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ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN

UNITED NATIONS

ECLAC

70 ECLAC FOR SUSTAINABLE DEVELOPMENT WITH EQUALITY

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In memoriam

Oscar Altimir
(1935–2018)

As we prepare this edition of *CEPAL Review*, our editorial team wishes to express its deep sorrow upon the death of Oscar Altimir on 27 September in Santiago. His departure is deeply felt by the ECLAC community, especially by those of us involved in the production of *CEPAL Review*. We acknowledge the intellectual legacy of Altimir, who directed this publication between 1996 and 2008, succeeding its first two directors: Aníbal Pinto Santa Cruz (1986–1996) and founder Raúl Prebisch (1976–1986). This editorial is intended to convey our heartfelt homage to Altimir's academic figure and distinguished career as a leading development economist in the region and as one of the most prominent thinkers of the Economic Commission for Latin America and the Caribbean (ECLAC) over the past 40 years.

Born in Argentina, Oscar Altimir joined ECLAC in the mid-1960s, taking on academic and training roles in planning and development at the Latin American and Caribbean Institute for Economic and Social Planning (ILPES). In the early 1970s, he served as an adviser to the Ministry of Economic Affairs of Argentina, and from 1969 to 1973 he chaired the country's Institute for Economic and Social Development (IDES). After performing regional advisory roles at various international organizations, in the mid-1970s he began his stellar career at ECLAC, where he held senior management positions.

Altimir served as Chief of the Statistics Division from 1976 to 1983, and as Chief of the Joint ECLAC/UNIDO Industry and Technology Division from 1984 to 1988. Subsequently, between 1989 and 1993 he was Chief of the Economic Development Division, and from 1994 to 1996 he spent his final years at ECLAC as Deputy Executive Secretary, under former Executive Secretary Gert Rosenthal. After his retirement, he assumed as Chief of the *CEPAL Review*.

During his tenure as Editor, the *Review* achieved major milestones that propelled it to its current standing as one of the foremost academic publications specializing in development issues in the region and beyond. Under the direction of Oscar Altimir, editorial standards were improved, researchers increasingly sought to have their manuscripts reviewed by our referees and to publish their articles in the *Review*, and its editorial line was broadened to more clearly reflect emerging trends in regional development.

In a special insert, published in the ninety-sixth edition of the *Review* (in December 2008) after André Hofman had taken the helm of the publication, we noted that during Altimir's tenure "...many of the articles published during this stage incorporated leading-edge analytical tools (econometric analyses, computable general equilibrium models, more refined sectoral analyses, etc.), and as a result our publication has been listed since December 2007 in the Thomson ISI Social Sciences Citation Index

(SSCI)".[1] Indeed, indexation has been an extremely important milestone in raising quality standards and achieving greater dissemination of *CEPAL Review* over the past 10 years.

As regards his contributions to the analysis of development issues in Latin America and the Caribbean, Oscar Altimir was known for his systematic study of poverty and income distribution in the region. He devoted over 30 years of his career to understanding these topics and their impact on the region's socioeconomic development and was a pioneer in the development of quantitative methodologies for their measurement. The foundations of the Commission's rich tradition in the analysis of poverty and distribution, embodied in publications such as *Social Panorama of Latin America*, hark back to the first works published by Altimir from the second half of the 1970s onward.

One of the most prominent pieces he produced on these topics was the article entitled "Income distribution and poverty through crisis and adjustment", published in the *Review* in 1994, in which he analysed the social costs of Latin America's external debt crisis in the 1980s and the subsequent adjustment policies, specifically in terms of the rise in the number of people living in poverty and the deterioration of income distribution.

Those of us devoted to social sciences and to the crucial task of studying and attempting to broaden our understanding of economic and social development are fully aware of Altimir's enormous contribution towards the achievement of these goals. The precipitous events of recent years —characterized by the complex tensions brought about by economic hyperglobalization— suggest that inequality, coupled with other global phenomena, severely hinders development.

Long-run studies on the nature of distributive inequality have enjoyed a significant boom in the first two decades of the twenty-first century, not only in our region, but also in academia and politics worldwide. In this regard, it would be fair and accurate to say that the seminal contributions of Simon Kuznets, Angus Deaton, Anthony Atkinson and, more recently, José Gabriel Palma, Branko Milanović and Thomas Piketty, could not be fully understood from a Latin American perspective without Oscar Altimir's outstanding contributions.

In closing, the editorial staff of *CEPAL Review* conveys its deep solidarity to the family, friends and colleagues of Oscar Altimir who were privileged to have known him. As Editor of the *Review*, I am compelled to record my immense gratitude to Oscar Altimir as a person, for his human qualities, for his wisdom and for his generosity in sharing his vast and varied knowledge with the new generations of economists concerned with development issues at ECLAC and throughout the region. His legacy is and will remain a source of constant inspiration to the editors of *CEPAL Review*.

The Editor

[1] See A. Hofman and M. Torres, "ECLAC thinking in the *CEPAL Review* (1976-2008)", *CEPAL Review*, No. 96 (LC/G. 2396-P), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC), December 2008. This was a transitional issue published jointly by the team headed by Oscar Altimir, together with Reynaldo Bajraj (who joined the Review in 2003 as Deputy Editor) and the new team made up of the authors of this note, respectively, as the Chief and Technical Editor, together with Osvaldo Sunkel as Chair of the Editorial Board of the *Review*, appointed under the current mandate of Alicia Bárcena as Executive Secretary of ECLAC.

Contents

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.

China's quest for natural resources in Latin America

Felipe Freitas da Rocha and Ricardo Bielschowsky[1]

Abstract

This article describes and analyses China's pursuit of natural resources in Latin America, particularly oil, iron, copper and soybeans, which account for over 70% of its imports from the region. This is motivated by the rapid growth and relative scarcity of natural resources in China itself, and the country's long-term planning that sees the region as a major supplier. In the case of oil, access occurs mainly through loans for oil and direct investments, while in iron and copper it is obtained through direct investments and imports. The method chosen by China to guarantee supply security seems to involve physical control of the resource in question. In the case of soybeans, the path chosen has involved imports increasingly intermediated by trading companies already present in the region, which have recently been taken over by China.

Keywords

China, imports, natural resources, petroleum, iron ore, copper ore, soy beans, economic relations, economic development, economic dependence, Latin America

JEL classification

O13, Q17, Q37

Authors

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[1] This article is a synthesis of the master's degree dissertation defended by Rocha (2016) under Bielschowsky's supervision.

I. Introduction

China is building global commodity supply chains, for which purpose it seeks to trade with the largest possible number of producing countries; and, drawing on its more than US$ 3.5 billion of reserves, it encourages its natural resource firms to invest abroad and directs its public banks to make loans repayable in oil and gas around the world.

The Latin American region plays an important role in China's strategy for gaining access to natural resources worldwide. Between 2000 and 2015, the value of Chinese imports originating in Latin America surged from US$ 5 billion to US$ 103 billion.

This article describes China's intense pursuit of natural resources in Latin America in recent years. In particular, it reviews the various strategies deployed to secure its supply of oil, iron ore, copper ore and refined copper and soybean and its derivatives, which in 2015 accounted for approximately 70% of China's imports from Latin America.

The article is divided into four parts, in addition to this introduction and the conclusion. In section II, the focus of the study is contextualized in theoretical and empirical terms. Section III then analyses Chinese access to Latin American oil and argues that, for economic rationality reasons, Chinese oil companies sell much of the Latin American oil under their control to the United States and within the region itself, while purchasing fuel from markets closer to China, which has characteristics better suited to its refining capacity. Section IV describes Chinese access to Latin American metallic minerals, focusing particularly on trade and foreign direct investment (FDI). The analysis concentrates specifically on copper (both ore and refined) and iron ore. Section V then describes China's access to Latin American soybeans and analyses how its strategy of investing in trading firms avoids the legal uncertainty associated with land purchase in Latin America. The work concludes with some thoughts on the way Latin America responds to the Chinese quest for natural resources, which is considered inappropriate for the region's development.[2]

II. Theoretical and empirical considerations

1. The Chinese pursuit of natural resources and the centre-periphery approach

Although this article is essentially empirical, interest in the subject relates to the centre-periphery focus of the Economic Commission for Latin America and the Caribbean (ECLAC) and the "historical-structural" approach that characterizes the institution. The study was motivated by a perception that current Chinese involvement in Latin America represents a new historical trend that affects the region's production structures, by strengthening the commodity-export model. In particular, the perception that this engagement reflects a new type of centre-periphery relationship, to which the region seems to be increasingly subordinated, and which includes China as the new vehicle of dependency on the central economies. The analysis of the recent surge in Chinese interests in the region seeks to enhance understanding of the process of reconfiguring centre-periphery relations, which is currently unfolding in Latin America.

[2] This article does not consider Chinese investments in natural resource access infrastructure because it this still an embryonic modality (although recurrently referenced by the press, such as the case of a potential interoceanic canal through Nicaragua and a possible railway connecting Brazil with the coast of Peru).

As is well known, the centre-periphery model dates back to the origins of ECLAC,[3] starting in the inaugural years of the organization under Raúl Prebisch (Prebisch, 1950; ECLAC, 1951). It was based on an analysis of the effects that trends in the central economies had on the countries of the region and the detection of an adverse long-term trend, based on slow technical progress and deteriorating terms of trade.

It was argued that, in the absence of well-managed industrialization —considered necessary but problematic, owing to poor production diversity, structural heterogeneity and an institutional framework that was unsuited to productive investment and technical progress (Rodríguez, 1981 and 2006; Bielschowsky, 1998 and 2009)— the region's international integration was destined to widen the gap in income and wealth relative to the central countries. The "dependency" theorizing of the 1960s and 1970s, generated a narrative in which the industrialization process unfolding in Latin America was seen as technologically and financially dependent on the centre.[4]

In the "lost decade" of the 1980s, caused by the debt with the banks that paralysed the region, and an initial perception of "financialization" (ECLAC, 1985) and passivity towards the unfolding technological revolution, the centre-periphery model continued to underlie the political-economy tradition of the regional reality —although the frequency with which the concepts "centre-periphery" and "dependency" are used may have diminished in those years as development theory faded. In the 1990s, the clear perception of "peripheral" behaviour was to be reinforced by the notion of subordination to financialization and the volatility of capital, generating major macroeconomic instability in Latin America (ECLAC, 1995), and the unfavourable conditions of Latin America's international engagement in the globalization of production (Di Filippo, 1998).

From the outset of the decade of 2000, China's performance in the region —and in its acknowledged new role as a central player— has constituted the new element that needs to be understood in depth, within the framework of the centre-periphery concept; for that reason, it deserves special empirical attention. This study contributes to that task.

Apart from being relatively sparse, research thus far into the quest for natural resources in Latin America has not invoked conventional theories relating to the internationalization of multinational enterprises. There are three reasons that explain the orientation of these studies and also the one followed in this article.

First, and as shown in this paper, conventional foreign direct investment (FDI) is only one of the avenues through which China gains access to Latin America's natural resources; in fact, FDI is relatively scarce in several natural-resource sectors (such as metals and food).

Second, Chinese FDI already existing in the region is almost entirely targeted on access to natural resources, so conventional theorizing on the subject has limited explanatory power. For example, Dunning's (1988) important theories on the search for an internal market, cheap labour, and technological assets are of little use in this case.

Third, and even more relevant, the behaviour of Chinese multinationals, especially in the natural resources sector, is essentially dictated by the planning interests of the Government of China. The latter is centralized and led by the Communist Party, which dictates the general orientation of the country's relations with Latin America, viewing the region as an important global source of raw materials.

The literature on the Chinese strategy for gaining access to natural resources shows that the interest of the Government of China is centred on national security and autonomy objectives, to enable it to grow in the long term (Corrêa, 2015; Jian, 2011; Peine, 2013; Sharma, 2014). These objectives are probably followed by three others, namely: to reduce the prices of the basic products they need; to find

[3] For a good review of the centre-periphery approach, see Love (2007).

[4] Expressed both in non-Marxist versions, such as Sunkel (1970), and Marxist versions, such as Dos Santos (1970).

alternative ways to invest the country's foreign reserves (currently excessively biased towards United States Treasury securities); and to ease pressure for exchange-rate appreciation. It is thus reasonable to assume that Chinese multinational companies operating in the sphere of natural resources, whose key management posts respond to directives from the Central Committee of the Communist Party of China, are encouraged to seek investments, in the world at large and in Latin America in particular, as providers of strategic services to the Government of China. Although this does not mean they no longer pursue profit-seeking objectives, the behaviour of these firms in their internationalization in Latin America represents a research field that is yet to be explored, and analytical work still needs to be done.

The present article introduces some of the patterns of Chinese engagement in Latin America, which differ across sectors and convey a sense of pragmatic adaptation by China to the competitive contexts prevailing in each sector. Nonetheless, this study does not intend to launch a typology according to the specific behaviour of firms in each sector. In future work, the principle that Chinese firms' investment decisions in Latin America are influenced by the State will likely be combined with the conventional theoretical interpretation of the behaviour of transnational firms.

Rather than theorizing about multinationals, the empirical contribution made by this article is more closely related to research on the "curse of natural resources". As is well known, the work of Sachs and Warner (1995) revived an old debate about whether natural resources would be a blessing or a curse. The authors presented empirical evidence for, and verified the existence of, a negative relationship between natural resources and their predominance in the export model, on the one hand, and economic growth on the other. Various explanations have been put forward for this, ranging from "Dutch disease" and the theory of commodity-export-driven growth (staple theory), to institutionalist theories that argue that the abundance of natural resources is associated with barriers to democracy, capture of the State, corruption and the outbreak of civil wars.[5]

Clearly, if applied to the case of China's quest for natural resources in Latin America, the natural resource curse hypothesis would logically be that, by intensifying commodity-export activities, China's effect on Latin American development tends to be negative. In that sense, it would not differ from the conclusions drawn from Prebisch's theories in the late 1940s and 1950s on centre-periphery relations —which, not by coincidence are considered a precursor of the natural resource curse hypothesis. From the ECLAC standpoint, the problems of commodity-export specialization include its lack of innovative capacity, and the fact that productive chains tend to "leak" abroad, through imports, thereby slowing growth. No less relevant are claims that this form of specialization subjects economies to deteriorating terms of trade and tends to expose them to an income elasticity of import demand that is greater than the income elasticity of global demand for their exports, thereby generating balance of payments deficits and, consequently, hampering growth and development.

In recent years, ECLAC has contributed an approach that has some similarities with the natural resource curse model, through its work on "natural resource governance" (ECLAC, 2014; Bárcena and Prado, 2016; Altomonte and Sánchez, 2016). Although this study does not evaluate the development effects of investments in natural resources, arguments of this type are considered in the final section of the article.

2. The importance of Latin American natural resources for China

As a continental country with an area of 9.5 million km^2, China has major fossil-fuel resources (coal, oil, natural gas), the world's greatest hydroelectric potential, large swathes of agricultural land and considerable metal reserves. Nonetheless, relative to the size of its population and economy, its resources are far

[5] See, for example, Maciel (2015), which makes an extensive review of the literature on the natural resource curse and its different approaches.

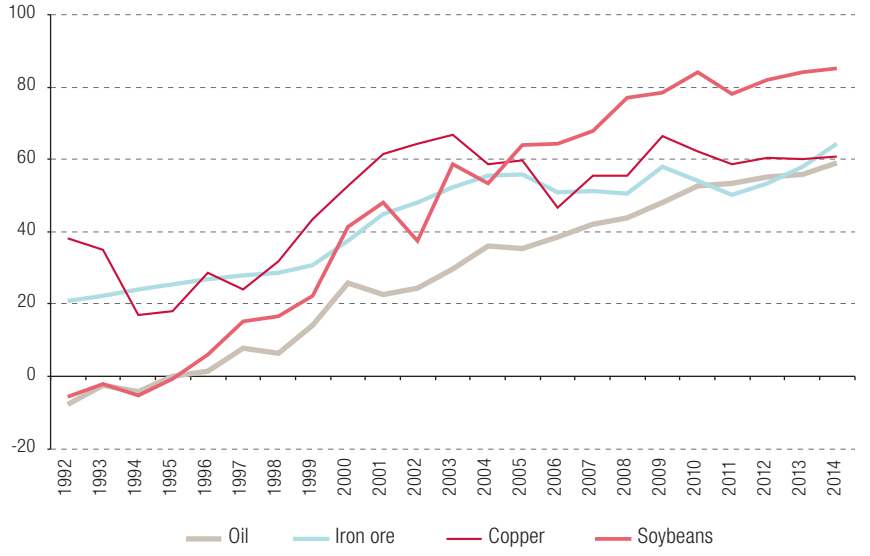
from abundant. Although it has for 19% of the world's population and generates 16.5% of global gross domestic product (GDP), China possesses 13% of global reserves of coal, 8.5% of the world's iron ore, 4% of its copper ore, 2% of total oil reserves and 2% of all natural gas, plus 10% of all agricultural land and 6.5% of the world's fresh water.

This relative scarcity has been revealed in all its intensity by China's rapid growth. In the last 35 years, Chinese GDP has grown at an average rate of 10% per year and turned the country into the second largest economy on the planet, at the same time making its production and consumption increasingly dependent on commodity imports.

In addition to the relative shortage, the production of raw materials in China suffers from a number of specific problems, which make it even more difficult to significantly increase the domestic supply of natural resources: large mature oil fields with declining production (EIA, 2015); high production costs in iron ore and bauxite (Carvalho and others, 2014; Yu, 2011); a low ratio of reserves to production in the case of various minerals, such as copper (17 years), manganese (15 years), lead (7 years) and zinc (8 years), among others. In the case of soybeans, the country's food security policy has made cereal cropping more attractive than oilseed production (Gale, Hansen and Jewison, 2015; Wong and Huang, 2012; Sharma, 2014).

In 1996, China became a net importer of oil and soybeans; and, in 2007 and 2009, respectively, it became a net importer of natural gas and coal. Net oil imports increased from 1.2 million barrels per day in 2000 to 6.7 million in 2015; iron ore imports grew from 44 million fine tons in 2000 to about 580 million in 2015; those of copper expanded from 1.1 million fine tons in 2000 to 7.2 million in 2015;[6] and soybean imports, which were at the level of 10 million tons in 2000, had surged to more than 82 million tons by 2015. The degree of China's reliance on imports of natural resources, measured as the ratio of net imports to consumption, is already 60% in the case of the main commodities, such as oil, copper and iron ore, and as high as 85% in the case of soybeans (see figure 1).

Figure 1
China: reliance on imports of selected raw materials, 1992–2014
(Percentages)



Source: Prepared by the authors, on the basis of F. F. Rocha, "Acesso chinês a recursos naturais na América Latina", Rio de Janeiro, Institute of Economics, Federal University of Rio de Janeiro (UFRJ), 2016.

[6] In this study references to copper include both concentrates of this metal and refined copper.

As Medeiros (2011, p. 211) notes, the twin processes of urbanization and heavy industrialization combine to make the Chinese pattern of accumulation intensive in natural-resources. Even with the expected shift towards a greater emphasis on domestic consumption as a source of growth, projections see the need for large-scale imports of natural resource-based commodities in the medium and long terms (Rocha, 2016).

China gains access to natural resources in ways that differ from sector to sector. The oil sector absorbs most of Chinese financing for production activity in Latin America, through loans repaid in oil (Gallagher, Irwin and Koleski, 2013). Oil, copper and iron absorb the majority of Chinese FDI in Latin America, which is undertaken by public companies (Chen and Pérez-Ludeña, 2014). In the case of soybeans, due to the legal difficulties associated with land purchase, the strategy has been to acquire two international trading companies that were already present in the region and seek to turn them into major operators in Latin America, in competition with the four main commodity traders, Archer Daniels Midland (ADM), Bunge, Cargill and Louis Dreyfus, collectively known as the "ABCD companies".

The relationship is profoundly unequal: China essentially views the Latin America as a source of raw materials; and, as argued in the conclusion to this article, Latin American governments and economic agents treat Chinese demand as just another market opportunity, rather than as an element to be harnessed for long-term sustainable development.[7]

III. Chinese access to Latin American oil

Chinese oil consumption more than doubled between 2000 and 2015, from 4.7 million to 10.8 million barrels per day. This has been driven mainly by burgeonng growth in gasoline and diesel consumption in the transport sector, resulting from expansion of the vehicle fleet (Rosen and Houser, 2007; IEA, 2012). Although industry is also a major consumer, its share of demand has shrunk from 50% in 2000 to 35% in 2013.

The International Energy Agency (IEA) predicts that Chinese demand for oil will increase by nearly 5 million barrels per day between 2014 and 2040, owing to the forecast vertiginous growth of the vehicle fleet, from 146 million units in 2014 to around 500 million by 2040 (IEA, 2015; EIA, 2014; Huo and Wang, 2012). It is estimated that, even with the use of improved oil extraction techniques and the development of oil production from compact formations (tight oil), Chinese oil production will dwindle over the next few decades, because its main oil fields products are mature and their output is declining (IEA, 2015; EIA, 2014).[8] As a result, net imports of this fuel are expected to grow to between 12 million and 14.5 million barrels per day by 2040, representing about 70% of Chinese consumption in that year (EIA, 2014; IEA, 2015; OPEC, 2015).

Among China's main supply sources (the Middle East, Africa, the Commonwealth of Independent States (CIS) and Latin America), its imports of Latin American oil grew by most between 2003 and 2015 (42% per year). Having been virtually non-existent in 2003, they had grown to around 854,000 barrels per day by 2015, corresponding to 13% of China's oil imports and 8% of its consumption. Roughly 91% of that amount was produced in three countries: the Bolivarian Republic of Venezuela (38%), Brazil (33%) and Colombia (21%).

[7] This does not mean China does not make investments in Latin American processing industries and services, just that those sectors are not considered a priority, and investments in them are still embryonic in the region.

[8] If the price of oil remains low, the future investments of the large State oil companies could be affected and further reduce Chinese oil production in the medium and long terms (EIA, 2014 and 2015).

China uses diplomacy to forge permanent trade links with other countries, both with respect to oil and for trade in general. In addition, as part of its autonomous development strategy, it also uses two instruments to secure its supply of oil, namely: direct investments by Chinese public companies, and financing by Chinese public banks which is repaid in barrels of oil. It is estimated that the first of these instruments has secured nearly 1.9 billion barrels of Latin American oil reserves,[9] while the second —considering only the contracts signed in 2008–2011— covers about 2.3 billion barrels (the sum of these amounts is equivalent to approximately 17% of proven reserves in Chinese territory).

Chinese FDI first entered the Latin American oil sector through an investment made in Peru by the China National Petroleum Corporation (CNPC) in 1994. According to Ortiz Velásquez (2016), in addition to non-disclosure of the values involved, there are several problems in measuring Chinese investments. Bearing this proviso in mind, the available figures show that the process of gaining access to oil in this way has been rapid.

Between 2001 and 2013, at least 23 Chinese investment projects were undertaken with the aim of securing access to Latin American oil, with a known value of nearly US$ 33 billion (Rocha, 2016). The four major Chinese State oil companies (CNPC, China National Offshore Oil Corporation (CNOOC), China Petroleum and Chemical Corporation (Sinopec) and the Sinochem Group) all entered Latin America in that period. As most of these investments in Latin America, both in value (US$ 25.4 billion) and in number (15), were made between 2010 and 2013, China's investments in the region's oil sector are a recent phenomenon.

Chinese firms have preferred to access Latin American oil by acquiring rights over fields belonging to firms already established in the region, or else by taking over the firms that hold those rights. Recently, they have begun investing in more technologically challenging projects, such as deep-water drilling in the Libra oil field off the Brazilian coast.

The reserves of these firms in the region include 750 million barrels in the Bolivarian Republic of Venezuela, 700 million barrels in Brazil, 284 million barrels in Argentina and 140 million in Ecuador. China's oil production on Latin American soil amounts to almost 400,000 barrels per day (see table 1), producing mainly in the Bolivarian Republic of Venezuela (200,000 barrels per day), and also in Argentina (50,000), Brazil (46,000), Ecuador (43,000), Colombia (28,000) and Peru (20,000). In addition, CNPC has a project to produce 1 million barrels per day in the Bolivarian Republic of Venezuela in conjunction with Petróleos de Venezuela, S.A. (PDVSA).[10] According to the National Agency of Petroleum, Natural Gas and Biofuels (ANP, 2014), production from the Libra field could attain 1.4 million barrels per day, generating a production equivalent of 140,000 barrels per day for both CNPC and CNOOC in Brazil. Accordingly, as China started to invest in Latin America only recently (2010–2013), its oil production on Latin American soil is likely to increase in the years to come.

Along with the expansion of imports and direct investments, since 2008 Chinese loans have been made with repayments in oil as a counterpart. The availability of reliable and disaggregated data on this modality is still sparse, and it is concentrated in 2008–2011.

[9] This estimate could double if reserves in the Libra field are confirmed; and it does not include the MPE3 (Orimulsion) and Junín 10 fields, located in the Orinoco Belt (Bolivarian Republic of Venezuela), one of the largest oil reserves in the world.

[10] See Bolivarian Republic of Venezuela (2014).

Table 1
Estimation of Latin American oil under Chinese control (FDI and loans) whether or not exported to China, around 2014–2015
(Thousands of barrels per day)

Country	Production via Chinese FDI	Repayment of Chinese loans	Total	Sent to China (Chinese imports)	Not sent to China
Argentina	50	0	50	6	43
Brazil	46	200	246	141	105
Ecuador	43	68	111	15	96
Peru	19	0	19	0	19
Venezuela (Bolivarian Republic of)	200	400	600	277	323
Subtotal	358	668	1 026	439	586
Colombia	28	0	28	203	0
Others	0	0	0	18	0
Subtotal	28	0	28	221	0
Total	386	668	1 053	660	586

Source: Prepared by the authors, on the basis of F. F. Rocha, "Acesso chinês a recursos naturais na América Latina", Rio de Janeiro, Institute of Economics, Federal University of Rio de Janeiro (UFRJ), 2016.

In that period, China signed nine such contracts in three of the region's countries: four in the Bolivarian Republic of Venezuela, with PDVSA, for a total of US$ 32.6 billion, which will provide China with at least 1,300 million barrels of oil over 12 years; one in Brazil, with Petrobras, for US$ 10 billion dollars, which will provide 700 million barrels of fuel to China over 10 years; and four in Ecuador, with EP Petroecuador (and the Ministry of Economy and Finance), for US$ 5 billion, which will generate at least 300 million barrels of oil for China over a 10-year period.[11] If these volumes are added to those underpinned by Chinese FDI, the country has already secured close to 10% of Brazil's oil reserves, 6% of Ecuador's, and 0.7% of those of the Bolivarian Republic of Venezuela.

This type of agreement involves more oil than is necessary to repay the loan. In all cases for which data are available, the time needed to pay back the loan principal (without accounting for interest) in barrels of oil is less than half the term of the agreement. In other words, oil is not being assigned to China simply to repay the debt, because there are contractual clauses that envisage sales to China after it has been paid.

In addition to directly securing rights to Latin American oil, loans for oil act as an additional way to facilitate access. Several cooperation agreements have been signed between China and Latin American countries as a result of Chinese loans (Downs, 2011; Sanderson and Forsythe, 2012; Alves, 2013). For example, in Brazil, after the Chinese loan for oil in 2009 to Petrobras, Sinopec and the Brazilian company also signed a strategic cooperation agreement, which gave the Chinese firm a share in two deepwater blocks along Brazil's north-eastern coast.

Another interesting feature is that the oil subject to these clauses can either be sent to China itself, or else it can be sold by the Chinese firms in other countries, at the exclusive discretion of the Chinese authorities (government, banks and State-owned companies). Furthermore, according to Jiang and Ding (2014), Chinese firms largely control how and to whom they sell their share of the output resulting from FDI. Between 2014 and 2015, loans for oil and investments enabled Chinese firms to control at least 1.05 million barrels per day of Latin American oil production (11% of regional output). Owing to the type of oil obtained from Latin America (heavy and unsuited to Chinese refineries, which specialize

[11] Other agreements of this type have recently been signed or negotiated. For example, in 2013, China lent US$ 5 billion to the Bolivarian Republic of Venezuela in exchange for sending 100,000 barrels of oil per day to China for three years (Gallagher and Myers, 2014); and, in 2015, new loans for oil were made in Brazil and the Bolivarian Republic of Venezuela (Myers, Gallagher and Yuan, 2016). In 2017 a contract for US$ 5 billion was signed between Petrobras and China Development Bank (CDB), in return for 100 thousand barrels/day of oil for 10 years (Petrobras, 2016 and 2017).

in light crude),[12] together with the high cost of transportation to China, selling to the United States or Latin America itself has been preferred.[13] As the former Minister of Trade and Industry of the Bolivarian Republic of Venezuela, Moisés Naim, remarked, "it's crazy to supply China from Venezuela" (Sanderson and Forsythe, 2012). The Chinese companies use the sale proceeds to buy oil in the Middle East and other regions closer to China, where the product has characteristics more compatible with its refining capacity. Thus, everything indicates that Chinese firms and banks are combining profit maximization strategies with the energy security policies dictated by their country's government.

China's priority is to secure ownership of the oil and the possibility of sending it directly to the country when deemed necessary. Table 1 shows that, in 2014–2015, it was only necessary to send to China less than half of the over 1,000 barrels per day that were under its control (either produced through Chinese FDI or appropriated as loan repayment). If all of this oil were shipped, it would represent about 20% of China's total imports in 2014. It should also be noted that investments are under way or planned that will reduce the cost constraint on importing from Latin America. Examples include Nicaragua's interoceanic canal and a refinery in Chinese territory to process the super heavy oil obtained from the Bolivarian Republic of Venezuela (EIA, 2015; Ray, Gallagher and Sarmiento, 2016).

Curiously, table 1 shows that China has very little claim on Colombia's oil and no oil business in Mexico, which are two of the four largest producing countries in the region, alongside the Bolivarian Republic of Venezuela and Brazil. This may indicate that the two countries are seen as areas subject to the geopolitical influence of the United States.

These procedures show that the Beijing authorities consider that the process of securing natural resources should not be entrusted to the free market, since it is of extreme national interest and fundamental for economic security. According to Downs (2011), although the China Development Bank (CDB), the leading Chinese financier in Latin America, has considerable autonomy, it is not a completely independent actor, since all its international projects require the approval of the Chinese Council of State. Furthermore, despite the reforms made to give more operational autonomy to the State oil companies, which can define tactics and objectives for global acquisitions, this did not mean strategic autonomy, since the main goals are established by the government (Corrêa, 2015). The Chinese Communist Party exercises control by directly or indirectly making appointments to the key positions in these firms (Jiang and Sinton, 2011; Corrêa, 2015).

IV. Chinese access to Latin American iron ore and copper

In recent decades, the processes of industrialization, urbanization and infrastructure upgrading have fuelled rapid growth in China's demand for metals, including copper, aluminium and iron (Coates and Luu, 2012). Its apparent consumption of iron ore grew from 118 million fine tons in 2000 to 872 million in 2014, while its consumption of refined copper increased from 1.9 million to 10.9 million tons in the same period.

As the consumption of various metals is expected to remain high, and the production of several metallic minerals is unlikely to increase significantly, China will continue to rely heavily on mineral imports in the years to come. The World Bank (2014) sees the urbanization rate in China increasing from its current level of 54% to around 70% by 2030. This means that China will have to accommodate roughly 300 million people in the cities over the next few years, in a process that will demand metal for

[12] See Altomonte (2013), Winter and others (2013), Rosen and Houser (2007), Koch-Weser (2015) and Jiang and Sinton (2011).

[13] See Winter and others (2013) and Koch-Weser (2015).

infrastructure building. Moreover, Berkelmans and Wang (2012) note that Chinese buildings will require more metal per square metre because, with the high population density, they are being built ever higher. In addition, the expected large increase in the number of automobiles —which by itself will increase metal consumption— will stimulate demand for buildings with large underground garages.

Due to the scant domestic availability of scrap metal (Holloway, Roberts and Rush, 2010; Zhang and others, 2015), Chinese metal production will remain highly intensive in mineral consumption over the next few years. In turn, the domestic supply of various metallic minerals will remain low relative to demand, since the reserve-production ratio is low; so, unless large deposits are discovered, there is little room for a significant increase in production. Moreover, according to the World Bank (2016), the price of iron ore is likely to remain subdued until at least 2020, so the various Chinese producers will be unable to remain profitable (due to its high cost of production), and they will go out of business (Carvalho and others, 2014).

Latin America is important to China as a supplier of various metallic minerals. For example, in 2014, the region accounted for the following shares of Chinese imports: iron ore 21%, copper 50%, silver 41%, zinc 32%, lead 12%, molybdenum 51% and tungsten 14%. Nonetheless, while China's net imports of iron ore and copper amounted to US$ 21 billion and US$ 11 billion, respectively, in 2014, its deficit in all other metallic minerals in the region was just US$ 2 billion in that year. Accordingly, this study focuses exclusively on iron ore, copper ore and refined copper.

Latin America is the second source region for Chinese imports of iron ore (23% in 2015), after Oceania, rising from 17 million tons in 2000 to almost 220 million in 2015. Of this total, 192 million tons were produced in Brazil, 11 million tons in Peru, 10 million tons in Chile and 5 million tons in other Latin American countries. The three countries mentioned currently account for 98% of Chinese imports of iron ore from the region.

Following the 2008 crisis, Chinese imports of Latin American iron ore also grew partly as a result of a strategy implemented by the Vale mining company, which currently handles 80% of China's imports of this mineral from Latin America. In the wake of the crisis, Europe and Japan, which were its main buyers, cut their demand drastically, and this caused the firm to redirect its exports to the Chinese market (Vale, 2013). Moreover, the free trade agreements signed between China and Chile (2006) and between China and Peru (2010), the main objective of which was to guarantee Chinese access to metallic minerals (Roldán and others, 2016), boosted mineral trade between the region and China.

In the case of copper, Latin America is clearly the main source region for Chinese imports of this metal, with a share rising from 20% in the mid-1990s to almost 50% in 2015. Volumes imported from Latin America grew from less than 100,000 fine tons of copper in the mid-1990s to over 3.5 million in 2015. In Latin America, China imports copper basically from Chile (66% in 2015) and Peru (24.5%), with smaller amounts sourced from Mexico (6%) and Brazil (3%).

In fact, the Latin American region is even more important for China than the trade data suggest, since the copper extracted in the region is also purchased by other countries that refine the metal and then export it to Chinese territory. For example, India, Japan and the Republic of Korea are all major suppliers of refined copper to China.[14] Nonetheless, as the latter's production of refined copper is mainly based on primary refining, and the aforementioned countries do not produce the mineral in significant quantities, its production of refined copper means importing the mineral ore mostly from Latin America (over 60% in 2014). In 2014, an estimated 400,000 tons of Latin American fine copper ore (just 6% of China's total copper imports in that year) were imported indirectly by China through those three countries.

[14] In 2014, these three countries supplied 10% of Chinese copper imports (copper ore and refined copper).

Chinese FDI in metals arrived in the region in the middle of the 2000 decade and thus far has had a relatively minor importance in China's access to Latin American metallic minerals. Nonetheless, there are strong reasons to suppose that these investments have already secured a significant amount of Latin American iron ore and copper ore for China, which will be accessed over the coming years (Rocha, 2016).

In keeping with the situation in China's mining sector, most of the firms that entered the region are State-owned, although private and hybrid companies have also ventured into the market. These firms prefer to access Latin American metallic minerals by acquiring majority rights over mines owned by firms already established in the region, or else by gaining control of the firms that hold those rights; and, also, over the mines that are already in an advanced stage of exploitation and technical quantification of reserves (Roldán and others, 2016).

In 2006–2014, 16 investments were made in the Latin American iron and copper mining sector, for a known value of nearly US$ 11 billion (Rocha, 2016). Peru was the Latin American country that received the largest number of projects and the highest value in absolute terms. According to González-Vicente (2013), this is mainly explained by the trading relationship already existing between Peru and China (through the Shougang Group's investment in 1992), along with its ultraliberal mining investment regime, and its availability of primary resources.

The Shougang Group currently produces 7.3 million fine tons of iron ore per year and holds claims over 764 million fine tons of Peruvian reserves. This volume is equivalent to approximately 11% of the reserves existing in Chinese territory. Until 2015, the only other Chinese firm specializing in iron ore in the region was Wuhan Iron and Steel Corporation in Brazil, whose production —through a small 10.5% stake in MMX Mineração e Metálicos— totalled just 180,000 fine tons. Guaranteed access is expected to increase in the future, however, as the mines of Pampa de Pongo (Nanjinzhao) in Peru, Vale do Rio Pardo (Honbridge Holdings) in Brazil and Oso Negro (Hebei Wenfeng) in Chile are developed and their resources are classified as reserves. Thus, while in 2014–2015 Chinese production of iron ore in Latin America amounted to some 7.5 million fine tons (equivalent to 5.4% of Chinese iron ore imports from Latin America in 2015), the coming on stream of the three projects (and the expansion of production from the Marcona mine by Shougang) mean that production should grow by nearly 30 million fine tons, to over 35 million (Rocha, 2016).

In the case of copper, China owns 20.7 million fine tons of Latin American reserves, equivalent to 70% of the reserves in Chinese territory. This does not include another potentially large volume to be determined in mining projects under the control of Chinese firms: El Galeno (Peru), Don Javier-Cercana (Peru), Panantza-San Carlos (Ecuador), Taltal (Chile) and La Plata (Chile). Of known reserves, 17 million fine tons are located in Peru (21% of that country's reserves), 3.5 million in Ecuador and 270,000 in the Plurinational State of Bolivia.

The only Chinese firms that produce copper ore on Latin American soil are the Aluminium Corporation of China Limited (Chinalco) and the consortium composed of China Minmetals Corporation, Suzhou Guoxin and China International Trust and Investment Company (CITIC) (Minera Las Bambas), two very recent ventures in Peru. Considering that Chinalco's production began in mid-2014 and Minera Las Bambas came on stream as recently as December 2015, it can be assumed that the Chinese firm's production of 190,000 fine tons of copper ore in 2015 (11% of Peruvian production) is bound to increase significantly as from 2016.

While China's production of copper ore in the region had secured only the equivalent of 5.3% of its Latin American-sourced imports by 2015, it is estimated that in Peru alone it will grow by more than 1 million fine tons, to a level around 1.2 million fine tons by 2021 (Rocha, 2016). This is equivalent to about two thirds of current copper ore production in China itself (1.76 million fine tons in 2014).

V. Chinese access to Latin American soya

China's rapid economic growth has been accompanied by major changes in diet, in terms of both the amount of food consumed and its composition. Because the income elasticity of demand for animal protein is high in China, income growth has fuelled a rapid increase in its consumption (mainly meat) (Ghose, 2014; Xing and Goldsmith, 2013). Moreover, as China is basically self-sufficient in the production of meat and soya meal, the increased demand for animal protein has boosted Chinese demand for soybeans. As a result, its consumption of the oilseed increased from about 10 million to 83 million tons between the early 1990s and 2014.

Westcott and Hansen (2016) estimate that Chinese soybean imports will top 100 million tons in early 2020. Although growth in the consumption of products of animal origin is likely to slacken (Xing and Goldsmith, 2013), the demand for soyameal will continue growing for a long time and, with it, the demand for soybeans.[15]

In terms of the domestic supply of soybeans, burgeoning Chinese urbanization and industrialization processes can be expected to reduce available arable land and cultivation areas (Ghose, 2014); and this process will be accentuated by water and soil pollution. Moreover, government policies foster cereal cropping and make this more profitable than soybean production, so that the area of the oilseed crop is unlikely to increase. The lack of access for Chinese soybean producers to the latest seed technology, compounded by the small scale of the farms and deficient agricultural practices, make it difficult to increase the productivity of the land, which has been flatlining since the mid-1990s (Clever and Xinping, 2016).

China's soybean imports from Latin America have been increasing since 1996 and, since 2000, have accounted for nearly 60% of its total soybean imports (the remaining 40% comes from North America). This means that Latin American countries supply nearly half of China's soybean consumption. In terms of concentration of production, China imports soybeans mainly from Brazil (77% in 2015), Argentina (18%) and, more recently, also from Uruguay (5%).

Contrary to media reports, China is not gaining significant access to soybeans in the Latin American region through land grabbing FDI. Far from it, its strategy was inspired by the large transnational trading companies, which control the entire soybean production chain (except cultivation). The key to the strategy has been to acquire firms that already have a soybean marketing logistics infrastructure in the region.

According to recent literature (Hofman and Ho, 2012; Myers and Jie, 2015; Oliveira, 2015), although the media has reported several Chinese investments aimed acquiring land for planting, most of them never took place or were merely rumours. China did try to make this type of investment to gain access to soybeans, but the investors were blocked by restrictions imposed on foreigners purchasing land in Brazil (2010) and Argentina (2011).

Authors such as Myers and Jie (2015), Oliveira (2015) and Hofman and Ho (2012) agree that, in Latin America, concerns about land grabbing investments are misguided in the case of Chinese firms. The vast majority of such investments involve firms from the United States, Europe, Argentina and Japan. Oliveira (2015) offers an interesting explanation for this exaggerated concern in Brazil, by positing the existence of an alliance between Brazilian ranch owners (*latifundistas*), industry owners, free market economists and lawyers, who strategically exploit the media to stoke fear and have restrictions imposed that disproportionately affect Chinese investors (in land) in Brazil, so as to position themselves as the indispensable partners for Chinese investments (and also for firms of other nationalities). The author notes that the four major commodities trading companies mentioned above (Archer Daniels Midland

[15] According to Xing and Goldsmith (2013), Chinese soya meal consumption will be almost 70 million tons in 2020 and over 100 million tons in 2030. If it is assumed that 80% of the soybean consumed in China is processed (crushed) and that 1 ton of oilseed generates 0.78 tons of soya meal, the demand for soybeans will increase from 83 million tons in 2014 to approximately 112 million tons by 2020 and 165 million by 2030.

(ADM), Bunge, Cargill and Louis Dreyfus, known as the ABCDs) also strategically harness the media to divert attention from the very large influence they exert on investments in land around the world and, simultaneously, to oppose the growth of Chinese competition in international agribusiness.

Only two investments by Chinese-owned firms to acquire land to access Latin American soybeans actually have been confirmed.[16] In 2007, the partnership between Zhejiang Fudi Agriculture Group and the Department of Agriculture of Heilongjiang Province purchased 16,800 hectares of Brazilian land (700 hectares in Rio Grande do Sul and 16,100 in Tocantins) for US$ 48.6 million (Myers and Jie, 2015; Oliveira, 2015). The initial intention was to gain experience and then buy more land in Brazil, produce their own soya in the country and export it to China. Owing to administrative and operational problems, however, Zhejiang Fudi Agriculture Group sold its majority stake to Chongqing Grain Group (CGG) (another Chinese firm) in 2011. The second confirmed investment was undertaken by CGG towards the end of the 2000 decade, when it acquired a 52,000-hectare ranch in western Bahia, on lower-quality land that was not yet ready for soybean production (Oliveira, 2015). As of early 2014, this project was a long way from becoming operational (Reuters, 2014).

To understand China's strategy for securing access to Latin American soya in the context of restrictions on land purchases by foreigners in the region, it is necessary to consider the oilseed market between Latin America and China. According to Wesz Junior (2011 and 2014), following processes of production-chain verticalization and horizontalization in the last two decades, the soybean market in Latin America is controlled mainly by the ABCD companies. These four large trading companies control everything from financing and the provision of inputs and technical assistance, to the marketing of output (grain purchase, storage, industrialization, exports and sales in the domestic market).

In Brazil, these firms provide financing to soya producers through forward purchases of production. This is often done by delivering inputs through the production chain under their ownership. In other cases, when the financing is advanced in cash, the producers acquire the inputs (fertilizers, pesticides, seeds, among others) from the company that finances them. Thus, it is the trading company, which has its own logistic capacity (storage, marketing channels, ports for export) and processing capabilities, that will decide how the grains will be marketed (domestic market or export, grains or meal-oil). Arrangements of this type, which are used by the firms to obtain raw material, makes the producers heavily dependent on the trading companies, since a single actor becomes the financier, input supplier, technical assistance agent, buyer of the production and responsible for marketing (Wesz Junior, 2011).

In South America, even before the sowing season, poorly capitalized smallholders can commit up to two thirds of their harvest through this type of financing, while well capitalized farmers often assign a quarter of their output (Oliveira and Hecht, 2016, cited in Wesz Junior, 2016). In Argentina, the industrialized soybean export sector is also concentrated in very few companies, of which the ABCDs are the most important. According to Wesz Junior (2014), these firms control between 70% and 80% of all soya exports from Brazil and Argentina.

The ABCD companies have major oilseed processing capacity in China (Peine, 2013; Sharma, 2014). Thus, by controlling the marketing of soybeans in Latin America, they use their logistics capacity to market and export the oilseed to their own processing industries in China, transforming soybeans into meal or oil and selling to the Chinese market.

[16] The purchase by Pengxin Group of 12,500 hectares of land in Santa Cruz (Plurinational State of Bolivia) for US$ 27.2 million (Myers and Jie, 2015) can be considered a third investment, although, according to the company's website, the ranch is already in operation (soybean, corn and sorghum) but no Bolivian soya oil has been imported by China (or exported by the Plurinational State of Bolivia to China). Other examples of FDI include investments to open offices or enter the sector (or acquire fertilizers), and Pacific Century Group's purchase in Brazil of AIG assets in CalyxAgro in 2010. Pacific Century Group is a company based in Hong Kong and, according to Oliveira (2015), it is impossible to know how much Chinese capital it has relative to that of other nationalities.

The Chinese strategy for gaining access to Latin American soya needs to be analysed in this context. Purchasing land without investments in logistics to market and export the production would make China dependent on large transnational corporations. For that reason, and as explained by Oliveira (2015), the Chinese firm Sanhe Hopeful would only be interested in financing soybean production after establishing itself as a grain terminal operator, either acquiring or building its own warehouses in the region, in order to export the soybeans purchased directly from Brazilian producers to supply their processing facilities in China.

To summarize, restrictions on land purchase by foreigners have only reinforced China's natural tendency to control soybean logistics and infrastructure. This explains why, in 2014, CBD and the Industrial and Commercial Bank of China (ICBC) lent US$ 2.1 billion to Belgrano Cargas and Logística to restore and upgrade the rail network in Argentina (Wilkinson, Wesz Junior and Lopane, 2015; Gallagher and Myers, 2014). In 2010, Sanhe Hopeful acquired 20% of a project to build a new grain terminal in the state of Santa Catarina (Oliveira, 2015).[17] There is also a Chinese proposal to construct a transoceanic railway connecting the Atlantic Ocean in Brazil with the Pacific Ocean in Peru, possibly passing through the Plurinational State of Bolivia (Ray, Gallagher and Sarmiento, 2016). This project aims to link the Pacific ports of Peru to the new Brazilian soybean frontier.

The most significant entry of Chinese agribusiness capital into the Latin American soybean complex occurred through an acquisition negotiated outside Latin America, but which had the region as its main target (Oliveira, 2015). In 2014, the State-owned China National Cereals, Oils and Foodstuffs Corporation (COFCO) bought 51% of Nidera (US$ 1.2 billion) and Noble Agri (US$ 1.5 billion) (Wilkinson, Wesz Junior and Lopane, 2015). In December 2015, COFCO acquired the remaining 49% of Noble Agri (US$ 750 million), thus securing sole ownership of the company. These investments avoid the challenges faced by Chinese greenfield investments in the soybean complex in Latin America, particularly those related to the bureaucracy involved in setting up businesses in the region, purchasing land and obtaining environmental permits.

The objective of COFCO when acquiring these firms is not to operate as a producer or a soybean processor itself, but as a trading company (Oliveira, 2015). In 2011, the president of the Chinese firm stated that the ABCD companies provided a good example for COFCO, given their successful participation throughout the entire industry supply chain (Myers and Jie, 2015). He explained that the firms in question are not involved in agricultural production, but they buy the harvests of local farmers and provide services and infrastructure.

Noble is present in Brazil, Argentina, Uruguay and Paraguay, in the soybean, coffee, sugar cane, biodiesel and cotton sectors. In the soya complex, the firm has a well developed logistics infrastructure, considerable storage capacity, soya processing units and a presence in activities in the upstream phases of the production chain, providing fertilizers, technical assistance and financing, like other global merchants. To gain an idea of the importance of this firm in the region, it is currently responsible for about 10% of all soybean exports from Argentina, as well as 5% of that country's exports of soya meal and 7% in the case of soybean oil; and its 2014 exports in the region (Brazil, Argentina and Paraguay) amounted to US$ 3 billion (FOB) (CIARA, undated; Wilkinson, Wesz Junior and Lopane, 2015).

The other firm acquired by COFCO, Nidera, also has a well-developed logistics infrastructure in the Latin American soya complex. It is present mainly in Brazil and Argentina and, to a lesser extent, in Uruguay (office and warehouse) and Paraguay (office). Its presence includes grain and fertilizer terminals and considerable storage capacity. It also acts in soybean processing, the production and marketing of seeds, the distribution of inputs (fertilizers, pesticides, and others) and the financing of producers, in addition to buying, storing and marketing cereals and oilseeds. Like Noble, Nidera is a major soya

[17] According to Oliveira (2015), the project has faced considerable opposition on social and environmental grounds; and, in early 2015, construction had not started because the environmental permit and the decree of public utility had still not been issued.

exporter in the region: the firm is currently responsible for 5% of Argentina's soybean exports, 7% of its soya meal exports and 9% of its soya oil exports; and, in 2014, it accounted for over US$ 3.5 billion (FOB) of the region's exports (Brazil, Argentina) (CIARA, undated; Wilkinson, Wesz Junior and Lopane, 2015).

In short, these two acquisitions enable COFCO to participate in financing activities, input provision, technical assistance and marketing of production in Latin America, and in processing soybeans in the form of meal or oil in China. This strategy has enabled it to avoid the problems faced by previous investments; and, at the same time, it has enabled China to become less dependent on transnational companies. The firm has established a solid presence in the Southern Cone soya complex, where its participation in the seed industry gives it advantages over the ABCD companies (Wilkinson, Wesz Junior and Lopane, 2015).

Lastly, it should be noted that there is another major path of access to Brazilian soybeans, which it was impossible to include in this study owing to lack of information. This involves foreign investment funds leasing soybean producing land, a modality that may already be in use in Latin America to circumvent the problem of land purchase restrictions. The fact that Chinese FDI is being targeted on soybean marketing and export logistics allows Chinese capital to spread through soya businesses by means of this "disguised" leasing. In the words of a specialist:

> Thus, the strongest presence of foreign capital in soybean production within Brazil comes through specialized farm management companies and pools de siembra that channel multiple capital sources into the sector. More careful research of these capital sources has yet to be undertaken, and it is certainly the case that some Chinese capital was indeed being channeled into soybean production in Brazil through such means (cf. Nakatani et al 2014), particularly via the Pacific Century Group participation in CalyxAgro (Oliveira, 2015).

VI. Conclusion

China's long-term growth dynamic depends, among other factors, on access to raw materials from around the world. Given their relative scarcity in China, securing external sources of long-term supply is one of the government's central objectives, which underlies a global diplomatic offensive aimed at diversifying import sources (Medeiros, 2008). The Going Global strategy, launched by the Government of China shortly after the turn of the century, is motivated mainly by reasons of national security and autonomy; but it also aims to change the terms of trade: China has sold its industrial products cheaply to conquer the international market; and it has paid high prices for the raw materials it needs in rapidly increasing amounts.

This article has made a much-needed evaluation of China's role in the ongoing reconfiguration of the "centre-periphery" relations to which Latin America has historically been subordinated. It has described and analysed China's quest for oil, metals (iron and copper) and soybeans in the region —products that currently account for over 70% of its imports from Latin America. The quest responds to the derived demand generated by China's rapid economic growth; and it is guided by long-term planning that sees Latin America as a major supplier of natural resources, given their abundance in the region.

The article has shown how access to oil is obtained mainly through loans for oil and through direct investments, while in the case of iron and copper it is obtained through direct investments and imports generally. In these cases, the path chosen by China to secure its supply seems to involve physical control of the resource. In the case of soybeans, the pragmatic path chosen has been imports increasingly intermediated by trading companies already present in the region and recently acquired by China. Another possible path, on which there is little information, could involve the leasing of land by investment funds with Chinese participation, which would be a way to avoid restrictions on land

purchase by foreigners. Investments in infrastructure in exchange for access to natural resources in general —still embryonic and therefore not considered in this article— could also mobilize large-scale Chinese resources.

As happened over several centuries of its history, Latin America benefits from trade in raw materials in different ways: in addition to generating income and employment, it earns large amounts of foreign exchange, which is necessary for the expansion of its economies. As has been noted several times in the past, natural resources are not, in principle, a "punishment from God." Nonetheless, and as noted in the recent literature on the "curse of natural resources", current trends in relations with China (and Asia generally) seem far less promising for Latin America than they could be if the region's countries, either individually or collectively, had a strategy in place to maximize the potential benefits offered by their natural resource abundance. Latin America lacks a long-term development strategy to harmonize Chinese interests with more ambitious targets for economic and social progress than are currently guiding governments in the region.

There are at least five issues associated with foreign capital inflows into Latin America, and in particular with Chinese interests in natural resources, which require attention, in terms of what ECLAC calls the "new governance" of natural resources (ECLAC, 2014; Bárcena and Prado, 2016; Altomonte and Sánchez, 2016).

Firstly, whereas in China itself foreign capital is encouraged to enter into partnership with local capital, but subject to a series of counterpart requirements that benefit the growth of added value and local technical progress, Latin America is a free space for Chinese acquisitions without major demands being made.

Secondly, the high returns obtained from commodity exports are not always adequately taxed, or else are taxed in a precarious manner, in the cases of both domestic and foreign capital; consequently, they do not always generate benefits for the local population.

The third issue is that commodity production tends not to be labour-intensive and, even in the case of soybeans and other foods, the image projected is that of the old "mining enclave" activity, with no development of productive linkages or technical progress at the local level. There is a genuine concern that Latin America's economies are undergoing a process of "reprimarization", which is being accentuated by the fact that technical progress led by manufacturing industry in the developed countries excludes the region from the global generation and diffusion of technological capacity.

The fourth problem is that the foregoing is compounded by excessive exchange-rate appreciations. In periods of rising commodity prices, macroeconomic policy should avoid exchange-rate appreciations that conspire against investments in industrial production, paying special attention to the exchange-rate effects of short-term capital inflows, which usually accompany commodity boom periods but generate or aggravate external crises when the bonanza ends.

Last but not least, the robust expansion of natural resource exploitation driven by Chinese demand has not been accompanied by environmental care; and this has negative consequences both for local populations and for the planet as a whole.

If Latin American countries were to adopt national strategies —such as those of China itself and the United States— or both national and regional ones —such as those of European countries— they would be able to benefit much more from China's natural resource needs than they have thus far. It would be even better if the strategy were adopted by mutual agreement between the countries of the region, as an integrated regional strategy.

As part of this, the Latin American countries would need to strike a balance between national-regional and global interests, to avoid becoming a stage for international disputes that do not benefit them. Until now, in global geopolitical terms, the region has been an area of initially European and,

subsequently, American influence. The unprecedented speed of the Chinese surge in the region can be questioned by Westerners and, in particular, by the Americans; and there are signs of this happening, as noted above. Not without reason, that question, which is not considered in this article, is preoccupying an increasing number of analysts of United States-China relations in regard to Latin America, especially in view of the agreement between Brazil, the Russian Federation, India, China and South Africa, the so-called BRICS group (Paz, 2012; Nolte, 2013).

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Corporate governance and international bond issues by Latin American corporations

Georgina Núñez Reyes, Ignacio Perrotini Hernández and Francisco López-Herrera

Abstract

This paper analyses the relationship between corporate bond issues and the existence of corporate governance frameworks that influence the development of financial markets by reducing information asymmetries and conflicts of interest. To this end, the international corporate bond market is reviewed and corporate governance standards in Brazil and in the four countries belonging to the Latin American Integrated Market (MILA) —Chile, Colombia, Mexico and Peru— are evaluated using a bond issues indicator developed by the Economic Commission for Latin America and the Caribbean (ECLAC), the Andean Development Corporation (CAF) and the Inter-American Development Bank (IDB). The evidence gathered using a probit panel model and a pooled probit model indicates that adherence to corporate governance standards can increase the likelihood that a firm will be able to carry out a successful international bond issue.

Keywords

Business financing, corporate governance, rules and regulations, capital markets, bond, corporate debt, econometric models, Latin America and the Caribbean

JEL classification

F65, G15, G32

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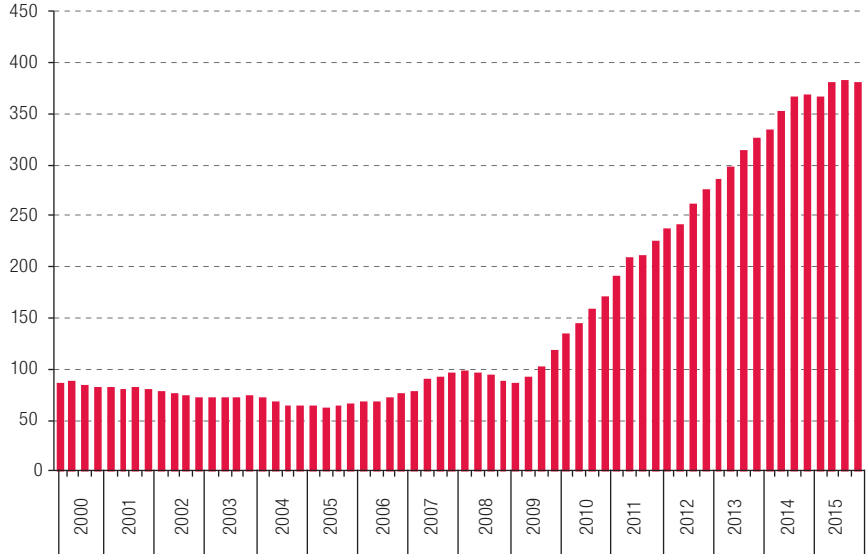
I. Introduction

Gozzi and others (2015) note that, for the period 1991–2013, corporate bond issues accounted for nearly 80% of all the capital raised by business enterprises worldwide and over 90% of the capital that they raised in markets outside their home countries. This shows just how important these markets are becoming under financial globalization. Since 2009, the corporate bond market has come to exert a growing influence over firms' financing decisions in Latin America. In fact, as shown in figure 1, the total stock of international corporate debt is four times higher than its pre-crisis level. Since debt instruments represent future payment obligations on the part of different economic agents, what happens in this market will necessarily have an impact in terms of the stability of the global economy.

Figure 1
Total international corporate debt as at the end of each quarter, 2000–2015
(Billions of dollars)



Source: Prepared by the authors, on the basis of Bank for International Settlements (BIS), "Debt securities statistics", 2016 [online] https://www.bis.org/statistics/secstats.htm?m=6%7C33%7C615.

International bond issues tend to have a greater impact on developing economies than domestic issues do. Çelik, Demirtas and Isaksson (2015) and Rodrigues, Kamil and Sutton (2015) attribute the growth of corporate debt in Latin America to international market conditions, which have been reflected in an appreciation of the currencies of Latin American countries against the dollar and in near-zero interest rates in the United States. In late 2014, the financial landscape changed when the United States Federal Reserve stopped applying its policy of quantitative easing,[1] under which had been buying up securities as a way of injecting liquidity into capital markets. Over the six years that this policy was in place, about US$ 4.5 billion in liquidity was transferred to developing economies, where it was used to finance corporate investments.

When this policy was discontinued, Japanese and European central banks tried to maintain the existing level of liquidity in financial markets by launching equivalent policy packages involving US$ 2.5 billion; these measures entailed the introduction of expansionary monetary policies by the

[1] The objective of quantitative easing was to lower long-term interest rates in order to spur aggregate demand and economic growth.

main developed economies (Núñez and Oneto, 2014).[2] According to Pérez Caldentey (2017), since the introduction of quantitative easing policies, the share of international bond markets in total lending to non-residents has risen from 40% to 48%.

The most dynamic actors in this area have been residents of Asia and Latin America. Between 2009 and 2015, international debt issues jumped by 12% in these regions, whereas, in developed countries, they edged up by a mere 0.23% during that period.

The expansion of debt stocks, coupled with the corporate scandals that came to light during the 2008 crisis, prompted bond purchasers, especially in the developed world, to bring stronger pressure to bear on regulators to improve the corporate governance of firms that issue bonds.[3] Particularly in the case of the financial system, corporate governance has come to be viewed as a powerful risk-mitigation tool. Improvements in this area that are seen as a way of protecting investors from fraudulent practices include increases in the flow of information and a reduction of information asymmetries between the parties to transactions involving debt issues, such as mergers and acquisitions.

The increase in corporate leveraging that has resulted, in part, from the upswing in the issuance of debt instruments observed since 2010 has been used to restructure existing debt (Gozzi and others, 2015). This has alerted the market and regulatory authorities to the possibility of defaults that could have system-wide impacts, not only on national and regional economies but on the global economy as well, especially since the corporate default rate has hit its highest point since 2009, according to Standard & Poor's (*Financial Times*, 2016). In the course of integration processes such as the formation of the Latin American Integrated Market (MILA),[4] the various countries' regulations and standards have to be aligned as much as possible so that the integration process will produce the fewest possible distortions in the national markets exhibiting good corporate governance practices. The various types of factors that limit corporate governance structures' ability to meet development challenges and those posed by the integration of financial markets, which include market failures (e.g. information asymmetries), along with the factors that hamper the effectiveness of regulatory schemes and their application, call for a more in-depth analysis.

Effective corporate governance schemes set within a broad legal framework and corporate strategy contribute to capital market development, reduce market failures and facilitate access to different sources of financing. The objective of this analysis is to provide evidence to show how effective corporate governance can increase the likelihood of successful bond issues.

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[2] Rogoff (2015) states that, with its quantitative easing policy, the Federal Reserve signalled the economy that, if long-term interest rates were to rise sharply, it would be willing to sustain the heavy losses it would incur by holding a large amount of old low-interest bonds. If the central bank buys only government debt, then its losses have little economic meaning. The fact that central banks filled their portfolios with low-yielding long-term debt helped to convince investors that they would keep short-term interest rates low for as long as possible. Rogoff concludes that quantitative easing is a weaker and more uncertain instrument than normal interest-rate policy.

[3] In an article published in *América Economía*, Tromben and others (2015) discuss the corporate governance failures revealed by a series of scandals in Latin American firms. They attribute these failings to shortcomings in the control exercised by decision-making bodies over dealings that weakened pension funds and allowed pension fund administrators to divert funds to political campaigns and parties, thereby also violating election laws. The firm SQM in Chile was one such case. Other cases, such as that of Petrobras, have been even more dramatic, since they have undermined the financial health of State-owned companies. In Chile, a proposal has been put forward for modifying the regulatory framework with a view to achieving a greater disaggregation of information on conflicts of interest, risk management, in-house whistle-blowing, compensation and the involvement of shareholders meetings.

[4] The Latin American Integrated Market (MILA) was originally formed by the stock exchanges of Chile, Colombia and Peru, had 563 listed companies and began operations in November 2010. Its initial total market capitalization of US$ 660.985 billion —Chile had a 50.6% share (US$ 334.461 billion), Colombia, 33.55% (US$ 221.775 billion) and Peru, 15.85% (US$ 104.749 billion)— made MILA the second-biggest exchange market in the region, after Brazil, which had a market capitalization of US$ 1,747,315,000,000. In terms of trading volumes, MILA was the third-largest market in Latin America, with US$ 57 billion in trades per year, after Brazil (US$ 633 billion) and Mexico (US$ 87 billion). Mexico, with an exchange market capitalization of US$ 457.997 billion, joined MILA in 2014. The largest share of securities in Peru came from mining companies (53%), while in Colombia the main source was industry (78%); in the case of Chile, the services sector accounted for 32% of its market capitalization. For further information, see [online]: mercadomila.com.

The first of the following sections provides background information, with special emphasis on Brazil and the four member countries of MILA, concerning the Latin American debt market and international bond issues, which have become the preferred avenue for corporate borrowing since the financial crisis of 2008. The discussion will then turn to the concept of corporate governance based on the regulatory frameworks and best practice codes in place in each of the selected countries. This will be followed by an econometric analysis of the influence exerted by a series of variables, including corporate governance, on securities issues. Conclusions are presented in the last section.

II. The Latin American securities market

Debt markets —and particularly corporate bond markets— were extremely buoyant during the period from 1 January 2005 to 31 December 2015. The 14,630 international and domestic corporate bond issues of 23 Latin American and Caribbean countries[5] in 2005–2015 totalled US$ 1.36 trillion and, of that total, nearly 60% (US$ 805 billion) was accounted for by international issues. Brazil, with an almost 40% share, and Mexico, with 29%, were the biggest issuers of international corporate debt (see table 1). In terms of the number of issues, Brazil accounted for nearly 75% of the total, followed by Chile, with close to 10%.

Table 1
Latin America and the Caribbean: international corporate bond issues, 2005–2015

	Value *(billions of dollars)*	Value *(percentages)*	Number *(units)*	Number *(percentages)*
Total issues	805.25		6 728	
Brazil	320.89	39.9	5 032	74.8
Mexico	236.88	29.4	403	6.0
Chile	72.88	9.1	666	9.9
Venezuela (Bol. Rep. of)	50.64	6.3	34	0.5
Colombia	34.81	4.3	73	1.1
Peru	32.71	4.1	102	1.5
Argentina	15.71	2.0	130	1.9
Other	40.73	5.1	288	4.3

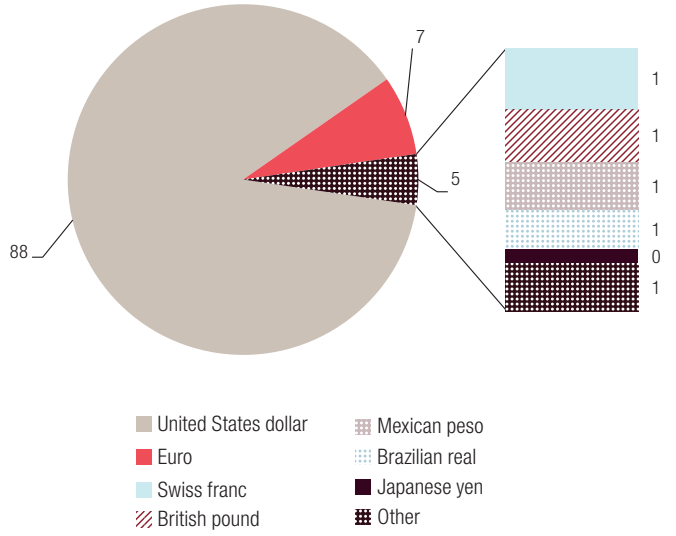
Source: Prepared by the authors on the basis of information from Bloomberg.

The international issues included in the sample were originally denominated in 22 different currencies. As shown in figure 2, however, 88% of them were conducted in United States dollars, with euro-denominated issues coming in a distant second (7%). This distribution may have become even more unbalanced in recent years, given the strengthening of the dollar since late 2014.

Figure 3 depicts the distribution of total debt issues by economic sector. According to figures published by Bloomberg, the largest issues in terms of value are mainly found in the energy sector, which accounts for 29% of total issues by value but just 3.2% by number of bond issues in the region. The financial sector accounts for 28% of the total by value and for nearly 83% by number of international issues of debt securities.

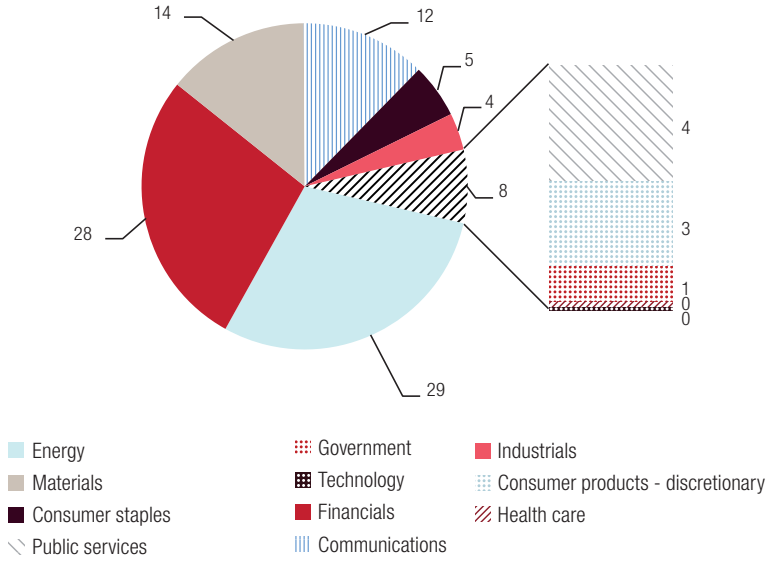
[5] Argentina, Bahamas, Barbados, Belize, Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Panama, Paraguay, Peru, Plurinational State of Bolivia, Saint Vincent and the Grenadines, Trinidad and Tobago, and Uruguay.

Figure 2
Latin America and the Caribbean: currencies used in international debt issues, 2005–2015
(Percentages)



Source: Prepared by the authors on the basis of information from Bloomberg.

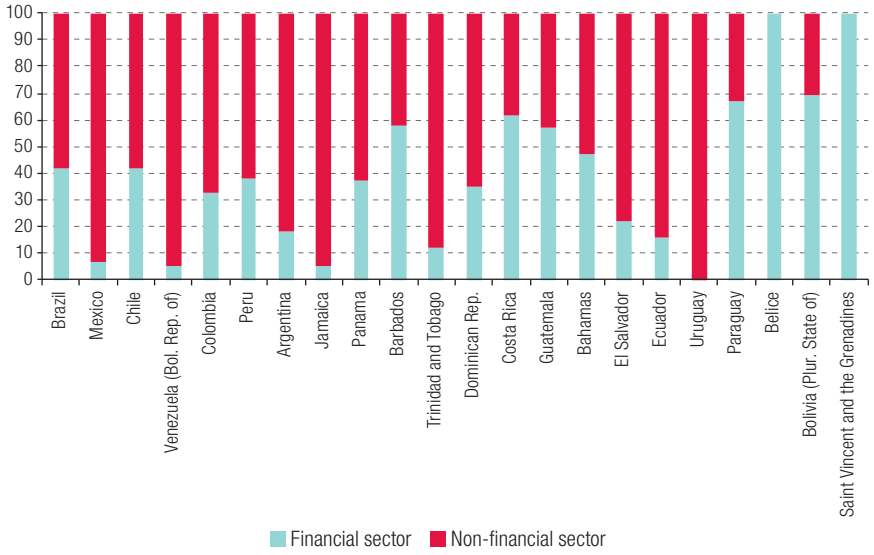
Figure 3
Latin America and the Caribbean: distribution of international bond issues, by value and sector of activity, 2005–2015
(Percentages)



Source: Prepared by the authors on the basis of information from Bloomberg.

Just seven countries of the region accounted for a full 95% of bond issues: the four MILA countries, Argentina, Brazil and the Bolivarian Republic of Venezuela. The other 16 countries were the source of the remaining 5% of the region's international corporate issues. The largest percentage of bond issues came from the non-financial sector (see figure 4).

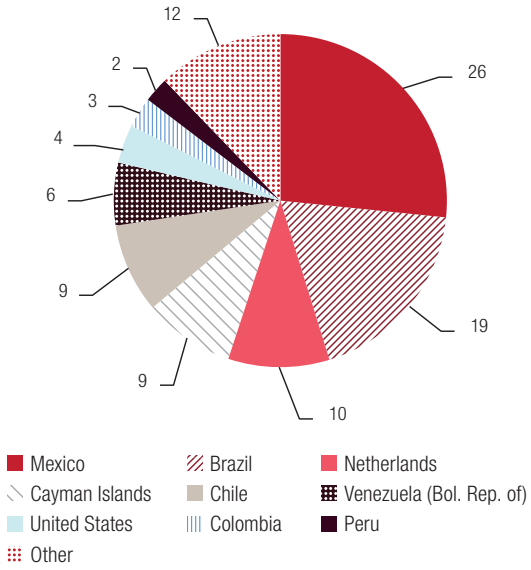
Figure 4
Latin America and the Caribbean (22 countries): bond issues of the financial and non-financial sectors, 2005–2015
(Percentages)



Source: Prepared by the authors on the basis of information from Bloomberg.

Figure 5 shows the distribution of the countries where corporate debt was placed: 26% of total bond issues were placed in the Mexican market and 19% in Brazil. Although 10% of the total debt was placed by a firm in the Netherlands, the corresponding risk is located in one or another country of the Latin American and Caribbean region. The Cayman Islands, which are generally regarded as a tax haven, account for 9% of total debt placements.

Figure 5
Recipient countries of Latin American and Caribbean debt placements, 2005–2015
(Percentages)



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

III. Corporate governance, regulatory frameworks and best practice codes

The absence of efficient, comprehensive autonomous mechanisms for monitoring corporate risk is one of the main problems that has come to light in recent years. The lack of the necessary specialized units within corporate governance structures is especially apparent at the corporate decision-making level.[6]

The risk classification criteria used by the MILA countries are similar to those used by credit rating agencies to assess issuers' ability to meet their payment obligations to investors within the time frames and on the terms stipulated in their contracts. An analysis of the figures raises some doubts, however, about how the application and effectiveness of some of their risk assessment methods are monitored and about the ways in which firms arrive at their decisions regarding leveraging.[7] The corporate governance regulatory frameworks examined in this section are the ones that were in place in 2005–2015. Issuers' decisions are in line with an effective corporate governance structure as perceived and appraised by the various market agents (institutional investors, credit rating agencies and issuing banks). The corporate governance index examined here is used to determine whether these aspects of corporate governance (subject to the existing regulations and best practice codes) are in line with increased access to the bond market under better terms and conditions.

The indicator used to assess corporate governance regulations and standards as they relate to issues of debt instruments was developed by the Economic Commission for Latin America and the Caribbean (ECLAC), the Development Bank of Latin America (CAF) and the Inter-American Development Bank (IDB) (Núñez and Oneto, 2012). It is based on international standards, including the corporate government principles framed by the Organization for Economic Cooperation and Development (OECD, 2016), and encompasses 9 categories and 19 different standards (see table 2).[8]

[6] Núñez and Oneto (2015) apply an indicator that has been constructed for use in measuring the quality of corporate governance in firms in five countries of the region. Their findings indicate that most of these firms did not have a committee whose main job was to monitor risk levels on an ongoing, comprehensive basis. For the most part, risk assessment committees and audit committees are the areas in which the greatest improvements in corporate governance are required in the region and particularly in the MILA countries and Brazil.

[7] In conducting risk assessments, emphasis is placed on information concerning bond spreads, and risk is interpreted as the spread between the yield of the bond in question and the yield of a zero-coupon bond for the same term of the United States Treasury Department. For the sample of firms used for this analysis for the period from 2005 to 2015, that spread averaged around 4.30%.

[8] This indicator was constructed on the basis of a number of international corporate governance standards, including the corporate governance principles of OECD (OECD, 2016) and CAF (2013), and national standards such as *The UK Corporate Governance Code* (FRC, 2011) and *The Combined Code of Corporate Governance* (FRC, 2008). It is designed to serve as a qualitative measuring tool for gauging the level of risk and of internal control specifically relating to a firm's bond issues. This is done in three stages: (i) the identification, in the aggregate, of the main procedures involved in issuing corporate bonds for which the board of directors is directly responsible, which include determining the firm's financing requirements, selecting and approving the engagement of the financial intermediaries who will be in charge of the bond issue, determining the level of risk associated with the issue and monitoring it, authorizing the issue based on the information it receives regarding the use made of the funds raised by that means and the implications of the firm's leveraging, and designing the internal control systems used to gather timely information on the effectiveness of risk management operations and the performance of the firm's directors; (ii) the definition of corporate governance standards having an impact on bond issues; and (iii) the definition of the criteria used to determine the relative importance of specific standards. For more detailed information on this indicator, see Núñez and Oneto (2012).

Table 2
Indicator for corporate governance/international bond issues

Category		Standard	Weighting *(percentages)*	No. of questions
Role of the board of directors	1	The board of directors sets up mechanisms for obtaining reliable information on all of the company's investments in financial and non-financial assets and its financing activities.	15.52	1
	2	The board of directors delegates responsibilities and functions only to corporate committees that are chaired by an independent external officer.	5.84	1
Structure of the board of directors	3	The board of directors is of a size that will permit it to arrive at decisions expeditiously.	0.94	2
Role of the chairperson of the board	4	The chairperson sets up mechanisms for selecting non-executive directors on the basis of the value they can bring to the table.	3.98	1
	5	The chairperson is an independent external officer.	1.88	1
Role and selection of executive or inside directors and of non-executive or outside directors	6	Directors keep abreast of the needs of the company and its employees.	7.79	2
External or independent directors	7	Non-executive directors advise the board of any conflict of interest relating to the company.	5.84	1
In-house directors	8	Executive directors sign documents whereby they assume legal responsibility for the information that they provide and disseminate and whereby they would be criminally liable for any violation in that regard and for any failure to divulge information to the board.	7.77	2
	9	The executive auditor is a member of the board of directors and reports directly to the board or to one of its committees.		
Audit committee	10	The audit committee is chaired by an independent external officer having expertise in internal control. The external auditor is engaged by the audit committee and reports directly to that committee.	19.40	2
	11	The audit committee approves the auditing programmes and follows up on the observations made by the auditors.		
	12	The audit committee approves the design and operation of the internal control system.		
	13	The audit committee is responsible for ensuring that an effective reporting system is in place that covers, in particular, financial aspects, risk management and the performance of the company and of the board.		
Corporate finance committee	14	The corporate finance committee is chaired by an independent external officer with expertise in that field. The corporate finance committee determines the firm's financing requirements and must approve the use of the financing mechanisms proposed by the firm's general managers.	15.52	4
	15	The corporate finance committee must approve the selection and recruitment of the financial intermediaries required to place the securities issued by the firm.		
Risk management committee	16	The risk management committee is chaired by an independent external officer with expertise in comprehensive risk management.	15.52	3
	17	The risk management committee must approve the financial and credit risk reports prepared by the firm's risk management unit.		
	18	The risk management committee reports regularly to the firm's general management and to the board of directors on the effectiveness of the investment strategy.		
	19	The risk management committee must approve the plan for the management (via mitigation, containment or transfer) of the non-financial risk detailed in the reports of the firm's general management.		
Total			100	

Source: Prepared by the authors on the basis of G. Núñez and A. Oneto (coords.), "Gobernanza corporativa en el Brasil, Colombia y México: la determinación del riesgo en la emisión de instrumentos de deuda corporativa", *Project Documents* (LC/W.468), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC), 2012.

The first three components (the role of the board of directors, its structure and the role of the board's chairperson) establish the overall framework for the firm's corporate governance system. The next three components correspond to the three specialized committees that provide information to the board on specific aspects of the bond issue. The indicator is based on questions that elicit a yes or no response: if the answer is "yes", it takes a value of 1; if the answer is "no", it takes a value of 0.

It is then normalized to produce a range of values from 0 to 10. This indicator was developed as a tool for the direct assessment of the corporate governance performance of 22 firms in Brazil and the four MILA countries that issue bonds, but it could also be used to evaluate the laws and best practice codes governing this activity. For the purposes of this study, both the standards and the original questions, as well as their weightings, have been adjusted. Almost all of the same categories were used, with the exception of those relating to financial investment committees, and the questions relating to each standard were modified to focus solely on the relevant laws, regulations and best practice codes; in addition, the mandatory standards (laws and regulations) and voluntary standards (best governance practice codes) were merged. The category weightings remained the same, and the weightings for the committee that was omitted were distributed among the others. In the standards matrix (see table 2) for evaluating the regulatory framework for corporate governance, transparency is a factor that cuts across all the categories included in the indicator. It figures in most of the individual standards and is the reason why the indicator can be applied to any type of international or national bond issue rather than only to government issues or the issues of listed companies.

These standards apply to capital markets and, in most cases, these corporate governance best practice codes are part of the package of information that stock exchanges request on a regular basis. This indicator is used to evaluate the standards applied by each of the selected countries and produces a single value for each country and each year. The requirement to report on corporate governance is, in many cases, discretionary and is based on the principle of "comply or explain". And this, in combination with the fact that relatively few firms are subject to corporate governance standards, may cancel out their possible effect in reducing information asymmetries.

One of the ways in which corporate governance standards have been changing is that more and more importance is being placed on having a larger number of non-executive (i.e. independent) directors on corporate boards. Improvements in this respect have been observed in many cases. This is especially important in cases of ownership concentration, where one agent owns over 50% of the equity in a firm. When the indicator was used to assess the prevailing standards and codes, the values shown in table 3 were obtained. The aggregate measurements of the corporate governance standards applying in the four MILA countries and in Brazil indicate that the performance of these five countries' regulatory agencies is quite similar and reflect the effort that has been made in recent years to improve and align their regulatory frameworks.

Table 3
Latin America (5 countries): corporate governance indicators, 2005–2015

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Brazil	4.27	4.27	5.06	5.06	5.06	5.06	5.06	6.14	6.14	6.14	6.14
Chile	2.56	2.56	2.56	2.56	2.56	3.06	3.06	3.58	6.84	6.84	7.25
Colombia	0.93	2.99	2.99	5.12	5.12	5.12	5.12	5.12	5.12	5.12	7.66
Mexico	4.48	6.19	6.19	6.19	6.19	6.19	6.45	6.45	6.45	6.71	7.12
Peru	4.39	4.39	4.39	4.39	4.39	4.39	4.39	4.39	4.39	7.76	7.76

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

The country with the lowest rating in 2015 was Brazil. This result is accounted for by the way in which risk is analysed and managed and by the existence of a provision under which one third of the members of boards of directors can be executives of the company in question (opening the way for potential conflicts of interest). Under Brazilian law, there must be a board of directors, but there must also be a fiscal council. The highest rating for 2015 is for Peru, and Colombia was the country that saw the greatest improvement in this respect for the period as a whole. Chile is the only one of the five countries that does not have a best practices code.

As far as the indicator's coverage of the different categories is concerned, Chile has the best standards concerning the role of boards of directors (standard No. 1) thanks to the amendments made to Corporations Act No. 18.046 of 2009. In the case of the structure of the boards (standard No. 2), the regulations of Colombia and Mexico both require at least 25% of board members to be independent.[9] None of the countries' provisions regarding the role of the chairperson of the board of directors (standard No. 3) stands out from the rest, although those of Chile, Colombia and Peru do explicitly state that, whether directly or indirectly, the general manager cannot chair the board of directors. The ratings differ in the cases of the audit committees (standard No. 4) and risk management committees (standard No. 5). Between 2004 and 2015, all the countries' legislatures except Peru's took steps to require firms to have audit committees, but this has not been done in the case of dedicated risk management or corporate finance committees.

Generally, speaking, the biggest improvements in the legal framework for corporate governance in the four MILA countries and Brazil occurred between 2013 and 2014. In the MILA countries, this probably has to do with the fact that they had to harmonize their laws in order to integrate their stock exchanges. In addition, some of the changes came on the back of corporate scandals in some countries (for example, the La Polar scandal in Chile) and of sectoral reforms in others (as in Mexico). The lowest ratings are for information on corporate committees and their responsibilities, especially in the areas of risk management and auditing. Information on how bond issues are financed is seen to be important, but few companies have specialized corporate committees to deal with that subject. There are no laws or regulations that deal specifically with State-owned companies that issue securities, but Núñez and Oneto (2015) found that the corporate governance structures of State-owned firms included some type of specialized unit dealing with financing and investments in financial assets, which did not tend to be the case in most of the private firms in their sample.[10]

IV. Econometric analysis

The data used for this analysis correspond to the international bond issues registered in the Bloomberg database for 2005-2015. During this period, 323 firms out of the 2,130 listed companies in the four MILA countries and Brazil conducted a total of 5,173 international bond issues. This sample was drawn from the group of firms for which balance sheets were available for at least one of the years in the study period. The "residence of issuer" approach was used to classify corporate bond markets.[11] Issues classified as domestic ("domestic" and "domestic medium-term notes") and private placements were removed in order to ensure that only international issues from parent companies or their subsidiaries were included. The average term of the bonds was 10 years and the median term was 8 years. These issues were denominated in 15 different currencies, but 80% of them were in United States dollars.

The decision to undertake a bond issue can be represented by a binary dummy variable, $Bond_{it}$, that can take either one of two values: yes = 1 with a probability of p_i, no = 0 with a probability of $(1-p_i)$.

[9] Bhagat and Bolton (2008) find that the degree of independence of a board of directors is negatively correlated with a firm's operational performance. This is of particular significance, given the special importance that regulations applying to listed companies place on their having independent boards.

[10] The sample used by Núñez and Oneto (2015) included State-owned companies, which tended to perform better than private firms in other sectors of the economy (the financial, services and manufacturing sectors) in terms of corporate governance. Companies in Chile and Peru had better ratings than firms in the other countries, primarily because they had at least three of the corporate committees identified in the indicator, while the other firms in the sample did not. A greater rigidity in the rules governing domestic equity and local bond markets was observed that tended to spill over into international debt markets.

[11] According to the residence of issuer approach (BIS/ECB/IMF, 2015, para. 7.61), "debt securities issued by a resident of the same economy in which the security is issued are classified as domestically issued, regardless of the currency of issue. All other issues are classified as internationally issued."

In other words:

$$Prob(Bond_{it} = 1|x,\beta) = p_i = F(x,\beta) \quad (1)$$

Given the characteristics of the database, a probit model for panel data was chosen in which $F(x,\beta)$ is the cumulative distribution function of the normal standard distribution $\int_{-\infty}^{x\beta} \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}} dz$. The estimated model is:

$$Bond_{it} = x'_{it}\beta + \varepsilon_{it} \quad (2)$$

The parameters can be estimated by finding the ones that maximize the logarithm of the joint likelihood function:

$$\ln L(\beta) = \sum_{i=1}^{n}\sum_{t=1}^{T}\{(Bond_{it})\ln F(x_i,\beta) + (1 - Bond_{it})\ln(1 - F(x_i,\beta))\} \quad (3)$$

In this analysis, use is made of three of the five accounting ratios discussed by Mizen and Tsoukas (2012) for assessing companies' financial health on the basis of their financial statements. The first is a one-period lagged leverage ratio, $LevR_{it-1}$ (total debt/total assets). If the value of this ratio is high, investors will either think that the company will not be able to meet its payment obligations and will not want to buy its bonds (negative response) or will think that it is creditworthy and that there will therefore be a greater likelihood that its bonds will be in demand (positive response). The square of the previous variable, $LevR^2_{it-1}$, is used in order to check whether or not there is a maximum (optimum) level of debt relative to assets after which there would be a change of direction in the response curve for the relationship between the dependent variable and the firm's leverage (see Margaritis and Psillaki, 2010). In order to capture the profitability effect, the $ProfR_{it-1}$ variable (defined as earnings before interest and taxes (EBIT)/total assets) is included; lower EBITs point to the probability that a firm will seek external financing.

The model used here included other variables, in addition to the above. One of these is $Size\_it$, which denotes the size of the firm. It is assumed that the bigger the firm, the more likely it is to issue bonds. Another variable is $CEMBI$, which is an index for dollar-denominated corporate bonds issued by emerging markets. Another is the $CorpGov_{jt}$ corporate governance index, which measures a firm's performance in terms of regulatory compliance and is assumed to correlate positively with the likelihood that a firm will seek financing on the bond market. This assumption is based on the expectation that the solid reputation which an issuer earns by complying with the corresponding laws and regulations will increase the probability that its bond issue will be successful. The model also includes the $Deriv$ and $VarTC$ variables, which measure the size of the derivatives market as reported by the Bank for International Settlements and variations in the exchange rate against the dollar in the country of the issuing firm, respectively. Dummy variables have also been included to take into account any influence that may be exerted by the year during which the issue is conducted and the scale of the sector of activity in which the company operates. Based on the foregoing, the specification of the model is as follows:

$$P(Bond_{i,j,t} = 1) = F(CorpGov_{i,j,t} + LevR_{i,j,t-1} + LevR^2_{i,j,t-1} + ProfR_{i,j,t-1} + Size_{i,j,t-1} + CEMBI_{i,j,t-1} + Deriv_{i,j,t-1} + VarTCj_{,t-1} + \sum DYj_{,t} + \sum DS_z) \quad (4)$$

where i represents the individual issuer, j stands for the issuer's country, z is the sector in which the firm operates and t is the time period.

In order to estimate this equation, two methods are used: a random-effects probit model for panel data and a pooled probit model. A total of 6,457 observations were analysed. In order to correct for the potential problem of endogeneity due to simultaneity, all the explanatory variables are lagged. This reduces the probability that the independent variables will be correlated with the contemporaneous residual. Table 4 shows the results of the estimates.

Table 4
Member countries of the Latin American Integrated Market (MILA) and Brazil: estimated probit models, 2005–2015

Variables	(1) Probit RE 3	(2) Marg. effects	(3) Pooled probit 3	(4) Marg. effects
Corporate governance index (L.CorpGov)	0.144***	0.00252**	0.120***	0.00247**
	(0.0509)	(0.00102)	(0.0342)	(0.00105)
One-period lagged leverage ratio (L.LevR)	4.693***	0.0819***	4.665***	0.0960***
	(0.830)	(0.0222)	(0.719)	(0.0153)
L.LevR squared ($L.LevR^2$)	-4.575***	-0.0799***	-4.576***	-0.0942***
	(1.096)	(0.0251)	(0.971)	(0.00787)
Earnings before interest and taxes/total assets (L.ProfR)	-1.32e-08	-2.31e-10	-1.14e-08***	-2.34e-10***
	(1.02e-05)	(1.78e-07)	(7.47e-10)	(7.27e-11)
Size of firm (L.Size)	0.200***	0.00350***	0.144***	0.00296***
	(0.0254)	(0.000816)	(0.0168)	(0.000912)
Index of corporate bonds issued in emerging markets (L.CEMBI)	-0.0137***	-0.000240**	-0.00958***	-0.000197**
	(0.00457)	(9.34e-05)	(0.00324)	(8.56e-05)
Size of derivatives market (L.Deriv)	2.92e-05***	5.10e-07**	2.75e-05***	5.66e-07***
	(1.09e-05)	(2.22e-07)	(7.06e-06)	(2.09e-07)
Variation of exchange rate against the dollar (L.VarTC)	-0.0117**	-0.000204*	-0.00763**	-0.000157*
	(0.00590)	(0.000109)	(0.00383)	(9.53e-05)
Materials	0.761***	0.0133***	0.659***	0.0136***
	(0.248)	(0.00512)	(0.182)	(0.00515)
Communications	0.685**	0.0120**	0.623***	0.0128**
	(0.287)	(0.00561)	(0.208)	(0.00569)
Energy	1.342***	0.0234***	1.252***	0.0258***
	(0.334)	(0.00746)	(0.269)	(0.00941)
Dummy variable for 2008 (D2008)	-1.151***	-0.0201***	-0.831***	-0.0171***
	(0.253)	(0.00575)	(0.174)	(0.00620)
Dummy variable for 2012 (D2012)	0.365**	0.00637**	0.186*	0.00383
	(0.155)	(0.00294)	(0.0975)	(0.00237)
Dummy variable for 2013 (D2013)	0.511***	0.00892***	0.301***	0.00619**
	(0.164)	(0.00330)	(0.103)	(0.00280)
Dummy variable for 2014 (D2014)	0.461***	0.00805**	0.239**	0.00493*
	(0.161)	(0.00314)	(0.105)	(0.00265)
Constant	-4.833***		-3.707***	
	(0.614)		(0.393)	
Observations	8.817	8.817	8.817	8.817
ID number	1.514			
Wald p-value	<0		<0	
Akaike information criterion (AIC)	1 965		2 297	
Bayesian information criterion (BIC)	2 163		2 489	
Pseudo R2			0.221	
Percentage correctly predicted (PCP)			96.22	

Source: Prepared by the authors.
Note: The standard error is shown in brackets: *** p<0.01, ** p<0.05 and * p<0.1.
ID: unique gateway identification (Bloomberg ticker).

The coefficient for the corporate governance indicator is not only high but also has a positive sign, which suggests that the probability of a bond issue being carried out successfully increases as a firm complies with higher and higher standards of corporate governance. In addition, the coefficient for leverage is also high and has a positive sign, indicating that companies that have issued bonds before are likely to be able to draw on that experience to heighten their chances of successfully conducting subsequent corporate debt issues on the international market. Interestingly, the estimated term for the square of the leverage ratio is also highly significant at conventional levels. However, although its numerical magnitude is similar to that of the leverage coefficient, the sign of its square is negative in both models, which suggests that there may be an optimum level of indebtedness after which it has decreasing effects on the possibility of successfully issuing fresh debt. The coefficient for company size is also very high and positive, which supports the hypothesis that firm size may be a contributing factor in successful bond issues on international markets.

The estimates indicate that operations in the energy, materials and communications sectors, in that order, had a highly significant positive impact on the probability of conducting a successful international bond issue. The dummy variable for 2008 was highly significant and carried a negative sign, whereas the coefficients for the years 2012, 2013 and 2014 were significant and positive.

V. Conclusions

Since 2009, the corporate bond market has been steadily becoming a more and more important source of financing for Latin American firms. Its growing role can be attributed in part to the buoyancy of the world economy triggered by the low interest rates established by government authorities in response to the 2008 financial crisis and to the policy of quantitative easing applied by the United States Federal Reserve, which had a powerful influence on international bond yields. This also constitutes a risk, however, since any change in these favourable global conditions (particularly the stance adopted by the United States monetary authority) could cause this source of financing for Latin American firms to dry up, which could threaten the stability of the region's economies.

This paper presents the results of a study in which the debt issues indicator developed by ECLAC, CAF and IDB was used to analyse the importance of compliance with corporate governance principles and good practices in Brazil and the four Latin American countries that have joined together in the Latin American Integrated Market (MILA). An econometric analysis based on a panel data probit model and a pooled probit model shows that firms that comply more fully with corporate governance principles and standards of best practice may have a much greater probability of conducting a successful international bond issue. The findings reported on in this paper underscore the importance of the role that good corporate governance, which involves the efficient and timely disclosure of relevant information, may play in ensuring transparency. Of course, these results may also be interpreted as signifying that the proper regulation of corporate activity in ways that minimize conflicts of interest and information asymmetries can help companies gain greater access to international bond markets as a source of the financing they need to pursue their production activities.

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The spillover effect of Chinese growth on South America: an analysis from international trade

Gercione Dionizio Silva, Marília Fernandes Maciel Gomes and Evandro Camargos Teixeira

Abstract

China's rising share of South American trade since 2001 has made that country's growth a matter of huge importance for the continent's economies. This study sets out to analyse the spillover effect of China's growth on that of the leading South American economies (Argentina, Brazil, Chile and Colombia) between 1981 and 2014. It analyses whether the increase in China's share of these countries' trade since 2001 has altered that effect. The findings suggest that, while positive, it has remained substantially unchanged. The main conclusion from these results is that expanding exports from traditional sectors of the South American economies (commodities) is not enough for earnings to increase with China's growth. The article emphasizes the importance of public policies designed to diversify South America's portfolio of exports to China, such as incentives for exporting by non-traditional sectors.

Keywords

China, international trade, economic relations, economic growth, South America, exports, measurement, econometric models

JEL classification

E12, F15, F4

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I. Introduction

The international trade integration process has advanced quickly and at the same time heterogeneously in recent decades, unifying the economic spaces of countries with different levels of development. In an internationally integrated economic space, changes in the economic circumstances of one country can affect the performance and well-being of other economies with which that country is integrated (Dornbusch, 1976; Obstfeld and Rogoff, 1995).

Trading links between countries, arising mainly from intersectoral trade, make foreign demand for a country's products very important for its domestic industrial activities. Accordingly, policymakers and the management teams of large corporations closely monitor economic activities in large countries and economic areas such as the United States, the European Union and China.

Specifically, great attention has been paid to the international impact that China's remarkable growth has had in recent years. China has come to prominence in the international market not only as one of the leading emerging countries, but also as one of the world's great trading hubs. Even by 2013, it accounted for an average of 11% of global product exports and imports, while in the area of services it was responsible for 4.4% of world exports and 7.5% of world imports (WTO, 2015).

Through its product buying and selling relationships, China plays a crucial role in a number of countries' trade flows, and particularly in the trade of South America. Although this trading partnership is of long standing, China's trade with the subcontinent really began to take off in 2001. In terms of trade flows, exports to China by the major South American countries (Argentina, Brazil, Chile and Colombia) began to growth exponentially in this period.

South America's exports to China grew by about 55% between 1995 and 2000, with the value exported rising by almost US$ 1 billion. Between 2001 and 2014, these exports increased by 1,595%, from some US$ 4 billion to some US$ 69 billion. Imports of Chinese products to South America behaved similarly, with growth of 140% between 1995 and 2000 and of about 1,830% between 2001 and 2014 (UNCTAD, 2015).

Since 2001, China's participation in South American markets has made it one of the subcontinent's main trading partners, with only the United States and European Union rivalling it in trade shares.

The large increase in South American exports to China has been due primarily to that country's continuous growth over recent decades. According to data from UNCTAD (2015), China's gross domestic product (GDP) has grown by an average of 9.86% a year since 1981. This makes it an outlier among countries with a similar level of development. For example, the average growth rate was about 4.74 percentage points for developing countries generally and 6.74 points for the group comprising Brazil, Russia, India, China and South Africa (BRICS) in the same period. Consequently, China's economic performance and external policies have come to greatly influence growth in the South American countries.

If just the effect of China's growth on South American exports is singled out, it can be inferred that this has positively influenced growth in South America, particularly since 2001. This conclusion is arrived at by considering the increase in China's share of international demand for South American products, i.e., South American exports. In other words, it can be inferred that the spillover effect (see Poirson and Weber, 2011) of Chinese growth on South America's economies has been positive and has increased since 2001.

However, the pattern of trade between them brings to light some points that bear examining. First, there is a great disparity in terms of value added between what is exported to China and what is imported from there. Cunha (2011) points out that the transactions of the South American countries with their trading partners centre mainly on exports of products with low value added and on imports of products with high value added. Setting out from an analysis of Brazil, the leading representative of the

South America countries where trade is concerned, Mattos and Carcanholo (2012) point out that the growth of exports from Brazil to China has historically been based on products with low value added, while import growth has mainly been in products with higher value added.

Second, the diversity of South America's portfolio of exports to China has not changed much in recent decades. As measured by Michaely's complementarity index,[1] trade complementarity between them is low. Between 1995 and 2013, South America's exports covered an average of just 29.1% of all products imported by China, while China's exports covered about 44.9% of demand in the South American economies.

Simple though this is, it shows that there may be limits to the potential gains to South America from China's growth. While it is important to encourage the expansion of traditional product exports in South America's export portfolio, this may not be enough for the spillover effect of Chinese growth to operate.

Setting out from these considerations, the aim of the present study is to analyse the spillover effect of China's growth on the growth rate of the South American countries in the period 1981–2014. This analysis is designed to ascertain whether the substantial increase in China's share of South American trade since 2001 has altered the spillover effect of Chinese growth. The idea is that its findings should answer the following question: is extending South American exports in established traditional sectors (commodities) to China enough for these countries to benefit from Chinese growth?

This article is divided into four sections besides the present introduction. Section II presents a brief analysis of the literature on the importance of external trade to an economy's growth, highlighting linkages in the growth of two economies. Section III addresses the methodological aspects of this study. The results obtained are detailed in section IV. Lastly, section V sets out some final considerations.

II. Literature review

In the literature, the impact of economic growth in one country on another country or set of countries is called growth spillover. Studies like Poirson and Weber (2011), Bayoumi and Swiston (2009) and Helbling and others (2007) highlight the positive character of the spillover effect. However, these studies have largely confined their analyses to more highly industrialized countries (developed economies), concentrating on cases like the United States, Japan, the eurozone and Germany.

It is important to emphasize that the effect of this spillover depends on how highly developed the economies concerned are, on their level of integration and on the transmission channel (Grossman and Helpman, 1997; Poirson and Weber, 2011; Helbling and others, 2007). According to Bayoumi and Swiston (2009), the three main channels whereby this effect is transmitted are international trade, financial markets and commodity prices. The present study takes international trade as the propagation channel for the spillover effect of China's growth. However, the ambiguity of trade effects on an economy's growth means that a few points need to be made.

Research into the spillover effect of growth commonly emphasizes its positive character, notwithstanding this ambiguity surrounding the effects of international trade, because growth in a country's income will stimulate imports of products from a trading partner. However, if international trade is assumed to be the main transmission channel, it should be stressed that the spillover effect of growth depends above all on the pattern of trade between countries. An increase in productivity in one country may lead to a rise in demand for products from a trading partner, i.e., an increase in

[1] Michaely's (1996) complementarity index shows the extent to which exports from a given country or group match another's imports. The index ranges from 0 to 1, where 0 is no match and 1 is a perfect match.

that partner's exports. Nonetheless, this increase may also drive up that trading partner's imports, as products from the first country become more competitive.

From this perspective, the impact of growth spillover from a major trading partner such as China can be negative for developing economies such as South America's whose trade pattern is based on exporting products with low value added and importing products with high value added. In other words, while the total value exported by South America to China may increase, South American imports of products from that country might increase yet more because China's products have become more competitive, since the competitiveness of these products is partly linked to economic growth (development), i.e., to improvements in the production process.

The effects of international trade on an economy are generally heterogeneous (Kneller, Morgan and Kanchanahatakij, 2008). From this perspective, it should be noted that there are two schools of thought in the literature regarding the impact of international trade. The first, the export-led growth school,[2] emphasizes that export growth has a positive effect on a country's economic growth. Thus, Cândido and Lima (2010) argue that exports played an important and substantial role in the performance of some Asian economies between 1995 and 2005. Lawrence and Weinstein (1999), for their part, note that imports were one of the main determinants of Japan's growth in the period 1964–1973. Acharya and Keller (2008) also point out that imports are a major source of technological learning for a country.

The second school of thought emphasizes the possibility that trade opening might have a negative impact on economic growth. On this view, external trade may lead to a reduction in the industry share of employment and GDP in a given economy (Bresser-Pereira and Marconi, 2010; Nassif, 2008; Oreiro and Feijó, 2010).

An increase in imports may have a negative impact on the economy in the short run but positively affect the growth rate in the long run. According to the theoretical model developed by Grossman and Helpman (1997), an economy may benefit from imports of products and services because it can thereby increase its stock of knowledge. In other words, the authors emphasize that imports positively influence domestic technological progress.

This progress, as highlighted by Solow's neoclassical growth model, is essential to an economy's long-run growth (Romer, 2011). The model developed by Solow emphasizes technological growth as an exogenous variable, but as Grossman and Helpman (1997) argue, it may either be developed domestically or be "imported" from other countries. This process of "importing technology" is known as technological spillover and might be regarded as a subdivision of growth spillover. According to Keller (2009) and Grossman and Helpman (1997), the spillover of technology from one economy to another occurs mainly through international trade and, specifically, through the importing of products and services.

Thus, given all that has been said, it is important to consider the combined effect of imports and exports on economic performance. According to the theory developed by Kaldor (known as Kaldor's laws), both exports and imports need to expand in such a way that they do not produce balance-of-payments disequilibria (Lamonica and Feijó, 2011).

Setting out from Kaldor's laws, Thirlwall and Hussain (1982) developed a theoretical model in which growth in an economy can be explained in part by international demand for products, i.e., by the equilibrium of the trade balance. According to the authors, the main obstacle to long-run growth in developing economies is balance-of-payments disequilibrium, mainly arising from the trade balance.

Given what has been indicated, it is safe to say that one country's growth will have an impact on another's, whether through relations of supply and demand or by technology transfer. Even so, the ultimate effect will depend on the trade pattern between the countries.

[2] This school singles out export growth as the main determinant of a country's income growth.

Furthermore, assuming exports and imports are in equilibrium, the impact of rising demand on a country's growth rate via higher exports will be determined by what set of products are exported. At the same time, as set out by North's (1977) theory of development, diversification of a country or region's export portfolio is vitally important in determining its development and growth. Basically, in an economy whose export portfolio is undiversified and includes products with low value added, export growth will be restricted to a few sectors. Consequently, rising exports will have little effect on economic growth.

III. Methodology

1. The spillover effect of growth based on international trade

A dynamic panel data econometric model was used to determine the spillover effect of China's growth on South America's given the trading relations between the two. The model was made dynamic by including the lagged dependent variable (Greene, 2002).

Although Gomes and Braga (2008) argue that using dynamic panel data models brings benefits such as an increase in degrees of freedom and a reduction in multicollinearity between the independent variables, this procedure complicates the analysis even as it brings greater effectiveness in the estimation of coefficients. The presence of the lagged dependent variable in the model generates a correlation of the independent variables with the error term, specifically the error-lagged dependent variable. This correlation, known as a serial correlation, creates problems of endogeneity between the variables (Greene, 2002).

To correct these problems, use is generally made of instrumental variables such as the estimation of coefficients by the generalized method of moments (GMM). Specifically, the dynamic panel could be estimated using the method developed by Arellano and Bond (1991). This method consists in estimating the equation by using instrumental variables correlated with the independent variables, but not with the error. These instruments can be obtained by means of the lagged variable itself or the lagged difference to find more effective estimators, so that the unobserved heterogeneity in the model, v_i, is eliminated (Gomes, 2007; Greene, 2002). Accordingly, the difference GMM was used in this study.

Given this, the model to be estimated can be expressed as follows:

$$gdp_{i,t} = \beta_0 + \beta_1 gdp_{i,t-1} + \beta_2 termsT_{i,t} + \beta_3\, for\_r\_capital_{i,t} + \beta_4 gdp\_CH_t + \beta_5 gdp\_CH01_t + \beta_6\, year01 + \beta_7\, year08 + u_{i,t} \quad (1)$$

where $gdp_{i,t}$ represents the growth rate of country i (Argentina, Brazil, Colombia and Chile, i.e., $i = 1, 2, 3$ and 4) in period t (for $t = 1, \ldots, T$), $gdp_{i,t-1}$, the income growth rate lagged one period, $terms\_t_{i,t}$ the rate of growth in the terms of trade of country i relative to China, $for\_r\_capital_{i,t}$ the rate of growth of real foreign capital stocks in country i, gdp_CH_t the domestic income growth rate in China, and $u_{i,t}$ the error term of the equation. In addition, dummy variables are included in mixed form to capture the effects of the shift in external trade between these countries in 2001 and since 2008. In the $year01$ variable, the value 0 is assigned to years prior to 2001 and 1 to the rest. Similarly, in the $year08$ variable, the value 0 is assigned to years prior to 2008 and the value 1 to all other years.

The additive dummy variable $year01$ is included in the model to control for the effect on the South American countries' autonomous growth rate of the general expansion of South America's trade with the rest of the world from 2001. The additive dummy variable $year08$ is meant to control

for the effect of the international financial crisis that originated in the United States in 2008. Lastly, the gdp_CH01_t variable is included to capture the effect that China's growing share of South American trade from 2001 had on the spillover of Chinese growth. This variable represents the interaction between the dummy variable $year01$ and gdp_CH_t.

It is important to emphasize once more that applying Arellano and Bond's (1991) methodology does away with endogeneity between domestic prices, external prices and the exchange rate, and likewise the simultaneity between the growth of external income and domestic income.

The model expressed in equation (1) is based on the theoretical model developed by Thirlwall and Hussain (1982). According to this, the long-run growth of a developing economy is determined in part by the relationship between exports, imports and capital flows. That relationship can be expressed as follows:

$$\left(\frac{E}{R}\right)(p_{dt} + x_t) + \left(\frac{C}{R}\right)(c_t) = p_{ft} + m_t + e_t \tag{2}$$

Equation (2) expresses the relationship between the rate of growth in capital flows (c_t), the proportion of imports financed from export revenues (E/R) and the proportion financed by capital flows (C/R), plus the rates of growth of exports (x_t), domestic prices (p_{dt}), external prices (p_{ft}), imports (m_t) and the exchange rate (e_t). Both proportions are used to weight the shares of exports and capital flows, considering that they have a different weight where the balance of payments is concerned (Thirlwall and Hussain, 1982).

According to Thirlwall and Hussain's (1982) model, export and import growth rates can be represented as:

$$m_t = \psi\left(p_{ft} - e_t - p_{dt}\right) + \pi(y_t) \tag{3}$$

$$x_t = \eta\left(p_{dt} - e_t - p_{ft}\right) + \epsilon(z_t) \tag{4}$$

where ψ represents the price elasticity of demand for imports, π the income elasticity of demand for imports, η the price elasticity of demand for exports, ϵ, the income elasticity of demand for exports, y_t the domestic income growth rate and z_t the growth rate of the world (trading partner). According to the model mentioned above, the expectation is that: ψ<0; π>0; η<0; ϵ>0.

Given all that has been said, export and import growth rates can be used to establish a clear relationship between one country's growth rate and another's. This relationship is determined as:

$$y_t = \frac{\left(\frac{E}{R}\eta + \psi + 1\right)\left(p_{dt} - e_t - p_{ft}\right) + \frac{E}{R}(\epsilon(z_t)) + \frac{C}{R}(c_t - p_{dt})}{\pi} \tag{5}$$

In equation (1), the variable $termsT_{i,t}$ represents the relationship (p_{dt}-e_t-p_{ft}), while $for\_r\_capital_{i,t}$ represents the relationship (c_t–p_{dt}) and the variable gdp_CH_t represents the variable z_t.

Thus, the inertia effect of the income growth rate β_1 is expected to be positive. As regards the effect of the terms of trade growth rate, this is expected to have a positive correlation with the dependent variable, since an improvement in the terms of trade would bring with it a relative increase in the value added exported by the countries of South America and, consequently, a rise in their domestic productivity. Nonetheless, it should be stressed that this effect depends on the relationship between the price elasticity of export demand η, the price elasticity of import demand ψ and the income elasticity of import demand π, as well as the proportion of imports financed by exports E/R.

As in the previous case, the rate of growth in real foreign capital stocks $for\_r\_capital_{i,t}$ is expected to present a positive sign relative to the dependent variable analysed. This is because, as Thirlwall and Hussain (1982) and Laplane and Sarti (1997) point out, foreign direct investment plays a very important role in financing growth in developing countries.

Lastly, on the assumption that the spillover effect of Chinese growth has a positive impact on the growth of the South American countries as hypothesized, the ultimate effect of a higher rate of growth in the trading partners' income is expected to be positive.

2. Data sources

The data used in this study come from national and international secondary sources and cover the four South American countries concerned (Argentina, Brazil, Chile and Colombia), besides China. The sources consulted were the World Trade Organization (WTO), the United States Department of Agriculture (USDA) and the United Nations Conference on Trade and Development (UNCTAD).

The data on annual changes in the real exchange rate and on the rate of growth of consumer price indices in each country (Argentina, Brazil, Chile, China and Colombia) are for the reference year 2010 and were obtained from the USDA database. Lastly, the GDP growth rates of the countries analysed in this study, the current values for foreign capital flows and stocks in the countries of South America and the values of the export complementarity and similarity indices for those countries came from the UNCTAD database.

IV. Results and discussion

Given the provisional character of the data used in the dynamic panel estimates, the Levin-Lin-Chu (LLC), Harris-Tzavalis (HT), Breitung and Im-Pesaran-Shin (IPS) unit root tests were applied to all the variables used. For the period studied, the presence of a unit root was only found in the growth rate of the price level in the South American countries. The problem of the non-stationarity of this series was eliminated by taking the first difference of the variable. The variables representing the South American countries' terms of trade with China were then created, together with the variable representing real foreign capital stocks in the South American countries, as described in the methodology of this study. The unit root tests were applied again, and no presence of unit roots was found.

Lastly, Arellano and Bond's autocorrelation test was carried out to check the goodness of fit of the model estimated. This test is applied to the difference residuals of the model and is meant to test for the absence of first and second order serial correlation. According to Silva (2014), the hypothesis of an absence of first order serial autocorrelation is to be rejected, but not second order autocorrelation. In the case analysed, the null hypothesis of first order autocorrelation was rejected with a significance level of 10%. However, it was not possible to reject the null hypothesis in the second order autocorrelation with any level of significance. This test demonstrated that the parameters estimated were robust and that the observed values tended to approach the actual values.

Table 1 presents the results of the estimation of the spillover effect of China's growth on the growth rate of the South American countries. The first variable that appears in the table is for the Latin American countries' growth rate lagged one period. This variable proved statistically significant at a 1% significance level. It also presented a positive relationship with the growth rate of the South American countries. Bearing in mind that this variable represents the inertia of GDP growth, the finding fits the theory, as it is to be expected that the growth of the economy the previous year will influence current

GDP growth and that this causal correlation will be positive. It is also observed that, according to the model, an increase of 1 percentage point in past growth will raise future GDP growth by about 0.18 percentage points.

Table 1
Spillover effect of China's growth on the growth of the South American countries, 1981–2014

Variable	Coefficient	Robust standard errors	Z-statistic	p-value
gdp_{t-1}	0.1833	0.0504	3.63	0.000*
terms_t_CH	0.0483	0.0073	6.59	0.000*
for_r_capital	0.0496	0.0067	7.31	0.000*
gdp_CH	0.2298	0.0948	2.42	0.015**
gdp_CH01	0.4744	0.3724	1.27	0.203^{NS}
year01	-4.7709	3.5061	-1.36	0.174^{NS}
year08	0.7278	0.6043	1.20	0.229^{NS}
constant	0.8928	0.9262	0.96	0.335^{NS}
Number of observations: 128	Wald chi2(3) = 63.73		Prob > chi2 = 0.000	

Source: Prepared by the authors.
Note: * significant at 1%; ** significant at 5%; NS: not significant.
Variables: gdp_{t-1} is the growth rate of the South American countries lagged one period; *terms_t_CH* is the growth rate of the terms of trade between the countries of South America and China; *for_r_capital* is the annual change in real foreign capital stocks in the South American countries; *gdp_CH* is the income growth rate in China; *gdp_CH01* is the dummy variable for interaction between *gdp_CH* and *year01*; *year01* is the additive dummy variable designed to measure structural changes from 2001; and *year08* is the additive dummy variable designed to measure structural changes from 2008.

As expected, the rate of growth in the terms of trade between the South American countries and China presented a positive and significant relationship at a 1% significance level in the period 1981–2014. Thus, the increase of 1 percentage point in the *terms_t_CH* variable entails a rise of some 0.048 percentage points in the average growth rate of the South American countries. Considering that this variable represents the ratio between the prices of the products exported by the South American countries and the prices of the Chinese products imported by these countries, the relatively low value presented by the estimated coefficient of this variable fits with expectations, since the transactions of the South American countries with their trading partners centre mainly on exports of products with low value added (commodities and products with little technology content) and imports of products with high value added (Cunha, 2011).

A specific example that can be taken is the trade of Brazil (the leading representative of South America where trade flows and GDP are concerned) with China. Historically, this relationship has been characterized by the expansion of Brazilian exports to China of products with low value added, as against which imports of products with higher value added have increased (Mattos and Carcanholo, 2012). It should also be pointed out that one of the main characteristics of products with low value added (commodities) is that their production has few repercussions on the domestic economy compared with other products and sectors, since there are few forward or backward linkages. Consequently, if South America's trade with China continues as it is now, even if the terms of trade improve and output in the beneficiary sectors subsequently rises, the ultimate effect on growth in South America's economies will be small, as illustrated by table 1.

Meanwhile, the *for_r_capital* variable, expressing the effect of real foreign capital stocks on the South American countries, proved significant at the 1% level, with a positive sign. This accords with expectations, since capital stocks are essential to the development of the South American countries and developing countries in general, owing to their importance in financing balance-of-payments deficits (Thirlwall and Hussain, 1982).

Nonetheless, the estimated coefficient indicates that the effect of this variable on South America's growth rate has been fairly small, since growth of 1 percentage point a year in these capital stocks will entail an increase of about 0.049 percentage points. Considering the importance of foreign direct investment to developing economies (both peripheral and semi-peripheral), the *for_r_capital* variable was expected to exert a greater influence on the growth rate in the South American countries, as highlighted by Thirlwall and Hussain (1982), Laplane and Sarti (1997) and Aoun, Verdi and Sato (2008).

The small impact of the *for_r_capital* variable may possibly be due to the influence exercised on it by inflation in the South American countries. By definition, this variable is determined by the difference between the annual change in capital stocks in current values and by the rate of growth in the price index for the South American countries. Considering that, as Bandeira (2002) points out, inflation has been traditionally high in the South American countries, the impact of real capital stocks will tend to be limited.

As regards the *gdp_CH* variable, which represents the rate of Chinese income growth and thence the coefficient of the spillover effect of China's growth on the growth rate of the South American countries, table 1 shows that the estimated coefficient is statistically significant: it presents a significance level of 5% and has a positive correlation with these countries' growth rate. This result fits the original working hypothesis and bears out the importance of China's growth to the South American countries given that, if other conditions remained unchanged, this growth would lead to growth in the subcontinent.

In view of what was said in the introduction and literature review of the present study, this spillover effect of Chinese growth should have a positive influence on the South American growth rate for two reasons: first, because of rising Chinese demand for South American products, as indicated in the theoretical model developed by Thirlwall and Hussain (1982), and second, because of the access the South American countries have had to China's stock of knowledge via imports of goods and services, as highlighted by Grossman and Helpman (1997).

Specifically, of all the variables included in this first analysis, this is the one that has the greatest impact on the growth rate of the South American countries, as an increase of 1 percentage point in China's growth rate will lead to an increase of roughly 0.23 percentage points in the growth rate of the South American countries. In other words, this variable reaffirms the importance of Chinese growth for the countries of South America.

The interactive dummy variable *gdp_CH01*, included to check whether there were changes in the spillover effect of Chinese growth on the South American growth rate from 2001, was not statistically significant. This finding suggests that the increase in trade flows between the South American countries and China did not significantly alter the spillover effect of Chinese growth on the South American growth rate. Thus, it is seen that the size of trade flows between two countries is not the main determinant of the spillover effect.

This result accords with the theoretical model used in the present study. According to Thirlwall's (1979) model, a precursor of the one used in this study, an economy's growth rate is roughly equal to the growth rate of exports divided by the income elasticity of imports. If an economy is to attain higher long-run growth rates, then, there need to be changes in the pattern of imports (the income elasticity of imports), plus an increase in product exports. On the basis of what was presented in the introduction to this study, it can be inferred that both grew in virtually equal proportions between 2001 and 2014, which implies that export growth had only a minimal effect on the growth rate in the South American countries.

To put it another way, exports of South American products to China have increased almost exponentially since 2001. This increase would be expected to have had a positive influence on the growth rate of the South American countries, with export growth in the period potentially stimulating domestic productivity, as pointed out by authors from the export-led growth school such as Edwards (1992), Melitz (2003) and Wacziarg and Welch (2008), who argue that growth in exports (or trade in general) plays an essential role in raising the domestic growth rate.

However, growth in the volume of South American product exports to China has been accompanied by a rise in imports of Chinese products into these countries, which may have discouraged domestic productivity growth. This possible negative effect on domestic productivity is ascribed in part to the so-called deindustrialization process highlighted by Bresser-Pereira and Marconi (2010), Nassif (2008) and Oreiro and Feijó (2010). Given this, it is hypothesized that the interaction of these two effects could cancel out the substantial rise in South American exports to China or reduce the positive effects of this.

It is important to take account of the diversity of the South American export portfolio. As North (1977) points out, the diversification of a region's export portfolio is a vital factor in calculating the impact of the export sector on that region's income. Consequently, a region with an undiversified export portfolio will not earn so much from an expansion of exports. Furthermore, because the value added of the South American export portfolio is low, the repercussions of higher exports on the economy will be quite limited.

Table 2 shows that South America's export portfolio is much less diverse than it could be. The complementarity index, shown in table 2, reveals how little capacity South American exports have to meet Chinese demand for imports.

Conversely, table 2 shows China's greater capacity to meet the demand for imports in the South American countries. On average, it can be seen that the South American export portfolio covers only 29.1% of all Chinese demand. As against this, China's covers an average of 44.9% of demand in the countries of South America. Chinese products are clearly better positioned in South American markets than South American products in Chinese markets.

Table 2
Complementarity index

Year	China - South America	South America - China
1995	0.418	0.276
1996	0.419	0.267
1997	0.427	0.281
1998	0.428	0.271
1999	0.434	0.275
2000	0.456	0.300
2001	0.456	0.297
2002	0.417	0.284
2003	0.421	0.282
2004	0.433	0.285
2005	0.454	0.288
2006	0.466	0.293
2007	0.455	0.290
2008	0.475	0.313
2009	0.471	0.307
2010	0.476	0.303
2011	0.473	0.307
2012	0.474	0.307
2013	0.479	0.297
Average	0.449	0.291

Source: United Nations Conference on Trade and Development (UNCTAD), "Data Centre", 2015 [online] http://unctadstat.unctad.org.

Besides all the above, the final effect of this spillover is directly related to the income elasticity of export demand ϵ, the income elasticity of import demand π and the percentage of imports financed by export revenues. On the one hand, an increase in π will reduce the Chinese spillover effect; on the other, an increase in ϵ and in the percentage of imports financed from export revenues will increase

this spillover. Specifically, it is possible to deduce that growth in imports of Chinese products into the South American countries is partly determined by growth in the income elasticity of import demand and that this growth cancels out the increase in the percentage of imports financed by revenues from exports to China and the income elasticity of export demand.

Thus, considering that the Chinese spillover effect depends on the income elasticity of export demand and that this is determined in part by the complementarity of South American exports and Chinese imports, any increase in it in the South American economies will come about because South American products represent a greater share of Chinese imports. As table 2 shows, however, there has been no significant change in the index of complementarity between them, which explains why the spillover effect of China's growth has been stable.

This stability may reflect, first, a lack of public policies to diversify South America's portfolio of exports to China such that this increase meets demand for products imported by the country and, second, an inability by South American producers to participate successfully in Chinese markets. South America's inability to penetrate Chinese markets is partly due to the domestic situation in that country. According to Filgueiras and Kume (2010), China's highly competitive character is explained by low-quality and thus lower-priced products. Schott (2006) mentions low wages in China as another possible reasons for its high level of competitiveness.

Lastly, although additive dummy variables (*year01* and *year08*) have been included to measure any possible structural change in the average growth rate of the South American countries, neither is found to be significant. Thus, neither the expansion of trade flows in 2001 nor the crisis of 2008 had a direct influence on these countries' growth rate. Besides these variables, the constant expressed in the model was not significant for the analysis either.

Although many studies have emphasized China's importance to South American trade since 2001, examples being Cunha (2007 and 2011) and Crossetti and Fernandes (2005), the present article shows that there has been no statistically significant alteration in the Chinese spillover effect on average growth in the South American countries. Thus, even if China has become a major source of growth spillover because of its strong demand for commodities, as highlighted by Poirson and Weber (2011), its impact on the rate of growth in the South American countries has not altered significantly over recent years.

When considering China's trade relationship with South America, it is important to emphasize that the country is placing local industries under great pressure because of its presence in markets that are important to industrial development (Mattos and Carcanholo, 2012). Consequently, growth in the Chinese economy also has an undesired effect on growth in the South American countries.

Lastly, it is concluded that the table 1 estimates are statistically significant and agree with the hypotheses of this study. Nonetheless, while the spillover effect of Chinese growth may be positively correlated with growth in the South American countries, it has not been influenced by the significant increase in trade flows between China and South America since 2001.

V. Final considerations

Given that China's growth has had a positive influence on its trade flows with the South American economies, especially in the last 10 years, the present study has sought to analyse the spillover effect of Chinese growth on growth rates in the countries of South America. Special attention has been paid to the impact of China since 2001, as it is since then that trade flows between China and South America have changed most dynamically. In particular, and on the basis of the theories presented in this study, it has been pointed out that the impact of China's growth on the growth rate of the South American countries has operated primarily through trade between them.

As expected, China's growth has been found to have had a large positive impact on the growth of the South American countries in the period 1981–2014. Consequently, taking models of international demand as the basis, it can be said that China's demand for South American products has had a positive influence on these countries' productivity. Thus, this relationship means that Chinese growth, or more specifically growth in Chinese demand, has been a major factor in the growth of the South American countries, despite its exogeneity relative to the continent's economies.

In addition, considering that trade flows between China and the South American countries increased greatly from 2001, this study has sought to analyse the impact of this increase on the spillover effect of Chinese growth. It has been shown, however, that there has been no statistically significant change in this effect since 2001. Importantly, too, there was no great change in the index of complementarity between South American exports and Chinese imports over the period analysed. In other words, there was no increase in the diversity of South America's portfolio of exports to China, even though the complementarity index suggests that the number of products exported by these countries might increase.

Thus, it can be said that growth in exports to China by traditional sectors (commodities) is not enough by itself to affect the growth spillover in these countries from trade. Accordingly, it is important to adopt policies to diversify South America's portfolio of exports to China, whether by maintaining prices, facilitating exports or investing in infrastructure that serves to increase the competitiveness of South American products in the international marketplace.

Thus, while there may be a positive relationship between China's growth and that of the leading economies of South America, policies are needed to expand the portfolio of South American exports to China. This is of the highest importance for increasing the spillover effect of Chinese growth on that of South America. As observed, China's growth has been remarkable even by the standards of other similarly developed countries.

Despite the difficulty of competing directly with these countries, given how competitive they are, increasing the spillover effect by enhancing trade in a variety of sectors is an important path to growth. However, little advantage has been taken of China's rapid growth.

Lastly, notwithstanding the importance of expanding South America's portfolio of exports to China, this study has not been able to go into detail on the subject. Further research is therefore needed to show which among the potential Chinese markets will ensure the greatest earnings, i.e., which of the products in demand in China can be exported by the South American economies. It is also important to emphasize that South American markets have been negatively influenced by the Chinese presence.

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Territorial inequality, equalization transfers and asymmetric sharing of non-renewable natural resources in Latin America

Giorgio Brosio, Juan Pablo Jiménez and Ignacio Ruelas

Abstract

Non-renewable natural resources (NRNR) contribute a large share of tax revenue in Latin American countries; and the fact that these resources are concentrated in just a few regions generates a high level of territorial inequality. This paper aims to analyse how NRNR revenues could be included in equalization grants, and how countries are implementing adequate equalization grant systems, or could do so. Based on fiscal equalization theory, vertical and horizontal systems are evaluated with reference to mid-level governments in Argentina and Peru. The study identifies a variety of political and economic costs for different NRNR revenue systems, where: (i) the provinces own the resources in question (Argentina); and (ii) NRNR revenues are collected and distributed by central government to a large number of subnational governments under a fully asymmetrical scheme (Peru).

Keywords

Renewable resources, tax revenues, local government, income, regional disparities, fiscal policy, Latin America, Argentina, Peru

JEL classification

Q380, H710, H770

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I. Introduction

A large and growing number of countries, including some in Latin America, are sharing non-renewable natural resource (NRNR) revenues asymmetrically with their local governments. Asymmetrical sharing may entail assigning a fiscal instrument, such as the right to levy royalties on oil and gas, exclusively to the governments of provinces where the resource is produced, as happens in Argentina. Alternatively, it may involve assigning a share of the revenue collected by the central government exclusively to the producing areas, as in the case of royalties in Brazil, or royalties and income tax in Peru.

Asymmetrical sharing is a non-necessary consequence of the spatial concentration of natural resources within countries. In practice, many countries do not use this arrangement, but prefer to share the revenue with all local governments. Asymmetrical sharing can create huge horizontal imbalances between different local government units, with impacts on equity, efficiency, and national cohesion.

Including NRNR in revenue equalization systems raises a number of issues and problems. These include the difficulty of defining the base on which the transfers are calculated; the high cost of equalization; the cyclicality of the revenues in question; the efficiency impact of including natural resource revenue in the equalization grants framework; and the fact that natural resources are exhaustible.[1]

Although revenue from natural resources is one of the main sources of local fiscal inequality, it is never considered in the revenue-sharing formulas used in Latin America —possibly because this revenue was (and perhaps still is) not considered tax revenue, which in fact it is (see, for example, Martínez Vázquez and Sepúlveda, 2012; Tommasi Saiegh and Sanguinetti, 1999).

The article is structured as follows. Section II is the most substantive and starts with a short presentation of the principle of interjurisdictional equity, before examining the main issues and challenges posed by including NRNR in equalization schemes. Section III provides an illustration of the different systems of equalization transfers that can be used for NRNR, weighing the advantages and disadvantages of each one. Section IV discusses territorial inequality, the assignment of natural resource rents to subnational governments in Latin America, their importance and spatial concentration and the implications that arise for equalization transfers. Section V considers the cases of Argentina and Peru. The aim here is not to suggest specific reforms for these countries, but to illustrate the main options for equalization and discuss their merits and shortcomings. The final section summarizes the conclusions.

Before proceeding to the next section, some terminology needs to be clarified. Strict economic criteria are applied in the selection of revenue sources, taxes and fees subject to equalization, also including royalties that are sometimes and, in some places, classified as non-tax income. Basically, there are no economic differences between income taxes and royalties (the two most common instruments used to extract natural-resource rents), because the revenue they generate in each case is the product of a tax rate applied to a tax base.

II. Interjurisdictional equity principle and issues associated with the equalization of natural-resource revenue

The interjurisdictional equity principle provides the rationale for equalization transfers. A general statement of the principle is that persons in comparable circumstances should have access to comparable public

[1] Also, according to the Government Finance Statistics Manual (IMF, 2014), when a unit extracts a mineral or energy resource under an agreement in which the yearly payments are a function of the amount extracted, the payments (sometimes described as royalties) are recorded as rent.

services in all places (Boadway, 2015). In other words, in the intergovernmental framework, equity implies that place of residence should not create differences between citizens in their access to public services or in the cost of access. Nonetheless, there are different interpretations of this principle (see box 1).

Box 1
Interjurisdictional equity: strictest interpretation

The strictest interpretation would mean that citizens in the same situation should have access to exactly the same quantity/quality mix of services and pay the same amount in taxes, wherever they reside.

$$\frac{\sum_1^t E_{c,d,ef,..j}}{R_{j,wy}} = k \text{ for each local jurisdiction } n \qquad (1)$$

where:

- E is expenditure on service t;
- R is the revenue that finances the service;
  - $c, d, e, f, \ldots$, is a set of characteristics determining the quality and quantity of service t; impacting on expenditure. Standards are expressed in terms of these characteristics and may also coincide with them. They are also referred to as standards in the literature.
  - w and y are the characteristics that determine the burden of taxes and/or levies imposed to finance the service. Naturally, these characteristics apply only when subnational governments have tax autonomy, in other words the faculty to determine the tax burden, at least partly. Examples would be tax rates, free public transport, or exemptions from health service payments for the elderly poor.
  - j is the beneficiary group.
  - k is the equity parameter.

Inter-jurisdictional equity is ensured by the equality of the k parameters —one for each group of individuals— across all jurisdictions. This would mean that individuals in comparable conditions, for example elderly people living alone, will be subject to the same proportional difference between what they receive in terms of health care and what they pay for it.

The higher the value of parameters c, d, e, f, the stronger is their upward impact on expenditure, increasing the gap with respect to revenue (and *vice versa* for low parameter values). The lower the value of the parameters applied to revenues the lower also is the revenue intake.

The average national value of k across all groups of individuals and all subnational governments measures the existing vertical fiscal imbalance, which is defined as the proportion of local expenditure that is financed by local revenues.

Full equalization implies that the transfer to each local government, T_n, is equal to the difference between expenditure and revenue:

$$Tn, = \sum_1^t E_{c,d,ef,..j} - R_{j,wy} \qquad (2)$$

Source: Brosio, G. and J. P. Jiménez (2015), "Equalization grants and asymmetric sharing of natural resources: options for Latin America", *Urban of Public Economic Review*, No. 2163, Santiago de Compostela, University of Santiago de Compostela.

Fully homogeneous service provision between jurisdictions requires very detailed constraints, in terms of standards defining every relevant characteristic of quality and quantity. This would make the operation of a decentralized system of government analogous to that of a centralized system; but then there would no longer be a rationale for having a decentralized system of government.

1. Which variable to equalize?

There are two major choices concerning the economic variable on which equalization is performed. The first is between actual revenue and fiscal capacity, and the second is between gross and net revenue. Actual revenue is the total amount collected by local governments from their various revenue sources. Although it is a very simple instrument in terms of information requirements, it does not provide the correct incentives to local government when used in equalization. For example, a wealthy local government that levies a property tax could be tempted to apply very low tax rates, thus reducing its revenue intake and becoming eligible for equalization transfers.

Fiscal capacity, which the literature also refers to as standardized revenue, is not the actual tax intake, but what a local government would collect by applying the average tax effort exerted by all other governments to its own tax base, and calculated as the average tax rate applied to different revenue sources (as illustrated below with reference to Canada). This means that transfers do not reward subnational governments that have a below-average tax burden, because their fiscal capacity, on which the transfer is determined, would exceed actual revenue. Fiscal capacity equalization is both equitable and efficient.

In principle, fiscal capacity equalization should be applied to all revenue sources and when subnational governments have tax autonomy. This may be a difficult exercise in the case of natural resource revenues, because of the large number of natural resources subject to taxation and the different characteristics impacting on price and revenue. For example, iron ore may have a different mineral content in different provinces, and a different value that would have to be taken into account when determining fiscal capacity. This can prove exceedingly difficult. Australia, however, has worked hard to estimate fiscal capacity for minerals (Searle, 2004), while Canada has decided to use the actual revenue intake instead (Boucher and McLure, 2015).

Secondly, there is the question of what to equalize —gross or net revenue. Raising revenue entails cost and requires effort, so gross revenue exceeds net. Also the difference between gross and net does not represent an element of fiscal capacity that requires equalization.

Revenues are never expressed in net terms for taxes and other levies not based on natural resources, such as personal income or property taxes. In equalization systems it is assumed that there are no collection costs for the taxes that are included in the equalization process. This is a reasonable and simplifying assumption when all the subnational government units involved have access to the same tax bases, because collection costs should be broadly similar across the various areas.

In the case of NRNR, however, this no longer holds true. Although most of the investment for the exploitation of natural resources is done by the producer firms directly, additional investment in local infrastructure specifically related to natural resource exploitation is usually required. Roads to the mines and oil fields have to be built; airports and ports may need upgrading. The production phase usually attracts migrant workers and their families into the producing areas. These flows generate new costs for the destination governments in terms of the demand for services and the need for new infrastructure (schools, health, transport and social services).

Local governments thus operate as factors of production contributing to the creation of the natural resource rent. They bear a cost that does not usually exist in the case of general taxes. Accordingly, NRNR revenue needs to be calculated in net terms, to evaluate the amount of the additional fiscal capacity that their availability generates for the governments that have access to their revenue.

Two systems are used to net gross revenues. The first is to operate on the expenditure side by including, within an expenditure needs and fiscal capacity equalization model, the expenditure needed for production (roads for example) or for the provision of services to the new population, or also to avoid environmental damage. On the revenue side, gross revenue is used. The model will take into account both the expenditure requirements of producer areas and the need to redistribute revenue in favour of non-producers.

The second alternative is to act exclusively on the income side by deducting from gross revenue the additional expenditure needed for production and for the additional provision of services and to compensate for environmental damages caused. Although the outcome of the two systems is similar, the financial cost of equalization is lower in the second case, which amounts to lowering the peaks considered for equalization.[2]

[2] Canada has partly solved this problem by applying a factor to scale back natural resource revenues subject to equalization.

2. Revenue cyclicality

The large fluctuations that occur in natural resource prices mean that revenues also vary widely. In some taxes, oscillations are also exacerbated by progressiveness, such as the taxes on income and rent, used for rent extraction.

When a system of equalization transfers that redistribute NRNR revenues to the benefit of the subnational governments of the non-producing areas is introduced, the revenue fluctuations are extended to the whole set of local governments, thereby exacerbating expenditure efficiency problems and also creating severe funding problems for the central government in vertical and open-ended equalization systems.

There are various instruments for dealing with the impact of revenue fluctuations on equalization transfers. A prima facie simple instrument consists in acting directly on the oscillations by implementing stabilization funds for subnational revenues and then determining the transfers on the basis of the stabilized revenue than can be channelled to the budget, according to the rules of the stabilization fund.[3]

An alternative solution would be to change the standard for equalization over time, reducing it in years of high revenue and raising it in low revenue periods. This would make the system more manageable, but it would also mean that the revenue gap between the richest and the poorest jurisdictions will vary according to natural resource price cycles.

3. Highly skewed distribution deriving from the spatial concentration of the resources

The heavy concentration of revenue in just a few jurisdictions poses a major challenge when implementing the principle of interjurisdictional equity, since it requires a system in which equalization transfers can become negative for the wealthiest jurisdictions.

The expression in the denominator of the left-hand component of equation (1) in box 1, $R_{j,wy}$ describes a system of revenue sources, in which receipts derive from the application of centrally defined parameters, such as tax rates, to locally assigned tax bases. Local assignment of NRNR revenue, combined with a distribution that is highly skewed in favour of a few jurisdictions, can result in total revenue in these jurisdictions exceeding, perhaps greatly, the amount of expenditure determined in the numerator of the same equation. To fulfil interjurisdictional equity, or, more specifically, to keep the equity parameter k equal for all, the revenue of these jurisdictions needs to be curtailed, which means their equalization transfer becomes negative. Horizontal equalization schemes are the technically appropriate instrument for negative transfers, as will be seen below, although they will likely be resisted by the paying jurisdictions.

4. Efficiency issues

Efficiency issues have to be approached from two distinct points of view. The first refers to the impact of revenue on migration by firms and individuals, specifically labour. When NRNR revenue is not equalized, resource-rich jurisdictions will be able to attract firms and workers by providing them with additional services or reducing the tax take. These moves create inefficient patterns of location across the country

[3] This alternative is not feasible in federal systems, where states or provinces cannot be forced to have stabilization funds. Moreover, if they do have them, they are free to determine the rules governing the flows into and out of the funds. In centralized systems, such as Peru, where natural resource revenues are collected by central government and then transferred, the latter could introduce not only subnational stabilization funds, but also a system for averaging NRNR revenue allocations over a medium-term period.

since migration would not be dictated by genuine economic location factors, such as proximity to market, or communication costs.[4]

The second efficiency problem refers to the impact of equalization transfers on the level of production of natural resources. In general, the existence of transfers induces the governments of the producing areas to reduce production, insofar as they have decision-making power over this. Here, a distinction needs to be made between equalization of actual revenue and equalization of fiscal capacity. In the case of actual revenue, the more a subnational government collects, the smaller the transfer it will receive. Hence, there is an incentive to reduce production; for example by denying exploration and operating permits.

When equalization is based on fiscal capacity, a variation in tax rates does not impact on transfers, thereby neutralizing the impact of equalization transfers on production. Underlying this second efficiency problem is the idea that the production level should be decided on the basis of broader criteria than the amount of individual transfers.

III. Approaches to equalization transfers

1. Interjurisdictional equity in the practice of decentralized systems

In the reality of most advanced equalization systems, equity is attained when transfers provide subnational governments with sufficient revenues to ensure that individuals in comparable circumstances have access to comparable public services in all localities after paying comparable levels of taxes and fees. In Canada this goal is explicitly stated in Subsection 36(2) of the Constitution Act of 1982: "Parliament and the Government of Canada are committed to the principle of making equalization payments to ensure that provincial governments have sufficient revenues to provide reasonably comparable levels of public services at reasonably comparable levels of taxation." In Australia, the interjurisdictional equity principle is not mentioned in the Constitution; nor is it defined in legislation or described in any agreement between governments. Instead, the definition has evolved over time, largely through the Commonwealth Grants Commission (CGC). The current CGC definition of the goal of equalization transfers is as follows: "State governments should receive funding from the pool of GST revenue such that, after allowing for material factors affecting revenues and expenditures, each would have the fiscal capacity to provide services and the associated infrastructure at the same standard, if each made the same effort to raise revenue from its own sources and operated at the same level of efficiency" (Commonwealth Grants Commission, 2010, p. 34).

2. Equalization of expenditure and revenue

Considering real-world examples, in Australia the standardized expenditure for each function is determined by applying a number of parameters ("relativities") to the average per capita expenditure of the states for the various functions, which impact on the expenditure needed to provide the services at a level deemed adequate.

Using the symbols of equation (1) the Australian system can be described as follows:

$$\frac{\sum_1^t SE_j}{SR_j} = k \text{ for each local jurisdiction} \qquad (3)$$

[4] A simple illustration of the efficiency problems is provided by Boadway and Flatters (1993).

where:

- SE is standardized expenditure, in other words the expense needed to provide the same quality and quantity mix for each service, assuming a national average rate of efficiency;
- SR is standardized revenue, in other words the revenue that can be collected by applying the average national tax rate to the potential (not the assessed) tax base.

Interjurisdictional equity and efficiency require that all subnational expenditures and all revenue sources assigned to the subnational government be considered when calculating the equalization grant. Insofar as rents from NRNR are assigned to subnational governments and, as such, constitute a source of revenue, they need to be included in equalization schemes.

Systems of the Australian type, discussed below, are the most comprehensive. They are targeted to ensure full equalization, closing both expenditure and revenue gaps (Searle, 2004). On the expenditure side, they potentially also include the additional costs and needs associated with the extraction of natural resources, hence addressing the difference between gross and net revenue.

3. Revenue equalization only

Alternative systems that act on the revenue side alone can also have a substantial equalization impact, and are less demanding in terms of information and administration complexity. Some of these systems may also be developed through time into a full expenditure- and revenue-based equalization system.

With specific reference to NRNR rents, the main alternatives are the following:

(a) Including rents obtained from natural resources in the set of revenues to be equalized, as in the Canadian system,

$$T_n = t_{si} \times (B_{si} / P - B_{ni} / P_n) \times P_n \quad (4)$$

where:

- TT is the total grant;
- T_n is the grant made to province n;
- t is the tax rate;
- B_i is the tax base of each of the i revenue sources subject to equalization;
- P is the population;
- si is the equalization standard, for example, the national average across all provinces subject, of each revenue source to equalization, as in Canada today, or the average of a group of provinces (as in Canada initially); and
- n represents beneficiary provinces, that is those for which the difference in the parentheses is positive.

Also:

$$TT = \Sigma T_n \quad (5)$$

The total grant is financed with a varying share of central government revenue, α.

If the standard provinces become wealthier —for example, following a huge increase in the price of the natural resources they exploit— the difference between them and other provinces will increase, forcing the central government to expand the total amount paid in equalization.

This is exactly what happened in Canada following the first oil shock. The huge hike in oil prices at that time inflated revenue in Alberta, where practically all Canadian oil production was concentrated. The standard tax base (the national average at that time) surged, requiring, *ceteris paribus*, a similar expansion in grants. Since the federal government had access to just 10% of oil revenues, keeping to the formula would have meant financing equalization payments out of its own tax revenues, thus facing a choice between incurring a deficit or squeezing its own expenditure.[5]

Over the years, Canadian governments have made basic corrections to the formula such as: (i) exclusion of the Alberta tax base from the equalization standard; (ii) outright exclusion from equalization payments of provinces, such as Ontario, that have a non-oil tax base above the national average; (iii) exclusion of a portion of the oil tax base from the equalization system; and (iv) imposition of a ceiling on the total amount paid in equalization.[6] Canada currently includes 50% of NRNR revenues in the equalization base. In other words, it equalizes up to 50% of differences in NRNR revenues.[7]

(b) The second alternative is to use a separate equalization system for natural resources.

In this case only revenue from natural resources is equalized, and equalization may also be funded only with NRNR revenues, implying no impact on other revenue sources.

That is:

$$T_m = t_s \times (B_s / P - B_n / P_n) \times P_n \quad (6)$$

where t and B refer to natural resource revenues only.

In some countries, separate equalization systems are generally funded only by natural resource revenues and do not *consider* other income sources. This is not a necessity, however. When equalization systems are funded with NRNR revenues alone, they amount to reserving a share of total national NRNR revenue for jurisdictions that produce little or nothing in the way of natural resources, and distributing them either according to the gap between their NRNR revenue and the national average, or according to other needs or indicators related to revenue capacity.

4. Vertical and horizontal equalization

There are two versions of equalization mechanisms: the vertical equalization model, as exemplified by the Australian and Canadian systems, whereby grants are paid by central government to subnational governments; and the horizontal equalization model, used in Germany (*Länderfinanzausgleich*), in which grants are paid from relatively wealthier jurisdictions to relatively poorer ones, without central government funding (see Spahn, 2001). Horizontal systems are closed, requiring no central-government funding. The Chilean Common Municipal Fund (*Fondo Común Municipal*) is another example of a horizontal system (Ahmad, Letelier and Ormeño, 2015).

[5] Furthermore, the disparity between Alberta and other provinces became so large that even wealthy provinces, such as Ontario, became beneficiaries of equalization transfers; although ultimately the transfer resulted from the federal government using the tax bases located in their jurisdiction (see Courchene, 1979 and 1988).

[6] In addition to actual reforms, a wide variety of proposals have been advanced in Canada to contain the cost of natural resource revenue equalization. Gainer and Powrie (1975) suggested that rents, profits and interest accruing to provincial governments should be taxed in the same way as factor incomes generated in the private sector. Given an average 30% effective tax rate, roughly 70% of NRNR revenues should be kept by the provinces and contribute to the base on which equalization is calculated. A non-parametric solution has been advanced by the Parliamentary Task Force on Federal-Provincial Fiscal Arrangements, under which only the portion of natural revenues that is used for budgetary purposes should be included in the equalization formula, which means that the portion syphoned off into non-budgetary heritage funds should be excluded.

[7] Office of the Parliamentary Budget Officer (2014).

In the vertical model, the skewness of the distribution of revenues to be equalized influences the total amount of the grant. Specifically, in open-ended systems, such as Canada's, where there is no upper limit to the total amount disbursed by the federal government, whenever the standard tax base —on which revenues are equalized in the jurisdictions concerned— increases, the total amount of the grant is also bound to increase, *ceteris paribus*. This may put central government finances under such a severe strain that the formula has to be changed.

Horizontal models do not face the same constructional difficulties. The degree of equalization is built into the formula and is not imperilled by sudden changes in the total amount of natural resource revenue and/or in the skewness of their distribution. Moreover, potential strains on central government finances cannot arise if the standard is set at the national average, because the total grant from net payer jurisdictions is equal to the total received by the beneficiary ones.

A typical formula based on fiscal capacity equalization, which amounts to revenue standardization, would be:

$$TT_J = \beta_J \left[ts\left(TB_J - TB_s\right)\right] \tag{7}$$

and

$$TT_I = \beta_i \left[ts(TB_s - TB_I)\right] \tag{8}$$

where, in addition to the symbols defined previously: β_{jI} are the equalization standards applied to the paying and receiving jurisdictions; J are the paying jurisdictions; and I are the beneficiary ones.

Thus,

TT_J is the total grant paid by the contributing jurisdictions according to the standardized tax rate ts and the grants required to attain the net national standardized average.

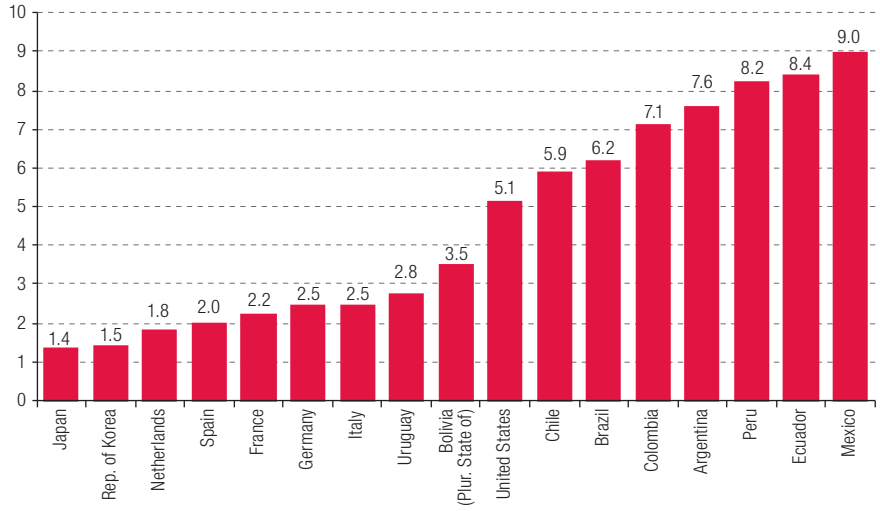
TT_I is the total grant received by the beneficiary jurisdictions according to the standardized tax rate ts and the grants required to align all regions to the net national average.

The stress is placed instead on the natural resource-rich jurisdictions, particularly if they represent a small share of the total national population. More specifically, the share of NRNR revenue they can retain is inversely related to their national population share. If equalization is designed to fully equalize per capita revenues, then the revenues shares retained by producer jurisdictions is the inverse of their population shares.

IV. Territorial inequality and fiscal disparities of NRNR in Latin America

One emerging issue that needs to be explored is territorial inequality within countries (ECLAC, 2017). The indicators most frequently used to gauge territorial differences in the same country include the ratio between the per capita GDPs of the wealthiest and poorest regions (in most cases measured at the level of major administrative divisions). In Latin American and Caribbean countries, the ratio between the highest and lowest regional per capita GDP generally exceeds 6:1 (except for Uruguay), while in developed countries it is seldom above 3:1 (see figure 1, ECLAC, 2017; Muñoz, Radics and Bone, 2016).

Figure 1
Territorial inequality in Latin America and OECD countries: ratio of regional per capita GDP (max/min), 2012–2015



Source: Prepared by the authors, on the basis of official data from the Economic Commission for Latin America and the Caribbean (ECLAC) and the Organization for Economic Cooperation and Development (OECD).

On the other hand, the NRNR contribution to public revenues is very large in a number of Latin American countries, as much as 40% in the Bolivarian Republic of Venezuela, Ecuador, Mexico, and Trinidad and Tobago in 2005–2008 (see Gómez Sabaini, Jiménez and Martner, 2017).

The highly unequal regional distribution of revenue implies sharp fiscal disparities. This is true when subnational taxes are levied on highly concentrated tax bases, such as consumption (for example ICMS in Brazil, "gross incomes" in Argentina, selective taxes in Colombia), or payroll in Mexico (see Muñoz, Radics and Bone, 2017); but it is even more significant when the tax base is NRNR because the deposits in question are highly concentrated regionally.

Argentina, Peru and the Plurinational State of Bolivia provide telling examples of the impact of NRNR revenues on subnational finances. In Peru, NRNR generates 15% of departmental revenue and accounts for 25% of the country's revenue inequality. In Argentina, a tiny share of provincial revenue generates around 18% of its fiscal inequality. In the departments of the Plurinational State of Bolivia, the direct hydrocarbons tax (IDH) —which is the main fiscal instrument used to extract hydrocarbon rent— plus other NRNR revenues (royalties) represents over 87% of total revenues and also generates more than 90% of inequality; almost 50% of NRNR is concentrated in Tarija which is the country's wealthiest department in per capita GDP terms (see table 1 below).

Table 1
Selected countries (3): NRNR revenue and territorial inequality, 2012–2015

Country	GDP gap	Wealthiest region	Poorest region	Fiscal instrument of NRNR revenues	NRNR revenues as percentage of subnational revenues	Inequality of subnational fiscal revenues (Gini)	NRNR revenues as percentage of subnational fiscal inequality (decomposition of Gini)
Argentina	7.6	Santa Cruz	Formosa	Royalties	2.7	0.238	18.0
Bolivia (Plurinational State of)	3.5	Tarija	Beni	Direct hydrocarbons tax (IDH) and royalties	87.3	0.541	99.2
Peru	8.2	Lima	Madre de Dios	Mining canon, sub-canon, royalties	4.8	0.327	25.0

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

V. Equalization transfers: alternatives for Latin America

As indicated in the first part of this article, this section simulates an equalization transfer system (vertical model) for the regions of Argentina and Peru (provinces). The horizontal model is simulated only for the provinces of Argentina.

In the simulation for Argentina, equalization is performed with respect to fiscal capacity. The standardization of own taxes uses geographical GDP (INDEC, 2004=100) as the tax base, while NRNR production is used for royalties. In Peru, equalization is performed relative to fiscal capacity for own taxes, again using regional GDP, with reference to actual revenue for the canon and sub-canon (NNRR). The simulations are evaluated before and after equalization transfers, using the following indices relative to total revenues: coefficient of variation (CV), fiscal gap (max/min) and the Gini coefficient.

1. Argentina

Argentina's provinces finance themselves with their own taxes, general and specific transfers, royalties and other revenues. Internally generated tax revenues generate one third of total revenue on average, transfers over 3/5, while royalties account for a mere 2% (see annex).

According to Article 124 of the Constitution, Argentina's provinces are the original owners of the natural resources located in their territory. This means that the provinces are responsible for entering into contracts with firms and for collecting royalties. This has augmented their power to control the price of the resources and the measurement of production. Nonetheless, the federal government retains the power, derived from an ordinary law, to regulate the sector. More importantly, it is also constitutionally mandated to regulate the domestic market and domestic prices; in addition, it has exclusive jurisdiction over import and export taxes and access to company profit taxation (although it does not use specific taxes —such as a special profits tax or a rent tax— to extract rent from oil and gas).[8]

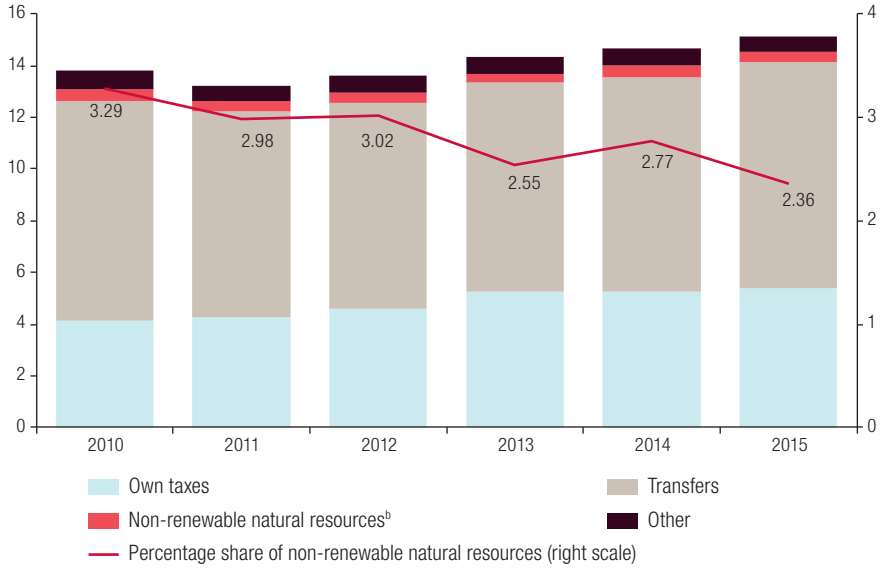
This peculiar cap on the amount of royalties that the producer provinces can raise has, to some extent, helped reduce disparities between producer and non-producer provinces; and it has attenuated the fluctuations in royalties revenue to between 2% and 3% of total revenues (see figure 2).

The huge geographical disparities in GDP (the maximum is more than six times the minimum, as reported in table 1), produce equivalent disparities in the intake of internally generated tax revenue. These disparities are partially corrected through the general transfer system and other grants. Inequalities are exacerbated by royalties that benefit the producer provinces only.

The impact of royalties fundamentally alters the ranking of provinces in terms of own revenues plus central government transfers. The top-ranked province becomes Santa Cruz, which receives the highest per capita allocation of royalties. The final impact of the combination of the various revenue sources is that, although no province is left with an unbearably low revenue level, interprovincial gaps remain extremely wide. Buenos Aires has a per capita revenue that is 1/5 that of the wealthiest province, Santa Cruz. Disparities of this magnitude would not be accepted in most federal systems.

[8] For further details on the institutional framework or impact of asymmetrical sharing in Argentina, see Brosio and Jiménez (2015).

Figure 2
Argentina: evolution and composition of subnational government revenues and revenue share of non-renewable natural resources, 2010–2015[a]
(Percentages of GDP and percentages of total revenue)



Source: Prepared by the authors, on the basis of official information.
[a] Revenues are classified according to the Government Finance Statistics Manual (IMF, 2014).
[b] Non-renewable natural resources revenues (royalties) are classified as rent (1415).

(a) Horizontal equalization model

Two alternatives are considered in this model. In the first, the revenues of all provinces are adjusted fully to the national average at least; in the second model, the equalization standard is set at 80% of the national average. Table 3 simulates how much producing provinces would contribute and how much other provinces would receive, along with the problems that the horizontal model would generate. The gap and surplus between the standard and standardized revenue of each province is shown in per capita terms; then both are multiplied by the population to calculate the revenues required to align all provinces to the national average.

In short, to adjust all provinces to the standard level would require Arg$ 7.8 billion, which is more than would be available from the producing provinces when their revenue is adjusted to the national average, in other words Arg$ 6.05 billion, as shown in table 2. This means that a horizontal close-ended model in Argentina would be unable, in the year of the example, to equalize —that is, align all provinces to the national average level. Only if the standard is set at 80% of national average would the horizontal closed-ended model work, since the total contributions from producing provinces would be equal to the transfers received by non-producing provinces. This is an important issue, because the higher the standard is set, the larger the transfer needed from the producing provinces, thus requiring interprovincial political agreements.

Needless to say, the producing provinces would oppose this equalization on political and constitutional grounds, unless the federal government gave them additional, potential, sources of revenue, possibly as part of a comprehensive reform of subnational finances.[9]

[9] The next four columns show that by using —in other words extracting from the producing provinces— royalties that exceed the net national average, it would be possible to adjust the non-producing provinces to a level (the equalization standard) equal to 71% of the national average. With this standard, the total amount received by the below-standard provinces would be equal to the amount paid by those above the standard.

Table 2
Horizontal equalization transfer: revenues required according to national average

A. Basic criteria

Standard according to total royalties	
Total royalties (*pesos*)	8 999 191 732
National population	40 117 096
National average of gross royalties (*per capita*)	224.32
Alternative standard (80% of gross royalties)	179.46

B. Horizontal equalization: results
(*pesos*)

Provinces	National average		80% of national average	
	Revenues required to bring the producing regions down to the national average	Revenues required to align all provinces to the standard level	Revenues required to bring the producing regions down to the national average	Revenues required to align all provinces to the standard level
City of Buenos Aires	0.0	648.3	0.0	518.7
Buenos Aires	0.0	3 505.1	0.0	2 804.1
Catamarca	0.0	82.5	0.0	66.0
Córdoba	0.0	742.3	0.0	593.8
Corrientes	0.0	222.7	0.0	178.1
Chaco	0.0	236.7	0.0	189.4
Chubut	1 693.8	0.0	1 716.6	0.0
Entre Ríos	0.0	277.3	0.0	221.8
Formosa	0.0	93.5	0.0	69.7
Jujuy	0.0	147.5	0.0	117.3
La Pampa	198.8	0.0	213.1	0.0
La Rioja	0.0	74.8	0.0	59.9
Mendoza	514.7	0.0	592.8	0.0
Misiones	0.0	247.1	0.0	197.7
Neuquén	1 664.5	0.0	1 689.3	0.0
Río Negro	411.0	0.0	439.7	0.0
Salta	0.0	84.7	0.0	30.3
San Juan	0.0	152.8	0.0	122.2
San Luis	0.0	97.0	0.0	77.6
Santa Cruz	1 353.3	0.0	1 365.6	0.0
Santa Fe	0.0	716.6	0.0	573.3
Santiago del Estero	0.0	196.1	0.0	156.8
Tucumán	0.0	324.9	0.0	259.9
Tierra del Fuego	213.8	0.0	219.5	0.0
Total	6 050.0	7 849.8	6 236.5	6 236.5

Source: Prepared by the authors.

(b) Vertical equalization model

The more inclusive is the equalization, in other words the larger the number of revenue sources covered, the higher is the level of equality attainable, provided that the total amount of the transfers to be allocated is large enough to bridge the gaps. Moreover, the standard set for equalization is decisive.

The way vertical equalization of provincial taxes and royalties works is shown in table 3 below and also in annex tables 4–6, separately for own taxes, royalties and the sum of the two. In this latter case, the system equalizes the entire fiscal capacity of the provinces, represented again by standardized revenue. With a vertical system, transfers to individual provinces below the standard are not provided by those above the standard, but are funded by grants allocated by the federal government (in this case, *coparticipación federal de impuestos* or federal revenue-sharing), which the new system intends to replace, at least in part.

In the simulation performed mostly for illustration purposes, the standard for own taxes is calculated as the average of the standardized revenues of the five wealthiest provinces excluding Buenos Aires (the wealthiest), namely Neuquén, Tierra del Fuego, Santa Cruz, La Pampa and Chubut.

The standard for royalties is the average of the standardized revenue of the five wealthiest provinces except Santa Cruz (the wealthiest) with a 20% reduction for costs (e.g. environmental damage and tax administration). In other words, revenue is netted. The wealthiest provinces are: Chubut, Neuquén, Tierra del Fuego, Río Negro and La Pampa. The standard for own revenue is relatively modest, since it excludes the wealthiest province. The standard for royalties is similar to that used for a long time in Canada, where the wealthiest province has also been excluded from equalization. The two standards make the comparison with the equalization capacity of the current system quite interesting.

In brief, vertical equalization has the potential to reduce fiscal disparities. As the table shows, after equalization, dispersion declines under all alternatives (CV); the ratio between the provinces with the largest and smallest fiscal resources (max/min) also falls; and inequality (Gini) decreases by between 12% or 33% depending on the instrument —or mix of instruments— applied (see table 3).

2. Peru

Among non-federal countries, Peru assigns one of the largest shares of NRNR revenues to its subnational governments. Fifty per cent of income tax revenue obtained from mining and oil companies is devolved to subnational governments, plus royalties.

Pending the completion of the decentralization process, regional governments in Peru are financed through two main revenue categories: ordinary/conditional revenues (*Recursos ordinarios*) and unconditional revenues. Conditional revenues are determined for (and allocated to) each region at the discretion of central government.[10]

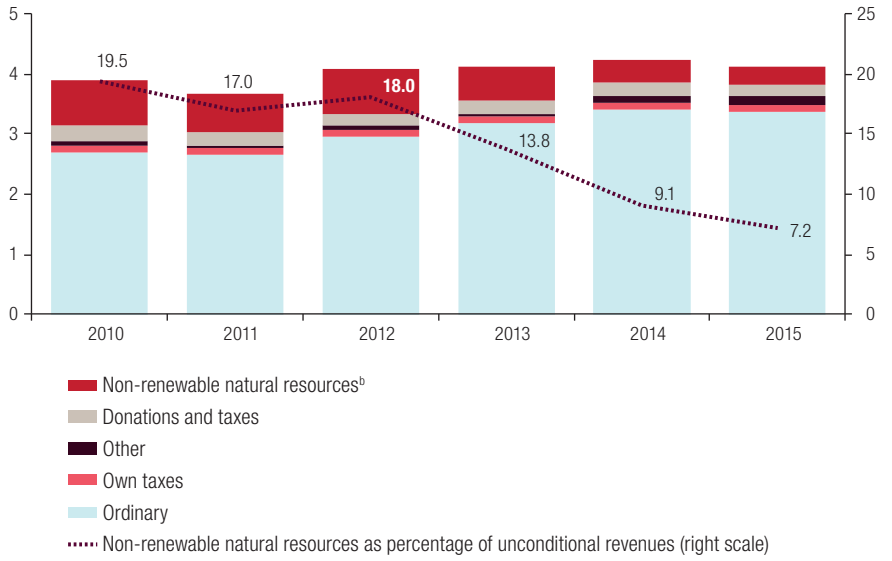
Unconditional revenues, which will only be mentioned here, include four different categories: (i) own revenues, consisting mainly of fees and receipts from the sale of services; (ii) transfers and donations, consisting mainly of grants from donors and international organizations; (iii) income from borrowing; and, lastly, (iv) a miscellaneous category (officially labelled *Recursos Determinados*) including natural resource revenue (the so-called mineral, oil and gas canon) and other additional fiscal instruments, mostly transfers, such as FED, FONIPREL and BOI[11] allocated to regions that are devoid of natural resources, and other revenue such as custom duties distributed to the main port of Callao.

Ordinary/conditional revenues still dominate financing in the regions, contributing between 60% and 80% of total revenues, as shown in figure 3. This fluctuating share does not depend on variations in their absolute amount, which is quite stable; instead it derives from the wide oscillations in the Canon and other NRNR revenues. The NRNR share of total revenue shrank from more than 19% of total revenues in 2010 to 7% in 2015 following the mineral and hydrocarbon price cycle.

[10] Conversely, regional governments have no autonomy over their use: basically, they serve to finance the regional branches of national ministries that have been regionalized. They are not labelled as regional revenues in the legislation and are not recorded as such in the official statistics, which makes it impossible to gain a complete picture of regional finances, let alone evaluate it. This is rather unusual and possibly stems from the initially supposed temporary nature of discretionary revenue (see also Letelier and Neyra, 2013).

[11] FED stands for *Fondo de Estímulo al Desempeño y Logro de Resultados Sociales* [Fund for the Stimulus of Performance and Achievement of Social Results]. BOI stands for *Bono de Incentivo por la Ejecución Eficaz de Inversiones* [Incentive Bonus for the Effective Execution of Investments] and FONIPREL stands for *Fondo de Promoción a la Inversión Pública Regional y Local* [Regional and Local Public Investment Promotion Fund].

Figure 3
Peru: evolution and composition of subnational government revenues and revenue share of non-renewable natural resources, 2010–2015[a]
(Percentages of GDP and of total revenues)



Source: Prepared by the authors, on the basis of official information from the Ministry of Economy and Finance [online] www.mef.gob.pe.
[a] Revenues are classified according to the Government Finance Statistics Manual (IMF, 2014).
[b] Non-renewable natural resources revenues (royalties) are classified as rent (1415).

The revenue intake from both income tax and royalties, which are assessed on the profit margin, are extremely sensitive to fluctuations in natural resource prices, and also to quantity variations. This renders this system of subnational allocation highly prone to wide fluctuations in the amount of revenue transferred.

A second, more important, consequence of assigning natural resource revenues to subnational governments are the huge horizontal disparities produced, particularly when natural resource prices are high. While own revenues and grants are relatively evenly distributed, revenues deriving mostly from natural resources (*determinados*) generate a high level of inequality in total revenues, contributing almost one quarter of this (exactly 25% according to table 1). Consequently, small regions, such as Moquegua, but also relatively large ones, such as Ancash, Arequipa and Cajamarca, receive substantial per capita amounts.

A second characteristic of NRNR subnational revenue allocation is the large number (a sizeable majority) of beneficiary regions. This creates a huge political obstacle to any reform attempt, as has been experienced by the Peruvian government.

Given the present system of regional government financing, simulations of reform options can apply only to the miscellaneous/discretionary revenue category, going from own revenues to NRNR revenues.

The option explored is based on the equalization of revenue from own sources and from natural resources (*determinados*), with no increase in total revenue accruing to regional governments. Consequently, equalization transfers are financed out of current regional revenues. In this first option, which takes into account the difficulty of reallocating natural resource revenues in the present political circumstances, revenue equalization transfers are financed out of donations and grants.

Fiscal capacity (standardized revenue) is calculated with reference to own revenues. Each region's GDP is taken as the base for the standardized tax rate, so the standard is determined, as was done

previously for Argentina, relative to the standardized per capita revenues of the wealthiest regions, such as Ica, Arequipa, Madre de Dios, Tacna and Cusco, while excluding Moquegua for 2011 and Moquegua and Lima for 2014, which are outliers.

Territorial revenue inequality is substantially reduced by aligning all regions to 100% of the selected standard absorbed in 2014, by using 85% of the pool of grants (*donaciones* and *transferencias*) to pay the necessary transfers to compensate regions poor in non-renewable natural resources.

Implementation in 2011 of the standard set for 2014 imposes a huge cost, owing to the high price of minerals and oil, making it impossible to fund the equalization scheme out of grants alone. Specifically, equalization would cost about one third more than the funds available. Without additional financing from central government, the pool of resources from grants only makes it possible to equalize 86% of the standard. In other words, a reasonable equalization target works in years of relatively low natural resource prices, such as 2014.

An alternative solution would be to lower the standard to a level that can reasonably be expected to work without requiring changes during wide price fluctuations. This option considers a standard at 80% of the average of the five wealthiest regions after eliminating outliers. Obviously, this has a cost in terms of a lower level of implementation of the interjurisdictional equity principle.

The results of the vertical model for both countries, Argentina and Peru, are shown in table 3.

Table 3
Argentina and Peru: summary results of vertical model
(Coefficient of variation, fiscal gap and Gini coefficient of total revenues, per capita)

Country	Year of simulation	Equalization instrument	Coefficient of variation		Fiscal gap (per capita max/min)		Gini		
			Pre	Post	Pre	Post	Pre	Post	Reynolds-Smolensky index
Argentina	2012	Using royalties	0.502	0.449	5.3	4.0	0.238	0.209	0.028
	2012	Using royalties and own taxes	0.502	0.355	5.3	2.9	0.238	0.159	0.079
Peru	2011	Mining canon, sub-canon and royalties (*determinados*) at 80% of the national standard	0.783	0.630	41.8	9.0	0.397	0.306	0.091
	2011	Mining canon, sub-canon and royalties (*determinados*) at 86% of the national standard	0.783	0.611	41.8	8.0	0.397	0.291	0.105
	2014	Mining canon, sub-canon and royalties (*determinados*) at 100% of the national standard	0.640	0.567	32.0	9.8	0.327	0.278	0.048
	2014	Mining canon, sub-canon and royalties (*determinados*) at 80% of the national standard	0.640	0.582	32.0	16.3	0.327	0.287	0.040

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

VI. Final remarks

This article has explored the issue of NRNR revenue equalization, when the revenue in question is shared asymmetrically between the central government and the subnational governments of the producing areas only. This is an increasingly important issue in many countries, including Latin American ones, where natural resources are spatially concentrated, and part of their revenue is allocated, asymmetrically, to the areas where production is taking place, or those affected by it.

Raising the issue of NRNR revenue equalization is not to underestimate its difficulties. Equalization may be very costly owing to revenue disparities; equalization also extends to the receiving governments the variations in revenue caused by fluctuations in the price of natural resources. Equalization is also

subject to political, legal and even constitutional difficulties. Nonetheless, the issue cannot be avoided. Inequality of natural resource revenue causes conflict between and within levels of government, even leading to secessionist pressures.

The article has explored the inclusion of NRNR revenue in different equalization schemes, distinguishing between vertical and horizontal models, and between models where natural resource revenue is equalized separately, and models where this is done in the framework of overall fiscal capacity equalization. The paper also provides a number of illustrative simulations with reference to Argentina and Peru; and it has considered fiscal capacity equalization models that are both equitable and efficient.

The results and their comments reveal, firstly, the huge degree of inequality produced by the asymmetric distribution of NRNR revenues. The main conclusion, deriving from the analysis for Argentina, is that vertical equalization systems that are comprehensive and encompass own taxes and natural resource revenue, have many attractive features. They are able to reduce inequalities at a lower cost than separate systems for own taxes and NRNR revenues, because they consider the interactions between these revenue sources. They are also politically more feasible, since their introduction and management require central government action only. Obviously, these conclusions assume the existence of substantial own and NRNR-dependent revenues, as in the case of Argentina, but not Peru, where natural resource revenues are relatively insignificant.

Nonetheless, when natural resource revenue disparities are huge, vertical equalization systems become very costly, because they place an unbearable burden on central government finances. Hence in those cases, horizontal equalization systems are called for; but, in this case, the political cost is likely to be very high and unsupportable, due to constitutional provisions and/or perceived entrenched rights.

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Annex A1

Table A1.1
Argentina (24 provinces): per capita fiscal revenues, 2012[a]
(Pesos per capita)

Provinces	Total	Own taxes	Transfers	NRNR revenues[b]	Other
Tierra del Fuego	38 052.7	5 849.0	19 141.7	3 102.3	9 959.7
Santa Cruz	32 454.5	4 817.4	13 353.8	6 648.9	7 634.4
Neuquén	21 944.7	4 709.9	6 961.7	4 833.9	5 439.2
La Pampa	19 198.8	3 083.1	11 419.4	731.9	3 964.4
Formosa	18 564.9	827.9	15 622.8	71.2	2 043.1
Chubut	18 046.8	3 126.6	6 452.0	4 661.3	3 806.9
Catamarca	17 626.5	1 477.7	13 766.6	415.0	1 967.2
La Rioja	15 492.6	933.3	13 975.4	0.0	584.0
Chaco	14 001.7	1 226.6	10 823.1	0.0	1 952.0
Entre Ríos	12 900.0	2 293.4	8 256.4	308.9	2 041.2
San Juan	12 752.8	1 715.4	9 415.7	487.1	1 134.7
San Luis	12 689.8	2 579.4	9 660.4	0.0	450.0
Río Negro	11 782.7	2 299.3	7 838.9	1 205.5	439.0
Autonomous City of Buenos Aires	11 594.9	9 671.3	1 402.5	0.0	521.1
Jujuy	11 443.7	934.6	10 312.5	6.1	190.5
Santiago Del Estero	10 756.9	978.0	9 563.5	2.7	212.7
Córdoba	10 653.9	2 633.8	5 167.6	0.0	2 852.6
Corrientes	10 182.6	1 017.0	7 349.8	46.7	1 769.1
Santa Fe	9 802.1	2 569.6	5 507.5	0.0	1 725.0
Misiones	9 788.6	1 671.8	6 957.4	114.4	1 045.0
Tucumán	9 686.7	2 225.8	7 133.7	0.0	327.2
Mendoza	9 255.9	2 619.7	4 887.9	682.9	1 065.4
Salta	8 358.2	1 388.6	6 484.4	235.3	249.9
Buenos Aires	7 121.3	2 952.2	2 672.4	0.0	1 496.8

Source: Prepared by the authors, on the basis of official information from the Ministry of Economy and Finance [online] www.mef.gob.pe.

[a] Revenues are classified according to the Government Finance Statistics Manual (IMF, 2014).

[b] Revenues from non-renewable natural resources (royalties) are classified as rent (1415).

Table A1.2
Peru (24 regions): per capita fiscal revenues, 2011[a]
(Soles per capita)

Region	Total	Own taxes	Transfers	NRNR revenues[b]	Others
Moquegua	1 324.1	51.6	114.4	949.4	208.8
Ancash	1 273.6	27.3	669.6	337.0	239.7
Tacna	965.8	153.3	209.6	589.6	13.3
Cusco	687.0	35.4	51.8	64.4	531.1
Pasco	612.4	22.1	37.9	394.8	157.7
Cajamarca	530.0	14.6	79.2	171.9	181.8
Loreto	526.9	86.9	71.7	0.0	281.1
Tumbes	525.0	31.6	34.8	0.0	458.6
Arequipa	462.2	54.0	185.5	192.2	30.5
Ucayali	412.7	41.0	26.7	0.0	345.0
Madre de Dios	402.2	99.3	48.7	0.3	253.8
Huancavelica	373.2	11.9	94.1	14.7	252.5
La Libertad	330.0	68.2	103.7	130.3	27.8
San Martín	292.2	24.0	29.1	0.5	183.2
Ayacucho	284.9	22.4	79.6	49.9	133.0
Ica	266.6	29.1	17.9	94.5	125.1
Apurimac	249.0	22.8	88.9	2.2	135.1
Puno	207.2	16.3	92.6	81.6	16.7
Junin	167.3	27.0	47.7	52.6	40.1
Piura	142.7	20.2	21.0	0.1	101.5
Amazonas	137.9	14.6	49.4	0.3	73.6
Huanuco	135.5	16.3	50.8	2.5	66.0
Lambayeque	108.1	31.7	15.5	0.2	60.8
Lima	31.7	3.3	3.9	10.9	13.6

Source: Prepared by the authors, on the basis of official information from the Ministry of Economy and Finance [online] www.mef.gob.pe.

[a] Revenues are classified according to the Government Finance Statistics Manual (IMF, 2014).

[b] Revenues from non-renewable natural resources (royalties) are classified as rent (1415).

Table A1.3
Peru (24 regions): per capita fiscal revenues, 2014[a]
(Soles per capita)

Region	Total	Own taxes	Transfers	NRNR revenues[b]	Other
Cusco	899.5	42.8	65.7	24.0	766.9
Moquegua	842.2	79.6	138.1	412.8	211.8
Tacna	633.2	177.7	104.5	324.1	26.9
Tumbes	490.9	37.2	45.2	0.0	408.6
Ucayali	450.2	40.2	57.8	0.0	352.2
Loreto	447.7	25.7	74.2	0.0	347.8
Arequipa	389.1	89.2	60.7	88.7	150.5
La Libertad	337.8	94.3	139.3	90.2	13.8
Apurimac	336.7	36.9	99.7	3.7	196.4
Ancash	328.7	30.5	136.9	149.0	12.3
San Martín	298.1	43.5	78.0	0.7	175.8
Ica	296.9	35.7	49.3	111.1	100.6
Ayacucho	286.9	33.7	117.5	7.6	128.2
Huancavelica	267.1	21.3	129.4	5.4	111.0
Cajamarca	246.5	13.9	77.0	92.6	63.0
Junin	244.7	30.3	54.9	9.0	150.5
Madre de Dios	221.9	102.0	68.5	2.3	49.1
Piura	213.5	28.4	28.6	0.5	155.9
Pasco	184.4	25.4	43.3	72.3	43.4
Amazonas	160.6	25.2	72.5	0.3	62.6
Puno	148.9	32.1	56.5	44.4	15.8
Lambayeque	124.5	77.3	42.2	0.0	4.9
Huanuco	116.0	19.9	85.0	0.4	10.7
Lima	28.2	3.9	5.3	3.6	15.5

Source: Prepared by the authors, on the basis of official information from the Ministry of Economy and Finance [online] www.mef.gob.pe.

[a] Revenues are classified according to the Government Finance Statistics Manual (IMF, 2014).

[b] Revenues from non-renewable natural resources (royalties) are classified as rent (1415).

Determinants of income inequality reduction in the Latin American countries

Carmen Ramos Carvajal, Mercedes Alvargonzález Rodríguez and Blanca Moreno Cuartas

Abstract

This article analyses patterns of income inequality and its determinants in the countries of Latin America in the period 2004–2013. First, income distribution in several countries is determined using the Theil index and is found to have decreased over the study period. An econometric panel data model is then employed to study the determinants of the level of inequality. Per capita GDP, per capita health spending, tax pressure, the poverty rate, the literacy rate and years of schooling are found to be statistically significant variables in explaining inequality. Multivariate techniques are then used to group the countries by level of inequality, thereby establishing a classification in terms of ability to reduce inequality.

Keywords

Income distribution, equality, measurement, econometric models, factor analysis, Latin America

JEL classification

C23, O15, O54

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I. Introduction

One of the most extensively documented characteristics of the Latin American countries is their high levels of inequality in family income distribution. As noted by Gasparini and Gluzmann (2012), most of the region's countries have always been among the most unequal societies of the developed world. Europe and the United States, even in the worst crisis periods, have had and continue to have much lower levels of inequity than Latin America, as discussed in Ayala (2013).

Economic inequality is understood to refer to the fundamental disparity that affords one individual certain material opportunities while denying them to another. On the basis of measures of income distribution inequality, it can be determined how growth and development is distributed between different social groups.

Income distribution is fundamental for determining the dynamics that generate economic growth and well-being of the population. Equitable distribution of income is one of the features of developed societies, whereas less developed economies tend to display more unequal distribution of income and wealth. This is undoubtedly a recurring theme in the literature, given its importance and its implications for well-being.

It may seem natural to assume that inequality would increase in situations of economic crisis. However, a number of studies have shown that the inequality-crisis binomial is not always present and that level of inequality is highly influenced not only by economic circumstances but also by the structure and characteristics of each territory, which precludes a generalized direct two-way link (Atkinson and Morelli, 2011; Adiego and Ayala, 2013).

A variety of conceptual approaches to inequality have been developed. Significant work has been done, among others, by Cowell (1977), Nygard and Sandström (1981), Foster (1983), Zubiri (1985), Ruiz-Castillo (1987), Pena and others (1996) and Dagum (2001).

Other authors have analysed economic and social inequality from a more applied perspective and in relation to Latin America. For example, without claiming to be exhaustive: Ariza and de Oliveira (2007), Martín (2008), Azevedo and others (2013), Lustig, López-Calva and Ortiz-Juárez (2013), Gasparini and Gluzmann (2012), and Morgan and Kelly (2013).

However, despite Latin America's high levels of inequality, analysis of economic development statistics shows that in the first decade of this century the region saw significant economic growth alongside a reduction in inequality. This may be thanks to the application of income transfer policies and investments in health and education (Perticara, 2012).

The main purpose of this work is to analyse patterns of income inequality and determinants of its evolution in Latin America countries in the past few years.

To this end, sections II and III examine inequality in income distribution in the Latin American countries in the period 2004–2013, using one of the most common measures employed for this purpose, the Theil index.

Section IV performs a breakdown of total inequality in the region, in two components: the inequality within each country and inequalities between countries. This exercise serves to analyse which of these components has been most influential in total inequality.

Section V estimates the impact of certain variables —such as GDP, education, health spending, poverty and tax pressure— on the reduction of inequality in the Latin American countries during the study period. A panel data methodology is used to perform this estimation, in order to control for specific unobservable effects in each country.

To complete this work, section VI uses multivariate techniques such as cluster and factor analyses. Cluster analyses yield groupings of countries that show similar patterns in the variables considered. Meanwhile, factor analysis is used to condense the information into a single indicator that can be used to determine which countries are best positioned to reduce inequality.

Lastly, the conclusions in section VII compile the main findings of the work.

II. Inequality: measurement and description of evolution

The literature on inequality offers a very large number of inequality indicators. This article uses the Theil index because of its decomposability, a property of great interest for empirical studies. The Gini index, a commonly used measure, has the limitation of non-decomposability, that is, it cannot be used to obtain the total inequality of a population from the internal inequality of its constituent groups and inequality between groups.

There follows a definition of the Theil index (1967): let X be the variable for income, which takes values $\{x_1,...,x_M\}$ with relative sequences $\{f_1,...,f_M\}$ $E(X)$ denotes the expected value of X, that is, the per capita income of the population.[1] The Theil index (TI) is given by:

$$TI(X)=\frac{1}{E(X)}\sum_{i=1}^{M} x_i \left[log\frac{x_i}{E(X)}\right] f_i=\frac{1}{E(X)}\sum_{i=1}^{M} x_i \left[log(x_i) - log\left(E(X)\right)\right] f_i \quad (1)$$

This indicator may be interpreted as the weighted mean of the deviations between the log of income and the log of per capita income of the population.

The main advantage of using a log function is that it permits greater importance to be assigned to the lower incomes, which is appropriate from the normative perspective of inequality as a social problem.

Under equidistribution, individuals' income would coincide with the expected value and the index would be zero, while in the opposite case, where one person accumulated all the income, the upper bound of the index would be given by $Mlog(M)$.

The Theil index is an appropriate indicator of inequality, because it has a series of properties that are considered desirable.[2] These include continuity, symmetry and the Pigou-Dalton principle (that is, if part of a rich person's income is transferred to a poor person, without altering the order of the ranges of income, inequality should not increase).[3] The Theil index also fulfils the principle of decreasing impact of progressive transfers, i.e. the closer the individuals involved in the progressive transfers are to the lower tail of the distribution, the more the value of the index falls (as long as the transfers are of the same amount and are made between individuals whose income differential is identical). It also fulfils the condition of non-homotheticity i.e. given constant total income, as inequality increases, greater importance is afforded to the situation of poorer individuals.

Lastly, as noted earlier, the Theil index fulfils the property of decomposition. This requires a consistent relationship between the level of total inequality in the population and inequality in its constituent subgroups. If information is available for M countries, the Theil index is given by:

[1] Theil was the first author to propose measurements of statistical information as a suitable framework for the study of inequality, on the basis of conceptual and operational arguments.

[2] Shorrocks (1980) was one of the authors to study the properties of the Theil index.

[3] In the strongest form of this property, inequality should decrease.

$$TI(X)=\sum_{C=1}^{M} TI_P(X)\frac{E_C(X)}{E(X)}\frac{N_C}{N}+\sum_{C=1}^{M}\frac{E_C(X)}{E(X)}\frac{N_C}{N}log\left(\frac{E_C(X)}{E(X)}\right) \quad (2)$$

where $TI_P(X)$ is the Theil index for country C, N_C is the population of country C, N is the general population, $E(X)$ is total per capital income and $E_C(X)$ is the per capita income of country C.

The first summand in equation (2) captures the internal inequality of the countries and the second captures the discrepancy between the different countries.

III. Income inequality in the Latin American countries

Latin America comprises the countries of the American continent where Romance languages are spoken, such as Spanish and Portuguese, i.e. Mexico, almost all of Central America (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama) and almost all the countries of South America (Argentina, Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Plurinational State of Bolivia and Uruguay). The rest of the continental countries of Central and South America (Belize, Guyana, Suriname and the territory of French Guiana) are generally not considered part of Latin America, since their cultural and economic ties link them more closely with the Caribbean region. There are Latin-colonized American countries in the Caribbean Sea: Cuba, the Dominican Republic and Puerto Rico, of Hispanic origin and French-colonized Haiti.

The work in this article encompasses 15 continental Latin American countries of those mentioned above, plus the Dominican Republic. It does not include the Bolivarian Republic of Venezuela, Cuba, Honduras or Nicaragua, owing to lack of necessary information. Puerto Rico is not included either, as a United States territory, nor is Haiti, as a country culturally more associated with the Caribbean than with Latin America and because it has a very precarious household survey system. In short, the countries included in this study are: Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Panama, Paraguay, Peru, Plurinational State of Bolivia and Uruguay.

1. Reconstruction of a database on inequality: first results

The Theil index is used to quantify income inequality in Latin America, since it fulfils the properties described above and has been used in a good number of studies (Villaverde, 1996; Duro, 2004; Goerlich and Mas, 2004; Martín, 2008; Azevedo and others, 2013, and Amarante, Galván and Mancero, 2016, among others).

This study covers a 10–year period (from 2004 to 2013), which is considered long enough to conduct a rigorous analysis of income inequality.

The first step was to compile information on inequality in the countries included for the period of the study, which was done using data on the Theil index provided by the World Bank and the Socio-Economic Database for Latin America and the Caribbean (SEDLAC).

Unfortunately, the information from these sources was not complete, and estimates had to be conducted for data that were not available for certain years and countries. Gómez, Palarea and Martín (2006) establish a classification of techniques for data imputation, such as use of the mean,[4] regression, stochastic regression and other more complex methods based on verisimilitudes. The latter,

[4] Imputation of the mean is generally not recommendable, as it shows very unstable behaviour.

while offering the best alternative, may involve a computation effort that, in certain situations, is not rewarded by the virtues of the inference. The present work employs regression to impute the missing observations, as this method yields good results and is simpler to implement, as noted by Gómez, Palarea and Martín (2006).

Table 1 shows the inequality levels for the countries of Latin America obtained using the Theil index for the period 2004–2013. The values shown with asterisks are the results of estimates. Coefficients of determination were calculated to ascertain the adequacy of the estimates; as may be seen, these are relatively high.

Table 1
Latin America: Theil index of inequality, 2004–2013[a]

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Mean
Argentina	0.451	0.449	0.446	0.423	0.389	0.358	0.346	0.332	0.312	0.310	0.382
Bolivia (Plurinational State of)	0.602*	0.547	0.472	0.469	0.389	0.416	0.34*	0.277	0.297	0.309	0.397
Brazil	0.647	0.647	0.629	0.603	0.588	0.578	0.576*	0.560	0.581	0.543*	0.604
Chile	0.607*	0.601	0.568	0.590*	0.584*	0.585	0.572*	0.541	0.561*	0.537	0.566
Colombia	0.625	0.622	0.631*	0.630*	0.632	0.614	0.627	0.599	0.568	0.574	0.608
Costa Rica	0.411	0.399	0.427	0.466	0.427	0.474	0.455	0.481	0.481	0.487	0.451
Dominican Republic	0.577	0.494	0.564	0.462	0.493	0.471	0.411	0.435	0.392	0.429	0.473
Ecuador	0.605	0.584	0.747	0.622	0.512	0.481	0.491	0.399	0.430	0.440	0.531
El Salvador	0.415	0.437	0.404	0.412	0.434	0.408	0.358	0.337	0.335	0.409	0.395
Guatemala	0.406	0.483*	0.550	0.608*	0.657*	0.696*	0.726*	0.746	0.757*	0.759*	0.567
Mexico	0.588	0.635	0.527	0.559*	0.599	0.529*	0.458	0.498*	0.503	0.468*	0.552
Panama	0.534*	0.511*	0.547*	0.520*	0.522	0.532	0.540	0.557	0.536	0.522	0.535
Paraguay	0.630	0.560	0.724	0.665	0.570	0.505	0.636	0.589	0.484	0.464	0.583
Peru	0.508	0.522	0.519	0.516	0.451	0.432	0.403	0.387	0.376	0.367	0.448
Uruguay	0.420	0.383	0.416	0.429	0.400	0.407	0.380	0.342	0.299	0.312	0.379
Mean	0.535	0.525	0.545	0.532	0.510	0.499	0.488	0.472	0.461	0.462	
Typical deviation	0.088	0.082	0.102	0.082	0.088	0.088	0.116	0.124	0.125	0.115	

Source: Prepared by the authors, on the basis of data from the World Bank and the Socio-Economic Database for Latin America and the Caribbean (SEDLAC).

[a] The values of the coefficients of determination for each of the countries whose inequality was estimated are: Brazil: 0.81; Chile: 0.60; Colombia: 0.84; Guatemala: 0.97; Mexico: 0.54, Panama: 0.71; and Plurinational State of Bolivia: 0.89.

Generally speaking, it may be said that, on average, the countries with the highest levels of inequality are Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico, Panama and Paraguay. Meanwhile, Argentina, Costa Rica, the Dominican Republic, El Salvador, Peru, the Plurinational State of Bolivia and Uruguay display lower levels of inequality. These results largely coincide with studies by Martín (2008), Amarante, Galván and Mancero (2016), and Amarante and Jiménez (2016), among others.

On the basis of analysis of inequality in the countries over the study period, three groups may be identified. In a first group —made up of Brazil, Chile, Colombia, Mexico and Paraguay— inequality is always above the average. These countries could be described as the most unequal from a structural point of view, since their level of inequity is above average for all the years examined. In a second group of countries —Argentina, El Salvador, Peru and Uruguay— inequality is below the average

throughout the period; accordingly, these are the least unequal countries structurally speaking. Lastly, a third group —Costa Rica, the Dominican Republic, Ecuador, Guatemala, Panama and the Plurinational State of Bolivia— show an inequality index above the average for some years and below the average for others. In this group of countries, inequality varies depending on economic and social circumstances.

2. The trend of inequality

Table 1 shows how total average inequality has decreased over the past few years. Observation of the indexes of inequality for each country for the first and last years of the period analysed shows that only Costa Rica and Guatemala have higher levels of inequality at the end of the period than at the beginning; the other countries show decreases over the period. Between 2004 and 2013 inequality has thus tended to fall. This has been noted by various authors, including Amarante, Galván and Mancero (2016), and Lustig, López-Calva and Ortiz-Juárez (2013). Some authors, however, such as Piketty (2014), indicate that inequality is underestimated in the Latin American countries owing to the concealment of high incomes.

In order to verify whether the differences in the inequality indicators at the beginning and the end of the period are significant, a Wilcoxon test was performed for two samples. The results are shown in table 2.

Table 2
Wilcoxon test, test statistics[a]

Z	-2.272
Asymptotic significance (bilateral)	0.023

Source: Prepared by the authors.
[a] Wilcoxon tests of signed ranges.

The null hypothesis of the Wilcoxon test (that inequality matches in the two periods) is rejected because the critical level is below 0.05; thus, statistically significant differences are found in inequality at the two points in time. At the same time, the Z-statistic demonstrates and bears out the decline in the level of inequality.

In addition, rates of variation in inequality were calculated, taking 2004 at the starting point and 2013 as the end. Given that in general terms inequality varies relatively little from one year to the next, it seems most appropriate to calculate the rate over the whole study period in order to detect changes in this variable. However, since a global economic crisis occurred during this period, the rates for an intermediate point —2007— were calculated as well, as the point at which the crisis was considered to have broken out. That is, the rates were calculated between 2004 and 2007 (the period before the crisis) and between 2008 and 2013 (the crisis period). The results are shown in table 3.

Observation of the entire study period shows that most of the countries have been able to reduce their levels of inequality, with the exception of Costa Rica and Guatemala. The countries that have reduced inequality the most are the Plurinational State of Bolivia, Argentina, Peru and Ecuador. When the two subperiods are examined, it is seen that the decrease in inequality begins in the first and is not slowed by the crisis; on the contrary, inequality decreases faster, generally speaking. This pattern, noted by Lustig, López-Calva and Ortiz-Juárez (2013) and Cornia (2012 and 2014), among others, indicates that the global crisis did not affect the downtrend in inequality, probably because the crisis affected the Latin American region less than other world regions, as pointed out by Mancha, Perticarari and Buchieri (2011) and Quenan (2013).

Table 3
Rates of variation in inequality, 2004–2013
(Percentages)

Country	2004–2013	2004–2007	2008–2013
Argentina	-31.33	-6.12	-20.41
Bolivia (Plurinational State of)	-48.57	-22.08	-20.51
Brazil	-16.04	-6.84	-7.58
Chile	-11.53	-2.87	-8.02
Colombia	-8.16	0.80	-9.18
Costa Rica	18.49	13.38	14.05
Dominican Republic	-25.52	-19.95	-12.93
Ecuador	-27.23	2.81	-13.93
El Salvador	-1.49	-0.75	-5.73
Guatemala	86.95	49.75	15.53
Mexico	-20.41	-4.93	-21.87
Panama	-2.25	-2.62	0.00
Paraguay	-26.26	5.55	-18.55
Peru	-27.80	1.58	-18.67
Uruguay	-25.66	2.21	-22.05

Source: Prepared by the authors.

IV. Quantification of the components of inequality in Latin Aamerica

The Theil index may be used to quantify inequality in an entire region, with the level determined by two aspects: inequality within each country (internal inequality or II) and the inequality of one country with respect to the others (inequality between countries or BI). The application of this property of decomposition permits the weight of both aspects to be ascertained and measured (see Villaverde (1996), Duro (2004), Goerlich and Mas (2004) and Martín (2008), among others). Equation (2) may be broken down into two summands: the first captures internal inequality within countries and the second captures the discrepancy between the different countries, so that total inequality (TQ) is the sum of the two, that is:

$$TQ=II+BI \tag{3}$$

This formulation was applied to the data available to quantify inequality in the entire region made up of the 15 countries studied, then that value was disaggregated into the components of internal inequality and inequality between countries. The results for the period studied are shown in table 4.[5]

[5] Using data on population and median income provided by the Economic Commission for Latin America and the Caribbean (ECLAC) and the Socio-Economic Database for Latin America and the Caribbean (SEDLAC).

Table 4
Decomposition of inequality obtained using the Theil index, 2004–2013

Year	Internal inequality (II)	Inequality between countries (BI)	Total inequality (TQ)	II/TQ (*percentages*)	BI/TQ (*percentages*)
2004	0.585	0.005	0.590	99.15	0.85
2005	0.595	0.005	0.599	99.21	0.79
2006	0.569	0.007	0.577	98.73	1.27
2007	0.562	0.006	0.568	98.89	1.11
2008	0.555	0.004	0.559	99.34	0.66
2009	0.529	0.004	0.534	99.21	0.79
2010	0.507	0.006	0.513	98.93	1.07
2011	0.502	0.005	0.507	99.07	0.93
2012	0.505	0.005	0.510	99.11	0.89
2013	0.485	0.005	0.490	98.99	1.01

Source: Prepared by the authors.

Total income inequality for Latin America overall fell between 2004 and 2013, as noted earlier. This fall in inequality is due, above all, to the decrease in internal disparities within the countries, since the inequality between countries held steady over the period studied. It may also be seen that the internal inequality component accounted for a much greater proportion of total inequality than inequality between countries in that period. These results seem to indicate that overall inequality in the region originates not so much in differences between countries, but in inequities within each. These findings are consistent with those of Milanovic and Muñoz (2008), who note that in Latin America as a whole, the differences in mean incomes between countries explain a relatively small part of inequality, while most is accounted for by inequalities within each country.

At the same time, analysing the second summand (BI) in equation (2)

$$BI = \sum_{C=1}^{15} \frac{E_C(X)}{E(X)} \frac{N_C}{N} log\left(\frac{E_C(X)}{E(X)}\right) \quad (4)$$

serves to ascertain which countries generate inequality and which "benefit" from it and which "suffer". If $EC(X)$ is less than $E(X)$ —i.e. if a country's expected income is below the expected income for the region, the quotient is less than 1 and the corresponding term is negative— then the country will "suffer" inequality. Conversely, if $EC(X)$ exceeds the total per capita income, the quotient is greater than 1 and the corresponding term is positive, then the country is a generator of inequality and "benefits" from it.

Table 5 presents the values for the different summands of inequality between countries.

The table shows stable patterns over time. Brazil and Colombia, for example, are countries that suffer inequality, since their income is below the mean for the region, while Argentina, the Bolivarian Republic of Venezuela, Chile, Costa Rica, the Dominican Republic, El Salvador, Mexico, Peru and Uruguay are generators of inequality, as their income is above the mean.

Having seen how inequality has decreased in Latin America, there follows an analysis of which determinants may be influencing this evolution. On the basis of the information available, this will be done by econometric analysis of panel data.

Table 5
Summands of inequality between countries, 2004–2013

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Argentina	0.005	0.008	0.011	0.012	0.012	0.013	0.013	0.015	0.016	0.016
Bolivia (Plurinational State of)	0.000	-0.003	-0.003	-0.002	0.000	0.001	0.000	0.002	0.001	0.000
Brazil	-0.039	-0.036	-0.029	-0.029	-0.027	-0.029	-0.034	-0.031	-0.028	-0.031
Chile	0.003	0.003	0.003	0.003	0.002	0.001	0.001	0.001	0.001	0.001
Colombia	-0.004	-0.002	-0.017	-0.016	-0.010	-0.011	-0.012	-0.010	-0.010	-0.010
Costa Rica	0.001	0.002	0.001	0.001	0.001	0.000	0.001	0.000	0.000	0.000
Dominican Republic	0.002	0.003	0.001	0.003	0.002	0.002	0.002	0.002	0.003	0.002
Ecuador	0.000	0.000	0.001	-0.001	0.001	0.002	0.001	0.003	0.003	0.002
El Salvador	0.003	0.002	0.004	0.004	0.002	0.002	0.002	0.003	0.003	0.003
Guatemala	0.002	0.001	-0.001	0.000	0.000	-0.001	-0.001	-0.001	-0.002	-0.002
Mexico	0.028	0.023	0.033	0.026	0.014	0.018	0.024	0.013	0.008	0.014
Panama	-0.001	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
Paraguay	0.001	0.001	0.000	0.001	0.001	0.001	0.000	-0.001	0.001	0.000
Peru	0.004	0.002	0.002	0.001	0.005	0.005	0.007	0.007	0.007	0.008
Uruguay	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002
Total for the region	0.005	0.005	0.007	0.006	0.004	0.004	0.006	0.005	0.005	0.005

Source: Prepared by the authors.

V. Determinants of the evolution of income inequality in Latin American countries, econometric panel data model

As noted earlier, the problem of inequality in Latin America has been addressed in different works and taking different approaches. Here, panel data methodology is used to explore which variables or factors may be determining the evolution of inequality levels in the period studied.

Among the variables that may determine economic inequality, the literature is unanimous in including the relative magnitudes of economic growth, education, health and the role of public policies, among others.

Table 6 shows the specific variables used in the analysis: per capita GDP, per capita health spending, tax pressure, a poverty indicator, the literacy rate, years of schooling, and an indicator of the effect of the economic crisis.

Panel data methodology was used to estimate the model, since this controlled for unobservable effects in each country.

Public policies act on market-based distribution by means of instruments such as taxes and transfers, which impact directly on the distribution of families' disposable income. Another facet of the State's redistributive action occurs through mechanisms that may be considered indirect, such as spending on education or health care. Although these do not affect households' current disposable income, they do produce a very important impact, albeit deferred, insofar as they foster human capacities, facilitate labour-market integration and contribute to higher standards of living (Amarante and Jiménez, 2016).

Table 6
Taxonomy of variables used

	Definition	Unit	Source
Theil index	Indicator of income inequality	0–1	World Bank/Socio-Economic Database for Latin America and the Caribbean (SEDLAC)
Per capita GDP	Proxy for country's level of development	Thousands of dollars per capita	ECLAC
Per capita health spending	Per capita spending on health care by the public sector	Thousands of dollars per capita	ECLAC
Tax pressure	Tax income in relation to GDP	Percentages	ECLAC
Years of schooling	Average years of schooling of the population aged 25–59 years	Years	World Bank / SEDLAC
Literacy rate	Literacy rate of the population aged 15–24 years	Percentages	World Bank / SEDLAC
Poverty	Population living in poverty	Percentages	World Bank / SEDLAC
Effect of the economic crisis	Dummy variable (takes a value of 0 in the period 2004–2007 and 1 in 2008–2013)	0 and 1	Authors

Source: Prepared by the authors.

In this regard, empirical studies have shown that education is a tool that helps to reduce inequity in income distribution (Alonso, 2001; Moller, Alderson and Nielsen, 2009; Peters, 2013, among others).

Authors such as Mercader-Prats and Levy (2004), Atkinson and Brandolini (2009), and Muinelo and Roca (2013) have drawn attention to the role of fiscal policy in explaining inequality. In this regard, the structure of the tax system should play a very important part (Molina, Guarnido and Amate, 2013). Peters (2013) notes that fiscal policy is an endogenous variable that reflects, through political processes, the preferences of the citizens (voters) regarding income distribution.

Levy and Schady (2013) and Azevedo, Inchaust and Sanfelice (2013) indicate a direct relationship between economic inequality and poverty, since both rise and fall following similar patterns.

However, since Kuznets (1955) proposed the well-known "U hypothesis", economic growth has been the factor most studied as an explanatory variable for inequality in income distribution. However, findings on the effects of economic growth on inequality are not unanimous. In the context of Latin America, De Janvry and Sadoulet (2000) and Medina and Galván (2014a and 2014b) have studied relationships between economic growth, inequality and poverty.

1. Panel data model, econometric specification

This methodology allows consideration of latent unobservable effects specific to each country (individual effects). If those unobservable effects exist and are not corrected, there will be a problem of omitted variables and the coefficients estimated in the model will be biased (see a detailed description of the panel data methodology in Baltagi, 1995). In addition, to avoid potential omitted variable bias because of variables that change over time, but are constant between countries, the model includes time effects.

$$TI(X)_{it} = \alpha_i + \beta_0 + \beta_1 GDPpc_{it} + \beta_2 HS_{it} + \beta_3 PI_{it} + \beta_4 TP_{it} + \beta_5 LR_{it} + \beta_6 YS_{it} + \beta_7 EC_{it} + u_{it} \quad (5)$$

Where i denotes the countries considered (i = 1,…,15), t are the years (t = 2004,…,2013), TI is the Theil index, $GDPpc$ is per capita GDP, HS is health spending, YS are years of schooling, LR is the literacy rate, TP is tax pressure, PI is a poverty index and EC is a variable that captures the effect of the crisis, taking a value of 0 from 2004 to 2007 and a value of 1 from 2008 to 2013.[6] α_i represents

[6] A crisis is considered to have occurred when GDP growth falls. The reference in this work is to the global crisis of the period 2008–2013.

the specific individual effect of each country, and is included in the model to take into account any factor that could influence the level of inequality beyond the explanatory variables included. Disturbances are denoted by uit and are assumed to be independent and identically distributed, with mean 0 and variance σ^2_u.

In order to identify the most appropriate specification of the panel model, the estimate was performed for both a fixed effects and a random effects model. The fixed effects model treats each α_i as a constant in the regression, while the random effects model treats α_i as a component of random disturbance. A Hausman test (1978) is performed in order to establish whether the random effects estimator is more suitable than the fixed effects one. The existence of specific effects for each country is contrasted using an F-test (for the fixed effects model) or the Breusch-Pagan test (for the random effects model). In both cases, the null hypothesis is that α_i is equal for all countries. If that hypothesis is not rejected, then it is a classic regression model and can be estimated by ordinary least squares (OLS). In other words, the Breusch and Pagan test and F-test indicate, respectively, the extent to which the random effects model and the fixed effects model are better than the grouped or merged data model.

Table 7 presents the main descriptive statistics of the variables analysed.

Table 7
Main descriptive statistics of the variables used

Variables	Mean	Median	Minimum	Maximum	Standard deviation
Theil index	0.52	0.52	0.25	0.84	0.13
GDPpc	6.74	5.98	1.68	14.29	3.42
Health spending	0.16	0.11	0.01	0.54	0.13
Tax pressure	13.37	13.28	8.11	20.84	3.03
Years of schooling	8.66	8.80	4.30	11.33	1.56
Literacy rate	97.60	98.33	84.99	99.75	2.58
Poverty index	6.48	6.02	0.23	20.71	4.30

Source: Prepared by the authors.

2. Empirical results

The results of the final estimations of the panel data model are shown in table 8. A Hausman test was performed and yielded a Chi-squared of (7) = 4.33 with a critical value of p = 0.7406, on which basis it is concluded that the random effects model is the most adequate.

The results of the model indicate that the contrasts of individual effects are significant and the Breusch-Pagan test rejects the corresponding null hypothesis on the non-existence of individual effects.

With respect to individual effects (given their existence), the F-statistics of the contrast indicate non-rejection of the null hypothesis (there are no time effects); accordingly, such effects need not be included in the model.

The results shown in table 8 indicate that all the variables, except the effect of the crisis, are significant at 1%. This seems to suggest that the economic crisis had no significant effect in Latin America, at least in relation to the evolution of economic inequality.

The results show a positive relationship with respect to economic development, measured on the basis of GDP, i.e. greater economic development leads to a rise in inequality. This finding is consistent with those obtained by Ravallion and Chen (1997), Molina, Amate and Guarnido (2011), and Acar and Dogruel (2012), for whom economic growth does not reduce income inequalities. Taking per capita GDP as a proxy for economic development, Molina, Amate and Guarnido (2011) find that higher GDP increased inequity in the countries of the European Union. This appears to bear out criticism of the use

of GDP as a measure of a country's development, since it considers only certain economic aspects and disregards social and environmental behaviours. Thus, an overall rise in a country's GDP may indicate growth, but not necessarily balanced growth (Costanza and others, 2009).

Table 8
Panel data models estimated to explain inequality in Latin American countries, 2004–2013

Variable	Panel data model
β_0	-1.9952
	(0.009)
β_1 (per capita GDP)	0.0226***
	(0.051)
β_2 (per capita health spending)	-0.4372***
	(0.011)
β_3 (poverty)	0.0057***
	(0.096)
β_4 (tax pressure)	-0.0169***
	(0.000)
β_5 (literacy rate)	-0.030***
	(0.000)
β_6 (years of schooling)	-0.0546***
	(0.006)
β_7 (effect of the crisis)	-0.0138
	0.329
Observations	145
R^2	0.52
Breusch-Pagan test	$x^2(1) = 290.18$***
	$p \approx 0$
F- F-test	F(14. 123) = 27.23***
	$p \approx 0$
Test de Hausman	$x^2(7) = 4.33$
	p = 0.7406

Source: Prepared by the authors.
Note: *** means that the null hypothesis was rejected at 1%.

Among the variables that may determine inequality, the literature shows that education is a tool that serves to reduce it (Alonso, 2001; Moller, Alderson and Nielsen, 2009; Peters, 2013, among others); accordingly, literacy and years of schooling exert a redistributive effect (Molina, Guarnido and Amate, 2013). Latin America has considerably increased the basic coverage of education: the percentage of children enrolled in the appropriate grade for their age is over 90% in primary school and between 60% and 80% in secondary school in most of the region's countries (Levy and Schady, 2013).

The effect of tax pressure on income distribution is as expected, as studied by Itriago (2014). However, some authors note that the redistribution capacity of taxes and transfers is limited in terms of changing levels of inequality in households' access to resources (Amarante and Jiménez, 2016), owing to lower levels of tax revenues and lesser distributive impact. Redistributive public spending in Latin America has very often been financed from regressive taxes, which has considerably eroded the net effects of fiscal policy (Gómez Sabaini and Morán, 2013).

Another variable that generates a correction in inequality levels is health spending. Higher health spending leads, indirectly, to lower inequality, by affecting consumption decisions and possibilities, insofar as the availability of good-quality public health services can free up families' resources for other consumption purposes (Gómez Sabaini and Morán, 2013; Atun and others, 2015). In this regard, the coefficient of the variable associated with health has the expected sign.

The coefficient of the poverty variable is also consistent with the direct correlation that many authors have found with inequality (Levy and Schady, 2013; Azevedo, Inchaust and Sanfelice, 2013). Poverty fell over the period studied, which has probably led to a decline in inequality (Cruces and Gasparini, 2013; Gasparini and Gluzmann, 2012).

It may thus be concluded that the reduction in inequality seen in Latin America is due, at least in part, to a decline in poverty in the countries, as well as attempts to strengthen and expand direct and indirect redistribution policies.[7]

VI. Ranking of Latin American countries by reduction in inequality levels

Section V determined some of the significant variables that explain, at least in part, the reduction in inequality in Latin America, on the basis of econometric estimations of panel data. These variables and a multivariate classification technique will be used to group the countries under study and determine which are better placed to reduce their levels of inequality.

First, a hierarchical cluster analysis was performed to classify the countries by their disposition to reduce inequality. Ward's method was used to establish the groups, with Euclidean squared distance. This technique is applied to the variables found to be relevant in reducing inequality (per capita GDP, poverty, health spending, years of schooling, literacy rate and tax pressure) for the last year in the period analysed (2013). However, the analysis was repeated for the other years in order to test the robustness of the results obtained, and yielded similar results.

Application of this technique yielded three groupings or clusters (see table 9).

It may appear strange that one of the groupings has only one country, but it was decided to main this three-group structure given the particular idiosyncrasy of Guatemala, which makes this country very different from the others.

The first cluster comprises Argentina, Brazil, Chile, Costa Rica, Mexico, Panama and Uruguay; the second, Colombia, Dominican Republic, Ecuador, Salvador, Paraguay, Peru and Plurinational State of Bolivia; and the third, only Guatemala.

[7] This work has used the Theil index as an indicator of inequality, on the basis of information from data provided by the World Bank and the Center for Distributive, Labor, and Social Studies (CEDLAS). The Socio-Economic Database for Latin America and the Caribbean (SEDLAC) was used, among other reasons, because it provides information on Argentina, unlike the other databases consulted. This was thought to be important, given Argentina's relative weight in the Latin American economy (in 2015 it represented around 11% of the GDP of Latin America and the Caribbean). In addition, there are other countries, such as El Salvador, Peru and Plurinational State of Bolivia, for which it is advisable to use World Bank data, given the serious lack of data from other sources. However, ECLAC is also considered to publish a very solid database which qualifies inequality using, among other things, the Theil index (see CEPALSTAT [online] http://estadísticas.cepal.org/cepalstat). By way of illustration, a number of comparisons were conducted between the results produced using both databases to yield a measure of the consistency of the conclusions obtained in this work. Initially, a non-parametric Mann-Whitney-Wilcoxon test was run on the Theil index for each country, to determine whether the behaviour of the two indexes (ECLAC and World Bank) was similar. The result of the test did not reject the null hypothesis (similar behaviour of the indicators from the two statistical sources) with critical levels of over 0.05 for all the countries analysed (except Brazil and the Dominican Republic, for which the hypothesis is rejected). Below, continuing with that comparison, the panel data model is estimated using data from the ECLAC Theil index, finding similar behaviours for the set of variables, with regard to both the signs and the scale of the coefficients. This all seems to indicate that the results are robust for the database employed to quantify inequality indicators.

$$TI(X)_{it} = 2.689 + 0.00001^{**} GDPpc_{it} - 0.0212^{**} HS_{it} + 0.0077 PI_{it} - 0.0002^{**} TP_{it} - 0.0073^{**} LR_{it} - 0.1056^{**} YS_{it} - 0.0002 EC_{it} + u_{it} \quad (6)$$

Where ** indicates that the estimates are significantly different from zero, below the 5% level. The comparison was not run for the data on poverty —which can also, to a degree, indicate disequilibria in income distribution— because the poverty data reported by ECLAC are taken from the World Bank.

Table 9
Country groupings by factors in inequality reduction

Cluster 1	Cluster 2	Cluster 3
Argentina	Bolivia (Plurinational State of)	Guatemala
Brazil	Colombia	
Chile	Ecuador	
Costa Rica	El Salvador	
Mexico	Paraguay	
Panama	Peru	
Uruguay	Dominican Republic	

Source: Prepared by the authors.

Table 10 characterizes these groups on the basis of the initial variables.

Table 10
Description of the clusters[a]

		N	Minimum	Maximum	Mean	Standard deviation
1	Poverty	7	0.34	6.01	2.6329	2.09523
	Per capita GDP	7	8.75	14.29	11.4714	2.13075
	Health spending	7	0.08	0.54	0.3529	0.15892
	Tax pressure	7	9.71	19.34	13.7886	3.58807
	Years of schooling	7	8.36	11.33	9.9557	1.14490
	Literacy rate	7	98.16	99.41	98.8657	0.40435
2	Poverty	7	2.19	7.70	4.2443	2.02906
	Per capita GDP	7	2.23	7.06	4.7714	1.65931
	Health spending	7	0.02	0.13	0.0829	0.03450
	Tax pressure	7	11.85	20.84	15.3200	2.83287
	Years of schooling	7	6.56	10.02	8.9800	1.13561
	Literacy rate	7	97.22	99.44	98.3957	0.80027
3	Poverty	1	14.49	14.49	14.4900	-
	Per capita GDP	1	2.92	2.92	2.9200	-
	Health spending	1	0.03	0.03	.0300	-
	Tax pressure	1	10.75	10.75	10.7500	-
	Years of schooling	1	4.82	4.82	4.8200	-
	Literacy rate	1	91.90	91.90	91.9000	-

Source: Prepared by the authors.
[a] There is no point in calculating the standard deviation for cluster 3, since it comprises a single country.

As may be seen in table 10, the first cluster is made up of those countries with lower poverty rates and higher levels of per capita GDP, health spending, literacy and years of schooling, on average. This group of countries may be said to be better positioned to continue reducing inequality levels (solely on the basis of the variables that the analysis showed were relevant). Group 2 consists of countries with higher poverty levels than group 1 and lower values for the other variables analysed, on average. For that reason, these countries are considered to be worse placed than those in the first group to reduce inequality levels. Lastly, Guatemala shows the highest rates of poverty and the lowest rates of per capita GDP, health spending, literacy rate and years of schooling, on average; accordingly, it may be concluded that it is the worst positioned country to reduce inequality (on the basis of the variables studied).

Pursuing this idea, a synthetic indicator was built using multivariate analysis to establish a classification of countries by their position for reducing inequality. This index was calculated for 2013. Although the authors are aware that the number of variables used to build this synthetic indicator is very small, they consider that the analysis is nevertheless an interesting one and sheds light on the phenomenon studied.

On the basis of Kaiser-Meyer-Olkin (KMO) and Barlett tests, it may be concluded that the data are adequate for a factor model. Table 11 shows that the KMO text is close to 0.7 and the Barlett test is significant for rejecting the null hypothesis.

Table 11
Kaiser-Meyer-Olkin (KMO) and Barlett tests

Kaiser-Meyer-Olkin measure		0.682
Bartlett test of sphericity	Approx. Chi-squared	47.002
	gl	0.15
	Sig.	0.000

Source: Prepared by the authors.

From the factor analysis it may be deduced that the variables considered are well explained by the factors retained, since all the communalities are above 0.6 (especially per capita GDP). The communalities are determined by the sum of the coefficients of correlation squared of each variable and the set of factors retained.

$$h^2_j(m) = r^2_{xj,y1} + \ldots + r^2_{Xj,Ym} \quad (7)$$

where Yi represents the i-th factor and Xj the j-th variable, and m is the number of factors extracted (see table 12).

Table 12
Communalities[a]

	Initial	Extraction
Poverty	1.000	0.753
Per capita GDP	1.000	0.864
Health spending	1.000	0.793
Tax pressure	1.000	0.642
Years of schooling	1.000	0.777
Literacy rate	1.000	0.860

Source: Prepared by the authors.
[a] The extraction method used is the principal components method.

Table 13 shows that the information contained in the initial variables is condensed into two factors that retain a variance proportion of around 78%.

Table 13
Eigenvalues and proportion of inertia retained

Component	Initial eigenvalues		
	Total	Percentage variance	Cumulative percentage
1	3.483	58.051	58.051
2	1.206	20.098	78.148
3	0.730	12.158	90.307
4	0.328	5.460	95.767
5	0.163	2.723	98.490
6	0.091	1.510	100.000

Source: Prepared by the authors.

Table 14 shows the matrix of rotated components on the basis of the Varimax method. It may be seen that the first factor is directly correlated with per capita GDP and health spending and inversely correlated with poverty. This axis captures economic factors that are involved in reducing inequality. The second factor is related directly to the literacy rate, years of schooling and taxes, i.e. it represents the impact of fiscal and social (basically education) policies, on reducing inequality.

Table 14
Matrix of rotated components[a]

	Component	
	1	2
Per capita GDP	0.928	0.051
Health spending	0.890	0.037
Poverty	-0.668	-0.553
Literacy rate	0.484	0.791
Tax pressure	-0.198	0.776
Years of schooling	0.609	0.637

Source: Prepared by the authors.
[a] Rotation method: Varimax with Kaiser normalization. Rotation converged in three iterations.

The synthetic indicator was prepared by obtaining the factor scores associated with the initial variables (see table 15).

Table 15
Component score coefficient matrix

	Component	
	1	2
Poverty	-0.162	-0.185
Per capita GDP	0.436	-0.232
Health spending	0.406	-0.203
Tax pressure	-0.220	0.423
Years of schooling	0.135	0.216
Literacy rate	0.023	0.370

Source: Prepared by the authors.

On the basis of these values, the synthetic indicator (SI) was obtained for the year considered, as follows:

$$SI_j = \sum_{i=1}^{r} z_{rj} X_{ij} \quad (8)$$

where z_{rj} represents the weighted average of the factor scores and X_{ij} the initial variables. The results are shown in table 16.

The results obtained from the construction of the synthetic indicator are consistent with those deriving from the cluster analysis: the countries with the highest scores in the ranking (Chile, Argentina, Uruguay, Panama, Costa Rica, Brazil and Mexico) are those in the first cluster. Those that follow (the Dominican Republic, Peru, Colombia, Paraguay, Ecuador, El Salvador and the Plurinational State of Bolivia) are in the second cluster and Guatemala is last in the ranking and some distance behind the country that precedes it.

Table 16
Synthetic indicator of inequality positioning

Country	Indicator	Ranking
Chile	12.235	1
Argentina	12.113	2
Uruguay	11.941	3
Panama	11.129	4
Costa Rica	10.888	5
Brazil	10.871	6
Mexico	10.558	7
Dominican Republic	9.967	8
Peru	9.865	9
Colombia	9.773	10
Paraguay	9.770	11
Ecuador	9.730	12
El Salvador	9.024	13
Bolivia (Plurinational State of)	8.514	14
Guatemala	6.898	15

Source: Prepared by the authors.

VII. Conclusions

This work has studied inequality in the Latin American countries using the Theil index for the period 2004–2013. The Theil index was chosen because of the properties it fulfils, particularly decomposition. The different countries have evolved in a heterogeneous manner in relation to inequality. As may be expected, substantial differences were found between one country and another.

The countries with the greatest income inequality over the study period were Brazil, Chile, Colombia, Mexico and Paraguay. Among the least unequal were Argentina, El Salvador, Peru and Uruguay. In the rest of the countries, inequality varies depending on economic and social circumstances (this is the case of Costa Rica, the Dominican Republic, Ecuador, Guatemala, Panama and the Plurinational State of Bolivia).

It was also found that inequality has fallen in most of the countries, except Costa Rica and Guatemala. The countries where inequality fell most over the period were the Plurinational State of Bolivia, Argentina, Peru and Ecuador.

Overall inequality for Latin American was obtained on the basis of internal inequality in each country and inequality between countries, with a fall being observed between 2005 and 2013.

By observing the sign of the indicator of inequality between countries, it may be determined which nations “suffer” inequality and which “generate” it. Here, Brazil and Colombia were found to suffer inequality every year, since their income was below the overall average. The other countries, meanwhile, benefited from inequality, as their income was above the average.

With a view to studying the socioeconomic determinant variables of inequality, a random effects panel data model was estimated. The following variables were found to be significant in explaining inequality: per capita GDP, per capita health spending, tax pressure, poverty rate, literacy rate and years of schooling. The economic crisis unleashed in 2008, which affected Europe so badly, had no significant effects in Latin America.

In order to systematize the behaviour of the countries vis-à-vis inequality, a cluster analysis was performed using a hierarchical cluster algorithm. The following three clusters were obtained: one comprising the countries with low levels of inequality, another comprising countries with high levels of inequality and third consisting only of Guatemala. The groups are fairly stable and vary little in their composition, which seems to indicate that inequality is a markedly structural characteristic.

Lastly, a synthetic indicator was constructed using factor analysis, to establish a classification of countries by their position in relation to reducing inequality levels.

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Does Amazonian land use display market failure? An opportunity-cost approach to the analysis of Amazonian environmental services

Marcelo Bentes Diniz, Vanessa Da Paixão Alves and Márcia Jucá Teixeira Diniz

Abstract

The article discusses whether deforestation in the Amazonian region should be considered a typical case of market failure and computes the opportunity cost of economic activities that promote deforestation relative to uses that keep the forest intact. For environmental resources threatened by Amazon deforestation, forms of productive land use ("opportunity" uses) are considered in terms of the net benefit values of primary land-based activities. The accounting exercise conducted in this study calculates the net benefit per hectare obtained from the direct use value (DUV) for different land use alternatives (timber, non-timber, livestock and agriculture); the indirect use value (IUV) related to carbon storage; and the non-use value (NUV) (existence value). The results show that the opportunity cost of deforestation in 2009 was positive for the most common land use, livestock activity. Such findings indicate a market failure. Nonetheless, this is not the only possible outcome when considering alternative land uses.

Keywords

Deforestation, forest degradation, economic aspects, costs, cost-benefit analysis, land use, agriculture, livestock industry, silviculture, environmental economics, environmental management, Brazil

JEL classification

Q57, Q23, O13

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I. Introduction

The traditional economics literature suggests that most environmental assets have no substitutes and that the absence of a "benchmark price" for their services distorts economic agents' perceptions of their value. In practice, as these assets have public good characteristics, a large proportion of the ecosystem services obtained by consumers cannot be captured exclusively by the agent that pays for the good. This distortion leads to market failure in terms of efficient allocation (Stiglitz, 2000), which in turn reveals a divergence between private and social costs (Pigou, 1932). Accordingly, the "prices" of environmental resources must be estimated to provide a technical foundation for their rational exploitation. This is typically based on environmental economic valuation methods (or techniques) grounded in neoclassical welfare theory (Pearce, 1976; Pearce and Turner, 1990; Kahn, 2005). One approach derives from the concept of opportunity cost applied to environmental conservation (Pearce and Markandya, 1987; Warford, 1987).

The strictly economic concept of opportunity cost defines opportunities foregone relative to the best use of certain economic resources, which confronts an efficiency concept (best use) with a resource scarcity concept. Nonetheless, in today's ecological context in which natural resource is considered critical, the opportunity cost concept and the method derived from it evaluate the income loss resulting from the constraints imposed on the production and consumption on private goods and services by measures to conserve or protect environmental resources. In the case of environmental resources threatened by deforestation, various forms of land occupation and productive land use are considered as "opportunity" uses (May, Veiga Neto and Chévez Pozo, 2000); and the opportunity costs represent the extractive land use of highest value (Naiddo and others, 2006).

In this connection many studies of the value of the Amazonian ecosystem have estimated the economic value of resources and environmental services from the standpoint of specific economic agents. Instead, this article aims to evaluate the net benefits for the region's main land-use activities (timber forest products, non-timber forest products, livestock and agriculture), viewing the productive uses of these net benefits as in direct competition with keeping the forest intact, and, consequently the net benefit that arises from "unproductive" uses (such as net benefits of carbon stocks, forest existence value).

Section II of this article discusses the main environmental services provided by the Amazon forest. Section III then builds on this by considering earlier studies that have attempted to value the Amazon's environmental goods and services. Section IV describes the methodological procedures adopted by the study, along with its results; and the concluding section provides some final thoughts.

II. Ecosystem services provided by the Amazon forest

Ecosystem services, along with their ecological processes, may be considered a subset of ecosystem operational structures (DeGroot, Wilson and Boumans, 2002). Moreover, these are not direct benefits, but inputs (Boyd and Banzhaf, 2007; Fisher and Turner, 2008; Fisher, Turner and Morling, 2009). They become services when they affect people's well-being (Fisher, Turner and Morling, 2009).

In the Amazon basin,[1] ecosystem services have a special impact because of the interconnections between the Amazon rainforest and the global climate system, owing to their function in carbon storage

[1] Amazônia Legal is a political-administrative division that encompasses the entire Amazon biome, areas of the Cerrado (Brazilian savannah) and natural grasslands, extending for 5 million km^2, or approximately 59% of all Brazilian territory. It span all of the northern Brazilian states (Acre, Amazonas, Amapá, Pará, Rondônia, Roraima and Tocantins) along with Mato Grosso and part of Maranhão (Pereira and others, 2010).

and sequestration (Nobre, Sellers and Shukla, 1991).[2] As a result, the planet´s climate balance becomes a function of the integrity of the Amazon rainforest. Moreover, the healthy functioning of the ecosystem throughout the basin sustains a wealth of biodiversity, which is of critical importance to the world's biological resources. With the Amazon supporting from 10 to 20 percent of global biodiversity, this maintenance function represents a valuable ecosystem service to the world community (Kaplan and Figuereido, 2006; Lopes, Nass and Melo, 2008).

At least 40,000 plant species, 427 mammals, 1,294 different types of bird, 378 species of reptile, 427 amphibians and 3,000 fish species are estimated to inhabit the Amazon rainforest biome (Rylands and others, 2000). A recent study by the World Wide Fund for Nature (WWF-Brasil, 2010) shows that between 1999 and 2009 approximately 1,220 new plant and vertebrate species were found in the biome, including 637 plants, 257 fish, 216 amphibians, 55 reptiles, 16 birds and 39 mammals. Furthermore, six Natural Heritage Sites and elements from 56 Global Ecoregions are partly or fully embedded in the Amazon rainforest biome, according to the classification adopted by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Over 600 different types of terrestrial and freshwater habitats are also found in this biome, which encompasses large endemic areas with native species that are not found anywhere else in the world.

In addition to sustaining biodiversity, Amazonian ecosystems provide important support services in the global water cycle and carbon sequestration. Together, these services make the region a "global commons resource" (Dasgupta, 1990; Grafton and others, 2004). In the case of water, they represent a global public good (Kaul, Grunberg and Stern, 1999; Kahn, 2005).

The Earth's rotation enables winds to circulate from the northeast and enter the region, carrying water vapour from the Atlantic Ocean that falls as rain. This rain is then partly recycled by the trees through evapotranspiration (Fearnside, 2004). An estimated 10×10^{12} m^3 of water enters the region annually through trade winds. The annual water flow into the Amazon river totals 6.6×10^{12} m^3 (Salati, 2001), while the remainder, 3.4 x 1012 m^3, is transported to other regions. Annual rainfall across the basin is estimated at between 1,350 and 1,570 mm, which corresponds to between 63% and 73% of the annual rainfall caused by the water evapotranspiration phenomenon in the region (Costa and Foley, 2000; Marengo and Nobre, 2001; Malhi and others, 2008).

In terms of carbon sequestration, tropical forests play a key role in the global carbon cycle, because they store a large amount in both the above- and the below-ground biomass. The Amazonian forest biomass is estimated to hold approximately 70 PgC (petragram of carbon), which corresponds to 10%–15% of the Earth's total carbon stock (Keller, Melilloand Zamboni de Mello, 1997; Houghton and others, 2001). Other studies, such as Saatchi and others (2007) have reported total carbon stock values, including dead and below-ground biomass, ranging from 77 to 95 Pg C, with a mean of 86±17 Pg C. Currently, the Amazon biome seems to be functioning as a carbon sink, absorbing between 0.44 and 0.56 Pg of carbon per year (Grace and others, 1995; Phillips and others, 1998; Malhi and others, 1998).

Although biodiversity maintenance, water recycling, and carbon sequestration are some of the most important ecosystem services provided by Amazonia, there are others such as fire protection and reduction of pathogens/diseases by controlling organisms (Foley and others, 2007). Although timber provides high-value market goods, the provision of non-timber forest products should be interpreted as a direct form of ecosystem service, sometimes with a market value (for example the Brazil nut). The wealth of the Amazon basin includes a timber volume of approximately 106.388 billion m^3 with an above-ground biomass stock of 92.203 billion tons and a below-ground biomass stock of 13.367 billion tons (84.2 and 65.1 million tons in Brazilian territory, respectively (SFB, 2010)).

[2] Nonetheless, in contrast, the threshold carbon release caused by tropical deforestation is not yet known in terms of its potential effect on continent-scale climate change, or if such a change really will take place at all (Stickler and others 2009).

Land-use changes in the Amazon region have been associated with fire and deforestation. Data from the TerraClass project (Embrapa/INPE, 2012) ahow that, by 2010, cattle ranching was already using 45.9 million hectares, occupying 66% of all deforested areas, while annual agriculture occupied 5.4% (about 4 million hectares).

Deforestation in the Amazon region is estimated to have emitted very large amounts of carbon into the atmosphere. During the peak of deforestation in the 1990s, the region may have emitted between 0.8 and 2.2 Pg C, which would represent about 10%–15% of global greenhouse gas (GHG) emissions in the period (Houghton, 2005). Accordingly, the continuation and intensity of deforestation have severe consequences for ecosystem functions in the Amazon basin (Foley and others, 2007), and could even affect rainfall in the region (Salati and Nobre, 1991; Sampaio and others, 2007; Nobre and Borma, 2009).

When considering the importance of Amazonian ecosystem services,[3] the benefits can be measured on local, regional, national, and global scales. Local beneficiaries are directly affected by the conflict between productive and unproductive land use. Regional beneficiaries are the residents of the region, which includes the first group of local beneficiaries but also those who do not compete for land use. National beneficiaries encompass all those who receive some sort of benefit within the country's borders, thus including the two previous categories. Lastly, global beneficiaries include those who receive benefits beyond the country's borders, arising from the non-excludable and non-rival characteristics of the Amazon ecosystem's "global commons" or "global public goods". Accordingly, they also encompass the aforementioned beneficiary categories.[4]

When beneficiaries are viewed from this perspective, there is a danger of double-counting. For example, local beneficiaries can enjoy direct-use benefits such as the supply of timber and non-timber resources; but they can also enjoy the benefits of other ecosystem services, such as regulation of carbon sequestration, which has (global) public goods characteristics. In contrast, the decision on whether to use the land productively or conserve the forest imposes a direct opportunity cost upon local economic agents, who may who fail to earn income as a result of the land use choice —in other words when conservation ("unproductive use") is chosen. Thus, for local beneficiaries, alternative forest uses, including deforestation to clear the way for different types of use, such as crop farming or livestock, compete with each other in terms of the potential income generated (benefits).

III. Review of literature on the valuation of Amazonian environmental goods and services

Researchers have started to study the economic values of the tropical forest, considering both its productive uses and its ecological values. This section reviews research on Amazonian deforestation. While the various studies use different methodologies, all agree that large-scale loss of the Amazonian biome represents a significant cost, as shown below. Annex table A1.1 summarizes the main studies and findings on Amazon ecosystem services valuation.

Various studies have put a value on Amazonian ecosystem services. Some attempt to assign a general value, or total economic value, to these services as whole (Andersen, 1997; Torras, 2000), while others attempt to value specific environmental services or resources only. The latter consider different spatial scales and report values for different years, which makes then difficult to compare.

[3] Anderson-Teixeira and others (2012) stress the significant role of terrestrial ecosystems in climate regulation through biophysical mechanisms (regulation of water and energy) and biochemical ones (regulation of greenhouse gases). Biogeochemical factors, land use change and agriculture jointly account for over 25% of global greenhouse gas emission. About 40% of gross CO_2 was emitted from deforestation in tropical forests between 1990 and 2007.

[4] An analysis of these features and how they may change in the case of ecosystem services goes beyond the remit of this article. For a discussion see Fisher, Turner and Morling (2009).

IV. Market failures and the opportunity cost of Amazon land use

1. Market failures

There are various sources of market failure related to land use in the Amazon, which result in deforestation across the region. One source of market failure, which can be considered prior to the land-use decision, stems from incomplete or imperfect information on land conversion opportunities. Agents are ignorant of most ecosystem services, such as support services, and regulatory and cultural services. Keeping the forest intact implies the need for such services; so the "landowners" would not capture the benefits (Kahn, 2005).

Another ex ante source of market failure stems from the inadequate definition of land rights in the region. On this point, Panayotou (1993) argues imprecise, or even non-existent property rights, compounded by the high transaction costs associated with environmental conservation, could also be viewed as sources of additional local market failures. They create a sense of free access to forest and land. These two sources of market failures are linked to very high transaction costs in the region: enforcement costs, stemming from lack of secure property rights (or contract enforcement); and measurement costs, arising from uncertainty arising from the incomplete and imperfect information on which economic decisions are based (Williamson, 1985).

For Pearce (1998), on the other hand, the deforestation process combines three "economic failures": failure of government intervention, failure of the local market, and failure of the global market. The first occurs as a result of government intervention. By creating infrastructure and direct and indirect mechanisms to sustain the profitability of "local" productive activity, government intervention artificially widens the gap between private costs and social costs, thus further fuelling the conversion of the forest into other forms of land use.

The other sources of failure stem from the externalities imposed by deforestation on the directly affected local population, including the land-use opportunity cost, and indirect effects on the population living outside the region's borders, who will lose the benefits of ecosystem services destroyed by deforestation. In practice, market failures lead to a rate of forest conversion that may be privately profitable but not socially optimal.

2. Opportunity costs

Opportunity costs measure what could have been achieved by using a resource in an alternative use. In protected land areas, the opportunity cost is typically the highest-value extractive land use (Naidoo and others, 2006). Pearce and Markandya (1987) suggest that opportunity costs can be partitioned into three components: (i) the direct cost of the activity, including the cost of labour and materials used in the extraction of natural resources; (ii) external costs imposed on a third party; and (iii) intertemporal costs related to possibilities for its future use or non-use. This classification is similar to that proposed by Warford (1987), who states marginal opportunity cost would ideally equal the price users would have to pay for resource-using activities. Thus, the opportunity cost of using and maintaining an environmental resource is measured as its net benefits (gross income minus production costs) under the predictable activity. This article considers two perspectives: the opportunity costs of deforestation and the opportunity costs of conservation (the same value with opposite signs).

V. Cost-benefit analysis of maintaining environmental goods and services provided by the Amazon

1. Methodological procedures

Deforestation costs offset the benefits of this process measured by gain obtained from the various alternatives for Amazonian land use, mainly logging, livestock farming, and both seasonal and perennial agricultural activities. In addition to those direct-use benefits, the value of indirect use of the Amazon forest is estimated on the basis of its carbon storage value and its existence value, according to previously published studies.

The net benefits (NB) yielded by the goods and services in question provide a good measure of the opportunity cost (OPC) of keeping the forest intact. So, the general rule of the valuation exercise developed adopts the following economic rationale:

$$NB\ DU\ (direct\ use) + NB\ IU\ (indirect\ use) - NB\ NU\ (non\text{-}use) = TEV\ (total\ economic\ value) \quad (1)$$

But,

$$OPC\ D\ (deforestation) = (NB\ IU + NB\ NU) - NB\ DU \quad (2)$$

or

$$OPC\ C\ (conservation) = NB\ DU - (NB\ IU + NB\ NU) \quad (3)$$

So,

$$OPC\ C = -\ OPC\ D \quad (4)$$

This logic is based on the hypothesis that net benefits are equivalent to their respective net returns, which may be estimated through the differences between the respective values of gross production and costs. Thus, the opportunity costs of maintaining or deforesting the Amazon forest are equivalent to the net benefits resulting from the use of environmental goods and services. This study values those "opportunity uses" in terms of direct use (DU), or land use (timber extraction + non-timber extraction + livestock farming + agriculture). These are taken to mean effective land use and have the opposite sign to the indirect use (IU) (carbon storage), and non-use (NU) or existence value (EV), according to previously published studies.

Three additional observations are worth making. The first considers the heterogeneity of Amazonian pastures and requires the direct use of land in different grassland formations in the region to be calculated, as another approximation to livestock opportunity cost. Second, the deforestation scenario follows the economic rationale that expects that OPC C to be positive if NB DU is greater than NB IU + NB NU. Third, an output OPC D that is positive means that leaving the land forested yields greater value than alternative land uses. In this case, continuing the deforestation process represents a huge market distortion.

2. Net benefit calculations

(a) Net benefit of direct use (NB DU)

(i) Timber

The area of timber exploited in the Amazon is unknown, although estimates range between 10,000 km² and 20,000 km² per year (Barreto and others, 2005). In 2009, 13 million m³ of native lumber were produced in the seven states of Amazônia Legal. This would give an estimated 9.46 m³/ha of timber, equivalent to a gross production value of R$ 802/ha (1,203,000,000/1,500,000), assuming a mean of 15,000 km² (1.5 million hectares) of timber exploitation in the region. In 2009, the mean production cost[5] of timber per cubic metre was R$ 143.84/ha. The mean cost of logging operations (felling, bucking, skidding and loading logs on trucks) was US$ 31 or R$ 61.7/m³; the mean cost of processing timber was US$ 41 or R$ 81.6/m³ (Pereira and others, 2010); and the mean transportation cost[6] per type of surface in the Amazônia Legal (river transport, paved highways and dirt roads) was US$ 0.23 or R$ 0.46/m³, which corresponds to R$ 0.54/m³ at 2009 prices. Thus, the Net Benefit of production, calculated as net production value = gross production value (R$)/ha —mean production cost (R$)/ha, would equal R$ 802/ha— R$ 143.84/ha = R$ 658.16/ha.

(ii) Non-timber forest products (açaí berry and palm heart)

The açaí berry is an example of a non-timber forest product, not only for its strong presence in the local market, but also because the açaí fruit has been used in many ways in several industries, including cosmetics and personal hygiene, pharmaceuticals and medical, food and beverages industry. This makes the açaí berry a key representative of how Amazonian biodiversity generates products with various economic applications. Possibly the most popular example of its applications and is fresh and lyophilized pulp, and powdered or dry açaí.

Brazilian açaí fruit production totalled 115,947 tons in 2009, with the main producing state, Pará, accounting for 87.4% of national production, or 101,375 tons. This had a production value of R$ 145.4 million in 2009 (IBGE, 2010), and representing R$ 166.4 million for the Amazon.

A study conducted on the island of Cumbu in Belém, in the state of Pará, to estimate the cost of açaí production during harvest (from June to October) estimates total expenditure[7] for a mean daily production of three 28-kg baskets at R$ 40.53. Thus, the production cost for the four-month harvest period would be R$ 4,863.60 (10 tons of açaí berry; Pinto and others, 2010). If the total production cost of 10 tons of açaí berry was R$ 4,863.60, then the total cost of the 101,375 tons produced in Pará state is approximately R$ 49.3 million, corresponding to roughly R$ 56.4 million for the Amazon as a whole. Thus, the net production value (R$ 166.4 million minus R$ 56.4 million) would be approximately R$ 110 million.

[5] Average exchange rate in 2009: US$ 1.00 = R$ 1.99 (BCB, 2009).

[6] The average transportation cost is the average of the confidence intervals defined for the mean transportation costs (5% probability level, n-1 degrees of freedom) reported in Lentini, Veríssimo and Pereira (2005) and aligned to the average exchange rate prevailing in 2009.

[7] Daily labour cost (R$ 30.00); a materials depreciation cost of R$ 1.53 per day of use; and a cost of transportation of açaí to the point of sale (port) of R$ 9.00 (Pinto and others, 2010).

The açaí palm tree is the most commercially abundant tree with uses both in the floodplain forest and in the lowlands, occupying approximately 10,000 km² (one million hectares) of the Amazon estuary (May, Veiga Neto and Chévez Pozo, 2000). Based on these figures, the net production value of açaí berry divided by the planted area of this plant species (in hectares) gives a value of R$ 110/ha.

Pará State also accounted for 96% of Brazilian national output of palm hearts in 2009, producing 4,897 tons, for a value of R$ 6.9 million (IBGE, 2010). Thus, this quantity will be taken as the reference value for the Amazon.

The financial analysis of a palm heart factory in Pará producing 30 tons of palm hearts per month (Pollak, Mattos and Uhl, 1996), reported a mean monthly cost of raw material (large, medium and small palm hearts) of US$ 4,302, equivalent to R$ 12,960.49, and a monthly production cost (wages, chemical products, maintenance, freight, firewood, boat, energy and depreciation) of US$ 3,086 or R$ 9,297.09 when converted into Brazilian reais at the 2009 exchange rate. So, the total production cost[8] of palm heart produced in 2009 would be R$ 741.92 per ton. The final production cost would be R$ 3.6 million, assuming an output of 4,897 tons of palm hearts in 2009. The net production value of palm hearts (R$ 6.9 million minus R$ 3.6 million) would be R$ 3.26 million or R$ 3.26/ha.

(iii) Livestock farming

Livestock breeding in the Amazon region is typically extensive, with beef production predominating. This activity is responsible for the greatest change in land use in the Amazon, accounting for over 2/3 of the deforestation that has occurred in recent decades. In the last twenty years, the size of the cattle population has almost tripled (IBGE, 2012), with an expansion driven by factors such as currency devaluation and improved animal production and tracking systems, which led to the eradication of foot-and-mouth disease (Nepstad and Stickler, 2008). Beyond that, other features of the process in the last three decades include the increasing replacement of natural pastures by cultivated pastures and an increase in the pasture stocking rate to above the Brazilian national average (Valentim and Andrade, 2009).

Furthermore, between 2001 and 2010 there were also increases in the size of cattle herds, slaughter rates (ratio of the number of slaughtered cattle to the size of the herd) and meat production, or what is effectively used from the animal by weight (Agra FNP, 2010). The first two indicators rose by nearly 60%, while the third increased by about 30%.

Table 1 reports the annual cost and annual income (net benefit per hectare of beef cattle production) for selected municipalities in the States of Pará, Tocantins and Mato Grosso. Thus, the mean of those cost values and the net benefit per hectare, of R$ 100.62/ha, is taken as the reference value.

The dairy cattle herd in Amazônia Legal in 2009 was approximately 6.06 million animals according to 2010 estimates (Agra FNP, 2010). In the same year, the region produced 2.7 billion litres of milk, for a yield of 446.79 litres/cow/year, with gross production value of R$ 1.7 billion (IBGE, 2010).

The cost of R$ 0.23 per kg/L produced,[9] reported in the survey conducted by Anualpec in 2010 on dairy cattle fodder expenditure, was used as a production cost when calculating the net value of milk production. This cost was used because fodder represents a large proportion of production costs in the dietary supplementation of pasture-raised animals. Thus, a production cost of R$ 622.95 million results from multiplying R$ 0.23/kg/L by the volume of milk production (2.7 billion litres) in 2009.

[8] Mean raw material cost (R$ 8,560.98) plus the monthly production cost (R$ 6,141.14) divided by 30 tons.

[9] R$ 0.227/kg milk is the cost of fodder supplement with traditional concentrate consisting of corn and soybean meal (Agra FNP Research, 2011b).

Table 1
Annual cost and income (net benefit)

		Annual cost		Annual income
		Reais/animal	Reais/arroba[a]	Reais/ha
Mato Grosso	Barra do Garças	152	43	120
	Alta Floresta	168	45	116
	Pontes e Lacerda	171	44.8	144
	Poconé	187	61.4	7
Tocantins	Gurupi	142	41.8	87
	Araguaina	167	43.9	124
Pará	Redenção	170	45.6	120
	Paragominas	172	50	87
Mean		166.12	46.94	100.62

Source: Agra FNP, *Anualpec 2010: Anuário da Pecuária Brasileira*, São Paulo, 2010.
[a] Arroba: is a unit of weight of varying value; in Brazil it is equivalent to 12 kg.

The net value of milk production (R$ 1.7 billion minus R$ 622.95 million) is approximately R$ 1.09 billion. Dividing that value by the area used as "clean" pasture,[10] considered proportional to the number of dairy cows in hectares (approximately 10% of the herd population), produces the following value: R$ 1,090,000,000/3,357,149 (33,571,494 x 0.1 = 3,357,149), which gives a net value of milk production of R$ 324.68 per hectare.

(iv) Land for pasture

The proposal made by Chomitz and others (2005), treats the difference between the price of land intended for livestock and the price of land kept for conservation as an opportunity cost. It was used here as a first reference in calculating opportunity cost. Thus, for values from the year 2009, the land prices (R$/ha) of different types of pastures in different producing regions of Brazil's Amazônia Legal are shown in table 2.

The mean value of different types of pasture was subtracted from the value of virgin forest, as shown in table 3. The figures show that the greatest differences between the value of virgin land and that of land used for livestock farming occurred when the latter was high-stocking pasture, usually intended for dairy livestock farming (R$ 1,574.82), or cultivated pasture, mostly intended for beef cattle (R$ 1,489.91). These values can be considered a first estimate of the opportunity cost of dairy and beef livestock farming, respectively.

[10] There are four categories of pasture: "clean" (with little or no woody vegetation); "dirty" (with significant invasion of weeds and woody shrubs); pasture with regeneration (areas in which the process of native vegetation regeneration is beginning); and pasture with bare soil (INPE, 2011). The "clean" pasture used in this study as reference corresponds to pasture undergoing a production process.

Table 2
Cost of land per hectare for different types of pastures in different Amazon states, 2009
(Reais per hectare)

BRL/ha	Acre		Amapá	Amazonas				Maranhão			Mato Grosso							Pará					Rondônia		Roraima	Tocantins	Media
	Rio Branco	Tarauacá	Macapá	Itacoatiara	Manaus	Parintins	Boca do Acre	Imperatriz	Santa Luzia	Alta Floresta	Aripuã	Barra do Garças	Pontes e Lacerda	Sinop	Vila Rica	Belém	Ilhas	Redenção	Santaréim	Cacoal	Porto Velho	Caracaraí	Gurupi	
Forest	185	80	238	90	90	85	125	400	212	733	469	800	1 017	679	502.5	110	900	492.5	412.5	500	200	207	767	387.61
Remote cultivated pasture	1 300	740																						1 020
Easily reached cultivated pasture	2 400	900					600																	1 300
Cultivated pasture										1 541.5	1 777.7	2 194.33	2 855.33	2 257	1 290				507.5	2 800	1 675			1 877.52
Native Pantanal pasture			110										825											467.50
Remote native pasture			800														80							440
Easily reached native pasture				500	500	450																		483.33
Dryland cultivated pasture												492												492
Wetland native pasture								1 983	992	2 250		85			300								783	1 065.50
High-stocking pasture										1 500				3 300	2 000	1 733	2 4502	541.5				650	1 525	1962.44
Low-stocking pasture				60			400							2 000	1 400	500	1 9501	412.5				305	908	992.83

Source: Agra FNP, *Anualpec 2010: Anuário da Pecuária Brasileira*, São Paulo, 2010.

Table 3
Difference between the value of land used for pasture and virgin forest

Land with improvements - forest	Mean	Reais/ha
Forest	387.61	
Remote cultivated pasture	1 020	632.39
Easily reached cultivated pasture	1 300	912.39
Cultivated pasture	1 877.52	1 489.91
Native Pantanal pasture	467.50	79.89
Remote native pasture	440	52.39
Easily reached native pasture	483.33	95.72
Dryland cultivated pasture	492	104.39
Wetland native pasture	1 065.50	677.89
High-stocking pasture	1 962.44	1 574.82
Low-stocking pasture	992.83	605.22
Average of all pasture types	1 010.11	622.50

Source: Prepared by the authors, on the basis of Agra FNP, *Anualpec 2010: Anuário da Pecuária Brasileira*, São Paulo, 2010.

(v) Agricultural production

Data from the *Agriculture in Brazil Yearbook, 2010 – Brazil Agrianual* were used to calculate the net benefit (in R$ /ha) based on the primary main perennial and seasonal crops (Agra FNP Research, 2011b). This calculation was performed assuming an increase in mean cost of between 20% and 50% more for the Amazon, depending on the crop and spatial scope of the data used in each case (see table 4).

Table 4
Net benefit of the main seasonal and perennial crops of the Amazon, 2009
(Reais and dollars per hectare)

Perennial crops	Reais/ha	Reais/ha (Amazon)	Dollars/ha (Amazon)
Banana	12 888	7 733	3 885.92
Cocoa	3 584	2 151	1 080.90
Black pepper	5 821	5 821	2 925.12
Coffee	4 080	2 448	1 230.15
Coconut	8 924	5 354	2 690.45
Passion fruit	22 395	11 197	5 626.63
Rubber tree	2 305	1 152	578.89

Table 4 (concluded)

Seasonal crops	Reais/ha	Reais/ha (Amazon)	Dollars/ha (Amazon)
Soybean	486.21	388.97	195.46
Corn	379.30	227.58	114.36
Upland cotton	1 179.62	943.16	473.95
Cassava	2 899.98	1 739.99	874.37
Sugarcane	355.31	213.19	107.13
Rice	431.59	258.95	130.13
Beans	1 377.71	826.63	415.39

Source: Agra FNP Research, *Agriculture in Brazil Yearbook, 2010. Brazil Agrianual*, São Paulo, 2011.

Note: The value of upland cotton at 260 arroba/ha is R$ 1,382; but the figure shown corresponds to 280 arroba/ha, to take account of higher per hectare costs in the Amazon (Maranhão State is the main producer).
The figure for rice corresponds to the result for rain-fed rice, considering a 40% higher cost for the Amazon.
The figure for bananas refers to stable production achieved in year 4–5, considering a 40% higher cost for the Amazon.
The figure for cocoa refers to the production phase from year 10 onward, considering a 40% higher cost for the Amazon.
The figure for (traditional) coffee refers to the production phase from years 4 to 18, considering a 40% higher cost for the Amazon.
The figure for sugarcane refers to São Paulo, fifth harvest, considering a 40% higher cost for the Amazon.
The figure for coconut refers to stable production, achieved between years 11 and 30, considering a 40% higher cost for the Amazon.
The figure for beans corresponds to 50 bags/ha.
The figure for cassava refers to 2 cycles 35 t/ha. The value of 2 cycles 30 t/ha is R$ 4,628.00.
The figure for passion fruit corresponds to rain-fed passion fruit (30 t/ha), considering a 50% higher cost for the Amazon.
The figure for maize refers to the first harvest of 6,600 kg/ha.
The figure for rubber considers stable production from years 12 to 27.
The figure for soybeans refers to a yield of 2,880 kg/ha, in the reference site of Roraima, considering a 20% higher transportation cost.
The means of the net benefit values used for 20, 50 and 100 hectares are 389.8; 1,044.25 and 1,410.50, respectively. The result is R$ 18.16/ha.
The figure for black pepper is the estimate made by Ferreira and others (2004), as a mean of the net benefit of the yield for the first six years of planting.

(b) Net benefit from indirect use: NB IU (carbon stocks)

Estimates of Amazon forest carbon stocks range from approximately 70 tC/ha to 120 tC/ha (Seroa da Motta, 2000). This study uses a mean carbon stock of 100 tC/ha in the region for the valuation exercise, where the loss of roughly 75 million tC is calculated by multiplying 100 tC/ha by the rate of deforestation in Amazônia Legal in 2009, that is roughly 7,500 km² (or 750,000 hectares).

In 2009, the price of carbon was US$ 15 or R$ 29.85/tC, according to the carbon credits sold by firms in the European Union,[11] considered the largest stock of carbon credits globally, which traded 5 billion tons of carbon in 2008. The value associated with carbon would be approximately R$ 3,000/ha, considering the mean carbon density of 100 tC/ha and a price at the upper bound of R$ 29.85/tC. Another alternative is to consider its lower bound, which gives R$ 1,500/ha. Those values are estimates of the net value obtained from the carbon stock in Amazônia Legal, which will be considered the valuation exercise in this study.

(c) Net benefit for non-use: NB NU (existence value)

Seroa da Motta (2002) estimates the annual value conserved Amazon forest to be equivalent to a world total of US$ 35.8/ha year[12] (US$ 31 for high-income countries and US$ 4.4 and US$ 0.3 for medium- and low-income countries, respectively) based on a study by Horton and others (2002).

[11] www.scienceblogs.com.br.

[12] The methodology used to estimate this value is described in the review of literature on the Existence Value associated with conservation of the biodiversity of the Amazon region in section IV.

Assuming a discount rate of 6%, that value would be approximately US$ 520/ha in perpetuity. The net present value of the standing Amazon forest, of R$ 1034.80/ha is found in this valuation exercise by adjusting that value to the average exchange rate of US$ 1.00 = R$ 1.99 prevailing in 2009.

(d) Deforestation (conservation) opportunity cost

Based on the assumptions made in the valuation exercise, as expressed in equations (1)–(4), the first step in quantifying the opportunity cost would be to identify conflicts of use —that is, one use of the environmental resource that precludes another type of use. The estimated benefits (costs) from timber extraction, non-timber extraction, livestock and crop-farming activities represent the welfare that would be lost if sustainable land practices use were adopted or if conservation units were created at the expense of those activities. This value is referred to as the deforestation opportunity cost.

Table 5 summarizes the estimates made of economic cost (benefit) in the Amazon according to the net values found both for activities associated with land use (timber extraction, non-timber extraction, livestock farming and perennial and seasonal agricultural activities) and for activities associated with carbon storage and the existence value for the year 2009.

Table 5
Summary of total opportunity cost estimates of the Amazon forest
(Dollars and reais)

Value share	Dollars/ha year	Reais/ha year
NB DUV		
(i) Plant extraction		
Timber	330.73	658.16
NTFP	56.91	113.26
(ii) Agricultural crops		
Seasonal	3 386	7 733
Banana	1 131	2 251
Cocoa	2 925	5 821
Black pepper	1 230	2 448
Coffee	2 690	5 354
Coconut	5 627	11 197
Passion fruit	579	1 152
Rubber tree		
Perennial		
Soybean	195	389
Corn	114	227.6
Upland cotton	474	943
Cassava	874	1 740
Sugarcane	107	213
Rice	130	259
Beans	416	827
(iii) Livestock		
Beef	50.56	100.62
Dairy	163.16	324.68
(iv) Land for pasture	622.50	1 010.11
NB IUV		
Carbon storage (tC) (Upper bound price)	1 507.54	3 000
Carbon storage (tC) (Lower bound price)	753.76	1 500
NB NU		
Existence value	520	1 034.8

Source: Prepared by the authors.

Thus, the welfare loss is analysed by considering the Amazon a space with land-use conflicts of this type. The aim is to obtain knowledge of the ecological dynamics resulting from the economic dynamics of the dominant production activities, which ultimately generate differences in land use and occupation patterns. This analysis also makes it possible to identify the drivers of deforestation, which contribute to changes in the availability of goods and services provided by the forest.

The estimated values of each direct use are competing values, because a particular use of one hectare in principle excludes the possibility of other uses, as in the case of livestock (pasture) vs. crop farming; or else they may be complementary values considering their possible uses at different times, such as timber extraction and livestock (or even with NT FP extraction). Indirect-use and existence values are always treated as complementary values in this study. Accordingly, the most common economic alternative of land exploitation and use in the Amazon: livestock (pasture), as summarized in table 6, always has a positive deforestation opportunity cost for different combinations of direct use values.

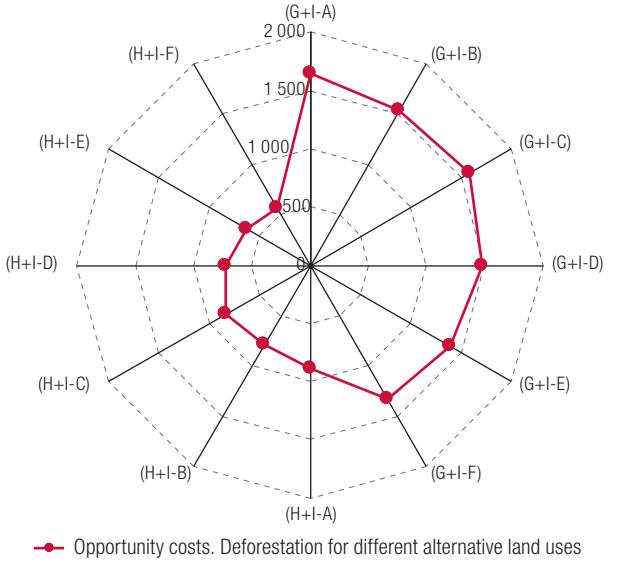
Table 6
Opportunity cost deforestation (conservation) – livestock
(Reais and dollars)

OPC D	Reais/ha	Dollars/ha
A. NB DUV livestock (beef) + timber	758.78	381.30
B. NB DUV livestock (dairy) + timber	982.84	493.89
C. NB DUV livestock (beef) + timber + NTFP	872.04	438.21
D. NB DUV livestock (diary) + timber + NTFP	1 096.10	550.80
E. NB DUV pasture + timber	1 280.66	643.55
F. NB DUV pasture + timber + NTPF	1 393.92	700.46
G. NB IUV (C upper bound price)	3 000.00	1 507.54
H. NB IUV (C lower bound price)	1 500.00	753.80
I. NB NU	1 034.80	520.00
Results	**Reais/ha**	**Dollars/ha**
(G+I-A)	3 276.02	1 646.24
(G+I-B)	3 051.96	1 533.65
(G+I-C)	3 162.77	1 589.33
(G+I-D)	2 938.71	1 476.74
(G+I-E)	2 754.00	1 383.92
(G+I-F)	2 640.89	1 327.08
(H+I-A)	1 776.07	892.50
(H+I-B)	1 552.02	779.91
(H+I-C)	1 662.82	835.59
(H+I-D)	1 438.77	723.00
(H+I-E)	1 254.20	630.25
(H+I-F)	1 140.95	573.34

Source: Prepared by the authors.

In fact, preserving the standing forest, which would simultaneously enable carbon storage (indirect use value) at an upper bound carbon price of R$ 3,000.00/ha (US$ 1,507.54/ha) or a lower bound carbon price of R$ 1,500.00/ha (US$ 753.76) and maintaining an existence value of R$ 1,034.80/ha (US$ 520), produces a total of R$ 4,034.80 (US$ 2,027.54) or R$ 2,534.8 (US$ 1,273.77). Nonetheless, this value is higher than other alternatives of livestock (beef + timber; diary + timber; beef + timber + NTFP; diary + timber + NTFP; pasture + timber; pasture + timber + NTFP), as reported in table 6 and figure 1.

Figure 1
Opportunity costs of deforestation (livestock) from different alternative land uses
(Dollars per hectare)



Source: Prepared by the authors.

Nonetheless, this result contrasts with other land uses such as crop farming, for example. It is possible to obtain a positive OPC D, which generally happens in the case of seasonal crops; but it is also possible to obtain a negative OPC for perennial crops (see table 7). Perennial crops averaged, respectively, US$ 1,697.4 or US$ 943.7 and (US$ 544.5) or (US$ 1,300.20) for the upper and lower bound carbon prices.

Table 7
Opportunity cost deforestation (conservation) – agriculture

OPC D	Reais/ha	Dollars/ha
J. NB DUV perennial crops (average)	5 784.00	2 906.50
K. NB DUV seasonal crops (average)	659.90	330.10
G. NB IUV (C upper bound price)	3 000.00	1 507.54
H. NB IUV (C lower bound price)	1 500.00	753.80
I. NB NU	1 034.80	520.00
Results	Reais/ha	Dollars/ha
(G+I-J)	-1 087.5	-546.5
(G+I-K)	3 377.9	1 697.4
(H+I-J)	-2 587.5	-1 300.2
(H+I-K)	1 877.9	943.7

Source: Prepared by the authors.

The main implication of the results presented above is that Amazonian land use demonstrates a type of market failure. Considering the average farm size (IBGE, 2008) in states with highest deforestation rates, the opportunity costs per agricultural establishment range as follows:[13] Rondônia (from US$ 36,871.71 to US$ 145,779.12), Pará (from US$ 41,599.83 to US$ 164,472.61); Mato Grosso (from US$ 162,815.10 to US$ 643,719.58).

[13] The Agricultural Census (IBGE, 2010) reports average farm sizes in selected Brazilian states as: Pará (109.2 ha); Mato Grosso (427 ha) and Rondônia (96.7 ha).

VI. Final thoughts

The valuation exercise described in this article reports the net benefits obtained from different land uses, including direct productive land use alternatives such as timber and non-timber production, livestock and crop farming. There are also net benefits from indirect uses and non-uses, which, as they keep the forest intact, are conservation uses. The estimated values of each direct use are either competing, because a particular use of 1 hectare in principle excludes the possibility of other or complementary use values, whereas the indirect-use and existence values are complementary values.

The results show that preserving the standing forest, which would simultaneously enable carbon storage (indirect use value) of R$ 3,000.00 (US$ 1,507.54/ha) and sustain an existence value of R$ 1,034.80 (US$ 520), would provide a total value of R$ 4,034.80 (US$ 2,027.54). This is higher the denser the land occupation and use in the Amazon basin: livestock in different land use forms intended for pasture as (beef + timber; diary + timber; beef + timber + NTFP; diary + timber + NTFP; pasture + timber; pasture + timber + NTFP). This implies a positive deforestation opportunity cost in practice and therefore a type of market failure (Stiglitz, 2000).

On the other hand, comparing the different types of agriculture, for seasonal crops, in general, provides similar results, i.e. a positive deforestation opportunity cost. For perennial crops, the deforestation opportunity cost is generally negative.

Lastly, it should be emphasized that the results reported here do not merely point to a best land-use alternative in the Amazon region; they also show that deforestation is an economic problem as well as an environmental one, since the vast majority of activities that cause deforestation generate positive opportunity costs. Positive opportunity costs arising from deforestation represent a market failure and produce socially suboptimal results.

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Annex A1

Table A1.1
Values assigned to Amazon ecosystem services in different studies

Type of ecosystem services	Biome/region	Value attributed/authors	Comments
Ecotourism and sport fishing	Amazon forest	US$ 26/ha (Andersen, 1997)	Amazônia Legal, NPV at a 6% discount rate
Conservation of natural resources	Amazon Northwest	US$ 13.34/month/person (Pessoa and Ramos, 1998)	WTP, many natural resources, Roraima State
Artisanal or commercial fishing	Eastern Amazon	US$ 30 - US$ 36/family/year (Muchagata, 1997)	Farmers from Marabá, Pará State
	Mangrove Swamp-PA	66% to 84% of family income (Glaser & Grasso, 1999)	Farmers from eastern Pará State
	Amazon wetland	US$ 909/family/year (Câmara, 1996)	Lake fisherman, Santarém, Pará State
Local and regional ecosystem services	Amazônia Legal	US$ 1,133/ha (Andersen, 1997)	NPV at 6% - hydrological cycle, nutrients
		US$ 390.40/ha (Fearnside, 1997)	NPV at 5% - hydrological cycle
Non-timber forest products	Amazônia Legal	US$ 167/ha (Andersen, 1997)	NPV at 6%
	Eastern Amazon	US$ 621,96 - US$ 795.77/family/year (Muchagata,1997)	Incl. hunting and fishing, Marabá, Pará State
	Mid-North	Babaçu: US$ 133.64/year/family (Anderson et al, 1992)	Monetary and non-monetary income, Maranhão State
	Wetland Estuary Amazon	US$ 3,171.55/family/year (Anderson & Ioris, 2001)	Açaí, cocoa, rubber, eastern Pará State
	Western Amazon	US$ 1,520 - US$ 2,500/year/Rubber Tapper (Hecht, 1992)	Bazil nuts and rubber, Acre State
Timber resources	Amazônia Legal	US$ 1,733/ha (Andersen, 1997)	NPV at 6%
	Eastern Amazon	US$ 92/ha/year US$ 379 - US$ 458/ha (Almeida & Uhl)	Financial results at 6% Paragominas, Pará State
	Amazônia Legal	US$ 25/ha (Anderson and others, 2002)	Timber extraction –1994 values
	Amazônia Legal	US$ 28.5 (Seroa da Motta, 2002)	Timber extraction – year-2000 value
	Eastern Amazon	R$ 95.39 to R$ 138.91 ha/year (Margulis, 2003)	
		R$ 123 ha/year (Fasiaben, 2009)	Average value of many studies updated to Oct. 2007
Global benefits	Amazônia Legal	US$ 198 - US$ 803/ha (Schneider, 1993)	Carbon sequestration
		US$ 1,422/ha (Andersen, 1997)	NPV at 6%, carbon, biodiversity
		US$ 1,819/ha (Fearnside, 1997)	NPV a at 5%, carbon, biodiversity
Existence value		US$ 35.8/ha/year (Seroa da Motta, 2002)	
Total economic value	Amazônia Legal	US$ 4,481/ha (Andersen, 1997)	NPV at 6%, cost of deforestation
	Amazônia Legal	US$ 1,175/ha/year: Direct use (US$ 549); Indirect use (US$ 414); Option value (US$ 18) Existence value (US$ 194) (Torras, 2000)	Values for the year 1993

Source: Prepared by the authors, on the basis of P. H. May, F. C. Veiga Neto and O. V. Chévez Pozo, "Valoração econômica da biodiversidade", Brasilia, Ministry of the Environment, 2000; and P. M. May, B. Soares-Filho and J. Strand, "How much is the Amazon worth? The state of knowledge concerning the value of preserving Amazon rainforests", *Policy Research Working Paper,* No. 6688, Washington, D.C., World Bank, 2013.
Note: NPV: net present value; WTP: willingness to pay.

Trade integration and export diversification: El Salvador's trade with the United States and Central America[1]

Raúl Vázquez and Rodrigo Alfonso Morales

Abstract

This article conducts a comparative analysis of the diversification of El Salvador's baskets of exports to the United States and Central America. It uses the most detailed level of disaggregation available and organizes products by technology intensity. The results show greater export diversification and sophistication in trade with Central America. Evidence is also found that, where El Salvador is concerned, it is more advisable to strengthen South-South integration, especially within Central America, than North-South integration.

Keywords

Economic integration, economic relations, international trade, intraregional trade, exports, export diversification, comparative analysis, trade statistics, El Salvador, United States, Central America

JEL classification

F15, F13, F43, F14

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I. Introduction

Since the 1980s, most developing countries have implemented a number of policies inspired by the economic guidelines of the Washington Consensus. In El Salvador, government policies have sought to implement these guidelines since 1989. As in a number of other developing countries, this has included the pursuit of trade liberalization, openness to inward foreign direct investment, privatization and economic deregulation of various kinds in the belief that these measures would lift economic growth and thence living standards. In the area of trade, the strategy has been to open up the economy through tariff reductions, the removal of non-tariff barriers and the signing of various free trade treaties (Lara, 2003).

The cornerstone of trade policy has been the negotiation and implementation of different free trade treaties, of which the most emblematic is the Dominican Republic-Central America-United States Free Trade Agreement (CAFTA-DR). In December 2004, El Salvador became the first country in the region to ratify this agreement, which came into force on 1 March 2006. The first goal in the original treaty document was to "encourage expansion and diversification of trade between the Parties" (Calderón, González and Sanabria, 2008).

Another important trade measure adopted in the region in the early 1990s was the relaunching of Central American integration in pursuit of full economic union between the member countries.[2] One preliminary phase on the way to this goal was to be a customs union. Owing to domestic and external factors, however, particularly the recent downgrading of the issue because of bilateral free trade, the customs union has yet to be fully implemented (Guerra-Borges, 2009). Indeed, the Central American integration agreements are subordinated to free trade treaties such as CAFTA-DR (Caldentey del Pozo, 2010).

Given this situation, the present study sets out to do two things. The first is to study the links between North-South and South-South trade integration and degrees of export diversification and sophistication. The second is to identify the factors behind the differences in North-South and South-South export diversification and sophistication. With these two purposes in view, El Salvador's trade relations with Central America (South-South integration) and the United States (North-South integration) are examined over the period from 2005 to 2015. The main contribution of this study is to compare the diversification and sophistication of Salvadoran exports to the United States and Central America, using the greatest level of detail available in the country's official statistics and organizing products by technology content. The findings yield important implications for the official trade policy of El Salvador and potentially other developing countries, particularly in the Central America region.

This article is organized as follows. Section II analyses the theoretical linkages between trade integration and export diversification and summarizes the main findings of some earlier research on the subject. Section III provides the requisite information on the methodological approach used and details the data sources, international trade nomenclatures, levels of disaggregation, correspondences and indicators employed. Section IV carries out a comparative analysis of the degree of diversification of exports to the United States and to Central America. Section V, lastly, presents the main conclusions of the study and makes some suggestions for policy in this area.

II. Elements of analysis for trade integration and export diversification

Economic globalization has manifested itself in new ways of organizing production that have led to geographical relocation and fragmentation of industrial tasks. This has given rise to an international division of labour between countries that ultimately limits the development options of less developed

[2] For the purposes of this study, the Central America region is deemed to comprise Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica.

countries, whose characteristics make them likely to be at the low value added end of global production (Gereffi, 1996). It is usually multinationals that decide where each production segment of global value chains are to be located, in consideration of labour costs or geographical location (Ernst, 2003). Gereffi (1996) argues that a developing country's prospects of moving up global value chains largely depend on the export roles it adopts and its ability to position itself in more sophisticated niches. The Central American economy's position and importance in these chains are heavily determined by the operations of the maquila industry in the region.

This is the background to the different trade integration agreements that now exist, be they North-South or South-South in character. This study uses Cohen Orantes's (1981) definition of integration: "Integration is defined as the process by which two or more governments, with the support of common institutions, adopt joint measures to strengthen their interdependence and thus obtain mutual benefits". According to Caldentey del Pozo (2000), integration is not an end in itself but should be an instrument of economic and social development for member countries. Like any process, integration can be divided into different phases or stages: a free trade zone or area, a customs union, a common market and economic union (Balassa, 1961).

The effects of integration on an economy are classified as static or dynamic. Static analysis is based on Viner's (1950) pioneering work on customs unions. These effects are analysed in terms of trade creation (welfare gains) and trade diversion (welfare losses). The main dynamic effects, meanwhile, are: improved economic efficiency, the creation of economies of scale, higher investment, stimulation of technological development and improved terms of trade (Caldentey del Pozo, 2000). According to Requeijo (1995), it is the dynamic aspects that justify policies to promote South-South integration.

However, Schweickert (1994) argues that North-South integration is more effective for a developing country because the static effects allow for greater short-run gains. Regarding the dynamic effects, a number of authors have noted that there are greater technology spillovers in North-South integration than in South-South integration, which encourages the development of knowledge-intensive industries (Schiff, Wang and Olarreaga, 2002; Coe and Helpman, 1995). These ideas about North-South integration are the ones that have shaped El Salvador's trade policy since the 1990s, as most clearly embodied in CAFTA-DR. However, belief in the benefits of North-South integration is rooted in orthodox foreign trade theory, which has traditionally emphasized the importance of specializing in sectors where a factor of production is relatively abundant and thus does not take account of the recent developments in international trade mentioned earlier, which concern the workings of global value chains and are part of intraindustry trade.

The benefits of integration between developing countries have also been documented by a number of authors. Of these benefits, the one most relevant to this study is the positive link between South-South integration and export diversification.

Here, Regolo (2013) argues that exports to countries with similar factor endowments are more diversified than exports to countries with different endowments. He also argues that the lower the costs associated with trade, the higher the degree of diversification. Sanguinetti, Pantano and Posadas (2004) find that another possible explanation for the positive causal relationship between the horizontal integration of developing countries and greater export diversification is the way economies of scale are fostered in the countries involved. Bekerman and Rikap (2010) find that, in the regional integration environment of MERCOSUR, Argentina and Brazil succeeded in diversifying their export baskets by creating new comparative advantages. This effect is attributed to MERCOSUR having offered an initial platform for developing organizational and production innovation processes that provided a basis for learning and economies of scale, all of which then led to export diversification both within the integration bloc and externally. In the theoretical apparatus used by Bell and Pavitt (1992), horizontal South-South integration benefits the development not only of production capabilities but of technological capabilities too.

The transmission channels between South-South integration and export diversification are the lower costs associated with trade (in the case of countries that are geographically close), economies of scale between the integrated countries, the creation of new comparative advantages and the development of technological and production capabilities. These mechanisms are closely related to the dynamic effects of integration on the economy and of export diversification on economic growth in developing countries.[3] Consequently, according to this school of thought, South-South integration schemes pursuing export diversification are desirable. The expectation is, in short, that a developing country's export basket will be more diversified in its trade with other developing countries than with more developed economies.

The necessary condition for transmission mechanisms between South-South integration and export diversification to work is the existence of technological spillovers conducive to the spread of knowledge. A number of authors working in the area of economic geography argue that related diversification effectively fosters technological spillovers (Boschma and Iammarino, 2009; Frenkel, Van Oort and Verburg, 2007), thereby enhancing the technological and production capabilities of developing countries and helping them move up global value chains.[4] Nonetheless, in the area of economic geography there is also recognition of the importance of unrelated diversification as a mechanism for cushioning any possible crisis within a related sector or sectors, as this improves long-run economic stability (Essletzbichler, 2005).

It can be established from this that South-South integration (like that between El Salvador and Central America) could favour export diversification more than North-South integration (like that between El Salvador and the United States) by creating dynamic effects that would have positive repercussions on growth. In developing countries, indeed, North-South integration has been promoted with the idea of the less developed country specializing in the factor it has in abundance rather than diversifying its export basket.

In the case of El Salvador, there are no studies employing the theoretical concepts and empirical methodology of this study. However, there are similar studies of export diversification and technology intensity using similar methodologies or analysing the Central America region as a whole.

Martínez and Cortés (2004) use specialized programmes (TradeCAN and MAGIC) to analyse the international competitiveness of Central American exports during the period 1990–2002. One of their main findings is that intraregional trade is mainly in industrial sectors. Likewise, they find that most of the 20 sectors accounting for the largest shares of Central American exports to the intraregional market are dynamic.[5] As regards trade with the United States, they argue that, although dynamic industrial goods have a greater export presence, what predominate overall are textiles, mainly associated with the maquila industry (Martínez and Cortés, 2004).

Beteta and Moreno-Brid (2014) suggest that structural change is needed in Central America to foster a virtuous circle of growth by creating a denser and more diverse production structure, fostering innovation and bringing about a more egalitarian distribution of income. They also argue that, to benefit more from the integration process, the countries of Central America need to produce and export more local value added, create high-quality jobs, harness the dynamism of the service sector, promote local

[3] The dynamic effects of export diversification on the growth of developing countries can be summarized as higher productivity, improved technological and production capabilities, the ability to independently discover new products, linkage of manufacturing activities, increasingly sophisticated production and the creation and enhancement of scale economies and externalities (Samen, 2010; Agosin, 2009).

[4] The term originally used in economic geography is "related variety", and it refers to export diversification within a group of products which present complementarities with one another and whose production calls for similar capabilities.

[5] Martínez and Cortés (2004) used the MAGIC software, taking the four-digit Harmonized Commodity Description and Coding Systems (HS) classification. In the TradeCAN methodology, exports of a good are deemed dynamic when the exporting country has a growing share of a market where demand for that good is rising.

production linkages, strengthen the intraregional market and improve coordination between the region's public policies. The authors briefly acknowledge the importance of moving forward with Central American economic integration and pursuing a policy of diversification for the production and export structure. They also note that the involvement of Central America in global value chains has lacked the dynamism seen in other parts of the world and attribute this to participation being largely confined to the maquila industry and export processing free trade zones.

Schatan and others (2008) set out to analyse whether Central American regional integration and CAFTA-DR are mutually complementary or whether, conversely, the treaty is weakening the regional integration process. According to their study, intraregional trade mainly involves non-maquila manufactures and thus contributes more value added and creates greater opportunities for small and medium-sized enterprises (SMEs) than extraregional exports, including those within the purview of CAFTA-DR.

Amaya and Cabrera (2013) use the so-called "product space" technique and calculate the proximity, complexity and productivity of the products exported by El Salvador, using the two-digit Standard International Trade Classification (SITC) Revision 2 (SITC Rev. 2). Emulating pioneering research that employs this methodological approach, the authors take the number of products with a revealed comparative advantage as an indicator of export diversification (see Hausmann, Hwang and Rodrik, 2007). They argue from their empirical work that El Salvador needs to diversify its export basket to create stronger links between export industries and the rest of the economy and achieve inclusive economic growth.

III. Methodology

The information source used to carry out this study was the Trade Balance Data Base of the Central Reserve Bank of El Salvador. Eight-digit data from the Central American Tariff System (SAC) were employed. The SAC is based on the Harmonized Commodity Description and Coding Systems (HS) of the World Customs Organization, although the revisions the latter makes to the system are not implemented immediately in the SAC, which in practice is a combination of different revisions of the HS.

The information obtained was reduced to a six-digit level with a view to using the correspondences of the World Integrated Trade Solution (WITS, 2016) and transfer the six-digit SAC (combined from the six-digit HS) to the six-digit HS 1988/92. This was done by using the correspondences developed via WITS (2016), namely:

- HS 1996 → HS 1988/92
- HS 2002 → HS 1988/92
- HS 2007 → HS 1988/92
- HS 2012 → HS 1988/92
- Combined HS → HS 1988/92

All the information was consolidated using the SA 1988/92 classification to obtain 5,017 products (six-digit codes of HS 1988/92). An additional correspondence downloaded from WITS (2016) was then used to transfer the data to SITC Rev. 2. This correspondence enabled the six digits of HS 1988/92 to be transferred to the four- or five-digit level of SITC Rev. 2, which was then reduced to three digits with a view to using the table supplied by the Economic Commission for Latin America and the Caribbean (ECLAC) to regroup goods by technology intensity (see table 1). This table was extracted from Durán Lima and Álvarez (2011), and it classifies the three-digit codes of SITC Rev. 2 into 6 categories and 11 groups.

Table 1
Classification of trade by technology intensity

Category	Three-digit codes of the Standard International Trade Classification, Revision 2
1. Commodities	001, 011, 022, 025, 034, 036, 041, 042, 043, 044, 045, 054, 057, 071, 072, 074, 075, 081, 091, 121, 211, 212, 222, 223, 232, 244, 245, 246, 261, 263, 268, 271, 273, 274, 277, 278, 281, 286, 287, 289, 291, 292, 322, 333, 341.
2. Natural resource-based manufactures	2.1. Industrialized agricultural and forestry products 012, 014, 023, 024, 035, 037, 046, 047, 048, 056, 058, 061, 062, 073, 098, 111, 112, 122, 233, 247, 248, 251, 264, 265, 269, 423, 424, 431, 621, 625, 628, 633, 634, 635, 641.
	2.2. Other natural resource-based products 282, 288, 323, 334, 335, 411, 511, 514, 515, 516, 522, 523, 531, 532, 551, 592, 661, 662, 663, 664, 667, 681, 682, 683, 684, 685, 686, 687, 688, 689.
3. Low-technology manufactures	3.1. Textile and fashion products 611, 612, 613, 651, 652, 654, 655, 656, 657, 658, 659, 831, 842, 843, 844, 845, 846, 847, 848, 851.
	3.2. Other low-technology products 642, 665, 666, 673, 674, 675, 676, 677, 679, 691, 692, 693, 694, 695, 696, 697, 699, 821, 893, 894, 895, 897, 898, 899.
4. Medium-technology manufactures	4.1. Automotive products 781, 782, 783, 784, 785.
	4.2. Medium-technology process industries 266, 267, 512, 513, 533, 553, 554, 562, 572, 582, 583, 584, 585, 591, 598, 653, 671, 672, 678, 786, 791, 882.
	4.3. Medium-technology engineering industries 711, 713, 714, 721, 722, 723, 724, 725, 726, 727, 728, 736, 737, 741, 742, 743, 744, 745, 749, 762, 763, 772, 773, 775, 793, 812, 872, 873, 884, 885, 951.
5. High-technology manufactures	5.1. Electrical and electronic products 716, 718, 751, 752, 759, 761, 764, 771, 774, 776, 778.
	5.2. Other high-technology products 524, 541, 712, 792, 871, 874, 881.
6. Other transactions	351, 883, 892, 896, 911, 931, 941, 961, 971.

Source: J. Durán Lima and M. Álvarez, "Manual on foreign trade and trade policy: basics, classifications and indicators of trade patterns and trade dynamics", *Project Documents* (LC/W.430), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC), 2011.

The procedures relating to the classifications and correspondences used in this study will now be systematized and summarized:

SAC (eight digits) → SAC (six digits) → HS 1988/92 (six digits) → SITC Rev. 2 (three digits) → ECLAC table (technology intensity).

Lastly, the 5,017 product codes of the HS 1988/92 classification are distributed in accordance with their technology intensity as indicated in table 2.

Table 2
Distribution of six-digit codes in the Harmonized Commodity Description and Coding Systems 1988/92 by technology intensity
(Numbers of products)

Categories and groups	
Commodities	619
Natural resource-based manufactures	1 191
Industrialized agricultural and forestry products	476
Other natural resource-based products	715
Low-technology manufactures	1 416
Textile and fashion products	737
Other low-technology products	679
Medium-technology manufactures	1 356
Automotive products	61
Medium-technology process industries	615
Medium-technology engineering industries	680

Table 2 (concluded)

Categories and groups	
High-technology manufactures	398
Electrical and electronic products	205
Other high-technology products	193
Other transactions	37
Total	5 017

Source: Prepared by the authors, on the basis of World Integrated Trade Solutions (WITS), 9 September 2016 [online] http://wits.worldbank.org/; J. Durán Lima and M. Álvarez, "Manual on foreign trade and trade policy: basics, classifications and indicators of trade patterns and trade dynamics", *Project Documents* (LC/W.430), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC), 2011.

The general trade indicators used are the trade balance, the export to import ratio, the share of exports in the country total and the shares of El Salvador's trade that are with the United States and Central America.

The diversification indicators used are the number of products exported and export shares by technology intensity. To obtain robust findings, two concentration indicators are used to calculate the level of diversification of El Salvador's basket of exports to Central America and the United States: the normalized Herfindahl-Hirschman Index (HHI) and the Theil Index (TI). Both indices use the six-digit nomenclature of the HS 1988/92 and group products in accordance with the table of technology intensity (see table 1).

We study the period from 2005 to 2015, examining specifically the years 2005 and 2015 and total trade with the United States and Central America between those years. This period of study was chosen because 2015 is the last year for which final information is available and because international trade data for the maquila industry have been disaggregated by destination or origin and by product in El Salvador's national statistics since 2005.

The HHI concentration indicator is calculated as follows:

$$HHI_j = \sum \left(\frac{x_{ij}}{\sum x_{ij}} \right)^2 \quad (1)$$

where HHI_j is the Herfindahl-Hirschman Index for the group of goods j, which may include all goods or a group of them, and X_{ij} is equivalent to good i belonging to j.

To compare the results, this index is normalized as follows:

$$HHIn_j = \left(\frac{HHI_j - {}^1/_{n_j}}{1 - {}^1/_{n_j}} \right) * 100 \quad (2)$$

where $HHIn_j$ is the normalized Herfindahl-Hirschman Index for the group of goods j and n_j is the number of products making up j.

The range of values yielded by the HHI calculation is from 0 to 100, and the scale proposed by Durán Lima and Álvarez (2011) is used to interpret them:

- Over 18: concentration
- Between 10 and 18: moderate concentration
- Between 0 and 10: diversification

The Theil Index of concentration (TI) is calculated as follows:

$$TI_j = \frac{1}{n_j}\sum_{i=1}^{n_j}\left[\frac{x_{ij}}{P_j} * \left(ln\frac{x_{ij}}{P_j}\right)\right] \quad (3)$$

where TI_j is the Theil Index for the group of goods j, x_{ij} is good i belonging to j, n_j is the number of products in j and $P_j = \frac{\sum_{i=1}^{n_j} x_{ij}}{n_j}$, i.e., the average exports of each of the goods in group j. The range of values of the TI varies depending on the number of products, from 0 to $ln\, n_j$. Consequently, to compare the results, the TI will be calculated using the following formula:

$$TI_j = \left\{\frac{\frac{1}{n_j}\sum_{i=1}^{n_j}\left[\frac{x_{ij}}{P_j} * \left(ln\frac{x_{ij}}{P_j}\right)\right]}{ln\, n_j}\right\} * 100 \quad (4)$$

where the variables have the values that were indicated for formula (3).

In implementing formula (4), the values of the TI range from 0 to 100. Durán Lima and Álvarez (2011) use formula (3) and suggest that, in the case of the five-digit SITC Rev. 2 (1,777 product codes), values above 4 represent concentration and those below 2.5 diversification. Consequently, this case is used to generate a typology as follows: $\left(\frac{4}{ln\,1.777}\right) * 100 \approx 53; \left(\frac{2.5}{ln\,1.777}\right) * 100 \approx 33$, and the following scale is used to interpret the results:

- Over 53: concentration
- Between 33 and 53: moderate concentration
- Between 0 and 33: diversification

As can be observed in formulas (3) and (4), if x_{ij} were equal to 0, the calculation of the TI would be undetermined. L'Hôpital's mathematical law is accordingly applied:

$$lim_{x_{ij}\to 0}\left(ln\frac{x_{ij}}{P}\right) = 0 \quad (5)$$

Cadot, Carrère and Strauss-Kahn (2011) argue that one of the advantages of using the TI is that it can be broken down into two parts: one corresponding to the degree of diversification between groups (intergroup) and one showing the degree of diversification within each group (intragroup). This is useful because it indicates whether diversification or concentration is within the groups analysed or between them.

The present study carries out this decomposition for all 5,017 products (TI^T), divided into 11 groups j by technology intensity (see table 1). The TI decomposition was carried out as follows:

$$TI^T = TI^W + TI^B \quad (6)$$

$$TI^W = \sum_{j=1}^{j} s^j\, TI_j \quad (7)$$

$$TI^B = \sum_{j=1}^{j} s^j\, (ln\frac{P_j}{P}) \quad (8)$$

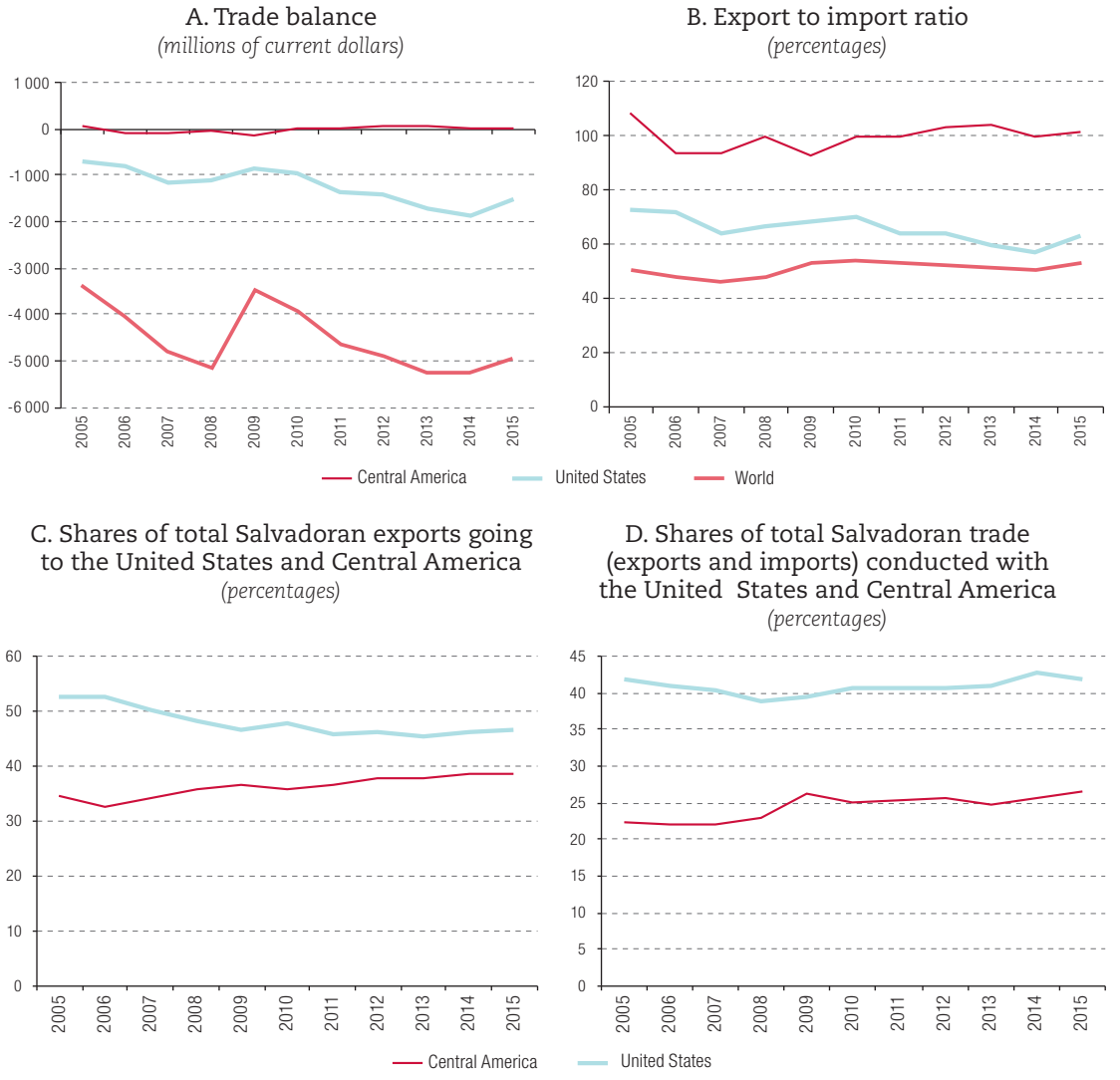
where TI^T is the Theil Index for all 5,017 products analysed, TI^W is the intragroup Theil Index, TI^B is the intergroup Theil Index, s^j is exports of j as a share of total exports, TI^j is the Theil Index for j, P_j is the average export amount of each of the goods in j and P is the average export amount of each of the 5,017 products analysed.

Decomposing the Theil Index is important for interpreting the results, as the intragroup TI is associated with related diversification and the intergroup TI with unrelated diversification.

IV. Results

This section compares the results obtained by calculating the diversification of El Salvador's exports to Central America and to the United States. By way of background, figure 1 presents a comparison of some important trade indicators. Since 2005, El Salvador's trade with Central America has been virtually in balance, whereas the country has been running a growing trade deficit with the United States, much as it has with the world as a whole (see figures 1A and 1B). This is a symptom of the ongoing loss of competitiveness sustained by the Salvadoran export machinery. El Salvador has managed to finance this growing trade deficit thanks to the contribution of family remittances, foreign direct investment and external borrowing.[6]

Figure 1
El Salvador: indicators of trade with the United States and Central America, 2005–2015



Source: Prepared by the authors, on the basis of information from the Trade Balance Data Base of the Central Reserve Bank of El Salvador.
Note: The export to import ratio denotes a trade surplus when it is over 100% (balance) and a trade deficit when it is below this.

[6] According to the Central Reserve Bank of El Salvador database, family remittances covered 82.51% of the total trade deficit between 2005 and 2015.

The data in figures 1C and 1D reveal that El Salvador trades more with the United States than with Central America, with the former accounting for 40.89% of the total between 2005 and 2015 and the latter for 24.58%. Of exports in the period, 36.51% went to Central America and 47.71% to the United States. If maquila is excluded, Central America becomes the leading destination for Salvadoran exports, with 47.47%, while the United States is in second place with 32.36%. This shows that, despite the implementation of CAFTA-DR, maquila exports still account for the bulk of the total, while intraregional trade is the main driver of El Salvador's non-maquila exports.

Heavy dependence on maquila industry has given rise to a dual economy within the country. This economy is characterized by rising labour productivity in the free trade zones that has not spilt over to the rest of the economy (Ugarteche, 1997). Pérez-Caldentey and Vernengo (2008) argue that the problem of countries with a dual economy is that they export cheap labour, either directly via immigration or indirectly via free trade zone regimes. According to Vernengo (2015), this creates problems similar to those the South American economies have with commodity exports, namely recurrent balance-of-payments crises because in the long run imports cannot be financed by exports.

Beteta and Moreno-Brid (2014) argue that the Central American countries participate in global value chains mainly through the maquila industry and export processing free trade zones. Because of this, the dynamism of foreign direct investment in free trade zones is counteracted by the net outward flow of capital and remittances in the form of profits and royalties. In the particular case of El Salvador, Vega, Morales and Ayala (2012) argue that maquila plants have few linkages with the local economy, operate mainly in the textile sector, benefit from tax exemptions and expatriate their profits.

As regards the number of products exported, table 3 shows that in all the categories of goods classified by technology content (with the exception of "other transactions" in 2015 and 2005–2015), a larger number of products are exported to Central America than to the United States. It can be inferred from this that there are more exporting firms, since the literature on intra-Central American trade maintains that most firms operating in intraregional trade are SMEs (see Castillo, Aguilera and García, 2013; Caldentey del Pozo, 2010; Schatan and others, 2008). Consequently, in the context of South-South Central American integration, intraregional trade has greater potential to foster local linkages that strengthen the domestic economy. Conversely, trade with the United States only entrenches a dual economy in which the local production structure is left ever further behind the maquila industry.

The number of products exported grew more quickly between 2005 and 2015 in trade with the United States (16.5%) than with Central America (5.11%). This growth was inadequate, however, for in 2015 El Salvador exported just 21.11% of the maximum possible number of products that could potentially be exported to the United States,[7] in contrast to a figure of 47.58% for its transactions with Central merica. Even so, the diversity of products exported to both the United States and Central America is very low compared to the number of products exported from Guatemala to these same destinations, as the latter exports 5.56% more to the United States and 10.76% more to Central America relative to the maximum number of exportable products.[8]

[7] The maximum number of exportable products is 5,017, i.e., the 5,017 codes of the six-digit Harmonized Commodity Description and Coding Systems 1988/92.

[8] This calculation was carried out using statistical information on Guatemalan exports from the United Nations Commodity Trade Statistics Database (COMTRADE) (WITS, 2016).

Table 3
El Salvador: products exported to the United States and Central America, by technology intensity group, 2005–2015
(Number of products)

Categories and groups	United States			Central America		
	2005	2015	2005–2015	2005	2015	2005–2015
Commodities	62	67	150	137	200	314
Natural resource-based manufactures	119	140	331	450	457	714
Industrialized agricultural and forestry products	92	102	204	219	239	325
Other natural resource-based products	27	38	127	231	218	389
Low-technology manufactures	415	471	791	784	782	1 067
Textile and fashion products	259	267	442	388	386	541
Other low-technology products	156	204	349	396	396	526
Medium-technology manufactures	204	254	623	687	710	1 030
Automotive products	14	19	38	34	37	55
Medium-technology process industries	65	84	201	276	273	413
Medium-technology engineering industries	125	151	384	377	400	562
High-technology manufactures	92	103	233	190	215	303
Electrical and electronic products	62	59	131	114	124	160
Other high-technology products	30	44	102	76	91	143
Other transactions	17	24	30	23	23	29
Total exports	909	1 059	2 158	2 271	2 387	3 457

Source: Prepared by the authors, on the basis of information from the Trade Balance Data Base of the Central Reserve Bank of El Salvador.
Note: Use was made of the six-digit Harmonized Commodity Description and Coding Systems 1988/92, which contains 5,017 categories.

Another point that should be emphasized is the unsustainability of the Salvadoran export pattern. The number of products exported was considerably lower in 2015 than in the period studied as a whole, and this was true of transactions both with Central America and, particularly, the United States.[9] Córcoles, Díaz-Mora and Gandoy (2015) argue that export diversification is one of the factors influencing the survival of export products, which would explain the differences between the country's trade with the United States and with Central America. Likewise, a number of studies indicate that low export survival is one of the main causes of the poor export performance of developing countries (Besedes and Prusa, 2007; Besedes and Blyde, 2010).

In the case of exports to the United States, most of the value is in low-technology manufactures, chiefly from the textile sector (see table 4). This finding matches that obtained by Martínez and Cortés (2004), who calculated from data up to 2002 that the textile sector was the basis of Central American exports to the United States. The main reason for this is the presence of the maquila industry, which operates mainly with the United States. In the period 2005–2015, meanwhile, medium- and high-technology exports to the United States accounted for just 11.48% of all exports to that destination, as compared to 17.63% of exports to Central America. This indicates that the technology intensity of Salvadoran exports is low.

[9] The number of products exported to the United States in 2015 represented 49.08% of the number of products exported to that country over the whole of the period between 2005 and 2015. In the case of exports to Central America, the figure rises to 69.05%.

Table 4
El Salvador: share of technology-intensive groups in exports to the United States and Central America, 2005–2015
(Percentages)

Categories and groups	United States			Central America		
	2005	2015	2005–2015	2005	2015	2005–2015
Commodities	4.12	3.94	5.06	2.15	2.94	3.07
Natural resource-based manufactures	4.14	7.22	6.78	24.21	26.47	27.86
Industrialized agricultural and forestry products	3.24	5.35	5.07	17.78	20.77	20.94
Other natural resource-based products	0.90	1.87	1.71	6.43	5.70	6.92
Low-technology manufactures	82.30	79.82	74.86	53.17	51.52	49.18
Textile and fashion products	80.82	78.26	73.56	26.52	22.12	20.05
Other low-technology products	1.48	1.56	1.30	26.65	29.41	29.13
Medium-technology manufactures	2.26	2.00	4.12	12.82	12.20	12.16
Automotive products	0.01	0.07	0.08	0.50	0.19	0.23
Medium-technology process industries	2.00	0.29	3.35	9.26	10.14	9.84
Medium-technology engineering industries	0.25	1.63	0.70	3.06	1.87	2.09
High-technology manufactures	6.91	6.42	7.36	6.10	5.22	5.47
Electrical and electronic products	6.85	6.33	7.28	1.32	0.92	1.16
Other high-technology products	0.06	0.09	0.08	4.79	4.30	4.31
Other transactions	0.26	0.60	1.82	1.54	1.64	2.25
Total exports	100	100	100	100	100	100

Source: Prepared by the authors, on the basis of information from the Trade Balance Data Base of the Central Reserve Bank of El Salvador.
Note: Use was made of the six-digit Harmonized Commodity Description and Coding Systems 1988/92, which contains 5,017 categories.

El Salvador's intraregional trade, as opposed to its trade with the United States, is characterized by greater diversity and a larger share of medium- and high-technology exports in the export total, the presence of SMEs and better export survival. This indicates that intraregional trade is a better stage on which to develop the technological and production capabilities needed to move up in global value chains by enhancing export roles.

The distribution of exports in monetary terms has likewise been less heavily concentrated in trade with Central America, with low-technology manufactures the foremost category. Nonetheless, the share of textile and fashion products in El Salvador's intraregional exports is considerably lower, suggesting a more diversified distribution of exports as measured by value. One explanation for this is the small role played by the textile maquila industry in intraregional trade.

In comparative terms, the structure of exports to the United States by value in the different technology intensity categories was much the same in 2015 as in 2005 (see table 4). This may be explained by two factors. The first is the predominance of the textiles sector, encouraged by El Salvador's Free Trade Zones and Bonded Warehouses Regime Act, which came into force in September 1998, before CAFTA-DR. The second is the very limited amount of technological spillover associated with Salvadoran exports to the United States during the study period, so that the structure of exports by value hardly changed. It needs to be emphasized that knowledge transfers via technological spillovers, an expected effect of North-South integration (Schiff, Wang and Olarreaga, 2002), have not occurred in the case of trade between El Salvador and the United States.[10]

[10] According to orthodox international trade theory, North-South integration encourages technological spillovers via imports of capital goods. In El Salvador, according to the COMTRADE database consulted in WITS (2016), imports of capital goods from the United States fell from 20.53% of total imports by value in 2005 to 15.30% in 2015. These imports declined every year in the period except 2006, 2009 and 2015. The average annual rate of decline was 2.13% during the study period, and 2008 and 2010 were the years with the highest rates: 17.44% and 10.60%, respectively.

Table 5 uses the *HHI* and *TI* to measure export concentration in 2005 and 2015.[11] Although there are large differences in magnitudes, it can be seen that the two indicators confirm the existence of a concentrated export pattern in most of the categories and product groups exported to the United States in both years. In the case of exports to Central America, although the export pattern is moderately concentrated, it looks more diversified when the *TI* data are interpreted.

Table 5
El Salvador: diversification indicators for exports to the United States and Central America, by technology intensity group, 2005 and 2015

Categories and groups	2005							
	United States				Central America			
	HHI	*HHI* typology	*TI*	*TI* typology	*HHI*	*HHI* typology	*TI*	*TI* typology
Commodities	47.74	C	78.61	C	9.15	D	54.24	C
Natural resource-based manufactures	20.23	C	68.91	C	4.89	D	49.54	MC
Industrialized agricultural and forestry products	28.13	C	68.53	C	6.67	D	48.35	MC
Other natural resource-based products	62.74	C	88.78	C	17.81	MC	62.41	C
Low-technology manufactures	11.52	MC	56.51	C	7.99	D	47.86	MC
Textile and fashion products	11.89	MC	53.46	C	27.36	C	62.46	C
Other low-technology products	10.55	MC	58.81	C	4.73	D	43.28	MC
Medium-technology manufactures	53.15	C	79.93	C	4.69	D	41.21	MC
Automotive products	23.13	C	57.32	C	52.49	C	70.23	C
Medium-technology process industries	24.27	C	87.73	C	53.20	C	45.00	MC
Medium-technology engineering industries	27.38	C	51.33	MC	5.16	D	39.81	MC
High-technology manufactures	39.48	C	80.38	C	26.45	C	65.21	C
Electrical and electronic products	40.07	C	79.06	C	19.86	C	53.45	C
Other high-technology products	18.02	C	62.44	C	41.44	C	75.12	C
Other transactions	41.79	C	66.60	C	19.72	C	47.01	MC
Total exports	8.16	D	58.08	C	2.74	D	42.49	MC
	2015							
Categories and groups	United States				Central America			
	HHI	*HHI* typology	*TI*	*TI* typology	*HHI*	*HHI* typology	*TI*	*TI* typology
Commodities	49.12	C	79.18	C	7.75	D	54.82	C
Natural resource-based manufactures	10.46	MC	60.93	C	4.91	D	49.12	MC
Industrialized agricultural and forestry products	15.32	MC	60.06	C	6.31	D	47.40	MC
Other natural resource-based products	30.14	C	78.23	C	21.02	C	61.96	C
Low-technology manufactures	10.34	MC	56.52	C	3.31	D	43.51	MC
Textile and fashion products	10.70	MC	53.69	C	7.43	D	50.94	MC
Other low-technology products	6.48	D	52.64	MC	5.97	D	45.58	MC
Medium-technology manufactures	51.36	C	76.47	C	3.21	D	41.56	MC
Automotive products	41.08	C	71.26	C	9.71	D	37.44	MC
Medium-technology process industries	41.96	C	55.57	C	11.05	MC	42.96	MC
Medium-technology engineering industries	76.53	C	87.44	C	4.39	D	37.61	MC
High-technology manufactures	62.25	C	85.81	C	29.95	C	65.70	C
Electrical and electronic products	63.99	C	85.89	C	9.51	D	44.86	MC
Other high-technology products	12.69	MC	54.88	C	43.72	C	75.36	C
Other transactions	54.61	C	75.57	C	17.21	MC	45.62	MC
Total exports	7.02	D	64.84	C	1.37	D	45.77	MC

Source: Prepared by the authors, on the basis of information from the Trade Balance Data Base of the Central Reserve Bank of El Salvador.

Note: Use was made of the six-digit Harmonized Commodity Description and Coding Systems 1988/92, which contains 5,017 categories. *HHI* is the normalized Herfindahl-Hirschman Index and *TI* is the Theil Index, while C stands for concentrated, MC for moderately concentrated and D for diversified.

[11] The *HHI* tends to produce overestimates when calculated for a large number of products. Consequently, preference will be given to the *TI* values when analysing the diversification of all products exported.

Going by the *HHI* and *TI* values, there were three groups of products whose exports to the United States were more diversified in 2005: textile and fashion products, automotive products and other high-technology products. In 2015, on the other hand, only the other high-technology products group exhibited greater diversification in the case of the United States than of Central America, and that group of products represents only a small proportion of the country's total exports.[12] This confirms that the profile of exports to the United States is undynamic and based on static comparative advantages, such as abundant low-skilled labour.

Taking all products together, there was a loss of export diversification between 2005 and 2015, and this was greater in transactions with the United States than with Central America (see table 6). Nonetheless, there were improvements in the diversification of some product categories and groups. Going by the *HHI* and the *TI*, diversification improved in two product categories and five groups in the case of trade with the United States and in two product categories and seven groups in that of intraregional trade. Where exports to Central America were concerned, however, diversification increased most in the high- and medium-technology groups, while in the case of exports to the United States it increased most in the low-technology and natural resource-based manufactures groups.[13]

Table 6
El Salvador: differences between diversification indicators for exports to the United States and Central America, by technology intensity group, 2005 and 2015

Categories and groups	United States		Central America	
	HHI	*TI*	*HHI*	*TI*
Commodities	1.38	0.57	-1.41	0.58
Natural resource-based manufactures	-9.77	-7.98	0.02	-0.42
Industrialized agricultural and forestry products	-12.81	-8.47	-0.36	-0.94
Other natural resource-based products	-32.59	-10.56	3.20	-0.45
Low-technology manufactures	-1.19	0.02	-4.68	-4.35
Textile and fashion products	-1.20	0.23	-19.93	-11.51
Other low-technology products	-4.07	-6.17	1.23	2.31
Medium-technology manufactures	-1.79	-3.46	-1.49	0.35
Automotive products	17.95	13.95	-42.78	-32.80
Medium-technology process industries	17.69	-32.16	-42.15	-2.04
Medium-technology engineering industries	49.15	36.11	-0.77	-2.19
High-technology manufactures	22.77	5.43	3.50	0.48
Electrical and electronic products	23.92	6.83	-10.35	-8.59
Other high-technology products	-5.33	-7.56	2.28	0.24
Other transactions	12.82	8.96	-2.51	-1.39
Total exports	-1.14	6.76	-1.37	3.28

Source: Prepared by the authors, on the basis of information from the Trade Balance Data Base of the Central Reserve Bank of El Salvador.

Note: Use was made of the six-digit Harmonized Commodity Description and Coding Systems 1988/92, which contains 5,017 categories. The *HHI* is the normalized Herfindahl-Hirschman Index and the *TI* is the Theil Index. The differences were obtained by subtracting the value of the 2005 indicator from that of the 2015 indicator. Thus, these different indicators show export diversification improving in the categories and groups that present negative numbers (shaded).

El Salvador's basket of exports to the United States became less diverse overall, with increased diversification in low-technology product groups being inadequate to offset this. The reason is that non-maquila sectors have languished in exports to that country, with the result that few products are exported and exports are heavily concentrated by value.

[12] Table 4 shows that other high-technology products accounted for a mere 0.08% of exports between 2005 and 2015.

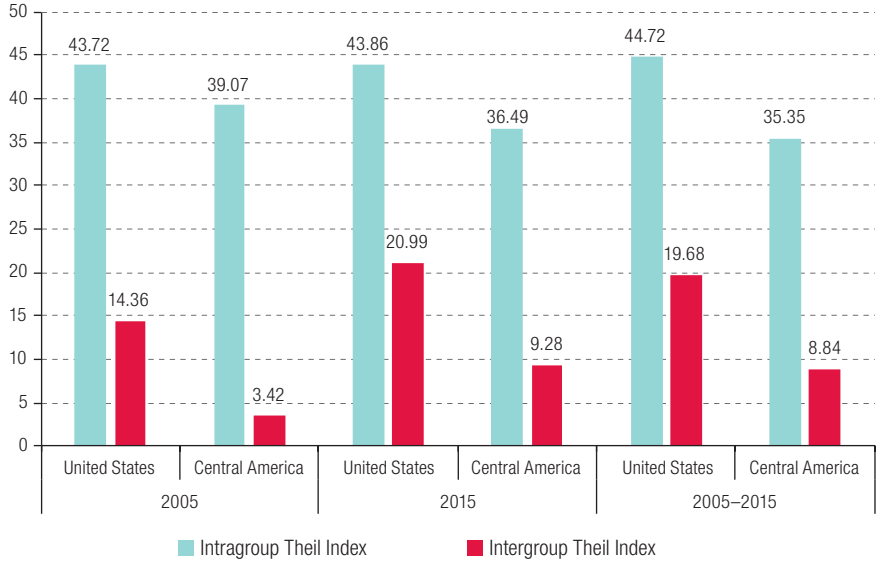
[13] In the case of trade with the United States, the level of diversification only increased in one high- or medium-technology group (other high-technology products), while in the case of trade with Central America it increased in four groups (all the medium-technology groups plus electrical and electronic products).

By contrast, although regional integration has been neglected in Salvadoran trade policy (Caldentey del Pozo, 2010), the increased diversification of El Salvador's export basket in intraregional trade between 2005 and 2015 took place in medium- and high-technology groups. Thus, trade within the framework of South-South Central American integration has greater potential to generate the dynamic effects of export diversification (see Agosin, 2009). Besides presenting greater diversification, the regional context favours exports of non-assembled manufactures, which contribute greater value added to the economy as a whole and generate more growth opportunities for SMEs (Schatan and others, 2008).

According to Samen (2010), export concentration entails economic and political risks. The economic risks are associated with export volatility and instability, which affect export earnings, growth, employment, investment, the trade balance and inflation, among other things. In the long run, there are also risks associated with the deterioration of the terms of trade, resulting in a low level of production linkage. From the political point of view, Collier (2002) argues that economic risks can lead to lawlessness and even armed conflicts.

To evaluate related and unrelated diversification, the TI is broken down into intragroup TI (associated with the former) and intergroup TI (associated with the latter). Figure 2 shows that the level of concentration of exports to both Central America and the United States is mostly explained by intragroup concentration. This reveals a lack of related diversification, which is a hindrance to efforts to move up in global value chains because there are few technological spillovers contributing to the spread of knowledge (Boschma and Iammarino, 2009). Concentration as measured by the intergroup TI also grew between 2005 and 2015, reducing unrelated diversification and increasing vulnerability to any crisis within a related production sector or sectors (Essletzbichler, 2005).

Figure 2
El Salvador: decomposition of the Theil Index for exports to the United States and Central America, 2005–2015



Source: Prepared by the authors, on the basis of information from the Trade Balance Data Base of the Central Reserve Bank of El Salvador.
Note: Use was made of the six-digit Harmonized Commodity Description and Coding Systems 1988/92, which contains 5,017 categories.

Over all the periods analysed in figure 2, related and unrelated diversification is greatest in the case of exports to Central America. Accordingly, it is suggested that Central American trade integration should be promoted as a mechanism for developing the technological and production capabilities of El Salvador through greater technological spillovers and a more stable macroeconomic environment.

According to Amaya and Cabrera (2013), El Salvador needs to diversify its export basket to achieve greater technology content in its exports, enhance production linkages and thus attain a higher level of economic growth that is sustainable over time. In addition, intraregional trade is presented as an opportunity to counteract the negative effects of the dual economy created by the maquila industry and thereby bring about structural change that helps create the virtuous growth circle suggested by Beteta and Moreno-Brid (2014), reduce dependence on specific products and mitigate the adverse developments that are a recurring feature of international markets. This opportunity can be taken up by strengthening intraregional trade and improving Central American economic integration mechanisms.

V. Conclusions

The virtues of intraregional trade as identified by research into Central America are reflected in the empirical analysis of this study. It has been found that El Salvador's trade with Central America presents higher levels of diversification, sophistication and commercial performance than the country's trade with the United States.

This is demonstrated by the fact that in trade with Central America the number of products exported is greater, production is more sophisticated (going by the value of medium- and high-technology exports) and the number of sophisticated products is greater. There is also greater export diversification generally and in all technology content groups, with the exception of other high-technology products. The main reason why exports to Central America are more diverse concerns the characteristics of the firms participating in El Salvador's international trade. Firms exporting to the United States are mainly part of the maquila industry system, which is operated by large multinationals from that country, while those operating in intraregional trade are mainly SMEs that have greater production linkages with the local economy.

The present study has found evidence that, in the case of El Salvador, it is more advisable to strengthen South-South integration (Central American integration) than North-South integration (integration with the United States). Although a more detailed study of the subject is needed, the findings suggest that there are greater opportunities for technological spillovers with South-South integration than with North-South integration. This assertion is supported by the fact that, between 2005 and 2015, the structure of the amounts exported to the United States by technology intensity was static, imports of capital goods from that country fell and exports to it exhibited little related diversification.

This paper proposes that strengthening trade relations with Central America is a better mechanism for capitalizing on the dynamic effects of trade integration and export diversification in the case of El Salvador. Concerted intraregional integration among Central American countries could enable them to move up global value chains together, while also helping to ensure greater participation by SMEs in international trade, diversification of the export basket, greater survival of exported products, strengthening of local production linkages, development of technological capabilities through technological spillovers (greater related diversification), reduction of fragility in the face of crises that may arise in a production sector or sectors (greater unrelated diversification) and a lessening of vulnerability to speculative movements in international markets.

There is a degree of consensus among different groups in Salvadoran society about the need to design an export diversification strategy. In fact, concrete steps are already being taken in that direction and the best example is the National Policy for Development, Diversification and Productive Transformation of El Salvador. There is also consensus regarding the importance of intraregional trade and Central American economic integration for the economic development of El Salvador and

Central America in general. However, as Caldentey del Pozo (2010) points out, El Salvador's bilateral trade agreements, especially those of a North-South character, such as CAFTA-DR, have relegated the promotion of intraregional trade and Central American economic integration to the background.

Within the framework of a strategic country vision, unifying national development policy and diversifying and transforming the economic structure of El Salvador with a trade policy focused on intraregional trade could, in combination with Central American economic integration, create the synergies needed to promote the competitiveness of the Salvadoran production apparatus, increase technological capabilities and generate sustainable and growing incomes that would ultimately improve the living standards of the population.

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Can the informal sector affect the relationship between unemployment and output? An analysis of the Mexican case

Alejandro Islas-Camargo and Willy W. Cortez[1]

Abstract

A key aspect of developing countries is the existence of a large informal sector. In the present paper, we analyse the effect of this feature on the relationship between unemployment changes and output growth for Mexico, a country characterized by the existence of a large informal sector. Following recent studies on Okun's coefficient, we first test whether the relationship between the cyclical components of unemployment and output is asymmetric. We then explore the possibility that this non-linear relationship may be affected by changes in the informal sector. Our results indicate that there is evidence of an asymmetric relationship between the cyclical components.

Keywords

Informal sector, labour mobility, unemployment, economic growth, mathematical models, case studies, Mexico

JEL classification

C34, E23, E24, E32

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I. Introduction

One of the central relationships in macroeconomics, known as Okun's law, establishes the cost of unemployment in terms of output.[2] Following Okun's (1962) seminal paper, early studies found that a 1 percentage point change in unemployment would cause a change of about 3 percentage points in output in the opposite direction. We now know that Okun's coefficient does not remain constant for a number of reasons, including changes in labour market institutions and technological and demographic changes.[3]

In a recent study for a group of 71 developed and developing countries, Ball and others (2016) find that unemployment is less sensitive to output fluctuations in developing economies than in developed ones. More specifically, they find that Okun's coefficient is about half as large on average in developing economies as in advanced economies. These authors further note that the literature has identified several factors that can help explain the difference in the responsiveness of unemployment to output fluctuations between these two types of economies.

One of these factors is the size of the shadow economy or informal sector.[4] In their cross-sectional analysis, these authors find some evidence that the existence of the informal sector affects the relationship between the formal labour market and measured output: the larger the informal sector, the smaller the Okun's coefficient. Dell'Anno and Solomon (2008) found that the informal sector reduced the size of Okun's coefficient even in large economies like the United States. One drawback of their study, however, is that they did not provide an explanation of the mechanism whereby the informal sector might affect this ratio. Another major shortcoming was that it did not consider whether the coefficient might change over time, or whether the relationship between unemployment and output might change over the business cycle. We do not yet know the mechanism whereby the informal sector affects the workings of labour markets in both developed and developing economies, but especially the latter, which are the focus of this study. Thus, it is important to analyse the relationship between open unemployment, informal employment and the relationship of both with output fluctuations. We expect that this analysis will help towards an understanding of labour market dynamics in the least developed countries, including their unemployment performance.

It is well known that a salient feature of labour markets in least developed countries is the existence of a large informal sector. According to the International Labour Organization (ILO), more than half of all non-agricultural employment in developing countries is in the informal sector. In Latin America, for example, ILO estimates that informal employment ranges from about 30.9% of employed workers in Costa Rica to about 72.8% in Honduras and 73.6% in Guatemala. Some 53.8% of non-agricultural employment in Mexico is informal.

ILO associates poor employment conditions and increasing poverty with informal employment.[5] Informality has also been associated with other characteristics that developing economies exhibit: high tax evasion, limited coverage of social security institutions and a reduced ability to manage the economy (Vuletin, 2008).

We argue not only that informal employment lowers the sensitivity of unemployment to output changes but also that it can help us understand the dynamics of the labour market in least developed countries. In this paper, we propose an empirical model in which the transition from one regime to the

[2] Or the impact of output growth on unemployment changes.

[3] For a brief overview of some of these studies, see Silvapulle, Moosa and Silvapulle (2004) and Islas and Cortez (2013), among others.

[4] The others are the mean unemployment rate, per capita GDP, the GDP share of the service sector and skill mismatches (Ball and others, 2016).

[5] See [online] http://www.ilo.org/global/topics/employment-promotion/informal-economy/lang--en/index.htm.

other depends on the change in informal employment. Following recent contributions on the non-linear Okun's coefficient, we test three models: a linear model, a non-linear fixed transition probabilities (FTP) model and a time-varying transition probabilities (TVTP) model.

Different theoretical models analyse the macroeconomic effects of the informal sector on developing economies. Agénor and Azenman (1999), for example, conclude within a general equilibrium framework that there is no close relationship between changes in output and unemployment and that a negative macroeconomic shock induces workers employed in the formal sector to move to the informal sector, with little effect on the aggregate unemployment rate. Other studies include those of Bhattacharya (2007), who analyses the relationship between the informal sector and income distribution in least developed countries, and Goldberg and Pavcnick (2003), who study the relationship between trade liberalization and informality. The main contribution of the present study is not claimed to be a theoretical one, the aim being rather to provide a plausible explanation of labour market dynamics when there is a large informal sector.

One of the largest Latin American economies, with a big non-agricultural informal sector, is Mexico. It also represents a unique case study because for three decades or so it has displayed one of the region's lowest unemployment rates and yet its growth performance has been rather disappointing. For these reasons, we picked Mexico for our study.

The paper is organized into a further six sections. Section II discusses recent studies of labour mobility between the formal and informal sectors in some Latin American countries. Section III briefly reviews some works on Okun's law. Section IV then considers recent estimations of Okun's coefficient for Mexico and describes the performance of the informal sector in the period of analysis. Low growth is compatible with low unemployment when there is a large informal sector. Section V describes the econometric models used to estimate the relationship between the cyclical components of output and unemployment. We propose three models and test whether the relationship is non-linear. Section V also describes the data used in the analysis. The empirical analysis is carried out in section VI, while section VII presents some concluding remarks.

II. The informal sector and labour mobility in Latin America

A key issue in the literature is the definition of informality. This has changed over the years. Originally, the term was used to describe a situation in which poor workers were employed in small production units because of a lack of better employment opportunities. The concept was later modified to include all workers not covered by labour legislation or social security (Tokman, 2011). Nowadays, the concept is somewhat more complex, as it includes a wide range of labour market activities which can be broadly grouped into two clusters. On the one hand, there are survival activities (casual jobs, temporary jobs, unpaid jobs, subsistence agriculture, multiple job holding). On the other, there are rational choice activities carried out in order to evade taxes, labour regulations and other government or institutional regulations. This includes non-registration of companies.[6]

Agreement on the definition of informality, however, has not led to consensus about how to measure it. Some researchers have taken workers employed in small production units not registered with regulatory institutions as a proxy for informal firms, while others have preferred to take workers without social benefits (e.g. health insurance and paid vacations) as the standard. A third group of researchers have combined both types of definitions. For example, Maloney's (1998) study of Mexico's labour

[6] See World Bank Group [online] http://lnweb90.worldbank.org/eca/eca.nsf/1f3aa35cab9dea4f85256a77004e4ef4/2e4ede543787a0c085256a940073f4e4?OpenDocument.

market defines three types of informal workers: (i) the self-employed, i.e. owners of informal firms with or without additional employees; (ii) informal wage earners, who are people employed in informal firms; (iii) contract workers, i.e., those who do not receive a regular wage or salary but are paid a percentage, on a piecework basis, by commission or under a fixed-term contract and are often connected to larger firms. Gong, Van Soest and Villagomez (2004) take workers employed in small production units (less than five workers), while Calderon's (2000) study of Mexico's labour market treats as informal those workers who are not registered with social security institutions. Bosch and Maloney (2010) include both workers in small firms and those left uncovered by labour legislation. Galli and Kucera (2003) use a slightly different definition: in addition to those employed in small firms, they include self-employed and domestic workers.

There are two important questions researchers have addressed recently when discussing developing and developed economies' labour markets. The first is whether these markets can be characterized as segmented or not, and the second is the extent to which they are flexible in adjusting to output shocks. Maloney (1998), for instance, provides some evidence against the segmented labour market hypothesis in the case of Mexico by estimating the transition probabilities between the formal and informal sectors. In a longitudinal analysis of three cohorts of workers,[7] he finds a significant probability of transition from the different types of informality to formal employment and vice versa. He estimates that the probabilities of transition from informal wage work, contract work and self-employment to formal wage work is about 42%, whereas the probabilities of transition from formal wage work to these different types of informal work are 6%, 4% and 5%, respectively; i.e., the flow runs in both directions, albeit with a much greater movement from informal to formal employment than from formal to informal.[8]

Galli and Kucera (2003), on the other hand, argue from the buffer hypothesis that informal employment is countercyclical, i.e., a negative output shock can be expected to induce an expansion of the informal sector. However, the different types of informal employment cannot all be expected to respond in the same way to business cycles. For example, informality driven by a survival strategy is likely to be countercyclical and voluntary self-employment procyclical. Similarly, informal employment will be procyclical if firms decide to increase the amount of subcontracting during expansions but countercyclical if they decide to reduce this type of employment at those times.

Bosch and Maloney (2010), for example, find that the patterns in the Argentine and Brazilian labour markets are similar to that in the Mexican labour market. Indeed, they identify other similarities between these labour markets. First, both unemployment and informality are countercyclical, i.e., both increase during recessions and decline during expansions. Second, the transitions from informality to formality and vice versa are procyclical, largely because of the scale of transitions from formal employment to self-employment. In a study of El Salvador's labour market, Funkhouser (1997) estimated the transition in accordance with gender characteristics. He found that there was a fair amount of mobility between the formal and informal sectors. Of male workers originally in informal employment, 7.3% moved into formal employment, while the transition from formal to informal employment was about 4.7%. The percentages of female workers were lower, at 2.1% and 3.3%, respectively.

For the Mexican case, Rodríguez-Oreggia (2007) estimates the probability of transition from informal to formal employment and vice versa for different time periods. He finds that this transition probability is higher for the former than for the transition from formal to informal employment. Alcaraz, Chiquiar and Salcedo (2015) use a self-selection model to estimate relative prevalence among voluntary

[7] Three cohorts of workers were taken from the National Urban Employment Survey (ENEU) in the period from the third quarter of 1990 to the second quarter of 1992. The cohorts are: third quarter of 1990 to third quarter of 1991, first quarter of 1991 to first quarter of 1992 and second quarter of 1991 to second quarter of 1992.

[8] The analysis covers male workers aged 16 to 65 with secondary education or less in 16 metropolitan areas. Two definitions of informal employment are used: unprotected workers and people working in microenterprises.

and involuntary workers. They find that between 10% and 20% of informal workers would prefer a formal job, but they also find that entry barriers to formal employment are statistically significant. They confirm the existence of segmentation, with both formal and informal employment being somewhat integrated.

Not long ago, Mexico's labour market was classified as a very rigid one, with Heckman and Pagés-Serra (2000) and Gil, Montenegro and Dömeland (2001), among others, arguing that it was heavily regulated by laws that impeded employment creation. The rigidity of federal labour law made it costly and difficult for firms to lay off workers during recessions, while they would hesitate to hire new workers during expansions because of the high costs involved, mainly as a result of the requirement to provide social benefits such as health insurance, housing loans, paid vacations and the like. This type of market rigidity explained why output changes could result in only small unemployment changes, as González Anaya (2002) argued.

Recent studies, however, have noted the significant changes that Mexico's labour market has undergone, particularly in the form of significant growth in informal employment. The existence of a large informal market with significant labour mobility between formal and informal employment suggests that Mexico's labour market can be characterized as a hybrid market, wherein firms in the formal sector are increasingly using different employment schemes in an effort to reduce their labour costs (Contreras, 2000; De la Garza, n/d).

Furthermore, it might be expected from the scale of informal employment and the barriers to entry to formal employment that, for instance, expectations of falling output would induce firms to reduce their recruitment plans.[9] This, in turn, would induce workers to either take an informal job or become unemployed. By the same token, rising output would induce firms to increase hiring under the flexible schemes available to them. Informal employment would decline and so would unemployment. It should be pointed out that unemployment changes would be smaller in either case than if the informal sector did not exist. This can be seen from the significant probability of transition from formal to informal employment, which prevents a much larger transition from formal employment to unemployment.

III. A few notes on Okun's coefficient

Since Okun's ground-breaking paper, the literature on the relationship between output growth and unemployment change has grown considerably. This literature provides support for the empirical validity of the trade-off between these two variables, although there is vast evidence that the magnitude of Okun's coefficient varies significantly within a given country (over time) and across countries (see, for instance, Silvapulle, Moosa and Silvapulle, 2004; Lee, 2000; and Harris and Silverstone, 2001). These studies are a radical departure from earlier ones which assumed that the coefficient was stable and reliable over time (Gordon, 1984).

The non-constancy of the coefficient has been attributed to a number of factors. From an accounting perspective, several authors have noted that its size depends on the evolution of variables such as technology, working hours, the capital utilization rate (Prachowny, 1993) and factor substitution (Courtney, 1991). Other studies have noted that the coefficient is also sensitive to model specification, which includes the form of the model (static versus dynamic), and to the detrending method used to remove non-stationarity: the first difference model versus the gap model (Crespo, 2003).[10]

[9] In some cases, firms would reduce the number of full-time workers and increase the number of part-time jobs under the subcontracting system.

[10] In the first difference model, output and unemployment are expressed in first difference (growth rates), while in the gap model they are considered as deviations from the long-term trend. Within the latter, a new question emerges: which filter to use. For example, in a comparative analysis across developed economies, Lee (2000) evaluated the stability and robustness of the law given that many European countries' labour market institutions had undergone changes.

One of the earliest investigations into a non-linear relationship between output growth and unemployment changes was Courtney (1991). Following a long tradition of research on United States business cycles, Courtney found that Okun's coefficient was dependent on the state of the cycle. In particular, he found that the effect of output growth on unemployment change was stronger in contractions than in expansions. He further argued that unobserved labour hoarding might be an important determinant of state dependence in Okun's law and specifically contended that it was the substitution between employees' hours and effort that explained the asymmetric behaviour of employment over the business cycle.

A priori, we cannot say whether it is in expansions or recessions that output change has the greatest impact on unemployment change. There are two contending explanations. On the one hand, there is the view that when the economy begins to contract, firms respond very quickly by laying off workers. As the recession ends, fearing that recovery may not last long, they adjust productivity, the number of hours worked or both rather than the number of workers (Jardin and Stephan, 2011). This asymmetric behaviour would provide an explanation for output growth having a stronger effect on unemployment during recessions than during expansions. The contrasting view is that firms are unwilling to lay off workers during recessions because of the high costs involved (due to labour laws) and because their investment in workers' training would be lost. It is further argued that these firms should hire more workers during recoveries because there are few institutional constraints. From this perspective, output growth would be expected to have a greater impact on unemployment during expansions than during recessions.

There were several additional conclusions in this study. First, even though the results were qualitatively similar, the authors found significant quantitative differences across countries. Second, the gap model yielded stronger evidence that the coefficient did not remain constant over time across countries than the first difference model. Third, a structural break was found somewhere in the early 1970s in most European countries, the exceptions being Austria and Canada. Fourth, the coefficient was much lower for most European countries than for the United States.

Harris and Silverstone (2001) further extended the analysis of asymmetry for key countries of the Organization for Economic Cooperation and Development (OECD) by estimating the long-run and short-run coefficients.[11] They found that the long-run coefficient lay between -0.39 and -0.5, with the United Kingdom and Japan being outliers. In the short run, they found evidence that unemployment adjusted asymmetrically to output growth; specifically, that it adjusted in the expected manner during the downturn of the business cycle. They did not find reliable evidence for the response of output to changes in unemployment. In terms of policy implications, a non-linear Okun's law would suggest that an asymmetric policy response is required to reduce output fluctuations. In some cases, unemployment changes would suffice, whereas in others price adjustments would be required to achieve equilibrium.

Crespo (2003) and Silvapulle, Moosa and Silvapulle (2004), among others, have found that regardless of the filtering technique used, non-linear models explain the relationship between the cyclical components of output and unemployment better than linear models. Both these studies also find that the impact of output on unemployment is stronger during recessions than during expansions.[12]

The works reviewed so far use a deterministic approach to estimate the asymmetric Okun's coefficient in the sense that they treat the switch from one regime to another as an exogenous and deterministic event. Since the early 2000s, however, this view has been overtaken by a new approach

[11] The sample included Australia, Canada, Germany, Japan, New Zealand, the United Kingdom and the United States. They used the Engel-Granger methodology for cointegrated series, wherein the error correction term is adjusted to incorporate asymmetry. Their procedure involved estimating the threshold points that minimized the sum squared residuals through a grid search.

[12] Crespo (2003), for example, applies both the Hodrick-Prescott (HP) filter to each series individually and the bivariate structural time series model proposed by Harvey (1989). Silvapulle, Moosa and Silvapulle (2004) also use Harvey's bivariate methodology to detrend the series.

that not only measures this switch by the probability of transition between the two states but posits that the change in regime is triggered by the size of the output gap. Moreover, the size of output gap required to induce the change in regime is estimated within the model.

IV. Informality and Okun's coefficient: the case of Mexico

Not many papers have estimated Okun's coefficient for Mexico, and there is no consensus about its size. Chavarín (2001), for example, estimated that the coefficient was close to Okun's original calculations for the United States economy.[13] González Anaya (2002) and Islas and Cortez (2013),[14] however, find much smaller coefficients. These smaller coefficients are puzzling, since the increasing flexibility of Mexico's labour market since the mid-1990s would suggest that the effect of output growth on unemployment should have been much larger.

It is not clear that greater labour market flexibility would necessarily be reflected in larger fluctuations in employment, however. There are two answers to the question about the likely effects of output fluctuations on unemployment fluctuations when labour markets are more flexible. If this flexibility involves the terms of employment, i.e., firms can hire and fire workers according to their production needs, then the answer is that output fluctuations should indeed have a greater effect on unemployment fluctuations. However, if flexibility involves the ability to recruit workers under flexible employment schemes, then output fluctuations should have a rather small impact on unemployment fluctuations, but should prompt greater mobility of workers between the different types of employment. The unemployment rate would still be affected by output fluctuations, but to a lesser extent.[15]

This is where the informal sector comes in. It has been recognized that several of these types of jobs are actually informal jobs in the sense that they do not provide the basic social benefits that formal employment does. If employment in informal firms is additionally taken into account, then cyclical output should have an even smaller effect on cyclical unemployment. The evidence presented in section II clearly brought out the significant scale of transition from formal to informal employment (and vice versa). Hence, when the informal sector is large, the effect of cyclical output on cyclical employment should be rather small, a finding already noted by Agénor and Aizenman (1999) and Dell'Anno and Solomon (2008).

As noted in section II, there are several definitions of informality. In what follows, informal employment (or employment in the informal sector) is defined as encompassing people working in informal firms. Informal firms are defined as those that are not registered with any government agency. Given that the main purpose of this study is to analyse how informal employment can affect the relationship between the short-term components of unemployment and output, no distinction is made between the different types of informal employment.

Table 1 presents a cross-correlation between gross domestic product (GDP) growth rates, informal employment and unemployment.

[13] Chavarín (2001) estimated that a 1 percentage point change in unemployment would induce a change of around 2.7 percentage points in output. Conversely, a 1 percentage point change in output was associated with a change of 0.3 percentage points in unemployment in the opposite direction.

[14] Islas and Cortez (2013) estimate that a 1 percentage point change in output is associated with a -0.5 percentage point change in unemployment, while a 1 percentage point change in unemployment is associated with a -1.66 percentage point change in output.

[15] Gong, Van Soest and Villagomez (2000) found evidence that the probability of transition from both formal and informal employment to unemployment was greater during recessions than in periods of expansion.

Table 1
Mexico: cross-correlation of GDP growth, informal employment and unemployment, first quarter of 1993 to second quarter of 2015

	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
(GDP,inf)	0.009	0.211	0.149	0.012	0.104	-0.059	-0.102	-0.008	-0.197	-0.097	0.124	0.028	0.014
(GDP,μ)	0.053	0.032	-0.069	0.093	0.004	-0.143	-0.375	-0.307	-0.082	0.058	-0.070	0.054	0.037
(μ,inf)	-0.050	0.048	-0.019	-0.121	0.037	-0.050	-0.315	0.182	0.022	0.033	0.077	0.017	0.074

Source: Prepared by the authors, on the basis of data from the National Urban Employment Survey (ENEU) and the National Survey of Occupation and Employment (ENOE).

Table 1 shows the cross-correlations between growth in GDP and informal employment (first row), growth in GDP and unemployment (second row) and growth in unemployment and informal employment (third row). The results indicate that informal employment leads the cycle and is procyclical. When lagged informal employment is taken, its relationship with output is found to turn negative, meaning that it becomes countercyclical. Unemployment is, as expected, countercyclical and contemporaneous. The results also indicate that the growth rates of unemployment and informal unemployment are negatively related and contemporaneous.

Traditional measures of Okun's coefficient for the relationship between unemployment and output show these as contemporaneous. The results presented in table 1 seem to confirm this, but they also suggest that informal employment starts to signal a recovery or slowdown a few quarters before this shows up in output. They also suggest that the relationship does not remain constant over time, as can be seen from the sign and size of the correlation coefficient at lag 5.

This last point is in line with Oliveira's (2002) conclusion that Mexico's business cycle is asymmetrical, with recessions being acuter and shorter than expansions. We thus argue that the relationship between the growth rates of unemployment and output depends on the state the economy is in, and specifically that this relationship is stronger during recessions than during expansions.

Now, in order to assess the impact of informal employment on the probability of transition from one regime to the other, let us define the regime the economy is in by the unemployment rate. The economy will be considered to be in the expansionary state whenever current unemployment is below its long-run trend and in the recessionary state whenever it is above this.

The following section provides details of the probability of transition from one regime to the other, and of the estimation technique.

V. Methodology

1. Empirical models

We estimate three models to measure the trade-off between cyclical output and cyclical unemployment. Model 1 assumes a linear relationship, model 2 is a Markov switching regime model with fixed transition probability (FTP) and model 3 relaxes the fixed transition probability assumption and is a-time varying transition probability model. As Filardo (1994) and Diebold and Rudebusch (1999) explain, the Markov switching model with time-varying transition probability (TVTP) is more flexible than the FTP. It recognizes systematic changes in transition probabilities before and after turning points, captures more complex temporal persistence and allows expected duration to vary over time. In this context, economic fundamentals and policy shocks can influence regime transition probabilities.

First, we consider the traditional linear regression-based model proposed by Moosa (1997) and label it model 1. It is as follows:

$$u_t^c = \alpha_0 + \beta y_t^c + \sum_{i=1}^{p} \alpha_j u_{t-j}^c + \varepsilon_t, \varepsilon_t \sim NID(0, \sigma^2) \quad (1)$$

where u_t^c denotes cyclical unemployment and y_t^c cyclical output. Lagged cyclical unemployment has to be included to remove serial correlation. Okun's coefficient is measured by the estimated value of β, the impact coefficient, such that $\beta < 0$.

In addition to the linear regression-based model, we consider the Markov switching FTP model to characterize the regime-dependent specification of Okun's law, which allows for an asymmetric effect of cyclical output on cyclical unemployment. The general idea behind this class of regime-switching models is that the regression parameters depend upon a stochastic, unobservable regime variable $s_t \in \{1,2\}$. The stochastic process for generating the unobservable regime is an ergodic Markov chain defined by the transition probability $p_{ij} = Pr(s_{t+1} = j | s_t = i)$, where i,j = 1 or 2. The transition probability p_{ij} gives the probability that state i will be followed by state j. The transition matrix is

$$P = \begin{bmatrix} p_{11} & p_{21} \\ p_{12} & p_{22} \end{bmatrix} \quad (2)$$

where p_{11} is the probability of remaining in the expansionary regime, defined as the outcome where p_{22} the unemployment rate is below its trend, while p_{22} is the probability of remaining in the recessionary regime, defined as the situation where the unemployment rate is above trend.

The time regime-dependent specification of Okun's law which allows for an asymmetric effect, model 2, is as follows:

$$u_t^c = \alpha_{0s_t} + \beta_{s_t} y_t^c + \sum_{i=1}^{p} \alpha_{j-1s_t} u_{t-j}^c + \varepsilon_t, \varepsilon_t \sim NID(0, \sigma_{s_t}^2) \quad (3)$$

where $\alpha_{js_t} = \alpha_{j1}, \beta_{s_t} = \beta_1, \sigma_{s_t}^2 = \sigma_1^2$ if s_t = 1, for j = 0,1,…,p, while $\alpha_{jst} = \alpha_{j2}, \beta_{st} = \beta_2, \sigma_{s_t}^2 = \sigma_2^2$ if s_t = 2, for j = 0,1,…,p.

Model 2 features two coefficients, β_1 and β_2. A priori, we expect that $\beta_1, \beta_2 < 0$, with cyclical unemployment responding negatively to cyclical output in either expansionary or recessionary regimes.

Finally, we consider model 3, which allows for the possibility of time-varying transition probabilities. For information variables in z_t, we choose the informal employment rate, since we assume that it has been the main cause of changes in the unemployment rate (see section IV). This is a departure from other studies, which have used the output gap or capacity utilization as the leading variable in the time-varying transition probability. Therefore, model 3 considers the following time-varying transition probabilities:

$$P[s_t = 1 | s_{t-1} = 1, \underline{z}_{t-1}; \underline{\delta}_1] = p(\underline{z}_{t-1}) = \Phi(\underline{z}'_{t-1}\underline{\delta}_1) \quad (4)$$

$$P[s_t = 2 | s_{t-1} = 2, \underline{z}_{t-1}; \underline{\delta}_2] = q(\underline{z}_{t-1}) = \Phi(\underline{z}'_{t-1}\underline{\delta}_2)$$

where $\Phi(.)$ refers to the cumulative density function of the standard normal distribution evolving as a function of $\underline{z}'_{t-1}\underline{\delta}_i$, i=1,2, where the (mx1) conditioning vector $\underline{z}'_{t-1} = \left(1, \Delta e_{inf_{t-1}}, \Delta e_{inf_{t-2}}, \ldots, \Delta e_{inf_{t-m-1}}\right)$, $\underline{\delta}_i' = \left(\delta_{i0}, \delta_{i1}, \ldots, \delta_{i,m-1}\right), i = 1,2$, and Δe_{inf_t} denotes the first difference of the informal employment rate. The two-point stochastic process on s_t can be summarized by the transition matrix

$$P\left[s_t = 1 | s_{t-1} = 1, \underline{z}_{t-1}; \underline{\delta}_i\right] = \begin{bmatrix} p\left(\underline{z}_{t-1}\right) & 1 - p\left(\underline{z}_{t-1}\right) \\ 1 - q\left(\underline{z}_{t-1}\right) & q\left(\underline{z}_{t-1}\right) \end{bmatrix} \quad (5)$$

where the history of the state of informal unemployment is in $\underline{z}_{t-1}$.

In the time-varying transition probability Markov switching model, transition probabilities are allowed to vary with the state of informal employment (upswing and downswing). The probabilities in model 3 reflect the duration of the Okun relationship expressed as a regime-dependent specification. For the model specification test, we follow Engel and Hamilton (1990), proving the following hypothesis:

$$H_0^{ss}: \alpha_{j1} = \alpha_{j2}, \beta_1 = \beta_2, \sigma_1^2 \neq \sigma_2^2; j = 0,1,2, \dots, p \quad (6)$$

If we cannot reject H_0^{ss}, the implication is that the true data-generating process derives from a single state as opposed to two states. The test statistic for the H_0^{ss} hypothesis is the Wald statistic, and it has the $\chi^2_{(v)}$. If we let $\sigma_1^2 = \sigma_2^2$, the test of H_0^{ss} has the so-called "nuisance parameter problem", i.e., the parameters p_{11} and p_{22} are unidentified.

To estimate models 1 to 3, we need time series for the unobserved components u_t^c and y_t^c. The cyclical components can be extracted by means of different methodologies, e.g., by considering a single or multiple time series setting. Here we concentrate on a bivariate time series approach that assumes the observed time series vector to be composed of an unobserved vector of trends plus a vector of cycles and takes into account the correlation between output and unemployment cycles. Laxton and Tetlow (1992) provided a historical overview of estimation procedures for potential output and found that two approaches had basically been employed since the 1980s: (i) structural approaches relying on a structural economic model, as in Ford and Rose (1989) and Adams and Coe (1990); (ii) stochastic approaches such as the one underlying the filter developed by Hodrick and Prescott (1981 and 1997). Laxton and Tetlow (1992) combined these approaches and proposed a semi-structural technique which is known as the Hodrick-Prescott multivariate filter (HPMV) (see, for example, Boone, 2000 and Chagny and Lemoine, 2002). However, the HPMV is not a true multivariate filter, but rather a multiple time series filter. The difference is akin to that between multiple regression, where there is only one dependent variable to be explained by several independent ones, and multivariate regression, where several dependent variables are to be explained simultaneously by one or more independent variables.

We use a different semi-structural technique based on a true multiple time series filtering method that was proposed by Guerrero, Islas and Ramírez (2017) and is known as the bivariate Hodrick-Prescott (BHP) filter. This new method can be used to extract a pair of trends that might share similar dynamic behaviours. One advantage of this method is that it employs only the first two sample moments of the variables involved. A second significant advantage is that it provides a way of deciding the value of the smoothing parameter that produces the desired percentage of smoothness for the trends. A third advantage is that it takes simultaneity in the estimation into account, correcting for likely biases. Further details of the methodology are available in a technical appendix available from the authors upon request.

2. The data

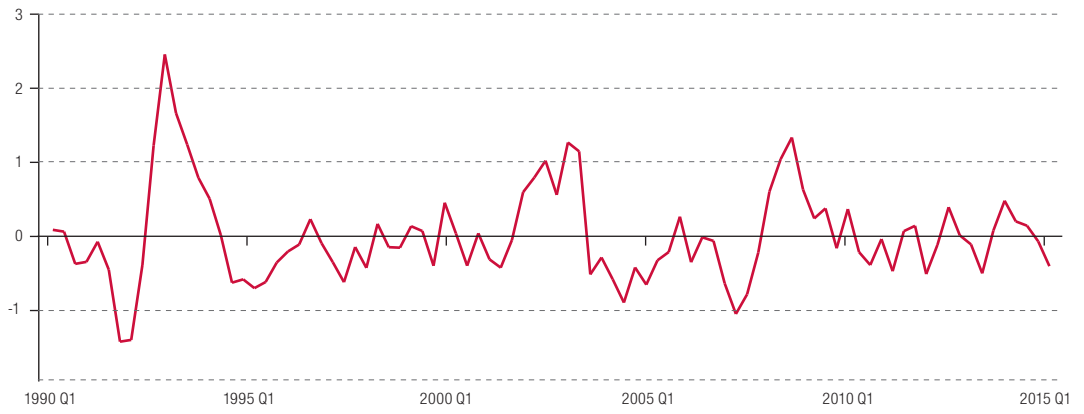
The key variables are output, unemployment and informal employment. Mexican GDP figures are those calculated by the National Institute of Statistics and Geography (INEGI) on a quarterly basis in real pesos, with 2008 as the base year. The unemployment series is the alternative unemployment rate estimated following the United States Bureau of Labor Statistics methodology.[16] There are two sources for the labour series (unemployment and informal employment): the National Survey of Urban Employment (ENEU) and the National Survey of Occupation and Employment (ENOE).

Both the unemployment rate and the informal sector rate are estimated for the 11 largest cities in Mexico.[17] We selected those cities because they were the only ones that were in both surveys (ENEU and ENOE) and could thus be made to yield a time series. We considered workers aged between 16 and 75. All data are quarterly and seasonally adjusted, covering the period from the first quarter of 1993 to the second quarter of 2015. Informal sector employees are defined as workers employed at unregistered firms.[18]

Figure 1 describes the behaviour of the jointly estimated cyclical components of output and unemployment, which were extracted using the methodology proposed by Guerrero, Islas and Ramírez (2017). This chart shows that the behaviour of the cyclical components is consistent with the economic theory of Okun's law, implying that cyclical unemployment is negative only if cyclical output is positive and vice versa.

Figure 1
Mexico: estimates of cyclical output and unemployment, bivariate Hodrick-Prescott filter with 90% smoothness, first quarter of 1990–first quarter of 2015

A. Cyclical component of unemployment

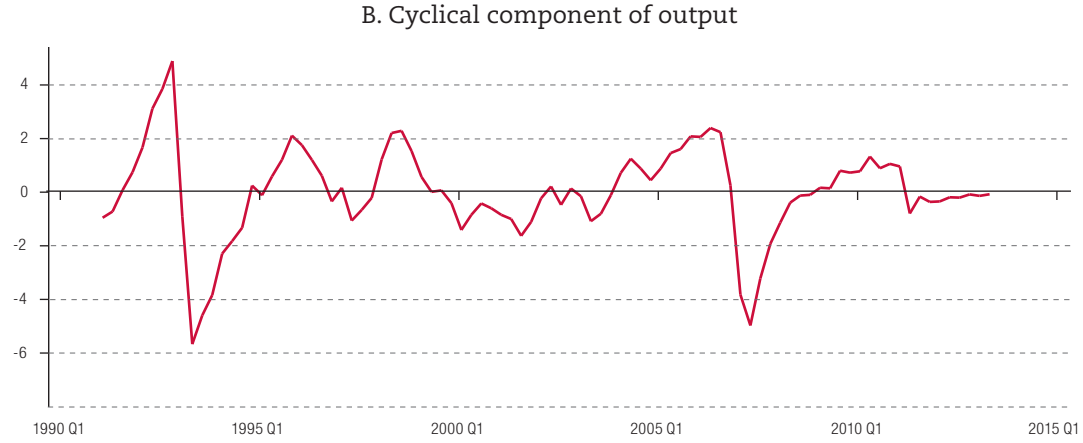


[16] See Fleck and Sorrentino (1994) and Martin (2000) for a discussion of the main differences between the methodology used by Mexico's INEGI to estimate unemployment and that of the Bureau of Labor Statistics. Traditionally, the INEGI methodology has grossly underestimated the unemployment rate, and although it has now been adjusted in some respects, there are still elements that flatter the Mexican unemployment rate relative to that of the United States economy.

[17] The cities considered in the analysis are Chihuahua, Guadalajara, León, Mérida, Mexico City, Monterrey, Puebla, San Luis Potosí, Tampico, Tijuana and Veracruz.

[18] It should be noted that this definition of informality is different from the definition of informal employment, which refers to employment not covered by social benefits, some of which may be in formal firms.

Figure 1 (concluded)



Source: Prepared by the authors.

VI. Empirical results

After obtaining the cyclical components u_t^c and y_t^c, we proceeded to estimate both linear and non-linear models. Table 2 presents the results for the three models.

The lag length of the autoregressive component of cyclical unemployment, p, was chosen as the one to minimize Akaike's information criterion. Starting with a maximum of six lags, the inclusion of one lagged value of u^c for model 1, five for model 2 and six for model 3 (together with one lag for Δe_{inf_t} in the TVTP model) was found to be accepted.

Table 2
Estimated results from models 1, 2 and 3

Model 1		Model 2		Model 3	
Parameter	Estimated	Parameter	Estimated	Parameter	Estimated
α_0	-0.0010 (0.0430)	α_{01}	-0.0374 (0.0395)	α_{01}	-0.0567** (0.0288)
β_1	-0.1806*** (0.0314)	β_1	-0.1207*** (0.0377)	β_1	-0.1092*** (0.0295)
α_1	0.4404*** (0.0623)	α_{11}	0.4059*** (0.0924)	α_{11}	0.3875*** (0.0220)
		α_{21}	0.0335 (0.186)	α_{21}	-0.0601 (0.0106)
		α_{31}	0.0894 (0.1025)	α_{31}	0.2070** (0.0971)
		α_{41}	-0.2414** (0.0876)	α_{41}	-0.3751*** (0.1009)
		α_{51}	0.0002 (0.0832)	α_{51}	0.1523 (0.1119)
		α_{02}	0.2259** (0.0923)	α_{61}	-0.1543* (0.0828)
		β_2	-0.3117*** (0.0152)	α_{20}	0.2307* (0.0932)
		α_{12}	0.7537*** (0.1391)	β_2	-0.2606*** (0.0369)
		α_{22}	-0.4835* (0.2534)	α_{21}	0.5920*** (0.1572)
		α_{32}	1.2359*** (0.2754)	α_{22}	0.0803 (0.2241)
		α_{42}	-0.7215** (0.2417)	α_{32}	0.0503 (0.1992)

Table 2 (concluded)

Model 1		Model 2		Model 3	
Parameter	Estimated	Parameter	Estimated	Parameter	Estimated
		α_{52}	-0.9283*** (0.2742)	α_{42}	0.1812 (0.2021)
		σ_{11}^2	0.0811** (0.0166)	α_{52}	-0.3859* (0.2224)
		σ_{12}^2	0.0445** (0.0219)	α_{62}	-0.0918 (0.1474)
		p_{11}	0.9054*** (0.0650)	σ_{11}^2	0.0813*** (0.0155)
		p_{12}	0.4650* (0.2814)	σ_{12}^2	0.0756** (0.0242)
				δ_{10}	2.8524** (0.5551)
				δ_{11}	2.4859* (1.4212)
				δ_{20}	3.3282** (1.5971)
				δ_{21}	-4.7561* (2.8266)
Log L -40.0831		*Log L -26.5087*		*Log L -22.3847*	
Model selection test: likelihood ratio test					
Model 1 versus model 2: 27.148***. Model 2 versus model 3: 8.2574*.					
Model 2 specification test: $H_0^{ss}: \alpha_{j1} = \alpha_{j2}, \beta_1 = \beta_2, ; j = 0,1,2, \ldots, 5$: 62.372***					
Model 3 specification test: $H_0^{ss}: \alpha_{j1} = \alpha_{j2}, \beta_1 = \beta_2, ; j = 0,1,2, \ldots, 6$: 44.774***					
Test of asymmetry: model 2 $H_0: \beta_1 = \beta_2$ 15.923***. Model 3 $H_0: \beta_1 = \beta_2$ 11.952***					

Source: Prepared by de authors.
Notes: The numbers in brackets are standard errors. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Given that three different models are considered in this paper, the likelihood ratio test was first used for model selection, the results being summarized in table 2. The likelihood ratio statistic suggests that model 2 (the FTP regime-dependent specification of Okun's law) is preferable to model 1 (the linear specification of Okun's law). This yields evidence of non-linearity in Okun's law for Mexico. The results also indicate that the mean cyclical unemployment rate is lower in the expansionary regime than in the recessionary regime (-0.0374< 0.2259). As mentioned earlier, the expansionary and recessionary regimes are described as outcomes where unemployment is below and above trend, respectively. Across the two regimes, the two state-dependent Okun's coefficients (β_1, β_2) are negative and significant at the 1% level. Further testing results in rejection of the null hypothesis H_0: $\beta_1 = \beta_2$, a result that supports the existence of an asymmetric Okun's coefficient. Cyclical unemployment is more responsive to contemporaneous cyclical output when the former is in the recessionary regime. The results indicate that a decrease of 1% in cyclical output is accompanied by an increase of approximately 0.31% in unemployment if the system is in a recessionary regime, while an increase of 1% in cyclical output reduces unemployment by approximately 0.12% when the system is in an expansionary regime.

Furthermore, the probability p_{11} of remaining in the expansionary regime at time (t), given that the unemployment rate was in the same regime at time (t-1), is 0.90. The probability p_{22} of being in the recessionary regime at time (t), given that the unemployment rate was in the same regime at time (t-1), is 0.53, smaller than p_{11}. These probability values indicate that if the unemployment rate is in the expansionary regime, it is more likely to remain in this regime than to switch to a recessionary one. In addition, table 2 shows that the probability of switching from an expansionary to a recessionary regime is almost 0.095, while the probability of switching from a recessionary to an expansionary regime is close to 0.47, which indicates that changes from recessionary to expansionary regimes are more likely than changes from expansionary to recessionary ones. The expected duration of regime j is defined

as $1/(1-p_{jj})$. Going by this result, we found that the average length of an expansionary regime was two and a half years, whereas the expected duration of a recessionary regime was approximately half a year.

We now estimate the model in terms of transitional endogenous probabilities. Unlike other papers that use output changes, this one allows the informal employment rate to explain the evolution of such probabilities. As explained in section IV, we consider informal employment to be one of the main causes of changes in the unemployment rate.

The likelihood ratio test comparing the model of time-varying transition probabilities with the model of fixed probabilities rejects the null hypothesis of constant probabilities in favour of the TVTP model. On the basis of these tests, we conclude that the model with endogenous transition probabilities is the best one for explaining the relationship between the cyclical components of unemployment and output.

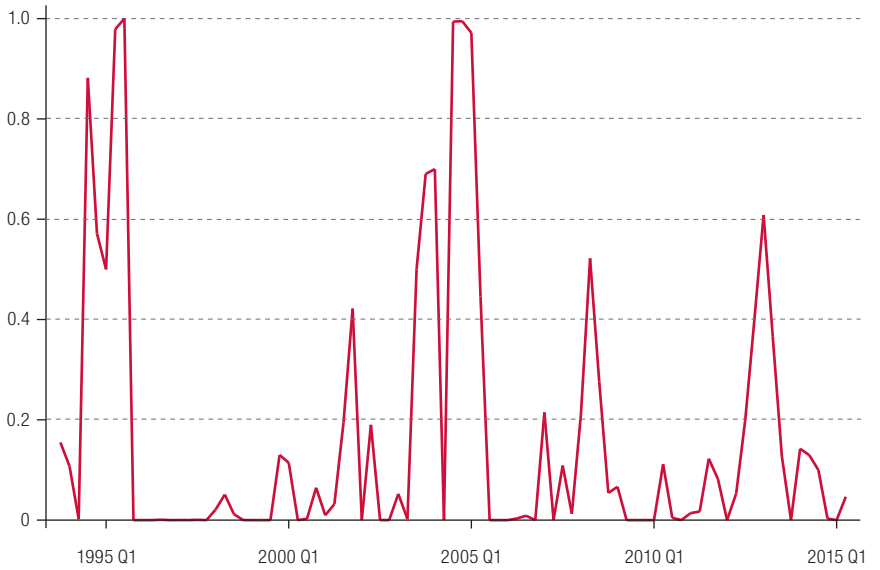
The TVTP estimations, also shown in table 2, validate the existence of two different states of the unemployment rate: an expansionary regime with negative mean cyclical unemployment (0.0567) and a recessionary regime with positive mean cyclical unemployment (0.2307). In this case, average mean cyclical unemployment in expansionary, and recessionary regimes are similar to those found for the FTP case.

We observe that the sign of the explanatory variable of the transition probabilities accords with economic intuition. In fact, the probability of remaining in an expansionary regime, with below-trend unemployment, increases with a rise in the informal employment rate. On the other hand, if the unemployment rate is in a recessionary regime, with above-trend unemployment, a rise in the informal employment rate decreases the probability of remaining in this regime.

As in the FTP model, the two state-dependent Okun's coefficients (β_1, β_2) are negative and significant at the 1% level across the two regimes. Further testing results in rejection of the null hypothesis H_0: $\beta_1 = \beta_2$, a result that supports the existence of an asymmetric Okun's coefficient. Cyclical unemployment is more responsive to contemporaneous economic growth when in the recessionary regime. The results indicate that a decrease of 1% in cyclical output is accompanied by an increase of approximately 0.26% in unemployment if the unemployment rate is in the recessionary regime, while an increase of 1% in cyclical output decreases unemployment by approximately 0.10% if unemployment is in the expansionary regime. Our results indicate that when informal employment is allowed to explain the evolution of transition probabilities, Okun's coefficient estimates are smaller than the estimates yielded by the FTP model. This corroborates our claim that when there is a large informal sector, the effect of cyclical output on cyclical employment should be rather small.

Figure 2 shows the smoothed TVTP of being in a recessionary regime with above-trend unemployment at each date in the sample obtained from the model of endogenous probabilities. The time when the unemployment rate switched from one regime to the other is based on $P\left(s_t = res|u_1^c, \dots, u_T^c; \widehat{\Theta}\right) \geq 0.5$ The switching between regimes is usually sudden, thorough and sporadic. The unemployment rate spends most of the time in an expansionary regime. Figure 2 indicates four changes from an expansionary to a recessionary regime during the sample period. The first occurred between the fourth quarter of 1994 and the third quarter of 1995, the period of the Mexican financial crisis of 1994. The second was between the second quarter of 2003 and the first quarter of 2005: the upward trend in the Mexican unemployment rate during this period could be related to the slowdown in Mexico at that time, with the economy stagnating in the second and third quarters of 2003, the second and third quarters of 2004 and the first quarter of 2005. The third was in the second quarter of 2008, when the global financial crisis started. The last switch from an expansionary to a recessionary regime occurred in the first quarter of 2013, and could be related to the performance of the Mexican economy. The economy grew by 1.1% in 2013, a large drop on the 3.9% expansion of 2012, making this its weakest performance since 2009, when there was a deep recession.

Figure 2
Smoothed probabilities of being in a recessionary regime, time-varying transition probabilities (TVTP) model



Source: Prepared by the authors.

VII. Conclusions

This paper evaluates the way a large informal sector influences the impact of output fluctuations on unemployment fluctuations. It also considers the possibility that this influence may change over the course of Mexico's business cycle. A non-linear specification of the relationship between cyclical unemployment and cyclical output was estimated for the Mexican economy. A Markov switching model with both fixed and time-varying transition probabilities was used to identify the presence of asymmetry across regimes. In the model of endogenous probabilities in particular, we allowed the probabilities to be affected by the rate of informal employment, which we consider to be the main cause of changes in the unemployment rate.

Our findings can be summarized as follows. First, we corroborate previous estimates that Okun's coefficient is rather low. We argue that this low coefficient is largely explained by the existence of a large informal sector and a high level of mobility between the formal and informal sectors. Second, we find evidence of a non-linear Okun's coefficient in Mexico. In particular, our results support the existence of regime-dependent Okun's parameters with a significantly higher absolute value for recessions than for expansions. This implies that cyclical unemployment is more responsive to changes in cyclical output when in the recessionary regime. Third, the hypothesis of fixed probabilities can be rejected in favour of time-varying transition probabilities, which means that a model with endogenous transition probabilities is the better one. Fourth, we propose that informal employment significantly affects the evolution of the unemployment rate. We find that the probability of remaining in an expansionary regime with below-trend unemployment increases with a rise in the informal employment rate, while if the unemployment rate is in a recessionary regime and is above trend, an increase in the informal employment rate reduces the probability of remaining in this regime.

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Social classes, economic sectors and changes in the Chilean social structure, 1992 and 2013

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Abstract

According to recent research studies, a central characteristic of Chilean society is its mesocratization, in other words the sustained growth of the middle class. This article tests that thesis empirically, using Erik O. Wright's class model and the shift-share analysis technique to study the changes that occurred in Chile's class structure in two periods 1992–2003 and 2003–2013. The study concludes that the idea of mesocratization is questionable; between 1992 and 2013, there are substantially fewer people located in middle-class positions than in the "popular" classes (working class and informal self-employed). Moreover, the growth of the middle class has been relatively marginal and has been accompanied by trends that contradict the idea of a mesocratic society (such as the expansion of the working class between 2003 and 2013).

Keywords

Social structure, social classes, middle class, working class, measurement, economic analysis, Chile

JEL classification

A14, C80, J21

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I. Introduction

For several decades the transformation of the class structure in advanced capitalist societies was analysed through the lens of two opposing theses. A variety of analysts highlighted the advent of a post-industrial, post-capitalist or programmed society, which meant the consolidation of a large middle class that was defined as one of the main classes of capitalism in the second half of the twentieth century (Bell, 1973; Dahrendorf, 1959; Touraine, 1971). These authors interpreted the phenomenon as the result of the de-proletarization of the post-industrial work process; in other words, as a consequence of how that process started to require a more skilled labour force, with higher levels of technical knowledge and autonomy. Some even claimed that the transformations in question would give rise to a "new class" that would significantly alter the foundational patterns of wage labour (Mallet, 1975; Touraine, 1971).

In contrast to this perspective, other analysts projected an image of capitalist development centred on the concept of "proletarianization". Starting with the famous study by Harry Braverman (1998), many argued that the transformation of the class structure in the second half of the twentieth century instead expressed a tendency for wage earners to lose control over the work process, along with the development of highly routine work subject to "top-down" control (Wright and Singelmann, 1982).

These two divergent interpretations fuelled a series of empirical investigations that produced often conflicting results (Crompton and Jones, 1984; Marshall and Rose, 1988; Wright and Martin, 1987; Wright and Singelmann, 1982). In recent decades, an important part of these debates was used to examine the transformations of the class structure in less industrialized nations. These studies analysed how the economic development and entry into globalized markets of countries such as the Republic of Korea, Taiwan Province of China and Turkey transformed their class structures (Kaya, 2008; Koo, 1990; Sen and Koo, 1992).

The debates on the post-industrial theses and proletarianization have not had a direct correlate in the recent analysis of class structures in Latin America and, more specifically, in Chile. Nonetheless, many of the arguments in the debate have been reproduced in one way or another in recent decades. Since the 1990s, many studies have claimed to identify a process of mesocratization in the class structure of Latin America in general and Chile's in particular (Franco, Hopenhayn and León, 2010; Hopenhayn, 2010; León and Martínez, 2007; Ruiz and Boccardo, 2015). This line of research sees the phenomenon as driven by the sustained growth of middle-class positions, which have medium-high skill levels or are invested with authority in the productive process, in other words the positions of "experts", supervisors or managers. Recently, however, a number of studies have questioned this idea, noting that the tertiarization of the economy has not produced an exponential growth of the middle class or a weakening of traditional class barriers, at least in the case of Chile (Gayo, Méndez, and Teitelboim, 2016).

This article aims to contribute to this debate by analysing the recent transformations of the Chilean class structure. Drawing on basic elements of the neo-Marxist class structure proposed by Erik O. Wright (1985 and 1997) and using the shift-share analysis technique, it attempts to empirically test the thesis that the growth of the middle class is one of the important, if not the central, characteristics of the structural change observed in Chilean society. Drawing on data from the National Socioeconomic Characterization Survey (CASEN) and the National Survey of Employment, Labour, Health and Quality of Life of Workers in Chile (ENETS), the study analyses the changes that occurred in the class structure in two periods: 1992–2003 and 2003–2013. The results of the analysis cast doubt on the idea of an increasingly mesocratic society. The data show that while some middle-class positions grew between 1993 and 2013, this growth was weak. Moreover, in 2003–2013, it was accompanied by an increase in the number of people employed in working-class positions, which is the largest class in absolute terms if the two periods are considered jointly.

II. Transformations of the Chilean class structure

Class structure change has been the subject of many studies in recent decades. In both Chile and Latin America generally, much of the research has focused on the study of the middle class (Castellani and Parent, 2011; Espinoza, Barozet and Méndez, 2013; Franco, Hopenhayn and León, 2011); Gayo, Méndez and Teitelboim, 2016; Gayo, Teitelboim and Méndez, 2013; López-Calva and Ortiz-Juárez, 2014; Ruiz and Boccardo, 2015). These studies broadly support the idea of an increasingly mesocratic social structure, that is, one with an increasingly large middle class. This mesocratization of the class structure has frequently been explained in terms of the growth of non-manual employment and the rising income levels of a large segment of the employed population (Franco, Hopenhayn and León, 2011; Franco and León, 2010, Hopenhayn, 2010).

In their analysis of Chilean society in the mid-1990s, Arturo León and Javier Martínez (1987) defended that idea by arguing that the expansion of the non-manual services sector fuelled a sustained expansion of the middle class in the country. According to these authors, the process implied both better chances of ascending to middle-class positions and the dismantling of the old worker cultures centred on industrial labour (León and Martínez, 2007, p. 312). The mesocratization thesis has recently been pursued further by Ruiz and Boccardo (2015), who analysed the transformations of the Chilean class structure using an update of the social categories matrix developed by León and Martínez.

Based on this framework, Ruiz and Boccardo claim that Chilean society has experienced steady growth of middle-ranking sectors of medium- and high-skill wage earners employed mainly in private-service office work (2015, pp. 64 and 65). The authors note that this process has been reinforced by an expansion of higher education in the country, which has produced new contingents of skilled labour, together with the sustained growth of "middle management sectors" on the back of the thriving financial or primary export sectors which have a higher status than the middle-ranking groups of the past, linked to State activity (2015, p. 112).

From a complementary perspective, other research has shown that both the region as a whole and several individual countries (including Chile) have experienced significant increases in rates of upward social mobility, defined as the transition between a manual working-class origin towards a non-manual middle class (do Valle Silva, 2007, Espinoza, 2006; Jorrat, 2005; Palomino and Dalle, 2012; Solís, 2005; Torche, 2014). Building on this idea, Torche (2005) described Chilean society as "unequal but fluid", in view of the significant levels of intergenerational mobility existing between the low-status locations (manual workers) and the middle-ranking positions (non-manual workers) in the class structure.

In Chile, the mesocratization thesis has not been confined to describing objective changes in the class structure, but has also been used to interpret the weakness of traditional class actors, such as the industrial working class. Several analysts have noted that the growth of the middle class is one of the main structural trends explaining the consolidation of meritocratic values among wage earners and, as a result, the weakness of the trade union movement in relation to industrial labour (León and Martínez, 2007, p. 312; Ruiz and Boccardo, 2015, p. 135). Other researchers have argued that the mesocratization of the class structure has led to the consolidation of a social structure in which "class struggle" has been superseded by "status struggle" (Espinoza, Barozet and Méndez, 2013, p. 180; Franco and León, 2010, pp. 72–74).

The mesocratization thesis thus highlights two interrelated processes. Firstly, it reveals the existence of a constantly expanding middle class, associated with occupational activities of medium and high skill levels, mainly in the private sector and in services. Secondly, this perspective also reveals the existence of middle-class identities that have not only been consolidated among wage earners in the private sector and services, but have also generated strong subjective barriers between these "white collar" wage earners and classical (industrial) manual workers.

III. Critical analyses of mesocratization in Chile

Some of central elements of this thesis have been the subject of debate in recent years. Addressing the subjective aspects of the notion of mesocratization, recent research on class consciousness in Chile has cast doubt on the idea that work that is commonly defined as middle class (non-manual work in service sectors such as trade and finance) inevitably produces identities and interests that differ from those of manual or industrial workers (Pérez-Ahumada, 2017).

Similarly, Gayo, Méndez and Teitelboim (2016) analysed patterns of cultural taste and consumption and concluded that, contrary to the idea of a middle-class society, the Chilean social structure contains symbolic and cultural class barriers that are still quite persistent (Gayo, Méndez and Teitelboim, 2013). These authors also argue that some of the variables traditionally associated with the study of inequality (such as economic resources, education and occupation) are decisive factors in the differences that exist in Chilean cultural practices. Based on this, Gayo and his collaborators infer that, although Chile's occupational structure has undergone a tertiarization process, this has not led to the emergence of a less polarized society, either economically or culturally. This conclusion is of vital importance for assessing whether Chile is in fact a middle-class society. Moreover, in keeping with the views expressed by the exponents of class analysis (Crompton, 1993; Oesch, 2006; Wright, 1985), this finding casts doubt on the idea that growth of the service sector inevitably means expansion of the middle class.

Research of this type has made a major contribution to the debate on mesocratization in Chile, which has been loaded with complexities associated, among other things, with the problematic definition of the concept of "middle class", and with a relative lack of data to make it possible to construct theoretically-based class structures that help define this concept empirically (Crompton, 1993). This partly explains why many studies base their findings and conclusions on varied definitions of what is meant by "middle class"; for example, definitions that reflect the position of individuals or families in the middle segment of the income distribution, their intermediate location in the income deciles or quintiles, or an occupation or simultaneous position in certain occupational and income scales (Barozet and Fierro, 2011; Castellani and Parent, 2011; Franco, Hopenhayn and León, 2011; Franco and León, 2010; Gayo, Teitelboim and Méndez; 2013, León and Martínez, 2007; Lora and Fajardo, 2013; Ruiz and Boccardo, 2015).

Despite the use of sometimes mutually inconsistent definitions, these studies have made a substantial contribution to analysis of the class structure. Especially significant, in the case of Chile, has been the contribution of research founded on theoretically-based class models, such as the work of Gayo, Méndez and Teitelboim (2016) based on Bourdieu (1984), or the study by Torche (2005) derived from the Erikson and Goldthorpe (1992) model. Drawing on approaches used in contemporary sociological literature, these studies have added a comparative dimension when examining the Chilean class structure, which affords a better understanding of its specific features.

IV. Research focus, analytical framework and hypothesis

Pursuing the line of theoretically-based research, this paper aims to contribute to the study of class structure in Chile within the neo-Marxist class model proposed by Erik O. Wright (1985 and 1997). The article makes an empirical analysis of the basic, and hence central, claim of the mesocratization thesis, namely the sustained growth of the middle class which has generated a clearly mesocratic class structure. It draws upon data from the CASEN survey and from ENETS to analyse the transformations of the Chilean class structure that occurred between 1992 and 2003 and in 2003–2013. A further aim

is to contribute to the analysis of classes in Chile through a statistical technique that is seldom used but highly relevant for studying changes in the class structure: shift-share analysis. As will be shown later, this technique makes it possible to identify the sources of change that explain the transformations seen in the class structure (in particular, sources associated with changes across economic sectors and changes in the class composition within each sector).

Like the neo-Weberian model proposed by Robert Erikson and John Goldthorpe (1992), Erik O. Wright's neo-Marxist scheme is a theoretically-based model that has been widely used in empirical research on class structures (Bergman and Joye, 2001; Crompton, 1993; Leiulfsrud, Bison and Jensberg, 2005; Li and Singelmann, 1999). In Chile, it was recently used to analyse the joint effect of class and gender on the quality of employment (Aguilar and others, 2016).

According to Wright (1997, pp. 17–26), class location stems from unequal control over the three main productive assets in contemporary capitalist society. The first of these are the means of production, the unequal ownership of which generates the distinction between the owner and non-owner (wage-earning) classes. The second and third productive assets of unequal ownership are skill and organizational assets (expressed respectively in the possession of expert knowledge and the occupation of positions vested with authority in the relations of production). Unequal possession of skill and authority assets is the fundamental mechanism that generates class distinctions among wage earners —for example, between unskilled and skilled workers or between managers or supervisors and workers without authority.

In Wright's schema, unequal control over these three productive assets determines the position of individuals in relations of exploitation. While the owners of means of production occupy the position of exploiters insofar as they contract the labour of others, those who do not own these means occupy the position of exploited when selling their labour power. In this context, middle-class positions are defined as being in a contradictory class location (Wright, 1985), for although they are exploited in their capacity as wage earners, they are also exploiters (or comparatively less exploited) as they assume the control of productive assets "qualifications" and "authority". Thus, a manager or a professional would be part of the middle class and, according to this model, an example of a contradictory class location. Although managers and professionals sell their labour power, they are also endowed with high levels of skill or authority, which gives them a privileged position relative to unskilled workers and those without authority.

If the mesocratization thesis is applied to this analytical model, the contradictory class locations —middle-class positions endowed with skills and authority— would be expected to grow steadily over time, while those of the working class would decline in an inversely proportional way. This is the main hypothesis that this article seeks to test in the ensuing empirical analysis.

V. Variables, data and techniques of analysis

1. Variables

The two main variables in this study are social class and economic sector. The former was constructed from the Wright (1997) class structure scheme; but a slightly modified version of the model of 12 social classes proposed by Wright was designed to better serve the aims of this article.[2] Specifically, the "petty bourgeoisie" category (self-employed who do not hire other people's labour power) was divided between the petty bourgeoisie itself and the informal self-employed, to represent the situation of the Chilean labour market more realistically. Accordingly, the owners of the means of production were divided into four class locations: capitalists, small employers, petty bourgeoisie and informal self-employed.

[2] Details on the criteria used to construct this class scheme can be found in Wright (1997, pp. 74–90).

The wage-earning population was analysed in terms of four class categories: managers, supervisors, experts and workers (skilled and unskilled). These four categories were chosen to make the results of this research comparable with those of similar studies based on the same class framework (Wright, 1997; Wright and Martin, 1987). The homogenization of these wage-earning class categories is especially important for this study for the following reason. Several research studies that propound the thesis of mesocratization tend to express this in terms of the growth of highly skilled work positions in wage-earning modalities, operating in the private service sector (Orellana, 2011, pp. 80 and 81; Ruiz and Boccardo, 2015, p. 64). For this reason, most of the analyses presented below were focused on the wage-earning class positions (managers, supervisors, experts and workers).

Table 1 shows the main criteria under which the eight class categories were constructed. The owner classes are subdivided into capitalists, small employers, petty bourgeoisie (self-employed persons who carry out activities that require medium and high skill levels and belong to groups 1 to 4 of the 1988 International Standard Classification of Occupations (ISCO-1988)) and informal self-employed (working in occupations located in groups 5 and 9 of ISCO-1988)[3] Moreover, among the wage-earning population, the respondents were distinguished by skill level and according to what Wright (1997, pp. 20–22) defines as "organizational assets" or authority.

Table 1
Class categories

	Owns means of production	Employs labour	Has decision-making power over the firm's management and organization[a]	Supervises the work of others	The job requires high-level educational qualifications[b]
1. Capitalists	Yes	Yes (more than 10 persons)	—	—	—
2. Small employers	Yes	Yes (between 2 and 9 persons)	—	—	—
3. Petty bourgeoisie	Yes	No	—	—	—
4. Informal self-employed	Yes (but low skill levels)	No	—	—	—
5. Managers	No	No	Yes	—	—
6. Supervisors	No	No	No	Yes	—
7. Experts	No	No	No	No	Yes
8. Workers	No	No	No	No	No

Source: Prepared by the author, on the basis of E. O. Wright, *Class Counts: Comparative Studies in Class Analysis*, Cambridge, Cambridge University Press, 1997; and E. O. Wright and B. Martin, "The transformation of the American class structure, 1960–1980", *American Journal of Sociology*, vol. 93, No. 1, Chicago, The University of Chicago Press, 1987.
Note: A long dash indicates that the criterion is not applicable to the classification of individuals in that category.
[a] Refers to the capacity to hire or fire workers, alter the goods or services produced by the company, change the way work is organized and influence the budget.
[b] For example, professional diplomas.

The economic sector variable was analysed on the basis of the International Standard Industrial Classification (ISIC). Because the various databases used different versions of this classification, it was decided to harmonize the data by constructing 22 categories derived from ISIC Rev 3.1 (data comparability problems made it impossible to generate a more fine-grained classification). In some more specific analyses, which are mentioned in the results section, aggregate versions of the economic sectors were used.

[3] Although there are many definitions of "work" and the "informal sector" (Portes and Haller, 2004), the available data were only sufficient to use the general classification criteria proposed by PREALC (1978).

2. Data

The data used in this article come from two sources. The first is the National Socioeconomic Characterization Survey (CASEN), which is a household survey widely used in Chile because its sample frameworks and the number of cases are suitable for making nationally representative estimates. It also has adequate information (although not sufficient) to estimate the number of people employed in various class locations. In other words, it makes it possible to correctly estimate the number of people that comprise the classes that own the means of production (employers and the self-employed).

The problem arises when classifying wage earners. The CASEN survey only has the traditional variable derived from ISCO-1988; but it does not include data that would make it possible to distinguish, for example, a worker without authority from a supervisor or a manager (that is, a high-level wage earner, with administrative capacities that go beyond mere supervision of the work of others). As the central aim of this study is to test the mesocratization thesis from a theoretically-based class perspective, this is not a minor problem. In order to solve it, the cases of the CASEN survey were classified according to information obtained from ENETS, which is the second data source used in this study. The latter was applied between September 2009 and October 2010 by the Ministry of Health, the Ministry of Labour and Social Security and the Labour Safety Institute of Chile, and it is representative at the national level (persons aged 15 years or older; n = 9,503). Unlike the CASEN survey, ENETS does allow for the construction of theoretically-based class schemas, since it contains enough information to operationalize the authority dimension proposed in the Wright framework.

The next section explains the classification of the cases of the CASEN survey on the basis of ENETS data, which made it possible to estimate the size of the wage-earning classes for 1992, 2003 and 2013. This estimate may be subject to problems associated with the time lapse between the ENETS and CASEN surveys (problems discussed in the next section). Nonetheless it was decided to work with ENETS, since it is still the only survey that makes it possible to apply the Wright model to the Chilean case.

3. Estimated wage-earning class locations for 1992, 2003 and 2013

The method used in this paper to estimate the class structure was developed in previous research on transformations of this structure (Wright, 1997; Wright and Martin, 1987; Wright and Singelmann, 1982). As noted above, the method was used only to estimate the size of wage-earning class locations (the estimates for the owner classes were calculated directly from the CASEN survey), following all the recommendations made in those earlier studies (Wright and Martin, 1987, pp. 25–28; Wright and Singelmann, 1982, pp. 192 and 193). The estimation of the cases was done in three stages. First, based on ENETS data, a three-way class/occupation/economic sector table was constructed, which revealed the class distribution in each occupation within each sector of the economy. The table thus presented the distribution of the four wage-earning classes within the nine occupational groups (as defined by the single-digit ISCO-1988 classification) for each of the 22 sectors of the economy. Then, the CASEN survey data were used to construct two-way occupation/economic sector tables, which made it possible to distinguish the total number of people in each occupation within each sector for 1992, 2003 and 2013. Lastly, the percentages of class/occupation/economic sector table obtained from ENETS were used to estimate the distribution of classes within the cells of the occupation/economic sector tables obtained from the CASEN survey. For example, if ENETS indicated that 20% of office workers (as per the "occupation" variable) who were employed in the financial services and insurance area (according to the "economic sector" variable) were supervisors (according to the "social class" variable),

then 20% of the members of this occupation in that economic sector according to the CASEN survey were defined as supervisors. This imputation process made it possible to calculate the total number of people in each wage-earning class location for 1992, 2003 and 2013 (errors in the occupation coding of the public version of the 1990 CASEN survey did not allow analysis for that year).

This method of estimating class size assumes that the class distributions within each occupation (within economic sectors) remain constant (Wright and Martin, 1987; Wright and Singelmann, 1982, p. 193). This may not be the case in some circumstances; for example, if proletarization or mesocratization phenomena occur within each occupation. If so, this estimation method would probably not be the most suitable for studying the distribution of the population in the class structure. Nonetheless, the studies in which this form of imputation has been used have shown that, aside from these potential shortcomings, the technique is appropriate in cases where the focus is on transformations of the class structure over a period of years, rather than on the absolute distribution of the labour force in each class category. These research studies have also suggested that the potential biases associated with a procedure such as this should not affect the analysis of changes in the structure insofar as they remain constant over time —in other words, whenever the same estimation method is used in all periods studied (Wright and Martin, 1987, pp. 10–11).[4] Potential limitations aside, therefore, this imputation technique proved very useful for analysing changes in the class structure from the standpoint of Wright's neo-Marxist analysis and using databases that ensure the national comparability and representativeness of the data.[5]

4. Technique of analysis

This article analyses the hypothesis of mesocratization using the shift-share technique, which is common in empirical analyses of transformations of the class structure (Gubbay, 2000; Marshall and Rose, 1988; and Martin, 1987; Wright and Singelmann, 1982) and is appropriate for the purposes of this paper. Moreover, this method makes it possible to divide the global changes that occur in the class structure in a given period of time, between those associated with changes in the class composition within each economic sector (the "class composition shift effect") and changes derived from the transformation of industries or economic sectors in themselves (the "industry shift effect"). In addition, the technique makes it possible to distinguish a third cause of transformation, namely the "interaction effect", which is a residual component indicating the combined effect of changes in the size of the economic sectors and the class composition within each of them.

This technique involves constructing counterfactual frequency tables for the distribution of classes in each economic sector. In doing this, the aim was to analyse the three sources of change mentioned above in the periods 1992–2003 and in 2003–2013.

In order to examine the effect of a change in class composition within individual sectors of the economy, a counterfactual table was constructed showing how many people of a certain social class (such as the working class) there would have been in a given year (2003 for example) —without considering the overall growth of the labour force— *if* the size of the economic sectors had not changed relative to 1992, but the distribution of classes within each sector had changed (as seen in 2003). This type of

[4] Further details on the possible biases associated with this estimation technique can be found in Wright and Martin (1987, pp. 25-28) and Wright and Singelmann (1982, pp. 207-208).

[5] Another possible bias concerns the level of aggregation of the variables. The data used in this study only permitted a breakdown into 22 economic sectors (rather than 37 as in the previous research in which this method of imputation was used). To test the possible flaws arising from with this problem, the author estimated the size of the classes with different versions of the "economic sector" variable for the years in which the data allowed this (2003 and 2013). These analyses revealed only minor variations in the size of each class (variations which were no more than 1% in relation to the total class structure presented here). More importantly, the analysis of these data showed that the pattern of change in the class structure —that is, the increase or decrease in class size— was exactly the same as that presented in this article.

class-composition effect reveals how a class expands or contracts in absolute terms, independently of the changes that might exist in the economic sectors. The mesocratization of the class structure should thus be expressed as an increase in the number of individuals located in middle-class positions within each economic sector (or in most of them), even if the sectors with the largest number of working-class people (for example, agriculture) had grown faster than those with a larger number of middle-class people (such as financial services).

The industry shift effect was analysed through a table of counterfactual data that indicate how many people of any social class there would have been in a given year (for example, 2003) —without considering the growth of the labour force— *if* the class composition within each sector had been the same as that of the previous year of analysis (1992), but the size of each economic sector (that is, the number of people employed in them) had changed (as seen in 2003). In conceptual terms, this type of effect shows how class structure changes as a result of the growth or contraction of specific economic sectors. Thus, the growth of the education and social-service sectors could be seen as a major force driving the mesocratization of the class structure, insofar as these sectors have large contingents of highly skilled workers. If these sectors grow faster than others that have a large unskilled labour force (such as agriculture), then the middle-class locations in the overall class structure should expand both absolutely and in relative terms. In this analytical technique, this is viewed as an effect of a change in economic sectors.

Lastly, the interaction effect is a residual element that represents changes in the class structure that result from people moving from one class within an economic sector to another in a different sector. For example, many analysts of the Latin American class structure have argued that the neoliberal transformation of the 1980s and 1990s entailed a process of deindustrialization and tertiarization, together with an increase in the petty bourgeoisie (especially the informal type), resulting from the "forced entrepreneurship" into which many former wage earners were driven (Klein and Tokman, 2000; Portes and Hoffman, 2003; Weller, 2004). According to the technique presented in this article, the interaction effect would be seen in the contraction of "blue-collar" working-class positions and the decline of the industrial sector that generated them, together with an increase in the tertiary sector and own-account activities. In other words, this effect should be understood as the joint result of the change in the composition of classes within industries (in this case, a decrease in wage-earning workers and an increase in self-employment) and the global transformation of the economic sectors (shown by a contraction of the industrial sector and the expansion of the service sector).

The procedures used to compile these counterfactual data tables are outlined in the annex.

VI. Results

Table 2 shows the main changes recorded in the size of the economic sectors, grouped into 22 categories, between 1992, 2003 and 2013. The data confirm the trends indicated in several previous research studies, namely that Chile's economic structure has experienced a sustained reduction in employment in the primary sector (especially in agriculture, hunting and forestry), the contraction of some industrial activities (for example, those related to textiles and leather) and an increase in employment in the service sector (Gayo, Méndez and Teitelboim, 2016; León and Martínez, 2007). These facts would support the thesis of mesocratization, since financial intermediation, real estate and business activities tend to require high skill levels. Their growth should therefore be expressed in a sustained increase in wage-earning middle-class positions and in the consolidation of a more mesocratic structure (Ruiz and Boccardo, 2015, p. 112).

Table 2
Chile: total employed population by economic sector, 1992–2013
(Number of persons and percentages)

	1992		2003		2013	
	No. of persons	Percentages	No. of persons	Percentages	No. of persons	Percentages
1. Agriculture, hunting and forestry	677 907	14.3	688 707	11.9	610 668	8.6
2. Fishing	66 621	1.4	80 457	1.4	51 792	0.7
3. Mining and quarrying	104 665	2.2	87 497	1.5	200 190	2.8
4. Manufacture of food products, beverages and tobacco	164 105	3.5	209 540	3.6	272 644	3.8
5. Manufacture of textiles and leather products	237 681	5.0	127 450	2.2	91 067	1.3
6. Manufacture of wood, paper and other products	160 458	3.4	179 689	3.1	181 574	2.5
7. Manufacture of petroleum and chemical products	52 391	1.1	62 155	1.1	41 334	0.6
8. Manufacture of plastic and non-metallic mineral products	55 292	1.2	42 639	0.7	44 008	0.6
9. Manufacture of basic metals	92 204	1.9	109 625	1.9	106 699	1.5
10. Manufacture and repair of equipment	49 370	1.0	55 286	1.0	65 517	0.9
11. Electricity, gas and water supply	37 132	0.8	33 949	0.6	40 261	0.6
12. Construction	431 564	9.1	508 957	8.8	680 510	9.5
13. Wholesale and retail trade	736 562	15.5	966 941	16.7	1 174 812	16.5
14. Hotels and restaurants	111 914	2.4	174 016	3.0	313 968	4.4
15. Transport, storage and communications	339 412	7.2	464 319	8.0	562 806	7.9
16. Finance, insurance and real estate activities	95 606	2.0	142 020	2.4	174 508	2.4
17. Business services	126 288	2.7	276 861	4.8	431 162	6.0
18. Public administration and defence	104 206	2.2	156 074	2.7	260 790	3.7
19. Teaching	269 574	5.7	402 411	6.9	554 876	7.8
20. Health and social work	168 871	3.6	243 170	4.2	389 898	5.5
21. Community and personal services	609 600	12.9	710 352	12.2	757 653	10.6
22. Recreational services	52 511	1.1	79 344	1.4	120 872	1.7
Total	4 743 934	100	5 801 459	100	7 127 609	100

Source: Prepared by the author, on the basis of data from the National Socioeconomic Survey (CASEN).

The consolidation of a "mesocratized" structure is put in perspective, however, when analysing the data in table 3, which reports the changes observed in the Chilean class structure between 1992, 2003 and 2013. For comparison purposes only, this table also includes percentage data for the United States between 1960 and 1980, calculated by Wright and Martin (1987), with a class structure model that is basically the same as the one used in this study.

Two phenomena stand out: first, in all three years, the majority of Chileans (around 59%) almost invariably are in a working-class location. This casts doubt on the middle-class nature of the Chilean class structure, especially considering the large number of informal self-employed (who are commonly understood in Latin American literature as an integral part of popular sectors along with the working class). Despite having shrunk over the years, in 2013 informal self-employed workers accounted for almost 15% of the total employed. Thus, in that year almost 75% of the population belonged to the lowest part of the class structure (informal self-employed and working class).

The second phenomenon is that wage-earning middle-class locations —managers, supervisors and experts— did increase between 1992 and 2013, but the increase was only moderate (between 1992 and 2013 none of these categories grew by more than 1.5 percentage points). Moreover, in 2003–2013 middle-class growth was accompanied by a similar expansion of the working class (by 1.4 percentage points). The data thus indicate that in the year in which the class structure was most mesocratized (2013),

wage-earning middle-class locations represented only 18.6% of the total employed. This is striking if the data are compared with those of the United States, which show that, in 1980, managers, supervisors and experts jointly accounted for just over 40% of total employment. It can also be seen that the managers class in that country has always represented a significant portion of the labour force, rising from 14.8% in 1960 to over 18% in 1980. In Chile, however, managers represented no more than 1.5% in any of the years considered. The experts category displays a similar picture, although it grew from 2.8% in 1992 to 3.8% in 2013, possibly as a result of the expansion of higher education during recent decades (Espinoza, Barozet and Méndez, 2013; Ruiz and Boccardo, 2015). Nonetheless, this increase is quite modest compared to that of the United States, and it is insufficient to reverse the weakly mesocratic nature of the Chilean class structure.

Table 3
Changes in the class structure in Chile (1992–2013) and the United States
(Number of persons and percentages)

Social class	Chile						United States[a]		
	1992		2003		2013		1960	1970	1980
	No. of persons	Percentages	No. of persons	Percentages	No. of persons	Percentages	Percentages		
Owners									
1. Capitalists	41 631	0.9	50 705	0.9	29 106	0.4	8.0	5.5	5.0
2. Small employers	126 337	2.7	176 896	3.0	84 840	1.2			
3. Petty bourgeoisie	166 874	3.5	302 064	5.2	372 109	5.2	5.8	4.4	4.3
4. Informal self-employed	877 442	18.5	903 190	15.6	1 054 839	14.8			
Wage earners									
5. Managers	66 446	1.4	81 276	1.4	104 560	1.5	14.8	16.3	18.4
6. Supervisors	557 486	11.8	708 075	12.2	947 584	13.3	11.5	12.4	13.2
7. Experts	130 984	2.8	192 922	3.3	271 451	3.8	5.6	7.4	8.6
8. Working class	2 776 735	58.5	3 386 332	58.4	4 263 120	59.8	54.3	54.1	50.5
Total	4 743 934	100	5 801 459	100	7 127 609	100	100	100	100

Source: Prepared by the author, on the basis of data from the National Survey on Employment, Work, Health and Quality of Life of Workers in Chile (ENETS) (2009–2010) and the National Socioeconomic Survey (CASEN) (1992–2013) and E. O. Wright and B. Martin, "The transformation of the American class structure, 1960–1980", *American Journal of Sociology*, vol. 93, No. 1, Chicago, The University of Chicago Press, 1987.

[a] In the United States, the "Capitalist" and "Small employers" classes are combined in a single large category. Similarly, the "Petty bourgeoisie" category encompasses both "Petty bourgeoisie" and "Informal self-employed" as defined here.

Having discussed these global changes in the class structure, it is now appropriate to describe these phenomena more specifically. Table 4 shows a decomposition of changes in the class structure obtained from the shift-share analysis for 1992–2003 and 2003–2013. Column I shows the total change observed in each class (in other words, how much it increased or decreased in each period); while column II shows the expected change, or how much each class should have grown if it had increased in the same proportion as the total employed population. Column III reports the net change in each social class —calculated controlling for the growth of the labour force— while columns IV to VI show the source or origin of that change (hence the sum of these effects is equal to the net change of each class). In other words, columns IV to VI represent changes in the class structure as an effect of: (i) the transformation of the economic sectors (column IV); (ii) shifts in the class composition within each sector (column V); and (iii) the combined effect or interaction of both factors (column VI).[6] Columns VII to X display the same information as columns III to VI, but as a percentage of the number of people in each class at the start of the periods analysed (1992 for the first period and 2003 for the second).

[6] As noted in the methodological section, the annex provides a brief explanation of the counterfactual tables from which the figures shown in table 4 were obtained.

Table 4
Chile: basic decomposition of changes in class structure, 1992–2003 and 2003–2013
(Number of persons and percentages)

	Net change and its decomposition[a] *(no. of individuals)*						Net change and its decomposition *(percentages)*			
	Total observed change I	Expected change II	Net change III	Effect of the shift in economic sectors IV	Effect of the shift in class composition V	Interaction effect (residual component) VI	Net change VII	Effect of the shift in economic sectors VIII	Effect of the shift in class composition IX	Interaction effect (residual component) X
1992–2003										
1. Capitalists	9 074	9 280	-206	-1 884	-281	1 959	-0.5	-4.5	-0.7	4.7
2. Small employers	50 559	28 163	22 396	5 324	19 027	-1 955	17.7	4.2	15.1	-1.5
3. Petty bourgeoisie	135 190	37 200	97 990	31 919	65 962	109	58.7	19.1	39.5	0.1
4. Informal self-employed	25 748	195 601	-169 853	-55 429	-85 232	-29 192	-19.4	-6.3	-9.7	-3.3
5. Managers	14 830	14 812	18	-135	-556	709	0.0	-0.2	-0.8	1.1
6. Supervisors	150 589	124 276	26 313	22 435	64	3 814	4.7	4.0	0.0	0.7
7.Experts	61 938	29 199	32 739	33 044	-231	-74	25.0	25.2	-0.2	-0.1
8. Working class	609 597	618 994	-9 397	-35 275	1 248	24 630	-0.3	-1.3	0.0	0.9
2003–2013										
1. Capitalists	-21 599	11 591	-33 190	439	-34 416	787	-65.5	0.9	-67.9	1.6
2. Small employers	-92 056	40 436	-132 492	-456	-132 395	358	-74.9	-0.3	-74.8	0.2
3. Petty bourgeoisie	70 045	69 049	996	18 596	-26 016	8 417	0.3	6.2	-8.6	2.8
4. Informal self-employed	151 649	206 459	-54 810	-109 853	67 082	-12 039	-6.1	-12.2	7.4	-1.3
5. Managers	23 285	18 579	4 706	2 225	2 302	179	5.8	2.7	2.8	0.2
6. Supervisors	239 510	161 858	77 652	58 561	18 715	376	11.0	8.3	2.6	0.1
7.Experts	78 528	44 100	34 428	34 260	251	-83	17.8	17.8	0.1	0.0
8. Working class	876 788	774 078	102 710	-3 772	104 477	2 005	3.0	-0.1	3.1	0.0

Source: Prepared by the author, on the basis of data from the National Survey on Employment, Work, Health and Quality of Life of Workers in Chile (ENETS) (2009–2010) and the National Socioeconomic Survey (CASEN) (1992–2013).

[a] The values of the cells in column III represent the changes in the number of people in each class category, without considering the overall change in the population. Because of this, in both periods the sum of those cells is equal to zero in the vertical direction. The values of the columns between IV and VI indicate the different components (effects) that explain the net change. Therefore, the sum of these components for each class coincides with the net change. Variations in the decimals of the sum are due to rounding of the calculations. The text and the annex provided more detailed explanations of this table.

A review of columns III and VII in the 1992–2003 section shows that, without considering the growth of the employed labour force, the experts category grew by 32,739 people (equivalent to an increase of 25%), while the working class experienced a net decrease of 9,397 people, representing a net change of -0.3%. In the case of experts, a breakdown of the net change shows that its growth reflects a change in the economic sectors, which resulted in a net increase of 33,044 people (column IV). This was equivalent to a net increase of 25.2% (column VII), which was offset by slight reductions: 0.2% as a result of the change in class composition and 0.1% as a result of the interaction effect (columns VII and VIII).

Between 2003 and 2013, the trends are similar to those exhibited in the first period. Nonetheless, two phenomena should be noted; firstly, unlike the 1992–2003 period, when managers experienced virtually no net change, in the second period this category recorded net growth of 5.8% (column VII). The increase was not very significant in absolute terms, however (as shown in column III, this 5.8% is equivalent to just 4,706 people). The second phenomenon that warrants consideration is the net growth of the working class, as shown by the fact that in 2013 there were 102,710 more workers than in 2003 (column III). The large size of this class explains why the absolute net growth (which was the highest of those observed with respect to any of the classes in either of the two periods) only meant a 3% increase (column VII). The breakdown of that percentage suggests that much of the growth in the working class is an effect of the change in class composition within the economic sectors (column IX).

It is also interesting to note what happens in both periods with the petty bourgeoisie and the informal self-employed categories. The former displays constant growth which, nonetheless, slows sharply in the second period (between 1992 and 2003 this class recorded net growth of 58.7%, while in 2003–2013 growth was just 0.3%). The opposite trend prevailed among the informal self-employed, as the shrinking of this category slows down in the second period. The net change in this class was -19.4% between 1992 and 2003, but -6.1% in 2003–2013.

These results cast doubt on the mesocratization thesis, at least with respect to the two periods analysed here. Although between 1992 and 2013 there was net growth of wage-earning middle-class positions, this was extremely small and did not produce significant transformations in the class structure. Moreover, the growth was accompanied in 2003–2013 by a net increase in the number of people employed in working class positions. This increase was, in fact, the highest in absolute terms considering the two periods studied (see column III of table 4). In short, the data indicate that the idea of an increasingly mesocratic structure is hard to sustain from a class perspective, such as the one used in this study.

To gain a more complete picture of these trends, table 5 reports the effects of the changes that have occurred in industries and the class composition (columns VIII and IX of table 4), broken down into five large economic sectors.[7] This table is useful as a complement to the information already described in table 4. For example, when analysing the latter, it was noted that the net increase in experts between 1992 and 2003 mostly reflected the change in economic sectors (as explained above, this effect was expressed as net growth of 25.2%). The data in table 5 suggest that most of this increase associated with the transformation of economic sectors is explained by the growth of activities grouped under the "Public, social, community and personal services" category. In effect, the expansion of these activities meant a net increase of 94.7% for the experts category. A similar trend can be seen in the second period analysed. As happened between 1992 and 2003, the net increase in experts in 2003–2013 is largely a consequence of the change in economic sectors and particularly the growth of activities associated with public, social, community and personal services.

[7] These economic sectors resulted from the grouping of the 22 sectors presented in table 2, which was done as follows: Extractive sector (activities 1 to 3); Manufacturing, construction and supply sectors (4 to 12); Trade, hotels/restaurants, transportation and communications (13 to 15); Insurance, financial services and business services (16 to 17); and public, social, community and personal services (18 to 22).

Table 5 also explains the net increase in the number of people employed in working-class positions between 2003 and 2013. As noted earlier, this positive net change is basically an effect of changes in the distribution of classes within the economic sectors (which meant a 3.1% increase in workers, according to column IX of table 4). Most of this net increase is due to the growth of the working class within the extractive sector, which experienced a net increase in workers of 5.9%, as shown in table 5. This means that within this sector, and aside from its growth or contraction, there was a proletarianization process which meant that there were more people employed in working-class positions in 2013. According to Table 5, something similar —but to a lesser degree— occurred with the growth of the working class in activities associated with the manufacturing, supply and construction sectors.

Table 5

Chile: breakdown of the effects of the change in the economic sectors and in the class composition by economic sector, 1992–2003 and 2003–2013

(Percentages)

	Extractive sector	Manufacturing, supply and construction	Trade, hotels, transport and communications	Insurance, financial and business services	Public, social, community and personal services	Total
1992–2003						
1. Capitalists						
Change in economic sectors	0.6	15.2	8.3	-0.9	-27.8	-4.5
Change in class composition	-0.5	22.4	-2.6	-20.3	-0.7	-0.7
2. Small employers						
Change in economic sectors	1.1	-8.0	31.7	3.1	-23.7	4.2
Change in class composition	0.5	11.3	16.7	-14.8	15.1	15.1
3. Petty bourgeoisie						
Change in economic sectors	-15.8	-18.2	36.4	21.2	-4.5	19.1
Change in class composition	-12.6	-10.9	68.4	-12.2	39.5	39.5
4. Informal self-employed						
Change in economic sectors	4.5	-2.9	13.9	-7.7	-14.1	-6.3
Change in class composition	8.2	10.2	-3.5	-16.1	-9.7	-9.7
5. Managers						
Change in economic sectors	-3.0	6.4	-8.5	5.9	-1.1	-0.2
Change in class composition	0.2	10.2	-9.4	-3.3	-0.8	-0.8
6. Supervisors						
Change in economic sectors	-4.9	6.5	-5.6	1.3	6.6	4.0
Change in class composition	-1.5	8.8	-6.4	1.1	0.0	0.0
7. Experts						
Change in economic sectors	-17.5	-25.1	-29.3	2.5	94.7	25.2
Change in class composition	-17.2	-25.0	-29.5	72.0	-0.2	-0.2
8. Working class						
Change in economic sectors	1.3	1.9	-5.4	0.5	0.5	-1.3
Change in class composition	5.8	4.2	-6.3	-1.0	0.0	0.0
2003–2013						
1. Capitalists						
Change in economic sectors	-3.9	13.9	1.4	8.6	-19.1	0.9
Change in class composition	-6.5	-8.4	-25.4	0.9	-28.5	-67.9
2. Small employers						
Change in economic sectors	-4.5	-0.1	15.6	6.4	-17.7	-0.3
Change in class composition	-8.8	-13.5	-19.5	-4.6	-28.5	-74.8
3. Petty bourgeoisie						
Change in economic sectors	-12.6	-17.0	40.8	12.1	-17.1	6.2
Change in class composition	-10.8	-14.5	14.9	10.0	-8.2	-8.6
4. Informal self-employed						
Change in economic sectors	4.2	7.0	4.5	-9.6	-18.2	-12.2
Change in class composition	8.6	10.0	12.6	-8.8	-14.9	7.4

Table 5 (concluded)

	Extractive sector	Manufacturing, supply and construction	Trade, hotels, transport and communications	Insurance, financial and business services	Public, social, community and personal services	Total
5. Managers						
Change in economic sectors	-1.7	3.8	-5.5	6.4	-0.3	2.7
Change in class composition	0.9	7.4	-6.5	4.3	-3.3	2.8
6. Supervisors						
Change in economic sectors	-2.3	3.1	-4.0	1.0	10.4	8.3
Change in class composition	-1.4	6.2	-4.3	-0.6	2.6	2.6
7. Experts						
Change in economic sectors	-13.9	-24.1	-31.4	-0.2	87.4	17.8
Change in class composition	-14.3	-23.9	-31.1	-1.2	70.7	0.1
8. Working class						
Change in economic sectors	1.6	0.1	-2.9	0.7	0.4	-0.1
Change in class composition	5.9	2.6	-2.8	-0.9	-1.7	3.1

Source: Prepared by the author, on the basis of data from the National Survey on Employment, Work, Health and Quality of Life of Workers in Chile (ENETS) (2009–2010) and the National Socioeconomic Survey (CASEN) (1992–2013).

Note: The values of each cell should be interpreted as the contribution of each economic sector to the components of change in the economic sectors and in class composition. The total of each row therefore represents the effects of the change of the economic sectors and of the class composition of table 4 (columns VIII and IX).

VII. Conclusions

The main conclusion to be drawn from this study is that the central claim of the mesocratization thesis in Chile, namely the that the growth of the service sector has given rise to a middle-class social structure, is questionable, at least in relation to the period analysed. It is true that Chile has experienced a steady reduction in the labour force employed in the industrial sector. It is also true that the growth of some activities in the services sector has a positive effect on the rise of the middle class (which is precisely what was revealed in this study when it was found that the net increase in experts is an effect of the growth of activities linked to public, social, community and personal services). Nonetheless, although these trends have been correctly highlighted by many of the proponents of mesocratization (León and Martínez, 2007; Ruiz and Boccardo, 2015), what is debatable is whether these phenomena are important enough in quantitative terms (absolute and relative) to be able to speak of an increasingly mesocratic class structure. As noted above, the Chilean class structure is characterized by the great persistence of its general features. These indicate that Chilean society is much more working class than middle class (according to the framework used in this study, while the working class alone accounts for about 60% of total employed, its share increases to nearly 75% when the informal self-employed are included). These results are similar to those obtained in other studies that have questioned whether the tertiarization of the Chilean economy has turned Chile into a middle-class country (Gayo, Méndez and Teitelboim, 2016).

Considering the pace of expansion of middle-class positions, together with the increase in the number of people employed in working-class positions between 2003 and 2013, it is hard to see the middle class becoming a numerically dominant sector of the class structure at some point. The outlook is even less optimistic when one considers that the two periods analysed should have captured the positive effects of two decades of rapid economic growth (Chile's gross domestic product (GDP) grew by an average of over 4% per year except in 1999 and 2009). Similarly, a comparison with similar research undertaken in the United States in the late 1980s (Wright and Martin, 1987) shows that the association between deindustrialization, the emergence of a service society and the growth of the middle class may well apply (under certain circumstances) to advanced capitalist societies, but may be insufficient to understand the case of Chile.

So what explains why the idea of mesocratization has become one of the most widely used concepts to analyse the recent changes in Chilean society? One possible explanation concerns the way in which the concept of social class has been defined in research studies; specifically, the fact that the definitions used reflect a tendency to automatically associate change in economic sectors —the growth of the services sector for example— with a change in the class structure —allegedly expressed in the expansion of non-manual middle-class jobs. Under the analytical strategy adopted in this study, this automatic association confuses two different sources of change: one observed across economic sectors and the other in the class composition within each one. By empirically identifying both sources of change and using theoretically-based analytical frameworks, this paper has attempted to contribute to the class analysis, showing how the Chilean class structure is more polarized and resistant to change that many assume.

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Annex A1

Construction of counterfactual data tables

Table 4 presented a summary of the sources of the transformation of the Chilean class structure in the two periods analysed. The data were obtained by constructing two tables of counterfactual data that show the following, with respect to each period in question: (i) the effects associated with the transformation of the economic sectors; and (ii) the effects of changes in the class composition within the economic sectors. These tables were developed following the steps described by Wright and Singelmann (1982, pp. 202–205). For explanatory purposes, the following paragraphs describe what these tables consist of and how they were produced for the 2003–2013 period.

1. Table of counterfactual data to measure the effects of the transformation of the economic sectors

Columns 1 and 2 of table A1.1 show the observed frequencies in each class category in 2003 and 2013. Column 3 indicates the expected change, in other words how much each class should have grown if it had done so in the same proportion as the total employed population. For example, in 2013 the size of the employed population increased by 22.86% relative to 2003. Thus, column 3 shows how many people there would have been in each class if each class had also grown by 22.86%. These three columns are the basis for the figures shown in columns 5 (Observed change), 6 (expected change) and 7 (Net change, which is the difference between the observed and expected change). The data from these three columns was presented in full in columns I, II and III of table 4.

Column 4 of table A1.1 reports the change in class size associated with the transformation of economic sectors. This weighted change represents how the classes would have been distributed, in 2013, in each of the 22 economic sectors if, apart from the expansion or decline of the sectors themselves, the distribution of the classes within them was been the same as in 2003. This was calculated by weighting the size of each economic sector in 2013 based on the distribution of classes observed in 2003. The values for each class thus represent the sum of each class category across the 22 economic sectors used in the calculations. Based on the above, column 8 presents a specific measure to capture the change in the class structure resulting from the transformation of economic sectors. This is defined as the difference between the weighted change (column 4) and the expected change (column 3). Thus, column 8 represents the increase or decrease in the number of people in each class category if there had been a change in economic sectors (controlled by the growth of the employed population), but not in the composition of classes within the sectors. The results of column 8 were shown in full in column IV of table 4.

Lastly, column 9 of table A1.1 reports the number of people that would have been in each social class if there had only been a change in the class composition within the economic sectors plus a joint transformation of the class composition and the economic sectors (that is, an interaction of the two effects). These values are not shown in any column of table 4 since it is impossible to interpret them directly. The information in question should be complemented with the results of table A1.2, which shows the effect of changes in the class composition and is presented in the following section.

Table A1.1
Chile: effect of the transformation of economic sectors and changes in the structure of classes, 2003–2013
(Number of persons)

	Employment				Change			Causes of the change	
	2003	2013	Expected 2013	Weighted as per 2003[a]	Observed	Expected	Net	Effect of the transformation of economic sectors	Effect of the transformation on the class composition and interaction effects
Column number / Social class	(1)	(2)	(3)	(4)	(5) = (2) - (1)	(6) = (3) - (1)	(7) = (5) - (6)	(8) = (4) - (3)	(9) = (2) - (4)
1. Capitalists	50 705	29 106	62 296	62 734	-21 599	11 591	-33 190	439	-33 628
2. Small employers	176 896	84 840	217 332	216 876	-92 056	40 436	-132 492	-456	-132 036
3. Petty bourgeoisie	302 064	372 109	371 113	389 709	70 045	69 049	996	18 596	-17 600
4. Informal self-employed	903 190	1 054 839	1 109 649	999 796	151 649	206 459	-54 810	-109 853	55 043
5. Managers	81 276	104 560	99 854	102 080	23 285	18 579	4 706	2 225	2 481
6. Supervisors	708 075	947 584	869 933	928 494	239 510	161 858	77 652	58 561	19 091
7. Experts	192 922	271 451	237 022	271 282	78 528	44 100	34 428	34 260	168
8. Working class	3 386 332	4 263 120	4 160 410	4 156 638	876 788	774 078	102 710	-3 772	106 482
Total	5 801 459	7 127 609	7 127 609	7 127 609	1 326 150	1 326 150			

Source: Prepared by the author, on the basis of data from the National Socioeconomic Survey (CASEN) (2003 and 2013) and the National Survey on Employment, Work, Health and Quality of Life of Workers in Chile (ENETS) (2009–2010).
[a] Weighted by the class composition prevailing in each economic sector in 2003.

2. Table of counterfactual data to measure the effects of the change in the class composition within the economic sectors

The first three columns of table A1.2 display the same information as the corresponding columns of the table described above. This is not the case in column 4, which shows how the classes would have changed if there had not been a transformation of economic sectors; in other words, if only the distribution of classes within them had changed. Mathematically, this is obtained by calculating the size that the economic sectors would have had in 2013 if each of them had continued to absorb the same proportion of the labour force as in 2003. Then, based on those expected totals for each economic sector, the size of each class within them is calculated from the percentages observed in 2013 —that is, assuming that the class composition changed as it did. The change in the size of the classes could then be quantified by also assuming that the structure of the economic sectors was the same in 2013 as in 2003. As in the previous case, the figures shown in column 4 generate those of column 8, which represents the effect of the change in class composition abstracting from the growth of the employed population. These values were presented in full in column V of table 4.

The figures displayed in column 8 of this table also served to isolate the interaction effect reported in column 9 of table A1.1. As noted above, this column shows the effect of the change in class composition plus the effect of the interaction between changes in classes and economic sectors. The "pure" interaction effect was calculated as the difference between those values (column 9 of table A1.1) and those shown in column 8 of table A1.2 (Wright and Singelmann, 1982, p. 205). This "pure" interaction effect was presented in column VI of table 4.

Table A1.2
Chile: effect of the transformation on the class composition and changes in the class structure, 2003–2013
(Number of persons)

	Employment				Change			Causes of the change	
	2003	2013	Expected 2013	Weighted as per 2003[a]	Observed	Expected	Net	Effect of the transformation of economic sectors	Effect of the transformation on the class composition and interaction effects
	(1)	(2)	(3)	(4)	(5) = (2) - (1)	(6) = (3) - (1)	(7) = (5) - (6)	(8) = (4) - (3)	(9) = (2) - (4)
1. Capitalists	50 705	29 106	62 296	27 880	-21 599	11 591	-33 190	-34 416	1 226
2. Small employers	176 896	84 840	217 332	84 938	-92 056	40 436	-132 492	-132 395	-98
3. Petty bourgeoisie	302 064	372 109	371 113	345 096	70 045	69 049	996	-26 016	27 013
4. Informal self-employed	903 190	1 054 839	1 109 649	1 176 731	151 649	206 459	-54 810	67 082	-121 892
5. Managers	81 276	104 560	99 854	102 156	23 285	18 579	4 706	2 302	2 404
6. Supervisors	708 075	947 584	869 933	888 648	239 510	161 858	77 652	18 715	58 937
7. Experts	192 922	271 451	237 022	237 273	78 528	44 100	34 428	251	34 178
8. Working class	3 386 332	4 263 120	4 160 410	4 264 887	876 788	774 078	102 710	104 477	-1 768
Total	5 801 459	7 127 609	7 127 609	7 127 609	1 326 150	1 326 150			

Source: Prepared by the author, on the basis of data from the National Socioeconomic Survey (CASEN) (2003 and 2013) and the National Survey on Employment, Work, Health and Quality of Life of Workers in Chile (ENETS) (2009–2010).

[a] Weighted by the structure of economic sectors prevailing in 2003.

What can be done about the dearth of information for local decision-making? An analysis from the design of a territorial development index based on administrative records

Ismael Toloza, Sergio Sánchez and Javier Carrasco[1]

Abstract

This article addresses the issue of information availability for decision-making at the subregional level. It proposes the construction of a territorial development index (TDI) based on administrative records and comprising 19 variables grouped into 6 dimensions: (i) cultural capital, (ii) social capital, (iii) human capital, (iv) institutional capital, (v) tangible capital and (vi) economic capital. The approach underlying the proposed model centres on territorial development and the structural factors determining it. The variables making up the TDI were selected in consultation with experts and with the use of multivariate statistical analyses. This paper sets out to document many of the phases, procedures and decisions leading to the TDI, as a way of opening up the discussion around this line of research. It concludes by presenting calculations of the TDI for the Chilean municipalities of Angol and Carahue.

Keywords

Local government, decision-making, information, information access, regional development, development indicators, multivariate analysis, Chile

JEL classification

O18

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I. Introduction

Chile lacks robust information for local decision-making.[2] It was with this assertion that the Outlying Areas Committee of the Chilean Senate opened its session of 6 June 2016.

The way development at all levels (national, regional, territorial and local) is understood has transitioned from approaches concentrating almost exclusively on economic growth towards models of multidimensional, holistic interpretation. On this view, the ability to trigger development processes depends on considerations that yield an understanding of the factors determining these processes and the public or private policy and management decisions that subsequently affect them. This understanding becomes more difficult as the observer delves deeper into the subnational scale and is able to obtain less and less information and data because of a lack of robust periodic series, or finds that such series as do exist, e.g., the National Socioeconomic Survey (CASEN) and the New National Employment Survey (NENE), are unrepresentative. In these circumstances, information presented in a format that describes the development and competitiveness indicators available for the interpretation of phenomena and for decision-making at the local level usually comes from a mix of sources. This means that the secondary information available needs to be reinforced or supplemented with primary information gathered through surveys or interviews. This process adds to the cost of obtaining indicators, so that the scope for reproducing them is limited or dependent on the availability of resources.

This dearth of information for decision-making at the territorial and local level has become a limitation and a challenge for the country. The situation was acknowledged in the report of the Presidential Advisory Committee for Decentralization and Regional Development (2014), which points to a need to create integrated regional systems of territorial information for decision-making, since while plentiful data are available in municipal or sectoral administrative records at the local and territorial level, it is important to determine their availability and reliability. There also needs to be a restructuring to enable data to be better exploited and provide more and better information for subnational public and private policymaking in a way that is more relevant to each territory's complexity and specificity. The growing demand for local and commune-level statistics is a concern that has been addressed since 2011 by the Social Observatory of the Ministry of Social Development (MIDESO), together with the office of the United Nations Development Programme (UNDP) in Chile. In this framework, thought has been put into the development of a methodology for estimating small areas from the data of the 2009 CASEN survey that can be reapplied in subsequent versions (Ministry of Social Development, 2013).

Against this background, the present article aims to make a contribution in at least two areas. First, it seeks to help remedy local information deficiencies by presenting a design for a territorial development index (TDI) constructed exclusively from information in administrative records. Second, it posits an approach to territorial development centred on identification of the structural factors that, as Boisier (2004) argues, are critical to the systemic emergence of development.

With these ends in view, a theoretical framework based on the structural development factors approach was created to provide the underpinnings for the design of the indicator. Currently available subnational indicators applying a territorial approach were reviewed. The TDI was then designed on the basis of the composite index construction methodology laid out in the *Handbook on Constructing Composite Indicators: Methodology and User Guide* published by the Organization for Economic Cooperation and Development (OECD, 2008) and in "Guía metodológica: diseño de indicadores compuestos de desarrollo sostenible" (Schuschny and Soto, 2009). The indicator was tested (i.e., calculated) in Carahue and Angol, two communes in the Araucanía region.

[2] As Filgueira (2006) puts it, this means the transformation of data into indicators and of these into information providing a means to greater social intelligence and knowledge (evolutionary pyramid of the incorporation of technical knowledge into public policy).

II. Theoretical framework

1. Territorial development and dynamics

As Alburquerque (2013) has noted, the old sectoral polices that used to define the central administration of the State have been giving way to policies designed with a territorial approach. This is because a position needs to be taken in the different local spheres on substantive development issues (e.g., production innovations, human resources and environmental sustainability). In this context, Vázquez Barquero (2007) argues that the development of a territory consists in a process of endogenous changes and transformations driven by the creativity and entrepreneurial capacity already present there. Accordingly, development processes cannot be explained by external mechanisms alone. These processes usually arise endogenously, putting territories' capacities to work by way of the mechanisms and forces that characterize capital accumulation and facilitate economic and social progress.

This particular approach to development seeks to explain how dynamics operate, are manifested, interact and evolve in a given territorial space. This is consistent with the statement by the United Nations Economic and Social Council (2011) that sustaining well-being depends on our ability to ensure that capital stocks (natural, tangible, human and social capital) are passed on to future generations.

In this context, and from the standpoint of complexity theory, Boisier (2004) understands the structure and dynamics of development as the emergence of a complex territorial system. Within this, it is possible to identify subsystems that, in turn, are comprised of more specific elements. Table 1 describes the six subsystems established by Boisier.

Table 1
Boisier's subsystems

(i) Axiological subsystem	A set of universal and singular values that define what it is to belong to a particular territory and that distinguish it from other territories.
(ii) Accumulation subsystem	Includes the accumulation of capital, technical progress and human capital, which are factors in the current theorization of endogenous growth. In the exogeneity of development it is possible to identify the importance of these factors with regard to territory, national political projects, general and sectoral economic policy and external demand (given the greater degree of openness). This makes it necessary to reconsider how public policy is made at the meso (regional) level, while institutions at the subnational level (region, province, commune) could play a proactive role in making these decisions more endogenous.
(iii) Decision-making subsystem	Configured by individual, corporate and collective agents, this is the human expression of the territory. Thus, it is not enough to identify and list all agents. What is necessary, rather, is to accurately identify the projects pursued by each, since disparate visions will have to be reconciled when a political project for development (a territorial development plan, for instance) comes to be settled on.
(iv) Organizational subsystem	This comprises the universe of public and private organizations in the territory. As with the previous dimension, what needs determining is not just the organizational map and its density, but the levels of interrelationship, linkage and synergy of its actions.
(v) Procedural subsystem	This refers to the procedures of the public administration in the territory for service provision, information flow management and actions in support of the territory to optimize its positioning in globalization (opportunities). The entropic (disorderly) characteristics of public information, which increase transaction costs and uncertainty and so act as a hindrance to economic growth, are recognized here.
(vi) Subliminal subsystem	Configured by nine categories of intangible capital, namely cognitive, symbolic, cultural, social, civic, institutional, psychosocial, media and human capital, which are considered key factors in development when this is likewise conceived of as an intangible outcome.

Source: S. Boisier, "Una (re)visión heterodoxa del desarrollo (territorial): un imperativo categórico", *Estudios Sociales*, vol. 12, No. 23, January–June 2004 [online] https://dialnet.unirioja.es/descarga/articulo/2108278.pdf.

There needs to be the greatest possible level of interconnection between these six subsystems, this being what is referred to by the concepts of "neuronal synapsis" and "neuronal synchrony". Without high-density synapses, development cannot arise (Toloza, 2007).

From another point of view, the methodological guide "Marco conceptual, metodológico y operativo de la planificación regional" (González, Sánchez and Araúz, 2011) produced by the Ministry of National Planning and Economic Policy (MIDEPLAN) of Costa Rica and UNDP indicates that the territorial development approach encompasses the dimensions described in table 2.

Table 2
Dimensions according to the United Nations Development Programme

(i) Economic and production dimension	This is associated with decisions and activities affecting the capacity for wealth creation with a territorial connection on the basis of the set of modalities of existing production systems and distribution structures for wealth produced at the territorial level. Dimensions such as investment, the quality and relevance of human capital formation, social capital, productivity, the generation of knowledge and innovation and popular knowledge also need to be taken into account, as they feed through into competitiveness and, especially, into economic inclusion and justice.
(ii) Social dimension	Described as the aspirations and needs of the population belonging to a territory, in the light of its diversity and socioeconomic, ethnic, cultural and age characteristics. In this dimension, inclusion, equity, respect for diversity and social responsibility need to be assured.
(iii) Environmental dimension	This is connected to the principles and strategies of sustainable development and environmental security and encompasses a very wide range of issues, such as care for life, bad social practices that increase the risks associated with climate change, pollution, socioenvironmental risk, salinization of underground reserves, waste management and species predation.
(iv) Cultural dimension	Territories differ from one another and are also socially heterogeneous internally, and this has a cultural manifestation. There are different elements of identity that can generate conflict and risk if not addressed in all their complexity and importance. This differentiation can also turn into inequality and exclusion if differences are not properly understood and addressed, something that is manifested in forms of organization, world views and production methods, among other things.
(v) Political and institutional dimension	Territorial development should be deliberately managed, which means creating scenarios, agendas and strategic roadmaps. It also requires institutional arrangements that give rise to policies, strategies and mechanisms for implementation, oversight and follow-up of actions in the short, medium and long run. All this should take place in a context of dialogue and consensus. Arriving at shared visions, priorities, agreements, responsibilities and areas of coordination requires institutions that can make the proposed strategic design work in practice. For this, it is necessary to ensure that the material, human, cultural and heritage resources available are used to support territorial development.

Source: H. González, O. M. Sánchez and Y. Araúz, "Marco conceptual, metodológico y operativo de la planificación regional: guía metodológica para el diseño de la estrategia de abordaje regional en planificación del desarrollo", Ministry of National Planning and Economic Policy/United Nations Development Programme (UNDP), 2011 [online] https://documentos.mideplan.go.cr/alfresco/d/d/workspace/SpacesStore/8c656860-8f17-47df-a6e1-67cfccf89dff/CPR-001_1.pdf?guest=true.

Accordingly, territorial development is conceived on the basis of a set of elements that enable it to be defined as a multidetermined yet comprehensive theoretical concept taking account of the economic and production, social, environmental, cultural and political and institutional aspects (González, Sánchez and Araúz, 2011).

Requejo (2007) develops a similar perspective from a structure based on five types of capital: natural, tangible-constructed, human, social and image capital (see table 3).

Table 3
Types of capital according to Requejo

(i) Natural capital	The reserve of goods furnished by the environment (land, forests, water, wetlands, etc.) that provide the territory with particular goods and services.
(ii) Tangible-constructed capital	Basic infrastructure, residential buildings, public equipment, production facilities and installations of any other kind, and equipment associated with production, public services and consumption in a territory.
(iii) Human capital	The population's ability to undertake production processes and attain higher levels of well-being and quality of life through the use of knowledge, capabilities and aptitudes.
(iv) Social capital	A society's ability to respond effectively to its needs and organize itself in order to adapt.
(v) Image capital	Recognition of the value associated with a territory's identity.

Source: J. Requejo, "Clases de capital territorial. Clases de capital territorial y desarrollo sostenible", 2007 [online] http://www.atclave.es/publicaciones/descargas/pub_desarrollo/17_clases_de_capital_territorial.pdf.

Analysis of the first part of the methodological guide to territorial economic development titled *Proposiciones para el proceso de construcción y realización de una estrategia de desarrollo económico territorial* (Chile Emprende, 2005) shows that decentralized management models with a territorial approach (commonly known as territorial development models) are structured on the basis of a multidimensional vision of development that recognizes the existence of different types of territorial capital. These are the whole range of natural, economic, human, institutional and cultural resources that give a territory its identity and special character, influence its competitiveness and represent its endogenous development potential. As with any form of capital, these are not fixed reserves of resources, since part of their essence is their potential to reproduce and expand.

The theoretical framework for territorial capital proposed by Chile Emprende (2005) refers to five dimensions (or types of capital): (i) corporate and labour competitiveness, (ii) tangible capital and land use planning, (iii) institutional capital, (iv) social capital and (v) identity and culture. Table 4 presents these concepts, supplemented and adapted for the purposes of the present design.

Table 4
Types of capital according to Chile Emprende

(i) Human capital	The critical mass of human resources in business, the workforce and academia, people with leadership capacities and their level of competitiveness and development.
(ii) Financial capital	Investments, capital availability, the supply of financing, intermediation instruments, borrowing capacity and financial institutions in the territory.
(iii) Tangible and natural capital	Land use planning to provide the infrastructure needed for development opportunities to be pursued, and also the territory's natural capital and the way it connects to these opportunities.
(iv) Institutional capital	The soundness of institutions in the territory, be they public or private, and standards, laws, programmes and service platforms, among other things.
(v) Social capital	For the purposes of this theoretical model, this means community social capital and the existence of networks, organizational management and cooperation assets, conflicts and the history of conflicts.
(vi) Symbolic capital	A territory's identity and culture, tacit knowledge and traditional lore, among other things.

Source: Chile Emprende, *Guía metodológica del desarrollo territorial*, Santiago, 2005 [online] http://www.dhl.hegoa.ehu.es/ficheros/0000/0243/Chile_Estrategia_de_desarrollo_econ%C3%B3mico_territorial_2009.pdf.

In this context, and from the point of view of territorial development, it is important to be clear about the dimensions of territorial capital that need to be brought into play to capture opportunities and determine the level of relative development currently exhibited by these dimensions. This is a way of attempting to establish which divides and variables might best be dynamized in order to exploit or capture development opportunities in a territory (Chile Emprende, 2005).

Thus, implementing development processes from the perspective of decentralized management models with a territorial approach requires an ongoing effort to accumulate these types of territorial capital. The trigger for the systemic emergence of a territory, on this view, is the pursuit of processes (policies, programmes, projects and actions) aimed at increasing territorial capital inflows while reducing outflows, in order to create a permanent accumulation dynamic.

For the purposes of this study, these last theories based on the six types of territorial capital as structural factors in development are the ones that make the most sense when it comes to constructing a territorial development indicator.

III. Methodology

The methodology was based on the *Handbook on Constructing Composite Indicators: Methodology and User Guide* published by OECD (2008) and on "Guía metodológica: diseño de indicadores compuestos de desarrollo sostenible", the methodology guide for designing composite sustainable development indicators prepared by Schuschny and Soto (2009).

First, setting out from the definition of the types of territorial capital described in the theoretical framework above, the following dimensions of the TDI were defined: symbolic or cultural capital, human capital, social capital, institutional capital, tangible and infrastructure capital and economic capital. It was decided that the pilot communes for estimating the indicator would be Carahue and Angol.[3]

In an initial phase, the working methodology used to construct the TDI was based on workshops, debates and periodic working meetings in which each of the decisions and components making up the model presented here were progressively arrived at.

The first exercise was to form a panel of experts[4] tasked with drawing up a preliminary list of explanatory variables in each dimension. Accordingly, a first workshop was held and 107 initial variables associated with the dimensions specified were established. Identification of the variables at this stage was mainly based on the thematic coverage criterion, meaning that the variables had to have a direct relationship with the operational definition of the dimension.

1. First model adjustment

The 107 variables were put through a filter based on the criterion of data availability in administrative records. This yielded a first adjustment that brought down the number from 107 to 88 (see annex A1).

2. Second model adjustment

Setting out from the 88 variables selected in the first adjustment, a second model adjustment was carried out on the basis of three additional criteria: (i) information quality, (ii) periodicity and (iii) representativeness.[5] In this way, a total of 49 variables were rejected, leaving a somewhat more restricted model with a total of 39 variables, as shown in table 5.

Table 5
Second identification of dimensions and variables for the territorial development index

Dimension	Variable	Operational definition
(i) Cultural capital	1. Cultural events	Number of large-scale cultural events per year, by commune.
	2. Tangible cultural heritage	Number of heritage assets recognized by decree, by commune.
	3. Intangible cultural heritage	Number of intangible heritage assets registered in the Information System for Heritage Management (SIGPA), by commune.
	4. Indigenous communities and associations	Number of indigenous communities and associations, by commune.
	5. Place brands and designations of origin	Number of geographical indications and designations of origin, by commune.
(ii) Social capital	6. Organizations with social aims	Number of organizations with social aims and current legal personality, by commune. These include parents' associations, older adult centres or organizations, sports clubs, neighbourhood committees and other functional groupings.
(iii) Human capital	7. Years of education	Years of secondary education, by commune.
	8. University selection tests (PSU)	Average PSU scores, by commune.
	9. Economically active population (EAP)	Percentage of the population that is of working age (employed and unemployed), by commune.
	10. Employability	Percentage of the EAP that is in work, by commune.

[3] These communes participate in the University is Territory (UNETE) regional performance agreement operated by the University of the Frontier, which facilitates data collection.

[4] The members were Ismael Toloza, PhD in Economics; Sergio Muñoz, PhD in Statistics; Javier Carrasco, MA in Statistics; Alejandro Henríquez, engineering manager of the office of the National Institute of Statistics (INE) in the Araucanía region; Sergio Sánchez, MA in Research Methodologies; Camilo Rosas, sociologist and lecturer in Social Statistics; Ana María Alarcón, PhD in Anthropology; and Carlos Pineda, Paula Arias and Patricio Gallardo, professionals with the INE technical unit in the Araucanía region.

[5] Namely information quality, meaning the existence of a validated methodology for data generation and recording; periodicity, which concerns the date and frequency with which data are updated; and representativeness, meaning the statistical validity of the data at the communal level.

Table 5 (concluded)

Dimension	Variable	Operational definition
(iv) Institutional capital	11. Municipal Common Fund (FCM) share	Percentage of total municipal revenue that is from the FCM, by municipality.
	12. Municipal revenues	Municipal revenues in millions of Chilean pesos, by municipality.
	13. Municipal spending	Municipal spending per capita in millions of Chilean pesos, by municipality.
	14. Communal Development Plan (PLADECO)	Existence of a current PLADECO, by municipality.
	15. Annual Municipal Education Plan (PADEM)	Existence of a current PADEM, by municipality.
	16. Annual Municipal Health Plan (PASAM)	Existence of a current PASAM, by municipality.
(v) Tangible and infrastructure capital	17. Concrete roads	Kilometres of concrete roads, by commune.
	18. Asphalted roads	Kilometres of asphalted roads, by commune.
	19. Gravel roads	Kilometres of gravel roads, by commune.
	20. Telephone coverage	Percentage fixed-line telephone coverage, by commune.
	21. Internet coverage	Percentage fixed-line Internet coverage, by commune.
	22. Square metres constructed	Square metres constructed and officially certified per capita during the year, by commune.
	23. Drinking water coverage	Percentage drinking water coverage, by commune.
	24. Sewer system coverage	Percentage coverage of sewer system, by commune.
	25. Electricity grid coverage	Percentage coverage of electricity grid, by commune.
	26. Educational establishments	Number of educational establishments, by commune.
	27. Health-care establishments	Number of health-care establishments, by commune.
	28. State-protected wilderness areas	Square kilometres of protected wilderness areas, by commune.
	29. Native forest	Square kilometres of native forest, by commune.
(vi) Economic capital	30. Microenterprises	Number of microenterprises, by commune.
	31. Workers in microenterprises	Number of workers in microenterprises, by commune.
	32. Small enterprises	Number of small enterprises, by commune.
	33. Workers in small enterprises	Number of workers in small enterprises, by commune.
	34. Medium-sized enterprises	Number of medium-sized enterprises, by commune.
	35. Workers in medium-sized enterprises	Number of workers in medium-sized enterprises, by commune.
	36. Large enterprises	Number of large enterprises, by commune.
	37. Workers in large enterprises	Number of workers in large enterprises, by commune.
	38. Investments	Number of projects being implemented, by commune.
(vii) Other variables	39. Poverty	Percentage incidence of poverty, by commune.

Source: Prepared by the authors.

In connection with the above, the document "Indicadores sociales y marcos conceptuales para la medición social" (Cerda and Vera, 2008) describes a number of aspects worth bearing in mind when variables are identified for the design of indices. They include the existence of data, the coverage of geographical areas and data accessibility and comparability.

(a) Consistency analysis

It was necessary to have analysable data to test the structure and functioning of the model, considering that commune-level data are hard to access. Accordingly, and for analytical purposes, it was considered that the most practical option would be to subject the model to a series of multivariate analyses using region-level data, given that more information is available for variables analysed at that level (see annex A2). According to Hair, Anderson and Tatham (1987), one of the advantages of multivariate techniques is that they provide the ability to analyse a whole set of variables for an object simultaneously, yielding results that could not be obtained with univariate methods.

This analysis serves various purposes. In the first place, it aims to confirm that the model is valid, i.e., that the set of variables selected does actually measure an object associated with territorial development. To this end, correlation and regression analyses were carried out (Cuadras, 2007) on

the indicator constructed in relation to poverty and development indicators. In the second place, conglomerate analyses were carried out (Figueras, 2001) with a view to understanding how the data for the set of variables were grouped in relation to the cases (in this exercise, the regions). In the third place, principal component factor analyses were carried out (García, Gil and Rodríguez, 2001) for each dimension with a view to analysing the internal structure of the variables and the way these were grouped into particular factors. Factor analysis aimed at reducing dimensions is important in that it provides a way of evaluating, on the basis of particular statistical proofs, which variables are the most suitable for explaining the behaviour of or changes in a particular object and which might be left out of the model. The aim here is to reduce the dimensionality of the set of initial variables, seeking to retain most of the information provided by the variables observed (Cea d'Ancona, 2002).

The SPSS and R-project statistics package was mainly used in the multivariate data analysis. Unlike other programs, which are more oriented towards descriptive analysis, this software provides a number of advanced methods of statistical modelling and multivariate analysis.

(b) Multivariate analysis

To study the feasibility of summarizing the information and reducing the dimensionality of the polynomial concerned, we first evaluated the relevance of carrying out a factor analysis with extraction using the principal components analysis method and with orthogonal rotation based on the Varimax method. Factor analysis can be used to find combinations of variables from the underlying interrelationships between them. These combinations, called factors, are intended to represent the information contained in the variables in a condensed form. This is achieved by using a smaller number of factors that encapsulate a large part of the information, something that is seen in the percentage variance accumulated by the factors. The principal components method, for its part, can be used to create factors that encompass great variability, reducing the dimension of the data. The Varimax rotation method modifies the representation of the factors, once they have been constructed, to bring out the shares of the variables composing them and make them easier to interpret.

When evaluating the relevance of carrying out a factor analysis, it is necessary to show, for each of the dimensions of the TDI, that the data possess certain characteristics which make its use appropriate. This was done by examining the correlation matrix and determining the degree of interrelationship between the variables being studied. Bartlett's test for sphericity, which indicates whether the observed correlations are significant, was then applied to each dimension. The Kaiser-Meyer-Olkin coefficient, which indicates the extent to which the information contained in these variables can be explained from the other variables, was also calculated. This is appropriate for factor analysis.

Next to be studied were commonalities, which bring out the extent to which the variance of a variable is explained by the factor solution. The rotated factor loadings of the variables were also determined. The analysis carried out for each of the dimensions will now be explained in detail.

i. The cultural dimension

The cultural dimension is represented by the following variables: cultural events (DC1), intangible cultural heritage (CD2), tangible cultural heritage (DC3), place brands (DC4) and indigenous communities (DC5) (see table 6).

Table 6 shows the correlations between the variables in the cultural dimension. It can be seen that they are strongly related. Thus, for example, the Pearson correlation between cultural events and tangible cultural heritage is statistically significant (p-value < 0.001). The same is true of the correlations between the pairing of the intangible cultural heritage and tangible cultural heritage variables, on the one hand, and the intangible cultural heritage and place brands variables, on the other (p-value < 0.05).

Table 6
Correlation matrix for the cultural dimension

Variable	DC1	DC2	DC3	DC4	DC5
DC1	1.000				
DC2	0.420	1.000			
DC3	0.967***	0.454**	1.000		
DC4	0.398	0.400	0.456**	1.000	
DC5	-0.078	0.303	-0.018	0.037	1.000

Source: Prepared by the authors.
Note: * p-value < 0.01; ** p-value < 0.05; *** p-value < 0.001.

Bartlett's test for sphericity proved significant (sig. < 0.001), which indicates that there are major correlations and thus that it is worth continuing with the analysis. At the same time, the Kaiser-Meyer-Olkin coefficient within the cultural dimension is about 0.6, meaning that factor analysis is not inadvisable (see table 7).

Table 7
Bartlett's proof of sphericity and the Kaiser-Meyer-Olkin coefficient (cultural dimension)

Kaiser-Meyer-Olkin measure of sampling adequacy		0.598
Bartlett's test for sphericity	Approximate chi-squared	40.149
	gl	10
	Sig.	0.000

Source: Prepared by the authors.

The conclusion from all these analyses is that it is appropriate to apply factor analysis to this data series. Accordingly, three factors were selected, accounting between them for 89.714% of the total variance. The first factor accounts for 51.960% of the total variance, the second for 23.757% and the third for 13.997% (see table 8).

Table 8
Explained variance (cultural dimension)

Component	Initial eigenvalues			Sum of squared saturations of rotation		
	Total	Percentage variance	Cumulative percentage	Total	Percentage variance	Cumulative percentage
1	2.598	51.960	51.960	2.598	51.960	51.960
2	1.188	23.757	75.717	1.188	23.757	75.717
3	0.700	13.997	89.714	0.700	13.997	89.714
4	0.485	9.705	99.419			
5	0.029	0.581	100.000			

Source: Prepared by the authors.

Lastly, analysis of the rotated component matrix shows that the cultural events and tangible cultural heritage variables alter in the same direction and are grouped into the first component (some might be left out of the polynomial). The intangible cultural heritage variable is not grouped into any component, meaning that it provides information which cannot be summarized in any linear combination of the other variables. The value of the commonalities, which exceeded 69.0%, should also be emphasized (see table 9).

Table 9
Rotated component matrix and commonalities (cultural dimension)

Rotated component matrix				
Variable	Component			Commonality
	1	2	3	
DC1	0.973	-0.015	0.173	0.977
DC2	0.415	0.572	0.443	0.695
DC3	0.956	0.040	0.232	0.969
DC4	0.218	0.020	0.950	0.950
DC5	-0.091	0.940	-0.037	0.892

Source: Prepared by the authors.

ii. The human capital dimension

The human capital dimension is constituted at this stage by the following variables: years of education (DE1), average score in university selection tests (PSU) (DE2), labour force participation rate (DE3), employment rate (DE4), regional revenues (DE5) and regional expenditure (DE6).

As regards correlations, there is a strong relationship between the labour force participation rate and the employment rate and a correlation between regional revenues and expenditure (p-value < 0.01) (see table 10).

Table 10
Correlation matrix for the human capital dimension

Variable	DE1	DE2	DE3	DE4	DE5	DE6
DE1	1.000					
DE2	0.058	1.000				
DE3	0.552**	0.316	1.000			
DE4	0.557**	0.302	0.915***	1.000		
DE5	0.382	0.747***	0.290	0.299	1.000	
DE6	0.383	0.750***	0.298	0.307	0.999***	1.000

Source: Prepared by the authors.
Note: * p-value < 0.01; ** p-value < 0.05; *** p-value < 0.001.

Similarly, Bartlett's test for sphericity proved significant (sig. < 0.001), while the Kaiser-Meyer-Olkin index within the dimension was 0.673, making it relevant to carry out the factor analysis (see table 11).

Table 11
Bartlett's test for sphericity and the Kaiser-Meyer-Olkin test (human capital dimension)

Kaiser-Meyer-Olkin measure of sampling adequacy		0.673
Bartlett's test for sphericity	Approximate chi-squared	127.581
	gl	15
	Sig.	0.000

Source: Prepared by the authors.

In this dimension, three factors accounting for 95.602% of the total variability of the dimension were selected. The first represents 56.922% of total variance, the second 27.080% and the third 11.601% (see table 12).

Table 12
Explained variance (human capital)

Component	Initial eigenvalues			Sum of squared saturations of rotation		
	Total	Percentage variance	Cumulative percentage	Total	Percentage variance	Cumulative percentage
1	3.415	56.922	56.922	3.415	56.922	56.922
2	1.625	27.080	84.002	1.625	27.080	84.002
3	0.696	11.601	95.602	0.696	11.601	95.602
4	0.180	2.993	98.595			
5	0.084	1.402	99.997			
6	0.000	0.003	100.000			

Source: Prepared by the authors.

The results of the rotation show that the average PSU score, regional revenues and regional expenditure variables have been grouped into the first factor, while the participation rate and employment rate are grouped into the second. The third factor is composed mainly of years of education (see table 13).

Table 13
Rotated component matrix and commonalities (human capital dimension)

Variable	Component			Commonalities
	1	2	3	
DE1	0.149	0.385	0.887	0.958
DE2	0.878	0.267	-0.265	0.912
DE3	0.151	0.945	0.198	0.955
DE4	0.152	0.938	0.215	0.949
DE5	0.950	0.091	0.263	0.979
DE6	0.950	0.100	0.260	0.979

Source: Prepared by the authors.

The commonalities of all the variables were in excess of 90.0%.

Thus, the results indicate that the dimensionality of educational capital can be reduced, given the strong correlation between the variables and the direction of their variability.

iii. The tangible dimension

The tangible dimension was initially constituted by the following variables: concrete roads (DF1), asphalted roads (DF2), gravel roads (DF3), earth roads (DF4), telephone coverage (DF5), Internet coverage (DF6), drinking water coverage (DF7), sewer system coverage (DF8), electricity grid coverage (DF9), educational establishments (DF10), health-care establishments (DF11) and square metres constructed per year plus services (DF12) (see table 14).

The correlation matrix shows a strong relationship between the variables. For example, there is the statistically significant correlation (p-value < 0.001) between telephone coverage and Internet coverage and between drinking water coverage and sewer system coverage (see table 14).

For this same reason, Bartlett's test for sphericity is statistically significant (sig. < 0.001). However, the Kaiser-Meyer-Olkin index value, at 0.438, is low (see table 15).

Table 14
Correlation matrix for the tangible dimension

Variable	DF1	DF2	DF3	DF4	DF5	DF6	DF7	DF8	DF9	DF10	DF11	DF12
DF1	1.000											
DF2	-0.337	1.000										
DF3	0.350	0.318	1.000									
DF4	-0.442**	0.527**	0.209	1.000								
DF5	0.123	0.159	-0.188	-0.291	1.000							
DF6	0.120	0.196	-0.174	-0.287	0.998***	1.000						
DF7	0.098	-0.105	-0.499**	-0.298	0.191	0.200	1.000					
DF8	-0.128	-0.256	-0.620**	0.049	0.244	0.241	0.591**	1.000				
DF9	-0.664**	0.176	-0.308	0.549**	-0.338	-0.346	0.154	0.220	1.000			
DF10	0.169	0.441	0.185	-0.227	0.877***	0.894***	-0.053	-0.130	-0.426	1.000		
DF11	0.191	0.543**	0.350	-0.127	0.788***	0.808***	-0.116	-0.244	-0.419	0.977***	1.000	
DF12	0.126	0.151	-0.143	-0.273	0.995***	0.991***	0.099	0.196	-0.365	0.888***	0.800***	1.000

Source: Prepared by the authors.
Note: * p-value < 0.01; ** p-value < 0.05; *** p-value < 0.001.

Table 15
Bartlett's test for sphericity and the Kaiser-Meyer-Olkin coefficient (tangible dimension)

Kaiser-Meyer-Olkin measure of sampling adequacy		0.438
Bartlett's test for sphericity	Approximate chi-squared	260.302
	gl	66
	Sig.	0.000

Source: Prepared by the authors.

In this dimension, a selection has been made of four factors that between them account for 89.919% of the total variance of the dimension. Details will now be given of the values associated with each of the factors individually and the percentage variance between them (see table 16).

Table 16
Explained variance (tangible dimension)

Component	Initial eigenvalues			Sum of squared saturations of rotation		
	Total	Percentage variance	Cumulative percentage	Total	Percentage variance	Cumulative percentage
1	5.040	42.001	42.001	5.040	42.001	42.001
2	2.697	22.472	64.473	2.697	22.472	64.473
3	2.259	18.823	83.295	2.259	18.823	83.295
4	0.795	6.623	89.919	0.795	6.623	89.919
5	0.508	4.615	95.460			
6	0.294	2.674	98.134			
7	0.149	1.352	99.486			
8	0.036	0.331	99.817			
9	0.018	0.165	99.982			
10	0.002	0.016	99.998			
11	0.000	0.002	100.000			

Source: Prepared by the authors.

The main variables composing the first factor are telephone coverage, Internet coverage, educational establishments, health-care establishments and square metres constructed per year. The second component centres on the drinking water coverage and sewer system coverage variables. The concrete roads variable is grouped positively into the third factor and the electricity grid coverage variable is grouped negatively. The fourth factor combines the asphalted roads and earth roads variables (see table 17).

Table 17
Rotated component matrix and commonalities (tangible dimension)

Variable	Component				Commonalities
	1	2	3	4	
DF1	0.050	0.032	0.918	-0.177	0.878
DF2	0.310	-0.144	-0.157	0.864	0.887
DF3	-0.071	-0.596	0.525	0.491	0.877
DF4	-0.247	-0.091	-0.448	0.710	0.773
DF5	0.970	0.183	0.030	-0.090	0.984
DF6	0.976	0.188	0.042	-0.058	0.993
DF7	0.033	0.927	0.157	-0.007	0.885
DF8	0.076	0.826	-0.242	-0.155	0.771
DF9	-0.362	0.264	-0.704	0.322	0.800
DF10	0.951	-0.137	0.178	0.166	0.983
DF11	0.883	-0.218	0.243	0.314	0.984
DF12	0.976	0.100	0.023	-0.105	0.974

Source: Prepared by the authors.

With these results, and given the strong commonality of the variables represented by the components selected, the inference is that it is possible to reduce the number of variables within the dimension. This can be achieved by representing them in constructs that take account of the thematic concept relating them, or by removing variables that are redundant in respect of the direction of the variability they express.

iv. The economic dimension

The last dimension analysed was the economic dimension, the initial proposal for which included the following variables: microenterprises (DEc1), small enterprises (DEc2), medium-sized enterprises (DEc3), large enterprises (DEc4), workers in microenterprises (DEc5), workers in small enterprises (DEc6), workers in medium-sized enterprises (DEc7), workers in large enterprises (DEc8) and investments (DEc9).

In this dimension, it can be seen that there is a high degree of correlation between all the variables except the last (DEc9), which does not have significant correlations with the rest (see table 18).

Table 18
Correlation matrix for the economic dimension

Variable	DEc1	DEc2	DEc3	DEc4	DEc5	DEc6	DEc7	DEc8	DEc9
DEc1	1.000								
DEc2	0.991***	1.000							
DEc3	0.978***	0.997***	1.000						
DEc4	0.964***	0.990***	0.998***	1.000					
DEc5	0.995***	0.995***	0.985***	0.975***	1.000				
DEc6	0.997***	0.997***	0.987***	0.978***	0.998***	1.000			
DEc7	0.986***	0.999***	0.998***	0.994***	0.991***	0.994***	1.000		
DEc8	0.959***	0.987***	0.996***	0.999***	0.971***	0.975***	0.992***	1.000	
DEc9	0.277	0.361	0.399	0.420	0.318	0.307	0.373	0.431	1.000

Source: Prepared by the authors.
Note: * p-value < 0.01; ** p-value < 0.05; *** p-value < 0.001.

In turn, Bartlett's test for sphericity and the Kaiser-Meyer-Olkin measure of adequacy indicate the relevance of continuing with the factor analysis and studying the reduction of dimensionality within the dimension (see table 19).

Table 19
Bartlett's test for sphericity and Kaiser-Meyer-Olkin test (economic dimension)

Kaiser-Meyer-Olkin measure of sampling adequacy		0.745
Bartlett's test for sphericity	Approximate chi-squared	495.949
	gl	36
	Sig.	0.000

Source: Prepared by the authors.

In the same way, it can be seen that just two factors explain 99.304% of total variance in the dimension. The first factor accounts for 89.940% of total variability and the second for 9.364% of the remaining variance in the dimension concerned (see table 20).

Table 20
Explained variance (economic dimension)

Component	Initial eigenvalues			Sum of squared saturations of extraction		
	Total	Percentage variance	Cumulative percentage	Total	Percentage variance	Cumulative percentage
1	8.095	89.940	89.940	8.095	89.940	89.940
2	0.843	9.364	99.304	0.843	9.364	99.304
3	0.055	0.616	99.920			
4	0.004	0.048	99.968			
5	0.002	0.021	99.989			
6	0.000	0.005	99.994			
7	0.000	0.004	99.999			
8	0.000	0.001	100.000			
9	0.000	0.000	100.000			

Source: Prepared by the authors.

Lastly, and as was to be expected given the analysis of the correlation matrix, the first eight variables associated with enterprises are grouped into the first factor, while the second absorbs the investment variable (DEc9). Thus, the conclusion is that the dimension can be explained with two components. The first is a linear combination of the first eight variables, while the variable associated with investment, when modified in another direction, is represented by the second component. The high value of the commonalities should be emphasized. These indicate that practically all the information contained in the variables is encompassed by the factors (see table 21).

Table 21
Rotated component matrix and commonalities (economic dimension)

Variable	Component		Commonalities
	1	2	
DEc1	0.983	0.135	0.98
DEc2	0.978	0.209	1.00
DEc3	0.970	0.238	1.00
DEc4	0.960	0.257	0.99
DEc5	0.982	0.160	0.99
DEc6	0.985	0.160	1.00
DEc7	0.976	0.215	1.00
DEc8	0.957	0.263	0.98
DEc9	0.196	0.980	1.00

Source: Prepared by the authors.

(c) Ranking of variables

A final validation stage was implemented as a supplement to the multivariate analysis for the reduction of variables and as a form of methodological triangulation enabling qualitative and quantitative technical and theoretical criteria to be integrated. This stage dealt with the weighting of criteria and the ranking of variables on the basis of Saaty's (1980) analytical hierarchy method.

This type of procedure is particularly suitable when decisions have to be made about the selection of particular elements. In this case, the objective of the application was to select a final list of variables, setting out from the definition of particular criteria. The method proposed by Saaty involves establishing a matrix of comparison between pairs of criteria and comparing the importance of each with the rest. The next step is to establish the main vector. This determines the weights, which in turn provide a quantitative measure of the consistency of value judgements between pairs of factors (Saaty, 1980).

Operationally, and in accordance with what the methodology suggests, the procedure included the following stages:

(i) Delineation of the problem:

How can a set of variables be selected to construct a TDI?

(ii) Identification of the objective:

Rank a list of variables for the construction of a TDI by identifying criteria and subcriteria of different kinds.

(iii) Determination of criteria and subcriteria:

The analytic hierarchy methodology was used to establish the criteria and subcriteria described below:

(a) Conceptual criterion: concerns the theoretical and conceptual aspects of the indicator.

- Conceptual definition subcriterion: whether the variable fits the theoretical definition of the dimension.
- Thematic coverage subcriterion: whether the variable is able to encompass some or all of the theoretical definition of the dimension.

(b) Statistical criterion: concerns the methodological and statistical aspects of the indicator.

- Factor analysis subcriterion: whether the variable brings variability to the dimension.
- Comparability subcriterion: whether the variable is present in the different communes and thus comparable.
- Quality subcriterion: whether the variable has the requisite statistical quality at the commune level.

(c) Management criterion: concerns the impact of public policy on changes in the indicator.

- Planning subcriterion: whether the variable may be affected by the operation of territorial plans or programmes.
- Influence-dependency subcriterion: whether the variable exerts a relationship of influence or dependency on other variables (or vice versa) in the polynomial.

(iv) Assessment methodology:

The assessment was carried out on the basis of paired comparisons of criteria and subcriteria. The intention is for the assessor to make a determination of one criterion's importance relative to another.[6]

[6] The panel of experts comprises three researchers from the Institute of Local and Regional Development of the University of the Frontier and five analysts from the National Institute of Statistics in the Araucanía region.

Each comparison of paired criteria was scored. In this case there are more than two scorers (eight in total), so that the final value of each paired combination will be equivalent to the average of the scores awarded by each of the scorers, both at the first hierarchical level (criteria) and at the sublevels (subcriteria).

The next step is to estimate the relative rates of the "v" criteria on the basis of the scores given in matrix "A". These relative weights are the particular vectors of matrix A. The method is based on the Perron-Frobenius theorem, which yields local priorities by solving the following optimization problem:

$$max\ Av = \lambda v \ \ s.a\ \sum_j jv_j = 1 \tag{1}$$

(v) The rating scale:

The criteria are evaluated using the scale proposed by Saaty (1980), which has nine rating levels. On this scale, 1 means that A is of the same importance as B, and 9 that A is of extreme importance relative to B. Table 22 presents details of the scale values and their definitions.

Table 22
Rating scale for the ranking method used

Value	Definition	Comments
1	Equal importance	Criterion A is as important as B.
3	Moderate importance	Experience and judgment slightly favour criterion A over B.
5	Strong importance	Experience and judgment strongly favour criterion A over B.
7	Very strong importance	Criterion A is much more important than B and its dominance is demonstrated in practice.
9	Extreme importance	Criterion A is irrefutably more important than B.
2, 4, 6, 8	Intermediate values expressing shades between the above.	
	The inverses of these values are used to express reciprocity.	

Source: Prepared by the authors.

(vi) Results of the rating:

Once the calculations had been carried out and the weights assigned to each of the criteria and subcriteria, the list of variables was ranked. Variables receiving low scores on the criteria assigned were discarded, reducing the model from one with 49 variables to a more restricted one with a total of 19 variables.

3. Third model adjustment

Subjecting the model to the different tests and methodologies and reducing as many dimensions as possible led to the identification of six types of capital for measuring the development of a territory. These capital types or dimensions are taken to include the variables that are most important or best explain the dimension. Table 23 describes the third model adjustment with the dimensions and variables needed for the final calculation of the proposed index.

Table 23
Operationalization of variables matrix

Dimension	Variable	Conceptual definition	Operational definition
Cultural capital	1. Tangible cultural heritage	Places, sites, buildings, engineering works, industrial centres, architectural ensembles, heritage areas and monuments of major architectural, archaeological, historical, artistic or scientific interest or value that are recognized and registered as such.	Number of heritage assets recognized by decree, by commune.
	2. Intangible cultural heritage	Living traditions or forms of expression inherited from forebears and passed down to descendants, such as: oral traditions, performing arts, social customs, rituals, festivities, knowledge and practices relating to nature and the universe, and techniques and lore related to traditional crafts.	Number of intangible heritage assets registered in the Information System for Heritage Management (SIGPA), by commune.
	3. Indigenous communities and associations	By an indigenous community is meant any group of people belonging to the same ethnicity who are in one or more of the following situations: (i) they are from the same family stock; (ii) they recognize a traditional headship; (iii) they own or have owned indigenous lands in common; (iv) they are from the same long-standing settlement. By an indigenous association is meant a voluntary functional grouping of at least 25 indigenous persons who join together in pursuit of some common interest and goal.	Number of indigenous communities and associations, by commune.
	4. Place brands and designations of origin	Geographical indications and designations of origin protect products from the country or from a region or local area, provided they have a quality, reputation or other characteristic attributable to their geographical origin.	Number of geographical indications and designations of origin, by commune.
Social capital	5. Organizations with social aims	Non-profit public interest organizations whose aim is to further the general interest, whether in respect of citizen rights, social assistance, education, health, the environment or any other matter of common interest (parents' associations, older adult centres or organizations, sports clubs, neighbourhood committees and other functional groupings).	Number of organizations with social aims and current legal personality, by commune.
	6. Electoral participation	Registered voters (in percentages) participating voluntarily in municipal elections.	Percentage voting out of total enrolled, by commune.
Human capital	7. Years of education	Average number of years spent in the education system. Applies to persons aged 15 and over.	Average years' education, by commune.
	8. University selection tests (PSU)	Average score in the Language and Mathematics university selection tests (PSU).	Average score in PSU, by commune.
	9. Professionalization of municipal personnel	Human capital with a degree or professional qualification employed by the municipality.	Percentage of professional workers employed in the municipality, by commune.
Institutional capital	10. Dependence on the Municipal Common Fund (FCM)	Dependence on the FCM (as the main source of funding) relative to revenues generated by the municipality itself. The FCM is a needs-based mechanism for redistributing financial resources between the country's municipalities with a view to ensuring that they function properly and can attain their purposes. The FCM was designed to benefit poorer districts, particularly those with few options for raising permanent revenues of other kinds for themselves, so that it provides the main source of municipal revenues.	Percentage of total municipal revenues provided by the FCM, by municipality.
	11. Municipal expenditure	Municipal budget item that includes operating, transfer and investment spending, the application of third-party revenues and other expenditure, divided by the population of the commune.	Municipal expenditure per capita in Chilean pesos, by municipality.
	12. Municipal ordinances	Ordinances are binding general regulations applicable to the community. They might include provision for fines not exceeding five monthly tax units (UTM), levied by the relevant local police courts.	Number of municipal ordinances, by commune.
Tangible capital	13. Road network	Concrete roads are made of concrete slabs separated by joints and laid on a properly compacted granular bed. Asphalt roads are made of jointless asphalt concrete wearing courses at least 10 cm thick.	Kilometres of concrete roads and asphalt as a percentage of all roadways, by commune.
	14. Internet penetration	Share of the population with a fixed-line home Internet connection.	Percentage Internet coverage, by commune.
	15. Square metres constructed	Square metres constructed and officially certified during the year. Constructions predating the General Buildings and Urbanization act of May 1931 are exempt from regularization.	Officially certified buildings as an estimated percentage of all buildings in the commune.
	16. Rural drinking water coverage	Share of the rural population with a drinking water supply in the home or on the property or access to a public standpipe or hydrant.	Percentage of rural drinking water coverage, by commune.
Economic capital	17. Workers' remuneration	Average employee remuneration as reported by the Internal Revenue Service (SII), estimated from pay levels and the number of workers.	Reported average monthly wage of employees in Chilean pesos, by commune.
	18. Investment by the National Fund for Regional Development (FNDR)	Implementation of regional investment programmes.	Annual per capita expenditure in Chilean pesos, by commune.
	19. Bank loans	A bank loan is credit in cash that a bank provides to a client, who commits to repaying it gradually in the future in instalments or in a single payment with additional interest to compensate the creditor for the time the money was unavailable.	Number of loans per capita, by commune.

Source: Prepared by the authors.

(a) Weighting of the territorial development index

The criterion of equal weighting of dimensions was used to assign relative weights to the dimensions and the respective variables within them. The benchmark taken was the criteria used by UNDP/MIDEPLAN (2005) in the allocation of weights for the communal human development index (HDI) and in the new methodology for measuring multidimensional poverty in Chile proposed by the Social Observatory of the Ministry of Social Development. Equal weighting means that the dimensions have the same specific weight within the index and that the same weight is applied to variables within each dimension.

According to Alkire and Foster (2011), the selection of weights can be considered a value judgment, open to public scrutiny. There is no definitive formula for allocating weights. Broadly speaking, however, there are at least two equally valid alternatives: (i) giving each variable the same weight, which might mean the dimensions having different weightings if the number of variables per dimension is different, or (ii) giving each dimension the same weight, which might mean the variables having different weightings if the number of variables per dimension is different. The second option is applied for the proposed index.

According to the premise on which equivalent or equal weighting is based, there are no generally accepted arguments justifying or supporting an allocation of different weights to the different dimensions, or variables, as applicable (Ministry of Social Development, 2013). Where the weighting of attitude scales is concerned, Canales (2006) states that, in the absence of any compelling theoretical or empirical reason to assign a greater weight to one question or another, it is best for them all to have the same weight. Thus, for example, institutional capital can be assumed to play as important a role in this case as tangible or social capital in bringing about territorial development processes.

The TDI proposed in this paper comprises a total of six dimensions (types of capital), so that each dimension will have a weighting of 16.6%. As already indicated, the weighting of each variable will depend on the number of variables per dimension. Table 24 describes the weighting of the index in detail.

Table 24
Structure of weights

Capital	Weight of dimension *(percentages)*	Variable	Weight of variable (*percentages*)
1. Cultural	16.67	1. Tangible cultural heritage	4.17
		2. Intangible cultural heritage	
		3. Indigenous communities and associations	
		4. Place brands and designations of origin	
2. Social	16.67	5. Organizations with social aims	8.33
		6. Electoral participation	
3. Human	16.67	7. Years of education	5.56
		8. University selection tests (PSU)	
		9. Professionalization of municipal personnel	
4. Institutional	16.67	10. Dependence on FCM	5.56
		11. Municipal expenditure	
		12. Municipal ordinances	
5. Tangible	16.67	13. Road network	4.17
		14. Internet penetration	
		15. Square metres constructed	
		16. Rural drinking water coverage	
6. Economic	16.67	17. Worker remuneration	5.56
		18. Investment by FNDR	
		19. Bank loans	

Source: Prepared by the authors.

(b) Description of the territorial development index

The territorial development index (TDI) is an indicator that draws together a set of variables which are dissimilar in both scale and units of measurement, grouped into six types of territorial capital. The purpose of these variables is to capture the main phenomena associated with development capacity, taking in not only the economic component but all the aspects that interact in the territory, including cultural, social and human capital.

As already discussed, the development factors incorporated into the measurement are: cultural capital, social capital, human capital, institutional capital, tangible capital and economic capital. Between them, they include a total of 19 variables. As explained in the previous section, each of the factors or capital types concerned is equally weighted, and its load is distributed equally between the variables underpinning each of the dimensions.

In other words, the specific weight of each dimension will be determined by the constant $w = \frac{100}{n}$, in which n is equivalent to the number of dimensions. Meanwhile, the weighting in each dimension will be specified as follows: $\alpha_i = \frac{100}{n*m_i}$, where m_i is the number of variables within the i-th dimension (i=1,2,…,n).

Given the diversity of scales of the variables concerned, and in view of the multiple data standardization alternatives, it was decided to apply the maxima and minima method, which was used by UNDP to standardize the HDI. As explained by the UNDP office in Chile, by establishing fixed floors and targets, the logic of normative minimum and maximum values allows each country, region and commune to be compared with itself. This methodology means, for example, that the absolute value of the HDI of an analysed unit does not depend on the performance of the rest and that it is a useful tool irrespective of any relative comparison (UNDP/MIDEPLAN, 2005). Thus, taking the above into consideration, it was decided to adapt them to a single common range of 0 to 1.

This is achieved by calculating the ratio between the effective distance and the range of variability for each variable. In other words, the following transformation is adopted for the j-th variable:

$$Z_j = \frac{X_j - X_j^{min}}{X_j^{max} - X_j^{min}} \quad (2)$$

Where $X_j^{min} = \min\,(X_j^k, k = 1, \dots, 342)$ and $X_j^{max} = \max\,(X_j^k, k = 1, \dots, 342)$. Lastly, the calculation of the index in each factor takes the following structure:

$$I_i = \alpha_i \sum_{j=1}^{m_i} Z_j \quad (3)$$

Thus, the general index can be calculated by taking the weighted sum of the indices by factors (equivalently, it is possible to take the sum weighted through the variables). The TDI will be determined by the following functional relationship:

$$I = w \sum_{i=1}^{n} I_i \quad (4)$$

Thus, the variability range of the indicator is between 0 and 1. Values closer to 1 denote greater development of the territory while, conversely, values closer to 0 indicate a lower level of development. The factor components highlight the opportunities and potential that can be exploited in them.

(c) Calculating the territorial development index

The results of the calculation of the indicator in the communes named, i.e., Angol and Carahue, will now be presented (see table 21).

According to the results of the TDI, the commune of Angol is more highly developed than the commune of Carahue. In numerical terms, Angol has a TDI of 0.280, while Carahue has a value of 0.232, giving a development gap of 0.048 points.

This difference can be explained by analysing the results for the territorial capitals. As figure 1 shows, Angol is more highly developed on all the factors measured except economic capital. The greatest differences are in human capital (0.096 points), cultural capital (0.089 points) and tangible capital (0.066 points).

Figure 1
Territorial development index by dimension, communes of Angol and Carahue

Source: Prepared by the authors on the basis of official statistics.

Angol presents better characteristics than Carahue in the human capital dimension, as it is better positioned on the years of education and PSU variables. However, the commune of Carahue presents a higher percentage of professional municipal personnel.

Regarding cultural capital, the comparative result is defined mainly by the larger number of place brands and of assets registered as intangible cultural heritage in Angol. In the commune of Carahue, these differences are partly offset by the predominance of indigenous communities and of tangible cultural heritage.

Angol again presents a better situation than Carahue where tangible capital is concerned, given that it has greater Internet penetration and a larger surface area of built infrastructure. However, the commune of Carahue has a higher percentage of concrete and asphalt roads in its total communal road network.

The commune of Angol is better placed than Carahue for institutional capital. This is because it is less dependent on the Municipal Common Fund (FCM), per capita municipal spending is higher and there are more municipal ordinances.

No significant differences are observed between Carahue and Angol where the social capital dimension is concerned because while Carahue has fewer social organizations, participation in municipal elections is greater there (see table 25).

Table 25
Calculation of the territorial development index

Capital	Variable	Angol	Carahue	Min.	Max.	ZAngol	ZCarahue	Angol	Carahue
Cultural	1. Tangible cultural heritage	6.0	32.0	0.0	190.0	0.03	0.17	0.18	0.09
	2. Intangible cultural heritage	8.0	5.0	0.0	61.0	0.13	0.08		
	3. Indigenous communities and associations	0.7	1.4	0.0	11.8	0.06	0.11		
	4. Place brands and designations of origin	1.0	0.0	0.0	2.0	0.50	0.00		
Social	5. Organizations with social aims	692.0	148.0	0.0	4 305.0	0.16	0.03	0.30	0.30
	6. Electoral participation	50.6	56.7	26.8	80.0	0.45	0.56		
Human	7. Years of education	10.0	8.0	7.0	16.0	0.33	0.11	0.36	0.27
	8. PSU	469.8	435.6	362.4	613.5	0.43	0.29		
	9. Professionalization of municipal personnel	0.2	0.3	0.0	0.7	0.32	0.39		
Institutional	10. Dependence on FCM	0.7	0.9	1.0	0.0	0.26	0.11	0.10	0.05
	11. Municipal expenditure	191.0	180.4	65.8	10 531.1	0.01	0.01		
	12. Municipal ordinances	16.0	13.0	2.0	609.0	0.02	0.02		
Tangible	13. Road network	11.2	14.4	0.0	100.0	0.11	0.14	0.35	0.28
	14. Internet penetration	22.9	7.1	0.0	100.6	0.23	0.07		
	15. Square metres constructed	2.1	0.9	0.0	24.1	0.09	0.04		
	16. Rural drinking water coverage	1.0	0.9	0.0	1.0	0.97	0.88		
Economic	17. Worker remuneration	185 833	333 223	46 164	1 703.167	0.39	0.55	0.39	0.41
	18. Investment by FNDR	32.1	85.9	0.0	4950.3	0.01	0.02		
	19. Bank loans	1.8	0.2	0.0	151.2	0.77	0.66		
Total								0.2802	0.2319

Source: Prepared by the authors on the basis of official statistics.

Where economic capital is concerned, lastly, Carahue has better figures than Angol, with higher average worker remuneration and a greater volume of investment devolved by the National Fund for Regional Development (FNDR) because of the major investment projects undertaken in recent times. When it comes to bank lending in the communes, however, Angol presents better figures than Carahue, perhaps because it has a larger bankable population.

IV. Conclusions

This article is the result of extensive work and long sessions of debate by a multidisciplinary team. For three years, the researchers set themselves to design a development index that would reflect how the application of particular types of capital can give rise to territorial development processes at the local level. To this challenge must be added the difficulties associated with the scarcity of information at the subregional level. This meant an intensive effort of review, systematization and selection of secondary data sources that could provide the model with thematic coverage while meeting criteria of representativeness, comparability and periodicity, among others. This was done for the purpose of providing local operators with a system for measuring development that would be workable enough to be reproduced over time.

In addition to all the above, there are other elements that reinforce the work done. The close relationship established between the theoretical, analytical and practical levels should be emphasized here. This is a proposal that sets out by creating a theoretical model (of types of territorial capital). This model brings together elements from the different development theories that define the dimensions of the index. The next step is a series of multivariate statistical analyses whose purpose is to make certain adjustments to the model by reducing the dimensionality of the data (and validating the proposal technically) and thence arrive at a simplified calculation of a TDI for the communes of Angol and Carahue on the basis of administrative records.

Also worth stressing is the importance given in this study to logging the research. In other words, rather than simply showing the results of the final calculation of the indicator, an effort has been made to document the different stages and methodological decisions taken to make adjustments in the indicator leading to a (more or less) definitive version. This is important insofar as this practice allows other researchers to acquaint themselves with more internal details of the process, including the procedures involved, the decisions made and the successes and failures. Ultimately, this type of methodological approach serves to foster open debate about how the requisite knowledge is progressively acquired in a particular scientific field.

The ultimate purpose in constructing an indicator of this nature is that it provides an opportunity to generate detailed information for decision-making. The first aim is to diagnose the underlying or structural factors that make development possible. The second is to supply information about variables that can be influenced by public or private policy decisions in order to improve development conditions (from a multidimensional perspective) in this territorial space.

Another substantive contribution are the theoretical approaches associated with the identification of structural factors that define the ability of a territorial space to cope with the complexity of development. The conclusion is that the approach based on types of territorial capital provides a sound basis for building on the analyses undertaken by Alburquerque, Vásquez Barquero, Boisier, Requejo and institutions such as UNDP. This represents a contribution, for example, to the deliberations involved in territorial management policymaking for underdeveloped areas in Chile.

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Annex A1

Table A1.1
Initial identification of variables by dimension

Variables identified	
Cultural dimension	1. Number of lof (clans)
	2. Number of indigenous communities
	3. Number of indigenous associations
	4. Kilometres of indigenous development areas
	5. Number of machis (religious healers)
	6. Number of loncos (heads of clans)
	7. Number of heritage assets
	8. Number of designations of origin
	9. Number of place brands
	10. Number of cultural events
Social dimension	11. Number of NGOs
	12. Number of neighbourhood committees
	13. Number of community unions
	14. Number of local committees
	15. Number of older adult clubs
	16. Number of youth groups
	17. Number of sporting associations
	18. Number of cultural associations
	19. Number of health-care organizations
	20. Number of women's groups
	21. Number of churches
	22. Number of charitable organizations
	23. Number of cooperatives
	24. Number of employers' associations
	25. Number of craft associations
	26. Number of student centres
	27. Number of political parties or groupings
Human capital dimension	28. Number of technical and professional workers
	29. Number of postgraduates
	30. Number of students taking university selection tests (PSU) and accepted by universities
	31. Number of professionals from the commune working in other communes
	32. Percentage of population that is of active age
	33. Number of workers by branch of activity
	34. Number of small and medium-sized enterprises
Institutional dimension	35. Number of business licences
	36. Number of municipal ordinances
	37. Existence of a current Communal Development Plan (PLADECO)
	38. Existence of a current Zoning Plan
	39. Existence of a current Institutional Strategic Plan
	40. Existence of a current Annual Municipal Health Plan (PASAM)
	41. Existence of a current Annual Municipal Education Plan (PADEM)
	42. Existence of a communal geographic information system (GIS)
	43. Kilometres of zones of tourist interest
	44. Number of financial services
	45. Number of training services
	46. Number of health-care platforms
	47. Number of transport platforms
	48. Number of telecommunications platforms
	49. Number of professionals per inhabitant
	50. Number of FNDR projects implemented with a favourable technical recommendation

Table A1.1 (concluded)

Variables identified	
Institutional dimension	51. Number of Regional Fund for Local Initiative (FRIL) projects implemented
	52. Number of Urban Improvement Programme (PMU) projects implemented
	53. Autonomous municipal revenue in Chilean pesos
	54. Percentage of budget spent on health
	55. Percentage of budget that depends on the Municipal Common Fund (FCM)
Infrastructure dimension	56. Number of universal access points
	57. Number of telecentres
	58. Number of information centres
	59. Number of libraries associated with BiblioRedes
	60. Percentage coverage of asphalted road networks
	61. Percentage coverage of surfaced road networks
	62. Number of first aid posts
	63. Number of doctor's surgeries
	64. Number of hospitals
	65. Number of complex care beds
	66. Number of dental chairs
	67. Number of X-ray machines
	68. Number of tomography machines
	69. Number of schools
	70. Number of boarding schools
	71. Number of libraries
	72. Percentage housing deficit
	73. Percentage housing materials deficit
	74. Percentage drinking water coverage
	75. Percentage electricity grid coverage
	76. Percentage sewer system coverage
	77. Number of machines for primary production
	78. Kilometres of State-protected wilderness
	79. Kilometres of maritime areas
	80. Kilometres of lake areas
	81. Kilometres of river areas
	82. Presence of volcanos
	83. Presence of metal mining resources
	84. Presence of non-metal resources
Economic dimension	85. Projected communal investments in Chilean pesos
	86. Square metres constructed
	87. Number of building permits
	88. Exports from the commune in Chilean pesos

Source: Prepared by the authors.

Table A1.2
Matrix of regional data for multivariate analysis

Variable	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	RM	XIV	XV
1. Cultural events	46 376.0	41 641.0	11 800.0	45 069.0	396 987.0	74 410.0	41 794.0	135 672.0	63 229.0	101 367.0	10 900.0	4 500.0	2 231 020.0	20 544.0	100.0
2. Tangible cultural heritage	73.0	100.0	41.0	56.0	176.0	71.0	99.0	80.0	98.0	74.0	21.0	61.0	426.0	41.0	36.0
3. Intangible cultural heritage	67.0	27.0	73.0	59.0	217.0	259.0	142.0	237.0	176.0	212.0	54.0	58.0	230.0	109.0	47.0
4. Indigenous communities and associations	364.0	151.0	124.0	14.0	85.0	7.0	24.0	501.0	2 867.0	767.0	39.0	35.0	201.0	610.0	240.0
5. Place brands and designations of origin	1.0	-	1.0	-	4.0	1.0	-	1.0	1.0	2.0	1.0	-	2.0		1.0
7. Years of education	11.2	11.5	10.5	10.5	11.1	10.1	9.3	10.2	9.8	9.6	9.9	11.1	11.4	9.8	11.0
8. University selection tests (PSU)	485.1	493.2	488.4	490.5	492.4	495.3	493.9	493.8	485.3	499.7	493.7	489.3	514.1	482.2	471.1
9. Economically active population	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.6
10. Employability	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.5
17. Concrete roads	4.0	1.0	2.0	89.0	369.0	207.0	209.0	382.0	311.0	450.0	93.0	171.0	399.0		
18. Asphalted roads	1 253.0	1 560.0	999.0	885.0	812.0	655.0	813.0	1 441.0	833.0	1 223.0	66.0	29.0	788.0		
19. Gravel roads	120.0	1 292.0	1 824.0	538.0	490.0	1 662.0	3 417.0	4 431.0	7 833.0	7 879.0	1 840.0	2 274.0	541.0		
20. Telephone coverage	59 558.0	128 530.0	45 134.0	93 788.0	344 874.0	89 575.0	95 449.0	279 668.0	107 528.0	115 585.0	13 061.0	39 362.0	1 910 206.0	58 429.0	36 169.0
21. Internet coverage	47 196.0	113 127.0	35 807.0	80 641.0	278 140.0	67 541.0	75 531.0	252 142.0	78 863.0	93 381.0	11 572.0	25 507.0	1 253 735.0	45 435.0	32 563.0
22. Square metres constructed	188.0	545.0	1 387.0	5 538.0	13 404.0	7 355.0	12 774.0	11 011.0	6 585.0	2 940.0	1 188.0	1 283.0	11 215.0	1 075.0	34.0
23. Drinking water coverage	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	0.9
24. Sewer system coverage	1.0	0.9	0.8	0.9	0.7	0.7	0.8	0.7	0.7	0.9	1.0	1.0	0.7	0.9	
25. Electricity grid coverage	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
26. Educational establishments	228.0	241.0	182.0	784.0	1 256.0	696.0	879.0	1 564.0	1 224.0	1 074.0	85.0	90.0	3 061.0	530.0	152.0
27. Health-care establishments	40.0	47.0	42.0	154.0	197.0	143.0	260.0	371.0	289.0	284.0	39.0	28.0	421.0	108.0	23.0

Variable	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	RM	XIV	XV
28. Protected wilderness areas	277 008.0	675 039.3	105 648.3	14 316.0	59 702.8	40 591.0	23 070.0	125 468.0	374 321.0	767 608.0	7 812 407.0	68 746.8	19 064.0	126 572.0	358 312.0
29. Native forest	2 000.0	1.6	519.6	238.6	176 009.0	80 605.1	85 802.1	270 650.3	297 872.7	355 228.6	1 137 503.6	517 892.6	211 139.3	365 293.1	-
30. Microenterprises	12 273.0	19 099.0	10 503.0	26 725.0	66 575.0	36 475.0	47 397.0	71 791.0	33 798.0	34 822.0	5 580.0	7 638.0	248 828.0	15 029.0	10 862.0
31. Workers in microenterprises	8 804.0	12 579.0	13 350.0	18 840.0	59 069.0	37 371.0	33 625.0	48 609.0	23 791.0	31 985.0	4 038.0	7 188.0	226 291.0	12 945.0	6 523.0
32. Small enterprises	3 201.0	6 012.0	2 754.0	5 760.0	16 429.0	8 587.0	9 851.0	15 841.0	7 088.0	8 439.0	1 005.0	2 009.0	88 009.0	3 083.0	1 752.0
33. Workers in small enterprises	27 404.0	42 369.0	22 930.0	65 522.0	161 927.0	114 453.0	123 728.0	166 293.0	78 554.0	81 938.0	9 671.0	18 988.0	751 508.0	30 903.0	23 003.0
34. Medium-sized enterprises	738.0	814.0	326.0	657.0	2 025.0	872.0	1 054.0	1 954.0	792.0	1 017.0	113.0	229.0	15 822.0	312.0	159.0
35. Workers in medium-sized enterprises	25 249.0	38 386.0	17 687.0	40 626.0	101 599.0	65 367.0	73 729.0	126 683.0	46 890.0	58 537.0	6 511.0	11 097.0	757 669.0	18 259.0	10 491.0
36. Large enterprises	364.0	301.0	121.0	248.0	782.0	363.0	325.0	672.0	240.0	373.0	23.0	112.0	9 263.0	88.0	45.0
37. Workers in large enterprises	29 901.0	75 041.0	30 068.0	57 322.0	197 277.0	119 003.0	85 091.0	166 320.0	84 988.0	105 763.0	6 245.0	26 747.0	3 470 327.0	17 164.0	9 139.0
38. Investments	2.0	6.0	6.0	-	-	1.0	1.0	-	2.0	4.0	3.0	3.0	6.0	1.0	-

Source: Prepared by the authors on the basis of official statistics.

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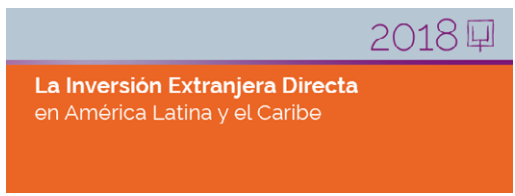

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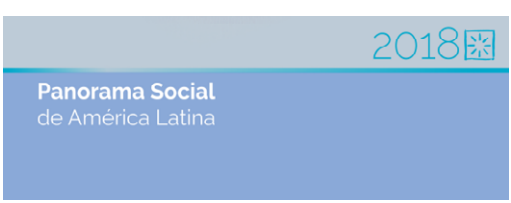

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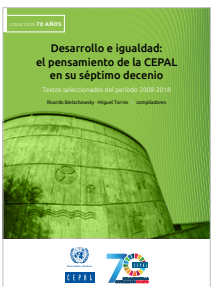

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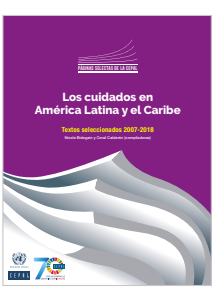

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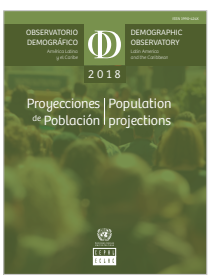

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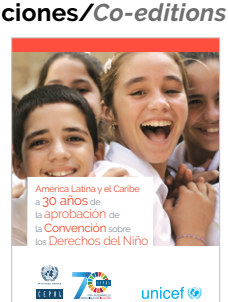

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