselect(Dados1, lag.max = 3 , type = "both")
m2
```

```
## $selection
## AIC(n)  HQ(n)  SC(n) FPE(n)
##      2      2      1      2
##
## $criteria
##                   1             2             3
## AIC(n) -2.468067e+01 -2.522555e+01 -2.496046e+01
## HQ(n)  -2.416505e+01 -2.434164e+01 -2.370825e+01
## SC(n)  -2.331625e+01 -2.288655e+01 -2.164687e+01
## FPE(n)  1.931389e-11  1.170008e-11  1.696069e-11
```

Through the R studio software, we execute the 'both' command because a model with constant and trend is being estimated. We apply the analysis to our database without logarithms and differences and as a result, we can observe in the output that following the decision criterion FPE we have a model of order 2.

Having determined the number of unit roots and the order of the VAR model, we can apply the methodology of Johansen (1991) to obtain the number of cointegration vectors. The calculation of the number of cointegration vectors is vital to apply the Vector Error Correction model (VEC-M) presented in the article; such a procedure was carried out through the R studio software.

```
## ######################
## # Johansen-Procedure #
## ######################
##
## Test type: maximal eigenvalue statistic (lambda max) , without linear trend and constant i
n cointegration
##
## Eigenvalues (lambda):
## [1] 5.775979e-01 4.949291e-01 3.922071e-01 1.397464e-01 6.915117e-02
## [6] 1.942890e-15
##
## Values of teststatistic and critical values of test:
##
##           test 10pct  5pct  1pct
## r <= 4 |  3.51  7.52  9.24 12.97
## r <= 3 |  7.38 13.75 15.67 20.20
## r <= 2 | 24.40 19.77 22.00 26.81
## r <= 1 | 33.47 25.56 28.14 33.24
## r = 0  | 42.23 31.66 34.40 39.79
```

The lambda values were 5.775979e-01, 4.949291e-01, 3.922071e-01, 1.397464e-01, 6.915117e-02, and 1.942890e-15 which represent the eigenvalues calculated for this system. Critical values and test statistics are calculated based on these lambda values.

The values of r =0 to r <= 4 represent the null hypothesis, performing the test for r<=3, we observe that the test statistic is 7.38, lower than the critical values 13.75, 15.67, and 20.20; therefore, we do not reject H_0, we are in the presence of 3 integration vectors.

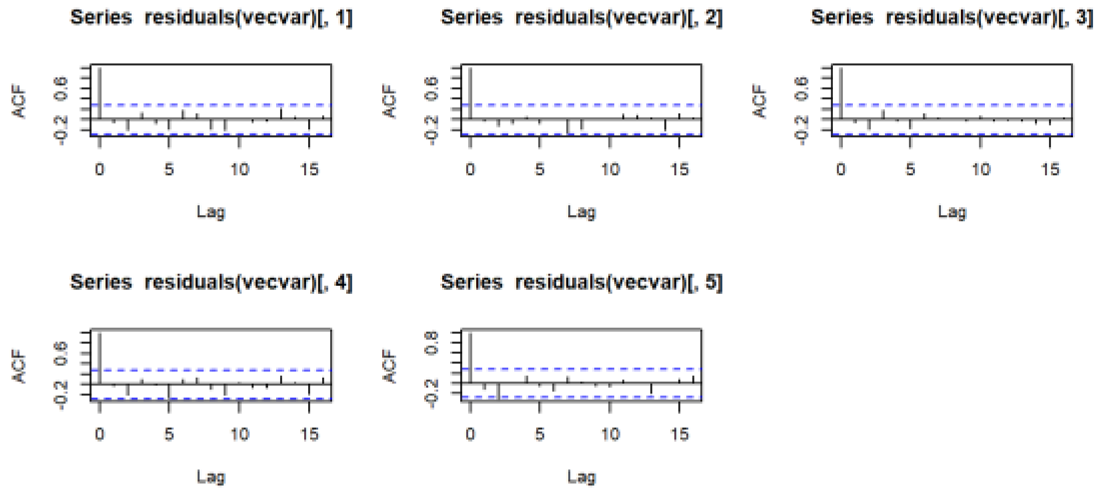
4. Root stability analysis

```
autoval <- roots(modelo.var)
roots(modelo.var)
```

```
##  [1] 0.9823102 0.9132032 0.8065308 0.8065308 0.6597713 0.6446529 0.6446529
##  [8] 0.6025183 0.2084020 0.1314178
```

The roots of the characteristic polynomial and its modules are all less than unity (1). The model is stationary; it does not have unit roots and therefore the estimators are consistent.

5. Model residuals



The serial correlation was not detected in the applied model.

6. LM test

```
model.BG=serial.test(vecvar,lags.bg=9,type='BG')

## Warning in pf(LMFh.stat, PARAMETER1, PARAMETER2): NaNs produzidos

model.BG

##
##  Breusch-Godfrey LM test
##
## data:  Residuals of VAR object vecvar
## Chi-squared = 245, df = 225, p-value = 0.1717
```

We do not correlate the lags up to lag number 9, p-value=0.1717 >0.05.

7. Portmanteau test

```
serial.test(vecvar, lags.pt = 15)
```

```
##
##  Portmanteau Test (asymptotic)
##
## data:  Residuals of VAR object vecvar
## Chi-squared = 328.57, df = 330, p-value = 0.5118
```

```
model.pt.asy=serial.test(vecvar,lags.pt=15, type='PT.asymptotic')
model.pt.asy
```

```
##
##  Portmanteau Test (asymptotic)
##
## data:  Residuals of VAR object vecvar
## Chi-squared = 328.57, df = 330, p-value = 0.5118
```

Through the Portmanteau test, we can ensure the absence of serial correlation up to lag number 15, p-value= 0.5118 > 0.05.