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Explanatory notes

- Three dots (...) indicate that data are not available or are not separately reported. A dash (-) indicates that the amount is nil or negligible.

- A full stop (.) is used to indicate decimals.
 The word "dollars" refers to United States dollars, unless otherwise specified.
- A slash (/) between years (e.g. 2013/2014) indicates a 12-month period falling between the two years.
 Individual figures and percentages in tables may not always add up to the corresponding total because of rounding.

Instability constraints and development traps: an empirical analysis of growth cycles and economic volatility in Latin America

Danilo Spinola

Abstract

Latin America and the Caribbean is a region characterized by a repetitive pattern of volatility that thwarts its development process. This article conducts an empirical investigation into its volatility, comparing it with other regions. First, an asymmetrical band-pass filter is used to decompose GDP growth time series into cycles of different types for 136 countries, employing data from the Maddison Project Database for 1950–2018. Next, *k*-means clustering methods are used to classify volatility patterns into groups to understand their characteristics. In most countries in the region, overall volatility is explained by the relative dominance of long-run economic cycles linked to heavy dependence on commodity exports, with changes in specialization resulting from technology-driven changes in the inputs used by the countries they export to. Despite claims to the contrary in the literature, the region is not the world's most volatile, but its countries have many particular, common characteristics.

Keywords

Economic conditions, economic growth, economic structure, macroeconomics, gross domestic product, business cycles, economic analysis, Latin America and the Caribbean

JEL classification

C21, C32, 047

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I. Introduction

Historically, sustaining growth has been a central problem for many developing countries seeking to implement a virtuous development strategy (Foster-McGregor, Kaba and Szirmai, 2015). Short-term growth spurts and high volatility in macroeconomic prices are constantly observed in developing countries, reducing their average period of stable growth. This results in an endogenous pattern of instability, reproduction of inequality, net outflows of financial capital and sharp fall-offs in investment. Macroeconomic volatility places major constraints on the economic development process, affecting long-term decision-making and creating periodic crises (Stiglitz, 2000). It impacts the economic structure, undermining long-run economic growth (Ocampo, Rada and Taylor, 2009).

Macroeconomic volatility is not a new issue, but it is currently a central problem for developing countries. Despite its importance, little effort has been made to understand the consequences of the type of volatility that emerges from the production structure, affecting the potential growth rates of economic systems. Volatility is usually treated as being related to stock market fluctuations and government debt (Eichengreen and Hausmann, 2010) rather than to structural fragility and the production structure, which leaves a gap in the literature.

Drawing on structuralist theory (Ocampo, 2002; Taylor, 1991), we plan to treat the periodic phenomenon of volatility as something driven by structural fragility (defined as the inability of an economy to absorb external economic shocks). We focus on aspects associated with volatility in GDP growth and empirically demonstrate different patterns of volatility in a variety of countries and regions.

Many structuralist authors have argued that the structural causes of volatility in Latin America and the Caribbean are related to its peripheral position in the international division of labour (Ffrench-Davis, 2005; Ocampo, Rada and Taylor, 2009; Prebisch, 1950). This position is characterized by external fragilities associated with these countries' specialized production structure and resulting in low resilience to external shocks, which is a major source of volatility. Accordingly, authors working in the structuralist tradition argue that the historical development of the Latin American and Caribbean economies has given these an idiosyncratic aspect that makes them more fragile (Furtado, 1965). However, there is a lack of empirical research to prove (or disprove) this claim. Do Latin American and Caribbean economies' volatility patterns actually differ from those of developed countries and other developing regions?

To answer this question, we shall (i) present some stylized facts about GDP growth volatility for the countries in our dataset, (ii) apply filtering techniques to decompose economic growth time series into different types of cycle and analyse the patterns that emerge from the data and (iii) use cluster analysis to build a typology that groups countries by their patterns of volatility. This methodological strategy will allow us to analyse the type of expansion cycle processes followed by each country.

Section II provides a brief review of the literature covering (i) the main theories behind the idea of economic cycles, (ii) the structuralist perspective and (iii) the empirical evidence for the existence of cycles. Section III presents the data used in this research. Section IV focuses on the methodologies employed, namely the Christiano-Fitzgerald band-pass filter and the *k*-means method of cluster analysis. Section V presents evidence from the original data before application of the filtering method. Section VI shows the results of applying the filters to the data and discusses them for the different types of cycle. Lastly, section VII summarizes the main results and concludes.

II. Literature review

This section consists of a literature review that presents the classical and current discussion of economic cycles and volatility, covering three main aspects: the relevance of cycles to economic theory, the approach taken to volatility in structuralist theory, and some methodological and empirical evidence for cycles in growth theory.

1. Cycle theory

The study and development of cycle theories has helped many analysts to understand economic dynamics. Different theories have approached the observation of economic cycles with their own explanations of the phenomenon (Korotayev and Tsirel, 2010). The relevance of studying these cycles is that when they arise in certain key economic variables, they affect countries' short- and long-run economic behaviour and development strategies. The existence and causes of cyclical behaviour have been extensively addressed by a whole tradition in cliometrics and cliodynamics.

Economists have long claimed to identify cyclical patterns in economic prices and growth. In the early days of the discipline, Juglar (1863) showed that cycles were related to business activity. They ranged from 8 to 11 years and were caused by investments maturing. This insight was later developed into business cycle theory, now a staple of economics. As regards long-run cycles, Kondratiev (1935) discussed the existence of periods of volatility in the world economy every 45 to 60 years (Korotayev and Tsirel, 2010). The identification and causes of long cycles are still the subject of debate, as will be discussed. Another type of cyclical behaviour, in the medium run this time, was discovered by Kuznets (1940), who related it to infrastructure investment. This type of cycle was discussed by Abramovitz (1961 and 1969), who empirically analysed the recurrence of periods of crisis in economic growth for a broad range of countries at similar intervals. Very short-run cycles (Kitchin cycles) are usually related to changes in inventories (Korotayev and Tsirel, 2010) and to international portfolio flows that create short-run oscillations.

In his classic book on business cycles, Schumpeter (1939) described how technological aspects tied in with the cyclical behaviour of an economy and proposed a typology for them in accordance with their periodicity. An updated version of his typology (Jadevicius and Huston, 2014) allows us to identify four types of cycles: the Kitchin cycle (3 to 5 years), the Juglar cycle (8 to 11 years), the Kuznets cycle (15 to 25 years) and the Kondratiev wave (45 to 60 years). The present study is based on this typology. It takes an expanded range for each cycle in order to have full time frame coverage in the band-pass filter calibration, which ranges from 2 to 60 years. The fluctuations of economic cycles are not only related to particular aspects of a specific economy, but are present in every economy, each with its special nature.

The reasons for the existence of cycles are a topic of great debate in economic theory, with different authors seeking to understand their causes. Those posited include (i) the build-up of inventories (Kitchin, 1923), (ii) credit behaviour, (iii) the maturing of investments (Besomi, 2014; Fukuda, 2009), (iv) infrastructure investments (Abramovitz, 1969; Kuznets, 1940), (v) technological development (Perez, 2010; Schumpeter, 1939) and (vi) international financial flows. Note should also be taken of Fischer's debt deflation theory (Palley, 2008) and of the financial instability hypothesis (Minsky, 2016).

The structuralist tradition is composed of theories that seek to explain the behaviour of cycles in developing countries, looking at both supply- and demand-side aspects of the macroeconomic system. The special feature of these theories is that they treat cycles as endogenous to the behaviour of the system, thereby differing from the traditional real business cycle framework, which treats the main sources of cycles as exogenous (Kydland and Prescott, 1990). From the real business cycle perspective, well-functioning markets result in a stable equilibrium, meaning that fluctuations are the result of real (e.g., technological) shocks leading to efficient responses from the market, not a structural characteristic of particular economic systems.

2. Structuralism and volatility: why are developing countries so volatile, and what is the international position of Latin America and the Caribbean?

The centre-periphery concept is at the core of the research conducted by the Economic Commission for Latin America and the Caribbean (ECLAC), historically linked as it is to the Latin American structuralist tradition. Latin America and the Caribbean has been seen as a region with a specific economic dynamic compared to other regions ever since the studies conducted by Prebisch (1950), Sunkel (1972), Furtado (1959) and Fajnzylber (1990), and more recently by Ocampo (2002), Botta (2010), Pérez Caldentey and Vernengo (2010) and Cimoli, Porcile and Rovira (2010). Latin America and the Caribbean is a region with a peculiar economic dynamic resulting from its peripheral position in the international division of labour. Taylor (1991) models and summarizes the effects of the centre-periphery dynamic in the establishment of a cyclical dynamic. His argument is that pronounced cycles have resulted from the idiosyncratic economic and institutional development of the region over history, a specificity that impacts the short- and long-run growth dynamic.

Prebisch (1950) developed a theory explaining the emergence of a centre-periphery (or core-periphery) dynamic in the international system. The position of each country in the system depends on the types of goods it produces (their technological intensity), which determines how the country participates in the international division of labour. The centre (the North, containing the central or core countries of the system) is the locus of technological change, producing new advanced, high-technology products with a high income elasticity of demand. On the other hand, the periphery (the South) participates in the international dynamic by producing and exporting raw materials and low-technology products. This theory marked the beginning of the Latin American structuralist tradition. Bielschowsky and Torres (2018) track all the improvements in structuralist theory over the 70 years of ECLAC economic thought.

The result has been the emergence of an uneven distribution of productive and technological capabilities that are reproduced endogenously over time, leading to institutional differences in which the periphery has a distinct economic dynamic in its long-run development as compared to the centre. In the centre-periphery framework, the underdevelopment of the production structure is seen as the main contributor to increasing fragility in developing countries (the periphery). Taking a long-run perspective, the theory posits a long-term decline in the terms of trade (the Prebisch-Singer hypothesis) that creates barriers to economic development.

Moving on to the post-Keynesian tradition, Thirlwall (1979 and 2012) developed the balance-ofpayments-constrained growth model. In this theory, countries are constrained in the long run by the income elasticity of demand for imports and exports of the products they trade. An increase in the growth rate should be compatible with external sector stability, which depends on the production structure and defines the pattern of fragility. More recently, Cimoli and Porcile (2014) linked external constraints to the technological capabilities of peripheral countries, merging the post-Keynesian, structuralist and evolutionary perspectives.

The lack of dynamism in the production structure of developing countries and the aforementioned fragility have resulted in a specific pattern of international trade specialization. Developing countries' activities are concentrated in low-technology products and highly standardized goods (commodities). This creates a disadvantage and worsens terms of trade: specialization in commodities results in higher volatility. Significant studies such as Ziesemer (2010) have evaluated terms of trade by observing commodity price trends: commodity prices in international markets are more volatile than those of high-technology manufactured goods. This volatility affects the balance-of-payments conditions of developing countries not only in the long run, as discussed by Thirlwall (2012), but also in the short run, constraining economic development. The source of high volatility in developing countries may be the increased fragility created

by a specialized and undynamic production structure (Hausmann and Gavin, 1996), itself resulting from a specific type of peripheral participation in the international division of labour.

This can be explained by certain specific mechanisms. Higher volatility in international prices generates a mismatch in the balance of payments (exports, imports and capital flows) which affects economic growth through the following channels:

- From a Keynesian perspective, it increases uncertainty, affecting economic agents' decisions in the short and long run, with investment projects that tie up large amounts of capital being perceived as less profitable. Marginal capital efficiency is reduced, as described by Keynes (1936). The result is fewer long-run projects, with smaller investments and less aggregate demand, leading to lower economic growth.
- Instability in the external account reduces the scope for importing capital goods. This is particularly serious for developing countries, where a virtuous catching-up strategy requires access to capital goods (machinery) in the technology vanguard (Stiglitz, 2000).
- Volatility in external prices affects a country's real exchange rate. Larger swings in the exchange rate increase uncertainty, which may generate greater opportunities for arbitration and speculation but does not improve the potential for development (Andrade and Prates, 2013).
- Uncertainty affects not only investment but also consumption. Real wages are very sensitive to changes in the exchange rate. In an uncertain environment, the price channel reduces consumption and aggregate demand (Gabriel, Jayme and Oreiro, 2016).
- Increased uncertainty regarding investment and the exchange rate affects agents' behaviour through higher price volatility. Agents defend themselves by increasing prices to protect their mark-up (Steindl, 1979). Thus, volatility can also be seen as an inflationary mechanism.
- Lower investment, especially in the manufacturing sector, is also linked to lower productivity. Following the classical Kaldor-Verdoorn discussion (Kaldor, 1975), debated by McCombie and Spreafico (2016), investment and growth boost not only the stock of capital but also its quality, generating economies of scale and greater learning opportunities. This, then, is another mechanism that reinforces underdevelopment through specialization in low-technology activities.

In mainstream economics, leading economists have argued that fragility is correlated with lower resilience to shocks, especially in the case of external shocks resulting from abrupt price changes (Blanchard and Gali, 2007) and also from institutional issues (Acemoglu and Robinson, 2012). Countries with less diversified exports suffer most from external price volatility. Volatility has historically been much higher for low-technology goods than for high-technology manufactured goods, and this exacerbates fragility in developing countries.

Most of the literature usually focuses on the short- and medium-term aspects of development. We would also like to focus on the long-run element, which our empirical analysis indicates may be crucial in explaining many of the oscillatory mechanisms operating in Latin America and the Caribbean.

Building on the traditional analysis used to explain cycles, we argue that another important explanation for the dynamics of volatility, especially in developing economies, lies in changes to the composition of inputs in a new emerging technology paradigm (Bollen and Appold, 1993; Bunker, 1985; Brady, Kaya and Gereffi, 2011). This relates the idea of long waves to that of natural resource dependence. An interesting piece of evidence comes from the long historical analysis of Latin America conducted by Bertola and Ocampo (2012). The authors observe the central role that international dynamics have historically had in the composition of development and the crucial part that the reorganization of (natural resource-related) economic activities has played in determining development patterns, volatility and

crises. Bulmer-Thomas (2003) associates dependence on input integration with the colonial legacy of the Latin American countries, following the same line of argument as Furtado (1959) in discussing the economic formation of Brazil. These contributions focus on the structural reasons why developing countries, especially in Latin America and the Caribbean, evince a strong and permanent pattern of boom and bust.

The import-export pattern is a central element in this discussion, whether in relation to short-run fluctuations or to long-run waves. As discussed above, a whole tradition in the literature has sought to identify the sources of both short-run and long-run volatility, but very few studies have set out to measure and explain them. The purpose of the present study is to use economic cycle theory to measure different aspects of volatility.

3. Cycle analysis methodologies and empirical evidence for economic cycles

Different methodologies have been developed in the field of time series to extract cycles from the original GDP growth time series data. There is a whole tradition in disciplines such as physics (oscillatory dynamics) in which frequencies are viewed as essential for understanding the behaviour of certain volatile phenomena. Much the same is true in economics, where we can empirically observe the existence of cyclical behaviour in many economic variables.

Mention may be made of three main methodologies used to empirically observe the existence of cycles: spectral analysis (Bossier and Huge, 1981; Korotayev and Tsirel, 2010; Van Ewijk, 1981), the filter design approach (Kriegel, Kröger and Zimek, 2009; Metz and Stier, 1992) and wavelet analysis (Gallegati and others, 2017). These methodologies focus on analysing the different frequencies that emerge from real time series.

Spectral analysis applies Fourier transforms to time series and observes their spectrum in different frequencies. Using power spectral densities, it is then possible to identify the existence of periodic oscillations in the time series. This method starts by removing the trend from the series as a requirement of stationarity. Fourier transformations use combinations of sines and cosines to represent a non-local function, so that changes affect the whole function. This restriction allows windowed transformation (bands) to be used. Wavelet analysis is analogous to spectral analysis but uses a finite domain.

It is important to mention the literature on structural breaks, which follows Pritchett (2000) and Bluhm, Crombrugghe and Szirmai (2016) in seeking to capture shifts in growth regimes. In this literature, a time series is not understood as a cyclical component around one stable trend, since the breaks change the slope of the trend over time, as seen in the trend-cycle decomposition of Perron and Wada (2016). This approach may help us understand ongoing changes in development strategies. Because of our focus on historical cyclical components and the need for a large number of observations, we have opted to study the filter decomposition with structural breaks at a later stage of the research. The large number of breaks reduces the number of observations available for observing the overall cycles, which potentially reduces the accuracy of the cyclical results. Accordingly, we have not used structural breaks in this analysis, but left it for the future to compare its results with those of an analysis using breaks.

This paper uses a filter design approach, a development of spectral analysis that involves identifying a specific band filter. There are various possible filters, as described and enumerated by Pollock (2013). One commonly employed is the low pass filter, also known as the Hodrick-Prescott filter (Hodrick and Prescott, 1997). Despite being one of the most widely used, this methodology was heavily criticized by Hamilton (2017) for its strong bias. Another important methodology is the band-pass filter, in its symmetrical (Baxter-King) and asymmetrical (Christiano-Fitzgerald) versions. The latter is used to observe long waves and growth cycles. The procedure entails filtering coefficients to isolate specific frequencies with a view to identifying the ideal filter band. We use the asymmetric

band-pass filter of Christiano and Fitzgerald (2003), which was also used by Erten and Ocampo (2013) to identify commodity cycles.

We find some empirical evidence for regular patterns of volatility (cycles) in GDP growth. There are many studies which test the existence of cycles at the global level. Korotayev and Tsirel (2010), using spectral analysis, argue that it is highly likely that Kitchin, Juglar and Kondratiev cycles exist at a global level. Kuznets cycles are the third harmonic of the Kondratiev cycle, detected as occurring every 17 years at the world level. In another important study, Diebolt and Doliger (2008) identified Kuznets swings for GDP growth.

Although these studies pointed to the existence of cyclical behaviour in economic systems, it is important to note that the findings of the literature are still open to debate, with contradictory results that are sensitive to the methodology applied. There is still disagreement about the empirical existence of short and long waves (Bosserelle, 2015). This debate is not a focus of the present study, which does not set out to question the results of the research cited, but it is worth mentioning that the existence of regular GDP growth cycles remains a controversial topic.

III. Data

This paper uses the Maddison Project Database, updated with data from the World Bank World Development Indicators. The database builds on the work of Maddison (2001 and 2003) and was most recently updated by Bolt and Van Zanden (2014), who calculated long-run historical per capita GDP data for a large number of countries and regions. The database has data from antiquity until 2010. We selected the period 1950–2010 and used per capita GDP growth rates from the World Bank Database to update the information from 2010 to 2018. The updating procedure involved removing population growth from the database in order to ascertain GDP growth (not per capita growth). The former Soviet republics and the former Yugoslavia were excluded from the database because of problems with their data.

The treated database consists of GDP growth data for 136 countries from 1951 to 2018. Christiano and Fitzgerald's (2003) band-pass filter was applied to each country's time series and the original data were decomposed into different cycles. With the cycle data extended, these cycles cover the very short run of 2 to 8 years (Kitchin cycle), the short run of 8 to 15 years (Juglar cycle), the medium run of 15 to 30 years (Kuznets cycle) and the long run of 30 to 60 years (Kondratiev cycle). The *k*-means methodology was used to cluster the results, dividing instability patterns into different groups.

GDP growth data were used in the research for two main reasons: (i) to remove the problem of non-stationarity of the time series, since stationarity is a fundamental requirement of the filtering decomposition analysis; and (ii) because GDP growth focuses only on the dynamic aspect of volatility. The aim is not to observe how the stock of wealth (GDP level) affects volatility, but how the flow (growth) is related to an oscillatory pattern.

IV. Methodology

1. The band-pass filter

Erten and Ocampo (2013) use the asymmetric band-pass filter to identify commodity price cycles. The same method is used here to filter the GDP growth time series. The asymmetric band-pass filter allows a time series to be decomposed into different frequency components, which are then used to identify the cycles in the different time series. This approach is combined with the identification of medium-run

cycles, following Comin and Gertler (2003) and Drehmann, Borio and Tsatsaronis (2012). The method adopted splits per capita GDP growth (y) into five components: (i) a long-run cycle (y^{LR}) with periodicities of 30 to 60 years (Kondratiev cycle), (ii) a medium-run component (y^{MR}) with periodicities of 15 to 30 years (Kuznets cycle), (iii) a short-run cycle (y^{SR}) with periodicities of 8 to 15 years (Juglar cycle), (iv) a very short-run cyclical component (y^{SSR}) with periodicities of less than 8 years (Kitchin cycle) and (v) a residual component e, which will be discussed later as the structural component.

$$y_t \equiv y^{LR}_t + y^{MR}_t + y^{SR}_t + y^{SSR} + e$$
(1)

The average length of a supercycle, as reported by Erten and Ocampo (2013) in their analysis, is 35.7 years, with a minimum of 24 years and just 3 (out of 18) supercycles being more than 40 years long. The Kuznets cycle is considered to have a periodicity of between 15 and 30 years. The long-run trend therefore has a periodicity of more than 30 years and up to 60 years, following the Kondratiev waves. A medium-run Juglar wave is then defined as having a periodicity of between 8 and 15 years, with the short-term Kitchin cycle having a periodicity of less than 8 years.

The idea behind this procedure is to identify different types of cycle from the original time series and apply the methodology to all the countries for which data are available. We then group countries with similar cyclical characteristics (e.g., larger oscillations in short-run cycles) into clusters. Lastly, we study the characteristics of each group. The asymmetric band-pass filter is helpful here, as it serves to identify bands for the periods in which we would like to extract the cycles. With the categories determined, we can then ascertain whether the Latin American and Caribbean countries evince any similarities, and what explains these.

We initially use the band-pass filter to extract the high-frequency Kitchin cycle from the original time series (see table 1). Then we adjust the band to extract the Juglar cycle from the residuals of the Kitchin cycle. From the residuals of the Juglar cycle, we extract the Kuznets cycle. The same procedure is used to extract the Kondratiev cycle from the residuals of the Kuznets cycle. The resulting data form a residual, which is linked to long-run economic growth. The sum of the five components yields the original time series. Cluster analysis can be used to group the different patterns of cyclicality extracted for different countries.

		, <u>1</u>	1
Cycle name	Main origin	Period <i>(Years)</i>	Possible cause as per the theory
Kitchin	Market/financial flows	0—8	Inventories (consumption)/portfolio decisions
Juglar	Business investment cycle	8–15	Medium-run investments
Kuznets	Structural investment cycle	15–30	Long-run investments (infrastructure)
Kondratiev	Technological cycle	30–60	Technological paradigm shift
Residual	Trend	-	Structural element, human capital

Table 1Cycles in economic theory and their respective time periods

Source: Prepared by the author.

2. Cluster analysis

Cluster analysis consists of organizing elements into similar groups by selected attributes. There is no standard way of clustering, but many different methodologies are used to group elements with similar aspects. In this paper, the *k*-means methodology, a method of vector quantization that groups observations in clusters by partitioning the data space into regions, is used to divide the selected countries into separate groups on the basis of their cycle standard deviations.

The *k*-means method minimizes distance in a graph in order to group elements with similar (selected) characteristics. We have to determine the number of groups (clusters) we wish to find. The method determines which observations are similar by the distance between them. The *k*-means method can use many variables. For example, we might choose eight relevant characteristics to group people with similar interests from a selected population.

Technically, k-means is a randomized method that divides data into k distinct clusters. The n objects are grouped into clusters by the nearest mean. The optimal number of clusters is not known and must be exogenously determined (however, there are tests available to help with this). The objective of this methodology is to minimize intracluster variance (the squared error function). This is done by identifying an objective function j that is used to calculate a distance function which must be then minimized. The objective function can be written as:

$$j = \sum_{j=1}^{\kappa} \sum_{i=1}^{n} \| x_i^{(j)} - c_j \|^2$$
(2)

where x_i represents case *i* and c_j the centroid for cluster *j*. The method first computes *k* exogenously given clusters. Then it randomly selects cluster centres and assigns observations to them, following the distance function, and calculates the mean of each object. This method is repeated until the distances are minimized, yielding clusters in which similar countries are divided from those that are dissimilar in respect of the selected variables.

V. Analysis by cycle type

In order to illustrate the methodology and the results obtained, we present the filtering method as applied to some selected Latin American and Caribbean country data below. Figure 1 shows the four types of cycle filtered from the original GDP growth time series for the selected countries. Each cycle has a detailed aspect and can be used to identify historical turning points in these countries' economies. This extraction procedure reveals the different degrees of stable volatility. An interesting aspect is the residual non-cyclical component. This reveals long-run features that could be related to the countries' economic structures.





Figure 1 Latin America and the Caribbean (selected countries): volatility, cycles and residual (Percentages)



Source: Prepared by the author, on the basis of Maddison Project Database.

Figure 1 shows the decomposition of growth time series into cycles and trend for Argentina, Brazil, Chile and Mexico. The scales are different in each graph because of the differences in the volatility patterns of each country. The short-run Kitchin cycles, in red, have the highest frequency and variance. This cycle is characterized by high amplitude and small duration. The presence of major economic crises can easily be seen in the strongly marked Kitchin cycle. This is the case with many Latin American countries in the 1980s, an example being the Mexican peso crisis of 1982.

Following the literature, each cycle can be linked to a major element. The short-run Juglar cycle follows the investment cycle in each economy, while the Kuznets cycle is associated with longer infrastructure-related investment cycles. The Kondratiev cycle is best approached by the theory of technological change (Perez, 2010). We can also observe the presence of a residual component which follows not a cyclical pattern, but a trend. This residual can be used to explain changes in the production structure, such as the decline in the share of the industrial sector as part of a specialization pattern that began in Latin America and the Caribbean in the late 1970s, which is a topic for a future study.

VI. Results of the cluster analysis as applied to cycles

The cluster analysis was applied to the different cycle components of the time series, with countries being grouped by their volatility patterns. The clustering algorithm was run 1,000 times because of the randomized aspect of the *k*-mean, yielding Monte Carlo frequencies that served to identify the groups. The cluster analysis took the short-, medium- and long-run cycles as inputs. The decision to isolate very short-run cycles was taken on the basis that cycles of this type captured all the noise from aspects (mostly political) not directly related to the economy. Cluster optimization criteria were employed to select the number of clusters, yielding nine groups.

Group 1 represents the least volatile countries, which include the majority of developed countries. This group is marked by low variance and a relatively large trend component (see figure 2), with overall volatility being explained mainly by long-run cycles, while very short- and short-run volatility play less of a role. Group 2 has similar characteristics to group 1, but greater variance and a larger role for very short- and short-run volatility. It still includes some developed countries, with certain emerging economies in Africa that show a similar volatility pattern making up the rest of the mix.



Figure 2 Variance of each cycle as a share of total variance (average per cluster group)

Source: Prepared by the author, on the basis of the Maddison Project Database.

As table 2 shows, overall variance is practically the same in groups 3 to 6. The differences lie in the relative contribution of each cycle to volatility. In group 3, the Kondratiev cycle is more important, while the trend, short-run and very short-run cycles explain a lower than average share of volatility. In group 4, both the Juglar and the Kondratiev cycles play more of a role, while group 5 shows a pattern in which the trend, medium-run and very short-run cycles are more prominent. In group 6, lastly, the Kitchin and Juglar cycles are very important (short-run oscillations explain a larger share of overall volatility).

Average variance in gross domestic product growth, by cluster group								
Group 1	7.90	Group 4	28.76	Group 7	33.09			
Group 2	15.93	Group 5	22.17	Group 8	69.97			
Group 3	21.84	Group 6	26.65	Group 9	181.13			

Table 2 Average variance in gross domestic product growth, by cluster group

Source: Prepared by the author, on the basis of the Maddison Project Database.

Group 7 has slightly higher average variance than the first six groups and is characterized by a larger role for the medium-run cycles. In groups 8 and 9, lastly, overall volatility has much greater variance, with the very short-run cycles playing a much larger role and the long-run cycle and long-run trend much smaller ones.

Table 3 compares the different groups by their cycle characteristics. Each group's shares are compared with the averages, showing which cycle is the most important in explaining the differences between the clusters. Each group evinces different behaviour that poses some questions. Why is a particular country more affected by the long-run cycle? What determines this? Is it related to the structural conditions of economies? Is it a matter of fragility?

	Kitchin (very short run)	Juglar (short run)	Kuznets (medium run)	Kondratiev (long run)	Trend		
Group 1			-	+	++		
Group 2	-	+	-	-	+		
Group 3	-	-	0	++	-	-	-1SD < X <
Group 4		++	-	++	-		<i>X</i> < -1SD
Group 5	+	-	+		+	+	0 < <i>X</i> < 1
Group 6	+	++	-		-	++	X > 1SD
Group 7	-	-	++	-	-		
Group 8	++	0	+	-	-		
Group 9	++	-	-	+	-		

 Table 3

 Summary of the relative contributions of each cycle, by cluster group

Source: Prepared by the author, on the basis of the Maddison Project Database.

Note: X represents the difference in the volatility of each cycle component relative to the average, by group, using the same data as in figure 2. ++ = greater by more than 1 standard deviation; + = greater by up to 1 standard deviation; -- = smaller by more than 1 standard deviation; (-) = smaller by up to 1 standard deviation.

Table 4 shows which countries are grouped in each of the clusters identified by the *k*-means methodology. Some regional features can be observed in this table. All developed countries are in groups 1 and 2. These first two groups also contain many low- and middle-income countries in Africa and Asia such as Bahrain, Bangladesh, Benin, Burkina Faso, India and Lao People's Democratic Republic. Most central Asian countries are in groups 8 and 9. Latin American and Caribbean countries fall between groups 2 and 7, with most in group 3.

What is measured is growth volatility, so a catch-up process immediately after the Second World War followed by a long period of stagnation, as in Japan, is measured in a specific way (heteroskedasticity). On the other hand, countries in a state of profound stagnation are not volatile, and this is the case with some of the developing countries in groups 1 and 2.

In Table 4, Latin American and Caribbean countries are highlighted in grey. It can be seen that half are in group 3 (11 countries out of 23), although the continent is represented in every group except the two most volatile (8 and 9). Puerto Rico follows a pattern similar to that of the developed countries. Colombia, Honduras and Mexico also have a volatility pattern close to that of group 2 developed countries. Chile and Uruguay differ from most Latin American and Caribbean countries, not in overall volatility, but in the very large role played in this by the very short- and short-run cycles. Cuba, Nicaragua and Peru are in group 4, Ecuador is in group 5 and the Bolivarian Republic of Venezuela and Trinidad and Tobago are in a more volatile group (7). In general, however, the Latin American and Caribbean countries fall into two main groups, those where the short-run (Juglar) cycle is more dominant (groups 2, 4 and 6) and the majority where the long-run (Kondratiev) cycle is more dominant (groups 3 and 4). These two groups will be termed Juglar-dominated and Kondratiev-dominated, respectively.

We expect countries in group 1, the least volatile group, to be most advantageously placed, followed by those in group 2. Groups 8 and 9 contain the countries that suffer most from volatility. From groups 3 to 7, however, no value judgement can be made about which countries are best placed. These groups simply identify countries whose situations differ in many respects, such as their integration into the international economy, institutions and economic structures, among other possible explanations.

	Group 1	Group 2	Gro	oup 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
Australia	Lao People's Democratic Republic	Burkina Faso	Algeria	Mongolia	Afghanistan	Burundi	Central African Republic	Cameroon	Cambodia	Angola
Austria	Morocco	Colombia	Argentina	Myanmar	Albania	Ecuador	Chile	Comoros	Chad	Equatorial Guinea
Belgium	Nepal	Finland	Bolivia (Plurinational State of)	Namibia	Cuba	Egypt	China	Cyprus	Democratic People's Republic of Korea	Iraq
Benin	Netherlands	Guinea-Bissau	Brazil	Panama	Djibouti	Hong Kong (China)	Democratic Republic of the Congo	Jordan	Gabon	Kuwait
Bangladesh	Norway	Honduras	Botswana	Paraguay	Eswatini	India	Lesotho	Republic of the Congo	Iran	Libya
Bahrain	Pakistan	Ireland	Bulgaria	Philippines	Ethiopia	Liberia	Mauritius	Sudan	Lebanon	Oman
Canada	Puerto Rico	Japan	Costa Rica	Sao Tome and Principe	Mozambique	Malawi	Niger	Trinidad and Tobago	Nigeria	Qatar
Germany	Senegal	Kenya	Côte d'Ivoire	Slovenia	Nicaragua	Malaysia	Seychelles	Venezuela (Bolivarian Republic of)	Rwanda	
Denmark	South Africa	Madagascar	Dominican Republic	Uganda	Peru	Republic of Korea	Thailand	Yemen	Sierra Leone	
France	Sri Lanka	Mali	Gambia	United Republic of Tanzania	Poland	Singapore	Uruguay		Somalia	
Guinea	Sweden	Mexico	Ghana	Zambia	Romania	Türkiye	Zimbabwe	Syrian Arab Republic		
Indonesia	United Kingdom	New Zealand	Greece		Saudi Arabia				United Arab Emirates	
Italy	United States	Portugal	Guatemala		Togo					
		Spain	Haiti							
		Switzerland	Hungary							
		Taiwan Province of China	Israel							
		Tunisia	Jamaica							
		Viet Nam	Mauritania							

 Table 4

 Cluster analysis applied to the standard deviations of the Juglar, Kuznets and Kondratiev cycles

Source: Prepared by the author, on the basis of the Maddison Project Database. **Note:** Latin American and Caribbean countries are highlighted. Results for the behaviour of economic cycles in Latin America and the Caribbean include the following (see table 5):

- Half the Latin American and Caribbean countries are in group 3, which is characterized by a middling standard deviation (neither small nor large compared to the world average). In group 3 (and 4), the long-run (Kondratiev) cycle is relatively dominant despite the long-run trend being relatively unimportant.
- Latin American and Caribbean countries are not altogether homogeneous as a group in their volatility patterns. This poses a challenge when it comes to generalizing results to the whole continent. Thus, anyone seeking a general theory for the causes of overall volatility in the Latin American and Caribbean countries must take these specificities into account and discuss the reasons for them. It is worth highlighting again that most Latin American and Caribbean countries are in one group (3).
- On one hand, the volatility pattern in the Latin American and Caribbean countries differs clearly from that observed in developed countries. On the other, it resembles that in some other developing regions, especially central Asia and parts of sub-Saharan Africa.
- Considering only the large countries in the region, Colombia and Mexico have a different pattern from Argentina and Brazil, while Chile is different again.

Juglar-dominated	Kondratiev-de	ominated	Juglar- and Kondratiev-dominated	Other
Chile	Argentina	Haiti	Cuba	Ecuador
Colombia	Bolivia (Plurinational State of)	Jamaica	Nicaragua	Puerto Rico
Honduras	Brazil	Panama	Peru	Trinidad and Tobago
Mexico	Costa Rica	Paraguay		Venezuela (Bolivarian Republic of)
Uruguay	Dominican Republic			
	Guatemala			

Table 5							
Countries of Latin America	and the Caribbean: cycle dominance						

Source: Prepared by the author, on the basis of the Maddison Project Database.

It is important to discuss the meaning of Kondratiev dominance. What does it mean when the long-run cycle contributes so much to growth volatility compared to the others?

Before the relationship between volatility and development is investigated, which is the goal of the research agenda this paper is associated with, it is useful to observe the aspects producing similar patterns at the world level. This can be done for groups of countries with many different volatility patterns. The cluster analysis yields the following results (see map 1 and map 2):

- Developed countries are the least volatile, as all of them are in groups 1 and 2. Oil-rich countries are the most volatile, being situated in groups 8 and 9.
- In addition to the more developed countries, there are many low- and middle-income countries in groups 1 and 2. This needs to be investigated further, as their low volatility may not be related to their structural conditions.
- Developing countries with similar overall volatility are found to have very different patterns when the sources of this volatility are examined. For some countries, volatility comes from shorter-run cycles, while for others it comes from longer-run cycles and the trend.



Map 1 Latin America and the Caribbean: volatility levels by cluster group

Source: Prepared by the author, on the basis of the Maddison Project Database. Note: 1 indicates the lowest level of volatility and 9 the highest.



Map 2 World: volatility levels by cluster

Source: Prepared by the author, on the basis of the Maddison Project Database. **Note:** 1 indicates the lowest level of volatility and 9 the highest.

1. Kondratiev dominance: the importance of the long-run cycle

The evidence in this research shows that most Latin American and Caribbean countries are in a situation where the Kondratiev long-run cycle is more dominant than in the other groups identified in the previous section. As already mentioned, Kondratiev long-run growth may be associated with technological changes in international trade patterns (Perez, 2010).

Latin America and the Caribbean depends heavily on commodity exports. A possible explanation for the dominance of the long-run cycle is that changes in the technological paradigm result in long-run volatility in commodity prices. This may be caused by a reduction in dependence on the inputs used in the previous industrial paradigm, with effects on the exchange rate. The emergence of a new paradigm requires new inputs, leading Latin American and Caribbean economies to adjust to the cycle and change the products they specialize in if they can. In Brazil, for example, there have historically been different commodity cycles: the rubber cycle, the sugar cane cycle, the gold cycle and the oil cycle. Each cycle was directly related to the industrial paradigm of the period.

The input volatility explanation has resonated strongly with the idea of dependence and world systems (Brady, Kaya and Gereffi, 2011). Schwartzman (1995) and Bollen and Appold (1993) pioneered the idea that trade dependence hurt diversification. This can be related to the concept of the natural resource curse (Collier, 2007), also mentioned by the new developmentalist school (Bresser-Pereira, 2008 and 2013). As Brady, Kaya and Gereffi (2011) suggest: "In an argument anticipated by Bunker (1985), the dependence on raw material exports fails to produce economic linkages into manufacturing, leads to cycles that hinder diversification, forcing government subsidization of distant outposts of extraction disconnected from urban populations and economic centres" (p. 188).

The pattern of increasing specialization worsens structural fragility, as it creates a strong dependency, in terms of external sector dynamics, on the price of a few commodities. When the demand for those commodities declines for some reason, such as a reduction in world demand caused by changes in production patterns, there is a large decline in their price, with a direct impact on the domestic economy of the exporting country. This is amplified even further by financial dynamics reacting procyclically to the economic crisis (De Paula, Fritz and Prates, 2020). This problem of external constraints has received a great deal of attention as regards short- and medium-run dynamics. However, we want to argue that there is also a long-run dynamic associated with this behaviour (Marañon and Kumral, 2019), as waves of industrial and technological development at the world level change input requirements, with a very strong historical effect on developing economies. This provides another factor in the explanation of long-run dynamics, one that is empirically and historically discussed by Bertola and Ocampo (2012).

Most developing countries, those of Latin America and the Caribbean included, are highly dependent on commodity production and exports. The region, though, seems to be integrated into the world economy in a special way. If we observe cycle synchronization (from the data used in this research), we see that Latin America and the Caribbean is actually closely coordinated with the international pattern. This coordination is not as strong in Africa and Asia. The economic space of Latin America and the Caribbean seems to be strongly linked to that of the developed countries, especially with regard to long-run changes. Short-run volatility is not as great as expected, but there is an element of dependency that generates high volatility in the long run.

Peripheral (but strong) integration is the key to the specificity of Latin America and the Caribbean, which has a low capacity for absorbing and generating technology and a structure that favours specialization in low-technology sectors. Lastly, economic history (Ffrench-Davis and Griffith-Jones, 1995) suggests that the debt crisis of the 1980s, changes in the openness of the capital account in the 1990s and the rise of China in the 2000s (Stiglitz and others, 2006) had a very strong impact on the volatility of growth

and exports in Latin America and the Caribbean that almost immediately affected short-run volatility and the medium-run pattern. For the long run, longer-term data are still needed to see the impacts of these changes on Kondratiev waves. However, we can argue that changes with the new industrial paradigm (Industry 4.0 and the green revolution) and the reallocation of production to new areas constitute a tipping point that will lead to the emergence of a new production system, with new input requirements. Erten and Ocampo (2013) identified these changes by analysing the long-run commodity cycle with an empirical strategy much like the one applied in this paper, finding that commodity prices were close to a tipping point in their long-run dynamics. Some major commodity prices have declined since 2014 (before the COVID pandemic), perhaps indicating the ebbing of the last wave and the beginning of a new one, with major implications for Latin America and the Caribbean.

2. Juglar dominance: the importance of the short-run cycle

We argue, on the basis of Korotayev and Tsirel (2010), that the Juglar cycle is related in the literature to investment cycles. High volatility in this cycle is associated with the fact that investment is carried out in blocks, tying up a great deal of capital. The uncertainty intrinsic to economic systems is greater in developing countries and results in investments being carried out during periods when economic conditions are positive, commonly the upturn of commodity cycles. These cycles start to mature, and economic conditions in the system change. There is a period of falling investment that coincides with a worsening of the economic environment, which increases uncertainty and raises the (opportunity) cost of new investments. This drop in investment leads to a downswing in the cycle.

This cyclical component is then associated with commodity cycles in developing countries. The dependence of the production structure on imports and exports of a few low-technology commodities is a major source of uncertainty. The balance-of-payments-constrained model (Thirlwall, 2012) states that investment in these economies tends to be endogenous to the situation in the external sector, which is also related to structural economic conditions (Cimoli, Porcile and Rovira, 2010). The destabilizing effects of export and import prices, together with the price and income elasticity of traded goods imports and exports, result in the oscillation captured by the Juglar cycle.

This is seen in countries such as Chile, Colombia and Mexico, where mining activities have traditionally been the main economic activity in respect of exports. Investments are responsive to changes in the prices of the mining products these countries export, being made when prices are sustained at a high level for a certain period of time (Bertola and Ocampo, 2012).

VII. Conclusions

Macroeconomic volatility is a thermometer that measures resilience when countries experience economic, political and institutional shocks. This paper set out to empirically study volatility at the country level. Its specificity lies in its effort to identify different types of regularities in GDP growth time series. Filter analysis was used to extract these regularities from the original series and identify different components (cycles). A cluster analysis applied to the cycle components allowed countries with similar volatility patterns to be identified.

The above procedure made it possible to constitute country groups that provided a basis for answering the question posed at the outset of this study: do the Latin American and Caribbean economies differ in their volatility patterns from developed countries and other developing regions? The answer to this question is not simple and needs to take account of the following. Latin America and the Caribbean is generally characterized by a middling GDP growth standard deviation (relative to the entirety of the 136 countries examined in the analysis). The long-run cycle plays a particularly important role in half its countries, even though the long-run trend (and the short-run cycle) are relatively unimportant. Latin American and Caribbean countries are not homogeneous in their volatility patterns, although they do have a common characteristic, namely the relative importance of the short-run Juglar cycle. Their differences make it difficult to generalize results to the whole continent. Thus, any general theory for the causes of overall volatility in the Latin American and Caribbean countries must take these specificities into account and consider the reasons for them.

Latin America and the Caribbean depends heavily on commodity exports. Changes in the technological paradigm result in long-run volatility in commodity prices. This may be caused by a reduction in dependence on the inputs used in the previous industrial paradigm, which affects the exchange rate (Guzman, Ocampo and Stiglitz, 2017). The emergence of a new paradigm requires new inputs, which would lead Latin American and Caribbean economies to adjust to the cycle and change the products they specialize in if they can, generating large, long-run Kondratiev cycle oscillations.

High volatility in the Juglar short-run type of cycle is related to the fact that investment is carried out in blocks. The uncertainty intrinsic to economic systems is greater in developing countries and results in investments being carried out during periods when economic conditions are positive, commonly during commodity cycle upturns. These cycles start to mature, and economic conditions in the system change. There is a period in which no new investments are made, coinciding with a worsening of the economic environment that increases uncertainty and raises the costs of new investment.

On one hand, volatility patterns in Latin America and the Caribbean clearly differ from the pattern observed in developed countries. On the other, the region's pattern is similar to that of many other developing regions, especially central Asia and parts of sub-Saharan Africa. We see some evidence that Latin America and the Caribbean behaves differently from developed countries, but no evidence to further differentiate it from other developing regions.

In summary, the evidence from the Maddison data shows that countries in Latin America and the Caribbean are more volatile on average than developed countries. However, countries in the region cannot necessarily be said to be more volatile than other developing countries. This is a common misconception in the structuralist literature, mainly because it tends to compare Latin America and the Caribbean with developed countries and not with other developing regions, which leads to sometimes misleading strong statements of this kind. At the same time, Latin America and the Caribbean is a continent with a common idiosyncratic cyclical pattern of its own that the filtering methodology brings to light, at least where most of its countries are concerned.

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The role of services in economic development and the core-periphery relationship¹

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Abstract

The literature on productive structure and economic growth shows the relevance of industry in expanding gross domestic product (GDP) in developed and developing countries. Recent studies suggest that the modern services sector (professional services) contributes to innovation, increased productivity, and, consequently, economic growth. This paper presents a theoretical discussion on the importance of the modern services sector for Latin America in order to update the central thesis of the Latin American structuralist approach. The data suggest that even in the context of a productive transformation characterized by a fall in the share of manufacturing and the rise of the services sector, international division of labour is perpetuated, based on the centre-periphery relationship. The results show that structuralist thinking is adequate to explain the persistent underdevelopment of Latin American countries from a perspective focused on the service economy.

Keywords

Economic development, service industries, deindustrialization, industrial development, structural adjustment, economic dependence, economic indicators, Latin America

JEL classification

01, 02

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I. Introduction

This paper analyses a theoretical discussion on the importance of the modern services sector for Latin America and proposes to update the central thesis of the Latin American structuralist approach. The world today is characterized on the one hand by developed countries that produce sophisticated services, which are technology-intensive and highly integrated with other sectors of the economy, and on the other hand by a group of (underdeveloped) countries that produce low-technology services, which are not very competitive internationally and are aimed at the domestic market. This represents a new stage of structural change that reinforces the centre-periphery dichotomy.

The paper innovates by reviving and revisiting the debate on economic growth in Latin American countries at the Economic Commission for Latin America and the Caribbean (ECLAC), placing the modern services sector at its centre.

The literature on economic growth shows the relevance of industry in the expansion of GDP in developed and developing countries. The manufacturing industry is the engine of this process owing to increasing returns to scale, which generate rises in productivity and, as a consequence, the growth of per capita income. In the case of developing countries, industrial expansion promotes a series of structural changes, with a production structure characterized by specialization and sectoral heterogeneity (Furtado, 1961; Kaldor, 1966; Thirlwall, 2002).

Recent studies suggest, however, that increasing the share of the modern services sector contributes to innovation and increased productivity, with positive effects on economic growth (Miles, 2008; Muller and Zenker, 2001; Pilat and Wölfl, 2004). These studies explore the possibility of interaction between the services sector and industry. Indeed, technological spillovers, generated by the modern services sector and connected with the high-tech industry, boost productivity and growth in the manufacturing industry.

The discussion on the role of the service sector arises amidst a relative loss, in developed countries, in the industrial sector share of total GDP beginning in the 1970s. For this group of countries, singularity was considered natural and typical of those that reached industrial maturity (Rowthorn and Ramaswamy, 1999; Palma, 2005, 2008 and 2019).

In Latin America, an identical experience has been observed since the mid-1980s. However, this process is precocious, as the share of manufacturing as a percentage of GDP began to recede before these countries reached the per capita income level of developed countries or were capable of creating an "endogenous nucleus of technical progress", a concept proposed by Fajnzylber (1983).²

For developed countries, this relative loss of industry share in GDP has resulted in the rise of a modern services sector whose activities are integrated into the industrial sector, and which is intensive in skilled labour and focused on the foreign market. In this set of activities, there is a continuous process of technological innovation and productivity improvement.

In underdeveloped countries, on the other hand, deindustrialization has happened concomitantly with the expansion of the not-very-competitive traditional and modern services sector. Service activities are not very knowledge-intensive and their contribution to the productivity of industry and to the economy as a whole is limited or nil.

To fulfil its objective, this article is structured into three sections, in addition to the introduction and the conclusions. Section II presents a synthesis of structuralist thinking and section III discusses the phenomenon of deindustrialization and the emergence of the service sector. Finally, section IV presents an analysis of the dynamics of modern services in the centre-periphery relationship.

The role of services in economic development and the core-periphery relationship

² An "endogenous core of technical progress" can be understood as the result of the establishment of a strategy that coordinates the resource and knowledge potential of each country, in certain sectors, to promote a new pattern of industrialization. For more details, see Fajnzylber (1983, pps. 374 and 375).

II. Latin American structuralism

In the mid-1950s in Latin America, mainly through ECLAC, authors such as Raúl Presbich, Celso Furtado, Anibal Pinto and Osvaldo Sunkel conducted studies to understand the economic problems of Latin American countries.³ A common point in these reviews was criticism of the neoclassical theory of international trade, based on comparative advantages, which holds that the outcome of technical progress is shared among countries.

As argued by the aforementioned authors, the reality showed a different picture, with a clear advantage for industrialized countries (the centre) compared to countries that exported primary goods (the periphery). According to the concept of deterioration of terms of trade, part of the technical progress of the second group of countries was transferred to the first. In the words of Prebisch and Cabañas (1949), "while the centers fully preserved the outcome of the technical progress of their industry, the peripheral countries transferred to them a part of the outcome of their own technical progress". Heterogeneity between productive structures is one of the explanations for this asymmetry in relation to gains resulting from international trade, as well as in relation to the level of development of these two groups of countries.

According to structuralists, that structure was more homogeneous and diversified in developed countries, while in peripheral countries it tended to be heterogeneous and specialized, in general, with a modern sector that exported one or a few natural commodities (Prebisch and Cabañas, 1949; Pinto, 1965 and 1970; Cimoli and Porcile, 2013).

Prebisch and Cabañas (1949) identified the biggest problem in the periphery as heterogeneity in the levels of sectoral productivity. Production specialization tended to generate recurring pressures on the balance of payments. The solution lay in the development of industry as a way to capture the outcome of technical progress and improve the population's standard of living (Prebisch and Cabañas, 1949; Furtado, 1961; Rodríguez and others, 1995; Rodríguez, 2009).

For Furtado (1961), the key factor for the development of capitalism was technological progress, which occurs through the incorporation and dissemination of new techniques, the result of which is to increase production and productivity. In developed countries, higher real wages led the economic system to develop technological innovations aimed at replacing labour with capital. Thus, the "technical progress of the developed economies has resulted in a gradual increase in the amount of capital per unit of labor and in a relative homogenization of capital density in the various productive activities" (Rodríguez, 2009).

However, there were structural problems in the industrialization process in Latin American countries. Among them were the following: (i) a low capital-to-worker ratio, the cause of low labour productivity; (ii) the absence of a sector producing capital goods; and (iii) little diversified (specialized) production, which, instead, focused on goods with low technological content (Furtado, 1961).

Thus, opportunities for autonomous industrialization in the periphery are limited. Domestic production is concentrated almost exclusively on the production of consumer goods and/or simpler products. Industrial producers tend to absorb only technological innovations that provide the best productive capacity domestically (Furtado, 1969).

The result is that peripheral economies have developed activities with a reduced level of technical progress, which limits the development of higher degrees of intersectoral complementarity and the vertical integration of production. The "initial specialization and the pattern of industrialization generated on this basis bring with it a slower pace of technical progress in the periphery" (Rodríguez, 2009).

³ For a general and systematic approach to Latin American structuralism, see Bielschowsky (1998), Rodríguez (2006 and 2009) and Torres (2019), among others.

For Furtado (1961), industry in the periphery tends to reproduce the external productive pattern, while developed countries internalize and disseminate new technologies, develop the capital goods industrial sector and spread technology to all economic sectors. The periphery remains dependent on imported technology, as it is unable to generate an endogenous technological development process.

On the one hand, a productive arrangement on the periphery leads to the adoption of imported technology that is not suited to the structural standards of society. On the other, it generates a low-growth dynamic in which it is impossible to minimize external account imbalances (Furtado, 1961). The pressures on the balance of payments become recurrent, given that the modernization of domestic industry occurs through the adoption and updating of standards and techniques systematically acquired from developed countries (Furtado, 1961; Albuquerque, 2007).

An attempt by peripheral countries to break with this cycle of dependency and low growth gave rise to the so-called "import substitution industrialization (ISI)" model, or, according to the definition of Bértola and Ocampo (2012), the model of "state-driven industrialization".⁴ The essential part of this strategy was the diagnosis of the need to reduce external dependence through the domestic production of manufactured products. The State was given a fundamental role in this process.

The actions and programmes undertaken in Latin America throughout this period and as part of this diagnosis are well known. Although with some lack of consensus, the results are also well known. According to some authors, the result of this development strategy can be considered as late and backwards in relation to Europe, reflecting a series of cyclical determinants and the dynamics of capital accumulation (Tavares, 1972).

However, even after a long effort to bolster industrialization, the centre-periphery relationship has not been overcome. Technological dependence and productive heterogeneity remain a characteristic of peripheral economies. Furthermore, in addition to these bottlenecks, short-term macroeconomic problems linked to fiscal balance and inflationary stabilization have been added. The next phase of the ECLAC school sought to address some of these problems in its analysis.

1. Neostructuralism

By the end of the 1970s, the legacy of the Latin American ISI model and the success of Asian industrialization based on a strategy of import substitution with export-led growth had contributed to the decline of the traditional ECLAC model. Policies based on the Washington Consensus occupied the economic agenda during the 1990s. However, the adoption of neoliberal recommendations resulted in a series of social and political problems, which enabled a theoretical reorganization based on neo-structuralism.⁵

The neostructuralist approach has advanced in relation to the old ISI model (ECLAC, 1990). Despite rescuing elements of the old structuralism, this new phase of Latin American structuralist thinking incorporates new strategies for conducting economic policy, proposing an economic model based on the idea of systemic competitiveness.

This economic model is sustained by State-managed competition, the construction of productive structures, the defence of fiscal balance, and macroeconomic stability and trade liberalization (Ffrench-Davis, 1988; ECLAC, 1990 and 1998; Ramos and Sunkel, 1993; Gwynne and Kay, 2000). The new formula stems from the finding that Latin American countries have bottlenecks associated with macroeconomic imbalances, obsolete industrial plants and technological backwardness (ECLAC, 1990 and 1998; Rodríguez, 2009; Missio and Jayme, 2012).

⁴ Bértola and Ocampo (2012, p. 151) argue that state-driven industrialization is a more precise concept because it highlights two defining characteristics: the growing focus on industrialization as a pillar of development and the significant expansion of the State's spheres of action in economic and social life.

⁵ For a systematic approach, see Bielschowsky (2010) and Ffrench-Davis and Torres (2021), among others.

According to Missio and Jayme (2012), under that approach, the State and the market are considered partners and the objective is to create the conditions for productive competitiveness and equity. In the 1980s, after the crisis at the beginning of the decade, the State had prioritized servicing the external debt, but the new proposal prioritized stimulating the development of the capacities required to incorporate technical progress and to minimize inequalities (ECLAC, 1990, 1998 and 2018).

To meet the proposed objectives, macroeconomic balance, supported by fiscal balance and countercyclical policies, is a *sine qua non* condition for development (Ffrench-Davis, 1988; Missio and Jayme, 2012). Fiscal consolidation must be compatible with the ability to deal with economic fluctuations of internal or external origin (ECLAC, 1998 and 2018).

According to Titelman and Pérez Caldentey (2015), cyclical trends in Latin America and the Caribbean are asymmetrical in duration and breadth. In this sense, to minimize the sharp fall in investment and negative effects on the pace of productivity and therefore on the long-term growth rate, macroeconomic policies need to strengthen countries' capacity to mitigate the effects of recessions on the productive structure.

In other words, fiscal balance and macroeconomic stability are essential for the State to be able to make the necessary investments in infrastructure, health and education and to control inflation, although the fundamental countercyclical function of fiscal and monetary policies cannot be neglected (Missio, Jayme and Oreiro, 2015). Thus, it becomes possible, in the long run, to reduce social inequality and to encourage the productive transformation necessary for economic development (ECLAC, 1990).

Finally, integration with international markets is another key element in this approach. Greater economic openness would enable access to the new technology trends incorporated in goods and services and would expand access to foreign investment (Missio and Jayme, 2012). As Rodríguez (2009) argues, neostructuralism recognizes the existence of a technological revolution in full swing, which itself is accompanied by an intense process of globalization. For neostructuralists, any long-term development strategy must consider both productive coordination policies and technological progress.

Specifically, from the standpoint of the generation and dissemination of technology, Fajnzylber (1983 and 1990) argues that the bottleneck for technical progress and productivity stems from the absence of an "endogenous core of technological dynamism", without which it is impossible to overcome underdevelopment. Policies to encourage the capital goods sector should be promoted, since that sector is capable of endogenizing and disseminating technological progress to other sectors.

However, despite the more precise diagnosis of the productive transformations necessary for development, the feasibility of the neo-structuralist agenda can be questioned in the light of two factors: (i) the deindustrialization movement underway in both developed and developing countries; and (ii) the emergence of new dynamic sectors. In relation to the last point, the emergence of the service sector is worth mentioning.

A series of productive changes is currently under way in the composition of employment and in intersectoral relationships. These transformations are broader and faster-paced than in past decades. Structuralist thinking did not sufficiently incorporate this new context into its discussions. As we will show below, these new themes have been widely discussed in the literature. Furthermore, we argue that an understanding of these new processes that induce structural change is vital for understanding the new paths that are opening up for development. That understanding is also essential for making sense of the new stage of the centre-periphery relationship that is outlined.

III. Industrial regression, deindustrialization and the service sector

Beginning in the 1970s, developed countries started to suffer a systematic decline of industry as a share of GDP. Rowthorn and Ramaswany (1999) note that deindustrialization is a phenomenon marked by a continued reduction in the share of industrial employment in the total employment of a given country. Palma (2005, 2008 and 2019) argues that deindustrialization is marked by the fall, in relative terms, of industrial employment, and subsequently in absolute terms, while the service sector becomes the main source of labour absorption.

For Tregenna (2008), this can be understood as a process in which not only industrial employment but also the value added of industry is reduced, in relation to total employment and GDP, respectively. In this sense, an economy becomes deindustrialized when the industrial sector loses importance as a source of employment and/or value added, so that the expansion of industrial production does not explain the lack of deindustrialization (Oreiro and Feijó, 2010).

The loss of the role of industry in GDP also occurred in Latin American countries in the mid-1980s. The scenario was completely different, marked by extremely low global growth rates, external and fiscal crises and a deterioration in the State's ability to intervene (Ocampo, 2008; Oreiro and Feijó, 2010). According to Salama (2012), among the countries most affected were Brazil, Argentina and Mexico, although the latter has adopted a "maquila" strategy to mitigate the deleterious effects of deindustrialization.

Flagging economic growth since the mid-1980s comes in addition to the poor performance of the service sector. The pattern of specialization in the list of service exports is very different between developed countries and Latin America (Kon, 2006; Busso, Madrigal and Pagés, 2013). It is argued that Latin America has been unable to advance in the modern services sector and that the activities that emerge from structural change do not have the attributes necessary to compete on the international market and fail to contribute to improving economic productivity (Pagés, 2010; McMillan and Rodrik, 2011; Ferreira and Da Silva, 2015).

Thus, there is evidence that the structural change resulting from the process of deindustrialization of underdeveloped countries is complemented by the creation of a service sector based on activities that absorb low-skilled and underpaid professionals, have low technological intensity and limited innovative capability, are unable to competitively participate in the foreign market, and are associated with a new and growing digital economic rent-seeking (Kon, 2006; Cruz and others, 2007; Torres and Ahumada, 2022).

Especially regarding digital economic rent-seeking, Torres and Ahumada (2022) argue that the service companies that began operating in Latin America are the result of global oligopolistic platforms that do not transfer productive capacity to the local fabric and do not provide qualified jobs or capital goods, but rather extract income for the central regions. Therefore, for the authors, this dynamic reinforces the peripheral condition, because innovations from the centre are expressed through the appropriation of income and the externalization of labour and capital costs.

In contrast, the increase in the share of modern services as an intermediate input used by industry in developed countries contributes to the supply of products with sophisticated technological content (Arbache, 2015). Therefore, revalorizing the existing literature on the service sector becomes essential to understanding the new global productive reconfiguration and its effects on Latin America.

1. The emergence of the service sector

Recently, the role of the service sector in growth has been gaining ground in the economic debate. Due to its peculiar characteristics, it has always been considered a residual sector in the economic literature because it aggregates all activities that do not fall under agriculture or industry. Baumol (1967) developed a theory that became known as the *cost disease*, whereby the growth of this sector implied a reduction in overall economic productivity, due to the replacement in the economy of a dynamic sector (industry) by this less dynamic sector.

However, studies indicate that the economic growth and productivity gains obtained by industry since the 1970s can be explained by the emergence of modern services, especially those resulting from new communication technologies (Aboal and Tacsir, 2015; Nordås and Kim, 2013; Lodefalk, 2014).

The evolution of the service sector in recent decades has made Oulton (2001) question the hypothesis of "*cost diseases*", arguing that this phenomenon only occurs if there is an increase in the share of final services in value added. The knowledge-intensive business services (KIBS) literature shows that they provide knowledge for the industry and contribute to generating innovation in the industrial sector (Miles, 2005 and 2008; Muller and Zenker, 2001).

Authors like Castellacci (2008), Savona and Steinmueller (2013) and Arbache (2015 and 2016) analysed the interaction between services and the industry and found that, especially for the most technologically advanced products, the number of services incorporated in final value has been increasing. Thus, it is understood that the current stage of the production process is characterized by the sale of products in "packages" that integrate physical production and services, demonstrating that the demand for services in all industrial sectors has been growing (Lesher and Nordås, 2006; Arbache, 2015).

These services can be divided into two types, namely value services and cost services. The former correspond to activities that add value to the production process and increase productivity and return on capital. These services are concentrated in developed countries where the supply of human capital and technological development is greater. Cost services contribute to the competitiveness of companies and increase production efficiency; however, they do not contribute to product differentiation (Pilat and Wölfl, 2004; Arbache, 2015; Giovanini, Pereira and Saath, 2020).

Cost services are found mostly in developing countries, in view of the structural weaknesses of those countries (UNCTAD, 2013; UNESCO, 2015). The literature also shows that the share of services as an input for industry varies between countries, so that demand for modern services tends to be higher in countries with a more technology-intensive industrial structure than in those with an industrial structure characterized by traditional sectors (Acemoglu and others, 2007).

The latest studies on the service sector argue that advanced manufacturing and industry 4.0 is a result of new technologies arising from the interaction between modern services and the industrial sector. It is argued that the new stage of the production system is linked to countries' capacity to develop modern service activities and that these new technologies will affect the industrial sector and impact countries' productivity and growth rate (Schuh and others, 2015; Georgakopoulos and others, 2016; Niggemann and Beyerer, 2016; Giovanini and Arend, 2017; Giovanini, Pereira and Saath, 2020; Cadestin and Miroudot, 2020).

In other words, in the current phase of structural change, countries' growth trajectory depends on the type of service that is developed, its degree of competitiveness and its level of integration with the industrial sector. Some countries will have highly competitive and integrated services in the industrial sector, while others will have serious production deficiencies. This clearly leads to the centre-periphery relationship originally proposed by ECLAC, which is the focus of the next section.
IV. The core-periphery division in the post-industrial context

After the 1970s, deindustrialization in developed countries came with productive redistribution. Each country has positioned itself in the global productive system based on its competitive advantages. This explains why industries with the highest technological content and with modern service activities are concentrated in developed countries. Peripheral countries were left to compete for the production of lower-added-value goods, as the Asian countries initially did, or for the supply of primary goods and some intermediate industrial activities, which is the case for Latin America.

That trend can be seen in figure 1, which shows regional GDP as a percentage of world GDP. Between 1970 and 2017, the global economy was characterized by the existence of two groups of countries. The first group is formed by the countries of Europe and North America (developed countries) and the second group is formed by countries in Africa, Oceania, Latin America and the Caribbean (peripheral countries).

Despite periods of growth in GDP and in total or sectoral employment in less developed regions, only part of Asia has been able to benefit from the global reconfiguration of production that began in the 1970s. The literature shows that State-coordinated industrial and financing policy was decisive for good Asian performance (Rodrik, 1994; Kim and Leipziger, 1997; Dahlman and Sananikone, 1997; Smith, 2000).





Source: United Nations Statistical Division.

Figure 2, which shows the evolution of productivity, helps to explain why Latin America has persistently remained in the group of peripheral countries and also explains the movement of Asian countries towards the group of developed countries. Asian productivity growth rates have risen consistently since the 2000s, while rates in Latin America have remained below those of all other regions.



Figure 2 Regions of the world: productivity, 1991–2021 (Index: 1991=100)

Since 1990, structural change in Latin America has contributed to lower aggregate productivity, with poor productivity in the service sector being one of the main factors explaining Latin American stagnation (Pagés, 2010; McMillan and Rodrik, 2011). The argument made by Furtado (1961) of low capital per worker and the identification of obsolete industrial plants and macroeconomic maladjustments under neostructuralism contributes to explaining the unfavourable evolution of Latin American productivity.

Especially in Asian countries, integration between industry and the modern services sector ensures high growth and productivity rates (UNCTAD, 2017). The new stage in the process of structural change characterized by the deindustrialization and reconfiguration of intra-sectoral employment may be the key to understanding the weak economic performance of Latin American countries.

1. Modern services, technology and industry as elements of structural change

Table 1 shows growth in the share of employment by sector over the last three decades. Between 1991 and 2000, employment participation in modern services in Latin America did not increase significantly. On the other hand, traditional services related to hotels, restaurants and other personal services grew by 0.85%. At the same time, it is important to highlight the loss of the share of industrial employment in total employment, by approximately 0.80%.

Globally, Asia had the highest growth rates in the modern services sector (communication; financial and real estate intermediation; business services and administrative activities). Eastern and Southern Asia stood out, with average growth rates above 3%.

From 2001 to 2010, the relative share of employment in financial intermediation and insurance activities increased in Latin America, with average annual growth of 6.22%, and was also up in real estate activities, business services and administrative activities, with growth of 2.83%. The pace of reduction in the share of industrial employment in total employment was maintained over that period.

Table 1

Regions of the world: average yearly employment growth, by sector and decade, 1991–2021 (Percentages)

	Region	Manufacturing	Electricity, gas and water supply	Construction	Wholesale and retail trade, accommodation and food service activities	Transport, storage and communication	Financial and insurance activities	Real estate, business and administrative activities	Other services
	Africa	-0.81	1.23	0.31	1.07	1.57	0.49	3.89	0.47
	Latin America and the Caribbean	-0.78	-2.33	0.58	0.85	0.72	-0.35	2.56	0.29
	North America	-1.46	-1.92	1.14	-0.07	0.06	0.09	1.94	0.08
8	Eastern Asia	-0.18	-0.32	2.17	3.44	3.22	3.33	4.77	3.38
-20	Southern Asia	-0.06	-0.46	3.13	2.88	3.12	3.16	6.20	-1.29
1991.	Northern, Southern and Western Europe	-1.80	-2.94	0.44	0.15	0.99	0.53	2.96	1.99
	Eastern Europe	-1.84	0.91	-3.49	2.41	0.26	1.67	2.17	-1.08
	Central and Western Asia	-0.82	0.55	-0.33	2.40	1.42	2.83	3.44	0.99
	Arab States	-0.03	-3.98	-0.54	1.35	-0.07	0.98	2.02	0.21
	Africa	-0.63	1.71	3.53	1.49	1.55	0.73	5.12	2.08
	Latin America and the Caribbean	-1.13	0.92	1.45	0.54	1.26	6.22	2.83	-0.64
	North America	-2.78	1.83	-0.08	-0.39	0.11	-0.23	1.21	0.39
10	Eastern Asia	1.20	2.48	4.73	2.03	1.88	2.88	5.73	1.89
-20	Southern Asia	0.66	0.29	6.53	1.36	2.59	3.98	5.63	-0.28
2001	Northern, Southern and Western Europe	-2.85	6.40	-0.27	0.02	0.90	-0.24	3.70	0.15
	Eastern Europe	-1.68	3.58	3.23	1.97	2.11	2.73	5.39	-2.99
	Central and Western Asia	0.10	2.52	3.03	1.02	1.79	1.70	6.67	2.53
	Arab States	-0.14	3.54	2.67	1.62	1.77	4.14	4.83	2.00
	Africa	0.27	2.70	1.78	1.06	1.25	1.00	3.21	0.53
	Latin America and the Caribbean	-0.76	1.13	0.39	0.16	0.51	0.74	1.94	-0.84
	North America	-0.73	-0.19	0.93	-0.76	1.42	0.39	0.58	-0.42
21	Eastern Asia	-0.95	0.46	1.96	2.23	2.35	3.01	4.77	1.75
-20	Southern Asia	0.70	5.96	2.22	1.36	1.12	1.59	6.57	0.22
2011-	Northern, Southern and Western Europe	-0.45	0.55	-1.31	-0.55	0.83	-0.11	1.16	0.06
	Eastern Europe	-0.12	0.09	-0.25	0.40	0.87	0.69	1.83	1.73
	Central and Western Asia	0.53	2.09	0.82	0.38	0.67	1.43	2.90	-1.04
	Arab States	-0.90	-0.29	-0.66	0.70	0.74	0.43	2.66	2.43

Source: International Labour Organization (ILO), ILOSTAT [online database] https://ilostat.ilo.org/.

On the other hand, average annual growth rates for employment in the modern services sector in Asia were over 2.5%. During this period, employment also grew in the Asian manufacturing sector. Europe and North America did not see significant growth in the percentage share of employment in service activities, except for Eastern Europe, where the rate was over 5% in real estate and in business and administrative activities. Northern, Western and Southern Europe had the second-best performance, with growth rates above 3% for both real estate and business and administrative activities.

Between 2011 and 2021, the modern services with the highest employment growth rate in Latin America were real estate activities, business services and administrative activities, at 1.94%.

Other service activities saw a major decline. The second-highest growth was observed in the activity of public utility services, such as electricity and gas, which grew by 1.13%, while industrial employment decreased slightly (-0.76).

Between 2011 and 2021, average annual growth rates in Eastern and Southern Asia for modern service activities were positive again, at over 2.3%. Average annual growth for industrial employment in Southern Asia was 0.70%. Over the same period, growth in Europe and North America was negative, in a context of constraints. The highest relative employment growth rates were found in Eastern Asia, Southern Asia and Central-Western Asia, in real estate activities and in business services and administrative activities, with a rate that exceeded 2.5%.

Considering the share of sectoral employment in relation to total employment, the evidence suggests different trajectories between Latin America and some Asian countries (those in Eastern Asia and Southern Asia), which confirms the proposition that structural change in Asia contributed to productivity growth (Pagés, 2010; McMillan and Rodrik, 2011). Asian countries stood out in the most technology-intense modern service activities throughout the period analysed. In Latin America, real estate activities, business services and administrative activities performed better. Furthermore, modern Latin American services only performed well between 2001 and 2010.

The evolution of Asian employment suggests that, as these countries advance in incorporating knowledge and training skilled labour in modern service activities, they are joining the group of countries that are important exporters of modern services (Pagés, 2010; UNCTAD, 2017).

That evolution reflects the international division of labour and the relative position occupied by the regions. As previously seen, information and communications technologies (ICTs) have made it possible to accelerate trade and decentralize productive activities, enabling the development of global value chains. Recent studies by the Organisation for Economic Co-operation and Development (OECD) suggest that efficient integration into global value chains can be an important element for increasing productivity levels (OECD, 2013; Kowalski and others, 2015).

Thus, investigating how Latin America participates in global value chains and which sectors are most important contributes to assessing the region's performance. ECLAC (2018) showed that the share of raw materials in exports of minerals and metals in the region has almost doubled in the last 20 years. At the same time, there is a decline in the share of finished products and, to a lesser extent, in semi-finished products. The region is present in the early stages of value chains, losing participation in links with higher levels of processing along those chains (ECLAC, 2018).

The relative position of Latin America in global value chains can also be assessed through two indicators, the *backward global value chain integration ratio* (share of foreign value added incorporated in a country's gross exports) and the *forward participation ratio* (value added of a country used by its foreign partners). The sum of the two indicators shows the country's participation in global value chains. Figure 3 shows the backward global value chain integration ratio by sector.

Southern and Eastern Asia have specialized primarily in the downstream segments (backward links) of global value chains, and those regions supply foreign inputs at above-average rates in comparison with the rest of the world. Foreign content is high in exports from Eastern Asia in virtually every sector, including those linked to modern services.

Likewise, there is a relatively high level of foreign content in European exports of telecommunications, financial intermediation services and computers and related activities. The sectoral share in global value chains of Latin America and North America (the United States, Canada and Mexico), however, was below average for most of the sectors analysed. In the first group of countries, the agricultural and mining sectors were the exception. Latin American service activities do not incorporate large amounts of foreign content (see figure 3).



Figure 3 Regions of the world: average backward global value chain integration ratio, by sector, 1995–2018 (Percentages)

On the other hand, modern services from Europe and North America (especially the United States) are primary sources used by other countries. This shows that even though Asian countries have caught up and have a strong share of service exports, the United States and Europe are leading in the dissemination of technical progress related to services.

The forward sectoral participation rates (see figure 4) show that Latin America stands out for having relatively strong links in sectors based on natural resources, food and transportation equipment. In other words, the region is basically a supplier of primary goods and products with low technological content. In addition, the region's services are not used by other countries in production chains. In fact, a strong correlation can be seen between the productive structure and sophisticated services, meaning that the productive structure is central to understanding structural change in the countries.

During today's transformation of production as during the phase of industry-led growth, central countries are playing the leading role in producing modern services. These countries disseminate technical progress through the service area and combine innovations, when necessary, with industrial products, aiming to ensure greater productivity and global leadership in production (Savona and Steinmueller, 2013; Arbache, 2015 and 2016).

Between 1991 and 2020, on average, the countries with the largest share of modern services in total value added were those with the highest economic productivity. Figure 5 shows that the developed countries (circle) account for more than 23% of the total value added from the sophisticated services sector.

Source: Organisation for Economic Co-operation and Development (OECD), "Trade in value added" [online] https://www.oecd. org/sti/ind/measuring-trade-in-value-added.htm.

Figure 4 Regions of the world: average forward global value chain integration ratio, by sector, 1995–2018 (Percentages)



Source: Organisation for Economic Co-operation and Development (OECD), "Trade in value added" [online] https://www.oecd. org/sti/ind/measuring-trade-in-value-added.htm.

Figure 5

South America (10 countries) and developed countries (10 countries):^{ab} relationship between economic productivity^c and value added of modern services, 1991–2020 (Thousands of dollars at constant 2010 prices and percentages)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), United Nations Statistical Division and International Labour Organization (ILO), ILOSTAT [online database] https://ilostat.ilo.org/.

- ^a The South American countries are Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay. The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.84.
- ^c Output per worker.

On the other hand, the South American countries (rectangle) are in the opposite situation.⁶ Despite some exceptions, such as Chile, Brazil, Colombia and Ecuador, whose share of the modern services sector in total value added is over 20%, Latin American countries have a reduced share of modern services in total value added compared to developed countries. As explained, the literature shows that economic productivity is closely related to modern services, which are inputs for the manufacturing sector and guarantee the competitiveness of developed countries.

Between 1991 and 2020 (see figure 6), it can be seen that the most competitive countries in service exports are those with the highest average productivity. Except for countries such as Switzerland and Belgium, whose productivity is high but which account for a low share of global trade in services, the leaders in global competitiveness in this sector are countries such as the United States, the United Kingdom and Germany.

More productive countries have a more homogeneous productive structure, meaning that technical progress is disseminated to all sectors of the economy. The largest European economies and the United States are the most dynamic in the service sector, while the peripheral economies are in the opposite position. The South American economies have the common characteristic of low productivity and a reduced share of services in foreign trade.

Thus, the position of the countries of South America in figures 5 and 6, in contrast with the largest European economies and the United States, suggests the existence of a dichotomy along the lines of the centre-periphery relationship. A similar phenomenon is observed in relation to the countries of Central America and the Caribbean (see figure A1.2).



Figure 6

South America (10 countries) and developed countries (10 countries):^{ab} relationship between economic productivity^c and global share of modern services exports, 1991–2020 (Thousands of dollars at constant 2010 prices and percentages)

Source: Economic Commission for Latin America and the Caribbean (ECLAC), United Nations Statistical Division and International Labour Organization (ILO), ILOSTAT [online database] https://ilostat.ilo.org/.

- ^a The South American countries are Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay. The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.58.
- ^c Output per worker.

⁶ Central American and Caribbean countries have low productivity. However, in some countries, the share of modern services in value added is equivalent to that of developed countries. One reason is the large presence of offshore companies and their relationship with the financial sector in Caribbean countries. See figure A1.1.

As service exports demand qualified human capital (figure 7) and advanced technological structure, the modern services sector is also associated with economic complexity. Research and development (R&D) activity brings together professionals from different scientific areas and is responsible for innovation in several industrial sectors. More complex economies have more technologically advanced industrial sectors and use modern services during their production processes (Acemoglu and others, 2007). This is not the case in peripheral economies.

Figure 7 suggests a positive correlation between the complexity of the central countries and higher participation of the modern services sector in the composition of total value added. On the other hand, peripheral countries are not very complex and have a low share of services in total value added (see the data on Central America and the Caribbean in figure A1.3). The productive heterogeneity and technological dependence proposed by the original structuralism contribute to explaining this new configuration. Sector discontinuities and the passive absorption of external technical progress weaken the symbiosis between industry and modern services in the periphery.

The economic share of the modern services sector in Latin American countries is lower compared to central countries. It is important to highlight that there does not seem to be a significant relationship between modern services and complexity in peripheral countries.⁷ This reinforces the relative position of Latin America as a producer of primary goods and manufactured products with low technological content.



Figure 7

Source: Economic Commission for Latin America and the Caribbean (ECLAC), United Nations Statistical Division and Harvard University, Atlas of Economic Complexity [online database] https://atlas.cid.harvard.edu/.

^a The South American countries are Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay. The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States.

^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.85.

The low complexity of the South American countries is reflected in weak competitiveness on the international market (see figure 8). The largest European economies and the United States lead technological progress, are more complex, and therefore lead the generation of service innovations. On the other hand, the countries of South America (and Central America, see figure A1.4) are less economically complex and less competitive internationally.

⁷ For Caribbean countries and Mexico, only Mexico has the complete data series. Figure A1.3 lists the value added of services and economic complexity.

Figure 8





Source: Harvard University, Atlas of Economic Complexity [online database] https://atlas.cid.harvard.edu/; United Nations Conference on Trade and Development (UNCTAD), UNCTADSTAT [online database] https://unctadstat.unctad.org/EN/.

^a The South American countries are Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay. The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States.

^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.64.

Analysing the performance of services in terms of complexity shows that the centre-periphery dichotomy is present. Ernst (2005), Ernst and Kim (2001) and Sarti and Hiratuka (2011) argue that central countries expand the stock of productive knowledge and disseminate it both in industry and in other service activities.

These dynamics enable central countries to gain ground in foreign trade and gain access to markets in less developed countries. Central countries dominate the export of manufactured goods of high technological intensity, while the situation of peripheral countries is the opposite. Figure 9 suggests the existence of a weak but positive correlation between the share of modern services in total value added and the prevalence of high-tech products in exports.

To a certain extent, this shows the degree of development of the national innovation system, and the symbiosis between services and the industrial sectors with the highest technological content, as proposed by Acemoglu and others (2007), UNCTAD (2013) and UNESCO (2015).

From the point of view of the centre-periphery relationship, Latin American countries (see figure A1.5) remain in a relatively unfavourable position. The modern services sector contributes little to generating value added, and the export basket is composed of low-technology items. As is the case in the industrial sector, the greatest exporters of services are the countries that are leaders in innovation (figures 10 and A1.6).

In addition to having a small share of modern services in the generation of their national income, peripheral countries lack the necessary requirements to engineer a process of knowledge and technology production (figures 11 and A1.7). As pointed out by Fajnzylber (1983), peripheral countries lack endogenization of technological dynamism. Where this process was absent in the industrialization phase, it becomes impossible to transfer a stock of knowledge to the modern services sector in the phase of productive reconfiguration, a situation that generates technological dependence in the service sector as well.



Source: Economic Commission for Latin America and the Caribbean (ECLAC), United Nations Statistical Division and World Bank, World Bank Open Data [online] https://data.worldbank.org/.

- ^a The South American countries are Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay. The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.75.

Figure 10

South America (10 countries) and developed countries (10 countries):^{ab} relationship between knowledge and technology production and global share of modern services exports, 2013–2020 (Index values and percentages)



Source: World Intellectual Property Organization (WIPO), Global Innovation Index [online] https://www.globalinnovationindex. org/Home; United Nations Conference on Trade and Development (UNCTAD), UNCTADSTAT [online database] https:// unctadstat.unctad.org/EN/.

- ^a The South American countries are Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay. The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.62.

Figure 11

South America (10 countries) and developed countries (10 countries):^{ab} relationship between knowledge and technology production and value added of modern services, 2013–2020 (Index values and percentages)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), United Nations Statistical Division and World Intellectual Property Organization (WIPO), Global Innovation Index [online] https://www.globalinnovationindex.org/Home.

^a The South American countries are Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay. The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States.

^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.85.

This weakens inter and intra-sectoral spillovers and contributes to modern Latin American services being uncompetitive. The symbiosis between industry and services becomes just the extension of a dependent relationship that reinforces the centre-periphery relationship and adversely affects long-term growth.

However, countries that share commercial service networks find better conditions to overcome underdevelopment, as appears to be happening with some Asian countries. Table 2 shows the largest service exporters and importers globally between 2000 and 2020. These countries account for more than 52% of foreign trade. It should be noted that no Latin American countries rank among the top ten services exporters and importers in recent decades.

The countries in the region are outside the circuit of foreign trade in services, demonstrating the existence of a gap between the most economically dynamic countries and the periphery. In addition to reinforcing the tendency towards low participation of Latin American countries in global value chains, as shown by ECLAC (2018), the results suggest the extension of the centre-periphery relationship to the modern services sector. The centre is comprised of countries whose service sector is internationally competitive and which disseminate innovations, while the periphery is characterized by an uncompetitive service sector and is separated from foreign trade.

Missio and Jayme (2012) argued that since ECLAC identified that a macroeconomic imbalance, the obsolescence of industrial plants and the technology divide were responsible for economic backwardness, the systemic competitiveness model proposed by neostructuralists is what drives economic growth. However, Latin American countries have not been successful in overcoming these deficiencies. Fiscal imbalance, deindustrialization and the technological gap remain characteristics of Latin America.

Integration with international markets as a strategy for accessing foreign investment and technological modernization has not changed the region's passivity in the endogenization of technical

progress. With deindustrialization, the knowledge stock that is generated in industry in developed countries is shared with the modern services that emerge, so that the dynamics of technical progress occur inter- and intra-sectorally.

	Country	Service exports: share of world total	Country	Service imports: share of world total
2000	United States	19.00	CountrySet sharUnited StatesGermanyJapanUnited KingdomFranceItalyNetherlandsCanadaBelgiumChinaTotalUnited StatesGermanyChinaUnited KingdomFranceJapanNetherlandsIndiaInted StatesGermanyChinaUnited KingdomFranceJapanNetherlandsIndiaItalyIrelandChinaUnited StatesChinaIndiaItalyIrelandFranceNetherlandsUnited StatesChinaIrelandGermanyFranceNetherlandsUnited KingdomSingaporeJapanIndiaIndia	14.45
	United Kingdom	7.89	Germany	9.09
	Germany	5.46	Japan	7.58
	France	5.30	United Kingdom	6.54
	Japan	4.55	France	4.00
	Italy	3.71	Italy	3.65
	Spain	3.45	Netherlands	3.51
	Netherlands	3.44	Canada	2.90
	Belgium	3.27	Belgium	2.75
	Canada	2.64	China	2.37
	Total	60.79	Total	56.84
2010	United States	14.63	United States	11.25
	United Kingdom	7.33	Germany	6.80
	Germany	5.66	China	4.99
	France	5.09	United Kingdom	4.81
	China	4.48	4.48 France	
	Netherlands	4.06	4.06 Japan	
	Japan	3.38	Netherlands	3.51
	India	2.94	India	2.96
	Spain	2.88	Italy	2.93
	Italy	2.55	Ireland	2.84
	Total	53.01	Total	49.03
2020	United States	14.03	United States	9.51
	United Kingdom	7.45	China	7.77
	Germany	6.00	Ireland	7.12
	China	5.42	Germany	6.34
	Ireland	5.38	France	4.81
	France	4.92	Netherlands	4.34
	Netherlands	4.33	United Kingdom	4.32
	Singapore	4.05	Singapore	4.15
	India	3.92	Japan	4.01
	Japan	3.13	India	3.13
	Total	58.62	Total	55.49

Table 2

Selected countries: largest exporters and importers of services, 2000, 2010 and 2020 (Percentages)

Source: United Nations Conference on Trade and Development (UNCTAD), UNCTADSTAT [online database] https://unctadstat. unctad.org/EN/.

This accelerates the generation of technical progress and widens the gap between developed and underdeveloped countries. As peripheral countries historically only replicate the centre's production techniques, Latin American industry does not have a stock of knowledge to share with services, which have emerged from deindustrialization. Therefore, modern Latin American services are not very competitive, and they tend to replicate the knowledge that is generated internationally. Structural change also reinforces the centre-periphery relationship in the service sector.

Although neo-structuralism recognizes the existence of an ongoing technological revolution, evaluations of economic backwardness and future development possibilities do not adequately consider the role of deindustrialization in structural change and the advancement of the service sector.

Therefore, it is argued that the effort to understand the determinants of technological progress, which now involves new dimensions and new forms of connection with production, has not been successful. In this context, it is possible to affirm that Latin America is in a peripheral position in this new stage of global structural change.

V. Conclusions

This paper discusses the importance of the modern services sector for Latin America, updating the central thesis of the Latin American structuralist approach to the centre-periphery dichotomy. We argue that deindustrialization contributes to the rise of services, a process which is endowed with a distinct character among countries.

Between 1991 and 2021, the data showed a spike in modern services as a share of employment in Asia and little growth in that regard in Latin American countries. Employment and productivity results support the thesis of Pagés (2010), McMillan and Rodrik (2011), and Ferreira and Da Silva (2015) that structural change in Latin America is contributing to a reduction in aggregate productivity.

Global value chain analysis showed that Southern and Eastern Asia have specialized more in the downstream segments (backward links), with above average levels of foreign input supply compared the rest of the world, while for Latin America, the degree of participation was low. Regarding forward sector participation rates, South American nations stand out for having relatively strong links in sectors based on natural resources, food and transportation equipment, as explained by ECLAC (2018). North American Free Trade Agreement (NAFTA) countries, especially the United States, lead the spread of progress in technical services.

The relationship between share of modern services in world exports and economic productivity suggests that the most productive countries lead the trade in modern services (Álvarez, Fernández-Stark and Mulder, 2020). The most complex countries are also the largest exporters in this sector. This confirms the thesis that knowledge-intensive business services are inputs for the industry and that they contribute to innovation.

These results are in line with the evidence that a connection between high-tech manufacturing and modern services is a characteristic of developed countries, corroborating studies by Miles (2008), Muller and Zenker (2001), Miozzo and Soete (2001), Lesher and Nordås (2006), Acemoglu and others (2007), Castellacci (2008), Savona and Steinmueller (2013) and Arbache (2015 and 2016).

Latin American countries are not complex, they are not very productive, and they are not leaders in technological progress in modern services. Central countries have competitive services, while peripheral countries occupy restricted space in foreign trade. One explanation for this dichotomy is that no "endogenous nucleus of technological dynamism" was developed during the industrialization phase of Latin American countries, as argued by Fajnzylber (1983).

As there was no endogenization of technical progress in the industrialization phase of Latin America, now, in the time of deindustrialization, there is no stock of technical knowledge that can spill over from industry to the service sector. The emergent modern services sector in Latin America needs all the conditions that exist in developed countries, and it has a tendency to perpetuate the pattern of replication of techniques and procedures once used by the industrial sector.

Therefore, the structuralist approach as it relates to a division between central and peripheral countries has contemporary relevance when transposed to an analysis that also involves the service sector, and it can contribute to explaining the longstanding underdevelopment of Latin American countries. Peripherality is also perpetuated in the service economy, and with it come new limitations on the economic growth of Latin American countries in a context of accelerated productive transformation.

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Annex A1



Source: Economic Commission for Latin America and the Caribbean (ECLAC), United Nations Statistical Division and International Labour Organization (ILO), ILOSTAT [online database] https://ilostat.ilo.org/.

- ^a The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. The countries in Latin America and the Caribbean are the Bahamas, Barbados, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.76.
- ^c Output per worker.

Figure A1.2

Latin America and the Caribbean (15 countries)and developed countries (10 countries):^{ab} relationship between economic productivity^c and global share of modern services exports, 1991–2020



Source: International Labour Organization (ILO), ILOSTAT [online database] https://ilostat.ilo.org/; United Nations Conference on Trade and Development (UNCTAD), UNCTADSTAT [online database] https://unctadstat.unctad.org/EN/.

- ^a The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. The countries in Latin America and the Caribbean are the Bahamas, Barbados, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.57.
- ^c Output per worker.

Figure A1.3

Latin America and the Caribbean (15 countries) and developed countries (10 countries):^{ab} relationship between economic complexity and value added of modern services, 1991–2020 (*Index values and percentages*)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), United Nations Statistical Division and Harvard University, Atlas of Economic Complexity [online database] https://atlas.cid.harvard.edu/.

- ^a The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. The countries in Latin America and the Caribbean are the Bahamas, Barbados, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.81.



Source: Harvard University, Atlas of Economic Complexity [online database] https://atlas.cid.harvard.edu/; United Nations Conference on Trade and Development (UNCTAD), UNCTADSTAT [online database] https://unctadstat.unctad.org/EN/.

^a The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. The countries in Latin America and the Caribbean are the Bahamas, Barbados, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago.

^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.58.





Source: World Bank, Economic Commission for Latin America and the Caribbean (ECLAC) and United Nations Statistical Division.

- ^a The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. The countries in Latin America and the Caribbean are the Bahamas, Barbados, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.55.

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- Source: World Intellectual Property Organization (WIPO), Global Innovation Index [online] https://www.globalinnovationindex. org/Home; United Nations Conference on Trade and Development (UNCTAD), UNCTADSTAT [online database] https:// unctadstat.unctad.org/EN/.
- ^a The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. The countries in Latin America and the Caribbean are the Bahamas, Barbados, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.65.



Source: Economic Commission for Latin America and the Caribbean (ECLAC), United Nations Statistical Division and World Intellectual Property Organization (WIPO), Global Innovation Index [online] https://www.globalinnovationindex.org/Home.

- ^a The developed countries are Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. The countries in Latin America and the Caribbean are the Bahamas, Barbados, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago.
- ^b Sample European countries comprise 80% of European GDP. Pearson correlation coefficient: 0.65.

Analysis of Central American trade integration from the perspective of intraregional value added

Roberto Orozco and Ramón Padilla Pérez

Abstract

The aim of this article is to study trade integration in Central America from a value added perspective, using the first regional input-output table, a tool developed by the Economic Commission for Latin America and the Caribbean (ECLAC) in close cooperation with the central banks and statistical institutes of the region. The strategy of open regionalism employed by the countries of Central America has resulted in significant subregional trade integration with regard to gross exports; however, these exports include a significant share of intermediate inputs from outside the subregion. The vertical specialization indicators (exports and imports) estimated in this article show that exports within Central America create less domestic value added than total exports and incorporate considerable intermediate inputs from outside the subregion, creating little value added in the subregion itself.

Keywords

Economic integration, foreign trade, intraregional trade, exports, imports, production specialization, value, input-output analysis, Central America

JEL classification

F14, F15, C67

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I. Introduction

Central America is the most integrated subregion in Latin America and the Caribbean in terms of trade: exports within the subregion¹ account for nearly 30% of total exports, and after the United States, the subregion is the main destination for its own exports. Recent data show that in 2020, in the context of the severe economic crisis caused by the coronavirus disease (COVID-19) pandemic, trade within Central America was more resilient than in other regions of Latin America (ECLAC, 2021).

Central American countries have the longest tradition of integration in Latin America: the process began in 1951 with the Charter of the Organization of Central American States and continued in 1960 with the creation of the Central American Common Market (CACM) (Martínez Piva, 2019a). In the 1980s, in a context of profound economic and political crisis, Central American countries enacted drastic reforms to the development model aimed at deregulating markets, reducing State intervention in economic activities and promoting trade and finance liberalization. This was the dawn of what the Economic Commission for Latin America and the Caribbean (ECLAC) called "open regionalism": the reconciling of regional interdependence with growing integration with markets outside the region (Martínez Piva, 2019b; ECLAC, 1994). That strategy has shaped the international integration of Central America, including for example with regard to the incorporation of value added from within and outside the subregion and in terms of sectoral export structures.

Thus far, trade between Central American countries has been analysed on the basis of national and regional balance of payments statistics, through the measurement of total import and export flows at current prices. In 2020, ECLAC concluded a technical cooperation exercise with the central banks and national statistical offices of Central America, Mexico and the Dominican Republic to create the first subregional input-output table. As a result, the analysis of integration can be complemented by indicators for the national and subregional value added from exports; in other words, it becomes possible to determine the share of purchases of domestic intermediate inputs and of those from within and outside the subregion in the final export value.

This article aims to study trade integration in Central America in terms of value added on the basis of the first subregional input-output table. In particular, this article will examine whether the Central American integration strategy, which has been successful with regard to gross exports, has also been effective in incorporating intermediate inputs from within the subregion itself.

Indicators for value added from trade within Central America, based on the subregional input-output table, enable an innovative analysis that is unprecedented in economic literature. To conduct a comprehensive assessment of trade integration, the methodology used for this study considers both the flow of exports between economies and the imported inputs for the production of exports. This is achieved by using the indicators proposed by Stehrer (2013) and Stehrer, Forter and Vries (2012), which generalize the calculation of vertical specialization by simultaneously estimating the value added created by exports and imports. The method consists of determining the flows of exports and imports from a given country, called the anchor country, and then estimating the value added created by those flows using the Leontief model.

From a regional perspective, the size and composition of value added created by trade show to what degree economies interact in regional productive processes and their dependency on them, making it possible to measure trade integration in terms of value added.

This article is organized into four sections. Section II, which follows, gives an overview of the development of the first subregional input-output table and describes the main elements of a regional

Analysis of Central American trade integration from the perspective of intraregional value added

¹ For the purposes of this study, the Central America subregion is deemed to comprise Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama.

table. Section III presents stylized facts of external trade in Central America, which serve as a starting point for analysing the indicators of the subregional input-output table. Section IV examines the indicators for Central American trade integration on the basis of vertical specialization indicators. Section V sets out conclusions, areas for further research based on the subregional table and public policy recommendations.

II. Developing the first subregional input-output table

In recent years, a number of exercises have been conducted to develop regional input-output tables, such as the World Input-Output Database (WIOD) and the Trade in Value Added (TiVA) database created by the Organisation for Economic Co-operation and Development (OECD). Other examples include the tables published by the Global Trade Analysis Project (GTAP) and the UNCTAD-Eora Global Value Chain (GVC) database of indicators for value added of trade.² However, while there have been recent efforts to develop national input-output tables, the countries of Central America are not represented in these databases.³

Between 2016 and 2019, ECLAC worked in close cooperation with the central banks and national statistical offices of the region to build and standardize national tables and a regional table, an initiative financed by the United Nations Secretariat as part of the United Nations Development Account.

The ECLAC subregional headquarters in Mexico coordinated the preparation of the first input-output table for Central America, Mexico and the Dominican Republic, while the ECLAC headquarters in Santiago and the ECLAC office in Buenos Aires⁴ coordinated the preparation of the South American input-output table. During the first phase, tables were prepared through subregional exercises. The tables were then combined to make one regional table (18 countries).⁵

In order to create a table for 40 homogenous economic sectors for each of the countries, it was necessary to harmonize the supply and use tables of each country, and thus their input-output tables.⁶ To quantify the trade interactions between the countries selected, a trade table describing the international trade flows (imports and exports) between these countries was developed. An employment vector was also created to estimate the impact of trade on direct and indirect job creation. As the background data (supply and use tables) required to create the national tables were available, a regional table was created with figures from 2011.⁷

A regional input-output table provides a snapshot of the economy of a region, in which domestic and international trade in goods and services are recorded for a standardized set of sectors for the countries that comprise the region. In addition, a regional table includes data on intraregional and extraregional final demand, intermediate imports from outside the region and the different components of value added. A regional table, like a national input-output table, is square and symmetrical.

² Multiregional input-output tables published by these organizations address a variety of levels of sectoral aggregation and different time periods, regions and countries. Details on the methodology employed to develop these tables and their specific characteristics are available at [online] http://www.wiod.org/home; https://www.oecd.org/sti/ind/measuring-trade-in-value-added. htm; https://www.worldmrio.com/; and https://www.gtap.agecon.purdue.edu/.

³ In particular, the work done by the central banks of Costa Rica, El Salvador, Honduras and the Dominican Republic stands out. They have developed their own input-output tables using supply and use tables created by their national accounts divisions.

⁴ This has been renamed the ECLAC office in Argentina.

⁵ A preliminary version of the regional table for Latin America, from 2011, is available [online] at https://www.cepal.org/es/eventos/ matrices-insumo-producto-como-herramienta-politicas-comerciales-industriales-america-latina.

⁶ The eight countries included in the subregional table are Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama.

⁷ It is important to note that input-output tables present structural economic characteristics that evolve slowly; for that reason, although the first table was created using data from 2011, it remains extremely relevant.

A regional input-output table comprises the following elements:

- (i) Intraregional intermediate consumption matrix, which shows purchases by the various sectors of the different countries of the region.
- (ii) Extraregional intermediate imports matrices, which show the consumption of imported intermediate inputs acquired by the countries of the region and produced by trading partners from outside the region.
- (iii) A production tax vector, which records the payment of taxes on production, by economic sector and country of the region.
- (iv) A transport and insurance vector, which records the amounts paid for these items, by economic sector and country of the region.
- (v) A national value added vector, which records payments made for productive factors (wages, gross operating surplus, mixed revenue and net taxes) by each sector and country of the region.
- (vi) Final intraregional demand matrix, which is made up of a set of rectangular submatrices that show domestic purchases and imports of final goods by and from countries of the region, by demand factor (final consumption and gross capital formation).
- (vii) A total extraregional exports vector, in which each element shows the flow of goods and services (intermediate and final) that each country of the region exports to trading partners outside the region.
- (viii) A gross production value vector, which shows the gross production value for each economic sector and country of the region.

In short, a regional input-output table is a double-entry table representing trade between the countries of a specific region. The sum of purchases (columns) is equal to the sum of sales (rows) and corresponds to the gross production value. As such, it represents a balanced economic system in which everything that is produced is consumed (Orozco, 2020).

III. Stylized facts of international trade in Central America

Between 1995 and 2019, the combined exports of Central American countries grew by 300%, an annual growth rate of 6.3%. In 1995, Costa Rica was the Central American subregion's leading exporter in gross value terms, accounting for 34% of all exports; the region's three main exporters (Costa Rica, El Salvador and Guatemala) accounted for 71% of all shipments from the subregion. In 2019, Costa Rica remained the leading exporter, with 35.5% of all exports, and the combined share of the abovementioned three countries had increased to 76.3%.

Exports within the subregion as a share of all Central American exports grew from 22.2% in 1995 to 31% in 2019, with marked differences across countries.⁸ In 2019, El Salvador had the highest concentration of exports in the Central American market, with exports thereto accounting for 54.5% of its exports, compared with 40% for Guatemala, around 22% for Costa Rica, Honduras and Nicaragua, and around 14% for Panama. Central American trade was also highly concentrated in the United States market, which accounted for between 26% and 43% of total exports in 2019. A significant share also went to the European market, which received 24% of the subregion's exports, with a smaller share going to Mexico (4%) and to Canada, China, the Dominican Republic and Japan (around 2% each).

⁸ In 2015 and 2016, the share of exports to the subregion itself hit an all-time high of 33%.

In gross value terms, exports from Central American countries have been in line with the abovementioned strategy of open regionalism. The importance of trade within Central America is firmly established; the subregion is the most integrated trade bloc in Latin America, ahead of others such as the Southern Common Market (MERCOSUR) and the Andean Community (CAN), whose exports of goods to Central America as a share of total exports in 2019 were 10.9% and 7.2%, respectively. In addition, Central American countries have also entered some global value chains — including textiles and clothing, electronic components, and medical equipment and devices— that are heavily oriented to the United States market. Trade destinations have also diversified and there has been strong growth in shipments to China and Europe, in particular to Germany, the United Kingdom and the Netherlands.

Eight countries were included for the construction of the first subregional input-output table: the six countries of Central America, the Dominican Republic and Mexico. An additional table comprising only the six countries of Central America was developed for a more focused study of Central American integration, the subject of this article. The data below are drawn from the Central American table (six countries).⁹

Table 1 presents total gross exports from the six countries included in this study, with data from 2011, the year of the regional input-output table. The columns distinguish between gross exports to other Central American countries and exports to countries outside the subregion. On average, 25.4% of total gross exports remained in Central America, with significant differences across countries: the highest coefficient is in El Salvador (48.4%), while the lowest is in Panama (9.1%).

		Total gross	exports within the subregion	Total gross exports outside the subregion		
Country	(Millions of dollars)	(Millions of dollars)	(Percentages of total gross exports)	(Millions of dollars)	(Percentages of total gross exports)	
Costa Rica	12 702	2 602	20.5	10 100	79.5	
El Salvador	5 032	2 437	48.4	2 594	51.6	
Guatemala	10 119	3 072	30.4	7 047	69.6	
Honduras	7 806	2 869	36.8	4 937	63.2	
Nicaragua	3 540	789	22.3	2 751	77.7	
Panama	11 065	1 003	9.1	10 062	90.9	
Total	50 263	12 772	25.4	37 491	74.6	

Table 1Central America: gross exports within and outside the subregion
and total goods and services exports, by country, 2011
(Millions of dollars and percentages of total gross exports)

Source: Prepared by the authors on the basis of the Central American input-output table developed by the Economic Commission for Latin America and the Caribbean (ECLAC).

Figure 1 shows the composition of gross exports by trade destination. The United States is the single largest destination for the exports of all countries in the subregion. Guatemala is the country with the highest concentration of exports to the United States market (43.6%), while Nicaragua has the lowest concentration (26.0%). In contrast with other Central American countries, Panama sends 41.2% of its exports to South America.

Figure 2 presents the composition of total gross exports between Central American countries by destination country. The highest coefficients are in bilateral trade between the three countries of northern Central America (El Salvador, Guatemala and Honduras); in the exports from Panama to Costa Rica; and in the exports from Nicaragua to El Salvador. However, export distribution is uneven and there are no marked concentrations in any particular market in the subregion.

⁹ ECLAC has published several studies of regional integration on the basis of the input-output table for Central America, the Dominican Republic and Mexico (eight countries). For example, see Orozco (2020), Torres and García (2020) and Orozco and Torres (2021).



Figure 1 Central America: breakdown of total gross goods and services exports, by trading partner or group of destination countries, 2011 (Billions of dollars and percentages)

Source: Prepared by the authors on the basis of the Central American input-output table developed by the Economic Commission for Latin America and the Caribbean (ECLAC).



Source: Prepared by the authors on the basis of the Central American input-output table developed by the Economic Commission for Latin America and the Caribbean (ECLAC).

IV. Trade -induced value added within Central America

As mentioned in the introduction, this article examines both the flow of exports between Central American economies and the imports of intermediate inputs and goods used in the production of those exports with a view to conducting a comprehensive analysis of trade-induced value added that goes beyond the traditional measurement based on gross export values. This analysis is made possible by the development of the first subregional input-output table. The methodology is based on the proposal of Stehrer (2013) and Stehrer, Forter and Vries (2012), according to which the value added created by exports and imports is estimated simultaneously.

The indicators for the value added created by trade proposed by Stehrer, Forter and Vries (2012) are derived by simultaneously considering the role of imports and exports when determining the specialization indicators for international trade for a given country. In that sense, the vertical specialization index proposed by Hummels, Ishii and Yi (2001) is generalized in the methodology, as is the calculation method proposed by Koopman and others (2011), since that index and method are based solely on export flows.¹⁰

The trade-induced value added is calculated by determining the value added created by the exports and imports of a given country, called the anchor country, for which the traditional specialization indicators, domestic value added and the foreign value added embodied in exports are estimated. The value added contained in the imports of the anchor country is also determined. It is made up of three elements: bilateral value added, multilateral value added and reimported value added.

Building on Stehrer, Foster and de Vries (2012) and Stehrer (2013), the following equation is used to calculate the value added contributed by trade:

$$Tv = \hat{v}L\hat{t}$$

where \hat{v} is the diagonalized vector of the coefficients for value added, meaning the share of value added in gross production; *L* is the matrix of production multipliers (or Leontief inverse table); and \hat{t} is a diagonalized vector whose elements contain exports and imports between the anchor country and the rest of the countries in the regional table.

In $Tv = \hat{v}L\hat{t}$, the specific elements for \hat{v} and \hat{t} are the following:

$$\hat{v} = \begin{bmatrix} va_1^r / x_1^r & 0 & 0 & 0 & 0 & 0 \\ 0 & va_2^r / x_2^r & 0 & 0 & 0 & 0 \\ 0 & 0 & va_1^s / x_1^s & 0 & 0 & 0 \\ 0 & 0 & 0 & va_2^s / x_2^s & 0 & 0 \\ 0 & 0 & 0 & 0 & va_1^q / x_1^q & 0 \\ 0 & 0 & 0 & 0 & 0 & va_2^q / x_2^q \end{bmatrix} = \begin{bmatrix} v_1^r & 0 & 0 & 0 & 0 & 0 \\ 0 & v_2^r & 0 & 0 & 0 & 0 \\ 0 & 0 & v_2^s & 0 & 0 & 0 \\ 0 & 0 & 0 & v_2^s & 0 & 0 \\ 0 & 0 & 0 & 0 & v_2^q / x_2^q \end{bmatrix}$$
$$\hat{t} = \begin{bmatrix} e_1^{r*} & 0 & 0 & 0 & 0 & 0 \\ 0 & e_2^{r*} & 0 & 0 & 0 & 0 \\ 0 & 0 & m_1^{sr} & 0 & 0 & 0 \\ 0 & 0 & 0 & m_2^{sr} & 0 & 0 \\ 0 & 0 & 0 & 0 & m_2^{sq} \end{bmatrix}$$

¹⁰ The vertical specialization index is defined as the proportion of imported intermediate inputs incorporated into exports. Using multiregional tables, the content of imported intermediate inputs included in exports can be estimated by trading partner. Each element of matrix \hat{v} represents the coefficient for value added by sector (1, 2) and by country (*r*, *s*, *q*); for example, $v_2^r = va_2^r/x_2^r$ is the coefficient for value added for sector 2 of country *r*.

In matrix \hat{t} , the expression $e_{i=j}^{r^*}$ represents the total exports (intermediate and final) of each sector of anchor country (r^*) to other countries (*s* and *q*, respectively). Equations $m_{i=j}^{sr}$ and $m_{i=j}^{qr}$ represent the total imports (intermediate and final) for each sector of the anchor country, coming from countries *s* and *q*, respectively.

The matrix derived from $Tv = \hat{v}L\hat{t}$ is defined as a matrix of value added created by bilateral trade between anchor country *r* and trading partners *s* and *q*. It is expressed as follows:

	$v_1^r l_{11}^{rr} e_1^{r*}$	$v_1^r l_{12}^{rr} e_2^{r*}$	$v_{1}^{r}l_{11}^{rs}m_{1}^{sr}$	$v_1^r l_{12}^{rs} m_2^{sr}$	$v_{1}^{r}l_{11}^{rq}m_{1}^{qr}$	$v_{1}^{r}l_{12}^{rq}m_{2}^{qr}$
	$v_2^r l_{21}^{rr} e_1^{r*}$	$v_2^r l_{22}^{rr} e_2^{r*}$	$v_{2}^{r}l_{21}^{rs}m_{1}^{sr}$	$v_2^r l_{22}^{rs} m_2^{sr}$	$v_{2}^{r}l_{21}^{rq}m_{1}^{qr}$	$v_2^r l_{22}^{rq} m_2^{qr}$
<i>T</i> .,	$v_1^{s} l_{11}^{sr} e_1^{r*}$	$v_1^s l_{12}^{sr} e_2^{r*}$	$v_1^{s} l_{11}^{ss} m_1^{sr}$	$v_{1}^{s}l_{12}^{ss}m_{2}^{sr}$	$v_1^{s} l_{11}^{sq} m_1^{qr}$	$v_{1}^{s}l_{12}^{sq}m_{2}^{qr}$
IV =	$v_2^{s} l_{21}^{sr} e_1^{r^*}$	$v_2^{s} l_{22}^{sr} e_2^{r*}$	$v_2^s l_{21}^{ss} m_1^{sr} \mathbf{IV}$	$v_2^s l_{22}^{ss} m_2^{sr}$	$v_2^s l_{21}^{sq} m_1^{qr} V$	$v_{2}^{s}l_{22}^{sq}m_{2}^{qr}$
	$v_1^q l_{11}^{qr} e_1^{r^*}$	$v_1^q l_{12}^{qr} e_2^{r*}$	$v_1^q l_{11}^{qs} m_1^{sr} $	$v_{1}^{q}l_{12}^{qs}m_{2}^{sr}$	$v_{1}^{q}l_{11}^{qq}m_{1}^{qr}$	$v_1^q l_{12}^{qq} m_2^{qr}$
	$v_{2}^{q}l_{21}^{qr}e_{1}^{r*}$	$v_2^q l_{22}^{qr} e_2^{r*}$	$v_2^q l_{21}^{qs} m_1^{sr}$	$v_{2}^{q}l_{22}^{qs}m_{2}^{sr}$	$v_2^q l_{21}^{qq} m_1^{qr}$	$v_2^q l_{22}^{qq} m_2^{qr}$

The following indicators can be identified in the matrix above:

- (i) Domestic value added embodied in the exports of the anchor country to its trading partners (section I). For example, $v_1^r l_{11}^{rr} e_1^{r*}$ represents the value added created in sector 1 of country *r* and embodied in the total exports of sector 1 from country *r* to its partners *s* and *q*. The sum of all elements that make up section I represents the total domestic value added embodied in the total exports of the anchor country to its partners *s* and *q*.
- (ii) Foreign value added embodied in the exports of the anchor country to its trading partners (section II). For example, $v_1^s l_{11}^{sr} e_1^{r^*}$ represents the value added of sector 1 of country *s* embodied in the total exports of sector 1 of country *r* to its partners *s* and *q*. The sum of all the elements that make up section II is the total foreign value added embodied in the total exports of the anchor country to its partners *s* and *q*.
- (iii) Reimported value added embodied in the imports of the anchor country that come from its trading partners (section III). For example, $v_1^r l_{11}^{rs} m_1^{sr}$ represents the value added of sector 1 of country *r* embodied in the imports of country *r* itself coming from sector 1 of country *s*. The sum of all elements that make up section III represents the total reimported value added embodied in the total imports of the anchor country that come from its trading partners *s* and *q*. The logic behind this indicator is as follows: first, country *r* adds value in its exports to countries *s* and *q*. Then, those exports are incorporated into the productive processes of trading partners and become new products, which, farther down the line, are imported by country *r*. In this manner, the anchor country reimports value added.
- (iv) Bilateral value added embodied in the imports of the anchor country that come from its trading partners (sections IV). For example, $v_1^s l_{11}^{ss} m_1^{sr}$ represents the value added of sector 1 of country *s* embodied in the imports of country *r* that come from sector 1 of country *s*. The sum of all elements that make up the sections labelled IV is the bilateral value added embodied in the total imports of country *r* that come from its partners *s* and *q*.
- (v) Multilateral value added embodied in the imports of the anchor country that come from its trading partners (sections V). For example, $v_1^q l_{11}^{qs} m_1^{sr}$ represents the value added of sector 1 of country *q* embodied in the imports of country *r* that come from sector 1 of country *s*. The sum of all elements that make up the sections labelled V is the multilateral value added embodied

in the total imports of country r that come from its partners s and q. Multilateral value added is created as follows: country q provides inputs to country s; country s incorporates the productive inputs of country q to create new goods; and anchor country r imports those goods. In this way, anchor country r indirectly creates value added in country q (through its imports from country s).

The indicators described in (i) and (ii) correspond to the traditional indicators for vertical specialization, meaning national and foreign value added embodied in exports. The indicators in (iii), (iv) and (v) refer to the value added created by imports, meaning reimported value added, both bilateral and multilateral. These five indicators enable the estimation of the value added contributed by the trade of the anchor country with its trading partners.

In table 2, gross export value is broken down into three factors: domestic value added, intermediate imports and trade and transport margins. As an illustration of the data in the table, in 2011, the gross value of exports of goods and services from Costa Rica was US\$ 12.702 billion, of which 77.1% corresponded to domestic value added, 21.8% to intermediate imports and the remaining 1.1% to trade and transport margins.

Table 2
Central America: domestic value added and intermediate imports embodied
in total gross exports of goods and services, 2011
(Millions of dollars and percentages of total gross exports)

Country	Total gross exports (Millions of dollars)	Domestic value added embodied in total gross exports		Total in imports in total g	termediate embodied ross exports	Trade an margins in total gr	Trade and transport margins embodied in total gross exports	
	((Millions of dollars)	(Percentages of total gross exports)	(Millions of dollars)	(Percentages of total gross exports)	(Millions of dollars)	(Percentages of total gross exports)	
Costa Rica	12 702	9 794	77.1	2 765	21.8	143	1.1	
El Salvador	5 032	3 213	63.9	1 700	33.8	118	2.4	
Guatemala	10 119	7 697	76.1	2 252	22.3	170	1.7	
Honduras	7 806	4 248	54.4	3 277	42.0	281	3.6	
Nicaragua	3 540	2 728	77.1	770	21.8	42	1.2	
Panama	11 065	9 375	84.7	1 561	14.1	130	1.2	
Total	50 263	37 054	73.7	12 325	24.5	884	1.8	

Source: Prepared by the authors on the basis of the Central American input-output table developed by the Economic Commission for Latin America and the Caribbean (ECLAC).

There are marked differences across the countries of the subregion with respect to the share of domestic value added in exports. Honduras and El Salvador have the lowest coefficients (54.4% and 63.9%, respectively). Panama has the highest (84.7%), followed by Costa Rica and Nicaragua (both 77.1%).

For the purpose of comparison, according to 2011 data from the OECD TiVA database, the share of domestic value added embodied in the exports of some South American countries, such as Argentina, Brazil, Chile and Peru, is over 85%. In the region covered by the United States-Mexico-Canada Agreement (USMCA), the average is 90%; and in the European Union, 87%.

The above figures correspond in large part to the open regionalism model of Central America, which was intended to ensure compatibility between specific integration policies and those aimed at boosting international competitiveness (ECLAC, 1994). In recent decades, this model has been characterized by the strengthening of subregional trade integration and the broadening of its areas of focus, while it has fostered trade liberalization, the signing of trade agreements with various partners from outside the region and the promotion of foreign direct investment (Martínez Piva, 2019a). Trade integration

between the countries of Central America, which stands out in Latin America, has thus coincided with participation in trade with countries outside the subregion, which is dominated by intermediate and final manufactured goods and aided by preferential tax regimes such as those governing free trade zones, maquilas and inward processing.¹¹

The sectoral composition of exports affects the proportions set out in table 2 with regard to domestic value added and the intermediate imports embodied in exports. For example, because of their very structure, manufactured goods exports tend to contain more imported intermediate inputs than do exports of services. In El Salvador, Honduras and Nicaragua, the highest absolute values for gross exports and domestic value added correspond to secondary sector exports, but they are also the most intensive in the use of intermediate imports. In Costa Rica, the secondary and tertiary sectors create the greatest value added of exports, while in Guatemala, the distribution of value added exported is relatively similar across the primary, secondary and tertiary sectors. In Panama, however, tertiary sector exports create most of the value added from trade, primarily through transport and tourism exports, which are less dependent on imported inputs.

In table 3, gross exports within the subregion are disaggregated into four components: domestic value added, foreign value added from countries within the subregion, intermediate imports from countries outside the subregion, and trade and transport margins incorporated into gross exports to the subregion. Each variable is presented for the country and the economic sector (primary, secondary and tertiary), in both absolute and relative terms, with respect to the total subregional exports of each country. In all Central American countries except Honduras, the share of domestic value added produced by subregional exports is lower than the share produced by total exports: for the subregion as a whole, the total share of the former is 64.7% (see table 3), compared with 73.7% for the latter (see table 2). The widest gaps between the two indicators are found in Guatemala (11 percentage points) and Costa Rica (6.8 percentage points). The fact that the share of domestic value added in subregional exports is lower than that of total exports could be related to the composition of the intraregional export basket of Central America.

Intermediate imports from outside the subregion, meaning inputs that are purchased from trading partners outside Central America and then incorporated into subregional exports, represent 30% of gross subregional exports. The highest share of intermediate imports from outside Central America in total subregional exports is observed in Honduras (35.8%), and the lowest, in Panama (14.9%).

There are also significant differences between sectors. On average, the share of domestic value added embodied in exports within the subregion for both the primary and tertiary sectors is more than 80%. In the secondary sector, in contrast, it averages 60.9%. In other words, although secondary sector subregional exports contribute the most to the creation of domestic value added in absolute terms, the content of domestic value added per dollar for secondary sector exports is US\$ 0.61, while for the primary and tertiary sectors, it is US\$ 0.81.

The fact that a smaller share of domestic value added is embodied in subregional secondary sector exports necessarily means that intermediate imports from outside the subregion account for a greater share: in the secondary sector, the figure is 33% on average, compared to 15.7% and 15.2% on average for the primary and tertiary sectors, respectively.

¹¹ The international trade strategy of Central America, based on free trade zone, maquila and inward processing regimes, has been widely studied. See Buitelaar, Padilla and Urrutia (1999), Granados (2003), Padilla and others (2008), Vargas Hernández (2010), Granados and Ramos Martínez (2012), ILO (2016) and Bamber and Frederick (2018).

Table 3

Central America: domestic value added, foreign value added from the subregion, and intermediate imports from outside the subregion embodied in gross exports of goods and services within the subregion, 2011 (Millions of dollars and percentages)

		Gross exports	within the subregion	Domest embodied within	ic value added in gross exports the subregion	Foreign values subregion e exports wit	ue added from the embodied in gross hin the subregion	Intermediate i the subregior exports wit	mports from outside n embodied in gross hin the subregion	Trade and t embodied within t	ransport margins in gross exports he subregion
Country	Sector	(Millions of dollars)	(Percentages of total gross exports)	(Millions of dollars)	(Percentages of gross exports within the subregion)	(Millions of dollars)	(Percentages of gross exports within the subregion)	(Millions of dollars)	(Percentages of gross exports within the subregion)	(Millions of dollars)	(Percentages of gross exports within the subregion)
Costa Rica	Primary	30	1.7	24	80.3	0	1.1	5	17.6	0	1.1
	Secondary	1 932	29.7	1 246	64.5	33	1.7	617	32.0	36	1.8
	Tertiary	641	14.2	560	87.4	4	0.6	74	11.6	3	0.4
	Total	2 602	20.5	1 830	70.3	37	1.4	697	26.8	39	1.5
El Salvador	Primary	34	19.7	26	78.7	1	2.1	6	17.2	1	2.0
	Secondary	1 738	53.3	921	53.0	70	4.0	684	39.4	63	3.6
	Tertiary	665	41.6	476	71.5	21	3.2	153	22.9	16	2.4
	Total	2 437	48.4	1 423	58.4	92	3.8	842	34.6	80	3.3
Guatemala	Primary	109	3.8	94	85.5	0	0.4	14	13.0	1	1.1
	Secondary	2 280	50.8	1 329	58.3	29	1.3	853	37.4	69	3.0
	Tertiary	683	24.8	577	84.4	5	0.7	95	13.9	7	1.0
	Total	3 072	30.4	1 999	65.1	34	1.1	962	31.3	77	2.5
Honduras	Primary	19	3.3	14	73.8	1	3.4	4	20.7	0	2.1
	Secondary	2 364	39.4	1 224	51.8	136	5.8	912	38.6	91	3.8
	Tertiary	487	38.9	356	73.1	12	2.4	110	22.6	9	1.9
	Total	2 869	36.8	1 594	55.5	149	5.2	1 027	35.8	100	3.5
Nicaragua	Primary	56	10.0	48	86.0	1	2.0	6	11.0	1	1.1
	Secondary	496	22.6	323	65.1	31	6.3	132	26.6	10	2.0
	Tertiary	237	30.1	210	88.7	6	2.7	19	8.1	1	0.4
	Total	789	22.3	581	73.7	39	4.9	157	19.9	12	1.5
Panama	Primary	9	3.3	8	83.3	0	0.6	1	14.7	0	1.4
	Secondary	212	18.7	154	72.7	2	0.9	51	24.1	5	2.3
	Tertiary	782	8.1	673	86.1	4	0.5	97	12.4	8	1.0
	Total	1 003	9.1	835	83.2	6	0.6	149	14.9	13	1.3
Overall total		12 772	25.4	8 261	64.7	356	2.8	3 834	30.0	321	2.5

Source: Prepared by the authors on the basis of the Central American input-output table developed by the Economic Commission for Latin America and the Caribbean (ECLAC).

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Meanwhile, the average share of foreign value added from the countries of the subregion is 2.8%. This figure corresponds to purchases of intermediate inputs within the subregion that are later incorporated into exports to the subregion. By sector, the average share of foreign value added of countries of the subregion is 3.3% in the secondary sector, 1.6% in the primary sector and 1.7% in the tertiary sector. Those relatively low numbers are an initial indicator of the scarcity of productive trade linkages between Central American countries. A breakdown of Central American trade indicates a high level of domestic value added content and imports of intermediate inputs from outside the subregion, but a low level of intermediate inputs purchased from other Central American countries.

Honduras is the country with the highest share of subregional foreign value added in exports within Central America (5.2%, equivalent to US\$ 149 million), followed by Nicaragua (4.9%, equivalent to US\$ 39 million) and El Salvador (3.8%, equivalent to US\$ 92 million). In Guatemala and Panama, the shares are lower: 1.1% (equivalent to US\$ 34 million) and 0.6% (equivalent to US\$ 6 million), respectively.

The sectoral composition of exports within Central America, in terms of domestic value added and the imports required to produce them, is influenced by the development strategy applied by the countries of the subregion over the past 30 years. As noted by Martínez Piva (2019b), trade within the subregion largely consists of natural resource-based and low-technology manufactures (56% in 2016). For these reasons, despite the fact that the secondary sector is the source of most subregional exports, it is also the sector that contributes the least to the value added per unit of product exported.

This phenomenon is analysed in greater detail in figure 3. The horizontal scale shows the share of domestic value added in subregional exports. The vertical scale shows imports from outside the subregion as a percentage of exports to the subregion.



Source: Prepared by the authors on the basis of the Central American input-output table developed by the Economic Commission for Latin America and the Caribbean (ECLAC).

Note: The size of each sphere is proportionate to the value of exports within the subregion for each sector.

The coordinate axes intersect at the point representing the average for the indicators selected (74.7% and 21.3%), defining four areas in the plane. Given the accounting complementarity between the variables, the sectors are distributed along a straight line with a negative slope. Sectors that are intensive in the use of intermediate inputs imported from outside the subregion, meaning sectors in

which the share of those inputs is greater than the share of domestic value added embodied in exports to the subregion, are located in the upper left-hand section (quadrant II). In contrast, sectors in which the share of domestic value added is greater than the share of the imports required for exporting which originate from outside the subregion are located at the bottom right (quadrant IV).

The colour of the sphere represents the three main groups of productive activity: primary sector (dark color), secondary sector (light blue) and tertiary sector (red). The size of each sphere is proportionate to the value of exports to the subregion for each sector.

As mentioned, the secondary sector is the main generator of domestic value added from subregional exports in absolute terms. However, one fact worth noting from figure 3 is that, in relative terms, the secondary sector contributes the least to the generation of domestic value added: it ranges from 51.8% in Honduras to 65.1% in Nicaragua (the secondary sector of Panama is an exception, with a share of 72.7%). As a consequence, the secondary sector accounts for the largest share of inputs imported from outside the subregion per unit of product exported. In the secondary sectors of El Salvador, Guatemala and Honduras, these inputs represent just over 37% of total exports to the subregion; in Costa Rica, they account for 32%; and in Nicaragua and Panama, the corresponding amounts are 26.6% and 24.1%, respectively.

In contrast, in the tertiary sector, the share of domestic value added embodied in exports within Central America is significantly higher: in El Salvador, it is 71.5%; in Honduras, 73.1%; and in the rest of the countries, it varies between 84% (in Guatemala) and 88.7% (in Nicaragua). The share of inputs imported from outside the subregion is therefore lower in the tertiary sector: 22% in El Salvador and Honduras and less than 14% in the rest of the countries in the subregion.

Along the same lines, primary sector exports within the subregion are characterized by a higher share of domestic value added, ranging from 73% (in Honduras) to 86% (in Nicaragua). However, because primary exports within the subregion make up a smaller share of total exports, the impact of this on the total share is limited.

To sum up, domestic value added and intermediate imports from outside the subregion embodied in exports to Central America vary by sector. With regard to the subregional average, secondary sector exports to the subregion account for the highest share of intermediate imports from outside the subregion, while those from the tertiary and primary sectors chiefly include domestic value added.

The indicators analysed above for domestic value added, foreign value added and the intermediate imports required for exporting are the traditional indicators for vertical specialization, which focus only on the role of total gross exports as a generator of value added. This article analyses, in addition to those indicators, the value added created by total imports within Central America. Below is the analysis of trade-induced value added in the subregion, meaning the value added created in Central America from exports and imports within the subregion.

Table 4 shows the value added created by trade within the subregion, broken down according to five variables: (i) domestic value added embodied in subregional exports; (ii) foreign value added originating in countries of the subregion and embodied in subregional exports; (iii) bilateral value added created by subregional imports; (iv) multilateral value added created by subregional imports; and (v) reimported value added created by subregional imports. Each variable is presented for the country and economic sector (primary, secondary and tertiary), both in absolute and relative terms with regard to the total value added contributed by the trade of each country within the Central American subregion.

Soutor	Value added contributed by	(1) Domestic value added embodied in gross subregional exports		(2) Foreign value added embodied in gross subregional exports		(3) Bilateral value added		(4) Multilateral value added		(5) Reimported value added	
0000	(Millions of dollars)	(Millions of dollars)	(Percentages of value added created by subregional trade)	(Millions of dollars)	(Percentages of value added created by subregional trade)	(Millions of dollars)	(Percentages of value added created by subregional trade)	(Millions of dollars)	(Percentages of value added created by subregional trade)	(Millions of dollars)	(Percentages of value added created by subregional trade)
Primary	77	24	31.2	0	0.4	52	67.4	1	0.7	0	0.3
Secondary	1 865	1 246	66.8	33	1.8	534	28.6	41	2.2	11	0.6
Tertiary	1 043	560	53.7	4	0.4	471	45.2	5	0.5	2	0.2
Total	2 985	1 830	61.3	37	1.2	1 057	35.4	47	1.6	14	0.5
Primary	102	26	25.9	1	0.7	74	72.6	1	0.6	0	0.2
Secondary	2 184	921	42.2	70	3.2	1 138	52.1	40	1.8	16	0.7
Tertiary	1 199	476	39.7	21	1.8	692	57.7	8	0.7	2	0.2
Total	3 486	1 423	40.8	92	2.6	1 904	54.6	48	1.4	18	0.5
Primary	124	94	75.4	0	0.3	29	23.7	0	0.3	0	0.3
Secondary	2 302	1 329	57.7	29	1.3	870	37.8	37	1.6	36	1.6
Tertiary	1 172	577	49.2	5	0.4	577	49.3	8	0.7	5	0.5
Total	3 597	1 999	55.6	34	0.9	1 477	41.1	45	1.3	42	1.2
Primary	44	14	31.3	1	1.4	29	66.3	0	0.8	0	0.2
Secondary	2 625	1 224	46.6	136	5.2	1 212	46.2	43	1.6	9	0.4
Tertiary	887	356	40.1	12	1.3	509	57.4	9	1.0	2	0.2
Total	3 555	1 594	44.8	149	4.2	1 750	49.2	52	1.5	11	0.3
Primary	69	48	69.6	1	1.6	20	28.3	0	0.5	0	0.0
Secondary	1 335	323	24.2	31	2.3	931	69.8	47	3.5	3	0.2
Tertiary	611	210	34.4	6	1.1	388	63.5	6	0.9	1	0.1
Total	2 015	581	28.8	39	1.9	1 339	66.5	53	2.6	3	0.2
Primary	17	8	44.0	0	0.3	9	55.0	0	0.6	0	0.1
Secondary	686	154	22.4	2	0.3	511	74.6	17	2.5	1	0.2
Tertiary	894	673	75.3	4	0.4	213	23.9	3	0.4	0	0.0

734

8 261

46.0

47.9

21

266

1.3

1.5

2

90

0.1

0.5

Table 4 Central America: breakdown of the value added created by trade within the subregion, by anchor country, 2011 (Millions of dollars and percentages of value added created by subregional trade)

Source: Prepared by the authors on the basis of the Central American input-output table developed by the Economic Commission for Latin America and the Caribbean (ECLAC).

0.4

2.1

6

356

Country Sector

Costa Rica

El Salvador

Guatemala

Honduras

Nicaragua

Panama

Overall total

1 597

17 234

835

8 261

52.3

47.9

Total

An analysis of table 4 shows at least three important findings. First, in all the countries considered, domestic value added embodied in subregional exports (column 1) and bilateral value added created by imports into each country of the subregion (column 3) account for more than 90% of the value added created by subregional trade. Second, in all the countries of Central America save Panama, there is a strong secondary sector component in the value added contributed by trade within the subregion. Third, the share of foreign subregional value added embodied in exports between Central American countries and that of multilateral and reimported value added created from imports is low. These findings are examined in greater detail below.

As an example, an analysis is conducted of the components that correspond to Guatemala, the country with the greatest value added created by trade within the subregion (US\$ 3.597 billion). Of that figure, 55.6% (US\$ 1.999 billion) corresponds to domestic value added embodied in subregional exports, meaning that most of the value added created by Guatemalan trade is created in-country. However, bilateral value added (the value added created in other Central American countries as a result of Guatemalan imports from those countries) represents 41.1% (US\$ 1.477 billion) of the value added created by Guatemalan trade inputs that Guatemala purchases from other Central American countries, whose respective intermediate inputs that Guatemala from the subregion but from third countries. At the sectoral level, domestic value added embodied in exports is primarily created by secondary sector activity (66.5%); the same sectoral concentration can be seen in bilateral value added (58.9%).

Lastly, foreign value added embodied in subregional exports and multilateral and reimported value added embodied in imports represent just 3.4% of the value added created by Guatemalan trade within the subregion. This result reflects the fact that few subregional productive networks are created through Guatemalan trade with the other countries of Central America. If there were more networks, the share of these three indicators would be greater. If Guatemala's exports to Central America contained a higher share of subregional inputs, foreign value added originating in the subregion would be higher. Similarly, if Guatemala used intermediate inputs imported from El Salvador, for example, which in turn used inputs imported from Costa Rica, then multilateral value added would be higher. Likewise, if Guatemala were to use imported inputs which contained Guatemalan inputs previously exported to other countries in the subregion, reimported value added would increase.

Two groups of countries can be distinguished from the analysis of the Central American countries. In the first group, made up of Costa Rica and Panama, the share of domestic value added embodied in subregional exports is greater than the share of the bilateral value added created by imports, meaning that the share of domestic value added in the exports of these two countries is greater than the share of the value added imported from the other countries of the subregion. In Costa Rica, those proportions are 61.3% (US\$ 1.830 billion) for domestic value added, and 35.4% (US\$ 1.057 billion) for bilateral value added; for Panama, the proportions are 52.3% (US\$ 835 million) and 46% (US\$ 734 million), respectively.

In Costa Rica, both domestic value added embodied in subregional exports and bilateral value added are mainly created through secondary sector trade. In Panama, the tertiary sector accounts for most of the value added embodied in the country's exports to the subregion, while secondary sector imports account for more than half of the bilateral value added. As shown in table 4, the sum of foreign value added embodied in subregional exports, multilateral value added and reimported value added accounts for just 3.3% of the total value added created by trade within Central America for Costa Rica, and for just 1.8% for Panama.

In the second group of countries, made up of Guatemala, Honduras, El Salvador and Nicaragua, the share of domestic value added embodied in subregional exports is lower than the share of bilateral value added created by imports. This means that countries in this group import more value added from the subregion than they export to the subregion. In Honduras, domestic value added embodied in subregional exports accounts for 44.8% (US\$ 1.594 billion), and bilateral value added accounts

for 49.2% (US\$ 1.750 billion) of trade-induced value added. In El Salvador, these figures are 40.8% (US\$ 1.423 billion) and 54.6% (US\$ 1.904 billion), respectively. The figures for Guatemala have already been analysed in this section.

Nicaragua is the Central American country with the least value added created by subregional trade (US\$ 2.015 billion): of that figure, 28.8% (US\$ 581 million) corresponds to domestic value added and 66.5% (US\$ 1.339 billion) to bilateral value added. In other words, Nicaraguan imports from the subregion have the highest share of bilateral value added of all the Central American countries. In sectoral terms, secondary sector trade is the main source of both domestic and bilateral value added in all the countries of this group.

In the four countries of the second group, foreign value added from the subregion embodied in exports to Central America and multilateral and reimported value added created by imports are also low: the sum of their shares is 4.5% in El Salvador, 3.4% in Guatemala, 6% in Honduras and 4.7% in Nicaragua. Honduran exports to the subregion therefore incorporate the greatest share of imported inputs from the Central American subregion.

The figures presented above reflect the volume and composition of the value added created by trade within the Central American subregion from a new perspective, using various measurements of domestic, foreign and subregional value added from the first Central American input-output table. Costa Rica and Panama are net exporters of subregional value added; El Salvador, Guatemala, Honduras and Nicaragua, in contrast, are net importers.

The results presented bolster the conclusions reached in previous studies on the basis of traditional trade statistics. Durán-Lima and Zaclicever (2013), for example, in their analysis of trade in intermediate goods (exports and imports), have found that Latin America is not a significant destination and origin of intraregional trade. In this context, compared with other subregions of Latin America and the Caribbean, and considering gross trade in intermediate goods to be an indicator of value chain participation, exports within the Central American subregion are more intensive in intermediate goods (an average of 42% in the 2010–2011 biennium). However, analysis of cross-industry bilateral trade (using the Grubel-Lloyd index) shows that some regional value chains exist, and that El Salvador is the Central American country that trades most with the subregion.¹²

As argued by Durán-Lima and Zaclicever (2013), input-output tables present the most accurate methodology for evaluating the participation of Latin American countries in international value chains, as they make it possible to capture not only the value added contributed by each economy but also the existing productive interrelationships between countries. This study, which focuses on intersectoral trade relations in Central America as a whole, measured in terms of value added, aligns with that assertion.

V. Conclusions

The data from the first Central American input-output table confirm the importance, in gross terms, of subregional trade. However, the data also indicate that exports within Central America create less domestic value added than total exports and include significant intermediate inputs from outside the subregion, thus creating little value added in the subregion itself. These results suggest that there is a limited presence of long and deep production chains within Central America that can significantly increase value added through subregional trade.

¹² Orozco and Torres (2021) present an analysis of intraregional trade networks. The authors indicate that despite the prevalence of patterns of low integration between Central American countries and sectors, three clusters can be identified when examining import and export networks: (i) Costa Rica and Nicaragua; (ii) Honduras and Guatemala; and (iii) Honduras and El Salvador. The last cluster is determined by the relationships between the textile and garment sectors of both countries.

Calculations of the trade-induced value added (exports and imports) show that the share of subregional foreign value added embodied in subregional exports is low, as is the share of multilateral and reimported value added created by imports. The highest share is recorded in Honduras, where the sum of these values is 6%, while the lowest share is recorded in Panama, at just 1.8% of all subregional trade. In contrast, intermediate imports from countries outside the subregion account for an average of 30% of gross exports within the subregion.

In other words, imports from countries of the subregion create very little indirect value added, given the low share of intermediate inputs originating in the subregion, as represented by the low values for the indicators for multilateral and reimported value added. The statistics show that although the gross value of subregional trade is high, Central America is largely dependent on inputs from outside the subregion.

This analysis also shows that there are various profiles as regards trade within the subregion and value creation through exports and imports. In El Salvador, Guatemala, Honduras and Nicaragua, the share of domestic value added embodied in exports to Central America is lower than the share of bilateral value added created by imports; in Costa Rica and Panama, these proportions are reversed.

The open regionalism strategy has resulted in significant trade integration in Central America with regard to gross exports; however, exports include a significant share of intermediate inputs from outside the subregion. Participation in international trade outside Central America has been dominated by exports of semi-finished and final manufactured goods, which are produced in the context of preferential tax regimes, such as those governing free trade zones, maquilas and inward processing. The widely studied maquila model is characterized by the substantial incorporation of intermediate inputs into exported goods (Buitelaar, Padilla and Urrutia, 1999; Granados, 2003; Padilla and others, 2008; Vargas Hernández, 2010; Granados and Ramos Martínez, 2012; ILO, 2016; Bamber and Frederick, 2018).

Accordingly, these results indicate a need to strengthen existing regional linkages and foster the establishment of new ones that increase intraregional trade flows and value creation. To achieve this, progress is recommended in the areas mentioned below. First, there is a need to continue breaking down the administrative barriers that hinder full participation in the common market. This includes the filling out of customs forms, the processing of sanitary and phytosanitary certificates, and packaging requirements and inspections at various points of the export process, among others, which also raise the cost of imported products (Martínez Piva, 2019a). Second, the strengthening of subregional logistics and mobility policies would offer a huge opportunity to improve the efficiency and connectivity provided by mobility services at a much lower cost than providing services of the same quality on an individual basis (Pérez, 2017). Third, initiatives to enhance and promote production linkages and strengthen regional value chains must continue to be encouraged, to provide meaningful support so that small and medium-sized enterprises in Central America can access financing, technical assistance and innovation incentives, among others. Fourth, as this article shows, not all sectors offer the same opportunities for integrating domestic and intraregional value added. In line with Chiliatto-Leite (2021), therefore, regional integration strategies, could place special emphasis on the activities and sectors with the greatest potential for creating intraregional linkages; in other words, it is important for regional integration strategies to be combined with measures to promote structural change.

This article shows one of the applications of input-output tables with respect to the analysis of regional integration. A more in-depth analysis could look into specific sectors and value chains, such as those of textiles, garments and the agrifood sector, which are extremely important in Central America. Another avenue for future research would be to conduct a dynamic analysis by updating the subregional input-output table, making it possible to study changes in the indicators over time. Through dynamic analysis, a more in-depth study could be conducted of the international trade participation patterns of Central American countries, such as variations in domestic and subregional value added over time. In that regard, ECLAC will continue to work with the governments of the region to build new regional input-output tables that can facilitate the dynamic analysis proposed, using the most recent information available.

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Energy security in Central America: a proposal for a comprehensive estimate

Daynier Escalante Pérez

Abstract

This paper presents a set of indicators for the evaluation of energy security in Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. A study of the energy problems of each country established indicators suitable for producing an energy security index (ESI). These indicators were submitted to experts for validation, with the help of energy sector specialists from the Central American countries. The Delphi method was used to process the results, and all the indicators were approved. SPSS software was used to conduct a principal component analysis with the aim of compacting the number of indicators, losing as little information as possible and obtaining an interpretable solution. The ESI for each country was calculated from the resulting variables. The ESI trend in each country was examined in the light of domestic and international events that may have had an impact on the behaviour of the indicators.

Keywords

Energy resources, petroleum, electricity, energy security, evaluation, energy statistics, statistical methodology, energy policy, Central America

JEL classification

O21, Q48, Q43

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I. Introduction

Since late 2006, when the oil price reached its highest level in more than two decades and weather events on a scale that could not be ignored confirmed the reality of climate change, countries have focused on analysing the relationships between climate change, sustainable development and the undesirability of current fossil fuel use because of its effects on economic, social and political life throughout the world (Lamy, 2006). Taken together, these elements were judged by society to be critical to its progress and to the response required in the face of the potential threats, risks and challenges posed by the global context. As a result, a new term arose: energy security. The policies based on this new concept turned to energy supply security, with a focus on geopolitical concerns and the operational reliability of national energy systems. First and foremost, energy security must mean access to enough affordable energy to meet domestic demand (Blyth and Lefevre-Marton, 2005).

The definition of energy security has changed over time. Following the oil crisis of the 1970s, the concept was related to crude oil supply risk because of possible disruptions originating in the Middle East. Based on studies conducted in the present century, other factors that affect the stability of the fuel supply and increase the price of energy have been added to the definition, such as political conflicts, unexpected natural disasters, concerns about terrorism, and energy-related environmental challenges (Intharak and others, 2007).

Energy policies in the Central American countries address the need for access to affordable energy services. They have shifted the electricity generation matrix towards clean and more efficient energy, establishing goals for including more renewable energy and reducing fossil fuel dependence. However, the energy policy plans consulted barely touch on the concept of energy security, giving it little attention or importance.

This document assesses the energy security of seven Central American countries that are served by the subregional headquarters of the Economic Commission for Latin America and the Caribbean (ECLAC) in Mexico and by the ECLAC subregional headquarters for the Caribbean: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. The databases of the World Bank, the Latin American Energy Organization (OLADE) and ECLAC were consulted. All data were accessed in digital format. In the case of the OLADE database, information is available on a restricted basis for public bodies. In addition to data from the abovementioned organizations, official information from ministries of energy, companies and regulators was used along with data from each country's national press and the official websites of economic and political bodies to analyse the behaviour of the indices by country.

The second section of this article analyses energy security at the global level, considering various definitions and estimation methods. The third section presents the methodology used to estimate the energy security of the countries in the subregion. The fourth section presents the results of the principal component analysis carried out with the Statistical Package for the Social Sciences (SPSS) software and examines the trend of each country's energy security index (ESI) in the light of domestic and international events that may have had an impact on the behaviour of the indicators. Lastly, the fifth section presents the conclusions of the research.

II. Defining and estimating energy security

The World Energy Council (WEC, 2012) highlights the interest of developed and emerging countries alike in energy security, but notes that there is no shared vision among governments, organizations, academia and analysts on what the concept means, which remains a challenge. After reviewing more

than 40 definitions suggested in the literature, Sovacool and Mukherjee (2011) report that the concept is fuzzy and the set of attributes it encompasses depends on the researcher's interests and objectives.

From academic and institutional studies on the subject, it is clear that energy security concepts and the debate around them have changed over time as a result of technological advances, the diversification of energy sources, social concerns, environmental considerations and the influence of society on public decision-making, as well as the proliferation of energy threats and challenges (Herrero, 2016). For most of the twentieth century, energy security policy focused primarily on avoiding oil shortages. Now, however, the focus is on the availability of adequate, affordable and sustainable resources to meet the demand not just for oil, but for energy (Intharak and others, 2007; UNDP, 2000; WEC, 2012).

The International Energy Agency (IEA) defines the concept essentially as the uninterrupted ability to meet demand (IEA, 2022). In line with this perspective, Kleber (2009) stresses the need to keep infrastructure intact in order to avoid energy outages from natural, accidental or intentional events. For other authors, it is the desirable characteristics of the supply that matter; for example, it should be environmentally friendly, properly governed and socially acceptable (Sovacool and Mukherjee, 2011). For their part, Von Hippel and others (2011) identify four energy security challenges: (i) the environment, (ii) technology, (iii) demand management and (iv) social, cultural and political factors. While some authors favour a broad, comprehensive definition applicable to all types of countries (Vivoda, 2010), others argue that a tailored definition is needed to truly help countries improve their energy security (Cherp and Jewell, 2014).

There are various techniques for estimating energy security (Abdalla, 2005; Jansen and Seebregts, 2010; Kemmler and Spreng, 2007; Kruyt and others, 2009; Schipper and Haas, 1997; Sovacool and Brown, 2010; Sovacool and Mukherjee, 2011; Unander, 2005). Most use indicators and indices designed to reflect reliability, adequacy, economy, sustainability and other desirable attributes of the energy supply, depending on the definition used. Indicators allow a vast array of complex data to be concentrated into recognizable patterns. The number and variety of indicators varies considerably in the literature, from a few to hundreds. The gap between indicators in developed and emerging countries is wide because of the asymmetries between them, their different circumstances and the information available.

As with the estimation of other ill-defined concepts, estimating energy security entails methodological problems. For example, the more qualities are required of the energy supply, the more indicators will be needed to characterize it, and this dilutes the original and primary concern, which is to avoid supply disruption (Cherp and Jewell, 2014). The qualities demanded of the energy supply are concepts that are often equally vague (sustainability, resilience and robustness, among others), meaning that finding the best and most accurate indicators is also a problem. Another issue is the weight given to each indicator when calculating a synthetic index, i.e., the selection of uncorrelated indicators, weighting factors and standardization criteria. Indicator selection is also critical when conducting analyses comparing different countries with substantially different energy security problems. Tanaka (2011) cautions that the characteristics and needs of each country or region are different, which makes it inappropriate to rely on uniform criteria for assessing energy-related issues.

For years, the Organization of American States (OAS) has been calling for urgent, concerted action to ensure that energy uncertainty does not undermine the prosperity of Latin America and the Caribbean. OAS has also called for progress in energy efficiency and integration and advocates cooperation in this field among all countries that have renewable energy initiatives with the aim of achieving energy sustainability (OAS, 2010 and 2014).

III. Methodology for evaluating energy security in Central America

An economy that can decouple economic growth from energy use through energy efficiency and conservation will have an energy security advantage. Several factors can influence energy supply security, including the availability of fuel reserves, the ability to procure supplies, the level of diversification of energy resources and suppliers, the accessibility of fuel resources in terms of availability of the requisite energy and energy transportation infrastructure, and geopolitical concerns related to resource procurement (Intharak and others, 2007).

The situation of each country's energy sector was analysed in the light of these factors, with a particular focus on difficulties that currently pose a problem for energy security. This analysis yielded a set of national indicators that each country can use to assess its energy security in the light of its own problems. The analysis of the issues in the countries of the subregion resulted in 40 indicators reflecting factors such as the independence, availability, reliability, affordability and quality of the energy supply.

Given the differing characteristics of the energy sector in the countries studied and the availability of experts to carry out the research, it was decided to conduct a Delphi-type survey. The following were considered in selecting the 45 experts who participated: (i) years of experience in the sector, (ii) knowledge of the topic under investigation, (iii) academic background, (iv) availability to participate in the research and (v) the general criterion of analytical capacity. The surveys were carried out in four stages (diagnosis, design, implementation and evaluation). From the third stage onward, the survey was carried out in a single round. It was thus not an iterative process, besides which feedback from each round (statistical information) was limited, but it was agreed that it was important to avoid exhausting the panel and to ensure that the results were not skewed.

Víctor Hugo Ventura Ruiz, who was Chief of the Energy and Natural Resources Unit at the ECLAC subregional headquarters in Mexico at the time, sent out email invitations for the survey. Responses were received in two ways, 8 via links and 27 in the form of email attachments. Of the 35 specialists who responded to the questionnaire, 34 had a high overall average rating (a competence level of 0.81), so the responses can be said to have been of good quality, and 58.8% had worked in the energy sector for more than 20 years. The opinions expressed by the experts were tabulated and statistically processed. The indicators were recognized by the experts as highly suitable (36.6%), clearly suitable (61%) and suitable (2.4%). From all the data validated by the experts, information on 29 indicators was obtained (see table 1). The time series period taken as the baseline was 2000–2017. Data from OLADE (2019), ECLAC (2019) and the World Bank (2019) were used. All data were accessed electronically. In the case of the OLADE database, information is available on a restricted basis for public bodies.

✓ Self-sufficient in energy	 Diversification of petroleum product suppliers
✓ Dependent on imported energy	\checkmark Diversification of external supply sources for oil and derivatives
✓ Dependent on imported gasoline	✓ Crude oil storage
✓ Dependent on imported diesel	✓ Gasoline storage
✓ Dependent on imported electricity	✓ Diesel storage
\checkmark Dependent on petroleum products in the transport sector	✓ Liquefied petroleum gas (LPG) storage
✓ Dependent on firewood in the residential sector	✓ Kerosene storage
✓ Inflows of currency for oil imports	✓ Fuel oil storage
✓ Currency generated by the hydrocarbon subsector	✓ Refineries' share of petroleum products consumed

Table 1 Central America: indicators of energy security

✓ Energy intensity	 Diversification of electricity generation
✓ Processing efficiency	✓ Electricity losses
✓ Diversification of energy production	✓ Rate of electricity coverage
✓ Diversification of energy consumption	✓ Affordability of gasoline
✓ Diversification of fossil fuel consumption	✓ Affordability of diesel
	 Affordability of residential electricity

Since the variables had different measurement units and scales, they were standardized unidirectionally (positive) in relation to the ESI, as proposed by Gupta (2008). In other words, the higher the value of the variable, the higher the ESI. The adjustment transformed all selected variables into the 0–1 scale, with 0 being the lowest value of the indicator, representing energy insecurity, and 1 being the highest value for energy security.

With the indicators standardized, principal component analysis was applied to construct the ESI. The SPSS statistical software package was used for this. When the descriptions of the principal component analysis in SPSS are analysed, it can be seen that this method is suitable. In this study, values above 0.7 are taken as a strong correlation (positive or negative). In deriving the principal components, the ESIs for each country and for the subregion as a whole (*ESI*_k) are calculated as a weighted sum of the components (C_n) within the total change in the ESI (sum of all eigenvalues) (see equation (1)). The weights (λ_n) are the variances of the successive principal components. The components are calculated as a linear average.

$$ESI_{k} = \frac{\lambda_{1}C_{1} + \lambda_{2}C_{2} + \dots + \lambda_{n}C_{n}}{\lambda_{1} + \lambda_{2} + \dots + \lambda_{n}}$$
(1)

The statistics confirmed the suitability of each of the analyses performed in SPSS.

IV. Analysis and discussion of the ESI evaluation

This chapter presents the ESI results obtained. It does not provide an analysis of the trend projection of the index, but rather a brief description of its behaviour in the period under study and the possible causes of this.

The ESI values for the subregion are confined to a range of 0.53 to 0.57. Figure 1 shows a number of up and down cycles in the ESI, with a declining trend. Dependence on the international oil price influences all countries in the subregion as net importers. For this reason, every fluctuation of the index is associated with the behaviour of oil shocks. The shutdown of refineries in several countries, rising imports (mainly from the United States), the growth of the vehicle fleet, international and national economic crises, increased electricity generation and the introduction of other energy sources for residential consumption are other events affecting the behaviour of the ESI in Central America that will be observed when each country is examined.



Figure 1 Central America: energy security index

1. Belize

The objectives of the national sustainable energy strategy launched by the Government of Belize include improving energy security by developing renewables and adopting more efficient energy transformation technologies. Given that Belize has no refineries and has to import all the petroleum products it needs, international oil market volatility is recognized as a vulnerability, which motivates the government's efforts to focus sectoral planning on increasing energy independence. In this context, the decline of oilfields and the possible suspension of offshore oil activities to avoid environmental damage that could affect tourism, one of the country's main sources of income, are of concern. Efforts to achieve self-sufficiency notwithstanding, regional integration is seen as a vital strategy to ensure the availability and reliability of the energy supply (MESTPU, 2012).

Although Belize's index value was the lowest of any country in the subregion in the early 2000s, it was the fastest-growing during the period, with marked up and down cycles (see figure 2). The index remained low from 2000 to 2005, precisely because of the country's heavy dependence on energy imports, which affects all indicators. Oil was found in 2005 by Belize Natural Energy together with European companies (SICA, 2005), and oil production increased in the following years. Energy production rose and imports fell as a result. Oil exports began in 2006, and a portion of output was allocated to power plants. Rising international oil prices and exports in those years caused the oil balance to shrink and turn positive in 2008.

In 2007, Belize's economy was affected by Hurricane Dean. Coupled with the global economic recession in 2008 and a drop in domestic tourism, this sent that year's recovery into reverse. The economy stagnated in 2009 and recovered in 2010 (The Commonwealth, n.d.). The crisis was also reflected in energy security, as oil consumption increased in a number of sectors. This situation led to an increase in imports, which, coupled with high oil prices on the world market, resulted in a very small negative oil balance in 2009. As the country recovered from economic stagnation in 2010, oil exports grew by 71% to US\$ 103.1 million owing to higher prices. There was also a sharp increase in electricity generation, especially from hydroelectric power plants (ECLAC, 2011). The oil production curve peaked in 2011 (González García, 2013), and as domestic crude output began to decline, fuel exports were also limited and imports increased.



Figure 2 Belize: energy security index

The ESI rose from 2013 to 2017. Electricity imports from Mexico decreased from 38.7% of total consumption to 26.6% in those years owing to increased production from renewable sources. Energy intensity increased as a result of measures implemented by the government to improve energy efficiency (ECPA, 2017). The electricity price decreased in 2017, as did average consumption per consumer (Rojas Navarrete, 2018). Electricity consumption increased owing to the progress of electrification in the country, especially in rural areas (ECPA, 2017). In addition, LPG consumption increased because of low prices (BBN, 2019), which meant a reduction in residential firewood consumption.

2. Costa Rica

Although Costa Rica has seen a slight recovery in this area in recent years, the country's energy security has declined (see figure 3). This deterioration, mainly from 2004 to 2015, was associated with the volatility of oil prices on the international market, the reduction in storage capacity due to the shutdown of several storage facilities (ECLAC, 2013) and the gradual decline in refined oil production, which was discontinued altogether in 2011 with the permanent closure of the Costa Rican Oil Refinery (RECOPE). This resulted in a higher oil bill, a reduced diversity of fuel suppliers and increased dependence on oil products from the United States (Salazar, 2016).

The ESI has been gradually increasing since 2016, mainly owing to a decline in domestic gasoline and diesel prices. The likely cause of this decline has been the collapse of international prices, coupled with an increase in the minimum wage (ECLAC, 2019). Furthermore, in the residential sector, biomass (firewood) for cooking has been gradually replaced by other fuels, mainly electricity, whose share increased from 42% to 63% from 1990 to 2015, while that of firewood decreased from 49% to 25% (ECLAC, 2018b). The rise in the ESI is linked to the fulfilment of energy strategies aimed at harnessing natural resources and increasing energy efficiency. The national energy system has been strengthened by clean electricity generation, mainly by hydropower plants, which poses energy security challenges because of the risk posed by droughts. The remarkable progress with electricity points up the difficulties encountered in reducing oil consumption, whose share of the energy mix remains high, at 63% in 2015 (Zárate Montero and Ramírez García, 2016).



Figure 3 Costa Rica: energy security ind

3. El Salvador

El Salvador shows a marked downward trend in energy security, which began to decline in 2002 (see figure 4), mainly because of rising imports of petroleum products and electricity, low momentum in efforts to harness local energy sources and high consumption of firewood by the residential sector. From 2008 to 2012, the ESI rose because fuel supply operations were launched by Puma Energy and Grupo Terra, which, together with other domestic companies, contributed to a greater diversification of suppliers (ECLAC, 2019). Storage capacity for gasoline and fuel oil has increased and it remains high for diesel, possibly because the Acajutla oil refinery began operating as a storage terminal when it was shut down. According to Puma Energy, it is more economically efficient to import fuels than to import crude oil and process it (Cabrera, 2015).



Source: Prepared by the author.

The shutdown of the refinery in 2012 drove up purchases of refined products and the oil bill, which accordingly weighed on the trade balance. Since 2013, imports have accounted for 70% of the total energy supply. The majority of petroleum products are supplied by the United States, and final consumer fuel prices are aligned with international market trends (ECLAC, 2019; CNE, 2013). There is neither a high level of hydrocarbon storage nor a diversity of storage sites. Other causes contributing to the low index value in 2017 were: (i) the growth of the vehicle fleet, leading to higher consumption in the transport sector (Peñate, 2018) and (ii) higher imports of electricity, which is purchased in the Regional Electricity Market (MER), as this is cheaper and means that consumers can be charged less for the service (Linares, 2019).

4. Guatemala

Figure 5 shows Guatemala's ESI, one of the highest in the subregion. Among the main factors contributing to its stability has been the performance of the electricity subsector, whose electricity exports make the country the main supplier to the Electricity Interconnection System for the Countries of Central America (SIEPAC). Another positive aspect is the price of electricity for the residential sector, which has made Guatemalan rates the lowest in the Central American isthmus since 2017. The fuel storage and distribution infrastructure, which is internationally classified as adequate and reliable, is another noteworthy feature (ECLAC, 2019).



Source: Prepared by the author.

The decline in the ESI since 2002 is essentially due to falling crude oil production and increased imports of refined products. Most oil production (90%) goes to the international market. The rest is used to generate electricity and to surface streets and roads (Espinasa and others, 2013a). Closure of the Escuintla refinery in 2002 led to the cessation of crude oil imports and an increase in purchases of finished products. Dependence on imports of oil and petroleum products from the United States has been rising, reaching 80% in 2017 (ECLAC, 2019). Increased theft and a booming black market in fuels are also undermining energy security.

The values of some indicators have fluctuated since 2008, causing the index to rise and fall. Some of the reasons for these results are: (i) imports of oil, its derivatives and coal have increased since 2009

(OLADE, 2019), owing largely to the growing demand from the San José thermoelectric plant (Espinasa and others, 2013a); (ii) the vehicle fleet has expanded, with a consequent increase in fuel consumption (Bolaños, 2016; Marroquin, 2018); (iii) high oil prices in the international market have affected the oil balance (Carcar, 2012), domestic fuel prices and the affordability of derivatives (Anaya, 2018); and (iv) residential firewood consumption is high owing to the absence or inaccessibility of modern energy services, which forces much of the Guatemalan population to resort to this fuel to meet their needs (INAB, 2015).

In the face of external dependence, there has been no lack of interest in harnessing local energy resources within a framework of sustainability (ENEE, 2016; Koberle, 2012; MEM, 2019; Ortiz, 2014). The objective of the National Energy Plan 2017–2032 is to enhance energy security by increasing the reliability of electricity grids and keeping rates stable (MEM, 2017, p. 96). However, it does not place as much emphasis on the issue of imported hydrocarbons and petroleum products, perhaps because of the limited scope for action to reduce this dependence. So far, the main efforts and achievements have centred on the diversification of electricity generation (MEM, 2018), although the importance of investing to increase efficiency, rationalize consumption and expand coverage, especially in rural areas, is also recognized (MEM, 2017). This last objective is fundamental to achieving universal access to modern energy, as firewood continues to be the most heavily consumed energy product in the residential sector, and replacement by LPG is not a sustainable option (INAB, 2015).

5. Honduras

Energy security in Honduras has improved steadily since the turn of the millennium (see figure 6). The ESI fell from 2006 to 2007, a development associated with increased imports from the United States, a shortage of fuel storage infrastructure (Domínguez Amador, 2014) and a 15.4% increase in the vehicle fleet (Benegas, Barahona and others, 2012). This caused the transport sector to increase its consumption by 14.1% from one year to the next. The ESI rose between 2007 and 2008 as fuel consumption in the transport sector fell (ECLAC, 2018a). Fuel imports from the United States also declined, while the share of imports from other countries, such as the Bolivarian Republic of Venezuela and Ecuador, increased. In addition, storage levels increased from one year to the next (OLADE, 2019), and electricity rates increased because of the rise in the international oil price (*Proceso*, 2011).



Source: Prepared by the author.

The ESI fell considerably from 2008 to 2010, owing to the global economic slowdown resulting from the financial crisis and to the economic, trade and non-economic sanctions imposed because of the political situation in the country after the coup d'état in June 2009. Some of the measures that affected the energy sector were: (i) the suspension of oil subsidies by PetroCaribe, (ii) the imposition of economic sanctions by the United States, and (iii) the suspension of all loans from the World Bank, the International Monetary Fund and the Inter-American Development Bank. These crises caused domestic production, consumption and imports to contract and affected supplier countries and companies, among others (*La Prensa*, 2011).

As the political crisis of 2009 was progressively overcome, the country began growing once again and economic and energy security indicators improved. With no oil fields or refineries, Honduras must import the petroleum products it consumes. In 2013, the oil bill accounted for 18% of total imports. Three companies (Texaco, Unopetrol and Puma Energy) dominate imports and supply. Fuel consumption has been subject to the volatility of international market prices since the abolition of oil subsidies in 2009. By 2017, 87.69% of the rural population in the country had begun increasing their firewood consumption, mainly as an energy source (Secretariat of Energy, 2018).

In recent years, dependence on petroleum products has dropped as the resources consumed to generate electricity have decreased because of progress with renewables and a rise in electricity imports. Honduras is the only country in the subregion with three regional electricity interconnections. Growth in electricity generation from clean energy sources has been steady. The country is home to the largest solar photovoltaic park in Latin America and the Caribbean. New hydropower plants and wind farms are also expected to come on stream (Twenergy, 2017). Unfortunately, the improvement on the generating side has not been reflected in increased affordability. Electricity coverage remains the lowest in the subregion, and electricity consumption has not increased despite population growth. Electricity rates are high and unstable owing to the still-large share of thermal power plants in the generating mix.

Despite this unevenness, the electricity subsector is leading growth in the energy sector. Some of the factors contributing to this are the availability of abundant renewable resources for electricity generation, a legal framework for the electricity subsector that makes it open to domestic and foreign investment, the removal of barriers to regional trade, and the strengthening of regional institutions and regulations, as well as domestic and regional infrastructure (PROHONDURAS, 2016). In addition, development policy and energy policy reflect the Sustainable Development Goals. However, energy security is subsumed in other objectives and has not emerged as an explicit goal matched by strategies to achieve it (ENEE, 2016; ECLAC, 2018a; PROHONDURAS, 2016).

6. Nicaragua

Energy security in Nicaragua declined until 2008 (see figure 7) and, although it recovered the following year, its behaviour has been erratic. This trajectory reflects economic difficulties and an unfavourable international environment. Between 2003 and 2008, the country experienced an energy crisis with constant electricity rationing (Ortega Hegg, 2007). Obsolescent equipment, lack of maintenance and heavy dependence on oil derivatives for power generation led to power cuts and high electricity prices. Once the shortages had been dealt with, recovery was undermined by a decline in output of refined products, increased imports of both petroleum products and electricity, and higher electricity rates (ECLAC, 2013). Inadequate infrastructure and weak competition in supply markets make Nicaragua the Central American country with the highest pre-tax fuel prices. Although storage capacity has increased, there is still not enough to take advantage of economies of scale in fuel imports (Álvarez Hidalgo, 2016).



Figure 7 Nicaragua: energy security inde

Electricity coverage and the use of renewable energy sources in electricity generation have increased in recent years (CONICYT, 2017). Nicaragua joined SIEPAC and regional electricity market operations in 2016. Residential consumption of firewood has been decreasing as modern energy sources have gained ground, although it has not been replaced by electricity but instead by LPG, an imported product (Alexander von Humboldt Centre, 2018). The objective of energy policy is to harness the potential of renewable sources in order to improve the sustainability of the energy mix, in particular by eliminating electricity generation with petroleum derivatives (Espinosa, 2016). However, energy security is not an explicit priority; rather, the focus is on the efficiency, coverage and quality of the electricity sector (ENATREL, 2016; PRONicaragua, 2019). A transition towards a national energy efficiency policy that contributes to national energy security is envisaged, but the concept is not defined (ECLAC, 2015).

The geopolitical risks of external dependence have emerged starkly in recent years. Because the United States displaced the Bolivarian Republic of Venezuela as the main fuel supplier, Nicaragua was hit hard by the economic sanctions imposed by the Trump administration. The Nicaraguan government's response was to create public companies and nationalize existing firms to ensure continuity of supply.

7. Panama

Energy security in Panama declined dramatically between 2001 and 2011 (see figure 8). Contributing factors included the transformation of the local refinery into a fuel import centre (Sánchez, Valdés and Castrellón, 2002) and the increase in the oil bill caused by burgeoning imports of refined products, which are more expensive than crude oil. The electricity bill was also affected, as more than 40% of generation in the period was with fossil fuels. Energy security has been on a more or less stable trend since 2011, but at lower levels than at the turn of the millennium. This stability has been achieved despite oil price volatility in the international market (SNE, 2016), which is reflected in domestic fuel prices and electricity rates (Espinasa and others, 2013b; Sánchez González, 2018). Firewood consumption has been decreasing since 2014 because of the penetration of subsidized LPG for the lower-income population (IDB, 2016). This replacement offers some advantages, but postpones the switch to electricity, which is the best option in terms of energy security and sustainability.



Figure 8

Thanks to the abundant potential of its renewable energy resources, the country has the opportunity to profitably meet its long-term energy needs and support its transition to a sustainable energy future. Panama's energy policy focuses on securing fuel and electricity supplies, diversifying the energy mix, reducing the carbon footprint and using energy rationally and efficiently. Panama also seeks to foster integration with the countries of the subregion in order to boost competitiveness and efficiency, thereby contributing to sustainable economic growth in the subregion and strengthening energy security in Central America (ETESA, 2017; SNE, 2016). The National Energy Plan 2015–2050, the energy sector diversification plan, reflects the ambition to achieve greater energy security in Panama, but although the concept is mentioned, neither its meaning nor the concrete measures required to achieve it are spelled out. The reliability and quality of supply in the electricity system are not high, despite the restructuring of the interconnection system in recent years. Nevertheless, there are projects in the subsector to generate 77% of electricity from renewable sources by 2050 (SNE, 2016).

V. Conclusions

The purpose of this research was to analyse the behaviour of energy security in the countries of Central America so far this century, with the help of a number of indicators validated by experts from the different countries that make up the subregion, in order to reflect on the design and fulfilment of energy policy strategies in each of these countries. The conclusions drawn from this work are set out below.

Local circumstances and sensitivity to energy security vary from country to country. As a result, the actions taken and the results achieved are bound to be different in each. None of the countries has had serious energy security problems, with the exception of Nicaragua, which had to take emergency measures as a result of economic sanctions imposed by the United States government.

Although Belize has been the best performer in terms of energy security, it has achieved this with oil. This is useful in the short and medium term, but not in the long term, because the energy transition to a lower-carbon economy is already under way throughout the world. Costa Rica, on the other hand, is pursuing energy security together with sustainability by accelerating the use of renewable energy sources.

All countries have placed more emphasis on continuity and economy in electricity supply than in fuel supply. Perhaps this is because of the greater scope for government action, as State-owned enterprises have long operated in the electricity subsector. In contrast, oil supply has traditionally been dominated by international companies, over which authorities have no control beyond regulation.

Not all energy imports have been inimical to energy security. Integration through SIEPAC has contributed significantly to improving energy security where electricity is concerned. The countries of the subregion see regional integration as an ideal mechanism for improving the availability and reliability of the energy supply. This is due to the size of their economies and the economies of scale that can be achieved through interconnection, coordination and harmonized regulation.

The price of fuels makes them unaffordable for the population, given low minimum wages and the extent of poverty and marginalization. Some countries subsidize LPG to improve access to modern energy sources, mitigate the price impact on the household economy, and encourage the replacement of firewood, whose (still very widespread) consumption affects the health of families and leads to deforestation. The disadvantage of the subsidy lies in the pressure it places on public finances and in the fact that it encourages the consumption of an imported fossil fuel. The alternative is to replace firewood with electricity, a sustainable and lasting solution that Costa Rica has been pursuing.

Despite efforts to increase the use of renewable sources, oil is still the mainstay of the energy supply. Owing to their high dependence on this fuel, the economies of the countries in the subregion are very sensitive to the cost of importing it. Oil price volatility is a permanent source of instability for energy security. The countries have sought to reduce this dependence through the use of local energy sources, mainly hydropower and, more recently, wind and solar energy. Efforts are also being made to rationalize consumption and make it more efficient.

Domestic hydrocarbon production contributes to energy security because it reduces the commercial and geopolitical risks of imports. Similarly, having a refinery, whether public or private, is considered to contribute to energy security. Moreover, refining domestically means that fuel can be sold below international market prices, and it is cheaper to import crude oil than finished products. It is paradoxical that the subregion's oil refineries have closed: by the end of 2017, only Guatemala and Nicaragua still had refineries. Oil companies have withdrawn from this business in favour of importing refined products, especially from the United States, whose competitiveness has increased as a result of the boom in unconventional hydrocarbons there.

Converting oil companies in this way for reasons of efficiency and business strategy has macroeconomic repercussions, since the oil bill rises and the economy needs to find dollars to pay it. Given these conditions, the concern has now shifted to storage capacity, which in some countries is meagre. Diversification of supply sources and suppliers should also be pursued in order to reduce the excessive dependence on refined products from the United States, which in some countries is as high as 100%.

The challenge going forward is to raise levels of energy security and sustainability. This is particularly important now that the countries are consuming more energy in an effort to close the huge industrial and social divides that separate them from countries with a higher level of development.

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The COVID-19 pandemic and social policy narratives in Costa Rica: the story of a (fleeting) opportunity

Juliana Martínez Franzoni¹ and Diego Sánchez-Ancochea

Abstract

Did the coronavirus disease (COVID-19) pandemic embolden ideas favourable to inclusive social policy in Latin America? This article addresses that question by examining the emergency cash transfer programme that was implemented in Costa Rica in 2020. Drawing on legislative debates and interviews with senior officials and analysts, the study reveals the fleeting emergence of ideas in favour of expanding non-contributory social protection. The new programme was quickly reined in by a discourse that assimilated fiscal responsibility to cutting social spending rather than expanding revenues. Avoiding simplistic generalizations, the findings invite a contextualized analysis of the impact of the pandemic on specific policy-making processes, and a consideration of the role of ideas in social policy debates. If there is a risk to inclusive social policy, it is the dominant discourse of austerity.

Keywords

COVID-19, viruses, epidemics, social aspects, social policy, fiscal policy, public expenditures, social security, income, Costa Rica

JEL classification

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I. Introduction

Cash transfers to ensure that people could continue to meet their basic needs were one of the emergency measures adopted most widely in the first half of 2020. Throughout Latin America, programmes were launched that were remarkable in terms of their speed of implementation, the justification of the beneficiaries, and the initial fiscal effort in contexts that were not noted for their generosity in terms of social protection (Blofield, Giambrumo, and Pribble, 2022).

It was largely through such measures that the COVID-19 pandemic introduced the notion of "crisis as opportunity" into the public policy debate. This appealed, in particular, to the possibility of developing a new narrative around the need for, and desirability of, greater and better social protection. Although the claim that the pandemic represented a historic opportunity gained broad support, the new ideas need to be analysed in political economy terms, in the context of actual policy processes.

An earlier paper (Martínez Franzoni and Sánchez-Ancochea, 2022) considered whether the crisis was indeed an opportunity, by studying the scope of transfer programmes in Central America, taking into account the combination of actors, policy instruments and narratives in each case. These variables are also present in an extensive literature on institutional conditions and power relations in public policy. In contrast, the present article explores the role of ideas as a fundamental channel for promoting changes in the way reality is perceived in the aftermath of a profound crisis.

Costa Rica is an ideal case for examining whether the crisis generated by COVID-19 created narrative opportunities. The country has robust social policies, solid institutions and a legacy on which to base pro-equality ideas; nonetheless, at the onset of the pandemic, it was faced with a significant deficit in the social protection of its large informal labour force, along with other indicators that reflect the erosion of Costa Rica's historical exceptionalism in human development.

This article describes how the problem surrounding emergency cash transfers in 2020 was constructed; and it analyses whether this construction was conducive to inclusive social policies in the long run. This approach makes it possible to move from a general and abstract consideration of the opportunities created by the pandemic shock to a more substantive discussion grounded in specific political processes and programmes.

The study focuses on the role of ideas about who is entitled to benefits and what the State's obligations are, but also on tax and other fiscal constraints. Empirical evidence shows that the pandemic in Costa Rica generated new ways of thinking that could be useful for addressing social policy deficits. However, austerity as the dominant narrative undermined any consideration of scenarios involving wider State intervention. While recognizing that it is difficult to draw general conclusions from the analysis of a single case, the study shows how the austerity discourse is threatening the future of Latin America just when it seemed to be on the decline in much of the Global North.

The analysis reconstructs narratives and interpretive frameworks at different moments in the public policy formation process. In the case of narratives, a distinction is made between problems and solutions. The problems spawn entities that are identified as victims, saviours and villains. Section II, for example, shows how victimhood rapidly shifted away from the individuals affected by the pandemic to be assumed the public finances. Moreover, solutions involving inclusive actions morphed rapidly into expenditure cuts and State downsizing.

The article draws on empirical sources of two types: official documents (mainly laws) and interviews. Each law consists of at least six documents of between 300 and 900 pages each, encompassing committee discussions, opinions, drafts and consultations with institutions. The official sources examined are summarized in table A1.1 in the annex.

II. COVID-19, ideas and social policy

This section firstly analyses the literature that highlights the importance of the role of ideas. Secondly, it defines a number of key variables, such as frames and narratives, and explains how to conceptualize their role in the public policy formation process. It then addresses the role played by narratives during the COVID-19 pandemic.

1. Ideas in public policy construction

As Swinkels (2020) explains, ideas are important power resources for defining reality at different levels of social activity. At the micro level, they give meaning to and guide people's actions; at the meso-level, they serve as tools that social actors use to craft discourses; and at the macro level, they make it possible to maintain some order in the joint actions of groups.

With respect to State action, the "interpretive turn" argues that public policy problems and solutions exist as such insofar as they are mediated by discursive constructions (Stone, 2012; Mehta, 2011; Fischer, 2003; Béland and Cox, 2010). Thus, public policy problems do not exist as objective realities independently of how they are defined and enter into public policy formation processes. How a problem is constructed can determine how —and even whether— a problem is considered a matter for public intervention (Stone, 2012; Edelman, 1985; Druckman, 2001). It is therefore worth making these ideas "objects of inquiry and meaningful categories" in their own right (Blyth, 2002, p. 17).

At present, when various analysts and policy actors argue that COVID-19 creates an opportunity to change development models and welfare regimes, they are referring largely to its influence on thinking about what is possible and desirable as regards the role of the State. These new ideas would, in turn, make it possible to trigger actions, not necessarily —nor only— discursive ones.

Nonetheless, studies of COVID-19 and its impact on political economy have actually paid little attention to ideas and narratives in specific contexts. Analysts and international organizations have demonstrated the emergence of new ideas about solidarity and the role of the State (ECLAC, 2021a and 2021b), providing powerful normative criteria whose viability is subject to political economy factors that require further analysis and research. However, studies on the determinants of political responses to the pandemic have paid little attention to the role played by ideas (for example, Blofield, Giambruno and Pribble, 2022).

2. Frames, narratives and public policy

To examine the role of ideas in the context of the pandemic as an opportunity, it is useful to analyse interpretive frameworks (Schön and Rein, 1995) and narratives (Stone, 2012). Interpretive frameworks establish parameters (French and others, 2017) or general assumptions (Schön and Rein, 1995; Entman, 1993), in this case to define issues that warrant government intervention. Such frameworks typically include, either explicitly or implicitly, notions of what is morally right (Entman, 1993; Stone, 2012). Narratives, in contrast, link problems to solutions and to actors who cause or solve problems (Stone, 2012). Thus, the same interpretive framework may encompass more than one narrative about how a public policy problem is constituted as such, and what should be done to solve it.

For Stone (2012, p. 158), "in politics, narrative stories are the principal means for defining and contesting policy problems. [...] Problem definitions are stories with a beginning, a middle, and an end, involving some change or transformation." Accordingly, narratives are organized around structural elements: a setting (as a narrative construction of the policy-relevant context); characters (including

heroes, victims and villains); problems, harms, or difficulties; causes of the problem; responsibilities; and solutions (French and others, 2017; Burnstein and Bricher, 1997; Stone, 2012).

Narratives are produced by actors and are associated with power relations that communicate ideas, with varying degrees of success (Jessop, 2014; Harjuniemi and Ampuja, 2019). Different narratives contribute to the formation of discourse coalitions between State and non-State actors who share an interpretive framework (Hajer, 1993). These coalitions can agglomerate different actors — such as specialists, political parties, and social movements— around a common denominator (Hajer, 1993). For example, Mazzini Marcondes and Santos Farah (2022) identify discourse coalitions that promote care policies, either for reasons of principle (such as achieving gender equality), or else for instrumental reasons (such as increasing female employment).

A crisis can give rise to both new interpretive frameworks and new narratives within pre-existing interpretive frameworks (Snow and others, 1986). For example, in conjunction with concepts of social and preventive medicine, the influenza pandemic of 1918 produced a new interpretive framework through which epidemiology slowly began to replace eugenic ideas (McDonald, 2020). Later, by gaining traction beyond the actors that produced them, those ideas would become hegemonic (Gramsci, 1971).

3. Pandemic and austerity

At the onset of the COVID-19 pandemic, it was repeatedly stated that the world had an opportunity to reinterpret many social problems and their solutions. This view was expressed, for example, by António Guterres, Secretary-General of the United Nations, and also by Alicia Bárcena, then Executive Secretary of the Economic Commission for Latin America and the Caribbean (ECLAC) (United Nations, 2020; ECLAC, 2020). The argument was that social and public policies needed to be revised.to address not only the virus, but also future crises and socioeconomic shocks. There were frequent calls for new pacts that paid less attention to fiscal space —that is, the existing room for manoeuvre to respond to the population's demands, determined by the size of the fiscal deficit and the public debt— and relied more on expanding public revenues than on cutting expenditures.

The pandemic boosted ideas that run counter to the austerity narrative, according to which deficit reduction is a government priority to be achieved mainly by cutting public spending (Bramall, Gilbert and Meadway, 2016, p. 120). Protecting fiscal space is even framed as a moral issue, as a condition for maintaining the country's credibility or stability (Heller, 2005). In Latin America, any narrative that strengthens the role of the State in social affairs must confront the narrative of fiscal austerity (Oxfam, 2022).

Austerity is a "good ideology" since it is an intuitive idea to which many people can relate. In hard times, people "tighten their belts", and the government should do the same. Moreover, from a conservative perspective, if the aim is to shrink government, it is politically more expedient to argue that the government is living above its means than to directly attack the poor (Jabko, 2013, p. 706). However, this is often a false ideology, or at least an incomplete one. It equates fiscal responsibility with shrinking the state, but seldom considers the possibility of increasing fiscal space by expanding the tax base through new progressive taxes. In societies that are highly unequal and severely affected by the pandemic, this second option is a necessary condition for long-term redistributive actions. In stark contrast, austerity measures repeatedly thwart the necessary redistribution of resources in unequal societies (Blyth, 2013).

Accordingly, any discussion of possibilities for a new post-pandemic social policy must take into account what is happening with ideas concerning austerity and, in particular, with the relationship between the actually and potentially available fiscal space and tax base.

III. Costa Rica viewed comparatively: a case study of narratives in the pandemic

In addition to physical distancing measures, the various Latin American governments implemented policies aimed at businesses and others targeting families. The latter included a combination of support for basic services, food and medicine deliveries and cash transfers, which jointly accounted for half of all measures (ECLAC, 2021a). In fact, with very few exceptions, all governments implemented at least one large-scale income transfer programme (Blofield, Giambruno and Pribble, 2021).

Costa Rica is an ideal case for studying whether the pandemic created opportunities for a narrative shift in favour of inclusive social policies. Firstly, it is a country with a legacy of universalist social policies based on the interaction between contributory and non-contributory programmes. Moreover, people have high expectations for the protection they receive from the State. In 2018, 85% of the population believed that the State should implement policies to reduce income inequality, which was 14 percentage points above the Latin American average (Maldonado and others, 2021).

Secondly, prior to the pandemic, the country was a laggard in terms of social protection, at least partly as a result of the growing informality of employment among both national and immigrant workers (although the latter represented a very stable share of the labour force) (Voorend, Alvarado and Oviedo, 2021). In February 2020, nearly half of the country's labour force was informal and mostly outside the coverage of both contributory safety nets (because they did not contribute to social security) and non-contributory measures (because they were not in poverty). Following the outbreak of the pandemic, the informality rate remained high, and unemployment doubled from 12% to 24% between the first and second quarters of 2020 (INEC, 2022).

Thirdly, at the onset of the pandemic, Costa Rica had no fiscal space; but, in theory, it had considerable potential for expanding tax revenue. In early 2020, it displayed a large fiscal deficit, equivalent to 6% of GDP, and public debt representing 57% of GDP (IMF, 2021). Yet ECLAC data show that the country's tax-to-GDP ratio was 22% in that period, almost 12 percentage points lower than the average among members of the Organisation for Economic Co-operation and Development (OECD) and also below that of Uruguay. More importantly, the potential for increasing Costa Rica's tax revenue becomes even clearer when social contributions are excluded to focus on taxes (direct and indirect) exclusively. Direct taxes represent just 7% of GDP in Costa Rica —almost three percentage points less than in Uruguay and also a lower percentage than in the less wealthy country of El Salvador (see figure 1).

In terms of pandemic response, starting with the declaration of a state of emergency on 16 March 2020, the Legislative Assembly ordered the mandatory closure of establishments and the non-mandatory confinement of individuals (Martinez Franzoni and Sanchez-Ancochea, 2022). It also approved a broad package of measures targeting businesses and families. Measures aimed at businesses included payment moratoria on value added tax (VAT) and income tax, authorization to suspend or terminate contracts or reduce working hours on an expedited basis, and a reduction in the minimum social security contribution base (Robles and Nercesián, 2022).

Measures targeting families included the transformation of school meals into food parcels delivered to families, and the possibility of drawing down unemployment assistance funds. However, the most important innovation in response to the pandemic was the creation of a cash transfer programme to compensate for sudden income loss, named *Bono Proteger*. This programme was announced on 19 March 2020, three days after the emergency was declared. It consisted of three disbursements of US\$ 107 or US\$ 214 that were paid between May and December to 700,000 of the 900,000 people who applied for them (see figure 2).



Source: Economic Commission for Latin America and the Caribbean (ECLAC), CEPALSTAT [online] https://statistics.cepal.org/ portal/cepalstat/dashboard.html?indicator_id=821&area_id=481&lang=en.





Source: Ministry of Labour and Social Security (MTSS), "Datos estadísticos Plan Proteger", 2020 [online] https://www.mtss. go.cr/elministerio/despacho/covid-19-mtss/plan_proteger/bono_proteger_datos.html [accessed on 10 May 2022]. Compared to its neighbours, Costa Rica's response in terms of emergency social spending was not particularly generous (see table 1). Nine countries (including neighbouring El Salvador, Guatemala and Honduras) spent more than Costa Rica on emergency social programmes in 2020 (ECLAC, 2021a). Some will argue that the scale of the response was governed by fiscal constraints — Costa Rica had the largest public-sector deficit in Latin America in 2019, for example. However, as noted above, it also had very low rates of direct and indirect tax collection: 15.5% of GDP, compared to 17.8% in Honduras, 18.2% in El Salvador, 18.5% in the Plurinational State of Bolivia and 23.2% in Argentina. It would therefore have been possible to respond to the crisis by attempting to construct a new discourse and develop a new tax policy. However, as described below, this never happened.

		(rerectinges of	(GDI)		
	General government tax revenue (2019)	Overall fiscal deficit (2019)	Central government fiscal deficit (2019)	Central government public debt (December 2019)	Emergency social spending (2020)
Argentina	23.2	-3.7	0.6	90.2	2.23
Bolivia (Plurinational State of)	18.5				2.83
Brazil	24.0	-5.7	-1.3	74.3	4.02
Chile	19.3	-2.9	-1.9	27.9	1.83
Colombia	17.1	-2.5	0.1	48.6	1.16
Costa Rica	15.5	-6.7	-2.7	58.5	1.27
Ecuador	14.6	-5.0	-1.9	47.8	0.13
El Salvador	18.2	-1.6	1.8	48.8	1.85
Guatemala	10.8	-2.2	-0.6	26.6	1.78
Honduras	17.8	-2.5	0.6	48.6	1.49
Mexico	14.1	-2.9	1.1	36.1	0.42
Nicaragua	19.2			42.3	
Panama	8.5	-4.1	-2.3	46.4	1.18
Paraguay	10.1	-2.8	-2.0	19.6	1.14
Peru	14.6	-1.4	-0.1	24.8	2.36
Dominican Republic	13.4	-2.3	0.4	39.6	1.70
Uruguay	19.5	-2.8	-0.4	49.0	0.14
Venezuela (Bolivarian Republic of)					

				Table 1	L		
Costa	Rica	in the	Latin	Ameri	can	context,	2019-2020
			(Perce	ntages oj	f GDF)	

Source: Economic Commission for Latin America and the Caribbean (ECLAC), CEPALSTAT [online] https://statistics.cepal. org/portal/cepalstat/dashboard.html?theme=2&lang=en [accessed on 5 December 2022] (for general government tax revenue); ECLAC, *Fiscal Panorama of Latin America and the Caribbean, 2021* (LC/PUB.2021/5-P), Santiago, 2021, pp. 28 and 30 (for overall fiscal deficit, central government fiscal deficit and central government public debt); ECLAC, *Social Panorama of Latin America, 2020* (LC/PUB.2021/2-P/Rev.1), Santiago, 2021, pp. 184–188 (for emergency social spending).

Note: The figures shown do not include social security contributions.

IV. Evidence: narratives during the development of Bono Proteger

A peculiarity of the political process in Costa Rica was the need for several legislative approvals, depending on whether the measures in question involved loans or successive reallocations of the regular budget. Diagram 1 shows that the decision-making process expanded social protection in April, but this was followed by moments of impasse and restriction. It also shows the unemployment rate and the number of *Bono Proteger* applications, as indicators of the fact that social needs and the public policy narrative did not always converge.

				Bono P	roteger:	milestones		
	IDB loan enters congress	Creation of Proteger Programme	Law creating <i>Bono</i>	1 st extraordinary budget	Reform of <i>Bono</i> Proteger	Rejection of 2 nd Extraordina	n Approval of Extraordinary ary Budget	Rejection of IDB Ioan
Decisions			Proteger	CAF loan	Decree	Budget		
	11 April	17 April	22 April	24 April	29 April	9 Jun	e 28 July	4 November
Applications	12 A \$250	pril 000			29 April Ø550 000	29 May Ø900 000		•
Transfers delivered				I	29 April ¢188 500	29 May ¢536 000		6 November ¢ 697 000
Ja	nuary-Marcl	1					July-September	October-December
onemployment	12.5%						24.5%	20%



Source: Prepared by the authors, on the basis of official information.

Legislative approval was required on a case-by-case basis, both for budget reallocations (54% of the total funds used for *Bono Proteger*) and also for additional funding (46%). Although this requirement was a constant throughout the period analysed, the rapid approval of the former contrasted with the conditionality and slowness of the latter. Moreover, from the outset, there was resistance to external loans that would have been used entirely to finance *Bono Proteger*. In fact, a US\$ 500 million loan from the Inter-American Development Bank (IDB) was in the legislative process between 9 April and 4 November, when it was finally rejected (Legislative Assembly, 2020a).

Table 2 contrasts two moments in 2020: a first moment (March–April) when measures to increase spending took centre stage; and a second (May–December) when the debate focused on the restrictions. The social impact of the pandemic was significant in both moments, as reflected in the level of unemployment, for example.

Table 2Costa Rica: emergency cash transfers and timing of legislative approval
of the key measures, 2020

Legi	slative sources	Entry in the Legislature	Time spent in the legislative process ^a				
First	moment (March–April)						
(i)	Approval of the Bono Proteger legal framework	2 April	20 days				
(ii)	Reactivation and approval of a loan from Corporación Andina de Fomento (CAF) ^b		3 days				
(iii)	Approval of the first extraordinary budget of 2020	8 April	16 days				
(iv)	Draft Law: Progressive and Solidarity-based Fiscal Contingency in the COVID-19 National Emergency	26 March					
Second period (May–December)							
(V)	Rejection of the second extraordinary budget of 2020	1 June	10 days				
(vi)	Approval of the second extraordinary budget of 2020	13 July	15 days				
(vii)	Second extraordinary budget (consolidated rejection and approval)	1 June	1 month, 27 days				
(viii)	Draft Law: Tax Fairness in the COVID-19 Emergency	18 June					
(ix)	Loan No. 5050/OC-CR Inter-American Development Bank (IDB)	6 August	2 months, 29 days				

Source: Prepared by the authors, on the basis of official information.

^a From entry in the Legislative Assembly to the approval or abandonment of the draft law.

^b Although the draft law had entered the Legislative Assembly in June 2019, its processing had been suspended in September 2019.

1. First moment: narratives of the expansion of state intervention

This moment is defined by two key events: (i) the creation of *Bono Proteger* (with new and inclusive eligibility criteria); and (ii) the securing of its initial funding. The government publicly launched the digital platform for receiving applications on 9 April; and it secured the funding to make transfers on a daily basis just 21 days later (MTSS/IMAS, 2020). During this period, a decree was issued and reformed, and two laws were passed. During this first moment of the pandemic, a new narrative emerged that recognized the lack of protection available to informal workers and the need for new instruments to include them —a discourse seldom heard previously in Costa Rica.

(a) April: Legal backing for Bono Proteger

On 9 April, the government announced the launch of the *Bono Proteger* programme (Legislative Assembly, 2020b). On the same day, the digital platform for receiving applications was launched and would soon process the largest volume of information for a social programme in Costa Rica's history. On 17 April, the government issued a decree formally establishing the programme (MTSS/MDHIS, 2020a); and between 18 and 21 April, it used funds from the National Commission for Risk Prevention and Emergency Management to make the first payments to 30,633 people (MTSS/IMAS, 2020). On 22 April, the Legislative Assembly adopted Law No. 9840, which gave the programme legal status (Legislative Assembly, 2020b).

Near-unanimous legislative support for the bill facilitated a rapid legislative process that took just 20 days from the time it was introduced in the Legislative Assembly to its adoption on second reading (see table 2). The motion, and the general tone of the legislative debate, revealed a climate of national unity: it reflected the idea of "everyone in the same boat" that underlies the opportunity narrative. When the bill came up for a vote in plenary, all other items on the agenda were postponed to allow it to pass.² Moreover, during the debate, positions were either omitted or else submitted mostly in writing, in order to speed up the process (Legislative Assembly, 2020c).

This same cross-party support was reflected in the statements made by lawmakers from Restauración Nacional, the party most ideologically distant from the government. One of its deputies voted in favour of creating *Bono Proteger*, "in the hope of helping the many families that had lost income owing to the effects of COVID-19" and noted that deputies and members of the government had joined forces, reached consensus, and drafted a legal text that took account of recommendations from several experts and the concerns of different sectors (Legislative Assembly, 2020c, p. 70).

The problem was defined as thousands of people rendered jobless or without income, victims of the COVID-19 pandemic. The solution was to guarantee an income to cover the estimated cost of a basic food basket for a three-person household. The programme made it possible to reach the wage-earning population, and also informal and self-employed workers provided they could document an income loss related directly to the pandemic. This innovative response was based on a criterion other than poverty for access to non-contributory programmes; and it created a narrative concerning the beneficiary population that could have been extended through time.

Nonetheless, even then the narrative on financing was less ambitious and did not make significant innovations. It is true that a special source of funding was used (the difference between the expected and actual price of fuels); but this was not permanent and did not bring the importance of progressive redistribution to the table.

² The motion was tabled on 13 April 2020 and approved by the 43 deputies present.

Lastly, and despite consensus on the virtues of the programme, a critical narrative was already appearing at this juncture. In two justifications of the vote cast in the second debate, opposition voices argued that the government should avoid making electoral use of the benefit. Concerns about the use of the funds led the legislature to tighten controls (Legislative Assembly, 2020b, articles 4 and 5). One of the only two deputies to oppose the bill alluded to the government's "fiscal voracity", an argument that would become commonplace in the ensuing weeks and months (Legislative Assembly, 2020d, p. 40).

(b) April: initial funding for Bono Proteger

The first extraordinary budget passed through Congress in just 16 days (see table 2), being adopted on 24 April. The government started executing the funds four days later, and had made nearly 198,000 transfers by 8 May (MTSS/IMAS, 2020). Considering only persons who had completed the procedures and were ready to receive the subsidy, 223,036 people were still waiting for the transfer (MTSS/IMAS, 2020). The adoption of measures to reallocate resources from the regular budget was swift and accompanied by a terse narrative, although afterwards criticisms were made of the government and its use of public funds.

The approach of the executive branch made heroes of the three powers of State, which coordinated a huge effort to redirect current expenditures towards the emergency measures, specifically the budget reallocations necessary to implement *Bono Proteger* (Ministry of the Office of the President, 2020). This reallocation would make it possible to fund the temporary support measures implemented by the Joint Institute for Social Aid (IMAS) and the Ministry of Labour and Social Security (MTSS), without neglecting the public finances. International loans were considered as a second financing option, but this possibility was limited by the already high level of Ecuador's dept-to-GDP ratio.³ At the time, the government was unwilling to use the crisis to go further increasing revenue, by proposing far-reaching measures to expand the tax base. Although some members of the social office (*gabinete social*) would have been sympathetic to this option, the guidelines of the economic sector of the office prevailed.

For the opposition, even at that time and despite the clearly urgent situation, the most important thing was to keep the public finances in balance, by introducing reforms to address the underlying problem: inefficiency and the costly state apparatus. Concerns were also expressed about the political use made of the transfers and the lack of resources to finance the Costa Rican Social Insurance Fund (CCSS).⁴

Accordingly, the opposition linked the provision of funding to address the emergency with greater expenditure restraint. The argument of the most critical lawmakers was that the (unproductive) State was being financed by the productive private sector. If the State needed downsizing before the crisis, the paralysis of the productive sector made it even more necessary to cut spending. In this context, tax solidarity is presented in a negative light, as a way of feeding a predatory and inefficient State, while the cuts are defined as insufficient and incomplete.

Thus, the opposition vilified the government for confronting the pandemic without public expenditure cuts, without clearly supporting the productive sector and without a comprehensive vision of the problem (Legislative Assembly, 2020e, p. 12). This narrative contrasted with the government's business support measures mentioned in section III.

³ M. del P. Garrido Gonzalo, Minister of National Planning and Economic Policy, personal interview, 6 October 2021, and E. Villegas, Minister de Finance, personal interview, 27 September 2021.

⁴ The change in the opposition's discourse may have responded partly to the 57 percentage point increase in the President's popularity, which rose from 19% in November 2019 to 76% in May 2020 (Pignataro, 2021). Significantly, however, criticism of the government adopted a discourse based mainly on austerity.

Nonetheless, despite the conflicting narratives described above, both the government and the opposition concurred in emphasizing expenditure cuts rather than expanding the tax base. The difference in criteria thus had more to do with the feasibility of further cuts than with the urgency of making them. This was evident, for example, in the position adopted by female legislators from the Citizen Action Party (PAC) in the Finance Committee. Most lawmakers at that time recognized the importance of the transfers; so their public expenditure stance did not involve questioning the adoption of the first extraordinary budget, as it would do a few weeks later with the second one.

The left-wing Frente Amplio party diverged from the rest of the opposition by proposing temporary progressive and solidarity-based measures to strengthen the public finances in the short term to meet the social needs generated by the current national emergency (Legislative Assembly, 2020f, p. 2). The Frente Amplio was the only political party to propose taxes on large taxpayers' profits, dividends and corporate-owned estates, as well as on high salaries and pensions. However, its proposals found little echo in the media and public debate.

2. Turning point: presidential narrative of austerity

It is now useful to consider the discourse of the President of the Republic himself, in order to understand what the government was thinking in the first few months of the pandemic. In the May 2020 work report, President Carlos Alvarado stated that, just as steps had been taken to protect health and life and to protect the people affected by the measures to attenuate the contagion curve, actions were now needed to protect the stability of the economy and boost its recovery (Legislative Assembly, 2020g, p. 16). Protection and fiscal stability went hand in hand.

The main problem was fiscal: the President explained how, before the pandemic, revenues were more robust and current spending lower, because the government had tightened its belt, thereby reducing the primary deficit to protect the country (Legislative Assembly, 2020g, p. 9). This statement proves that President Alvarado never abandoned the mindset of austerity and spending limits. In his speech, he explained how reducing the fiscal impact of the pandemic would require public expenditure austerity to continue belt tightening wisely (Legislative Assembly, 2020g, p. 17).

In his speech, the President referred to *Bono Proteger* as a hero in the solution of social problems, because it showed that eliminating extreme poverty in Costa Rica was technically possible (Legislative Assembly, 2020g, p. 9). Even at that time, however, the President considered tax revenues as immutable; and he expressed his regret, as President, that the country currently did not have the fiscal space to achieve this; but there would be no excuse for failing to do so in the near future, once it had climbed out of the hole caused by the pandemic. He considered the same was true for informality (Legislative Assembly, 2020g, p. 7).

At that time, reaching the additional 400,000+ people who were estimated as the *Bono Proteger* target population depended on other funds that Congress had not yet secured. In terms of financing the programme, the President reaffirmed the importance of an austerity approach. He praised the ability of the Ministry of Finance to redirect resources, as reflected in a budget that only contained expenditure cuts (affecting universities, municipalities and development associations, for example) to provide funding for cash transfers, health services and education. Taken together, President Alvarado's statements show that the political-electoral dynamic was not centre-stage; because if it had been, he would have tried to blame the political opposition, which had majority representation in Congress, for not approving additional spending. Instead, he reinforced an austerity narrative that was once again becoming dominant.
3. Second moment: narratives of constraint on State action

As from June the discourse opportunity created by the pandemic vanishes almost completely, and the language of austerity, focused exclusively on the expenditure side, clearly predominates. This moment is also defined by two main events: the initial rejection of the second extraordinary budget (9 June) and its adoption five weeks later (9 July). The following paragraphs reconstruct the two moments and show that the main difference between them was the scale of the current expenditure cuts that the government offered in exchange for authorization to reassign funds.

(a) June: a brake on funding for Bono Proteger

In June, the sense of urgency had diminished to the point where the austerity narrative now started to affect support for *Bono Proteger* for the first time. The Minister of National Planning and Economic Policy noted that the narrative that the government needed to cut expenditure to respond to the pandemic had taken hold.⁵ The conversation started to revolve almost exclusively around the macroeconomic fiscal problem, with scant reference to increasing the tax base as a way to solve the problem. The initial rejection of the second extraordinary budget was based on the same arguments that had been propagated since the first extraordinary budget: the need for further expenditure cuts.⁶ Despite the fact that some 350,000 people were still waiting for the first extraordinary budget took only 16 days to complete the legislative process, the second required two versions and took nearly two months.

The various ministers who appeared in the Legislative Assembly transmitted nuanced opinions as to the desirability of increasing funding for *Bono Proteger*, and on whether the country was facing primarily an economic crisis (with a significant fiscal dimension) or a social crisis (with fiscal implications). Citizen movements reinforced the austerity narrative by blocking streets and protesting against any tax increase.⁷ The economic elite pushed a very similar view. In May 2022, the Costa Rican Union of Private Enterprise Chambers and Associations (UCCAEP) demanded structural adjustments from the government, including the rationalization of public expenditure (Robles, Alvarenga and Fuchs, 2022).

The problem, both in the Legislative Assembly and in the street, was defined as purely fiscal. By this time, the public finances had claimed the mantle of victim, and the need for income among the people targeted by *Bono Proteger* no longer featured in the debate. Most of the opposition vilified the government for not making real cuts. According to a deputy from the National Liberation Party (PLN), the government continued to spend as if there was no pandemic and there had been no reduction in revenues (Legislative Assembly, 2020h, p. 689). This statement was echoed by legislators from the other congressional groups in their justification for voting against the second extraordinary budget (Legislative Assembly, 2020h, p. 689).

The left-wing opposition also saw the government as the villain, albeit for different reasons: they criticized its decision not to use the escape clause provided for in the Law for the Strengthening of Public Finances in the event of economic recession. Although the Ministry of Finance had promised to do so, in the end it never took the decision. The left accused the government of negligence by mismanaging and closing services; what was needed was an investment plan to promote economic growth.

⁵ M. del P. Garrido Gonzalo, Minister of National Planning and Economic Policy, personal interview, 6 October 2021.

⁶ J. L. Bermúdez, Minister of Human Development and Social Inclusion and Executive President of IMAS, personal interview, 22 April 2021.

⁷ I. Treminio, Researcher, University of Costa Rica, personal interview, 28 April 2021, and J. Vargas Cullell, Political Scientist, personal interview, 16 August 2021.

The solution proposed by the majority of the opposition was a fiscal consolidation plan and an extraordinary budget that would signal that the government must tighten its belt. In other words, cut spending, as a PLN deputy explained (Legislative Assembly, 2020h, p. 689). An explicit request was made to the government to take steps to reduce spending and make it more efficient, and to approve and discuss the extraordinary budget when it contains a genuine cut in expenditure (Legislative Assembly, 2020h, p. 698). There was talk of mismanagement of *Bono Proteger* funds and even crimes (Legislative Assembly, 2020h, p. 698). There was talk of mismanagement of the State and the sale of assets (Legislative Assembly, 2020h, p. 713); and there were calls for reform of the State and the sale of assets (Legislative Assembly, 2020h, p. 697). Other parties spoke of the need to correct inefficiencies and take steps to achieve real cuts, all of which was very much in line with the sense of responsibility associated with austerity.

(b) July: support for Bono Proteger funding in exchange for greater austerity

By June, the discrepancies between the government and opposition narratives had deepened. Both agreed on the need for austerity; but they disagreed on the extent of it. The opposition eventually approved the extraordinary budget, arguing that it did so owing to the number of people unemployed and affected by the pandemic, rather than because the government had made the necessary budget cuts. The government, for its part, argued that the greatest success of the new budget was that it asked for half a billion colones less than the amount that would have been needed previously (about $\cancel{\ell}$ 900 million) (Legislative Assembly, 2020h, p. 679).

The imperative need to promote austerity measures prevailed over the convenience of expanding government action. The president of the central bank said that once the impact of the cycle on revenues had been controlled for, the response was contractionary; so the fiscal deficit had widened because of the economic contraction, not because of the public response.⁸ Both State and non-State actors continued to claim a lack of fiscal space. The urgency of working within a given fiscal space that could not be expanded through increased tax revenue was very clear in the authors' conversations with senior officials, including those most directly involved with the emergency social programmes.⁹

However, the Cabinet did try to increase available resources through external borrowing, specifically in the form of a loan from the Inter-American Development Bank (IDB). This loan, amounting to US\$ 249 million, in addition to US\$ 20 million in non-reimbursable cooperation funding, would have made it possible to deliver transfers to 100,000 informal workers as new *Bono Proteger* beneficiaries. At the same time, 65% of the funds would be used as budget support to finance current expenditures. The Legislative Assembly rejected the loan, considering that it deceived the public and that it was using *Bono Proteger* as a front for financing current expenditures (Legislative Assembly, 2020a).

At this time, the influence of discourses on government inefficiency in Costa Rica was clear to see. In particular, an audit on the use of *Bono Proteger* funds, published in December 2020 by the Comptroller-General's Office (CGR), undermined the prestige of the programme and was widely used by the political opposition (CGR, 2020). The Comptroller-General's Office concluded that the programme's achievements had been the basic ones that were to be expected from a cash transfer, although the programme had shortcomings that reduced its efficiency and effectiveness since weaknesses had been detected, such as possible leakages, erroneous payment and incorrect benefit amounts; non-receipt of benefits by eligible recipients and unjustified discontinuation of benefits (CGR, 2020, p. 27, point 3.1). Surprisingly, the evaluation did not acknowledge the programme's success in terms of its speed of implementation and capacity to protect populations in dire need.

⁸ R. Cubero, President of the Central Bank of Costa Rica, personal interview, 17 September 2021.

⁹ J. L. Bermúdez, Minister of Human Development and Social Inclusion and Executive President of IMAS, personal interview, 22 April 2021, and G. Dinarte, Minister of the Office of the President and former Minister of Labour and Social Security, 12 May 2021.

As at the time of rapid response, a proposal was made to expand the tax base, but it did not succeed. In this case, the proposal was made by a deputy of the ruling PAC, who would very soon leave the party. This proposal aimed to use fiscal policy mechanisms to tax persons with robust income and economic capacities; so as to distribute the burden of the economic recession and contribute to Costa Rica's security and social stability (Legislative Assembly, 2020i, p. 2). The proposal included taxes on individuals and corporations of a kind that would have moved the country from a vision of expenditure austerity to one of opportunity to expand spaces in response to a severe social crisis. However, this proposal was not accepted among the political class or the media.

V. Stylized analysis of narratives

The foregoing analysis shows that the pandemic undoubtedly created significant opportunities, at least initially, centred on recognizing the need to broaden eligibility criteria and raise the profile of informal workers as subjects of rights. A narrative of opportunity and learning was also developed: in his May report, the President stated that implementation of *Bono Proteger* showed that, if the country set its mind to it, it would be possible to eradicate poverty once the fiscal constraint was overcome.

The adoption of the programme and the expansionist narrative was made possible largely by the high level of uncertainty that prevailed initially. Nonetheless, this quickly diminished, with the result that the initial opportunities faded away and the prevalence of the austerity narrative was restored. Very soon, the commitment to draw attention to the lack of protection for informal and self-employed workers was eclipsed by narratives that equated fiscal responsibility exclusively with expenditure cuts.

Table 3 summarizes the findings presented, according to the main narratives and interpretive frameworks.

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Narratives		Problem	Villain (cause of the problem)	Solution	Interpretative framework	
Discourse coalition	1 - Government, heads of social institutions	Liquidity to care for people affected by income loss	Coronavirus disease pandemic (COVID-19) (social problem)	Minimum income through the <i>Bono Proteger</i> , use of current expenditure cuts encouraged	Fiscal space is confined to expenditure management; the tax base is given	
	2 - Government, economic sector managers	Liquidity for emergency care with expenditure restraint	Demand for resources generated by the COVID-19 pandemic	Minimum income through <i>Bono Proteger</i> , with containment of more permanent current expenditure		
3 - Majority opposition		Delicate fiscal situation	Government that does not adjust (political problem)	Minimum income through <i>Bono Proteger</i> , provided that there was a sufficient permanent reduction in spending.		
4 - Left-wing opposition		Lack of tax solidarity to deal with the emergency	Government and majority opposition shift the costs of the emergency on to the working majority	Temporary solidarity- based tax measures	Revenues and expenditures are constantly distinguishable; the tax base is expandable	

Table 3

Costa Rica: emergency cash transfers, main narratives and interpretive frameworks, 2020

Source: Prepared by the authors.

The fiscal constraint was the interpretive framework that focused on just one way to address the budget constraint. It grouped together three distinct narratives, as summarized in stylized form below. The first and second reflect cabinet positions, while the third and fourth summarize majority and minority positions in the legislature, respectively.

1. Narrative 1 - Within the cabinet

The authorities in the social sector and a member of the economic team believed that it would have been desirable to expand emergency State intervention. However, this was impossible due to the macroeconomic guidelines set within the government itself. It was argued that all possibilities for additional funding had been exhausted, and that conditions no longer existed to continue with *Bono Proteger*, either inside or outside the government. A framework of "maximum efficiency" within a given tax base was accepted, not necessarily because it was liked, but for reasons sof political feasibility.

The immediate post-pandemic period implied by this vision involves continuing with measures that do not require new funds (such as the adoption of non-monetary measures to support employability).

2. Narrative 2 - Within the cabinet

In the economic sphere of the government, the problem with the intervention may have been its excessive generosity. It was argued that it was impossible to increase spending owing to the lack of legislative agreement. For this group, the fiscal problem marshalled the approach to the social response. The idea conveyed by some interviewees was that resources should have been spread more widely to achieve a higher return; the failure to do so detracted from the viability of the programme. The notion of operating with the means available is deeply rooted in these actors, without the possibility of increasing taxes being considered even for a moment.

The post-pandemic period that emerges from this vision for social policy involves focusing on pre-pandemic measures of expenditure restraint.

Narratives 1 and 2 formed a discourse coalition. In other words, actors with different visions of the State came together and acted in the same direction, not so much —or not only—because of their coordination, but because they operated under the same set of assumptions. Albeit for different reasons, in both cases the prevailing idea was that the government should not —or could not— consider expanding revenues; instead it had to become more efficient. This point of view is at odds with the idea of the crisis as a transformative opportunity, specifically involving tax increases that would make it possible to expand revenue and, thus, gain additional fiscal space.

3. Narrative 3 - Majority legislative opposition

The view of most of the opposition was that the crisis aggravated an already fragile fiscal situation and demonstrated the need to reduce public spending (containment was insufficient). It was therefore unrealistic to consider imposing higher taxes on a private sector that was absorbing the entire impact of the crisis. The tax base in this case appears as a given.

This third narrative differed from the previous two by identifying the government as the villain. Nonetheless, the three narratives shared a common interpretive framework: austerity should be the guiding principle of public policy, even during the pandemic.

Taken together, narratives 1, 2 and 3 make austerity a "catch-all". Austerity functioned as an interpretive framework, organizing discussion on the different instruments and measures, even in the midst of the crisis triggered by COVID-19. With the tax base seen as indistinct from the fiscal space, the fiscal crisis ordered the remaining priorities.

4. Narrative 4 - Minority legislative opposition

Outside of this interpretive framework, another which considered the tax base as a variable operated with relatively marginal importance. Two lawmakers (a women and a man), along with a number of civil society voices, proposed considering tax revenue as a variable. This was expressed in draft laws and in proposals discussed in the media, albeit with little impact. In the authors' opinion, this dual narrative (the need for a response supported by additional taxes on the rich) was the real window of opportunity — not only in Costa Rica, but in many other countries too.

VI. Conclusions and implications of the case

Visualizing the pandemic as an opportunity means recovering the role of the State as guarantor of rights and reducer of inequalities. Implicitly or explicitly, the response to the crisis makes it possible to recover the role of the State and propose a more inclusive social policy, financed by a tax increase that reflects a broad social compact (United Nations, 2020; ECLAC, 2020).

In the case of Costa Rica, the pandemic created a very valuable opportunity: to include informal work within social protection. In a country in which social policy has oscillated for decades between contributory programmes and anti-poverty measures, and where informal workers already represented 46% of the workforce before the pandemic, *Bono Proteger* opened the door to a more inclusive narrative that could have driven broader reforms. The opportunity was short-lived, however, as the austerity discourse soon regained its pre-eminence.

Guaranteeing fiscal responsibility without sacrificing the necessary social spending, in a high-debt situation, necessarily means expanding the political space to create new progressive taxes. However, in Costa Rica during the period studied, no attempt was made to construct this new political space, owing to the dominance of an austerity narrative that included a critical attitude toward the public sector, among other things. The factors explaining this deserve greater attention, beyond the scope of this article, including consideration of the role of elites in the dominant macroeconomic vision, for example (Robles, Alvarenga and Fuchs, 2022).

While each experience is undoubtedly different, the findings of a case study such as this are an invitation to consider certain overlooked variables when examining the pandemic as an opportunity. This analysis has demonstrated the importance of contextualizing opportunities and examining the role of ideas, particularly the continuing influence of the austerity narrative centred on expenditure cuts. This interpretive framework has two distinct components: the cost of fiscal irresponsibility and the refusal to consider tax hikes.

It is difficult to imagine a new horizon for more inclusive public policy in Central America (and other regions of the Global South) without a profound redefinition of macroeconomic policies and the discourse surrounding the State. Moreover, any macroeconomic rethinking requires "unravelling the thread": in other words, firstly, separate the fiscal space clearly and simply from the tax base; and, secondly, specify the conditions for expanding tax revenue through progressive mechanisms. Although this is a difficult task, it is more urgent than ever, given the internal and external challenges facing the region.

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Annex A1

 Table A1.1

 Costa Rica: emergency cash transfers, legislative sources analysed

	Source	Number of process or law	Date of adoption
(i)	Executive Decree creating the Proteger Programme	Executive Decree No. 42305 - MTSS-MDHIS	17 April 2020
(ii)	Amendments to the Executive Decree creating the Proteger Programme	Executive Decree No. 42329 - MTSS-MDHIS	29 April 2020
(iii)	Law on the protection of working people during the COVID-19 disease emergency	Law No. 9840 (Legislative Process No. 21909)	22 April 2020
(iv)	Approval of the loan agreement between the Republic of Costa Rica and Corporación Andina de Fomento to finance the Public Finance Strengthening Support Programme	Legislative Decree No. 9833 (Legislative Process No. 21449)	24 March 2020
(V)	First Extraordinary Budget of the Republic for Fiscal Year (FY) 2020 and reform of the Law of the Ordinary and Extraordinary Budget of the Republic for FY 2020	Law No. 9841 (Legislative Process No. 21918)	24 April 2020
(vi)	Draft Law on progressive and solidarity fiscal contingency during the COVID-19 national emergency	File No. 21883	Not applicable
(vii)	Constitutional Message from the President of the Republic of Costa Rica	Not applicable	4 May 2020
(viii)	Second Extraordinary Budget of the Republic for FY 2020 and second legislative amendment to Law No. 9791, Law of the Ordinary and Extraordinary Budget of the Republic for FY 2020	Legislative Process No. 22008	9 June 2020 (negative majority opinion)
(ix)	Second Extraordinary Budget of the Republic for FY 2020 second legislative amendment to the Law of the Ordinary and Extraordinary Budget of the Republic for FY 2020	Law No. 9879 (Process No. 22080)	28 July 2020
(X)	Approval of Loan Agreement No. 5050/OC-CR between the Republic of Costa Rica and the Inter-American Development Bank (IDB) to finance the programme to protect the jobs and income of vulnerable populations affected by coronavirus in Costa Rica	Process No. 22132	4 November 2020 (negative majority opinion)
(xi)	Draft Law on tax fairness during the COVID-19 emergency	Process No. 22034	Not applicable

Source: Prepared by the authors, on the basis of official information.

Productive development policy for Chile: an alternative to stagnation

Manuel Agosin¹

Abstract

Since 1998, Chile has been experiencing a significant slowdown in its economic growth. The Chilean economy's recent poor performance is attributable to a halt in productive and export diversification around the beginning of the twenty-first century. State interventions have been horizontal, eschewing those to support specific industries. Intermediate interventions have focused on promoting activities (such as new exports and technologies) that form only a small part of the Chilean economy, leaving a wide margin for market forces to select companies and sectors. In terms of vertical policies, support for green hydrogen is proposed, as this is an emerging industry in which Chile has clear comparative advantages. The article also argues for exchange rate policies that mitigate sharp fluctuations in the real exchange rate and ensure a stable and competitive exchange rate for new exporters.

Keywords

Economic growth, productivity, production diversification, export diversification, industrial policy, technological innovations, renewable energy sources, monetary policy, foreign exchange rates, development policy, Chile

JEL classification

O47, F13, F31

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I. Introduction

In small, open economies (such as Chile's), aggregate growth is inexorably linked to export growth. However, export growth is not possible without diversification, especially in an economy with the characteristics of Chile's, whose exports of copper account for almost 30% of world exports of the metal.

The clearest driver of growth is investment. Looking deeper into its causes, it is not difficult to link volumes of investment to increases in exports and, in particular, to diversification beyond the country's traditional export good, which cannot grow faster than demand for it, or, in the case of Chile, without resulting in a fall in its price.

The boom that followed the recovery from the financial crisis of 1982–1985 was largely a result of sustained export diversification. A process that had begun toward the end of the military dictatorship became more pronounced and a series of new exports emerged, including some 3,000 categories of manufactured goods.

The stagnation that followed the Asian and Russian crises in 1999, which has continued to this day, is tied to the lack of emergence of new exports. In fact, some items, such as manufactured goods, declined sharply. From the early 2000s, the economy experienced positive disruption from a large rise in the real price of copper, which lasted until the global financial crisis of 2007–2008. After a short-lived drop in copper prices, starting in 2009, rises continued until the end of 2013, mainly owing to high Chinese demand for the metal. The boom cycle seemed to come to an end in 2014.²

The clear improvement in the terms of trade since the beginning of the 2000s caused the Chilean economy to suffer considerably from what is known as the Dutch disease, characterized by marked appreciation of the currency. This is perhaps the cause of the stagnation of non-copper exports, the decline of some key exports and the limited appearance of new products.

This article proposes a set of policies to revive export growth and diversification. It stresses that the need to combat global warming presents Chile with unique opportunities for productive diversification, which must be supported by industrial policy for the coming decades. The article also addresses measures relating to the exchange rate, to make it a more effective instrument of productive development policy.

The article is structured as follows. Section II discusses the relationship in the context of Chile between GDP growth and export growth, focusing on export diversification. Section III explains the links between diversification and export complexity on one hand, and growth on the other. Section IV outlines the productive development policy proposals; the aim is for the proposals to consider the country's political economy environment and eschew extreme measures that would be difficult to implement successfully. Section V looks at how exchange-rate policy can support productive transformation, without abandoning the floating exchange rate that has been in place since 1999. Section VI provides some conclusions.

II. Aggregate growth and export growth

Chile is at a crossroads. Since 2010, the country has been governed by a variety of coalitions, but no strategy has yet been found to improve on the meagre growth seen in its economy over more than two decades. This article postulates that the explanation for the gradual slowdown in growth is exhaustion of the productive development policies that boosted growth substantially after the recovery from the financial and economic crisis of 1982–1985 and, in particular, after the return to democracy in 1990.

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² Given the huge demand for copper in the transition to e-mobility, copper prices are likely to resume their uptrend as more and more conventional vehicles are replaced with electric vehicles.

It is time to rethink productive development policy (once called "industrial policy") to make it stronger and more aligned with the objective reality of the Chilean economy in the global situation it must face.

Many policy reforms were proposed and implemented by the governments that followed the military dictatorship. Despite the efforts made over more than 30 years, productive development policy has never been one of the Chilean economic authorities' core concerns. Projects have not been assigned sufficient resources and have not been maintained after each change of government. In order to succeed, industrial policies must be State policies and not depend on who is in government.³ In Chile, since the return to democracy, each new government has made radical policy changes instead of building on existing successes, resulting in this lack of continuity.⁴

The economy returned to its 1981 GDP level only in 1987. After the "golden age" of the Chilean economy (1987–1998), when an annual growth rate of 7.2% was attained, the economy gradually slowed, taking growth to even weaker levels than those recorded during the military government (see figure 1). One factor that contributed to the exceptional growth in 1987–1998 was significant diversification of the export basket, adding new goods such as salmon, wine, fresh fruit, paper and pulp, wood products and even many manufactured goods.⁵



Source: Prepared by the author, on the basis of data from Central Bank of Chile.

The sustained slowdown in growth largely explains why criticism of the market economy has intensified and demands for redistribution have proliferated. The Central Bank of Chile and the Ministry of Finance report a gradual but sustained slowdown in the potential (i.e., long-term) growth of the

³ According to Breznitz (2007, p. 148), Ireland has been persistent in its productive development policies, which have been supported by both liberal-reformist and conservative governments. Breznitz calls these policies "neoliberal interventionism", because they combine an adherence to the market with a large role for government in attracting foreign investment in high-tech sectors.

⁴ This is especially true in the case of the National Council for Competitiveness Innovation (CNIC), created in the closing months of the government of President Lagos, whose direction was radically changed during the first government of President Piñera, and in the case of the High Technology Investment Promotion and Attraction Programme, also created during the government of President Lagos, which, despite being successful on a small scale, was transferred from the Production Development Corporation (CORFO) to InvestChile (a Ministry of Economic Affairs entity aimed at attracting, regulating and recording foreign direct investment), and left without resources.

⁵ This phenomenon is described very well in the individual papers published in Meller and Sáez (1995).

economy, attributable to a decline in investment and no expansion of total factor productivity (TFP). The two phenomena are related. Investment will not pick up in a small economy whose tradable sector is still dominated by copper. Nor are increases in TFP going to be achieved if the economy does not move into new, higher productivity sectors. The halt of the productive and export diversification process that began in 2000 is one of the main causes of Chile's stagnation.

In contrast to more recent trends, the rapid growth of the economy in the 1987–1998 period coincided with substantial productive and export diversification. From the mid-1980s to the end of the 1990s, non-mining exports at constant prices grew at a rate of 11.5% (author's calculations based on data from Central Bank of Chile).⁶ In 1997, they accounted for almost two thirds of total exports. Likewise, Agosin and Bravo-Ortega (2009) established that the sharp increase in exports up to 2000 was largely a result of the "discovery" (in the sense employed by Hausmann and Rodrik, 2003) of new export products. According to Agosin and Bravo-Ortega (2009), a good is considered an "export discovery" when, defined at the four-digit level of the Standard International Trade Classification (SITC) in the United Nations International Trade Statistics Database (UN Comtrade), it exceeds US\$ 1 million exported (at 2000 prices) in any year of the 1962–2000 period and remains at least at that level throughout the remainder of the period after its discovery. The work of Agosin and Bravo-Ortega (2009) shows that the bulk of export discoveries occurred in the 1985–2000 period, following the trade liberalizations of the 1970s and the recovery from the severe financial and economic crisis of 1982–1983.⁷ The study estimates that, by 2000, more than one third of Chilean non-mining exports were of products that were not exported before 1980.⁸

The good performance of non-copper exports was largely a result of economic policies that gave them a boost, even during the dominance of the "neoliberal" policies of the military dictatorship. For example, the subsidy for afforestation and reforestation established at the beginning of the military government (Decree Law No. 701 of 1974) ultimately led to sharp increases in exports of wood, paper and pulp. The investments made by the non-profit corporation Fundación Chile in salmon farming, supported by the Japan International Cooperation Agency (JICA) in the late 1970s, resulted in a marked growth in farmed salmon exports from in the mid-1980s.⁹ The marked depreciation of the Chilean peso in real terms after the 1982 crisis (which lasted for most of the rest of the 1980s and the 1990s, although with a tendency toward appreciation in the latter decade) also contributed to boosting investments in new potentially exportable products, which bore fruit a few years later. The "simplified drawback", which was in place between 1985 and 2003 and consisted of a 10% subsidy for exports of less than US\$ 20 million for an entire tariff heading, also contributed (Agosin, Larraín and Grau, 2009). This subsidy was granted in exchange for the rebate of customs duties on imported inputs and the benefit disappeared automatically when the tariff item exceeded US\$ 20 million.

Although new exports continued to grow until 2008, their pace of growth slowed and they gradually accounted for a smaller and smaller proportion of total exports, mainly owing to a copper price boom. In the decade from 2008 to 2018, non-copper exports as a whole have been stagnant. In terms of volume, copper exports, in real terms, grew at a rate of 0.7% per year, while non-copper exports increased at a rate of 1.6%. Between 2008 and 2018, prices of exports other than copper remained steady. Figure 2 shows values at constant 2013 prices of copper exports and other products for the 2008–2018 period.

⁶ All actual export figures have been calculated on the basis of export values deflated by their own international price indices.

⁷ Agosin and Bravo-Ortega (2009), table 2, p. 58.

⁸ This hypothesis tallies with the analysis conducted more than a decade earlier by Amin Gutiérrez de Piñeres and Ferrantino (1997).

⁹ Agosin, Larraín and Grau (2009) and Agosin (1999). See also Achurra (1995) and Hosono, lizuka and Katz (2016).



Source: Prepared by the author, on the basis of figures from Central Bank of Chile.

Note: Each export category is deflated by its own price index. Non-copper export figures are aggregates of exports at constant prices of all components of that category.

If the country is to return to a growth rate of 5% or more, non-copper exports will have to grow much faster than GDP. Since Chilean copper exports account for almost 30% of world exports of the metal, they will not grow at a rate above 3% (based on unitary income elasticity of copper demand and considering that the world economy will not grow much more than that figure in the medium term). In addition, Chile is depleting its known high-grade deposits, meaning that growth in world demand puts a ceiling on foreseeable growth in Chilean exports of the metal. Therefore, exports of other goods and services will have to grow at a much faster rate.

Part of the inequality in income distribution in Chile seems to be caused by the low density of high-productivity jobs and the predominance of unskilled and informal jobs. Only a few sectors are at the world's production possibility frontier and are capable of generating high wages. A recent article showed that countries that produce a more diversified and complex basket of goods (in the sense of including more knowledge) tend to have lower levels of inequality than others such as Chile, which can produce very few goods competitively and whose productive and export basket is concentrated in low-complexity goods (Hartmann and others, 2017).

III. Some analytical considerations

The Chilean experience shows that, in a small and open economy, with almost all productive sectors located within the world production possibility frontier, fast growth is related to new goods being added to the productive and export basket.

Several studies on developing countries support the hypothesis that, controlling for other variables that influence growth, initial export diversification is a good predictor of future economic growth. In one study (Agosin, 2009), a theoretical model is outlined and an empirical growth model is estimated with a sample for 124 developing countries over the 1980–2003 period. The regressions performed indicate

that a diversification index (unity minus the Herfindahl-Hirschman index applied to exports from the UN Comtrade database disaggregated at the three-digit level of SITC was positively correlated with growth, after controlling for other variables that could affect it. Hesse (2008) reaches similar conclusions using a Theil index of export concentration. Using panel data for developing countries, Hesse finds that the Theil index at its extensive margin is negatively correlated with growth in these countries.

Other studies have expanded on the idea that what matters is not only production diversification and export diversification, but also promoting more technologically sophisticated exports. These authors —at the Center for International Development of the Kennedy School of Government of Harvard University— put emphasis on diversification into more complex products. The studies define an index of economic complexity for countries based on disaggregated export data and conclude that initial export complexity is positively correlated with subsequent growth, even after including various controls (see, for example, Hausmann and Rodrik (2006), Hausmann, Hwang and Rodrik (2007), Hausmann and Klinger (2006), Klinger and Lederman (2006) and Hausmann and Hidalgo (2011)).

Obviously, complexity goes hand in hand with diversification, but the role of exports with a higher technological content is also emphasized. The way the Harvard researchers' studies determine whether a country has a more complex export basket is related to the type of goods: if they are typical of those exported by countries with higher per capita income, the economic complexity index will be higher than if the country exports goods linked to those exported by lower-income countries. For example, of 128 countries for which economic complexity index calculations were performed, ordered from highest to lowest, in 2017 Chile was in sixty-sixth place, while in terms of per capita GDP it was in forty-first place.¹⁰

It is therefore important to ask why exports and particularly their diversification or complexity are key determinants of growth in developing countries. There are three reasons why exports are critical. First, the vast majority of countries do not produce capital goods. Therefore, investment unavoidably requires exports. Second, domestic markets tend to be small and production for the domestic market promptly runs into demand problems. This is why import substitution did not achieve the objective of boosting the economies of many small countries. Third, as Cherif and Hasanov (2019) stress, the act of exporting forces firms to improve their productivity and innovate to remain competitive, which they are not compelled to do in protected domestic markets. These authors suggest that companies' inability (or reluctance) to export manufactured goods, rather than high tariffs, are behind the slow economic growth of many countries such as those in Latin America. The successful Asian economies (the Republic of Korea, Singapore and Taiwan Province of China) seem to have been quite protectionist, but at the same time compelled their companies to export and thus continuously modernize.

The literature linked to Hausmann, Rodrik and their co-authors and the work of Cherif and Hasanov (2019) both emphasize that industrial policies should aim for innovation and increased complexity, not just diversification. However, in the case of countries such as Chile, which still depend on a limited number of export goods and are also far from the world's major markets, diversification on its own appears to be a good first step, as suggested by Benavente (2016). Nor is it advisable for countries that do not meet all the prerequisites for success in advanced manufacturing to embark on production of complex goods without considering the likelihood of achieving the desired results. Brazil's unsuccessful experience with its information and communications technology policy, in which considerable government resources were spent with negligible results, is a lesson for other countries considering a leap towards creating new sectors that are too far removed from their existing comparative advantages.¹¹

¹⁰ See Atlas of Economic Complexity, Harvard University [online] https://atlas.cid.harvard.edu/.

¹¹ Brazil's failed efforts to build an information and communications technology industry, for both software and hardware, are described in Crespi, Fernández-Arias and Stein (2014), pp. 16–18. The same text discusses the more successful experience of Embraer, although this company only became internationally competitive after being privatized, following a long period as an Air Force company. One lesson from Embraer is that one must keep in mind the need not only to establish a final assembly company, but also to foster the emergence of competitive parts and inputs companies that enable the firm that assembles the final product to operate.

Furthermore, achieving greater complexity in production and exports partly depends on the density of a country's internationally competitive sectors. Assuming that there is a random element to the success of innovations, the more diverse its exports are, the greater the chances of successful innovation. In the case of Chile, where only a handful of products are exportable, success in innovation is limited.

In a recent study, Agosin and Retamal (2021) model the growth of an economy as the addition of new production functions to existing ones. For a production function to be integrated into a country's production, there must be a pioneer who "discovers" its parameters. This involves copying technologies that are already in use in other economies, which entails a variety of costs. Shortly after a technology is introduced, other producers ("copycats") can use it without incurring the costs of its discovery. In fact, the scaling up of production and exports is contingent on the emergence of these copycats. However, for the technology to be used, public investment is needed in infrastructure in a broader sense of the word (not only physical infrastructure but also public regulations, an adequate institutional framework, training of human resources in specific skills, and even the availability of credit).

In the model, growth occurs not as a result of producing more of the same (it is even assumed that the traditional sector does not grow) but rather by adding new productive sectors. The particularity of these sectors is that they require not only unskilled labour but also skilled labour, which is supposed to arise from on-the-job learning. Therefore, production by these sectors has a spillover effect: it creates skilled labour that can be used by other sectors.

The model has no analytical solution, since it is open to the introduction of new sectors. But it is possible to simulate it, giving the parameters reasonable values and making sure that it converges to feasible solutions. The model has three economic policy variables, which in reality represent a stylized view of industrial policy: (i) investment subsidies that aim to promote new production functions; (ii) the corporate income tax rates for different parties (in the traditional sector and, in the modern sector, for pioneers and copycats); and (iii) the options for deciding which infrastructure projects to invest in, given that each project does not benefit one sector alone but a family of sectors that use the same non-tradable inputs (for example, infrastructure that enables production of computer monitors can also be used by producers of television sets and other electronic goods).

The results obtained from the simulations are of considerable interest. Because the model includes an equation that represents the necessary budgetary equilibrium, a larger subsidy for investment to promote new production functions takes resources away from infrastructure spending. The policies that maximize the growth rate consist of partially subsidizing investment of pioneers and investing in sectors that are intensive in skilled labour, precisely because of the spillover effect from these sectors on other sectors with potential that are intensive in skilled labour.

The model includes a simulation that accounts for learning by doing. The simulation yields a path of GDP over a 50-year period that is quite similar to those followed by the per capita GDPs of the Republic of Korea and Taiwan Province of China. Without learning by doing, the path of GDP is very similar to that of Chile's per capita GDP.

In short, what these new studies indicate is that there are several components of a successful industrial policy. First, as Cherif and Hasanov (2019) emphasize, policies should steer producers toward international markets. Second, they must broaden the range of products produced by a country, because, as Hausmann and Rodrik (2003) state in their seminal work, there is a spillover effect that discourages investment in information, since it benefits those who have not made the investment. Third, any new sector requires a supply of its essential non-tradable inputs (what Agosin and Retamal call "infrastructure"). In this area, it is fundamental that the steps taken by the State are well thought-out.

IV. Modern productive development policies for Chile

It has become customary to classify productive development policy instruments according to two dimensions: (i) whether they are horizontal in nature (which is to say that they could support any sector with a market failure that the policy seeks to correct) or vertical (aimed at fostering the emergence of a specific industry or strengthening one) and; (ii) whether they are implemented through market interventions (in other words, altering relative prices) or through provision of public goods. Under this classification, policies can be divided into four categories: (1a) horizontal policies implemented through market interventions; (1b) horizontal policies implemented through provision of public goods (for example, a relatively stable and competitive exchange rate for new exports); (2a) vertical policies implemented through market interventions; and (2b) vertical policies implemented through provision of public goods. We will not look at examples that have already been studied (in particular, in the work of the Inter-American Development Bank (IDB) edited by Crespi, Fernández-Arias and Stein, 2014), but we will use this classification to discuss policies that can help Chile out of its stagnation.

Chile has in fact implemented some productive development policies and they contributed to export diversification. Thus, new export sectors have appeared, including fresh fruit (increasingly varied), farmed salmon (which has become a large industry, exporting more than US\$ 6 billion), forestry, pulp and paper (with exports of US\$ 7 billion) and wine (with exports of US\$ 2 billion). State agencies have been involved in the emergence and consolidation of these sectors and have taken on different roles. The specific policies that contributed to these successes are described in the work by Meller and Sáez (1995), Agosin (2009 and 2011) and Agosin, Larraín and Grau (2009).

The various dimensions of industrial policy for the future are summarized in table 1, using the classification of Crespi, Fernández-Arias and Stein (2014), but adding a third dimension: intermediate policies that are between horizontal and vertical ones, which exclude some industries and support others, without indicating in principle which specific sectors will benefit from the incentives included in the policy.

	Horizontal (H)	Vertical (V)	Intermediate
Provision of public goods (P)	Competitive and stable exchange rate	Support venture capital	
	ononango rato	Convert the Production	
	Strengthen and improve free trade agreements	Development Corporation (CORFO) into a development bank	
		Support human capital for emerging industries	
		Public-private coordination	
Market intervention (M)		Capitalize on potential comparative advantages: green hydrogen, lithium, green mining	Temporary subsidies for new exports
			Incentives for investment in new technologies

Table 1Productive development policies that show potential for Chile

Source: Prepared by the author.

Some of the main features of the policies listed in table 1 are described below. Because it is especially important, the question of the exchange rate will be addressed toward the end of this article.

In addition to the exchange rate question, the other policy that appears in the top left cell (HP policies) refers to increased participation in the global market through multilateral agreements within the framework of the World Trade Organization (WTO), multilateral treaties — such as the Comprehensive

and Progressive Agreement for Trans-Pacific Partnership (CPTPP) — or bilateral treaties. Notably, Chile has not entered into agreements with some countries in South-East Asia and those agreements it has signed with other countries (such as India) are quite restrictive. Access to markets is extremely important for countries such as Chile that need to export in order to grow. Strengthening and modernizing existing agreements and signing new agreements with countries that are key markets are therefore vital government contributions to productive development policies.

In the cell in the third column, first row, of table 1 (VP policies), there are several policies which Chile is lacking. One is support for venture capital. State participation in promoting venture capital can take several forms: some State agencies (such as BancoEstado, the Production Development Corporation (CORFO) or a potential new development bank) may invest in such companies together with private investors, public regulation may support new companies being floated, or the profits from the sale of companies created by venture capital firms may be exempt from capital gains taxes. Also, facilitating initial public offerings (IPOs), which is how venture capitalists most commonly divest successful firms, could give the industry a substantial boost.

Perhaps the most important task for the State in pursuing new activities to diversify the production and export apparatus is establishing a development bank, potentially by transforming CORFO, whose current role is that of an administrator of around 150 development programmes, which are difficult to assess in terms of effectiveness. Chile needs a development bank to financially support new activities that will lead it to become a developed country. One of the problems faced by entrepreneurs is the scarcity of capital for investment in fixed capital. A development bank can attract long-term capital at preferential rates for investments that are well aligned with the country's long-term goals.

It is not necessary for the development bank to interact with end users of its financing facilities: it can function as a second-tier bank, using commercial banks as a conduit for resources to reach users. This removes the need for the development bank to undertake due diligence for each loan and reduces the temptation to use resources for other purposes. The most successful development bank in the world and the largest in Europe is the German government's KfW. Except in the event of a crisis, KfW acts as a second-tier bank (see Moslener, Thiemann and Volberding, 2018).¹² In its financial activities, CORFO has already been acting increasingly as a second-tier bank (Jiménez, 2009).

In several developed and developing countries, development banking plays a pivotal role between the public sector units that formulate development policy and the financial sector. Since a development bank is an entity that is financed largely by placing bonds with State guarantees on national and international financial markets, it must remain solvent and aim to obtain and retain the best possible credit rating, without this affecting it being less profitable than private banks, because a portion of its loans are at below-market rates and its goal is social returns and not private profits.

In this same cell is education at the university and technical levels, focused on the needs of new industries. Training in new technical and professional skills must be aligned with the development policy vision and the specific industries it aims to promote.

Lastly, this cell includes the role of the State of coordinating its own agencies, as well as coordinating the public sector and private companies. This function includes removing bureaucratic hurdles, coordinating different public agencies, drafting regulations, designing proposed legislation as necessary and acting as a forum where the private sector, universities and the public sector can coordinate their actions.¹³

¹² This work is part of an interesting set of recent studies on development banking in various countries edited by Griffith-Jones and Ocampo (2018).

¹³ Devlin and Moguillansky (2012) provide examples of such institutions that have worked well in other countries and draw conclusions for Latin American countries.

In the cell in the fourth column, second row, are some sectors that already appear to be of great importance for the future: green hydrogen, lithium and decarbonization of mining. All are aligned with the commitments made by the country under the Paris Agreement to address global warming. If the mining sector does not make the transition to green mining, in the medium term Chile will not be able to export mining products because they will be subject to high carbon footprint taxes in importing countries.

Given that solar power and wind power in Chile are among the cheapest in the world, the country could become one of the main exporters of hydrogen extracted through technologies that make use of green energy (Ministry of Energy of Chile, 2020). Green hydrogen fulfils two functions: it contributes to decarbonization of the national economy and diversifies exports with a new product that will be in demand worldwide. Studies indicate that Chile is already internationally competitive in green ammonia and that within a few years it will be competitive in green fuels. Development of this industry would be of prime importance for the economic future of the country. It is estimated that, by 2040, green hydrogen could become an industry that could rival today's mining industry.

To realize this potential, government action is required in the following areas to overcome the coordination problem: (i) ensuring a supply of specific human capital for this new industry, estimated at some 500,000 skilled workers, including technicians and professionals; (ii) committing to maintaining rules of the game that are conducive to business; (iii) developing regulations for green hydrogen that meet international standards and facilitate international certifications for producers; and (iv) adapting ports for transporting the fuel to foreign markets and performing other work on infrastructure to supply domestic users (such as mining). The investments required are likely to be greater than those either the State or the domestic private sector is in a position to make.

The projections for lithium are also particularly good, both in terms of exports and in terms of production of components for global e-mobility value chains.

In this study, we will examine two policies that could be said to be intermediate or hybrid that could be designed and implemented relatively quickly, as they have precedents in previous policies. One such policy these are possible policies, not past policies as indicated in this sentence, please reword was previously abandoned and the second is still in place through InvestChile, but has been left without any financing.

These policies are distinguished firstly by the fact that authorities select the characteristics of the sectors that they wish to support, but leave it to market forces to determine which specific sectors are developed. And secondly by the fact that public support is either strictly temporary or ends automatically.

One intermediate policy could be a 5% subsidy for new exports, defined as those for which the entire export category accounts for less than US\$ 50 million. Once exports reach the threshold, all the companies that export goods in the category cease to receive the subsidy. It could be argued that WTO has prohibited subsidies; however, the Agreement on Subsidies and Countervailing Measures contains a de minimis clause for developing countries. This means that for the importing country to take action against the exporter, the subsidized exports must exceed 2% of imports of the good into the importing country. It is unlikely that a small subsidy for an entire tariff heading, which would automatically disappear when exports exceed US\$ 50 million, would result in retaliation against Chile.¹⁴

¹⁴ A reader who is familiar with the history of trade policy over the last 40 years will realize that this proposal is connected to the "simplified drawback" that was in place until 2003, when Chile classified it as a subsidy and notified the WTO that it would be suspended. This version does not link the subsidy to a refund of customs duties on imported inputs and is easier to operate. Agosin, Larraín and Grau (2009) show that the "simplified drawback" was highly effective in supporting manufacturing exports.

The other policy already mentioned is the High Technology Investment Promotion and Attraction Programme, which ran from 2001 to 2010, when the first Government of President Piñera withdrew its funding. That programme succeeded in attracting around a hundred companies. Its main incentive was a subsidy for hiring skilled labour (US\$ 25,000 per worker) and a US\$ 5,000 subsidy for each unskilled worker. The subsidy was granted on a one-time basis and the companies undertook to remain in Chile for ten years. It is estimated that the programme generated some US\$ 2 billion in service exports (see Agosin and Price, 2009).

Lastly, a competitive and stable real exchange rate is the broadest, cheapest and probably the most powerful instrument of productive development policy. This is the subject of the following section.

V. Adjustments to exchange-rate policy

The question of exchange-rate policy has been left for the end of this article. It is fundamentally a horizontal policy, implemented by providing public goods. The exchange-rate regime is determined by the central bank's choice of monetary policy. In the case of Chile, the correlate of the floating exchange rate that has been in place since late 1999 is the inflation targeting regime, whereby the interest rate is used to maintain the inflation rate within the Central Bank's target range (set for more than two decades between 2% and 4%). However, because the level of the real exchange rate and its volatility have an enormous impact on economic growth, and thus on the profitability of tradables sectors — particularly new exports that are close to becoming profitable— productive development considerations should be taken into account when formulating the framework for a floating rate. Therefore, having an exchange rate that favours export diversification does not necessarily entail abandoning a floating exchange rate, which has been a vital tool in maintaining price stability in Chile since it was adopted in late 1999. In a recent article, Guzmán, Ocampo and Stiglitz (2018) put forward a thorough argument on the importance of a competitive and stable exchange rate for growth.

There are two reasons to consider the foreign-exchange market different from goods and services markets. First, unlike prices of individual goods, the exchange rate affects the entire economy. To achieve productive diversification, it is important for the real exchange rate not to be too uncertain and for it to be at a level that stimulates new exports.

Second, the level and volatility of the real exchange rate can be influenced by economic policy measures. However, this article is not arguing for frequent foreign-exchange intervention by the Central Bank. It is more important to have an impact on the fundamentals of the real exchange rate, which is to say that part of copper revenues that now pass through the foreign-exchange market can be saved and short-term, liquid capital movements unrelated to internal macroeconomic equilibrium can be discouraged when necessary.

Exchange-rate volatility, both real and nominal, has been high in Chile, particularly since the adoption of a floating rate and in comparison with other emerging economies. These assertations are tested in this article using econometric tests outlined later, which are available to any person seeking further information. With the real exchange rate as a first-order integrated series, the monthly real exchange rate figures reveal that there are two structural breaks in the series from January 1986 to July 2019. The first occurred in April 1991 and the second in May 2000. The latter break came at almost the same time as adoption of the floating exchange-rate regime.

In this article, the relative level of volatility in the periods from April 1991 to May 2000 and June 2000 to July 2019 is estimated in three different ways. The first is to estimate the standard deviation of the moving average of the logarithm of the real exchange rate in 12-month windows. The second is to estimate, through a generalized autoregressive conditional heteroskedasticity (GARCH) model, the

predicted conditional variances in the multilateral real exchange rate for the two periods. The third is to estimate the first indicator for a representative group of emerging economies and compare the volatility of Chile's real exchange rate with its emerging peers.¹⁵

The result of the first two methods for estimating the volatility of the real exchange rate is that it was more volatile in the second period, when a floating-rate regime had already been adopted. The third method indicates that, in the 1990s, Chile was in a group of countries with relatively low real exchange-rate volatility and from 2000 onward in a group with high real exchange-rate volatility.¹⁶

Fluctuations were caused by external shocks, both financial and real, that affected the economy, and by agents' overreactions, which are characteristic of asset markets. Firstly, fluctuations in the price of copper are important, as its prominence in exports means that when copper prices rise, there is a real appreciation of the Chilean peso (decrease in the value of foreign currency) and depreciation, naturally, when copper prices fall.

Secondly, there tend to be large inflows of capital, resulting in net inflows that are difficult for the domestic economy to absorb when international markets are very liquid and risk-tolerant; these flows generally come to a sudden stop when international markets become illiquid, when interest rates in core countries rise or when the fundamentals of recipient countries worsen following booms. These sudden stops, in the Case of Chile — and in many emerging economies — have come after booms that have resulted in appreciation of the peso in terms of the real exchange rate, thus pushing up the cost of imports and the current account deficit, leading to rises in asset prices (real estate and shares) that far outstrip what is suggested by the assets' long-term fundamentals.¹⁷

Regarding copper prices, the cyclically adjusted fiscal balance rule the authorities have followed is aligned with the rule for economic activity: saving the difference between the long-term price and the observed price and spending it when the difference is negative.

The means of calculating the long-term price is crucial for managing copper price booms and busts. Since the rule was established, the long-term price estimated by a committee of experts mandated by the Minister of Finance has tended to follow the observed price very closely, but with a lag. As a result, during booms the long-term price estimates are too high and the fiscal savings tend to be too small. The opposite occurs during downturns. In other words, the treasury does not save enough when prices are high and does not spend enough when they are low. This was perhaps why the Economic and Social Stabilization Fund (FEES), the Chilean sovereign wealth fund, did not accumulate enough resources during the commodity super-cycle, which could well have been used to alleviate the macroeconomic consequences of the price decline since mid-2013. This is also one of the reasons why the exchange rate tends to appreciate excessively during copper booms and depreciate sharply during copper price declines.

There is another long-term argument for changing the fiscal rule with respect to its copper component, relating to the intergenerational distribution of the benefits of a non-renewable resource. To avoid unfairly disadvantaging future generations by consuming copper revenues in the present, all the net revenues of the treasury from profits of the National Copper Corporation of Chile (CODELCO)

¹⁵ Data for the emerging economies that served as comparators were obtained from the Bank for International Settlements, but are available from 1994 onwards. Therefore, we compare Chile's real exchange-rate volatility with that of these countries for the periods from January 1994 to May 2000 and from June 2000 to July 2019.

¹⁶ A full description of the tests performed and their empirical results are available from the author for interested readers.

¹⁷ These arguments are expanded on in Agosin and Huaita (2012) and Agosin, Díaz-Maureira and Karnani (2019). The studies contain an extensive bibliography of the literature on booms and sudden stops. Capital inflows are considered excessive when they exceed 5% of GDP or of some monetary aggregate and, in addition, are more than one standard deviation of the series of net capital inflows for the entire period under analysis. Sudden stops are defined as falls in net capital inflows of at least 5% of GDP that are more than one standard deviation of the changes in net inflows for the period under analysis.

and from taxes plus royalties on the income obtained by the private companies involved in the copper industry should be saved by the Government in its sovereign wealth fund.¹⁸

As mentioned above, the second variable affecting the real exchange rate is Chile's net capital flows. The most important variable that determines its behaviour is related to changes in international financial markets' appetite for liquidity, which tend to lead to substantial fluctuations in the nominal and real exchange rates. This is why it is advisable for the Central Bank to have the option to apply a small tax on capital flows,¹⁹ which could be activated when capital flows are expanding and returned to zero when there is no need to discourage flows.

Two regimes can be distinguished, in terms of the variables that have affected the real exchange rate since 1986. The first ran from January 1986 to December 2004 and can be referred to as a regime of the real exchange rate being determined by the financial account. From 1986 to 1997, aggregate net capital inflows (the absolute value of the financial account balance over the entire period) were 117% of the quantity of money, measured as M3.²⁰ In the subsequent years through to the end of 2004, aggregate net inflows were just 8% of M3 over the entire period. Therefore, in the first stage there was strong appreciation of the real exchange rate (despite the existence of a target range for the nominal exchange rate) and in the second stage there was also a significant depreciation.

The second regime was marked by the copper cycle. Between 2004 and 2018, despite fluctuations in its real price, copper rose 47% in real terms. The real exchange rate first showed significant appreciation, which was only partially reversed from 2012 onward. These figures and their effects on the real exchange rate are shown in table 2 and figure 3.

Chile: real exchange rate, financial account and real copper price,
aggregate changes in the periods 1986–1997, 1997–2004 and 2004–2018
(Percentages)

Table 2

Periods	Change in real exchange rate (1986=100)	Financial account/M3 (Percentages)	Change in the real price of copper in 2012 prices
1986–1997	-22.0	116.5	30.2
1997–2004	26.9	7.9	9.1
2004–2018	-8.1	19.9	65.4

Source: Prepared by the author, on the basis of data from Central Bank of Chile and Chilean Copper Commission (COCHILCO).
 Note: An increase in the real exchange rate means depreciation; a decrease, appreciation. The real price of copper is equal to its nominal price deflated by the United States producer price index. The base for the United States producer price index is 2012.

¹⁸ This proposal is taken up by Atria and others (2013), pp. 333–348. In essence, this is the rule put forward by Hartwick (1977), known as Hartwick's rule. Norway is an example: since the 1990s, Norway has accumulated all oil profits in its sovereign wealth fund and spends only the return on the fund's investments. As a result of this policy, it has managed to accumulate 1.3 trillion dollars in its sovereign wealth fund, making the country almost independent from oil price swings, in addition to protecting its real effective exchange rate from the fluctuations it would experience in the absence of this policy.

¹⁹ Unlike the reserve requirement for capital inflows employed in the 1990s, this proposal would tax all capital inflows and outflows, including foreign direct investment. The experience of the 1990s suggests that agents tend to disguise their capital as items that are exempt. The proposal is, in essence, the Tobin tax (1978 and 1996). It has been shown that a small tax on capital inflows and outflows affects only short-term capital movements and has minimal effects on long-term capital. For the case of the reserve requirement, this is demonstrated in Agosin and Ffrench-Davis (1996) and Frankel (1996).

²⁰ M3 (or "broad money", in IMF usage) is a better variable to express the relative value of capital movements than GDP, because it is a proxy for the size of the financial sector. It is defined as coins and banknotes in circulation, demand deposits, time deposits, savings deposits, plus other credit or investment instruments that are readily convertible into liquid money without loss of value (for a more precise definition, see Banco Central de Chile, Statistical Data Base (BDE) [online]: https://www.bcentral.cl/en/web/ banco-central/areas/statistics/monetary-and-financial-statistics/monetary-aggregates).

Figure 3 Chile: real exchange rate, net capital flows and real copper price, 1986–2018 (Annual figures)



B. Dominance of the real copper price, 2005-2018





Lastly, in order to moderate the fluctuations that occur in foreign exchange markets because agents have different expectations for the future exchange rate, it is proposed that the Central Bank have some additional tools available in its array of policies. First, the bank should periodically publish a report on exchange-market conditions, specifying the range of the equilibrium exchange rate (the one that would occur in the absence of speculative occurrences). The report should also discuss liquidity conditions on international capital markets, the variables that are affecting them, their possible future

trends and how they are expected to affect the equilibrium real exchange rate. This information would help foreign-exchange market agents not to overreact when making decisions regarding the future direction of the exchange rate.²¹

Some observers have argued that the foreign-exchange problem could be managed by deepening the foreign-exchange derivatives markets. However, these markets do not trade long-term instruments, which are what real investors would need. Derivatives are useful not for productive investors but for those who need to offload short-term risks (importers and exporters) and for counterparties who are willing to shoulder such risks.

VI. Concluding remarks

It is clear that the Chilean economy, after growing at "Asian" rates over the 1987–1998 period, has been stagnating. In fact, the economic growth rate from 2013 to 2019 was just 2.0%, barely exceeding the population growth rate, which has been around 1.5% in recent years, owing to large immigration flows. For there to be a return to growth, it is essential to diversify production and, as the economy is small and open, this entails diversifying exports.

Policies have been proposed to develop green hydrogen, a commodity for which Chile has an obvious potential comparative advantage. Successful development requires the State to be able to coordinate the various public and private parties that must contribute. Likewise, use of the country's large lithium deposits and implementation of a decisive policy to transition toward green mining, making use in part of green hydrogen to replace fuels based on hydrocarbons, can help Chile to boost its export growth and not miss out on comparative advantages in mining.

The article has argued for a limited set of productive development policies, including "intermediate" policies that are between horizontal and vertical ones. These policies would be adjusted to the current capacities of the State and rely on market forces to identify companies and sectors to be encouraged.

One of the intermediate policies that Chile already has in place that has been successful but has been left unfunded can be activated quickly. It would not be difficult to assign resources once again to the High Technology Investment Promotion and Attraction Programme. In addition, this programme should be open to joint ventures with domestic and foreign capital and to eligible purely domestic companies.

The second intermediate policy is a small subsidy for new exports, defined as those that, considering all exporting companies, total less than US\$ 50 million. The subsidy would end when exports of the subsidized tariff item reached that threshold.

Regarding the exchange rate, it is proposed that policy target its fundamentals and not necessarily abandon the floating exchange rate. This would entail fiscal policy moving closer to adopting Hartwick's rule of saving a large portion of net copper revenues. It is also recommended that a small tax on capital inflows and outflows be considered, to be applied when conditions on international financial markets so require.

Of course, these recommendations are far removed from today's pressing concerns. While the uncertainties that are affecting the world economy continue and while the circumstances of Chile in recent months continue to hamper economic activity, there will be no fresh rise in copper prices or a

²¹ Exchange-market agents often act in a destabilizing manner. When a factor external to the exchange rate causes it to appreciate (or depreciate), some bet that the recent market trajectory will continue, while others expect the price to return to the mean. Nominal exchange rate movements are determined by which of these two groups of agents is dominant in the market. If it is the first group, the nominal exchange rate will move away from equilibrium; if it is the second group, the exchange rate will return to its equilibrium levels. See the development of a formal model with "speculative" and "fundamentalist" agents in De Grauwe and Grimaldi (2006).

boom in capital flows, the real exchange rate will remain depreciated and the risks will largely relate to a potential global recession, in which the key international variables that influence the Chilean economy (copper prices and international capital flows) will follow more unfavourable trends. Given this situation, now seems an opportune time for policymakers to anticipate new cycles in copper prices and capital movements and to commit to an exchange rate that favours non-copper exports, with less future volatility, without abandoning the prevailing exchange rate regime.

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Pass-through of exchange rate shocks in Brazil as a small open economy

Thallis Macedo de Assis Gonçalves, Luiz Fernando Cerqueira and Carmem Aparecida Feijó

Abstract

An econometric model is used to analyse pass-through from the exchange rate to inflation, considering the monetary policy instrument variable, the target variable, the level of economic activity, the level of credit and the exchange rate. This system is exogenously affected by commodity prices, the level of external sector activity and the uncertainty perceived by international investors. Using vector error correction models, we find greater pass-through to administered prices than to free prices and a marked asymmetry characterized by stronger exchange rate pass-through when the domestic currency appreciates (deflationary effect) than when it depreciates (inflationary effect). Moreover, we note that the asymmetry in pass-through to domestic prices is due to the behaviour of free prices, since asymmetry in administered prices is not very significant.

Keywords

Monetary policy, foreign exchange rates, prices, inflation, measurement, mathematical analysis, Brazil

JEL classification

E31, E52, F31

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I. Introduction

The exchange rate is one of the main prices in the economy. Given a certain level of domestic and external prices, it is the exchange rate that regulates the international purchasing power of domestic currency-denominated rents and the purchasing power of foreign currency rents over goods denominated in domestic currency, so that the competitiveness of domestic industry, the cost of imported inputs and the ability of the domestic economy to absorb global consumer goods are determined by the exchange rate, at least in the short run. It is thus of interest to both academics and monetary policy practitioners to know how exchange rate movements affect the pass-through mechanisms whereby the base interest rate influences its target variable, namely the rate of inflation for final consumption goods (Brun-Aguerre, Fuertes and Phylaktis, 2012).

The literature defines exchange rate pass-through as the percentage change in domestic prices given a 1% change in the exchange rate, i.e., it is the exchange rate elasticity of domestic prices (Campa and Goldberg, 2005; Assis, Cerqueira and Feijó, 2019). However, it should be noted that in the vector autoregressive (VAR) model methodology and variants such as the vector error correction (VEC) and structural vector autoregressive (SVAR) model methodologies, exchange rate pass-through is measured by means of impulse response functions, which, by construction, measure the elasticity of domestic prices to exchange rate shocks not anticipated by the model, i.e., the reaction of domestic prices to exchange rate shocks as such and not the partial reaction of domestic prices to any change in the exchange rate as measured by other methodologies.

This paper uses different VEC specifications to measure exchange rate pass-through in the Brazilian economy over recent years (2003–2016).¹ The VAR model is very frequently used in the literature on exchange rate pass-through (Belaisch, 2003; Minella and others, 2003; Nogueira, 2007; Souza and Alves, 2010; Pimentel, Luporini and Modenesi, 2016),² but we find that little consideration is given to testing for cointegration between variables, since if one or more cointegrating relationships are detected, the system being examined should be represented by a VEC. Moreover, non-inclusion of the error correction term in the VAR in differences may lead to autocorrelations in the residuals (ultimately leading to unnecessary lags being added to deal with the problem) and to biased forecasts, since a variable that is important in describing the dynamics of the system is being omitted.

This paper differs from the rest of the relevant literature on the Brazilian economy in that it gives due weight to cointegration tests and handles pass-through from the exchange rate to prices with a model that treats external shocks as unmodelled (exogenous) variables, given that commodity prices, for example, are set in international markets and depend on variables other than those endogenous to the macroeconomic system that is important for monetary policy. This system is described by the policy instrument variable, the policy target variable, the nominal exchange rate, the level of credit and the level of domestic activity. Therefore, it does not seem reasonable to treat as endogenous a variable that depends on a number of factors external to the system. Moreover, we consider a wider range of shocks that may interfere with measurement of the domestic price response to exchange rate shocks: in addition to international investors' perception of short-term uncertainty. We believe that we thus better distil genuinely unexpected exchange rate shocks and their impact on prices. We have based our choice of variables on a review of the Brazilian and international literature,³ filling in gaps that we

¹ The era following the fixed exchange rate regime and the instability caused by the 2002 elections.

² These studies obtain their main results from vector autoregressive (VAR) models. The Brazilian literature, curiously, relegates to the background the possibility of cointegration between variables endogenous to its estimation models.

³ Particular mention may be made of Belaisch (2003), Minella and others (2003), Nogueira (2007), Capistrán, Ibarra and Francia (2012), Burstein and Gopinath (2014), Donayre and Panovska (2016), Pimentel, Luporini and Modenesi (2016), Brun-Aguerre, Fuertes and Greenwood-Nimmo (2017) and Bejarano Aragón, Moura and Moura (2018).

consider significant, and on the Central Bank of Brazil's publications dealing with its own VAR and VEC models (Central Bank of Brazil, 2012b and 2013).

The paper shows that there is more pass-through to administered prices than to free prices. There is also evidence of asymmetric pass-through⁴ in the full version of the extended consumer price index (IPCA) and in the free price category within the IPCA. This asymmetry is characterized by stronger pass-through of domestic currency appreciation shocks than depreciation shocks: in absolute terms, the long-run effect on prices of an appreciation shock is about twice as large as the effect caused by a depreciation shock. Moreover, it is shown that the pass-through of a domestic currency appreciation to free and administered prices is of similar magnitude, while there is much greater pass-through to administered prices than to free prices are subject to a competition effect that counteracts the pass-through of positive cost shocks to the final consumer.

In sum, Brazilian monetary policy cannot ignore this important non-linearity (pass-through asymmetry) in the relationship of the exchange rate to domestic prices in Brazil, which deserves further investigation, as well as other possible non-linearities (Carneiro, Monteiro and Wu, 2004; Correa and Minella, 2006) in the variables that are important for monetary policy. The discovery of non-linearities as strong as the asymmetry shown in this paper reveals how urgent it is to review the use of purely linear models when approximating relationships of relevance to monetary policy.

Section II that follows reviews the empirical literature of recent years. Section III presents our own empirical analysis. Section IV, lastly, draws conclusions.

II. Exchange rate pass-through in Brazil over recent years

In an emerging economy like Brazil's, with a highly volatile exchange rate (Minella and others, 2003; Kaltenbrunner and Painceira, 2015) and its own foreign exchange market idiosyncrasies,⁵ a proper understanding of the relationship between exchange rate movements and final consumer prices is essential for the design of an appropriate monetary policy that can help stabilize inflation (Minella and others, 2003; Mishkin, 2004; Nordstrom and others, 2009; Ghosh, Ostry and Chamon, 2016). The autoregressive vector methodology and its variants are very widely employed in the literature to measure exchange rate pass-through (Jacobson and others, 1999; Central Bank of Brazil, 2012b), and their use is interesting, as they provide an analysis with minimal researcher interference and with a priori application of restrictions derived from the theory (Central Bank of Brazil, 2012b). We shall now review a selection of papers from recent years in which this type of methodology has been used to study the situation in Brazil (see table 1).

⁴ See section III.2.

⁵ Ventura and Garcia (2012) present the sui generis relationship between the futures market and the spot market in Brazil, where they find evidence that the short-term futures market (transactions for foreign currency delivery within 30 days) is the locus of price formation, with prices transmitted to the spot market through arbitrage transactions.

Table 1 Summary of studies using the VAR, SVAR and VEC methods to measure exchange rate pass-through without considering asymmetry

Authors	Model	Pass-through measuring method	Sample	Cointegration testing	Twelve-month pass- through to the IPCA <i>(Percentages)</i>
Belaisch (2003)	VAR	$\frac{\Delta P_{t,t+j}}{\Delta E_{t,t+j}} imes 100$	June 1999 to December 2002	No	17.00
Minella and others (2003)	VAR	$\frac{\Delta P_{t,t+j}}{\varepsilon_{Et}} \times 100$	September 1994 to December 2002	No ^a	17.90
	VAR		September 1994 to June 2002	No ^a	14.10
Nogueira (2007)	VAR	$\frac{\Delta P_{t,t+j}}{\varepsilon_{Et}} \times 100$	January 1995 to June 1999	No	131.00
	VAR		July 1999 to December 2004	No	11.00
Souza and Alves (2010)	VEC	$\frac{\Delta P_{t,t+j}}{\Delta E_{t,t+j}} imes 100$	January 1999 to December 2002	Yes	12.57
	SVAR		January 2003 to December 2009	Yes ^b	1.78
	VAR		January 2003 to December 2009	Yes	1.53

Source: Prepared by the authors, on the basis of A. Belaisch, "Exchange Rate Pass-Through in Brazil", *IMF Working Papers*, No. 2003/141, Washington, D.C., International Monetary Fund (IMF), 2003; A. Minella and others, "Inflation targeting in Brazil: constructing credibility under exchange rate volatility", *Journal of International Money and Finance*, vol. 22, No. 7, December 2003; R. P. Nogueira, "Inflation targeting and exchange rate pass-through", *Economia Aplicada*, vol. 11, No. 2, June 2007; R. G. Souza and A. F. Alves, "Relação entre câmbio e preços no Brasil: aspectos teóricos e evidências empíricas", thirty-eighth national meeting, Brazilian Association of Graduate Programmes in Economics (ANPEC), Salvador, 7–10 December 2010 [online] https://www.anpec.org.br/encontro2010/inscricao/arquivos/000-63cb7b0661 b466d2e5760e4a82f422dc.pdf [accessed on 5 January 2023].

Note: VAR: vector autoregressive model; SVAR: structural vector autoregressive model; VEC: vector error correction model; IPCA: extended consumer price index.

^a The method used by Belaisch (2003) and all those who follow her is the ratio of the changes in the price level and the exchange rate accumulated from *t* until *t* + *j*, given a shock at *t*. The other method considers only the relationship between the cumulative change in the price level and exchange rate shocks not anticipated by the model.

^b No cointegrating relationship was identified for this sample period.

Belaisch (2003) measures the exchange rate pass-through ratio for t=j after a given shock of t=1 as the ratio between the cumulative change in the price level and the cumulative change in the exchange rate, both up until t=j.

Belaisch (2003) estimates a VAR(2) for the period from July 1999 to December 2002, including the oil price index (IMF, 2022), the physical production index for industry (the old Monthly Industrial Survey-Physical Production (PIM-PF) prepared by the Brazilian Institute of Geography and Statistics (IBGE)), the exchange rate, and one of the following price indices, for each case: the general price index-domestic supply (IGP-DI), the wholesale price index (IPA), the IPCA, the tradable goods IPCA, the non-tradable goods IPCA, the administered prices IPCA and the free prices IPCA.⁶ The variables were used in first difference, as the unit root tests indicated that they were all I(1).⁷ The impulse response functions were calculated from the orthogonalized residuals using the Cholesky decomposition. The author finds that exchange rate pass-through to the IPA is much more persistent and faster than that to the IPCA. The IGP-DI also responds quickly, but the impact is smaller and shorter-lived than in the case of the IPA. Among consumer prices, tradable goods prices are the most sensitive to exchange rate shocks. Free prices show similar behaviour, but less marked. The impact on non-tradable goods prices is small, but persists for 12 months, which is consistent with the idea that these experience second-order shocks after the exchange rate shocks (the direct inflationary impact on tradable goods

⁶ The first two (the IGP-DI and the IPA) are produced by the Brazilian Institute of Economics (FGV IBRE, 2022) and the other five (the IPCA and its subindices) by the Brazilian Institute of Geography and Statistics (IBGE, 2022).

⁷ Integrated of order 1.

prices is transmitted with some lag to non-tradable goods prices).⁸ Administered prices react faster than free prices, but the impact on the former is less persistent and loses statistical significance after one quarter. Belaisch (2003) identifies a 12-month pass-through of 53% for the IGP, 120% for the IPA, 17% for the full IPCA, 15% for both free and tradable goods prices, 5% for administered prices and 12% for non-tradable goods prices.

This greater impact of exchange rate shocks on the IPA than the IPCA challenges the notion that the strength of exchange rate pass-through diminishes along the production chain (McCarthy, 2000; Choudhri, Faruqee and Hakura, 2005), as identified by Capistrán, Ibarra and Francia (2012) in the Mexican case in their observation of pass-through to imported product prices, producer prices and consumer prices.

Minella and others (2003) estimate two specifications of the VAR for the period from September 1994 to December 2002. In both specifications, the authors include seasonally adjusted industrial production as a proxy for the level of activity, the emerging markets bond index plus (EMBI+)⁹ as a way of controlling for the financial crises in the period (the Mexican, South-East Asian, Russian, Argentine and Brazilian crises), the exchange rate of the Brazilian real against the dollar and the monthly average of the effective Over/SELIC rate. In one, prices were measured by the IPCA, and in the other, the IPCA was broken down into administered and market (free) prices.

Unlike Belaisch (2003), Minella and others (2003) estimate a larger exchange rate pass-through for administered prices than for free ones, but the measurement method differs: these authors estimate the exchange rate pass-through as the ratio between the cumulative 12-month change in the price level and the value of the exchange rate shock in the first of those 12 months. Thus, they estimate exchange rate pass-through of 32.7% for administered prices and 17% for free prices. If the second half of 2002 is removed from the sample, exchange rate pass-through is 19.7% for administered prices and 7.8% for free prices (the drop in the expected values is considerable, but, taking a 95% confidence level, there is no statistical difference between the two estimates in the pass-through values for each price category). For the full IPCA, pass-through was 17.9% in the full sample and 14.1% in the reduced sample. When considering only the inflation targeting period (July 1999 to December 2002), exchange rate pass-through is lower: 20% for administered prices, 11.3% for free prices and 13.1% for the full IPCA. However, the values for administered and free prices are not statistically significant in the period of the inflation targeting regime, probably owing to the paucity of observations.

Nogueira (2007) analyses exchange rate pass-through and the "fear of floating"¹⁰ in a number of developed economies (Canada, Sweden and the United Kingdom) and emerging ones (Brazil, Czechia, Mexico, the Republic of Korea and South Africa) that have adopted an inflation targeting regime. Following the methodologies used by Calvo and Reinhart (2002) and Ball and Reyes (2008), the author identifies a reduction in exchange rate intervention in all countries after the adoption of the inflation targeting regime. The question is whether exchange rate intervention is driven by a fear of inflation or a more generalized fear of floating. The monetary authority of a country adopting a targeting regime would have an incentive to try to influence the exchange rate if it identified high pass-through of the exchange rate to prices in the economy, so that fear of inflation may translate into a fear of floating, but the latter would be characterized by attention to exchange rate movements that was inconsistent with the monetary policy regime adopted in the economy (i.e., there would be exchange rate interventions).

⁸ Some non-tradable goods may have tradable goods as inputs, or there is simply a tendency for relative prices to readjust.

⁹ Specifically, the authors used the EMBI for the period from September 1994 to December 1998 and the EMBI+ for the rest of the sample.

¹⁰ The concept is taken from Calvo and Reinhart (2002) and refers to interventions in the foreign exchange market by the monetary authority of an economy that appear inconsistent with announced monetary policy objectives, even when the adoption of a floating exchange rate regime has been officially declared.

With these perspectives, Nogueira (2007) analyses macroeconomic data (international reserves, interest rates, exchange rates of national currencies per dollar unit, inflation rates, output growth rates) for developed economies between January 1985 and December 2004 and for emerging economies between January 1995 and December 2004 by analysing the variability of the data before and after the adoption of the inflation targeting regime and using the VAR method to measure exchange rate passthrough to prices. The author finds that exchange rate pass-through is lower in developed economies than in emerging ones and that it falls significantly in both after the adoption of the inflation targeting regime. Through variance decomposition, however, he finds that the exchange rate remains an important determinant of the inflation rate, even after the adoption of the targeting regime, which would seem to justify the reactions of most central banks in the economies analysed to exchange rate movements, taking the form of interventions that are intended to avoid exchange rate pass-through spilling over to consumer prices and are therefore consistent with the targeting regime, being induced by the fear of inflation. In the Brazilian case in particular, the author finds that, given a 1% exchange rate shock at t = 1, there is a 1.3% change in the general price level at t = 12 before the adoption of the inflation targeting regime. After the adoption of this regime, the cumulative 12-month impact on the general price level is only 0.11%. In other words, the cumulative 12-month pass-through ratio of exchange rate shocks decreases from 1.3% before the adoption of the targeting regime to 0.11% afterwards. Even so, it should not be lightly assumed that the adoption of the regime was the determining factor in this decline in exchange rate pass-through, since, except for the first half of 1999, the period before the targeting regime coincides with the exchange rate peg period, so that the sharp reduction in pass-through may be partly explained by the adoption of a floating exchange rate (Albuquerque and Portugal, 2005).¹¹

An exception in the Brazilian literature as regards the concern with testing for cointegration between variables of interest is Souza and Alves (2010), but in our view these authors do not consider enough variables, do not address exogenous shocks as we do, do not deal with the issue of asymmetry and do not show whether the choice of lags for estimating the models eliminates possible autocorrelation of the residuals, which if present casts doubt on the estimates in the context of these models. Souza and Alves (2010) investigate exchange rate pass-through in the period from 1999 to 2009 and, identifying a structural break in the exchange rate in January 2003, split the analysis into two samples, finding evidence of a cointegrating vector between the IPCA, the exchange rate, the Institute for Applied Economic Research (IPEA) industrial production index and the oil price index,¹² also provided by IPEA, in the period from January 1999 to December 2002, with no cointegrating relationship between the variables in the rest of the sample. Thus, estimates are made using the VEC method for the first period and the VAR and SVAR methods for the second. The methodology for measuring exchange rate pass-through is the same as that used by Belaisch (2003). The authors find strong evidence of a reduction in exchange rate pass-through between the two periods, with an estimated 12-month pass-through of 12.57% in the period from January 1999 to December 2002 and an estimated 12-month pass-through of 1.53% using VAR and 1.78% using SVAR in the period from January 2003 to December 2009.

Pimentel, Luporini and Modenesi (2016) introduce the possibility of asymmetric exchange rate pass-through, i.e., impacts of different magnitudes on prices following an exchange rate appreciation or depreciation. For the period from January 1999 to November 2013, the authors estimate that the inflationary impact of an exchange rate depreciation is significantly larger than the deflationary impact of an exchange rate appreciation. They use the IPCA as a measure of the general price level; the monthly index of physical industrial production (PIM-PF) calculated by IBGE as a proxy for the level of activity stimulated by aggregate demand; the monthly average buying exchange rate between the Brazilian real and the dollar; and the commodity price index calculated by IPEA and the dollar-denominated

¹¹ Having access to more data on the inflation targeting regime, however, the Central Bank of Brazil (2011) reports a decline in exchange rate pass-through during the period this regime was in force.

¹² Endogenous model variables.

international oil price published by the International Monetary Fund (IMF) as proxies, used in different specifications, for cost behaviour (aggregate supply shocks). With different specifications, and without including asymmetry in exchange rate pass-through, the authors estimate for the floating exchange rate period up to May 2012 that, given an exchange rate shock at *t*, between 5.9% and 7.2% of the exchange rate change caused by that shock is passed through to prices in the 12-month period starting at *t*. When asymmetry is included, an unexpected 1% appreciation in the exchange rate at t = 1 leads to a 0.024% change in the price level at t = 12. This is surprising, because exchange rate appreciation, the positive change in the price level at t = 12 is between 0.056% and 0.077%.

III. Brazil as a small open economy

1. Some methodological considerations

When variables of relevance to monetary policy in an economy are analysed, it is usual for them to have a unit root, i.e., these are variables that have a stochastic trend and are thus non-stationary. Examples generally include monetary aggregates, the general price level, the exchange rate, indirect indicators of the level of activity and sometimes even the base rate. For this reason, when estimating the interrelationships between these variables in a VAR, it is usual to work with the first differences of the series or with the first differences of the logarithms of the series.

When a set of integrated series of order 1 (I(1)) has a statistically stable long-run relationship, these variables are said to be cointegrated (Banerjee and others, 1993, chap. 5). Every cointegrating relationship is represented by an error correction model (Engle and Granger, 1992; Banerjee and others, 1993, chaps. 5 and 8). This name comes from the fact that the one-period lagged deviation of the long-run relationship enters the equation describing the short-run dynamics of at least one of the variables. That is, when z_t , I(0), with zero mathematical expectation, is a linear combination of n I(1) variables, the first difference at t of at least one of the n endogenous variables in the model is significantly affected by the deviation of the long-run relationship between the n variables at t - 1. Thus, a first-difference VAR model is only suitable for measuring exchange rate pass-through if we eliminate the possibility of there being an error correction term relating to a long-run relationship between the endogenous variables.

Moreover, we do not consider it reasonable to treat variables such as international commodity or oil prices, which are commonly used as proxies for inflationary cost or supply shocks, as endogenous to the economic system that is relevant to domestic monetary policy. This system is basically described by five main variables: the monetary policy instrument variable, the monetary policy target variable, the level of activity in the domestic economy, credit (elasticity of domestic liquidity)¹³ and, of course, the exchange rate, which is the factor of interest for this paper. These variables coincide with those used by the Central Bank of Brazil in its vector autoregressive models and with the monetary policy transmission channels it considers (Central Bank of Brazil, 2012a, 2012b and 2013).

Furthermore, in order to correctly isolate the effects of exchange rate shocks unanticipated by the model on domestic prices, it was decided to include three variables exogenous to the endogenous domestic monetary policy system: an international commodity price index, an index representing the economic activity of the external sector, and a measure of international investors' perception of uncertainty, since at times of greater uncertainty in financial markets investors seek out safer assets, preferably

¹³ In other words, the ability to expand liquidity coupled with the willingness to lend, given the banking system's reserves in cash and securities that are immediately convertible to goods and assets at face value.

denominated in currencies that rank higher in the hierarchy of the international monetary system,¹⁴ which also leads to reactions in base interest rates to forestall very large and abrupt depreciations of the domestic currency; in other words, it is an important predictive variable for the system we are concerned with in this paper. Brazil is deemed here to be too small to affect these variables, i.e., they exogenously impact the system described by the five endogenous variables mentioned above, these being variables that are very much affected in the sphere of the domestic economy and, more specifically, that of domestic monetary policy.

Capistrán, Ibarra and Francia (2012) formulate the same consideration in the case of the Mexican economy with respect to variables in the United States economy that affect it exogenously. They use these variables, much as those in this article are used, as proxies for Mexican external sector variables, which are insignificantly affected by the Mexican economy. Given the size of the Brazilian economy and its participation in world trade and capital flows, it is reasonable to treat it as a small open economy in the sphere of analysis we are concerned with.

Lastly, our measure of exchange rate pass-through, as befits the methodology used, will start from the analysis of impulse response functions, which we will derive using the methodology of generalized impulse response functions, which are robust to the ordering of variables (Pesaran and Shin, 1998).

Let us take a VAR(p) with exogenous variables as follows:

$$Y_t = \sum_{i=1}^{p} \Gamma_i Y_{t-i} + \Upsilon D_t + \Phi X_t + \varepsilon_t$$
⁽¹⁾

Taking the standard assumptions of stability of the VAR(p) process, no error autocorrelation (but without restricting the possibility of contemporaneous correlation between the components of ε_t), independence between the errors and the stochastic and deterministic regressors, and non-perfect multicollinearity between Y_{t} ,..., Y_{t-p} , X_t and D_t , the stochastic process $\{Y_t\}_{t=-\infty}^{+\infty}$ can be represented as:

$$Y_t = \Psi(L)D_t + \Xi(L)X_t + \Theta(L)\varepsilon_t$$
⁽²⁾

where $\psi(L)$, $\Xi(L)X_t$ and $\Theta(L)$ are infinite-order matrix polynomials.

Taking Ω_{t-1} as the known history of the economy up to t - 1, we can write:

$$E(Y_{t+k} \mid \Omega_{t-1}) = \Psi(L)D_{t+k} + \sum_{i=1}^{\infty} \Xi_{i+k}X_{t-i} + E\left(\sum_{h=0}^{k} \Xi_{k-h}X_{t+h} \mid \Omega_{t-1}\right) + \sum_{i=1}^{\infty} \Theta_{k+i}\varepsilon_{t-i}$$
(3)

If we consider that the economy is affected at t by a vector $\delta' = (\delta_1, ..., \delta_n)$ of shocks to the n variables of Y_t , we get:

$$E(Y_{t+k} \mid \varepsilon_t = \delta, \Omega_{t-1}) = \psi(L)D_{t+k} + \sum_{i=1}^{\infty} \Xi_{i+k}X_t + E\left(\sum_{h=0}^{k} \Xi_{k-h}X_{t+h} \mid \Omega_{t-1}\right) + \Theta_k\delta + \sum_{i=1}^{\infty} \Theta_{k+i}\varepsilon_{t-i}$$

$$(4)$$

Pass-through of exchange rate shocks in Brazil as a small open economy

¹⁴ Currencies with a wider currency area, such as the dollar, which is accepted worldwide, the euro, which is accepted throughout Europe and in countries that have substantial trade relations with Europe, and the Japanese yen, which is also accepted as a means of payment in transactions between residents and non-residents in a number of economies that trade with Japan. These are the main currencies in the currency hierarchy, whose ranking criterion is the international liquidity of the financial asset. The Brazilian real clearly stands lower in the international currency hierarchy than the currencies listed above.

With the shock occurring at the given t, we are interested in the time profile of the response of each variable in a system to an unexpected shock due to the dynamics of the system itself. The impulse response function of each variable is a measure of this profile. So given δ and Ω_{t-1} , we obtain a function that for each value of k returns the response Y_{t+k} to a shock at t. Pesaran and Shin (1998) call this function the generalized impulse response function, and we represent it as:

$$GI(K, \delta, \Omega_{t-1}) = E(Y_{t+k}|\varepsilon_t = \delta, \Omega_{t-1}) - E(Y_{t+k}|\Omega_{t-1}) = \Theta_k \delta$$
(5)

Considering that at *t* there is only one shock to variable *j* and supposing that the errors of the autoregressive form of Y_t follow a multivariate normal distribution, ¹⁵ $\varepsilon_t \sim N(0, \Sigma)$, we can write:

$$E(\varepsilon_t | \varepsilon_{jt} = \delta_j) = (\sigma_{1j}, \sigma_{2j}, ..., \sigma_{mj})' \sigma_{jj}^{-1} \delta_j = \sum S_j \sigma_{jj}^{-1} \delta_j$$
(6)

where $(\sigma_{1j}, \sigma_{2j}, ..., \sigma_{mj})'$ is the vector of contemporaneous covariances between the errors of each equation of the system, σ_{jj} is the variance of the *j*-th element of ε_t and ς_j is a vector of zeros, except the number 1 in its *j*-th entry.

Scaling the shock δ_j to one standard deviation of ε_{jt} , Pesaran and Shin (1998) define the generalized impulse response function as:

$$GI_{j}(k) = \sigma_{jj}^{-1/2} \Theta_{k} \Sigma S_{j}$$
⁽⁷⁾

Let us now assume that the *n* endogenous variables of Y_t are I(1), but are cointegrated, so that we observe $Y_t \sim CI(1,1)$ (Engle and Granger, 1992). We then represent the model in its error-corrected form:

$$\Delta Y_t = \alpha \beta' Y_{t-1} + \sum_{i=1}^{p-1} C_i \Delta Y_{t-i} + BX_t + \alpha \beta' HD_t + \in_t$$
(8)

where D_t is a vector of deterministic components that may be present in the cointegrating relationship (so that $\alpha\beta'Y_{t-1}$ is a zero mean stationary process) and B, H and C_i , with i = 1, ..., p - 1, are coefficient matrices.

Following Pesaran and Shin (1998), given that the first difference of Y_t is I(0), let $C = I_n - \sum_{i=1}^{p-1} C_i$ and $\alpha \perp$ and $\beta \perp$, such that $\alpha' \alpha \perp = \beta' \beta \perp = 0$, as long as $\alpha \perp C \beta \perp$ is the full range, we get:

$$\Delta Y_{t} = \sum_{i=0}^{\infty} Z_{i} X_{t-i} + \sum_{i=0}^{\infty} A_{i} \alpha \beta' D_{t-i} + \sum_{i=0}^{\infty} K_{i} \in_{t-i}$$
(9)

where Z_i , A_i and K_i , for i = 0, 1, ..., coefficient matrices.

Let \sum_{ϵ} be the covariance matrix of ϵ_t and $\psi_k = \sum_{j=0}^k K_j$ with $\psi_0 = I_n$, then the generalized impulse response function for endogenous level variables, scaled to a unit shock, is:

$$GI_{j}(k) = \sigma_{jj}^{-1} \psi_{k} \sum_{\epsilon} \zeta_{j}$$
(10)

¹⁵ Pesaran and Shin (1998) point out in their second footnote that "when the distribution of the errors ε_t are non-normal, one could obtain the conditional expectations $E(\varepsilon_t | \varepsilon_{jt} = \delta_j)$ by stochastic simulations, or by resampling techniques if the distribution of errors is not known".
In a model using the natural logarithms of the nominal exchange rate and the level of consumer prices, the impulse response function of the price level logarithm in the event of a unit exchange rate shock provides exactly one measure of exchange rate pass-through, as it represents the elasticity of the price level in the event of an exchange rate shock.

As an extension of the original model, the effects on free and administered prices and the presence of asymmetry in exchange rate pass-through will also be separately analysed. The free and administered price index series were constructed by setting the July 2003 index value at 100 and accumulating the percentage changes for each price category. We shall now explain the methodology used to consider the possibility of asymmetry in exchange rate pass-through.

Given LEXCHANGE+ and LEXCHANGE- defined as follows:

$$LEXCHANGE_{t}^{+} = \sum_{i=1}^{t} \omega^{+} \Delta e_{t}; \begin{cases} \omega^{+} = 1, & \text{if } \Delta e_{t} > 0\\ \omega^{+} = 0, & \text{if } \Delta e_{t} \le 0 \end{cases}$$
(11)

$$LEXCHANGE_{t}^{-} = \sum_{i=1}^{t} \omega^{-} \Delta e_{t}; \begin{cases} \omega^{-} = 0, & \text{if } \Delta e_{t} \ge 0\\ \omega^{-} = 1, & \text{if } \Delta e_{t} < 0 \end{cases}$$
(12)

where Δe_t is the first difference of the natural logarithm of the exchange rate.

To carry out the empirical analysis presented in the next subsection, the following steps were taken: (i) selection of the monetary policy-related variables serving to model the system that concerns us, based on the literature and the models used by the Central Bank of Brazil; (ii) execution of unit root tests to determine the order of integration of each of the variables; (iii) determination of the number of lags for a VAR with variables in level; (iv) application of the cointegration test; (v) preliminary VEC and VAR estimations and observation of the generalized impulse response functions; (vi) for each VEC, testing for the significance of the coefficients of each variable in the cointegrating relationship and also weak exogeneity; and (vii) final specifications. To determine the number of lags, lastly, we used two methodologies that were equivalent in all the models presented in this paper: the maximum lag was set at eight and the Lagrange multiplier test for autocorrelation was used to find the smallest VAR with non-autocorrelated residuals. Following the Central Bank of Brazil (2012b), we used the Hannan-Quinn information criterion to determine the size of the VAR and added lags as necessary to eliminate autocorrelation in the residuals of the LM test. These methodologies were applied to the VAR in levels, so that the VECs have one lag less.¹⁶

2. Why is the exchange rate passed through asymmetrically?

Asymmetry in exchange rate pass-through means that aggregate prices react differently depending on the direction of the exchange rate shock. Asymmetric import prices in the domestic economy can be explained by the market power of firms exporting to it, which are able to maintain their foreign currency margins in the event of an exchange rate depreciation and to profit when there is an appreciation. Other possible explanations include constraints on the distribution networks of firms exporting to the domestic economy or export limitations in the countries from which the domestic economy imports, so that higher demand for imported goods resulting from the increased international purchasing power of the domestic currency in periods of appreciation puts upward pressure on the foreign currency price of imported goods, thereby reducing the impact of the exchange rate appreciation (Brun-Aguerre,

¹⁶ To ensure parsimony in the size of the VAR, we only rejected the null hypothesis of no autocorrelation when the p-value was less than 0.01.

Fuertes and Greenwood-Nimmo, 2017). Another possible cause of pass-through asymmetry arises when a firm faces reasonable competition in the international market and fights for market share in foreign markets. In the event that an importing country's currency appreciates, the firm maintains its price in its own currency and allows full exchange rate pass-through to the price in the importing country's currency. In the event of a depreciation, the exporting firm, in order to maintain market share, absorbs some of the loss of purchasing power of the importer's currency by cutting the price in its own currency, thereby reducing the pass-through to the price paid by the importer (Pimentel, 2013, pp. 36–37; see Pimentel, 2013; Pimentel, Luporini and Modenesi, 2016; Brun-Aguerre, Fuertes and Greenwood-Nimmo, 2017; Assis, 2017, chap. 1; and Assis, Cerqueira and Feijó, 2019 for more detailed theoretical discussions on this topic).¹⁷

In the international literature, the issue has been investigated in studies such as those by Pollard and Coughlin (2003), who observe asymmetric short-term exchange rate pass-through in half the 30 industrial sectors analysed in the United States between 1978 and 2000, but find that no one type of asymmetry predominates; Bussière (2013), who in a study of the Group of Seven (G7) countries between 1980 and 2006 finds a tendency towards greater pass-through of local currency depreciations than appreciations in the short run; and Delatte and López-Villavicencio (2012), who study quarterly data between 1980 and 2009 for Japan, Germany, the United States and the United Kingdom and find greater pass-through of depreciations in the long run. In the Brazilian case, the literature on the asymmetry of exchange rate pass-through is still quite sparse. We highlight here the studies by Pimentel, Luporini and Modenesi (2016) and Assis (2017), which find asymmetries in opposite directions: the former authors find greater pass-through of depreciations than of appreciations, while Assis finds just the opposite, in addition to observing even stronger asymmetry than was found by Pimentel, Luporini and Modenesi (2016).

3. Empirical analysis

To achieve the objectives of this study by means of the methodology described, we will use the measures presented in table 2 for the theoretical variables that concern us. This table is complemented by the analysis of variables used in our model, included in tables 3, 4 and 5.

Variable	Measure	Abbreviation	Source
Real base rate	Annualized Over/SELIC interest rate (cumulative for the month) deflated by the percentage change in the monthly general price index (IGP-M) for the current month ^a	INTEREST	Central Bank of Brazil and Brazilian Institute of Economics (FGV IBRE)
Exchange rate	Real exchange rate/average free dollar for the month	EXCHANGE	Series 3697 of the Central Bank of Brazil Time Series Management System (SGS)
Cumulative positive percentage changes in the exchange rate	See section III.1	LEXCHANGE+	
Cumulative negative percentage changes in the exchange rate	See section III.1	LEXCHANGE-	-
Activity level	Central Bank of Brazil economic activity index (IBC-Br)	IBC	Central Bank of Brazil
Consumer price index	Extended general consumer price index	IPCA	Brazilian Institute of Geography and Statistics (IBGE)

Table 2 Variables used

¹⁷ This is an example of pricing to market, where an exporting firm faced with different market structures in the markets it sells to (one in the domestic market and one in international markets) price-discriminates between these markets, making it a more aggressive competitor in international markets (which leads to the exchange rate pass-through asymmetry described above) and something more akin to an oligopolist in the domestic market (Krugman, 1986).

Variable	Measure	Abbreviation	Source
Credit	M4/monetary base, the latter seasonally adjusted using the moving average method in a multiplicative model	CREDSA	Central Bank of Brazil
Free consumer price index	Cumulative changes in the IPCA for free prices, taking July 2003 as 100	FREE	Constructed from the percentage change series available from the
Administered consumer price index	Cumulative changes in the IPCA for administered prices, taking July 2003 as 100	ADMS	Institute of Applied Economic Research (IPEA), Ipeadata [online] http://www. ipeadata.gov.br/Default.aspx, using the definitions of the Central Bank of Brazil
Commodity prices	Brazil index of commodity prices (IC-BR) converted to dollars	IC	Central Bank of Brazil
External sector activity	United States total industrial production index (2012 average=100)	IND ^{US}	Board of Governors of the Federal Reserve System, "Industrial Production: Total Index" [online] https://fred. stlouisfed.org/series/IPB50001N
International investors' perception of uncertainty	Chicago Board Options Exchange (CBOE) Volatility Index (VIX) (monthly average of daily closing values)	VIX	Chicago Board Options Exchange (CBOE), "CBOE Volatility Index: VIX" [online] https://fred.stlouisfed.org/series/VIXCLS ^b

Source: Prepared by the authors.

^a Consistent with the practice of the Central Bank of Brazil, "Revisão dos modelos de vetores autorregressivos com fundamentação econômica - 2012", *Relatório de Inflação*, vol. 14, No. 3, September 2012.

^b VIX measures are now available for emerging markets, including specifically for Brazil (this should perhaps be treated as an endogenous variable), but the observed data for these measures do not cover the entire sample period dealt with by this paper.

Table 3										
Descriptive	statistics	for	the	endo	genous	variab	les			

	DLOG(IPCA)	DLOG(IBC)	DLOG(EXCHANGE)	INTEREST	LOG(CREDSA)
Mean	0.004944	0.001829	0.000691	5.932555	2.850260
Median	0.004787	-0.003013	-0.005452	5.975032	2.820874
Maximum	0.013114	0.118665	0.188575	31.737390	3.199159
Minimum	-0.002103	-0.063896	-0.070322	-11.410070	2.627624
Standard deviation	0.002616	0.036181	0.036942	8.110612	0.157833

Source: Prepared by the authors.

Table 4 Descriptive statistics for the exogenous variables

	DLOG(IND ^{US})	DLOG(IC)	LOG(VIX)
Mean	0.000976	0.003159	2.883016
Median	-0.001173	0.004653	2.815523
Maximum	0.046533	0.081658	4.137396
Minimum	-0.050636	-0.181264	2.381176
Standard deviation	0.017284	0.034099	0.352920

Source: Prepared by the authors.

Table 5										
Endogenous	variables	in	the	extended	models					

	LEXCHANGE-	LEXCHANGE+	DLOG(FREE)	DLOG(ADMS)
Mean	2.016269	2.931270	0.005010	0.004829
Median	2.165229	2.884575	0.005000	0.003500
Maximum	2.967498	4.242634	0.012000	0.033600
Minimum	0.885990	2.094315	-0.003500	-0.011100
Standard deviation	0.599040	0.639886	0.002873	0.005353

Source: Prepared by the authors.

We considered that using the real interest rate in the way described above would shed more light on the effectiveness of monetary policy and that it was more in line with the previous result of Assis (2017), who, in exercises similar to those carried out in this paper, found that while the Central Bank of Brazil was more reactive to shocks affecting the inflation expectations expressed in the targeting regime operating in the country, a monetary policy shock was more powerful when it was able to raise the real interest rate at the same time, in line with the literature following the so-called "Taylor rule".

In addition, the credit proxy was the one used by the Central Bank of Brazil (2012b) in several of its models. However, given the strong seasonality of the monetary base in December, when it grows strongly because of banks' need for liquidity and increased demand for paper money from the public, it was necessary to strip out this effect from the monetary base series before including this series in the models, as the seasonal dummies did not adequately reflect the seasonal effect.¹⁸ Thus, the proxy obtained reflects the relationship between the total money supply (on the broadest definition) and the trend, multiplied by a stochastic component, of the monetary base. This reflects the capacity of the banking system, given the behaviour over time of the money supply in its strict official sense, to expand the liquidity available in the economy, i.e., it is a measure of the elasticity of the Brazilian monetary system.¹⁹

Including commodity prices is necessary, not only because of their historical importance for the country, but also because they are very important for understanding a number of economic phenomena of the last decade and a half in Brazil (Bresser-Pereira, 2009; Finello and Feijó, 2017). The atypical appreciation of commodity prices, which peaked at the height of the subprime crisis (in the second half of 2008), and its resumption after the "eye of the storm" with a new peak in April 2011, led to appreciation of the currencies of a number of commodity exporters, including Brazil, which seems to be linked to what some researchers have called the reprimarization of the Brazilian export model,²⁰ in opposition to the description of Dutch disease in Bresser-Pereira (2009). Moreover, it led to an unprecedented build-up of international reserves. As a commodity price measure we use the Brazil commodity index (IC-BR), calculated in reais by the Central Bank of Brazil and converted to dollars. Including the commodity index also serves to control for cost shocks arising from the external sector that are not due to exchange rate depreciation, and is a measure of changes in nominal prices in the benchmark foreign currency.

In the area of monetary policy, it is also important to address the impacts caused by movements in the level of activity in the external sector, since this affects the current transactions balance, which is a variable essentially linked to the exchange rate, impacting domestic economic activity and tradable goods prices. Because the United States is one of Brazil's main trading partners, as well as the world's largest economy and issuer of the international reserve currency, we have selected the United States total industrial production index as a proxy for the level of external sector activity.²¹

Initially, we also considered introducing the federal funds rate as an international benchmark interest rate control, but the behaviour of the series²² raised difficulties that were not compensated for by substantial control advantages, as the interest rate differential is largely explained by changes in the Brazilian interest rate, given that the effective federal funds rate is much more stable than the effective SELIC rate.

As a way to increase exogenous shocks to the Brazilian monetary policy system by introducing information not captured by the external sector activity level or by commodity prices, we included a

¹⁸ To test whether the seasonal dummies used explained the effect, the credit variable was regressed without seasonally adjusting the base vis-à-vis the dummy variables, and the effect was found to be still very strong in the residuals.

¹⁹ In this case, elasticity means the ability of liquidity in the economy to expand and contract in response to public demand for it.

²⁰ See Oreiro and Feijó (2010).

²¹ Industrial production: total index (IPB50001N), index 2012=100, monthly, not seasonally adjusted (see [online] https://fred. stlouisfed.org/series/IPB50001N).

²² This includes a break since the introduction of the "near-zero" nominal interest rate policy in the post-crisis period and long periods of stability interrupted by periods of increase or decrease. These phenomena can compromise the results of exercises like those conducted in this section.

measure of risk perception in international financial markets. Thus, the VIX index enters the model as a way of controlling for exogenous shocks to financial flows into the Brazilian economy. The VIX index measures the expected short-term volatility of a wide range of exchange-traded securities, which reflects the "mood" of international investors, undoubtedly an important factor in the conduct of domestic monetary policy.

Once the endogenous and exogenous variables had been chosen, we tested for the presence of unit roots in each of the series. The tests used were the augmented Dickey-Fuller (ADF) test, the Elliot, Rothenberg and Stock (ERS) optimal point test and two Ng and Perron (NgP) tests, MZa and MZt. For the ADF, an augmented Dickey-Fuller regression was first fitted for each series to choose the smallest number of lags with non-autocorrelated residuals. Where necessary, centred seasonal dummies were included,²³ as these are constructed in such a way that they do not shift the test distribution, so that the test value²⁴ can be compared with the critical values calculated in EViews. These dummies are so constructed that they take the value (P-1)/P in the seasonal period of interest and -1/P in the rest of the seasonal periods, with P being the number of seasonal periods. For example, if the data are monthly, the January dummy takes the value 11/12 every January and -1/12 in the other months. In the case of the NqP and ERS tests, the guadratic spectral kernel method and automatic Andrews bandwidth selection were used for the spectral estimation. The sample consisted of monthly data from August 2003 to August 2016 (157 observations). The tests were performed with constant only, and with constant and trend for the natural logarithms of the chosen series (except for the INTEREST variable) and constant for their first differences.²⁵ Table 6 summarizes the results of the tests. The values of interest for the tests of the level series are presented in the annex (see table A1.2).

	A	DF		1	E	ERS		
Series	D	DondT	[)	D an	D and T		D and T
	U	D allu I	MZa	MZt	MZa	MZt	U	Danu I
INTEREST	I(0)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)
LOG(EXCHANGE)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)
LOG(IBC)	l(1)	l(1)	l(1)	I(0)	l(1)	l(1)	l(1)	l(1)
LOG(IPCA)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)
LOG(CREDSA)	l(1)	l(1)	l(1)	l(1)	I(0)	I(0)	l(1)	l(1)
LOG(FREE)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)
LOG(ADMS)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)
LOG(IC)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)
LOG(IND ^{US})	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)
LOG(CPI) ^a	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)	l(1)
LOG(VIX)	I(0)	l(1)	I(0)	l(1)	I(0)	l(1)	I(0)	l(1)

Table 6Summary of unit root test results

Source: Prepared by the authors.

Note: ADF: augmented Dickey-Fuller test; NgP: Ng and Perron tests; ERS: Elliot, Rothenberg and Stock optimal point test; D: drift; T: trend.

^a Logarithm of the United States Consumer Price Index for all urban consumers, prepared by the Bureau of Labor Statistics of the United States Department of Labor. This variable is used to estimate the real exchange rate adjusted by the variation of domestic and external prices. See [online] https://www.bls.gov/cpi/.

²³ When their inclusion considerably reduced the number of lags needed to eliminate autocorrelation in the residuals. See IHS Global Inc. (2015, p. 942) for a discussion of these dummy variables.

²⁴ The value corresponding to the *t*-statistic (which actually follows a variant of the Dickey-Fuller distribution) of the coefficient of the lagged variable in the ADF regression.

²⁵ The NgP and ERS optimal point tests do not allow specification to be carried out without a deterministic term. Since at most we consider that the original series had a linear deterministic trend, it is not reasonable to consider the presence of a trend in the first differences.

In the case of the VIX index, employing a union of rejections methodology (Harvey, Leybourne and Taylor, 2011), we reject the unit root for log(VIX), as tests with a constant reject the unit root null hypothesis and tests with a constant and trend do not reject the presence of unit root in the series.

After a series of tests including and excluding variables, we arrived at four models: the first with the full IPCA; the second with the IPCA decomposed into free and administered prices; the third with the full IPCA and the exchange rate decomposed to obtain the pass-through asymmetry; and the fourth with inflation and the exchange rate decomposed. In the first models, three lags were identified in the VAR in levels, and both cointegration tests (Johansen trace and maximum eigenvalue test) pointed to two cointegrating vectors. Their respective VECs were estimated with two lags. When pass-through asymmetry is included, the autocorrelation in the residuals increases considerably, requiring the VAR to be increased so as not to reject non-autocorrelation of the residuals by the Lagrange multiplier (LM) test; including the first difference of log(VIX) in a different way from log(VIX) as we did in the previous two models helped to maintain parsimony, and the VECs were estimated with six lags. With seven lags in the VAR in levels, both tests indicated a cointegrating vector (see figure 1). In all models, the first differences of the logarithms of IC and IND^{US} were taken (see figure 2).



Figure 1 Endogenous variables, 2003–2016



Source: Prepared by the authors.

Note: Measures for the variables: IPCA: extended consumer price index; EXCHANGE: real exchange rate/average free dollar for the month; IBC: Central Bank of Brazil economic activity index (IBC-Br); INTEREST: Annualized Over/SELIC interest rate (cumulative for the month) deflated by the percentage change in the monthly general price index (IGP-M) for the current month; CREDSA: M4/monetary base, the latter seasonally adjusted using the moving average method in a multiplicative model.



Figure 2 Unmodelled variables, 2003–2016

Source: Prepared by the authors.

Note: Measures for the variables: IC: Brazil index of commodity prices (IC-BR) converted to dollars; IND^{US}: United States total industrial production index (2012 average=100); VIX: Chicago Board Options Exchange (CBOE) Volatility Index (VIX) (monthly average of daily closing values).

In the first model, the first cointegrating vector was subjected to the restriction that the log(IPCA) coefficient was 1 and the log(IBC) coefficient was 0, while in the second vector the opposite was done, so that both vectors were identified without further restrictions and weak exogeneity of the exchange rate cannot be rejected. In the model with free and administered prices not including pass-through asymmetry, the identification restrictions on the cointegrating vectors were 1 for the log(FREE) coefficient and 0 for the log(IBC) coefficient in the first vector, while in the second vector they were 1 for the log(IBC) coefficient and 0 for the log(ADMS) coefficient. Again, weak exogeneity of the exchange rate cannot be rejected.

In the model with asymmetry and the full IPCA, the cointegrating vector included neither LSNE (the cumulative negative percentage changes in the exchange rate) nor log(CREDSA). In the latter model, no restriction beyond the coefficient 1 for log(FREE) can be imposed on the cointegrating relationship, at the risk of the LM test rejecting non-autocorrelation in the residuals. This difference in the restrictions (and these could not be statistically rejected) between the asymmetric models could explain the inconsistency between the estimates showing that the pass-through of depreciations was larger for the two IPCA components than for the full IPCA.

The base of the full IPCA in the same period was changed to make the series comparable, as shown in figure 3.







B. IPCA

Source: Prepared by the authors.

Note: EXCHANGE: real exchange rate/average free dollar for the month; LEXCHANGE+: cumulative positive percentage changes in the exchange rate; LEXCHANGE-: cumulative negative percentage changes in the exchange rate; IPCA: extended general consumer price index; ADMS: cumulative changes in the IPCA for administered prices, taking July 2003 as 100; FREE: cumulative changes in the IPCA for free prices, taking July 2003 as 100.

Tables 7 and 8 show the exchange rate pass-through estimated by the models using the methodology described. We present the results of the 12-period price response, taking into account the exchange rate shock in the first period. The long-run effect is the one that remains unchanged in the price level after a certain period, i.e., it is the one that establishes the increase in prices, other things being equal, relative to what they would be if the shock had not occurred at t = 1, from a certain time after the shock and for an indeterminate period.

Exchange rate pass-unough									
+	Summatria IDCA	Symmetric dec	omposed IPCA	Asymmet	ric IPCA				
L	Symmetric IFCA	FREE	ADMS	Appreciation	Depreciation				
1	0.0061	-0.0024	0.0281	-0.0043	0.0082				
2	0.0147	0.0038	0.0440	-0.0179	0.0135				
3	0.0203	0.0119	0.0458	-0.0362	0.0142				
4	0.0256	0.0198	0.0445	-0.0461	0.0175				
5	0.0330	0.0275	0.0493	-0.0796	0.0404				
6	0.0420	0.0360	0.0585	-0.0927	0.0458				
7	0.0499	0.0429	0.0677	-0.1134	0.0492				
8	0.0566	0.0480	0.0769	-0.1313	0.0548				
9	0.0627	0.0523	0.0859	-0.1458	0.0633				
10	0.0677	0.0554	0.0939	-0.1559	0.0692				
11	0.0719	0.0577	0.1005	-0.1699	0.0777				
12	0.0755	0.0595	0.1062	-0.1825	0.0802				
Long run	0.0930	0.0623	0.1258	-0.2422	0.1095				

Table 7Exchange rate pass-through

Source: Prepared by the authors.

	-	0	1	, i	8
+		Appre	eciation	Deprecia	tion
l		FREE	ADMS	FREE	ADMS
1		0.0140	-0.0410	-0.0012	0.0424
2		0.0156	-0.0779	0.0021	0.0624
3		0.0026	-0.0980	0.0047	0.0620
4		0.0001	-0.1214	0.0062	0.0765
5		-0.0317	-0.1599	0.0295	0.1109
6		-0.0462	-0.1598	0.0305	0.1382
7		-0.0561	-0.1754	0.0341	0.1477
8		-0.0707	-0.1926	0.0475	0.1391
9		-0.0843	-0.2029	0.0595	0.1413
10		-0.0975	-0.2030	0.0666	0.1521
11		-0.1209	-0.1965	0.0781	0.1589
12		-0.1368	-0.1930	0.0789	0.1657
Long run		-0.2337	-0.2161	0.1302	0.1955

 Table 8

 Exchange rate pass-through, decomposed IPCA model with asymmetric pass-through

Source: Prepared by the authors.

With our pass-through estimation methodology, tables 7 and 8 should be interpreted as follows: assuming that the model reflects the real dynamics of the variables in the economy, the value of a cell corresponds to the elasticity of the price level in that period relative to a given exchange rate shock at t = 1, so that if the value of the cell for t = s is 0.1, this means that, if the exchange rate changes unexpectedly by x% at t = 1, the price change expected by the model relative to what prices would have been in the absence of the shock at t = 1 is (x*0.1)% at t = s. In other words, the impulse response function measures the change in prices relative to what they would have been if there had not been a shock (unpredicted by the model dynamics) at t = 1. Thus, for example, the first model tells us that, if the exchange rate undergoes a change unpredicted by the model dynamics of 1% in the current period, current prices will be 0.0061% higher and will accumulate a change of 0.0755% in 12 months relative to what they would have been in the absence of the shock at the absence of the shock, assuming all else remains constant.

The above results, like those of Minella and others (2003), indicate a much larger exchange rate pass-through in administered prices than in free prices. Free prices are more subject to market competition, unlike administered prices, which still include contractual prices indexed to price indices that are more sensitive to the exchange rate than the IPCA, such as the monthly general price index (IGP-M). The IGP-M is heavily influenced by the IPA, which is an index more sensitive to exchange rate movements (Belaisch, 2003; Albuquerque and Portugal, 2005), as well as being a kind of producer price index, associated therefore with prices at the top of the production chain (unlike the IPCA, which measures the prices of final goods to consumers), and it has been observed that pass-through decreases along the chain (McCarthy, 2000; Choudhri, Faruqee and Hakura, 2005; Capistrán, Ibarra and Francia, 2012). Furthermore, it has been shown, as in Assis (2017), that there is asymmetric pass-through in which the pass-through of domestic currency appreciation is much stronger than the pass-through of depreciation. This suggests that the exchange rate can be used to control inflation via appreciation. Thus, there is the possibility of offsetting inflationary shocks from other sources through appreciation of the domestic currency, either by attracting capital via a higher interest rate (a transmission mechanism whose power is underestimated when the type of pass-through asymmetry noted in the econometric exercises conducted in this paper is present) or by intervening directly in the currency spot or futures market. The latter seems to have been the preferred route for the Central Bank of Brazil (Garcia and Volpon, 2014; Rossi, 2015) and possibly for good reasons, as Ventura and Garcia (2012) point out.²⁶

²⁶ The authors note that the exchange rate in Brazil, unlike the world's major money markets, is determined not in the spot market but in the very short-term futures market.

We also observe greater asymmetry in free prices and little asymmetry in administered prices, so that the marked asymmetry in pass-through from the exchange rate to the IPCA is due much more to market-regulated prices than to prices contracted for over the course of the year or controlled by the government.

IV. Conclusions

The demonstration of a marked asymmetry in exchange rate pass-through characterized by greater pass-through of domestic currency appreciation shocks indicates that interventions by the monetary authority to strengthen the exchange rate are quite important in preventing further deviation of the inflation rate from its target in the face of other inflationary shocks. Thus, rather than fearing the detrimental effects on inflation control that may result from exchange rate depreciation, there could be a case for reacting through interest rates or intervention in the currency spot or futures market (see Garcia and Volpon, 2014; Rossi, 2015; Assis, 2017, chap. 2). The reason is that domestic currency appreciation would serve to generate deflationary pressures in the face of other inflationary shocks. Thus, our results indicate that the power of the exchange rate to transmit monetary policy shocks for the purpose of holding down inflation has been underestimated.

In sum, there is strong evidence that exchange rate pass-through is non-linear (asymmetric), and the monetary authority should take this asymmetry into account in its models. It is further suggested that there needs to be more research into non-linear relationships between exchange rates and domestic prices and between the variables of interest to policymakers.

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Annex A1

Lags _	Symmetric IPCA		Symmetric FR	Symmetric FREE and ADMS		tric IPCA	Asymm and	Asymmetric FREE and ADMS	
	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	
1	39.0808	0.0362	47.2527	0.0993	56.7191	0.0153	59.7967	0.1388	
2	20.3334	0.7291	36.0607	0.4658	35.3087	0.5013	42.1443	0.7452	
3	22.2339	0.6222	28.7980	0.7976	41.6040	0.2399	52.8725	0.3270	
4	30.0535	0.2223	43.9895	0.1693	46.9853	0.1040	52.4281	0.3425	
5	20.6480	0.7121	36.2741	0.4559	52.0696	0.0405	59.2674	0.1495	
6	27.1980	0.3461	38.6004	0.3529	51.1179	0.0489	53.7773	0.2965	
7	35.2182	0.0843	37.8543	0.3847	53.5763	0.0299	50.5711	0.4113	
8	19.5033	0.7724	31.2219	0.6952	25.2953	0.9088	28.2160	0.9925	
9	22.6693	0.5969	47.4854	0.0954	27.8162	0.8337	42.8133	0.7208	
10	25.1717	0.4528	49.9947	0.0605	30.8326	0.7127	47.6918	0.5262	
11	19.3288	0.7811	33.7468	0.5762	34.1944	0.5547	50.2111	0.4252	
12	30.0456	0.2226	52.5850	0.0366	26.6668	0.8712	51.7590	0.3667	

Table A1.1 Lagrange multiplier tests for autocorrelation of residuals

Source: Prepared by the authors.

Table A1.2 Unit root test

	ADF		ER	S		Ng-Perron			
	C			CondT	M	MZa		MZt	
	U	C and T	U	C and T	С	C and T	C	C and T	
Critical value at 5% significance	-2.879	-3.438	3.144	5.651	-8.1	-17.3	-1.98	-2.91	
Series									
INTEREST	-4.774	-4.672	1.320	2.385	-21.831	-45.101	-3.303	-4.697	
LOG(EXCHANGE)	-1.337	-1.489	13.273	40.810	-2.022	-1.869	-0.986	-0.799	
LOG(IBC)	-2.757	0.090	28.957	6.256	0.614	-17.576	-0.387	-2.481	
LOG(IPCA)	1.873	0.079	4 537.436	60.310	2.126	-0.301	14.643	0.162	
LOG(FREE)	1.535	-1.052	5 398.554	77.923	2.106	0.230	15.911	0.129	
LOG(ADMS)	-2.046	0.190	657.620	27.254	2.110	-3.121	5.468	-1.129	
LOG(CREDSA)	-2.050	-0.313	29.632	5.810	1.199	-19.633	0.645	-3.267	
LOG(IC)	-2.589	-2.246	25.554	19.174	-1.012	-5.015	-0.619	-1.434	
LOG(IND ^{US})	-2.622	-2.605	8.356	14.357	-3.117	-6.191	-1.030	-1.731	
LOG(VIX)	-2.904	-2.888	1.746	5.670	-16.201	-16.356	-2.789	-2.833	

Source: Prepared by the authors.

Table A1.3Cointegration tests, p-values

	Symmetric IPCA		Symmetric FREE and ADMS		Asymme	Asymmetric IPCA		Asymmetric FREE and ADMS	
	Trace	Maximum eigenvalue	Trace	Maximum eigenvalue	Trace	Maximum eigenvalue	Trace	Maximum eigenvalue	
0	0.0000	0.0001	0.0000	0.0000	0.0094	0.0218	0.0002	0.0000	
1	0.0046	0.0072	0.0022	0.0049	0.1733	0.0903	0.2151	0.2598	
2	0.1957	0.3816	0.1324	0.2258					

Source: Prepared by the authors.

Health system privatization, the pandemic and deprivatization under discussion

María José Luzuriaga

Abstract

This article analyses the privatization processes that have been implemented in the health systems of Argentina, Brazil, Chile and Colombia. It describes and characterizes the participation of the public and private components of each of these systems, and analyses the politics of the public policies involved in these privatization processes. The results reveal the presence of multiple public-private relationships that adopted different forms over time. The article also analyses some of the responses provided and the challenges faced by the health systems during the coronavirus disease (COVID-19) pandemic, along with the role played by private entities in particular. This analysis aims to examine the trajectories of the studied policies and to identify their limitations as well as potentialities for reversing privatization processes.

Keywords

Health, privatization, health services, health policy, laws and regulations, right to health, public sector, private sector, pandemics, Argentina, Brazil, Chile, Colombia

JEL classification

|11, |13, |18

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I. Introduction¹

The public-private relationship is central to the analysis of public health policies, and public policies are considered to have played a crucial role in expanding the market for health plans and insurance. Nonetheless, market dynamics are seen as imposing a clear constraint on the application of universal public health policies.

Against this backdrop, this paper studies health system privatization processes in four Latin American countries: Argentina, Brazil, Chile and Colombia. It identifies and analyses the national contexts, especially the political scenarios in which government policies were formulated and implemented, which promoted or limited the expansion of the market for private plans and insurance in health systems. Privatization is understood as a process that expands the participation of entities that sell health and insurance plans. Consequently, the public sector retreats, as its regulatory capacity is reduced and government spending declines. However, as noted by Paul Starr (1988), increased public spending may generate privatization processes, contrary to expectations. Drawing on the approach of that author, who sees privatization as describing a direction of change rather than a specific origin or destination, the present article attempts to analyse the trend of policies, in order to determine how the public-private relationship has evolved in the selected countries' health systems.

The proposal consists in comparing the political dimension of the policies, with the aim of facilitating a more comprehensive understanding of the privatization processes in the region, and potentially leading to explanations that will identify the causes of the singularities and common features of the processes studied.

This study is based on a review of literature on the four countries' health systems, considering the period spanning 1980–2016.² The outbreak of the coronavirus disease (COVID-19) pandemic, in March 2020, made it necessary to include, within the framework of the approach used in this study, a section that analyses some of the responses that the health systems provided to confront the health emergency. This analysis revealed that in 1980, entities selling health and insurance plans were well established in the four countries (Bahia, 1999; Tetelboin, 2013; Belmartino and Bloch, 1993). At the same time, policies were implemented that aimed to reverse or slow down the expansion of this sector, such as the Unified Health System (SUS) in the specific case of Brazil. In 2016, serious attempts were made to introduce reforms, of varying structural intensity, promoting privatization processes. These reforms were implemented either explicitly, targeted to the health sector by the government, or else implicitly, through indirect measures that stimulated market expansion. The former category is exemplified by the reforms introduced in the following countries: Argentina, where Universal Health Coverage (CUS) was approved in 2016 through Decree No. 908/2016 (although this was never implemented because of the change of government); Chile, where the creation of the FONASA Plus national health fund was proposed and disseminated as a national plan to enable the public sector to compete more effectively with health insurance institutions (ISAPREs); and Brazil, where, among other measures, the Popular Health Insurance Project was implemented as a strategy to reduce spending in the sector and increase individual participation in financing (Bahia and others, 2016). These measures were never implemented, despite strong impetus from government circles and various private entities. In the case of measures in the second category, referred to as indirect, these reflect the general underfunding of the public sector, the lack of control or compliance with existing regulations governing increases in the premiums of health plans and insurance, and the subsidies and tax benefits granted to the firms, among other issues affecting the sector.

¹ This article presents the results of the author's doctoral thesis, titled "Los procesos de privatización de los servicios de salud en cuatro países de América Latina: Argentina, Brasil, Chile y Colombia. Semejanzas y singularidades en los recorridos y los resultados" (Luzuriaga, 2016).

² The time limit was defined so as to comply with the completion date of the doctoral thesis.

This article consists of five sections, the first being the introduction, which describes the importance of the topic and the organization of the study. Section II presents the main theoretical references and the theoretical-methodological approach proposed for studying the public policies that drove the health system privatization processes. This section also explains the methodological choices made in the selection of cases and policies, the dimensions of analysis and the data sources used. Section III reports the main findings in terms of the features of the selected public policies that stimulated or constrained the health system privatization processes. The different cases are then compared to provide a more comprehensive analysis of the privatization process in the region. Section IV describes the main responses of the health systems, focusing specially on the role played by entities selling health plans and insurance, and on the government actions that targeted this subsector during the pandemic. Lastly, section V offers provisional thoughts on the opportunities and challenges faced by health systems today in terms of reversing the current privatization processes.

II. Theoretical and methodological considerations

1. Case selection

Argentina, Brazil, Chile and Colombia were chosen for the study because each one displays key characteristics for analysis, spanning greater private sector participation, a mixed system, and one in which the public sector is more important. Moreover, in the four countries analysed, some of the organizations that participate in the market for health plans and insurance are among the leading firms in the country and have maintained this position during the period analysed. A recent study by Goyenechea and Ruiz (2020) reveals the growing participation by multinationals in Latin American health systems and warns that their involvement in different countries has affected the capacity of the systems to provide a public response.

Another criterion considered when selecting the countries was the uniqueness of each one during the health reform processes implemented in the 1980s and 1990s. In Chile, a pro-market health reform was implemented that was considered pioneering; but it had consequences, in terms of systemic inequities, that persist to this day. Ten years later, a privatizing reform was introduced in Colombia that attempted to avoid the adverse effects observed in the Chilean reform; but this objective was not achieved. Brazil has one of the largest markets for private health plans and insurance; but it is also one of the few countries in the region to have implemented a universal health system. Lastly, Argentina is positioned between the foregoing cases. Although a pro-market structural reform was proposed in the 1990s, its content was amended in response to fierce resistance from the trade union movement. Nonetheless, since the late 1990s, prepaid medicine firms have expanded their presence in the health system, with various interruptions as discussed in Section III.

2. Analysis of the political dimension of the policies to understand health-care privatization

The theoretical framework mainly involves a comparative analysis of the health system privatization processes, starting by identifying the scenarios that made them possible, the actors involved, and the situations that either hindered or stimulated them.

A central aim was to understand the ways in which public and private elements were involved in the four countries' health systems. Several authors have stressed the importance of studying privatization processes in contemporary health systems, placing more emphasis on measuring the practical effects of these processes on systemic performance, such as expanding access and enhancing the quality of the services provided (Maarse, 2006; Saltman, 2003; Mackintosh and others 2016; Alkhamis, 2017; André, Batifoulier and Jansen-Ferreira, 2016; Vargas Bustamante and Méndez, 2014). It is also generally accepted that designating a given health system configuration as predominantly public or private has become highly ambiguous, since in this classification the ideological component has been imposed on an analysis based on conceptual developments and systematic empirical data (Starr, 1988; Maarse, 2006; Saltman, 2003; Sestelo, 2012). In terms of recommendations for future research, the aforementioned studies highlight key issues such as: the need to define what is understood by public and private, the cases in which a privatization process can be identified and the frames of reference that are most effective for identifying the multiple and dynamic boundaries between public and private.

To this end, the article considers a number of studies applied to public policies, and to the health sphere in particular. The central focus was on the political dimension of public policies, as conceived by Theodore Marmor in *The Politics of Medicare* (2000), which centred on understanding the political process unleashed during the Medicare programme, using a variety of approaches and theoretical strategies.

In that work, the author set out to revisit the major debates that took place, beginning with the process of drafting the Medicare programme through to its implementation. The aim was to understand the key changes that were made to the content of this health policy, the main achievements, the conditions under which it was possible to maintain the central contents until approval, the intensity of the debates that were generated by it, the interest of the major pressure groups involved, and the speed and effectiveness with which the programme was implemented. The most salient issues include the key political actors and the interests and values at stake that have turned the Medicare programme into one of the central policies of United States politics for three decades.

Accordingly, the focus was placed on the political dimension of the policies studied, and, in the case of the Medicare programme, the author defined units of analysis according to their stage of policy development. These units included: government actions; the organizational behaviour of the major groups involved; bargaining strategies, both of the groups and of individual actors; and bureaucratic cycles. In all cases, an attempt was made to identify the constraints and opportunities that impinged on the progress of the policy.

In keeping with the proposal of this study, the political dimension of the public policies involved in the health service privatization processes was analysed on the basis of five analytical moments, which, depending on the specific dynamics of each of the policies analysed, were not necessarily separated in time. The first moment is the context, which refers to the sociopolitical and economic situation in which the policy under study began to be formulated. The second moment is the origin of the policy, in which the objectives and foundations of the policy are analysed, as well as the reasons why it was tackled ahead of other competing projects. In the third moment, which concerns the development of the policy itself, the focus is on the organizations that participated in the debate, the negotiation processes, the sequence of proposals presented and the alternatives to the main project. In the fourth moment, implementation, the analysis focuses on the more bureaucratic dimension and on identifying the factors that enabled or hindered implementation of the policy. Lastly, in the fifth moment, the aim is to take stock of the results achieved, by evaluating the distance between the initial proposal, the sanctioned policy and the results achieved.

3. Selection of the public policies and sources used

In each of the cases studied, the policies were selected for their impact on the reconfiguration of the public-private relationship in the health system, whether in terms of financing, service provision, management or investment (Maarse, 2006).

Another selection criterion was the relevance and depth of the debates on health system privatization processes that were triggered during the formulation and implementation of the respective policies.

The sample comprised a total of 13 public policies, which were analysed according to the dimensions described above. It is important to clarify that the selected policies included two cases related to judicial decisions: the ruling handed down in 2010 by the Constitutional Court of Chile against the Table of Risk Factors; and Decision No. T-760 of the Constitutional Court of Colombia, issued in 2008. While neither of these rulings is public policy per se, they have generated intense political debates on structural aspects of health systems, involving a wide range of social actors. Moreover, the rulings were used as a basis for developing health reform projects in both countries. For these reasons, and because it was possible to analyse them using the theoretical and methodological approach being proposed, the rulings in question were included in the study. Tables 1, 2, 3 and 4 below present the policies analysed in this study.

 Table 1

 Argentina: policies selected to study the health system privatization process, 1990–2016

Year	Public policy	Stages	Social actors and institutions
1993–1997/1998	Decree No. 9/1993, which provides that the beneficiaries of union- based health-care schemes (<i>obras</i> <i>sociales</i>) regulated by Laws Nos. 23660 and 23661 shall be entitled to change their social welfare fund.	Context Origin Development Implementation Results	Ministry of Economy World Bank General Confederation of Labour (CGT) Ministry of Health and Social Action Latin American Economic Research Foundation (FIEL) Novum Millenium Foundation
2011	Act No. 26682, which establishes the regulatory framework governing prepaid medicine firms.	Context Origin Development Implementation Results	Undersecretariat of Consumer Protection Consumers and Users Association of Argentina (ACUDA) Medical Confederation of the Argentine Republic (COMRA) Argentine Confederation of Private Clinics, Sanatoria and Hospitals (CONFECLISA) Civil Association of Integrated Medical Activities (ACAMI) Chamber of Health-care Institutions of the Argentine Republic (CIMARA) Association of Private Medicine Institutions (ADEMP) Superintendency of Health Services)

Source: Prepared by the author.

Table 2

Brazil: policies selected to study the health system privatization process, 1980-2016

Year	Public policy	Stages	Social actors and institutions
1990	Act No. 8080 creating the Unified Health System (SUS).	Context Origin Development Implementation Results	Social movements Left-wing political parties Preventive medicine departments Medical movements (Brazilian Medical Association, National Academy of Medicine, etc.) Student movements Universities Health movement Municipal mayors (<i>Prefeitos</i>) Progressive parliamentarians Chambers of commerce Representatives of private hospitals and clinics Economic bureaucracy
1998	Act No. 9656 regulating private health plans and insurance.	Context Origin Development Implementation Results	Superintendency of Private Insurance (SUSEP) Brazilian Association of Group Medicine (ABRAMGE) Consumer advocacy organizations Legislative branch Ministry of Health Ministry of Economy National Association of Private Hospitals (ANAHP) Brazilian Medical Association Unions
2015	Act No. 13097, which permits direct or indirect participation by foreign firms or capital in health-care activities.	Context Origin Development Implementation Results	ANAHP Antares Consulting Chamber of Deputies

Source: Prepared by the author.

Table 3Chile: policies selected to study the health system privatization process, 1980–2016

Year	Public policy	Stages	Social actors and institutions
1980	Political Constitution of the Republic of Chile, Decree with Force of Act No. 3 of 1981, and regulations that amend or complement it. Creation of health insurance institutions (ISAPREs).	Context Origin Development Implementation Results	Ministry of Economy Undersecretariat of Planning and Cooperation Commission for the Study of the New Political Constitution of the Republic of Chile (Ortúzar Commission) Social Security Bureaucracy Chicago Boys Medical Association Doctors Union
1986–2002	Act No. 18566 related to the 2% subsidy granted to ISAPREs.	Context Origin Development Implementation Results	Executive Branch Association of Chilean Insurance Firms (AICH)
2004	Act No. 19966 and regulations that amend or complement it. Universal Access to Explicit Guarantees Plan (Plan AUGE-GES) or Reform of the Reform.	Context Origin Development Implementation Results	Ministry of Health Ministry of Finance Legislative Branch National Health Fund (FONASA) Trade Unions Medical Associations AICH Clinicas de Chile A.G.
2010	Constitutional Court Ruling No. 1710-INC, against the table of risk factors (Art. 38 ter of Act No. 18933).	Context Origin Development Implementation Results	Judiciary
2014–2015	Ministry of Health Decree No. 71 of 2014. Creation of the Presidential Advisory Commission for the Study and proposal of a new model and legal framework for the private health system.	Context Origin Development Implementation Results	Presidential Advisory Commission composed of representatives and experts from the different health sectors.

Source: Prepared by the author.

Table 4

Colombia: policies selected to study the health system privatization process, 1990–2016

Year	Public policy	Stages	Social actors and institutions
1993	Act No. 100, which created the General Social Security Health System.	Context Origin Development Implementation Results	World Bank World Health Organization (WHO) Colombian Medical Union Association (ASMEDAS) Colombian Medical Association Colombian Medical Federation Unified Workers Confederation of Colombia (CUT) Unión Patriótica Academic groups National School of Public Health of the University of Antioquia Foundation for Higher Education and Development Seventh Commission of the Senate: responsible for social security Colombian Association of Medical Schools (ASCOFAME) National Trade Union National Trade Union National Association of Workers and Public Servants of Health, Comprehensive Social Security and Complementary Services of Colombia (ANTHOC) National Association of Nurses of Colombia (ANEC)
2008	Ruling No. T-760, ordering the government to make structural reforms to guarantee compliance with the right to health.	Context Origin Development Implementation Results	Constitutional Court People's Health Movement (PHM) Office of the Ombudsperson
2015	Statutory Act No. 1751, which aims to guarantee the fundamental right to health, regulate it and establish its protection mechanisms.	Context Origin Development Implementation Results	Constitutional Court Executive Branch National Medical Board National Board on the Right to Health

Source: Prepared by the author.

In the cases analysed, the study considered the academic output of the main references on the subject in each of the countries. The primary sources used were official documents (administrative records of the various State institutions tasked with supervising and overseeing the entities that sell health plans and insurance); specific legislation related to each of the policies; news on the selected policies published in the main national commercial newspapers; specific sectoral output of organizations selling health plans and insurance; institutional briefings, transcripts of debates in legislative commissions or parliamentary sessions related to the policies studied; presidential platforms and messages, and also policy announcements; business and economic journals and specialized publications on the entities that sell health plans and insurance.

III. Results

As indicated at the start of this article, the aim of the study was to provide theoretical and empirical elements to gain a more secure understanding of the extent to which it is feasible to envisage limiting or rolling back the health system privatization processes. Accordingly, an attempt was made to improve understanding of the factors that prevented universal public health policies from being formulated and becoming established. It is argued that the growing presence of private actors in the health system further undermines the principle of solidarity. Evidence of this includes the increased participation of private actors — health promotion entities, prepaid medicine firms, health insurance institutions and firms that sell health plans and insurance— in the management of social security funds in the countries studied. A private sector logic is thus introduced into the system, based on the individualization of contributions and the segmentation of benefits by ability to pay. This eliminates any possibility of organizing a health system based on the principles of comprehensiveness and universality, targeted to the population's health needs.

In line with the foregoing, studies have been carried out in the region that analyse the irregularities that exist in systems dominated by firms selling private health plans and insurance. In particular, case studies on Chile and Colombia warn of the high degree of judicialization present in the health systems, arising from various types of non-compliance related to denials of access, and restrictions thereon, imposed by private organizations (Rodríguez Garavito, 2012; Yamin and Parra Vera, 2009; Zamora Vergara, 2012; Goyenechea and Sinclaire, 2013; Luzuriaga, 2018). Most of these studies also warn of the weakness of government regulations that are intended to prevent such violations. In both the Chilean and the Colombian systems, numerous policies and projects have been developed to correct problems of access to health care associated with practices of segmentation, exclusion and reduction of benefits, as well as other abusive practices that are common in health systems where there is a major presence of firms and business groups. This diversity of problems generated by private health plans and insurance is largely explained by features inherent to the dynamics of the sector itself, as exemplified by Pollock (2016) in relation to the North American health system:

[...] risk selection and avoidance [undermine] the goal of access and universality. The United States [...] denies more than one in five of its population access to health care. Overtreatment and denial of care, catastrophic costs and spiraling health expenditure are the hallmark of United States health care. [...] Markets operate through selection and exclusion, the transfer of risks and costs to service users, and the denial of care to those who need it most.

Several recent studies on the privatization of health systems, both in the countries of the region and elsewhere, highlight the onward march of this process and its impact on increasing inequality in access to health services and the use made of them, and also on the deterioration of the population's health status (Unger and De Paepe, 2019; Rahman, 2020; Turino and others 2021; Milcent and Zbiri, 2022; Bahia, 2022). The assumptions made in the study include the uniqueness of the different privatization processes and how government policies stimulated expansion of the market for health plans and insurance in the four countries. The main findings that confirm the assumptions made and contribute to the proposed reading of the subject under study are presented below.

1. Constraints on privatization processes

Although a privatization process can be said to have taken place in all of the cases studied, the process has been subject to restrictions. Pursuant to the analytical proposal of Maarse (2006), contextual and political constraints were identified, along with constraints imposed by competing policies (which were brought before the legislature and could therefore be processed and debated in Congress), by sector-specific policies and by resistance from social actors who were able to bring pressure to bear on the decision-making process.

The contextual constraints stemmed from structural problems in the policies of the four countries, such as unemployment, the informal labour market and income levels. Policies that acted as constraints on privatization include political decisions to expand health-care coverage. In this situation, it is worth mentioning the Universal Access to Explicit Guarantees Plan (AUGE-GES Plan),³ which reveals the complexity of the subject, since it served both as a constraint and as a stimulus to privatization. It acted as a constraint because it curbed the growth of the number of people covered by the health plans sold by ISAPREs; at the same time, it led to an increase in the number of people affiliated to public social security (FONASA). It also stimulated privatization because public funds were transferred to private facilities (which, through the vertical integration process, mostly belonged to ISAPREs), partly to ensure that the guarantees required by the AUGE-GES plan could be met.

Factors that hinder the health system privatization process include greater State control over the financing of social security, the strengthening of the public health insurance system, and greater control over the quality of health services (Okma and others, 2010; Lenz, 2007; Hertel-Fernandez, 2009).

Nonetheless, a number of studies warn that the AUGE plan intensified the privatization trend (Tetelboin, 2013; Goyenechea and Sinclaire, 2013; Parada and others, 2014). These studies mention issues such as the creation of a new inequality between beneficiaries who had pathologies covered by AUGE and those who did not, as well as the introduction of a privatizing logic that allowed private clinics to be contracted in the system when public services could not respond to the demand of those needing care, given the legal requirements of the AUGE Plan. According to Tetelboin (2013), the AUGE plan established a new form of public-private interaction in the health system that led to greater privatization. Similarly, Goyenechea and Sinclaire (2013) note that the process of contracting the private network meant that it received large transfers from the State.

Among the key actors in this process, the judiciary played a fundamental role in setting a limit on privatization policies, especially in Colombia and Chile. In Colombia, the Constitutional Court played a key role in the process of mobilization and social demand in relation to the right to health by various social organizations. It is worth mentioning the importance of Ruling T-760/08, which, based on the compilation of a series of cases involving health-promotion entities' failure to respect this right, ordered the government to implement structural measures to guarantee effective access to the system (Abadía and Oviedo, 2009; Rodríguez Garavito, 2012; Borrero Ramírez, 2014). It also created the Commission for the Follow-up of Ruling T-760 of 2008 and the Structural Reform of the Health and Social Security

³ The AUGE-GES Plan was one of the central policies of the government of President Lagos (2000–2006); it was initially presented in 2004 as the Explicit Health Guarantees (GES) regime, and came into force in 2005. It defined a minimum set of benefits of mandatory provision by both public and private health-care managers (FONASA and the ISAPREs, respectively). Initially, the plan covered 56 pathologies; today it covers 85. Analyses of the policy suggest that the results had positive aspects; but to gain approval, the government had to make significant concessions that led to key aspects of the original project being altered.

System (CSR). The commission comprised organizations drawn from the academic, political and social sectors; and it played an essential role in the legislative follow-up of the ruling and in designing the reform of the system. This was approved in 2015 through Statute No. 1751. In the case of Chile, Ruling 1710-INC of 2010, handed down by the Constitutional Court, which was initiated ex officio to decide on the constitutionality of Article 38 ter, on risk factors, has been used widely as jurisprudence by both the judiciary and the regulatory body. As in the case of Colombia, it was also one of the foundations of the health system reform proposal formulated in 2014 during the government of Michelle Bachelet.

In both countries, rulings by the Constitutional Court, in the case of Colombia, and the Constitutional Tribunal, in the case of Chile, have forced governments to develop effective policies aimed at establishing greater economic protections and enhanced access for the clients of entities that sell health plans and insurance, as well as tighter restrictions and controls on the activities of the firms in question (Luzuriaga, 2018).

There have also been constraints on privatization associated with policies that competed with those selected in this study. The privatization of the social security system and the labour flexibilization law in Argentina, which took centre stage in the political debate, relegated the project of competition between union-based healthcare schemes to a lower priority. In the midst of the crisis of union legitimacy, De Fazio (2013) highlights the central role that the union leadership played in the sanctioning and application of the laws on labour market flexibilization and social security privatization, and also in limiting the structural reform of the health system which had been proposed by the Ministry of Economy. According to De Fazio (2013, p. 310):

The defeat in the domain of labour regulation during those years can be understood as payback for the increased funding that the leaderships would obtain to finance their social services. Thus, some unions became shareholders in the privatization of public firms, and in retirement and pension fund administrators (AFJPs), among other benefits, which resulted in this new union strategy being called "business unionism".

It is argued that the temporary coexistence of these policies in the legislative and political debate hampered the government's ability to negotiate with the trade union movement. At the same time, the progressive weakening of the union leaderships, which were further delegitimized after the two aforementioned laws were passed, contributed to the General Confederation of Labour (CGT) adopting a more radical position. Lastly, there is no underestimating the risk that the progress of the reform project, and free competition with prepaid medicine firms, entails for trade unionism in terms of the loss or reduction of control over the funds of union-based health schemes.

The project to totally deregulate union-based health coverage was abandoned, and the reform that was implemented had input from the trade unions. The first general strike by CGT took place when the government attempted to liberalize competition between union-based health schemes and prepaid medicine firms. This resulted in Decree No. 9/1993, which established competition only between the union-based health-care entities themselves (De Fazio, 2013). This type of constraint on the privatization process was not observed in the other countries studied.

2. Incentives to privatization processes

The incentives to privatization include arguments put forward by representatives of the entities selling health plans and insurance, and there are similarities in this regard in the four countries studied. These include the following: the inability of the government to respond to needs in terms of using and accessing health services; the government's failure to serve the entire population; models considered virtuous, such as those of Chile and Colombia; the fear of nationalization; the public sector's incompetent resource management; and the lack of understanding or knowledge about private and public sector

roles among individuals and the government. These arguments are particularly germane to the analysis of the impact of public policies, given the positions of power that private sector actors have occupied through their associations and organizations, and their ability to exert pressure on decision-making bodies regarding sectoral policies.

All countries have legal rules for allocating public funds to the private health sector (to firms and business groups that sell health plans).⁴ The regulations in question are expressed in policies that stimulate the supply of and demand for health plans and insurance. Clear examples of this type of policy are the free choice policy in Argentina and the tax deductions and exemptions granted to firms that contract health plans and insurance and to the individuals who buy them in Brazil. In addition, credit lines, loans and subsidies are granted to these firms and business groups in all four countries.

3. Common aspects of the privatization processes

In terms of the general issues that are common to all the cases, the following topics recur in the content of the legislation: regulation of minimum coverage; mechanisms to reduce the various forms of adverse selection (classification, segmentation, risk selection);⁵ control of premium hikes; attempt to improve or create registration and information systems that are better adapted to the reality of the sector and to users' demands; and proposals to improve or implement a hospital cost recovery system that would allow for expenses incurred by the public sector to be reimbursed when providing services to affiliates who have private coverage.

The regulations include expressions such as "free choice" or "free option", mainly in relation to the regulatory framework governing firms that sell private health and insurance plans. These expressions need to be questioned, since freedom of choice does not exist as such in any of the cases. In Argentina, not everyone who has a job can choose where to direct their contributions. By contrast, Chile and Colombia have an obligatory component whereby a percentage of the wage is automatically deducted for social security.

The arguments of the entities that sell health plans and insurance are another common feature in the four cases. These arguments include the following: indignation at judicialization; a belief that the role played by the private sector in the health system is misunderstood, both by the public and by the government; emphasis on their own capacity and efficiency, as well as the innovative component that they bring to the system; mention of public institutions' lack of capacity as a basis for their own participation and excessive regulation which makes the activity unviable. Also interesting is these organizations' comment on the right of individuals to have differentiated access if they can pay for it. In one case, they illustrate this with the metaphor of an airliner with different seat classes. They also vehemently dispute the rules that require the extension of mandatory coverage and restrict the possibility of choice on whether to admit persons with chronic diseases. They also denounce rules governing premiums as unconstitutional measures that threaten the freedom of private enterprise and the survival of the sector, stressing that they are demagogic and reflect total ignorance of the sector.

In general, the medical associations have cooperated in policies promoting privatization, specifically the expansion of entities that sell health plans and insurance. A recurring argument has been that these organizations provide an indispensable source of employment. However, there has also been resistance. In Chile, the medical association and the doctors' union mobilized when the AUGE plan was implemented initially, warning of the risks posed by the privatizing elements of the plan. In the

⁴ Although the main activity of the firms and business groups studied is the marketing of health plans and insurance, in some cases these entities also participate in other markets, such as hospital management, medical supplies, diagnostics and medical education, among other health-care areas. Some also have interests in other domains, such as the audiovisual sector.

⁵ For an analysis of the "adverse selection" category in the health-care market, see Bahia (2018).

case of Colombia, Act No. 100 of 1993 also triggered resistance from the medical associations, which participated actively in the various debates on the statutory law.

Organizations representing private clinics and hospitals participated in the coalitions and in the debates, and they adopted a clear position regarding the policy of promoting technical administrative control by the State.

Labour unions acted by setting a clear limit on privatization measures, as was seen in Argentina and Colombia, and to a lesser extent in Chile. In Brazil, these unions expressed support for entities selling health plans and insurance.

Government agencies also clearly played an important role in the policies analysed. Some have been more active, such as the Undersecretariat for Consumer Protection in Argentina when the law on prepaid medicine firms was formulated. In all cases, government supervisory and oversight bodies were created when the health plan and insurance sector was already well established, and some were created during the regulatory process.

The various institutions tend to naturalize the existence of the market.⁶ In all cases, there is fluid circulation between the senior managers of the entities that sell health plans and insurance and those of the institutions that supervise and oversee the sector. This prevents effective control over the former because the roles of supervisor and supervised become blurred. This phenomenon has been called the "revolving door" or "public-private circulation".⁷

A previous study (Luzuriaga, 2018) argued that the increasing trend towards judicialization in the countries studied reveals legislative gaps and limited State capacities to regulate the sector. As noted in that study, which drew on primary and secondary data, a similar profile of complaints is observed, including premium hikes, the denial of certain benefits or coverage restrictions, and the unilateral amendment of contractual conditions.

This phenomenon is not exclusive to the countries studied or to the region, since similar results are obtained from European health systems where private insurance is present, as noted in studies such as André, Batifoulier and Jansen-Ferreira (2016). This provides empirical data to challenge the response of various international agencies that recommend expanding the coverage of private health plans and insurance to improve the conditions for the population to gain access to their benefits.

Considering the legislative branch, the account of the debates does not reveal any polarization. The exception seems to have been the debate on the health chapter of the Brazilian Constitution of 1988. Moreover, the Brazilian judiciary adopted a strong position in favour of the rights of clients of health plans and insurance. In some cases, as in Colombia and Chile, the judiciary played an active role, demanding that the executive branch adopt structural measures to solve the recurrent problems of access and denial of coverage to the population. In Colombia, participation by social organizations was fundamental for putting the Constitutional Court ruling into effect, by making sure debate on the Colombian health system's structural problems, and the key aspects thereof, were established and kept visible.

⁶ For Brazil, a recommended reference is Sestelo, Souza and Bahia (2013).

⁷ According to Castellani, the "revolving door" is defined in this way in the literature on elites (Gormley, 1979; Eckert, 1981; Cohen, 1986; Che, 1995), and it can be observed when analysing the multiple post-holding and circulation by members of the economic elite in the private and State sectors (Castellani, 2016).

IV. Health system responses and challenges in the face of the pandemic

The outbreak of the COVID-19 pandemic revealed countless situations that reflect the shortcomings and weaknesses of Latin American institutions and policies, especially their health systems. As noted in various studies, the health systems of Argentina and other countries in the region are highly fragmented, segmented and underfunded; and their capacity to respond to the population's health needs reproduces and magnifies their societies' structural inequalities.

Clearly, in a context of increasing inequality, efforts should not be the same for all, as this would be a denial of societal inequality and an act of social injustice. During the pandemic, it became increasingly evident that not everyone suffers from the crises in the same way: as noted in a recent Oxfam report (Ruiz, 2020, cited in López and Sturla, 2020), the wealth of the richest and highest-income economic groups has increased significantly.

As discussed in this article, the region's private sectors have played a leading role in defining health policy in their countries. As a result of the pandemic, these sectors were the main beneficiaries of various types of subsidies, and in all the cases analysed they have managed to resist government attempts to temporarily integrate health resources to provide a more effective response to the crisis.

In the United States, where the health system has a greater preponderance of firms selling private plans and insurance, the firms in question reported an increase in their profit margins during the pandemic (Abelson, 2020). In the second quarter of 2020, firms such as Anthem, Humana and UnitedHealth Group all reported higher earnings than in the year-earlier period (Abelson, 2020; Andrietta and others, 2021, p. 8).

Accordingly, in the context of the COVID-19 pandemic, it is important to know what role the representatives of this sector are willing to play and what costs they are willing to assume, given the magnitude and seriousness of certain events, such as the health emergency that a pandemic entails. The following represent some of the attitudes that were propagated at the onset of the pandemic in Argentina, based on statements made by the main spokespersons of the prepaid medicine firms: "Today we are all links in the public health chain";⁸ "Dealing with this crisis requires commitments and responsibility from all social and political actors for the common good";⁹ and "There is no room now for speculation or pettiness".¹⁰

Private-sector participation, especially in actions aimed at providing a coordinated response and supporting government policies, was insignificant relative to the demands and requirements expressed since the start of the pandemic. For example, there was a failed attempt in the first half of 2020, when the former Minister of Health of Argentina, Ginés González García, announced that a project was being studied to formulate a Decree of Necessity and Urgency (DNU). This aimed to integrate public and private health resources as a public good, in order to provide the national government with greater steering and coordination capacity to cope with the pandemic. The project was never presented and was soon abandoned. Some sectoral organizations denounced the proposal as a "health populism" measure.¹¹ In this context, the private health sector benefited from various subsidies, lower taxes and a reduction in expenses owing to the reduced demand for studies, consultations and treatment during the lockdown periods. An analysis made by the Argentine Centre for Political Economy (CEPA) on the performance of prepaid medicine firms during the pandemic shows that the main players —Galeno,

10 See Infobae (2020b).

⁸ See Fortuna (2020).

⁹ See Infobae (2020a).

¹¹ See La Nación (2020).

Medicus, Medifé, Omint, OSDE and Swiss Medical— generated average revenue of US\$ 6.8 billion per year in 2015–2020, and accumulated US\$ 44.4 billion between them. These six firms account for 76% of the slightly more than six million affiliates (direct or indirect) of prepaid medicine. The report also states that the trend is similar in terms of per capita revenues, which range from about US\$ 1,000 to US\$ 1,500, without much variation between the different firms. Income per capita declined in 2017 and 2019 before recovering strongly in 2020 (CEPA, 2022).

A recent study formulated a conceptual framework to classify the performance of different countries in responding to the pandemic. In line with what has been expressed in this article, the role of politics and the importance of time in government decision making is of interest when evaluating the results. The study argues that health system response capacity is fundamental, but not sufficient, to respond to the pandemic; that political containment measures and their timely enforcement play a central role; and that the differentiated presence of these three dimensions and their interrelationship give rise to different scenarios and outcomes. These determine different pandemic outcomes, as measured by community spread of the virus and the incidence of cases and deaths when vaccines and treatments are absent (Herrero and Belardo, 2020). These authors suggest that interactions between the aforementioned variables determine the evolution of the epidemic in each country. The analysis of the variables in different countries enabled them to classify countries in three groups — "denialist", "gradualist" and "strict"— according to their response to the pandemic.

Based on the measures it adopted, Argentina was placed in the strict group. According to the authors, countries in this group grasped the new reality immediately and adopted drastic measures rapidly: "no one hesitated and they gradually closed borders; and they banned mass events, the presence of students in classrooms and travel by people to their jobs" (Herrero and Belardo, 2020, p. 110).

Lastly, in the Argentine case, the challenges set by the government include the proposal announced by the Vice-President in late 2020, in which she expressed the need to integrate the health system and called on everyone to participate in constructing the Integrated National Health System:

We have to move towards a national health system that integrates the public, private and social security systems to optimize resources. The pandemic gave us the opportunity to reformulate the health system in record time, but we need to make a different effort (Página 12, 2020).

Brazil, by contrast, was classified in the denialist group. As occurred also in the United States, the United Kingdom and Mexico, Brazil denied the seriousness of the pandemic for a long time and focused its concerns on the economic paralysis. The pandemic has enabled the Unified Health System (SUS) to gain great social legitimacy.¹² As noted by Bahia (2022), the expression "If it were not for SUS, things would be much worse" is a way of manifesting respect and appreciation for this universal public policy.

Strategies aimed at blocking the spread of the virus were rendered inaccessible, owing mainly to the four factors mentioned by Bahia:

Minimization of the magnitude of the pandemic and the discrediting of scientific guidelines; the adoption of a misleading official programme of "early treatment" (use of ineffective drugs) [...]; insufficient and intermittent policies of emergency cash assistance and delay in expanding the installed capacity of intensive care beds; and, lastly, administrative discontinuities and financial mismanagement in the Ministry of Health, compounded by the inaction of the crisis committees (Bahia, 2022, p. 2).

¹² The Unified Health Service is one of the universal public policies most widely recognized and supported by Brazilian society and by a broad political spectrum, despite having its scope reduced by budgetary and political constraints (see Escorel (1999) and Paim and others (2011)).

Firms selling health plans and insurance in Brazil did not play a leading role in actions to control the spread of COVID-19. As noted in Andrietta and others (2021, p. 19), they did not promote health protection actions, nor did they guarantee the differentiated care recommended by the Ministry of Health, in terms of performing specific examinations.

Brazil's scientific institutions and civil society movements promoted a debate aimed at unifying the use of public and private resources for the health care of seriously ill patients. The debate reached Congress and the judiciary, but did not progress further. On the contrary, the National Supplementary Health Agency adopted measures that expressed the protection of sectoral interests and issued recommendations aimed at maintaining selective procedures and incentives for preserving contracts (Andrietta and others, 2021).

What has been seen since the start of the pandemic is a lack of cooperation and a refusal to collaborate by firms selling health plans and insurance, and the continuity of public policies to ensure that public resources continue to flow to the private sector.

The aforementioned study by Herrero and Belardo classified Chile in the gradualist group. This is defined as countries that applied physical isolation measures gradually, and in some cases very timidly, until the progression of the disease and the exponential increase in deaths became evident (Herrero and Belardo, 2020, pp. 105–106). The health systems of these countries collapsed rapidly, because of the delay in implementing lockdown and mitigation measures.

An analysis of the challenges faced by Chile should not lose sight of the intense left-wing social mobilizations that have vehemently challenged the neoliberal policies and the governments that came after the Pinochet dictatorship, for their inability to reduce structural inequality. The main demands and claims include, in particular, inequalities in the health system and the recurrent failure of the ISAPREs to provide adequate health care, despite being a very lucrative sector that benefits from public policies.

This context of large-scale mobilizations led to the election of a government with strong popular support. In his first speech as president, on 11 March 2022, Gabriel Boric highlighted the role of the social mobilizations and the central place that the gender and human rights perspective will have in his policies:

[...] they are protagonists in this process. The Chilean people are protagonists. We would not be here without the social mobilizations. We arrived here to commit ourselves body and soul. "I have seen your faces" said Boric, before going on to enumerate the LGBTI+ community, indebted students, persons searching for disappeared detainees, children, among others. "It's you that have my commitment" (*El Mostrador*, 2022).

Announcing his first measures, Boric referred to the health sector:

The pandemic proceeds on its course, continuing to cause loss of life [...]. We need to embrace each other in society, we need to smile again. It's so important to love each other. We succeed together (*El Mostrador*, 2022).

In the context of analysing possibilities for transforming the Chilean health system, the current government has worked continuously, since taking office, to develop a reform proposal to construct a single health system in which the National Health Fund (FONASA) would play a central role in the financing and control of the system as a whole.

This context opens up the possibility of building a universal health system, in which the public sector will be strengthened and financed from general taxation. It should be remembered that a similar proposal was made at the start of the Bachelet administration, but it failed to gain parliamentary status to be debated. If the current proposal is implemented, it will be a very important reference for the whole region, especially since Chile has been a pioneer in the implementation of several privatization policies, in the health system particularly.

V. Selected considerations and questions

This analysis aimed to draw attention to the contradictions and tensions that exist in some of the leading academic explanations of health systems and policies in the region, and also in the health system privatization processes. An additional and more oblique aim was to analyse the relevance or explanatory capacity of certain analytical categories that have been used repeatedly to explain the success or failure of health policies.

The policies studied in the different cases reveal similarities and coincidences in the nature of conflicts, the actors involved, the viewpoints and arguments put forward, and the legislative content. The similarities include the existence of limits to privatization, caused by market and regulatory failures, and structural constraints. As noted throughout this work, the market for health plans and insurance is determined by the labour market; and, in the countries studied, the behaviour of this market is characterized by major instability and informality.

The theoretical framework used in this study reveals issues that have scarcely been mentioned in the debate on health systems in Latin America, especially with regard to privatization. Most published studies view privatization as a shortcoming of the system, an unintended consequence. As a result, it is not treated as a set of ideas and intentional projects in which the State and the various institutional organizations have played a central role.

Based on the assumptions and results presented above, new analytical strategies need to be developed to steer and support the complex and shifting movements of public-private relations in health systems. Based on rigorous and systematic knowledge in this line of research, it is possible to find significant spaces to design actions that will make it possible to influence proposals for more egalitarian and solidarity-based health models. As noted in a recent article (Luzuriaga and others, 2021), the content of the debate should aim at exchanging ideas on the following issues, among many others:

- What is the appropriate size of each of the subsectors and what differences between them are permissible?
- What characteristics would the private subsector need to adopt to act in solidarity and contribute to the equity of the system?
- What differences in access to health care are socially acceptable?
- How could integration be achieved to allow for more adequate cost compensation?
- How can resources be used rationally without compromising service quality and coverage?
- How can resource allocation be made more transparent?
- How can the information systems existing in the subsectors be integrated to enable adequate planning and decision-making?
- How can the extraordinary revenues earned by some subsectors be adjusted?
- How can the entire population be assured adequate access to the health system?
- How can resources be distributed more equitably?

Structural changes are rare and do not occur in power vacuums, particularly when they aim to expand rights and redistribute, and especially in societies where business groups and sectors with higher levels of income and wealth have hindered or prevented such policies from advancing. For this reason, and for all of the above, the creation of partnerships and common agendas focused on priority policies, such as the construction of a universal, egalitarian and comprehensive health system, can and should be a banner, alongside other demands, that strengthens the collective struggle of the region's countries.

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Economic complexity and employment in Brazilian states

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Abstract

This paper has three objectives: (i) to identify promising sectors worth encouraging with a view to fostering the development of the Brazilian states; (ii) to evaluate the impact of economic complexity on the volume of employment; and (iii) to simulate how many new jobs would be created if each state were to become competitive in the activities considered promising for it. The results obtained vindicate the approach of the Economic Commission for Latin America and the Caribbean (ECLAC), which emphasizes the contribution of changes in the production structure to the development process, and reaffirm how important complexity is in improving the economic performance of countries or regions, whether this is measured by income or employment.

Keywords

Industrialization, industrial policy, production diversification, competitiveness, employment, economic development, regional development, regional economics, Brazil

JEL classification

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I. Introduction

Changes in the production structure are an essential means of achieving higher levels of economic development (Lewis, 1954; Hirschman, 1961; Myrdal, 1960; Thirlwall, 2002). In particular, according to Furtado (1964), Prebisch (1950) and the other thinkers at the Economic Commission for Latin America and the Caribbean (ECLAC), underdevelopment is not a stage through which countries now at an advanced stage of development necessarily had to pass, but a historical process with particular characteristics.

The structuralist approach of ECLAC is based on the centre-periphery concept. As Rodríguez (2009) points out, there is an "original unequal development" in the world economy. The existence of developed economies creates a dynamic that tends to extend the development of those already developed (central) economies and to perpetuate the economic underdevelopment of developing (peripheral) economies. Thus, the fundamental characteristic of the centre-periphery approach is its focus on a particular systemic dynamic whereby inequality is inseparable from the performance of the system as a whole (Rodríguez, 2009, p. 84).

One effect of this division is slower average earnings growth in the periphery. Peripheral status tends to be continually reinforced and reproduced by its own dynamic and by interaction with the centre. While new production techniques have been introduced relatively quickly in the centre, the introduction of such techniques in the periphery is belated and slow. In peripheral countries, such know-how is disseminated only in sectors connected with export activity (Rodríguez, 2009, p. 81). This peculiarity of the periphery results in the predominance of "hybrid economies" where a capitalist core coexists peaceably with archaic production structures.

This process leads to symptomatic differences between the production structures of the centre and the periphery. The hybrid character of the peripheral economies creates two specificities: (i) production specialization (the commodity export sector is given priority in resource allocation); and (ii) structural heterogeneity, since sectors with high productivity and sectors with very low productivity coexist in the domestic economy. The countries of the centre, on the other hand, have just the opposite characteristics, possessing diversified and more homogeneous structures (Rodríguez, 2009). This difference in their production structures determines the process of economic development in the two groups.

The structuralist approach has returned to the forefront of the economic development debate in recent years as a result of the pioneering work of Hausmann, Hwang and Rodrik (2007) and Hidalgo and Hausmann (2009). These authors proposed a new methodology for calculating the sophistication of countries' products and production structures, based on the economic complexity approach. Using a modern method of analysing production structures that drew on disaggregated international trade data, they presented new evidence on the importance of structural change oriented towards more complex industrial sectors for the attainment of higher income and productivity growth.

More recent work has built on these studies to advance our understanding of the structural transformation process. However, it should be borne in mind that the way this process is coordinated differs by country. That is, less developed countries need a planned diversification strategy able to guide the production of more complex goods (Gala, Camargo and Freitas, 2017; Freire, 2017; Hartmann and others, 2020).

Considering this, some studies have used complexity indicators to design production diversification policies for developing countries (Hausmann and Chauvin, 2015; Hausmann, Santos and Obach, 2017; Romero and Freitas, 2018; Romero and Silveira, 2019). In the case of Brazil, the unwinding of the commodity boom highlighted the need for a redesigned production diversification strategy to increase the country's economic complexity and thereby boost its growth.

The objective of this study is to examine the obstacles associated with the structural differences between the Brazilian states (including the Federal District) and to propose a methodology for identifying

promising sectors in order to promote the diversification of each state's production structure.¹ The complexity methodology was adapted for this purpose, with data on employment in economic activities being used instead of international trade data, a change that opened the way to new findings and yielded important empirical conclusions which served to quantify the concrete effects of increased economic complexity on the volume of employment. In addition, once the activities to be incentivized in each state had been identified, simulations were carried out to estimate the increase in employment in the event that the activities highlighted began to be carried out competitively.

The paper is divided into five sections, including this introduction. The second section presents the complexity methodology, which forms the methodological basis of the study. The third section analyses structural conditions in the states and presents the decision rule for selecting the activities that hold out the greatest potential for economic development in each. The fourth section details the estimates of the employment impact of complexity and the simulations of the employment impact in each state if the proposed diversification strategy is adopted. Lastly, the fifth section presents the final considerations of the paper.

II. Methodology

1. The economic complexity approach

The studies by Hausmann, Hwang and Rodrik (2007), Hidalgo and others (2007) and Hidalgo and Hausmann (2009), in particular, are milestones in the formulation of a new methodology for analysing the importance of structural change to development. These papers argue that the future performance of a country's economy will be substantially affected by which products it specializes in and produces competitively.

In their pioneering study, Hausmann, Hwang and Rodrik (2007) propose indicators that represent the first step in the formulation of the complexity methodology. They use the per capita incomes of countries that are competitive in the production of each product to infer their average productivity or sophistication. Thus, the sophistication index of product p is the weighted average of the per capita incomes of the countries that export it competitively:

$$PRODY_{p} = \sum_{c} \left[\frac{\left(X_{pc} / \sum_{p} X_{pc}\right)}{\sum_{p} \left(X_{pc} / \sum_{p} X_{pc}\right)} \right] Y_{c}$$
(1)

where *X* are exports of product *p* for country *c*, and *Y* is per capita income.

Similarly, Hausmann, Hwang and Rodrik (2007) define the sophistication index of country c as the weighted average of the sophistication of the products that the country exports:

$$EXPY_{ct} = \sum_{p} \left(\frac{X_{pct}}{\sum_{p} X_{pct}} \right) PRODY_{p}$$
⁽²⁾

As mentioned above, the products that countries specialize in predict future economic performance. *EXPY* is thus the level of income or productivity of the basket of exported products. However, the index can sometimes be unreliable, as it is constructed with reference to countries' per capita income.

¹ As will be seen, this methodology is adapted from those proposed by Hausmann and Chauvin (2015), Hausmann, Santos and Obach (2017) and Romero and Freitas (2018).
This does not give due importance to each country's production structure, and the characteristics of each product are not measured as well as they might be, since it is enough for it to be exported by higher-income countries.

Hidalgo and Hausmann (2009) use the revealed comparative advantage (RCA) indicator proposed by Balassa (1965) to refine this methodological proposal. The index compares each product's share of the local market with the share of the same good in the world market. Once this is done, it is possible to infer how efficient each country is at producing a given product. Formally:

$$RCA_{pct} = \frac{X_{pct} / \sum_p X_{pct}}{\sum_p X_{pct} / \sum_c \sum_p X_{pct}}$$
(3)

The interpretation of the indicator is as follows: if the index value is over 1, the country is highly competitive in the production of the product analysed, while if it is under 1, the country is uncompetitive.

To develop the complexity measures, the authors measure country diversification and product sophistication. According to Hidalgo and Hausmann (2009), diversification refers to the amount of goods exported by the country with revealed comparative advantages, while the level of sophistication of a product is measured by its ubiquity, i.e., how many countries export the product concerned with revealed comparative advantages. Formally:

$$D_{ct} = \sum_{p} M_{pct} \tag{4}$$

$$U_{pt} = \sum_{c} M_{pct} \tag{5}$$

In this case, D stands for diversification and U for ubiquity. M represents a matrix in which a country takes the value 1 if it exports good p with revealed comparative advantages and 0 otherwise. The authors showed that complex countries tended to be highly diversified, while a complex product had a low degree of ubiquity. Moreover, diversification and ubiquity are negatively correlated measures, i.e., more diversified countries tend to produce goods with lower ubiquity.

However, although diversification and ubiquity are primary indicators of the complexity of each country and product, respectively, these measures are only initial approximations, and more refined measures of complexity can be obtained by combining the two (Hidalgo and Hausmann, 2011). According to Hausmann and others (2011), a poorly diversified country producing goods that are not very ubiquitous can be considered more complex than a poorly diversified country producing more ubiquitous goods. The same is true of ubiquity. A highly ubiquitous good produced by poorly diversified countries may be considered less complex than a highly ubiquitous good produced by highly diversified countries.²

In examining the relationships between diversification and ubiquity, Hausmann and others (2011) developed product and country complexity indices calculated by successive iterations between the indices. Analysing only the first iteration, in the case of the product complexity index (PCI), it is clear that the greater the diversification of the countries exporting a good and the lower its ubiquity, the more complex it is. In the case of the economic complexity index (ECI), the more diversified the economy and the less ubiquitous the goods produced and exported with revealed comparative advantages, the greater the complexity.

Another important contribution by Hidalgo and others (2007) concerns calculation of the proximity of products according to the probability of co-occurrence, as a way of capturing similarities in the

² This interaction between the diversification and ubiquity indicators has to be considered when looking at a case like diamonds, a good that has a low level of ubiquity but can be exported by undiversified countries. Hence the need to consider the two concepts in tandem. Without the interaction, to take a complementary example, undiversified countries producing goods with low levels of ubiquity may be mistaken for more complex ones.

capabilities required to produce goods.³ In other words, the authors adopt the conditional probabilities of exporting with revealed comparative advantages to ascertain the proximity of two products in terms of the resources required to produce them. Thus, they calculate the probability of a good being exported, given that another good is already being exported. The authors define the level of proximity between two products (*p* and *j*) as:

$$\varphi_{p,j} = \min\left\{P(RCA_j = 1 \mid RCA_p = 1), P(RCA_p = 1 \mid RCA_j = 1)\right\}$$
(6)

In this expression, for a country *c*:

$$RCA_{p,c} = \left\{ 1, if \ RCA_{p,c} \ge 1; 0, otherwise \right\}$$
⁽⁷⁾

The authors use proximity levels to form a network that connects the different products. In this network, called the product space, products that require similar capabilities tend to cluster together. In addition, the most complex products are located in the centre, while the least complex products are located in the outermost positions of the network (Hausmann and Klinger, 2006).⁴

To better examine the information implicit in the product space, Hausmann and others (2011) developed indicators to measure the ease with which competitiveness could be acquired in a given industry, considering the existing capabilities of the economy, and to indicate the new opportunities for development created by the acquisition of competitiveness in each industry.

Setting out from the assumption that products close to one another in the product space use similar production capabilities, Hausmann and others (2011) propose an index that measures how easy it is to produce a given good competitively with reference to the competitive production of nearby goods, which serves as a proxy for existing capabilities. This index, called the product density index (PDI), measures the proximity of a given product in relation to the country's current production structure (products with revealed comparative advantages), thus indicating how difficult it is for that country to achieve a comparative advantage in the product. This measure also reflects the amount of new production know-how that a region needs to acquire in order to manufacture and export a given product with comparative advantages. In other words, the lower the PDI, the more skills need to be acquired and the longer and more difficult or costly the process of acquiring revealed comparative advantages, but which have a high PDI, emerge as products with strong potential for competitiveness gains.

The PDI is calculated as the sum of the proximities (φ) of the products in which the country has revealed comparative advantages relative to product p, with the index being standardized by the sum of the proximities between all the products in the network relative to product p:

$$PDI_{pct} = \frac{\sum_{p} M_{ict} \varphi_{pi}}{\sum_{p} \varphi_{pi}}$$
(8)

Since more complex products generate higher income growth, it is important to analyse the gain generated by the acquisition of competitiveness in each product. Hausmann and others (2011) also formulate the complexity outlook gain index. From this, it is possible to measure the gain that a given

³ The term "co-occurrence" can also be used to identify this relationship of proximity. In other words, the authors use the idea of proximity to calculate the likelihood of a good being produced, given that another specific good is already being produced.

⁴ The configuration of the product space matches the centre-periphery definition advanced by ECLAC. The most complex products are in the centre and are therefore produced by central economies.

good brings by facilitating the production of more complex goods hitherto unproduced. A high value for this index means that the product is closer to other more complex products. Formally, the indicator is:

$$COGI_{pct} = \sum_{p} \frac{(1 - M_{cit}) \varphi_{pi} PCI_{it}}{\sum_{p} \varphi_{pi}} - (1 - DI_{pct}) PCI_{pt}$$
(9)

This methodology, shaped and systematized mainly by Hausmann and others (2011), is an essential part of the most modern approaches to economic complexity. The basic thesis centres on the perception that a country with a complex economy is one whose exports are dominated by non-ubiquitous and diversified products. From this, it is possible to understand the different levels of development characterizing each nation.

On the basis of the indicators described so far, it can be seen that the external market plays a key role in this methodology. However, the approach described here will not be based on export data, but on those for employment and economic activities. By contrast with the traditional interpretation, this adjustment allows consideration to be given to the domestic markets of the places concerned. Moreover, since the Brazilian economy is also largely centred on the domestic market, it can be better analysed by the interpretation using employment data.

This paper adapts the complexity approach to estimate the relationship between economic activities. According to Freitas (2019), the proximity between activities can be measured from the combination of occupations in the employment of different industries. In other words, just as it is possible to group products by the capabilities they require, it is also possible to aggregate industries by the occupations they make use of. This methodological process, known as "co-occupation", is also present in the work of Farjoun (1994) and is discussed in more detail in the next section.

2. Co-occupation and the measurement of indicators

According to Farjoun (1994), firms diversify through networks of industries that are interrelated in terms of the resources they need. The author thus considers it important to observe the similarities between resources (e.g., the human knowledge present in different occupations) in order to explain the diversification patterns of firms. On the basis of these groupings, which the author calls "resource-related industry groups", firms can share and transfer similar resources to benefit from and stimulate the diversification process (Farjoun, 1994, p. 188).

The ability to group firms by the resources they use can be interpreted similarly to the concept of co-occurrence of production capacities in nearby industries, as proposed by Hidalgo and others (2007).

The present research adapts proximity between products to find the proximity between industries with similar occupations. Freitas (2019) argues that the concept of co-occupation provides a basis for estimating the proximity of industries with similar employment profiles and using employment data to construct complexity indicators.

According to Freitas (2019), the first step is to define the effective occupations (EO) indicator, analogous to Balassa's (1965) index of revealed comparative advantage, as a basis for calculating the other complexity indicators from employment data. Applying the concept of co-occurrence, employment data will be used instead of export data as in equation (3). For this purpose, the index of revealed comparative advantage is calculated to capture effective occupations in each industry, as follows:

$$EO_{s,o} = \frac{emp_{s,o}/emp_s}{emp_o/emp}$$
(10)

where $emp_{s,o}$ is employment in occupation o in sector s and emp_s is total employment in sector s in the country. To supplement these, emp_o is total employment in occupation o in the country and emp is total employment in the country.

Thus, if the EO indicator is 1 or greater, the share of occupation *o* in sector *s* is greater than the share of that occupation *o* in the country as a whole, and so it is valid to say that the sector in question effectively provides employment for that occupation. Conversely, if the EO indicator is less than 1, the conclusion is that the sector does not effectively provide employment for that occupation in the location being analysed.

A second adapted indicator is the proximity indicator. This can be used to find the probability of an industry providing employment for a certain occupation given that another industry already does so. It is therefore a way of measuring the similarities between industries in terms of occupation. Thus, according to Freitas (2019), equation (4) can be adapted to ascertain the relationship between industries *s* and *i* as follows:

$$\theta_{s,i} = \min \left\{ P(EO_{io} = 1 \mid EO_{so} = 1), P(EO_{so} = 1 \mid EO_{io} = 1) \right\} \forall s \neq i$$
(11)

where for industry s:

$$EO_{s,o} = \left\{ 1, if EO_{s,o} \ge 1; 0, otherwise \right\}$$

$$(12)$$

Using these adaptations, it is possible to calculate the complexity indicators with the data on employment and economic activity. Lastly, in addition to the indices calculated, a general indicator encompassing all the others also needs to be constructed so that a production diversification strategy can be proposed, this being one of the objectives of the research.

III. Interpretation of the results

1. Analysis of production structures

Data from the 2010 annual social information report (RAIS) (Ministry of Economy, 2010) will be used to assess how complex activities are and which structures these activities are based on.⁵ Compiled by the Ministry of Economy, RAIS is a database of employment data by economic activity. In this case, section C (manufacturing industry) and divisions 10 to 32 of version 2.0 of the two-digit National Classification of Economic Activities (CNAE 2.0) are considered. Thus, 23 activities will be analysed for the 27 units of the federation. Table 1 lists all activities considered in the research in order of complexity.

⁵ The year 2010 was chosen so that the results would not be biased by the current economic crisis and also so that the impact of the complexity indicators on the volume of employment in more recent years could be calculated afterwards.

Code of the National Classification of Economic Activities, version 2.0 (CNAE 2.0)	Activities	Product complexity index	Classification
26	Electronic products	1.402	1
28	Machinery and equipment	1.378	2
27	Electrical products and materials	1.365	3
22	Rubber and plastic products	1.302	4
32	Miscellaneous products	1.302	5
29	Automotive vehicles	0.983	6
25	Metal products	0.973	7
18	Printing and reproduction of recordings	0.815	8
30	Other transport equipment	0.794	9
31	Furniture	0.647	10
21	Pharmochemicals and pharmaceuticals	0.495	11
20	Chemicals	0.432	12
12	Tobacco products	0.331	13
17	Paper and cellulose	0.179	14
24	Metallurgy	-0.332	15
23	Non-metallic mineral products	-0.445	16
14	Wearing apparel and garments	-0.468	17
10	Food products	-0.482	18
13	Textiles	-0.611	19
16	Wood products	-0.905	20
15	Leather and footwear	-1.154	21
11	Beverages	-1.427	22
19	Coke and oil derivatives	-1.428	23

 Table 1

 Brazil: economic activities in order of complexity

As can be seen in table 1, the most complex activities are those which apparently require the most production capabilities, while the least complex are more primary activities in which production does not require high levels of specification. The activity with the highest product complexity index value is electronic products, a less ubiquitous and more diversified sector. At the other extreme, the least complex activity is coke and oil derivatives.

Map 1 presents the levels of complexity of the Brazilian states, with the units of the federation ranked in descending order. The darker regions (red) represent higher standard deviations from the ECI and the lighter ones (light blue) lower standard deviations. The results show that states with lower levels of complexity predominate, as only the South and South-east regions, Amazonas and the Federal District have an ECI with a standard deviation greater than 0. In other words, all states that are not in this grouping have negative complexity indices.

Moreover, as can be seen, the South-east and South regions are exceptionally complex: São Paulo, Paraná and Rio de Janeiro are the states with the highest ECIs. At the other extreme, the North-east region is the least complex: Paraíba and Alagoas are the states with the lowest ECIs. A separate case, which does not follow the patterns of its region, is the state of Amazonas, which has the fifth-highest index because of production in the Manaus free trade zone. However, Amazonas' high ECI is not unexpected, as it is a maquila economy, like Mexico, whose ECI likewise overstates its real production capabilities.





Note: The figures in brackets are the ECI values for each state.

2. Promising sectors for production diversification

As Hidalgo and Hausmann (2009) point out, increasing complexity has significant effects on the future economic performance of any country or region. Therefore, diversification proposals aimed at increasing complexity are essential to accelerate economic development.

With this in mind, Hausmann and Chauvin (2015) and Hausmann, Santos and Obach (2017) used complexity indicators to propose diversification strategies for Rwanda and Panama, respectively. As Hausmann, Santos and Obach (2017, p. 34) emphasize, this approach is very promising, as it is based on a methodology with a high degree of analytical rigour.

Setting out from these studies, an indicator was developed with the aim of classifying the three activities which have the greatest potential to increase each state's complexity depending on its particular production structure, and which should therefore be the focus of public development policies. Because this paper adopts a high level of aggregation, the option of identifying three activities opens up more opportunities for the states, since each category includes a great many subsectors that can be chosen. Moreover, picking out three options expands the amount of data that can be provided to policymakers. To this end, three dimensions are considered and will be given equal weight in the diversification rule: current capabilities, market opportunities and analysis of gain.

Table 2 shows how the indicator is constructed. Each of the three dimensions encompasses a number of indicators, all with the same weight. As finally formulated, the indicator represents the mean of the three dimensions. In listing the results, furthermore, it was necessary to remove activities in which each state already had revealed comparative advantages. Thus, for each state, all sectors whose index of revealed comparative advantages was higher than 1 were discarded. This process is necessary because the aim of the industrial policy approach to be pursued is to diversify the economy and not to specialize in sectors that are already competitive.

Dimension	Weight	Indicator	Weight
Current capabilities	0.33	Number of jobs	0.25
		Value of revealed comparative advantage	0.25
		Sector density index	0.25
		Competitiveness opportunity (revealed comparative advantage greater than 0.5)	0.25
Market opportunities	0.33	Value imported in Brazil	0.50
		Value imported in the world	0.50
Analysis of gain	0.33	Sector complexity index	0.50
		Complexity outlook gain index	0.50

Table 2

Characterization of the product score index to produce a diversification proposal

Source: Prepared by the authors.

Note: Within the dimensions, the indicators were standardized (from 0 to 1) to estimate the scores. The weights assigned to each indicator are also instruments of analysis that depend on the purpose they are intended for. The decision in this case was to use equal weights.

Four indicators are used to characterize existing capabilities in each unit of the federation: (i) the number of jobs per activity; (ii) revealed comparative advantage; (iii) the sector density index (to measure the gap between the existing production structure and the one required by the sector analysed); and (iv) the competitiveness opportunity (an extra weight is assigned to products with a revealed comparative advantage score above 0.5 in order to highlight the easiest opportunities for competitiveness gains).

To measure the market opportunities of each sector, two indicators are considered: (i) the value imported in Brazil; and (ii) the value imported in the world. In contrast to the other indices, the data for this second dimension are not employment data but trade data and therefore have a different classification. To reconcile these data with the employment classification, import data classified in the two-digit Harmonized Commodity Description and Coding System (HS 2007) were matched with those in CNAE 2.0 (see table A1.1 in annex A1). Brazil's import data were obtained from the COMEX STAT platform of the Ministry of Development, Industry and Trade, while world import data were taken from the United Nations Comtrade database.

The last dimension considers the possibility of gains from the acquisition of revealed comparative advantages in the sectors analysed. Two indicators are used for this: (i) the sector complexity index (determined by the product complexity index of the activity); and (ii) the complexity outlook gain index, which measures the opportunities created by the competitive production of the new product for the subsequent production of more complex products.

Following this rule, the sectors were ranked by score and the three with the highest values for each unit of the federation were selected, with the proviso that each activity could be repeated six times at most. As there were only 23 activities for 27 states, the probability of repetition was high. The maximum number of repetitions, six, was chosen in view of the scope this still left within each section of CNAE 2.0. In other words, this limitation notwithstanding, there are many activities within each section (an average of 4.5), allowing states to specialize simultaneously in the same one. On the basis of this decision rule and the production structure as of 2010, the sectors holding out the most promise for the development of the states are as presented in table 3.

Unit of the federation	National Classification of Economic Activities, version 2.0 (CNAE 2.0)	Activity	Revealed comparative advantages	Complexity outlook gain index	Product density index	Score
AC	27	Electrical products and materials	0.031	0.177	0.100	0.961
AC	29	Automotive vehicles	0.008	0.187	0.103	0.196
AC	26	Electronic products	0.001	0.206	0.103	0.077
AL	27	Electrical products and materials	0.012	0.165	0.112	0.987
AL	20	Chemicals	0.800	0.192	0.138	0.347
AL	28	Machinery and equipment	0.098	0.139	0.116	0.294
AP	11	Beverages	0.891	0.292	0.093	0.583
AP	29	Automotive vehicles	0.006	0.173	0.098	0.333
AP	28	Machinery and equipment	0.004	0.140	0.091	0.306
AM	28	Machinery and equipment	0.512	-0.340	0.275	0.309
AM	24	Metallurgy	0.453	0.055	0.287	0.101
AM	21	Pharmochemicals and pharmaceuticals	0.032	-0.022	0.250	-0.113
BA	10	Food products	0.428	0.467	0.397	0.210
BA	29	Automotive vehicles	0.416	0.059	0.340	0.203
BA	23	Non-metallic mineral products	0.714	0.471	0.377	0.035
CE	26	Electronic products	0.179	0.107	0.161	-0.031
CE	30	Other transport equipment	0.157	0.119	0.157	-0.097
CE	21	Pharmochemicals and pharmaceuticals	0.372	0.189	0.177	-0.098
ES	19	Coke and oil derivatives	0.428	0.624	0.394	0.426
ES	28	Machinery and equipment	0.257	-0.180	0.359	0.284
ES	10	Food products	0.649	0.281	0.368	0.142
FD	27	Electrical products and materials	0.029	0.128	0.056	1.273
FD	28	Machinery and equipment	0.034	0.103	0.055	0.515
FD	18	Printing and reproduction of recordings	0.304	0.149	0.075	0.513
GO	20	Chemicals	0.741	0.193	0.211	0.310
GO	23	Non-metallic mineral products	0.924	0.336	0.220	-0.006
GO	24	Metallurgy	0.211	0.344	0.208	-0.037
MA	27	Electrical products and materials	0.005	0.143	0.129	0.969
MA	23	Non-metallic mineral products	0.927	0.245	0.153	0.506
MA	19	Coke and oil derivatives	0.476	0.277	0.164	0.467
MT	23	Non-metallic mineral products	0.914	0.254	0.199	-0.052
MT	24	Metallurgy	0.133	0.254	0.169	-0.060
MT	30	Other transport equipment	0.045	0.114	0.149	-0.131
MS	14	Wearing apparel and garments	0.653	0.259	0.153	0.054
MS	11	Beverages	0.703	0.360	0.136	-0.015
MS	26	Electronic products	0.010	0.159	0.115	-0.015
MG	30	Other transport equipment	0.236	-0.037	0.399	-0.067
MG	13	Textiles	0.927	0.421	0.367	-0.112
MG	16	Wood products	0.551	0.506	0.422	-0.152
PA	19	Coke and oil derivatives	0.175	0.493	0.250	0.453
PA	10	Food products	0.756	0.341	0.240	0.335
PA	23	Non-metallic mineral products	0.843	0.367	0.228	0.100
PB	26	Electronic products	0.130	0.202	0.119	-0.017
PB	21	Pharmochemicals and pharmaceuticals	0.016	0.245	0.144	-0.044
PB	14	Wearing apparel and garments	0.474	0.291	0.148	-0.069
PR	13	Textiles	0.730	0.188	0.467	-0.183
PR	15	Leather and footwear	0.380	0.385	0.477	-0.190
PR	30	Other transport equipment	0.069	-0.426	0.440	-0.198

 Table 3

 Brazil: promising economic activities in each unit of the federation

Unit of the federation	National Classification of Economic Activities, version 2.0 (CNAE 2.0)	Activity	Revealed comparative advantages	Complexity outlook gain index	Product density index	Score
PE	19	Coke and oil derivatives	0.625	0.497	0.292	0.480
PE	20	Chemicals	0.641	0.151	0.252	0.300
PE	24	Metallurgy	0.385	0.321	0.259	0.035
PI	19	Coke and oil derivatives	0.306	0.316	0.174	0.520
PI	20	Chemicals	0.090	0.187	0.144	0.270
PI	10	Food products	0.359	0.217	0.160	0.227
RJ	20	Chemicals	0.629	-0.181	0.515	0.357
RJ	28	Machinery and equipment	0.469	-0.580	0.509	0.332
RJ	29	Automotive vehicles	0.227	-0.367	0.502	0.231
RN	11	Beverages	1.000	0.618	0.248	0.056
RN	23	Non-metallic mineral products	0.953	0.326	0.236	-0.004
RN	15	Leather and footwear	0.218	0.514	0.271	-0.029
RS	24	Metallurgy	0.770	0.094	0.389	-0.077
RS	30	Other transport equipment	0.256	-0.302	0.389	-0.111
RS	14	Wearing apparel and garments	0.613	0.181	0.404	-0.191
RO	27	Electrical products and materials	0.006	0.158	0.105	0.986
RO	29	Automotive vehicles	0.033	0.174	0.104	0.220
RO	26	Electronic products	0.013	0.192	0.104	0.089
RR	29	Automotive vehicles	0.003	0.178	0.065	0.396
RR	26	Electronic products	0.010	0.216	0.064	0.386
RR	18	Printing and reproduction of recordings	0.050	0.209	0.068	0.140
SP	14	Wearing apparel and garments	0.904	0.036	0.623	-0.228
SP	11	Beverages	0.974	0.610	0.635	-0.314
SP	31	Furniture	0.859	-0.640	0.626	-0.345
SC	15	Leather and footwear	0.732	0.473	0.467	-0.157
SC	30	Other transport equipment	0.697	-0.295	0.406	-0.187
SC	21	Pharmochemicals and pharmaceuticals	0.107	-0.096	0.372	-0.303
SE	20	Chemicals	0.900	0.199	0.229	0.394
SE	10	Food products	0.506	0.319	0.251	0.196
SE	24	Metallurgy	0.030	0.349	0.224	-0.058
TO	27	Electrical products and materials	0.018	0.175	0.090	0.966
ТО	19	Coke and oil derivatives	0.941	0.255	0.145	0.938
TO	10	Food products	0.696	0.204	0.143	0.680

Note: The values presented in the table are unstandardized. Although all the indices employed were standardized to produce the score indicator, the original values before standardization were used to better identify the characteristics of each sector in the states.

The states are Acre (AC), Alagoas (AL), Amapá (AP), Amazonas (AM), Bahia (BA), Ceará (CE), Espírito Santo (ES), Federal District (FD), Goiás (GO), Maranhão (MA), Mato Grosso (MT), Mato Grosso do Sul (MS), Minas Gerais (MG), Pará (PA), Paraíba (PB), Paraná (PR), Pernambuco (PE), Piauí (PI), Rio de Janeiro (RJ), Rio Grande do Norte (RN), Rio Grande do Sul (RS), Rondônia (RO), Roraima (RR), São Paulo (SP), Santa Catarina (SC), Sergipe (SE) and Tocantins (TO).

From the results presented in table 3, it can be seen that the diversification options were fewer in the more complex states, where there are a great many sectors with comparative advantages. In other words, since a high level of aggregation was applied to activities, the more complex states were left with lower-scoring, uncomplex ones because, as mentioned above, there was already a substantial number of complex activities with revealed comparative advantages.

Consequently, some states need differentiated public policies. São Paulo, for example, is the state with the highest complexity, and the diversification proposal based on the indicator calculated consists of three sectors that may have the effect of reducing its complexity, because although specialization in these activities would increase diversification, the average ubiquity of the state could also rise, which

is a negative. Even so, the proposal for São Paulo was kept for information purposes and also so that this problem could be examined. In view of this limitation, it is important to use more disaggregated classifications of the CNAE 2.0 in similar studies in the future.

There are two other important points to note. The situation in the Federal District and Tocantins is the reverse of that in São Paulo. Lacking activities with revealed comparative advantages, these units of the federation had more options for diversification gains. In addition, some sectors were overestimated because of the strength of certain dimensions of the scoring index, as in the case of coke and oil derivatives. When Brazilian and world imports are considered, the market opportunities dimension substantially increases the score for this activity in the states because of its share of total imports by value. In 2017, for example, world imports associated with this activity accounted for 8.5% of the total.⁶

The diversification proposal prepared supports the ECLAC interpretation. Above all, it highlights the need for change in the production structure in order to achieve a higher level of development. States with lower levels of complexity are encouraged to invest mainly in less ubiquitous and more diversified activities, in order to reduce the differences in technical progress within and between states.

IV. The effects of complexity on employment

1. Econometric tests

As Prebisch (1950) emphasizes, the industrialization of Latin America led to a considerable increase in the incomes of the region's countries. According to Prebisch (1950, p. 5), "the industrial employment of the unemployed, or ill-employed, has thus meant a considerable improvement in productivity and, consequently, where other factors have not brought about a general lowering of productive efficiency, a net increase in national income".

Fixed effects models derived from a 2006–2015 panel database were used to estimate the effect of complexity on employment in Brazil. The commodity boom in this period reoriented economic activity in the country towards the primary sector. The result is an underestimation of the effect of complexity on job creation in Brazil in this period, as primary sectors are less complex. The period was selected, however, to furnish a larger number of observations for estimating the panel model.

As a control, we introduced the gross domestic product (GDP) figures provided for each state by the Brazilian Institute of Geography and Statistics (IBGE), deflated by the GDP deflator with 2010 as the base year. The interaction between the ECI and GDP was also considered in the regressions. As mentioned above, more complex regions have higher incomes. It is thus important to check the impact of this interaction on employment (*emp*). Lastly, two additional controls (*X*) were used: the logarithms of population (IBGE) and industrial employment (RAIS) in each state.

The equation estimated is therefore as follows:

$$\ln\left(Emp_{it}\right) = \beta_0 + \beta_1 \cdot ECI_{it} + \beta_2 \cdot \ln\left(GDP_{it}\right) + \beta_3 ECI_{it} \cdot \ln\left(GDP_{it}\right) + \beta_i \cdot X_{it} + \varepsilon_{it}$$
(13)

The correlation between the variables of interest is shown in figure 1. The relationship between ECI and employment is positive, with a correlation level of 0.69. However, the points are distributed in a dispersed manner and the trend between these variables is not as similar.

⁶ The figure is for activity 27, using the two-digit HS 2007 classification. The source is the COMEX STAT platform of the Ministry of Development, Industry and Trade.



Figure 1 Brazil: relationship between the economic complexity index (ECI) and employment, 2006–2015

Table 4 presents the results of the regressions. Model i details the result of the model estimated using only the ECI and the state's real GDP. The results indicate that state GDP has a positive and significant effect on employment, but the ECI does not. Model ii brings in the interaction between GDP and the ECI. Now, both the state's GDP and the ECI have an employment effect that is positive and significant at the 5% level. The interaction, in turn, has a negative and significant effect. This indicates that the ECI has a stronger influence in states with low GDP, while in states with higher GDP, the influence of complexity on the volume of employment is small. In model iii, population is introduced as an additional control. It has a positive sign and is significant at 10%. The other variables remain significant, but the coefficient of the ECI decreases. In model iv, industrial employment is introduced and population is removed. In this model, industrial employment has a positive sign and is significant at 5%. This indicates that an increase in industrial employment induces an increase in overall employment in each state. Crucially, the ECI remains significant, suggesting that the structural composition of the economy is important even when the effect of industrial employment is considered. In model v, population and industrial employment are included as controls. While population shows no significant effect on employment, the other variables maintain a 5% significance level. A reduction in the ECI coefficient is also observed. Lastly, it is interesting to note that the models explain about 90% of the variance of overall employment.

	Model i	Model ii	Model iii	Model iv	Model v	
Economic complexity index (ECI)	0.003	0.718**	0.553**	0.544**	0.469**	
	(0.013)	(0.201)	(0.126)	(0.189)	(0.154)	
Ln of GDP	0.364***	0.343**	0.329**	0.267**	0.277**	
	(0. 076)	(0.086)	(0.100)	(0.087)	(0.090)	
ECI*Ln of GDP		-0.039**	-0.030**	-0.029**	-0.025**	
		(0.011)	(0.007)	(0.011)	(0.009)	
Ln of population			0.739*		0.542	
			(0.320)		(0.264)	

Table 4Effects of complexity on employment

	Model i	Model ii	Model iii	Model iv	Model v
Ln of industrial employment				0.238**	0.176**
				(0.082)	(0.046)
Constant	6.894***	7.305***	-3.706	5.973**	-1.756
	(1.342)	(1.530)	(4.408)	(1.602)	(3.857)
Unit of the federation fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R ²	0.891	0.895	0.907	0.907	0.913
Number of observations	270	270	270	270	270

Note: The dependent variable is the logarithm of the volume of jobs. Robust standard errors are clustered by region (cluster correction) in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Thus, in model iv it can be observed that both complexity (represented by the ECI) and the logarithms of GDP and industrial employment present positive and significant effects. When population is introduced in model v, this variable does not show statistical significance. It was therefore decided to adopt model iv, in which all the variables considered were significant, as a benchmark.

One of the objectives of this section is to measure the relationship between complexity and employment, and the following equation, based on (13), defines the average marginal effect of the ECI on employment:

$$\frac{\partial \ln\left(Employment\right)}{\partial ECI} = \beta_1 + \beta_3 \cdot \ln\left(GDP\right) \tag{14}$$

Therefore, the average marginal impact of the ECI on the variance of employment is 0.017. In other words, a one-unit increase in the ECI generates an increase of about 0.017% in employment. Similarly, the average marginal effect of GDP on the variance of employment is 0.27.

By using the estimate of the average impact of complexity on employment, it was possible to simulate the impact of the acquisition of competitiveness in the sectors identified in section III on changes in employment, taking the 2010 production structure as a basis. To do this, it was assumed that the states would come to have revealed comparative advantages in the activities proposed, and the ECI was recalculated accordingly. To find the new value of the ECI, however, the indices were not calculated together, but separately. Since this indicator is related to the structure of all the other states, the index does not necessarily increase when it is calculated after the proposal is treated as the change caused by the average impact (0.017) if the ECI remained constant for all the states, i.e., if only the unit of the federation being considered were to adopt the diversification strategy featured.

2. Simulations

Once the change in the ECI had been calculated, going by the average effect on the logarithm of employment, it was possible to find the change in employment caused by the acquisition of revealed comparative advantages in the sectors considered promising. The estimation results are presented in table 5. Column (i) presents the initial complexity, and column (ii) presents the index once the three activities considered promising are being carried out competitively (revealed comparative advantage greater than 1). Column (iii) shows the change in the index once the proposal has been implemented. In columns (iv) and (v), the process is similar: column (iv) shows the number of jobs initially and column (v) the number of jobs after the diversification gain. Column (vi) shows the change in jobs. Lastly, for comparison, column (vii) shows the change in jobs if there is a one-unit increase in the ECI.

	Economic complexity index (ECI)		Change in	Emplo	oyment	Change in	Change in employment
Unit of the federation	Before the proposal	After the proposal	the ECI	Before the proposal	After the proposal	employment	if the ECI increases by one unit
	(i)	(ii)	(iii)	(iv)	(V)	(vi)	(vii)
RR	-0.833	0.186	1.019	78 585	79 930	1 345	1 320
AP	-0.777	-0.236	0.541	108 191	109 174	983	1 817
AC	-0.743	-0.018	0.725	121 187	122 663	1 476	2 036
TO	-1.002	-0.735	0.267	238 955	240 027	1 072	4 014
PI	-0.780	-0.708	0.072	377 463	377 920	457	6 341
RO	-0.733	0.162	0.895	334 290	339 316	5 026	5 616
SE	-0.509	-0.364	0.145	369 579	370 479	900	6 208
AL	-1.005	-0.325	0.680	470 992	476 372	5 380	7 912
PB	-1.105	-0.552	0.553	579 504	584 887	5 383	9 735
RN	-0.281	-0.128	0.153	575 026	576 504	1 478	9 660
MA	-0.740	-0.491	0.249	636 625	639 288	2 663	10 694
MS	-0.479	-0.307	0.172	560 789	562 409	1 620	9 420
MT	-0.063	0.146	0.209	656 542	658 847	2 305	11 029
AM	1.457	1.615	0.158	575 739	577 267	1 528	9 672
CE	-0.166	0.330	0.496	1 325 792	1 336 839	11 047	22 271
PA	-0.806	-0.750	0.056	951 235	952 130	895	15 979
ES	0.473	0.512	0.039	860 421	860 985	564	14 454
PE	-0.123	-0.116	0.007	1 536 626	1 536 807	181	25 813
GO	-0.627	-0.463	0.164	1 313 641	1 317 260	3 619	22 067
FD	0.441	1.756	1.315	1 099 832	1 124 127	24 295	18 476
SC	1.384	1.416	0.032	1 969 654	1 970 713	1 059	33 087
BA	-0.281	-0.128	0.153	2 139 232	2 144 730	5 498	35 936
PR	1.682	1.727	0.045	2 783 715	2 785 819	2 104	46 762
RS	1.492	1.496	0.004	2 804 162	2 804 350	188	47 106
MG	0.235	0.286	0.051	4 646 891	4 650 872	3 981	78 061
RJ	1.524	1.681	0.157	4 080 082	4 090 843	10 761	68 539
SP	2.366	2.300	-0.066	12 873 605	12 859 332	-14 273	216 257

 Table 5

 Brazil: simulation of the effects of complexity on employment

Note: The states are Acre (AC), Alagoas (AL), Amapá (AP), Amazonas (AM), Bahia (BA), Ceará (CE), Espírito Santo (ES), Federal District (FD), Goiás (GO), Maranhão (MA), Mato Grosso (MT), Mato Grosso do Sul (MS), Minas Gerais (MG), Pará (PA), Paraíba (PB), Paraná (PR), Pernambuco (PE), Piauí (PI), Río de Janeiro (RJ), Rio Grande do Norte (RN), Rio Grande do Sul (RS), Rondônia (RO), Roraima (RR), São Paulo (SP), Santa Catarina (SC), Sergipe (SE) and Tocantins (TO).

The states where the diversification gain produced the most jobs were the Federal District, Ceará and Rio de Janeiro. Because these units of the federation have more jobs, the change in the ECI leads to a more than proportional increase in jobs there compared to other states where the change in the ECI is larger and the number of jobs smaller (such as Roraima and Rondônia). Thus, these three states alone were responsible between them for the creation of about 46,000 new jobs.

At the same time, the states where the ECI changed the least registered fewer new jobs. Leaving aside São Paulo, where employment changed negatively, Rio Grande do Sul and Pernambuco were the units of the federation where employment changed the least in response to the diversification proposal presented in the previous section. The ECI rose by 0.004 and 0.007 in these two states, resulting in the creation of just 188 and 181 additional jobs, respectively.

The only atypical case where the increase in activities with revealed comparative advantages led to a decrease in the ECI and employment was São Paulo. This occurred because the indices are calculated in relative terms across sectors and states. The sectors proposed for São Paulo (wearing apparel and

garments, beverages and furniture) are not very complex. Thus, despite increasing the diversification of the state's production structure, these sectors contributed to higher average ubiquity, reducing the complexity of the state's economy. Ubiquity in São Paulo was 5.5 in 2010, and the average ubiquity of the three sectors indicated by the diversification rule for the state is 9. In this case, therefore, the diversification component did not outweigh the increased ubiquity, as it did in Rio Grande do Norte, the only other case in which the average ubiquity of the activities considered for specialization was higher than the state average.

Considering this, it is important to note that there are three main reasons for the problem in São Paulo. First, the decision criterion: the high degree of aggregation of activities in CNAE 2.0 means that when activities that already have revealed comparative advantages are removed and a maximum number of repetitions is stipulated, less complex activities end up being selected for São Paulo. Second, diversification, with three more sectors producing competitively, does not mitigate the effect of increased ubiquity. Third, the structural characteristics of the state of São Paulo necessitate public development policies very different from those required by the other units of the federation. In other words, the fact that this state has a high level of economic complexity and is highly diversified places it on a different level, giving it greater scope for modernization in activities where there are already revealed comparative advantages. These considerations should therefore be taken into account in future studies.

The results presented in this section indicate that, in addition to strongly influencing GDP (Hausmann and others, 2011; Romero and Silveira, 2019), complexity also has a considerable impact on the volume of jobs in the economy. As Hausmann, Hwang and Rodrik (2007) point out, specialization in different products leads to different economic growth outcomes and also influences job creation. This once again underlines the need to modify the production structure in order to raise the level of economic development of the states, as argued in classic ECLAC studies.

V. Final considerations

Following the structuralist conception of economic development and drawing on recent studies that have used complexity indicators to structure production diversification policies, this article has sought to use the economic complexity approach to identify promising sectors with a view to increasing employment and economic growth in the Brazilian states. First, the complexity methodology was adapted so that employment or occupational data could be used to calculate regional complexity indicators. Next, panel data models were used to estimate the impact of complexity on employment. Lastly, as a way of evaluating the proposal developed, we carried out simulations of the effects of the diversification proposals on employment in Brazilian states in the event that they were to start producing competitively in the activities concerned.

To begin with, we drew on the work of Hausmann, Santos and Obach (2017) and Romero and Freitas (2018) to formulate an indicator that could be used to develop a diversification proposal for the Brazilian states. Complexity indicators were calculated with employment data to produce a ranking of promising products. From this, it was possible to identify the three most promising activities for public policies to focus on with a view to incentivizing competitiveness gains in each unit of the federation, given its existing production structure. Because the activities in which each state had revealed comparative advantages were removed and a limit was set on the number of repetitions, the sectors identified for the most complex states ended up being of low complexity. This process was mainly due to the high level of aggregation of the CNAE 2.0 activities selected, which was partly responsible for the limitations of the research when it came to proposing strategies for São Paulo. The use of a lower level of aggregation for future studies would avoid this problem.

This research has also made it possible to estimate the impact of increased complexity on employment. On the basis of panel data for the period 2006–2015, it is estimated that the addition of one ECI unit generates an increase of 0.017% in employment. This average marginal effect depends on states specializing in products that increase their complexity. Accordingly, the goods to be prioritized in public policies must not only be consistent with domestic structural characteristics, but must increase diversification and reduce the average ubiquity of the units in the federation.

The average marginal impact calculation conducted as part of the model estimation made it possible to measure the increase in jobs in the event that the states followed the diversification proposal. We first calculated how much the ECI might rise as a result of the acquisition of revealed comparative advantages in new activities. From this new value, using the average ECI effect, it was feasible to calculate the change in the number of jobs in each state's labour market. In the aggregate, the simulations demonstrated the possibility of 81,000 additional new jobs. The proposal could have a particularly strong impact in certain states. The Federal District, Ceará and Rio de Janeiro would gain about 46,000 new jobs.

The analysis presented in this paper demonstrates the clear relationship between the structuralist approach of ECLAC and the results of the research based on the economic complexity method. According to the paper's findings, a state's level of complexity has major implications for the volume of employment. This indicates that competitive production in sectors that are more diversified and less ubiquitous, and that thus increase the complexity of the state concerned, is reflected in a higher volume of jobs and is a driver of economic development.

The methodology described in this paper is therefore an important tool for guiding development policies. The difficulties arising from the unwinding of the commodity boom, which drove the reprimarization of the Brazilian economy, underline the importance of implementing sound and effective industrial policies to accelerate structural change in developing economies and boost income and employment growth. While fiscal constraints are a major limitation on the design of diversification policies, instruments such as exemptions, subsidized credit with conditionalities and government procurement can be used to encourage the development of strategic sectors. However, it is crucial for these measures to be time-limited and governed by well-established rules, with a quid pro quo required in the form of higher productivity or exports.

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Annex A1

Table A1.1

Correspondence between version 2.0 of the National Classification of Economic Activities (CNAE 2.0) and the Harmonized Commodity Description and Coding System (HS 2007)

CNAE 2.0	HS 2007
Two digits	Two digits
10	02, 03, 04, 05, 11, 13, 15, 16, 17, 18, 19, 20, 21, 23
11	22
12	24
19	27
20	28, 29, 31, 32, 33, 34, 35, 36, 37, 38, 39
21	30
22	40
15	41, 42, 64
14	43, 61, 62, 65
16	44, 45, 46
17	47, 48
18	49
13	50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 63
32	66, 67, 92, 95, 96
23	68, 69, 70
24	71, 72, 73, 74, 75, 76, 78, 79, 80, 81
25	82, 83, 93
28	84
27	85
30	86, 88, 89
29	87
26	90, 91
31	94

Source: Prepared by the authors.

Demographic aspects and regional income convergence in Brazil: a panel data approach

Rubiane Daniele Cardoso de Almeida, Benjamin M. Tabak and Tito Belchior Silva Moreira

Abstract

The framework of condition convergence forms the theoretical basis for different dynamic panel data approaches, but depending on the specifications, the method and the time period, results can vary significantly. This article presents empirical results of applying different panel data approaches to study the impact of demographic factors on regional growth of the 27 states of Brazil over 2000–2014. The results suggest that estimation using the generalized method of moments (GMM) is likely to be more consistent and efficient than the other methods studied. The results also point to a significant and negative relation between the demographic variables and regional economic growth. It is hoped that this study will contribute to the literature, by offering a comparative model framework and an analysis of demographics and economic growth.

Keywords

Economic growth, regional development, income, population aspects, population trends, macroeconomics, econometric models, Brazil

JEL classification

J11, O47, R11

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I. Introduction

Thoughts and discussions on income convergence between countries initially likely emerged over the course of the eighteenth and nineteenth centuries. Subsequently, in the twentieth century, Solow (1956) and Swan (1956) developed a complete theory on economic growth and convergence. Since then, different formulations have been developed, with multiple methodological and econometric applications.

This study addresses intraregional convergence, which is to say convergence of regions within a country. All 27 federative units of Brazil are analysed: 26 states and the Federal District, containing the capital Brasilia.¹ The econometric methodology used is based on dynamic panel data models, comparing four such models. In addition to these methods, indicators of inequality are used, such as the Gini coefficient and the Theil index, as well as the coefficient of variation. Econometric methods are used to find empirical evidence of β -convergence, and indicators of inequality to determine whether there is σ -convergence.

Anecdotal evidence suggests that inequality in income, wealth and opportunity are continuing to rise worldwide. Data from the *Human Development Report 2015* published by the United Nations Development Programme (UNDP, 2015), covering 2014, show that around 80% of the world's population holds just 6% of global wealth. One new development, however, is the decline between 1990 and 2014 in the number of people living in extreme poverty around the world, from 1.9 billion to 836 million. In addition, according to the same report, Brazil obtained an inequality-adjusted human development index (IHDI) value of 0.56 in 2014, below the average for Latin America and the Caribbean, which was 0.57. In this regard, in a recent study, King and Ramlogan-Dobson (2015) found evidence that growth in almost all Latin American economies is actually systematically related to that of the United States, but that some countries have converged to rather low relative income levels.

Economic activity in Brazil is highly concentrated geographically. The South-East region, the country's second smallest, holds more than 44% of the population and is responsible for more than half of national gross domestic product (GDP). However, a comparison of the years 2001 and 2012 shows a fall in the GDP share of the South-East region from 59.1% to 54.9% and rises for other regions such as the Midwest, whose share increased by more than 1 percentage point. This pattern may be indicative of a process of regional de-concentration.

Examining labour force income in 2014, the Federal District reported the worst rates of income inequality in the country. In the Federal District, the Gini coefficient (which measures concentration of income in a given group) was 0.58, followed by the states of Acre, Amazonas, Maranhão and Bahia, with coefficients of around 0.53.² The state of Santa Catarina was the least unequal in Brazil, with a coefficient of 0.42. Overall, for Brazil, the coefficient was 0.60, indicating large disparities among regions. Map 1 shows the coefficients for each state in 2014.

The existence of a process of income convergence between regions is very important in the study of economic growth and inequality. According to Abramovitz (1986), technologically backward countries have the potential to grow faster than developed countries, provided they have enough capacity to take advantage of the technological level of leading countries. The question is whether poor countries have higher growth rates than rich countries.

¹ For the purpose of simplicity, all 27 federative units of Brazil will be referred to in this article collectively as states.

² The Gini coefficient varies from 0 to 1. The closer to 0, the lower the income inequality, and the closer to 1, the higher the income inequality. Data extracted from IPEA (2022).



Map 1 States of Brazil: Gini coefficients, 2014

Source: Prepared by the authors, on the basis of Institute of Applied Economic Research (IPEA), Ipeadata [online database] http://www.ipeadata.gov.br/Default.aspx.

In this context, the aim of this study is to analyse the process of convergence between Brazilian states from 2000 to 2014, considering the dynamic panel data approach. The article contributes to discussions in the literature by including demographic variables, seeking to analyse their impact on economic growth and convergence. Another contribution of this article is empirical discovery based on different panel data approaches and different estimation methods, focusing mainly on the generalized method of moments (GMM). The importance of this topic lies in the key information that can be provided to policymakers.

Our observations complement existing results on Brazil. Among the most recent studies, Cravo, Becker and Gourlay (2015) and Resende and others (2016) previously found conditional β -convergence but at relatively slow rates. The main methodological difference with respect to those studies is that we primarily control for the demographic characteristics of each state, through the fixed-effects model, while convergence in the two other papers is conditional on specific factors such as education, population density or infrastructure. The increase in convergence rates in fixed-effects (FE) estimates is in line with Islam (1995) who attributes the difference to omitted variable bias in regressions without FE.

Resende and others (2016) do not focus solely on the state-level but also compare their results to those obtained from other less aggregated spatial units. The differences, however, are minor, suggesting that the findings hold in a general context, irrespective of the level of analysis. The multilevel analysis in Dapena and others (2017) reveals internal divergence in the most developed states in the South-East

region and in the states of the North-East. At the national level, their estimation confirms the previous positive relative convergence results. Thus, our work complements the existing literature for Brazil, specifically applying a demographic perspective to convergence and growth through GMM.

In short, the results show relevant changes in demographic characteristics among the Brazilian regions. Migration processes are less intense and are occurring in reverse, with people returning to their region of origin and fertility appears to be declining in all states. The empirical evidence shows a negative influence of population density, migration and fertility rates on per capita income; although these variables are in transition, they do appear to demonstrate the persistence of some socioeconomic and cultural characteristics of Brazil.

In addition to this introduction, the paper has four sections: section II outlines the basic concepts of convergence and empirical evidence on the subject; section III describes the data and empirical strategy used; section IV provides the results of the σ -convergence and β -convergence tests; lastly, section V summarizes the study and offers some final considerations.

II. Methodological aspects

1. Theory and estimation

In the recent debate about economic growth and income convergence, two theoretical approaches to empirical research stand out. The first relates to the model put forward by Solow (1956), which suggests that poorer regions tend to grow faster than richer regions owing to decreasing returns to scale on the capital stock. The second approach draws from the discussion of conditional convergence, which seeks to identify the factors that drive economic growth, according to Barro and Sala-i-Martin (1991). In order to test the convergence condition, these authors added, to the basic model of Solow (1956), a set of variables that refer to differences in the steady-state of the different economies. This approach is based on the supposition that there will only be convergence between countries or regions if they are similar to each other.

One critique of the model proposed by Barro and Sala-i-Martin (1991) is that it omits unobservable effects or considers them insignificant. Islam (1995) proposes a method that considers the different production functions of economies, which may overcome problems of this nature, comprising a dynamic panel data model that includes in its equation unobservable country effects. Islam (1995) compares his results with those of Mankiw, Romer and Weil (1992), emphasizing the changes that occurred when including specific effects.

For this study, we opt for a dynamic panel data model based on Islam (1995), in which the lagged dependent variable captures the short-run autoregressive behaviour of income. As shown by Islam (1995), the model can be written as:

$$Lny_{i,t} = \gamma Lny_{i,t-1} + \sum_{j=1}^{n} \beta_{j} X_{it} + \eta_{t} + \mu_{i} + \nu_{it}$$
(1)

where $\gamma = e^{-\lambda t}$, $\lambda = -\frac{\ln \gamma}{\tau}$ being the speed of convergence and τ the variation in time, and the parameters μ_i and η_t are specific to each state and each year, respectively. The vector X_{it} represents the structural characteristics of each region. The convergence velocity can best be interpreted through the definition of half-life, i.e., half the time it takes an economy to reach half the distance to its steady-state.

Islam (1995) used the least squares dummy variable (LSDV) method in the dynamic version. As Roodman (2006) points out, the panel data approach is better than cross-sectional regression as it enables controlling for endogeneity and omitted variable bias. However, the LSDV method may not

eliminate the existing bias in the case of dynamic panel estimation, since the lagged dependent variable is negatively correlated with the error term, underestimating the coefficient value.

In fact, Caselli, Esquivel and Lefort (1996) raised the endogeneity problem of explanatory variables not considered by Islam (1995). As a solution to the problem identified in Islam (1995), the authors propose the use of a GMM estimation developed by Arellano and Bond (1991). In this paper, in addition to the classical methods — ordinary least squares (OLS) and LSDV— we estimate the following models: two-stage least-squares or instrumental variables (IV) by Anderson and Hsiao (1981), difference GMM by Arellano and Bond (1991) and system GMM by Blundell and Bond (1998), which follows the analysis structure proposed by Roodman (2006). Thus, our intention is to provide a comparative table of estimates, to find the most consistent model for the sample, focusing primarily on demographic variables.

2. Data

A dataset was constructed for the 27 Brazilian states³ and covering the period from 2000 to 2014. When selecting variables, the aim was to include ones traditionally used in the analysis of growth and convergence models, with some added demographic variables —ratio of urban to total population, population density, migration and fertility (see table 1). The main sources of data are the Brazilian Institute of Geography and Statistics (IBGE) and the Ipeadata database of the Institute of Applied Economic Research (IPEA). The economic variable considered is per capita GDP. This is the classical variable used in growth models. An additional proxy variable is included for human capital: the proportion of formal workers with a high school education or higher. The purpose of including this variable is to analyse how qualification of the workforce impacts on growth. The variable representing employment is the percentage of the total population that is in work. Capital expenditure as a proportion of each state's GDP is used as a proxy for public investment.

Description		Mean	Std. dev.	Min.	Max.	Source
Dependent variabl	e					
GDP	Per capita GDP <i>(Reais)</i>	16 016	10 337	4 477	64 013	Institute of Applied Economic Research (IPEA), Ipeadata Brazilian Institute of Geography and Statistics (IBGE)
Independent varia	bles					
Human capital	Proxy for human capital: share of formal workers with high school or higher education	0.243	0.108	0.070	0.654	IBGE
Investment	Capital expenditures to GDP (Reais)	31 269	22 686	7 993	130 681	Ipeadata
Employment	Ratio of employed persons to total population	0.410	0.068	0.254	0.526	lpeadata
Urbanization	Ratio of urban population to total population	0.808	0.097	0.587	1.000	IBGE
Population density	Demographic density: inhabitants per square kilometre	66 634	101 080	1 546	483 258	IBGE
Migration	Migration rate: ratio of residents not belonging to the state to total population	0.194	0.136	0.038	0.537	IBGE
Fertility	Fertility rate: live births per woman aged 15–49 years	2.219	0.471	1.583	3.696	IBGE

Table 1Summary statistics

Source: Prepared by the authors.

Notes: The table shows mean, standard deviation, minimum and maximum value for the main variables in 2000–2014. The number of observations is equal to 27 in each year.

³ Brazilian states: Acre (AC), Alagoas (AL), Amapá (AP), Amazonas (AM), Bahia (BA), Ceará (CE), Distrito Federal (DF), Espírito Santo (ES), Goiás (GO), Maranhão (MA), Mato Grosso (MT), Mato Grosso do Sul (MS), Minas Gerais (MG), Pará (PA), Paraíba (PB), Paraná (PR), Pernambuco (PE), Piauí (PI), Rio de Janeiro (RJ), Rio Grande do Norte (RN), Rio Grande do Sul (RS), Rondônia (RO), Roraima (RR), Santa Catarina (SC), São Paulo (SP), Sergipe (SE) and Tocantins (TO).

The demographic variables are: the portion of the population that lives in cities; population density expressed as inhabitants per square kilometre; migration, expressed as the number of inhabitants not born in a state as a proportion of its total population; and the fertility rate, which is the number of children born to women of childbearing age (15-49 years). These variables were selected to verify the impact of the demographic characteristics of each region on growth and economic convergence.

In order to account for possible business cycle fluctuations, and in order not to capture short-term growth, triennial averages of the variables are used. As the series covers 15 years, this results in 5 time points, as in Islam (1995). The descriptive statistics are presented in table 1. The natural logarithm is used for all variables, in order to follow the classical methodology for convergence models. According to Wooldridge (2010), in some cases the logarithmic transformation can alleviate problems of heteroscedasticity. In addition, it can narrow the amplitude of values of the variables, making estimates less sensitive to outliers.

Map 2 shows the spatial distribution of the per capita GDP variable for 2014.



Map 2 States of Brazil: spatial distribution of per capita GDP, 2014

Source: Prepared by the authors.

In general, the states of the North and North-East regions have the lowest per capita GDPs, while the states of the South and South-East have the highest. Thus, it appears that the states with the highest product or income are surrounded by similar wealthy states and vice versa. This may be a result of socioeconomic interaction between neighbouring regions -technological overflows, labour mobility, economies of scale - or may also result from macroeconomic policies and sociocultural characteristics.

III. Results

An oft-repeated fact in the literature is that analysis of convergence uses two main measures $-\sigma$ - and β -convergence— which are different, but also complementary. These two approaches gained prominence mainly through the seminal work of Barro and Sala-i-Martin (1992). Because neither kind of convergence necessarily entails the other, and because each has its own merits, we agree with Young, Higgins and Levy (2008) that it is worth studying and comparing the two forms.

1. *o*-convergence

Even in the earliest studies of regional inequalities, such as those of Kuznets (1955) and Williamson (1965), convergence between territories was already attracting the attention of researchers in the area and has continued to do so. In these initial studies, an index similar to the standard deviation was used as a measure of income dispersion, known today as σ -convergence. This then became the simplest concept of convergence and, according to Barro and Sala-i-Martin (1991), can be understood as the continuous dynamics of reducing the differences between regional incomes, which leads to less dispersion and less inequality between economies. The literal concept of σ -convergence was introduced by Barro (1991).

The standard deviation, however, is not an adequate measure to compare variables that are measured at different scales or even when the scale of a single variable changes significantly over time. The coefficient of variation, which is defined as the standard deviation relative to the mean of a variable, is independent of the absolute magnitude of the variable and is therefore a more appropriate measure to test convergence.

Another means of obtaining evidence of this process would be to observe the behaviour of indicators of income inequality. These indicators have the capacity to demonstrate whether the differences between incomes in different states have become larger or smaller over a period. Figure 1 shows the main indicators of income inequality: the Gini coefficient, the Theil index and coefficient of variation. The Gini coefficient and Theil index are similar and vary between zero and one. The value zero corresponds to a complete equality between the incomes, whereas the value one corresponds to a complete inequality between the incomes.

As shown in Figure 3, the overall trend over time is a downward one. Although from 2004 to 2009, the coefficient of variation seemed to show some stability, it began falling again in 2009. The Theil index is the most unstable, with several peaks over the period but a general trend of declines, since at the start of the period the indicator stood at around 0.68 but had reached 0.50 by its end. The Gini coefficient also shows a decrease over the period, albeit a less pronounced one, but with a more linear trend than the other indicators. Overall, these indicators provide some evidence of σ -convergence. In a recent study for the provinces of China, Tian and others (2016) also use the coefficient of variation for σ -convergence analysis and find a reduction in the dispersion of income over time.



Figure 1

Note: The number of observations is 27 in each year.

2. β -convergence

Before we analyse the empirical results obtained for convergence, figure 2 facilitates analysis of the convergence process according to Barro and Sala-i-Martin (1991), showing the relationship between the natural logarithm of per capita GDP in 2000 and its average annual growth rate for 2000–2014. To illustrate this relationship more clearly, a trend line is drawn, and a trend line has been drawn to show the linear regression. The decreasing relationship shows that those states with higher initial values experience lower growth rates in this variable. This behaviour is typical of a convergence process.

The states with the greatest economic lag at the beginning of the period and with the highest growth rates are: Piauí, Maranhão and Pernambuco, which are part of the North-East region. The characteristics that may have influenced the convergence process in that region include: (i) income redistribution policies, mainly through the Bolsa Família direct aid programme for the poorest families since 2003; (ii) expansion of the agricultural frontier in the Cerrado ecoregion of tropical savanna in eastern Brazil, particularly in terms of soybean, irrigated fruit growing and export diversification; (iii) expansion of credit with an emphasis on residential credit through the Minha Casa, Minha Vida programme (in 2006, loans were equivalent to 26% of the region's GDP, and in 2010 to 49%); and (iv) economic stability through implementation of the Plano Real which sought low inflation to increase the purchasing power of the low-income population and contribute to reducing social inequality.

We implement tests for the β -convergence conditional including characteristics of each state, according to tables 2 and 3. Adopting a comparative approach and based on the literature, we use the following models: OLS, FE, IV (Anderson and Hsiao, 1981), difference GMM and system GMM. The dependent variable is the natural logarithm of per capita GDP. Table 2 shows the results for the model without the demographic variables. Table 3 shows the results including the demographic variables.



Note: The graph includes the results of a simple linear regression between the two variables under consideration.
 ^a Brazilian states: Acre (AC), Alagoas (AL), Amapá (AP), Amazonas (AM), Bahia (BA), Ceará (CE), Distrito Federal (DF), Espírito Santo (ES), Goiás (GO), Maranhão (MA), Mato Grosso (MT), Mato Grosso do Sul (MS), Minas Gerais (MG), Pará (PA), Paraíba (PB), Paraná (PR), Pernambuco (PE), Piauí (PI), Rio de Janeiro (RJ), Rio Grande do Norte (RN), Rio Grande do Sul (RS), Rondônia (RO), Roraima (RR), Santa Catarina (SC), São Paulo (SP), Sergipe (SE) and Tocantins (TO).

		Dependent variable	e: Ln(GDP) _{i,t}				
	OLS	FE	IV	System GMM	Difference GMM		
Ln(GDP) _{i,t-1}	0.910***	0.582***	0.852**	0.842***	0.615***		
	(0.029)	(0.078)	(0.410)	(0.047)	(0.104)		
Human capital	0.071*	0.282***	0.284***	0.139**	0.252***		
	(0.038)	(0.054)	(0.091)	(0.051)	(0.075)		
Investment	0.009	0.046	0.037	-0.003	0.027		
	(0.011)	(0.028)	(0.034)	(0.016)	(0.027)		
Employment	0.162***	0.204	0.299	0.229***	0.431		
	(0.045)	(0.155)	(0.262)	(0.063)	(0.183)		
Constant	0.583***	1.629***	-0.103	0.952	-		
	(0.162)	(0.325)	(0.086)	(0.262)			
R ²	0.988	0.939	-	-	-		
Implicit λ	0.031	0.180	0.053	0.057	0.162		
Half-Life	22.04	3.84	12.98	12.09	4.22		
Observations	108	108	108	108	108		
Instruments	-	-	-	13	9		
Hansen				10.78	10.70		
				[0.21]	[0.05]		
AB(2)				0.23	0.95		
				[0.81]	[0.34]		

Table 2 β -convergence analysis

Source: Prepared by the authors.

Note: Standard error in parentheses. P-value between square brackets. VIF_{max} = 5.05; Heteroscedasticity test: χ^2 (1) = 0.15, p < 0.696. The Wald test for the FE model: χ^2 (27) = 777, p < 0.001. GMM estimates (the last two columns) were performed in first-step robust, limited in 4 lags to prevent the proliferation of instruments. * significant at 10%, ** significant at 5% and *** significant at 1%.

	Dependent variable: Ln(GDP); +							
	OLS	FE	IV	SYS	DIFF			
Ln(GDP) _{i.t-1}	0.909***	0.433***	0.666**	0.779***	0.610***			
	(0.030)	(0.085)	(0.310)	(0.088)	(0.141)			
Human capital	0.047	0.147***	0.286***	0.152**	0.179***			
	(0.034)	(0.061)	(0.095)	(0.077)	(0.056)			
Investment	0.007	0.043*	0.037	-0.017	0.026			
	(0.014)	(0.025)	(0.032)	(0.030)	(0.028)			
Employment	0.090	0.280	0.413	0.216**	0.641***			
	(0.067)	(0.182)	(0.273)	(0.103)	(0.140)			
Density	-0.007	-0.551*	-0.825	-0.008	-0.878**			
	(0.005)	(0.294)	(0.530)	(0.006)	(0.332)			
Urbanization	-0.039	0.070	-0.078	0.105	-0.134			
	(0.081)	(0.157)	(0.286)	(0.114)	(0.201)			
Migration	0.014	-0.116	-0.081	0.029*	-0.266**			
	(0.010)	(0.091)	(0.126)	(0.016)	(0.102)			
Fertility	-0.144**	-0.990***	-0.110	-0.106	-0.674**			
	(0.072)	(0.224)	(0.458)	(0.090)	(0.302)			
Constant	0.639***	4.212***	-0.103	1.350**	-			
	(0.177)	(1.158)	(0.086)	(0.515)				
R ²	0.989	0.953	-	-	-			
Implicit λ	0.031	0.279	0.053	0.083	0.164			
Half-Life	21.79	2.48	12.98	8.32	4.20			
Observations	108	108	108	108	108			
Instruments				17	13			
Hansen test				12.03	9.01			
				[0.21]	[0.10]			
AB(2)				0.16	0.67			
				[0.87]	[0.50]			

Table 3 β -convergence analysis (including demographic variables)

Note: Standard error in parentheses. P-value between square brackets. VIFmax = 9.34; Heteroskedasticity test: $\chi^2(1) = 0.71$, p < 0.399. The Wald test for the FE model: $\chi^2(27) = 632$, p < 0.001. The GMM estimates (last two columns) were performed in first-step robust, limited in 4 lags to prevent the proliferation of instruments. * significant at 10%, ** significant at 5% and *** significant at 1% level.

The estimates provide positive results for the presence of β -convergence, meaning that they will only converge to the same steady state if they are similar to each other. The coefficients obtained for the variable initial income are greater than 0 and less than 1 and statistically significant to less than 1%, except in the IV model. However, Islam (1995) emphasized in his study that the use of OLS to measure β -convergence may not be the most appropriate methodology. This estimator would be consistent if the individual effects of each state were captured by the error term and it was not correlated with the explanatory variables. As discussed in Islam (1995), one way of addressing individual effects would be through the FE estimator. However, in the case of a dynamic panel this method can generate unreliable estimators, since the lagged dependent variable is correlated with the mean of the errors.

Given the difficulty of finding good instruments for the variables that present problems, Roodman (2006) notes that researchers are often faced with the need to design instruments from the data set itself. This is the case for this research.

According to Ding, Haynes and Liu (2008), as it does not consider unobserved time and regional effects, the OLS estimate tends to tilt up the coefficient of the lagged dependent variable, given its correlation with the error. Roodman (2006) shows that although FE estimation is better than OLS, it does not eliminate the bias of the dynamic panel, since a negative correlation remains between the

lagged dependent variable and the error term, tilting the value of the coefficient down. Therefore, the true value of the coefficient of the lagged dependent variable must be between the values found by the OLS and LSDV estimates, which serve as boundaries or intervals. Thus, an estimated coefficient for the lagged dependent variable that lies within this range offers some reliability.

As a starting point, the simplest way to incorporate any instrument into a regression is by using the two-stage least squares (2SLS) method, which refers to the Anderson and Hsiao (1981) instrumental (IV) estimators. This model was estimated in first difference using an instrument for the lagged dependent variable, such as $\Delta y_{i,t-2} = y_{i,t-2} - y_{i,t-3}$.

Our analysis focuses on the GMM estimators, because, according to the literature, they may present greater consistency. The results shown in the last two columns of table 2 indicate income convergence. Roodman (2006) recalls that the Sargan statistic is a special case of the Hansen statistic under the assumption of homoscedasticity. Thus, for robust GMM estimation, the Sargan test is inconsistent. Therefore, taking into account the Hansen statistic presented in table 2, the instruments used in the GMM models are valid. Considering the GMM difference and GMM system models, in table 2 the estimated convergence velocity is 5%–16%, indicating that the time required for the states to reach half the distance to their steady state is 4–12 years. As expected, the proxies for human capital and employment have a positive impact on per capita income.

Adding the demographic variables, in table 3, we observed that the speed of convergence increases, being between 8 and 16% for GMM models. The half-life passes to the interval between 4 and 8 years. It is important to highlight that these results are higher than the ones found by Barro and Sala-i-Martin (1990 and 1995), which were around 2% for European regions and North American states. This fact may contribute to the theory that poorer regions grow faster than richer regions. In recent studies, Mishra and Mishra (2018) and Tian and others (2016) also find evidence for convergence in regions of India and China, respectively.

In the case of the GMM difference model, the variables that represent human capital and labour continue to have a positive impact on income. With this model, there is no significant change in the speed of convergence when the variables of interest are added. Demographic variables — population density, migration and fertility— seem to have an impact on income, as expected. Population density has a negative impact, meaning that the more people per square kilometre, the lower the per capita income, suggesting that it is preferable for populations not to agglomerate in large urban areas. But this variable can also refer to population growth, which is naturally negatively correlated with income if income growth does not occur with the same intensity.

The fertility rate variable has a negative impact on income. The fertility rate is declining in Brazil, owing either to women's higher labour force participation or to the notion that successful families have few children. In 2000, the country's total fertility rate (TFR) was 2.36, but it had fallen to 1.79 in 2014, below the population replacement rate. There are two scenarios that complement each other with regard to this negative correlation between income and fertility. In the first scenario, the states with the lowest income are those with the highest fertility rates, even though fertility is declining for all states in the period analysed. In the second scenario, historically, the higher the income of a region, the lower the fertility rate tends to be; indeed, based on average values for the period, the Federal District is the state with the highest per capita income and also the lowest fertility rate (1.75).

According to IBGE data (2000 and 2010 censuses), education and income level are crucial factors for TFR. Among women with no schooling or up to three years of schooling, TFR fell from 3.8 to 3.0 between 2000 and 2010, and for those with four to eight years of schooling, from 2.8 to 2.6. In contrast, among women with a high school education, (9–11 years of schooling), TFR estimates show an increase from 1.6 to 1.8 over the same period and for those with 12 or more years of schooling, from 1.1 to 1.2. In terms of wage levels, there was a fall in TFR in all income strata, but among the

lower-income strata the fall was sharper. In this regard, TFR was 1.3 among women with income of one to two minimum wages and 1.1 among those with incomes of more than two minimum wages in 2010. These TFR are called lowest-fertility levels and are comparable to European countries with very low fertility such as Italy and Portugal (see Kohler, Billari and Ortega, 2002; Morgan, 2003, Breton and Prioux, 2009).

Notably, the sample of women of childbearing age (15–49 years) increased between the two census years (2000 and 2010) from 46 million to 53 million. Schooling levels among women also underwent significant changes, as the number with 9–11 years of schooling rose from 13 million to 20 million and those with more than 12 years of schooling climbed from 4 million to 10 million. Conversely, the number of women with up to eight years of schooling fell.

Migration is an important means for people to improve their economic well-being and quality of life. Therefore, net population movements tend to be towards prosperous areas that offer better prospects in terms of real income. Although migration is considered to be a mechanism for reducing spatial income differentials (McCann, 2001), the impacts may depend on the characteristics of the migrants, such as entrepreneurship capacity and skills that can contribute to the economic growth of their destination (Poot, 2008). In the GMM difference model, this variable has a negative impact on income, perhaps meaning that characteristics of migrants are a critical factor. Indeed, in Brazil, many low-income families, mainly from the North and North-East regions, migrate in search of a better life.

However, according to data from IBGE, migration between regions of the country slowed between 2000 and 2010, and states from the North-East region, in addition to retaining population, began to record emigrants returning from the centre or south of the country. In 2009, the North-East states that reported the most significant return migration — more than 20% of total immigrants — were Pernambuco, Sergipe, Rio Grande do Norte and Paraíba. While São Paulo and Rio de Janeiro have begun to receive fewer immigrants in the last decade, states previously considered to have high outflows of migrants have begun to lose less population, such as Piauí and Alagoas. Bahia and Maranhão continued to post negative net migration, but also decreased flows.⁴

Since the 1990s, the literature on economic growth has included several studies of the role of internal migration in the convergence of per capita income. However, the current literature on the effects of migration is still inconclusive. Observed results may depend on several characteristics of the study, research methodologies, type of data and the spatial scale of measurement in which the research was performed.

Lastly, there are other important considerations. As this research consists of a test for the hypothesis of income convergence and of choosing the most appropriate estimation method, the results should not be seen as definitive, but rather as a stimulus for new studies on the subject. Although the GMM specification indicates a more robust analysis, Roodman (2006) emphasizes that this methodology should be used in the case of panels with a small T (period) and large N (individuals), in order to obtain better results. Nonetheless, a "large" number of individuals is not precisely defined. In any case, other studies use the same method with a small number of individuals, such as Ding, Haynes and Liu (2008) and Cabral and Varella Mollick (2012). This corroborates the relevance of the method and the possibility of obtaining more consistent results on economic growth and income convergence.

⁴ Data from the National Household Survey (PNAD) 2009 and 2000 and 2010 censuses (IBGE, 2022a and 2022b).

IV. Conclusions

This article analyses the convergence process among Brazilian states, considering the impact of demographic variables on income. We examine the process of σ -convergence through inequality indicators, as well as the process of β -convergence using econometric models, establishing a comparative framework.

In general, the results show favourable economic convergence in the 2000–2014 period. In the analysis of σ -convergence, the indicators show a decreasing trajectory in their dispersion, indicating that the Brazilian states have become, on average, more equal in economic terms. Our analysis also finds β -convergence. The variables that refer to education and employment showed positive correlation with income, as expected.

Graphical analysis reveals that the states with the highest convergence rates are in the North-East region. The key factors behind the improvement in social conditions are the large income transfers from the government through social programmes, economic stability owing to the implementation of the Real Plan (Plano Real), the expansion of the agricultural sector and an increase in the supply of credit.

In addition, the results confirm the negative relation between economic growth and fertility. Given regional diversity and inequality, this may indicate that higher fertility rates are still occurring among the poorest populations in the states. Policymakers must therefore ensure they carefully incorporate the demographic transition and its social and economic effects into policy design.

As regards migration, the demographic scenario is changing. Migration processes are less intense and are occurring in reverse, with people returning to their region of origin. Even so, migration's impact on income is still negative, perhaps suggesting certain characteristics in this population group, particularly in terms of schooling, which may be more limited.

Our reading of the data is that, most probably there are several stationary states in the Brazilian regions, owing to their considerable economic and cultural diversity. Therefore, confirmation that there is a convergence process does not necessarily mean there will be a reduction in disparities. Without other regional development initiatives, regional economic inequalities are likely to persist.

The main contributions of this research are the provision of empirical evidence of income convergence over a recent period, the comparison of various methods of estimation and the focus on specific demographic factors. Among these factors, the migration rate and fertility rate are particularly important, since the Brazilian economy has a history of high levels of both, but more recently with significant changes. In addition, empirical results suggest that the high fertility rates of the poorest women affect GDP. Lastly, we propose that further studies on the subject look at other geographical levels.

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