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70 ECLAC FOR SUSTAINABLE DEVELOPMENT WITH EQUALITY

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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.

More unequal or less? A review of global, regional and national income inequality

Verónica Amarante and Maira Colacce

Abstract

This article presents a multi-perspective discussion of trends in income inequality. Recent evidence from many sources shows that global income inequality is high and relatively stable, with the main changes being driven by developments in China and India. In developed countries, the trend has been towards higher levels of inequality over the last thirty years; and this has also been true of developing countries in the past decade, with the exception of Latin America, which is analysed here in detail. In the region, income became less unevenly distributed between 2002 and 2014, mainly because inequality within countries declined in most cases; but the latest measurements suggest that this trend is faltering.

Keywords

Economic growth, income, income distribution, equality, measurement, developed countries, developing countries, China, Latin America

JEL classification

D31, D61

Authors

Verónica Amarante is Chief of the Office of the Economic Commission for Latin America and the Caribbean (ECLAC) in Montevideo. Email: verónica.amarante@cepal.org.

Maira Colacce is a consultant with the ECLAC office in Montevideo. Email: maira.colacce@gmail.com.

I. Introduction

An apparently simple question, which has been posed several times in various fields, is whether economic inequality is greater in our days than it was a few decades ago. In other words: are modern societies becoming more economically equal, or are individual living standards increasingly tending to diverge? Answering a question of this magnitude is complex, and it needs to be approached from different angles to obtain a comprehensive and concrete response. This article seeks to provide inputs to this endeavour, by summarizing recent evidence from various international studies on the subject and delving deeper into specific aspects on which new evidence is presented. To that end, the article draws on a variety of sources, although individual inequality, of either income or consumption, is always analysed on the basis of household surveys. This means ignoring other approaches, such as the inequality of wealth, or other data sources that make it possible to identify the incomes of the wealthiest people with greater precision.

The article starts by reviewing the evidence on the status and trend of global inequality, which entails considering the income or consumption of all individuals in the world as if there were no political boundaries between countries. As differences between individuals arise from inequality both between countries and within them, the study is complemented by a discussion of national experiences. Here a distinction is made between the evolution of inequality in developed and developing countries, since the respective trends have diverged in recent years. Among developing countries, the situation of China is considered in greater detail, since it has a huge influence on global inequality as well as a national trend with interesting specifics. Lastly, the article makes an in-depth analysis of the situation in Latin America, both as a whole and in terms of its individual countries, where inequality mostly declined in the last decade, in contrast to the trend in the developed world. Nonetheless, the latest available data suggests that this process may have reached a plateau. The article's ultimate objective is to present an up-to-date and wide-ranging discussion on income inequality, seeking to provide a general overview of the global and regional situation. The analysis considers different time periods: in the case of global inequality and that of both developing and developed countries, it embraces the entire period covered by the revised bibliography, while the regional analysis focuses on the last decade, during which the previously rising trend of inequality has reversed.

II. Global inequality

As economies become more integrated, factors of production increasingly cross borders, and the perceptions and aspirations of the population of each country are increasingly influenced by living standards elsewhere. All of these factors make differences beyond national borders more salient and thus arouse concern for inequality among all inhabitants of the world. The literature on global inequality originally responded to the need to assess the extent to which globalization may have reduced differences between individuals around the world, if the poorest (and most heavily populated) countries had grown faster than the richest (and least populated), despite generating greater inequality within countries. These studies also set out to analyse whether the rules governing the interactions between rich and poor countries affect global inequality.

Although there are several reasons for studying global inequality, Anand and Segal (2008), draw attention to moral or ethical arguments, since disparities between individual incomes around the world can be considered unfair; and this lays the foundations for measuring differences in income between individuals globally rather than by nationality. Secondly, global inequality can explain certain phenomena, such as international migration or bargaining power in international institutions. Lastly,

global inequality trends are useful for analysing the predictive power of certain theories. For example, neoclassical growth theory predicts that incomes will converge in the long run between countries, and even between individuals, whereas dependency theory predicts divergence.

Before pursuing the analysis, it is important to distinguish between the different concepts of global inequality that are discussed in the literature, to understand their implications and uses. Milanovic (2005) and Anand and Segal (2008) define four concepts of inequality worldwide, based on the elements considered: the units of analysis (countries or persons), the unit of measurement (total, per capita or household income), and the weighting of the countries (uniform or by population or income).

In "concept zero", inequality between countries is addressed by ranking countries according to their total income, with each country given the same weight. This concept is the most appropriate for analysing issues of geopolitics and access to markets. In "concept one", inequality between countries is estimated considering the per capita income of each country, again weighted equally. This can be used to assess the empirical validity of the convergence or divergence postulated by the different growth models. Neither of these two concepts will be used in the analysis presented below. In "concept two", inequality among all individuals in the world is considered by assuming that their income is the per capita income of their country. This concept is known as inequality between countries and can be obtained in the same way as "concept one", but in this case weighting countries by population size. In "concept three", which is adopted in the analysis discussed below, inequality between individuals is measured by considering the per capita income of the household to which they belong. This measure is the global analogue of the distribution generally used to measure inequality within countries; in other words, it is equivalent to assuming that there are no borders. In the remainder of this section, references to global inequality refer to this latter indicator.

Several recent articles have analysed this concept of global inequality and its evolution; and three of them share methodological criteria that make comparison possible. Unfortunately, as they are based on data from household surveys, the oldest calculations only go back as far as the 1980s. These are the studies by Lakner and Milanovic (2016), Niño-Zarazúa, Roope and Tarp (2014), and Anand and Segal (2015), whose systematization provides an updated panorama of the state of the art in the subject.[1] These studies use data from each country's household surveys to estimate its income distribution profile and average income. Income distribution quantiles (generally ventiles) are considered for each country; average per capita income is attributed to each quantile, and a database is constructed of the quantiles of the different countries of the world.[2] To make the incomes comparable, they are converted into a common format, using purchasing power parity (PPP) indices.[3]

An initial result that is common to all three studies is that global inequality is very high —comparable to that of the most unequal countries in the world, if not higher. Table 1 shows that the global Gini index varies between 67 and 72.2, depending on the year and the estimate considered. There are no major movements in the indicator during the period considered: the three studies analysed find variations of around 2 points over a period of two decades. These authors note that the differences are small enough to suspect that they are not statistically significant; and what stands out is the stability of the measurement.[4] An update of Lakner and Milanovic (2016) incorporates data up to 2011 and concludes that the global Gini index has dropped sharply in recent years to reach a level of 64 (Milanovic, 2016).

[1] Anand and Segal (2008) review previous studies on the subject and also discuss Bourguignon (2015), which is not reviewed here since it makes different methodological choices that do not allow comparison with the other results. In particular, in Bourguignon (2015) the per capita-income data obtained from household surveys is rescaled to coincide on average with the per capita income reported in the national accounts.

[2] In the referenced studies, population coverage exceeds 90% of the world population in the most recent years, but there are major gaps in the earlier period, when household survey data was not generalized in all countries.

[3] In all three cases, the data are expressed in 2005 dollars using the World Bank conversion factor.

[4] Since surveys from different sources using different sampling methodologies are considered, the standard errors of the global measurement cannot be calculated.

Table 1
Global Gini coefficient
(Percentages)

	Lakner and Milanovic (2016)	Niño-Zarazúa, Roope and Tarp (2014)	Anand and Segal (2015)
1985-1988	69.4	70.2	72.2
1993-1995	69.1	70.4	71.9
1998	68.4	-	71.5
2002-2003	68.7	-	71.9
2005-2008	67	68.1	70.5

Source: Prepared by the authors, on the basis of C. Lakner and B. Milanovic, "Global income distribution: from the fall of the Berlin Wall to the Great Recession", *World Bank Economic Review*, vol. 30, No. 2, Washington, D.C., World Bank, 2016; M. Niño-Zarazúa, L. Roope and F. Tarp, "Global interpersonal inequality: trends and measurement", *WIDER Working Paper*, No. 2014/004, Helsinki, World Institute for Development Economics Research (UNU-WIDER), 2014; and S. Anand and P. Segal, "The global distribution of income", *Handbook of Income Distribution*, A. Atkinson and F. Bourguignon (eds.), vol. 2, Amsterdam, Elsevier, 2015.

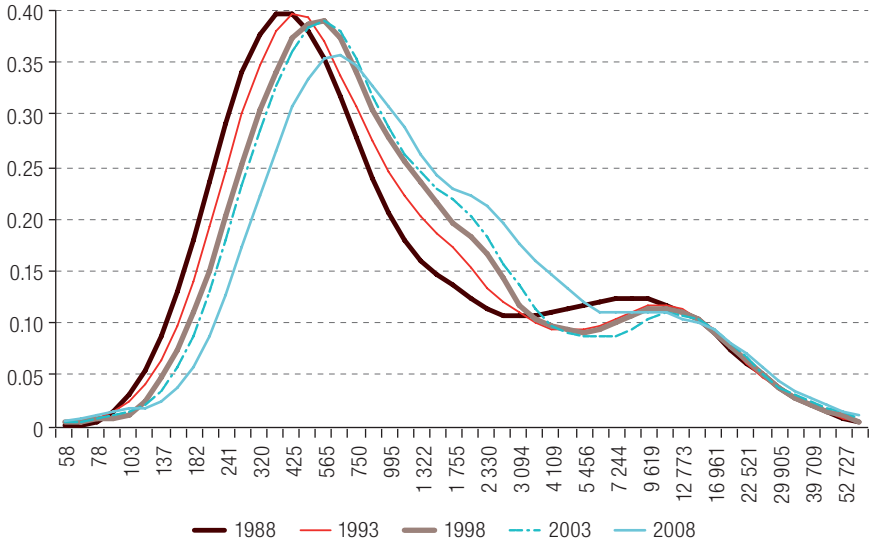
To gain a better understanding of the factors underlying this apparent stability, two components of inequality are distinguished: between countries and within them. A measure of income inequality between countries is calculated by assuming that each person's income is equal to their country's per capita income. The difference between global inequality and this measure of inequality between countries is the component attributed to inequality within countries.[5] The three studies reviewed agree that inequality is greater between countries than within them. Lakner and Milanovic (2016) note that, if in 2008 the average per capita incomes of the countries were equalized, while maintaining the income distribution within each one, then global inequality would fall by roughly 77%. In contrast, if incomes within the countries were equalized and the differences between them maintained, then global inequality would only fall by 24%.

While inequality within countries became more accentuated in the period analysed, that between countries declined. In other words, the increase in inequality within countries was more than offset by a sharp reduction in differences between them, leading in turn to slight falls in the global inequality indicator. The divergent trends of inequality between and within countries causes important changes in the composition of the global index: for example, Niño-Zarazúa, Roope and Tarp (2014) estimate that the within-countries component of inequality accounted for 20.4% of the global index in 1985, but the proportion had almost doubled to 38.8% by 2005. These movements mainly reflect developments occurring in China and, to a lesser extent, in India. Both of these countries experienced an increase in inequality and alongside strong growth in average income. Given these countries' large share of the world's total population, their movements make inequality grow within countries globally and reduce inequality between them. The simulation described by these authors shows that, if these countries had grown at the rate they actually did but their income distribution had not changed relative to 1975, global inequality would have fallen 3% further than it actually did. On the other hand, the authors note that, if the population of China and India had grown at the rate that it did but the income and distribution of 1975 had been maintained, inequality in 2005 would have increased significantly (by 12%).

[5] This measure of inequality between countries is a weighted average of inequality within each country. When using the Theil index (GE (1)) as a measure of inequality, this is weighted by each country's share in global income. When the selected inequality indicator is the mean deviation of the logarithmic income (GE (0)), each country is weighted according to its share in total population.

The importance of China and India is also clearly revealed in a graphical analysis of the evolution of the global income distribution (see figure 1). Two major movements stand out: the rightward shift of the distribution in the period considered (which implies income growth) and the change in the shape of the distribution, with the double mode gradually tending to disappear.

Figure 1
Global income distribution, selected years[a]
(Log income density and PPP[b] dollars at 2005 prices)



Source: Lakner, C. and B. Milanovic, "Global income distribution: from the fall of the Berlin Wall to the Great Recession", *World Bank Economic Review*, vol. 30, No. 2, Washington, D.C., World Bank, 2016.
[a] Population-weighted logarithmic scale.
[b] Purchasing power parity.

Lakner and Milanovic (2016) note that both movements can be explained almost entirely by the changes recorded in China and, to a lesser extent, in India. Both of these countries shift to the right in the distribution (see figure 2), leaving sub-Saharan Africa on the far left.

Figure 2
Global ncome distribution, selected years[a]
(Log income density and PPP[b] dollars at 2005 prices)

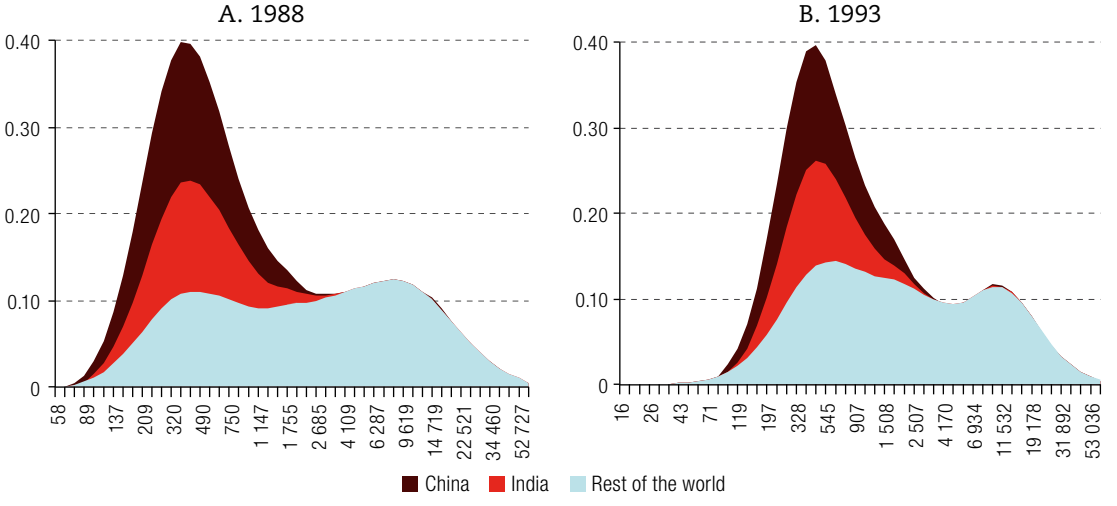
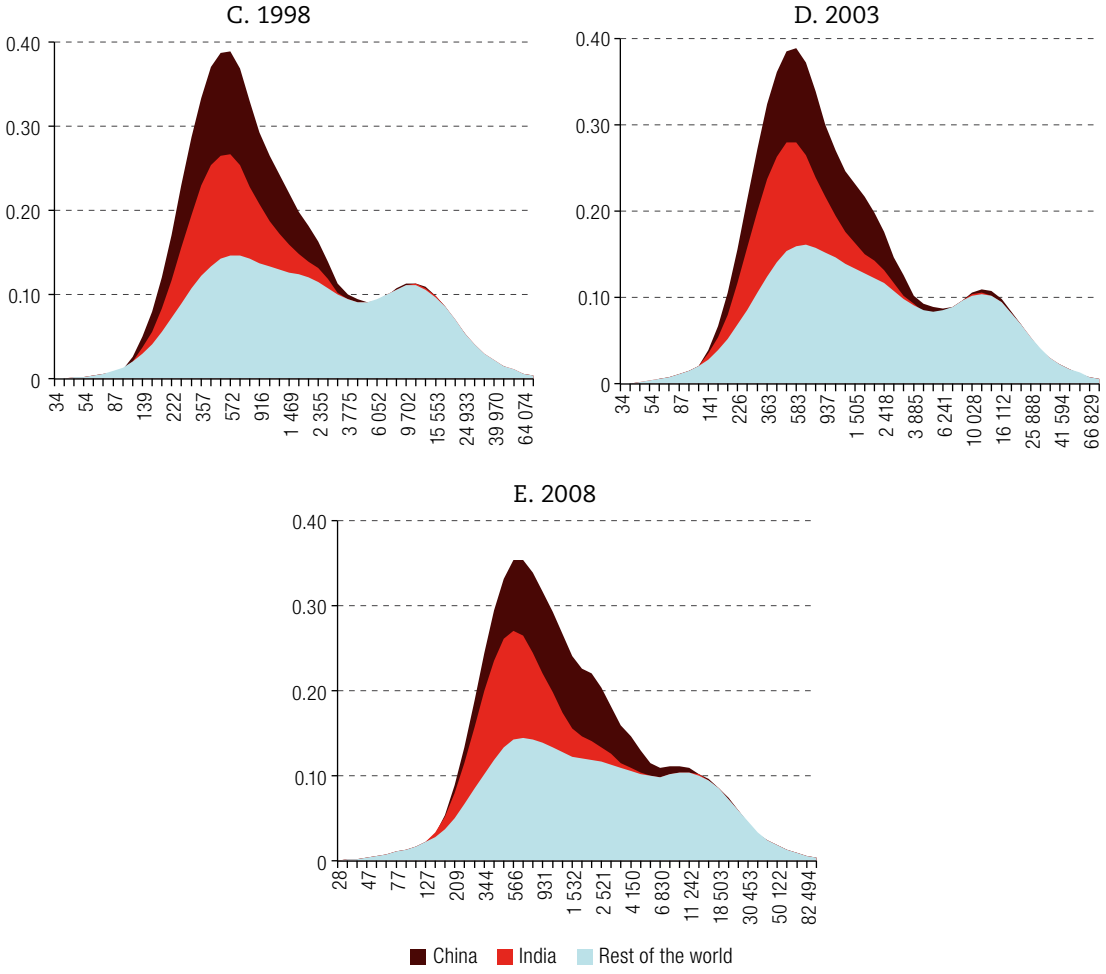


Figure 2 (concluded)



Source: Lakner, C. and B. Milanovic, "Global income distribution: from the fall of the Berlin Wall to the Great Recession", *World Bank Economic Review*, vol. 30, No. 2, Washington, D.C., World Bank, 2016.

[a] Logarithmic scale.

[b] Purchasing power parity.

In short, the studies reviewed show that, in all time periods analysed, global inequality is very high, at levels similar to or above those of the most unequal countries in the world. Between the 1980s and the decade of 2000, the main indicators remain stable or, at best, decrease slightly in the most recent years. Inequality between countries accounts for the majority of global inequality and has fallen moderately; while inequality within countries has increased greatly. These movements are mainly explained by trends in China and India, where economic growth in the period went hand-in-hand with a sharp increase in domestic inequality, while incomes approached middle-income country levels.

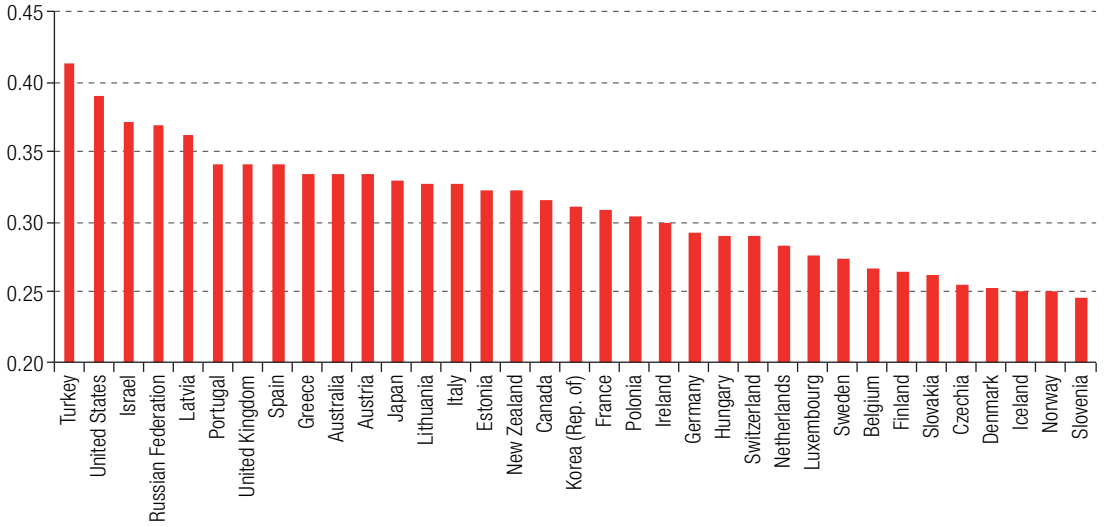
III. Inequality in developed and developing countries

Analysing inequality at the country level is a complex task, since context and evolution differ. The literature usually considers developed and developing countries separately, since the determinants of inequality and its evolution seem to differ between the two groups.

In recent studies that include data on inequality in developed countries, the indicators vary widely, ranging from a Gini index of 0.25 in Denmark, Iceland, Norway and Slovenia, to 0.41 in Turkey and 0.39 in the

United States, according to information from the Organization for Economic Cooperation and Development (OECD) (see figure 3). The Nordic countries (Sweden, Norway, Denmark and Finland) are among those with the lowest levels of inequality, along with the Benelux nations (Belgium, Holland and Luxembourg) and some Eastern European countries. Turkey, the United States, Israel and Russia are at the opposite extreme.

Figure 3
Developed countries: Gini index of equivalized household disposable income, around 2011



Source: Organization for Economic Cooperation and Development (OECD), OECD Income Distribution Database.

The trend between 1975 and 2010 shows inequality increasing in practically all developed countries for which information is available (see figure 4). In some cases (the United States, the United Kingdom and the Netherlands), inequality grew strongly in the 1980s; while in others (Canada, the Nordic countries and Germany) this happened in the 1990s. Even in France, which achieved a sharp drop in its Gini coefficient, the indicator rose in the decade of 2000 (Morel li, Smeeding and Thompson, 2015). Owing to these movements, inequality among high-income countries displays less dispersion than in the 1980s; but the country inequality ranking remains basically unchanged during the period.

Figure 4
High-income countries: trend of the Gini coefficient of household disposable income, 1975-2010

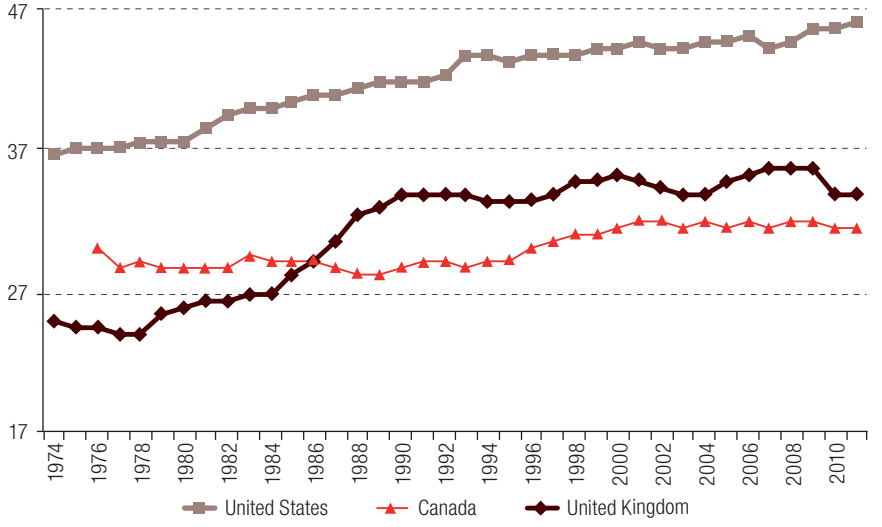
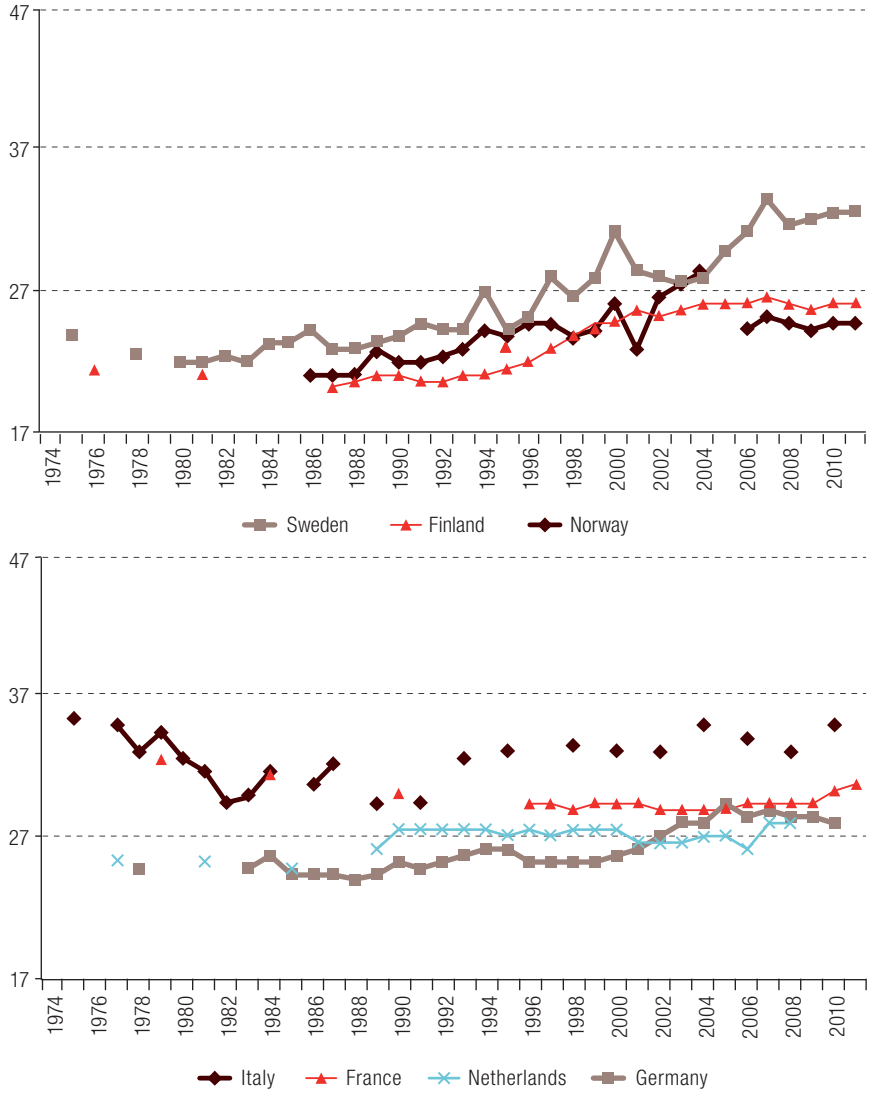


Figure 4 (concluded)



Source: Prepared by the authors, on the basis of A. B. Atkinson and S. Morelli, "Chartbook of economic inequality", *ECINEQ Working Paper Series*, No. 2014-324, Society for the Study of Economic Inequality (ECINEQ), 2014.

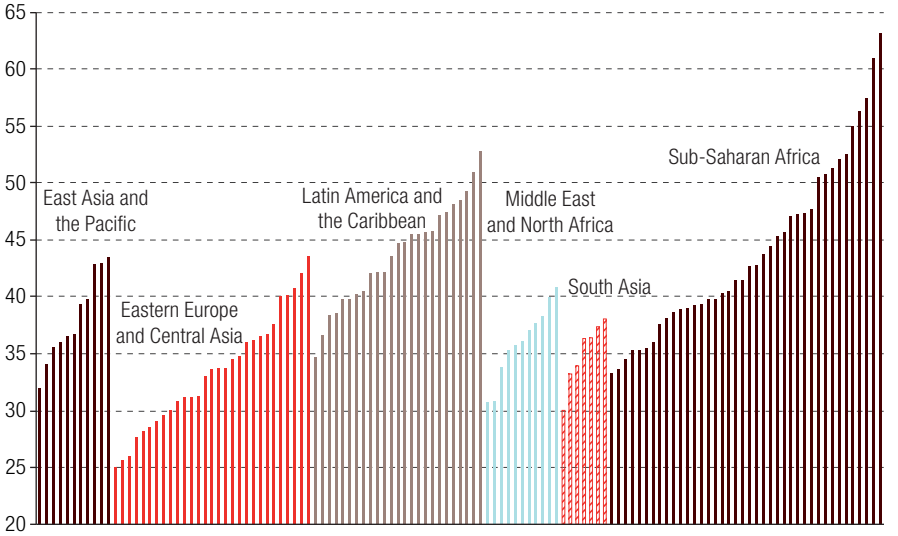
Although household surveys clearly provide up-to-date and comparable data that make it possible to construct indicators of inequality in the different countries of the world, these surveys also have major shortcomings in terms of capturing high incomes (Atkinson, Piketty and Sáez, 2011), in developed and developing countries alike. In the former, Morelli, Smeeding and Thompson (2015) show how, beyond the methodological problems involved in comparing data from tax records, the ranking of countries by inequality levels does not change much when the income appropriated by the top 1% is used as an inequality indicator.[6] These authors also draw attention to the rising trend of this indicator in developed countries, and to the fact that the 2008 financial crisis did not cause a structural break in this trend. In relation to the English-speaking countries, Piketty and Sáez (2013) find that the increase in inequality would be even more pronounced, if the incomes of the richest were properly measured.

[6] Ruiz and Woloszko (2016) obtain similar results by applying a statistical adjustment to household survey data in developed countries.

The reasons for this growth in inequality in developed countries remains a matter of debate, and several explanations have been put forward. Firstly, the process of technological innovation may have fuelled demand for skilled workers and thus increased the wage differential in their favour. Trade and financial liberalization, in addition to globalization, could have had a similar effect in pushing up skilled wages in developed economies and thus aggravating inequality. In practice, it is very hard to separate the two effects —globalization and trade liberalization— since technological progress, for example, allows for the fragmentation of productive activities and production abroad, which can be interpreted as an effect of trade specialization (OECD, 2011). More recently, and especially since the global financial crisis of 2008, emphasis has been placed on the growing importance of the financial sector in the economies. This is consistent with Piketty's widely publicized claim (2014) that the rate of return on capital has been higher than the long-run economic growth rate, and that this return has been concentrated in very few hands, thereby fuelling a large increase in economic inequality.

Inequality levels display greater dispersion in developing countries than in developed ones, with the range of Gini coefficients spanning nearly 40 points, from 25.6 in Ukraine to 63.1 in South Africa (Alvaredo and Gasparini, 2015). Figure 5 shows the Gini indices of 122 developing countries grouped according to their respective regions.[7] While sub-Saharan Africa is the region containing countries with the highest levels of inequality, it also displays the greatest dispersion. Its (unweighted) average inequality is the highest in the world, although the median of Latin American countries is higher. Moreover, nearly all countries in the world with very high levels of inequality (Gini coefficients of over 50) are located in sub-Saharan Africa; but that region also has a similar share of countries with medium or high levels of inequality. In contrast, nearly all Latin American countries have high levels of inequality. Eastern Europe and Central Asia are the only regions containing countries with low levels of inequality (below 30 points). In the other three regions of the world, most countries are in the medium-inequality range.

Figure 5
Developing countries: Gini coefficient of per capita household consumption, around 2010

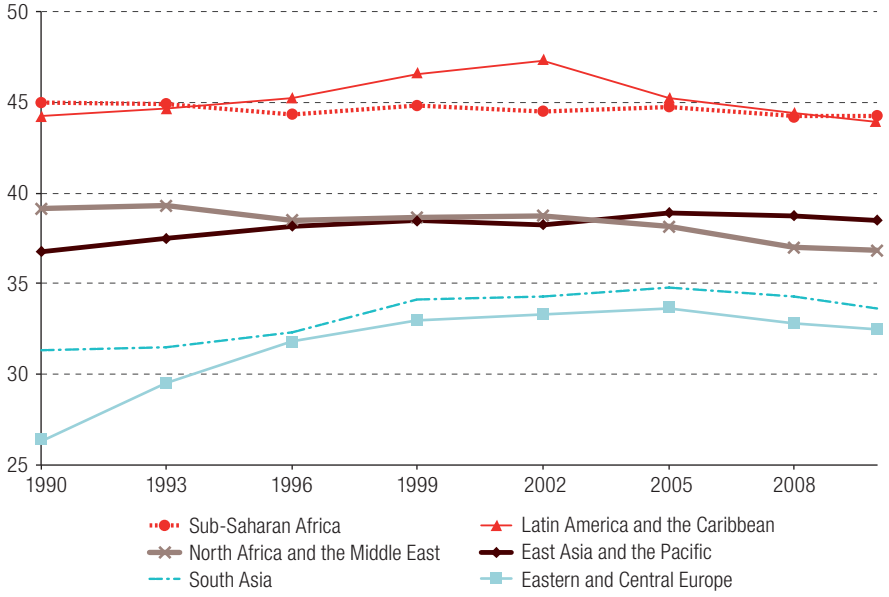


Source: F. Alvaredo and L. Gasparini, "Recent trends in inequality and poverty in developing countries", *Handbook of Income Distribution*, A. Atkinson and F. Bourguignon (eds.), vol. 2, Amsterdam, Elsevier, 2015.

[7] These figures are obtained from PovcalNet, which reports the distribution of per capita consumption, except for Latin America and some Caribbean countries where the distribution of per capita income is shown. For the data to be comparable, Alvaredo and Gasparini (2015) adjust the records of this region based on the Gini index of consumption or income taken from seven countries for which information is available. In these seven countries, the average Gini index of consumption or income is 0.861.

The differences between countries are much greater than the changes they experience through time. Alvaredo and Gasparini (2015) analyse a panel of developing countries in the period spanning 1981 to 2010 and find that 88.5% of the variance in the panel is due to differences between countries. These authors also note that the country ranking has remained virtually unchanged, even though the developing world has undergone major political, economic and social changes in the last four decades. This suggests that there are certain underlying factors that greatly affect the level of inequality in a country, and that these have not changed over time. Figure 6 shows movements in the average Gini coefficient by region between 1990 and 2010, calculated on the basis of per capita consumption cited in the aforementioned article.

Figure 6
Developing countries (six regions): Gini coefficient of per capita consumption, 1990-2010[a]



Source: F. Alvaredo and L. Gasparini, "Recent trends in inequality and poverty in developing countries", *Handbook of Income Distribution*, A. Atkinson and F. Bourguignon (eds.), vol. 2, Amsterdam, Elsevier, 2015.
[a] Unweighted average for each region.

Whereas the Gini index in Latin America rose in the 1990s but dropped back in the decade of 2000, the index for sub-Saharan Africa remained practically unchanged. In contrast, inequality increased vigorously in Asian and Eastern European countries. In Asia, the greatest increase in occurred in China, where income growth was so great that it impacted on the global distribution, as discussed in the previous section. This phenomenon is now analysed further, while the trend of inequality in Latin America is considered in greater depth in section V.

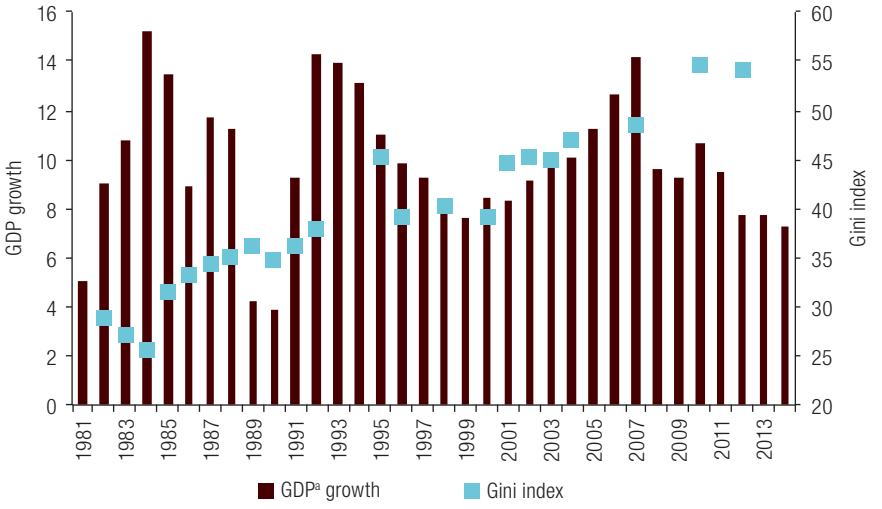
IV. Deeper analysis of selected realities: inequality in China

Household income growth in China has been so rapid that it has caused a rightward shift in the global income distribution and a change in its shape, as discussed in section I. The expansion of Chinese production and job growth fuelled a significant increase in workers' pay and household income. This meant, firstly, a very substantial reduction in poverty levels: according to World Bank estimates, the

proportion of people with per capita incomes of less than US$ 2 per day (in purchasing power parity terms at 2005 prices) fell from 84% in 1987 to just under 19% in 2011. Relative to a poverty line of US$ 1.25, the poverty rate fell from 54% to 6% in the same period.

On the other hand, there was a sustained increase in inequality, since the gains generated by this rapid economic growth were not equally shared among the different households, social groups or regions of the country. The last available figure for the Gini coefficient (2012) is 54, which implies a rise of 25 points since 1982 and nearly 15 points relative to the values of 2000 (see figure 7). In other words, along with the remarkable growth of the economy and the reduction of poverty, inequality has skyrocketed.

Figure 7
China: economic growth and inequality, 1981-2014
(Percentages and Gini coefficients)



Source: International Monetary Fund (IMF), World Economic Outlook Database and World Institute for Development Economics Research (UNU-WIDER), World Income Inequality Database.
[a] Gross domestic product.

Numerous studies have highlighted the vertiginous rise of income inequality since the 1978 economic reform (Meng, Shen and Sue, 2013; Xie and Zhou, 2014). This reform encouraged the rapid urbanization and industrialization of certain "special economic zones", where the engine of economic growth of the last 25 years was concentrated. Foreign capital flowed into these areas, spawning industrial enterprises and greatly expanding demand for labour. This was accompanied by housing subsidy programmes in urban areas, in response to a strong flow of immigration from rural zones. Based on this process, today there is a significant difference between wages received in the urban coastal zone and pay levels in rural areas (Tao Yang and Zhou, 1999; Sicular and others, 2007). Given that municipalities (counties) are responsible for collecting a large proportion of tax revenue and providing services such as education, health and even pensions, there are major differences in public service quality between areas with different income levels (Dollar, 2007).

In addition to regional inequality, education premia have increased considerably and are currently a powerful differentiator between the wages of urban workers in China (Xie and Zhou, 2014). Between 1988 and 1995, education premia almost doubled (Hauser and Xie, 2005) and the upward trend continued in later years (Jansen and Wu, 2012). Previously, wage levels were very similar between the different professions and technical capacities. The reform process, in conjunction with greater market participation and the retreat of public-sector activity and employment in recent years, has widened schooling-based wage differentials. As of 1999, the Chinese government introduced a policy to expand

tertiary education, thanks to which the proportion of urban population with a university degree rose from less than 10% in 2003 to over 20% in 2010. This change, in conjunction with other variants in schooling levels among the Chinese labour force between 1996 and 2010, seems to have fuelled greater inequality (Zhou, 2014). While the Chinese population has seen its absolute level of income rise along with a rapid increase in inequality, declining levels of happiness or satisfaction with life were detected in various jobs between 1990 and late 2000 (Bartolini and Sarracino, 2014; Brockmann and others, 2009). This has been associated with a population segment that feels relatively disadvantaged and whose expectations are not being fulfilled, even though its situation has improved in absolute terms.

V. Deeper analysis of selected realities: inequality in Latin America

This section makes a detailed analysis of the trend of inequality in Latin America over the last decade, between 2002 and 2014. Just as global inequality was examined above, the analysis starts by using the global inequality methodology, considering the region as a whole, and then focuses on national realities.

1. Regional inequality

The application of a methodology similar to that used in global studies of inequality, but considering Latin American countries only, makes it possible to gauge income inequality among the inhabitants of the region as a whole, and see how that inequality has evolved. Since this calculation involves fewer countries, it is possible to combine individual data from all of the household surveys conducted in the region, instead of combining ventiles as is done in global inequality studies. A regional income vector is obtained, and its distribution and recent modifications are analysed to ascertain whether the distributive changes occurring within the countries of the region in the last decade have been accompanied by improvements in the distribution of income among Latin Americans, or if the gaps have widened. Then, the results of an exercise of this type are used to update the analysis of Amarante, Galván and Mancero (2016), considering 16 the region's countries at three points in time: around 2002, 2009 and 2014.[8] In addition, a number of simulation exercises are presented.[9]

Two alternative vectors are used to obtain income figures that are comparable between countries. The first of these is PPP-adjusted per capita household income (World Bank, 2015).[10] [11] As an alternative way of equalizing the purchasing power of households and analysing the robustness of the results, the poverty lines calculated by the Economic Commission for Latin America and the Caribbean (ECLAC) to estimate poverty at the regional level are used as price deflators. As these poverty lines represent the cost of acquiring a basic basket of food products and goods that satisfy other basic needs, they

[8] A similar analysis can be reviewed in Cord and others (2016).

[9] Table A1.1 of the annex provides a breakdown of the surveys and the years used.

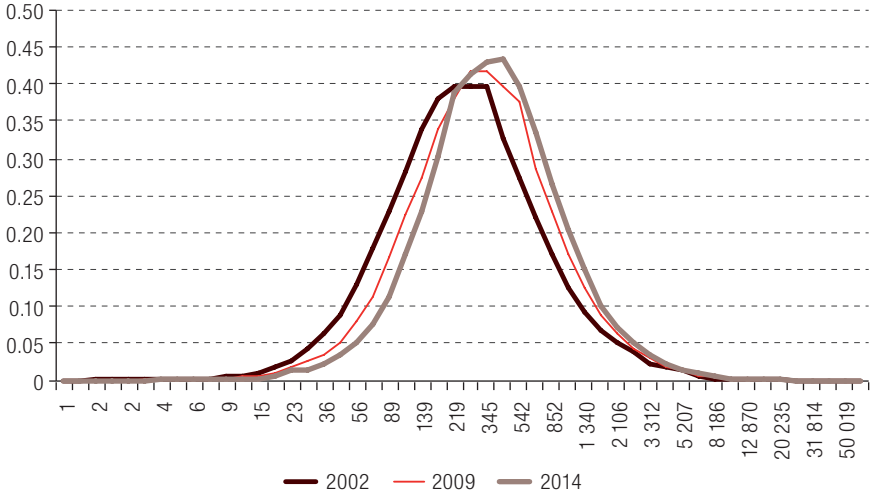
[10] Incomes were updated to 2011 according to the variation recorded in each country's general consumer price index (CPI), in order to apply the PPP factors estimated for that year. In the case of Argentina, the simple average of the price indices of five provinces has been used as a deflator since 2007. As the reliability of the estimates made under the 2011 PPP is subject to debate, all estimates are made using the 2005 PPP conversion factors. The results, which are very similar, can be requested from the authors.

[11] Both income vectors (adjusted for PPP and deflated by poverty lines) use household income corrected for non-response to the surveys and adjusted to the national accounts figures. This is the income measurement that ECLAC used to calculate poverty up to 2016 (see ECLAC, 2014b). As from *Social Panorama of Latin America 2016* (ECLAC, 2016), a new series of household income has been presented in which the various items included, and the imputation of non-response are revised from the conceptual and operational standpoints. The figures are also not aligned to the national accounts.

can be interpreted as reflecting the differences in the cost of achieving a similar level of wellbeing between countries.

A glance at the global PPP-adjusted income distribution for Latin America reveals its sharp shift to the right between 2002 and 2009, reflecting the growth of household income (see figure 8). This movement is repeated in 2014, albeit to a lesser extent. Comparing one period with the other also shows that the distribution has become less dispersed.

Figure 8
Latin America, income distribution 2002, 2009 and 2014[a]
(Log income density and PPP[b] dollars at 2011 prices)

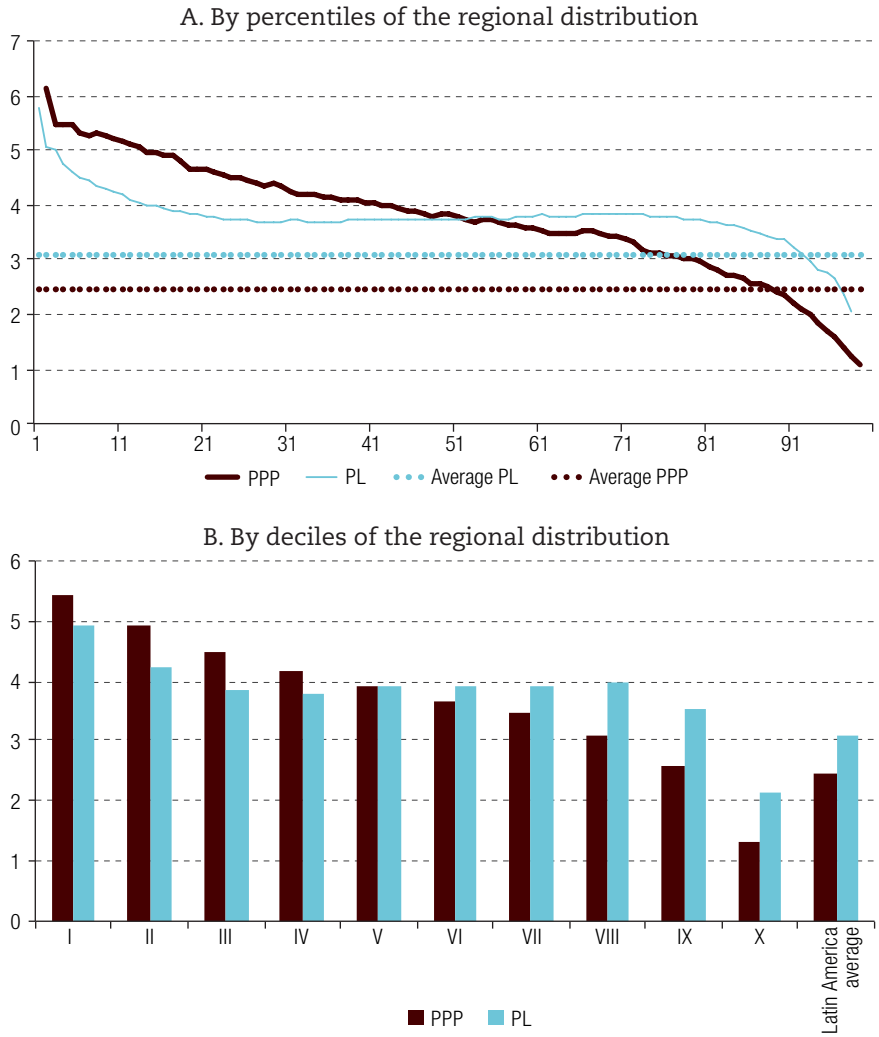


Source: Prepared by the authors, on the basis of household surveys.
[a] Population-weighted logarithmic scale.
[b] Purchasing power parity.

The average per capita income of the inhabitants of Latin America grew by 30.5% between 2002 and 2014 in purchasing power parity terms, and by 39.7% if expressed relative to the poverty line. In that period, income grew in all percentiles of the distribution, although not uniformly: the lower percentiles achieved higher growth, as can be seen from the changes by decile and percentile (see figure 9). Both in terms of PPP-adjusted income, and in terms of the poverty line, the growth declines as the income level rises. According to Ravallion and Chen (2003), the growth incidence curve shows that growth has been pro-poor. This is particularly clear in the case of PPP-adjusted income, which reports stronger growth than income adjusted by the poverty line among households in the lower half of the distribution. The greater growth of income among individuals in the lower part of the regional distribution is therefore an initial indication of less global inequality in the region.

Unlike the global pattern, indicators of inequality in Latin America do not differ significantly from subregional or national observations, which suggests a certain homogeneity in the region, even though the level of the indicator is high relative to other regions. This shows that the differences between the inhabitants of Latin America are broadly similar to those between the inhabitants of each country. In terms of trend, the three indicators considered (Gini, Theil and the 90/10 ratio) show an improvement between 2002 and 2014, whether measured in purchasing power parity terms or relative to the poverty line (see table 2). Nonetheless, in most indicators, the bulk of the improvement occurs between 2002 and 2009, while in recent years the pace of reduction of inequality has slowed substantially, especially when analysing income relative to the poverty line.

Figure 9
Latin America: variation in real incomes, 2002-2014[a]
(Percentages)



Source: Prepared by the authors, on the basis of household surveys.
Note: PPP means purchasing power parity and PL means poverty line.
[a] Annual equivalent variation.

Table 2
Latin America: global inequality indices, 2002, 2009 and 2014
(Percentage points and percentages)

	2002	2009	2014	Annual equivalent variation 2002-2014	Annual equivalent variation 2002-2009	Annual equivalent variation 2009-2014
PPP income[a]						
Gini coefficient	0.588	0.553	0.532	-0.8	-0.9	-0.8
Theil index	0.767	0.653	0.595	-2.1	-2.3	-1.8
90/10 ratio	14.5	12.6	10.9	-2.4	-2.0	-2.9
PL incomeb						
Gini coefficient	0.580	0.552	0.551	-0.4	-0.7	0.0
Theil index	0.772	0.664	0.648	-1.4	-2.1	-0.5
90/10 ratio	12.3	11.4	11.3	-0.7	-1.1	-0.1

Source: Prepared by the authors, on the basis of household surveys.
[a] Purchasing power parity.
[b] Poverty line.

If income inequality among the region's inhabitants is broken down into inequality between and within countries (based on the Theil index), it can be seen that most (nearly 90%) of overall regional inequality originates within the countries (see table 3). This result differs from the global decompositions analysed above, which indicate that between 60% and 85% of global inequality worldwide (depending on the measures and years considered) stems from differences between the countries' average incomes, and that this inequality is decreasing. Restricting the analysis to Latin America results in greater homogeneity between countries, as would be expected by reducing the number of countries included in the calculation. Moreover, inequality within countries determines regional inequality almost entirely. These results indicate that the countries' internal dynamics, linked to their social, institutional and political realities, is more relevant for the consideration of regional inequality than dynamics between countries (such as those linked to migration or trade). These results are similar to those found by Amarante, Galván and Mancero (2016) for the region. Nonetheless, each country's contribution to global inequality depends mainly on its share in total household income in the region, hence the importance of Brazil and Mexico, which have a very heavy weight in the decomposition (see table A1.2 of the annex).

Table 3
Latin America: decomposition of the Theil index by country, 2002, 2009 y 2014
(Theil index points and percentages)

	Theil decomposition			Weight of the components		
	2002	2009	2014	2002	2009	2014
PPP income[a]						
Within countries	73.7	61.0	55.1	96	93	93
Between countries	3.0	4.4	4.4	4	7	7
Theil	76.7	65.3	59.5	100	100	100
PL income[b]						
Within countries	73.1	66.4	54.9	95	92	85
Between countries	4.1	5.5	9.9	5	8	15
Theil	77.2	60.9	64.8	100	100	100

Source: Prepared by the authors, on the basis of household surveys.
[a] Purchasing power parity.
[b] Poverty line.

Moreover, the reduction in the region's global inequality during the period is mainly explained by the decrease in inequality within the countries. Here again, the processes of distributive improvement that have occurred in Brazil and Mexico are very important. The importance of the between-country component of inequality (which reflects differences between per capita incomes) has increased. Inequality between countries explains a smaller, although growing, part of global inequality in the region. These results show that living conditions among Latin American people are relatively more uniform today than they were a decade ago, although the differences in country per capita incomes are larger. The decrease in global inequality in the region, together with the absolute prevalence of intra-country inequality and its deconcentrating effect, are similar to, although more accentuated than, the findings reported by Gasparini and Gluzmann (2012) relative to 1992-2006 and those reported by Amarante, Galván and Mancero (2016).

Two simulation exercises are performed (see table 4). The first consists in calculating a hypothetical Latin American income distribution for 2014, as if only its structure had changed, but average income had not risen relative to 2002 (distribution effect). The second calculates a hypothetical distribution for 2014 assuming only the average income of the countries had changed, but not the structure of the distribution relative to 2002 (growth effect). If income had not grown between 2002 and 2014, but its structure had changed, the Gini index would have fallen even more steeply (dropping to 0.524 instead of 0.532 in 2014). In contrast, if income had merely increased, but its structure had not changed, inequality would have increased, and the Gini index would have been 0.595 in 2014. This indicates

that the two movements observed in the period have opposite effects on inequality: average income growth has been unequal, but the change in the structure of income has more than offset this effect.[12]

Table 4
Latin America: simulations of income inequality per capita, 2014
(PPP dollars[a] at 2011 prices and indicator points)

	2002	2014	Distribution effect	Growth effect
Average income	477	622	475	623
Gini index	0.588	0.532	0.524	0.595
Theil index	0.767	0.595	0.581	0.752
90/10 ratio	14.5	10.9	10.6	14.3

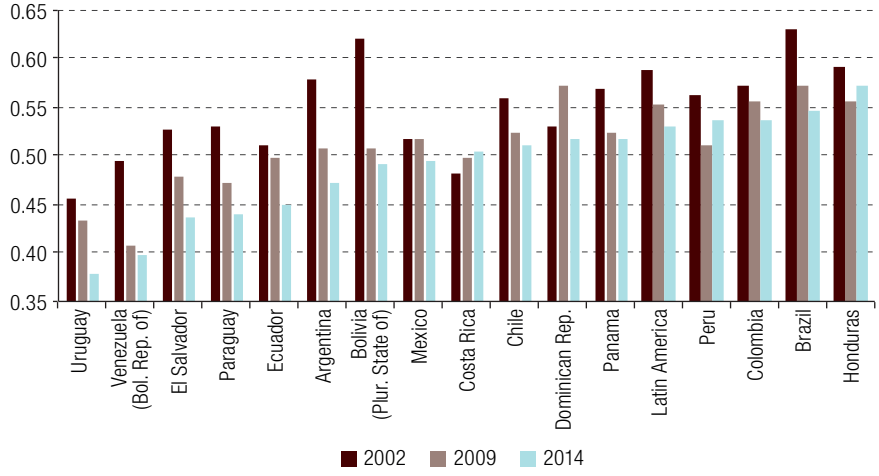
Source: Prepared by the authors, on the basis of household surveys.
[a] Purchasing power parity.

In summary, as reported in Amarante, Galván and Mancero (2016) for 2002-2012, the regional inequality indicators dropped sharply in 2002-2014, which indicates that the relative differences across the population regionwide are smaller than a decade ago. The reduction in inequality within countries is what basically explains the drop in global inequality across the region; and it is mainly the change in the structure of income (the distribution effect) that explains this.

2. Inequality at the national level

Income inequality, measured through the Gini index, has declined in nearly all Latin American countries analysed since 2002 (see figure 10). The two exceptions are Costa Rica and the Dominican Republic where the index rises (in the latter case, only in 2009).[13] The best relative achievements between 2002 and 2014 occur in the Plurinational State of Bolivia, the Bolivarian Republic of Venezuela, Argentina, Paraguay and Uruguay, with reductions of more than 4% per year.[14]

Figure 10
Latin America (16 countries): Gini index, 2002, 2009 and 2014



Source: Prepared by the authors, on the basis of household surveys.

[12] If the decompositions are based on the end-year of the period instead of the initial one, the results are almost identical.

[13] In the case of Costa Rica, methodological changes were made to the household survey in 2010 that cast doubt on comparability of the series.

[14] The reduction in income inequality occurs a little later, starting in 2007.

Different inequality trends across countries change the income-inequality ranking. For example, Argentina and the Plurinational State of Bolivia were among the region's five most unequal countries in 2002 (along with Brazil, Honduras and Colombia), whereas in 2014 they are located in the upper middle range of the table, ranked 6th and 7th, respectively.

Income inequality in Latin America has trended up since the 1980s, with a different dynamic in each country, but with the persistence and high levels that have historically been characteristic of the region. The decline that began in most countries in 2002 largely reflects labour market developments, where the dispersion of labour income narrowed considerably. In a context in which average income varied widely, incomes in the lowest part of the distribution —pertaining to low-skilled workers— grew by more, which reduced the skill premium. This could be due to an increase in the supply of skilled workers, an increase in the demand for less skilled workers or a combination of the two. Nonetheless, beyond the general patterns, national experiences are dissimilar, and several factors, operating with different intensities, may have contributed to the aforementioned reduction. Thorough discussion on this can be found in ECLAC (2014a), Gasparini and others (2012), and Cornia (2014), among other sources. In general, macroeconomic stability and external conditions have favoured the region in the period analysed. More specifically, labour market institutions, such as the minimum wage and collective bargaining arrangements, have contributed significantly in the Southern Cone economies (see, for example, Maurizio and Vázquez, 2016). In the Central American economies, non-labour income sources, particularly remittances, have had an equalizing impact in some cases (Acosta and others, 2008). More generally, non-contributory transfers to households with children and non-contributory pensions helped reduce inequality in the previous decade.

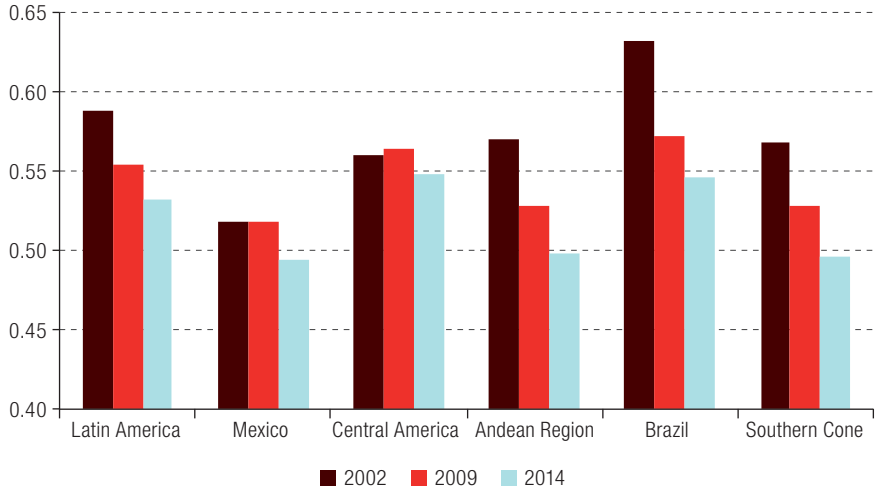
Given the heterogeneity prevailing in Latin America, it is useful to make a detailed analysis of movements in its constituent subregions, of which five are considered: Central America, the Andean Region, the Southern Cone, Mexico and Brazil. The two latter countries are considered separately owing to their preponderance in the region, in terms both of population and income. As noted in section I, the region's Gini index shows that Latin American incomes are becoming less unequal, although the process seemed to be faltering at the end of the period. The regional movements basically reflect what happened in South America, since patterns in both Mexico and Central America are different. On this point, the relative size of Brazil in the region, in terms of both population and income (37% and 45%, respectively, in 2014), means that movements occurring in that country have a significant impact on the aggregate indicator for Latin America.

While Central America was the most unequal subregion in 2014, Brazil was the least equal in 2002 (see figure 11). The meagre improvement in the Central American indicators, compared to a robust reduction in inequality elsewhere, pushes that subregion into last place. At the other extreme, Mexico is the least unequal part of Latin America, closely followed by the Southern Cone and the Andean Region. Apart from the fall in inequality in the region as a whole, its subregions are converging in terms of inequality.

The variation in income by percentiles displays differential patterns across subperiods and subregions, as shown in figure 12. In one group, the Andean Region, Brazil and the Southern Cone exhibit rapid income growth in all percentiles and a negative gradient, which benefits the poorest households and fosters a reduction in inequality. The second group contains Mexico and Central America, with a lower growth rate that slightly favours to the poor in the case of Mexico but has no distributive effects in Central America (the respective curve is almost horizontal). The Andean Region displays the most uniform movements across subperiods, although initially at a higher level. Average income grows strongly in the lower-income sectors, especially in the first decile. Between the first decile and the last ventil, growth is relatively uniform and significantly lower in the wealthier segments. In Brazil, growth is strong in the low- and middle-income brackets in both subperiods, although in 2002-2009, income growth

is lower in the last ventil. The Southern Cone records the strongest growth of all subregions, although with a less equal profile than elsewhere. Lastly, Mexico is the only subregion in which income declined in both subperiods, although by more in the second. Nonetheless, among the poorest segments, the second subperiod is more fruitful: while in 2002-2009, average income growth among the poorest is below average, between 2009 and 2014 it is considerably higher, resulting in above-average growth for the whole period.

Figure 11
Latin America (16 countries)[a] and subregions: Gini index of per capita income, 2002, 2009 and 2014[b]



Source: Prepared by the authors, on the basis of household surveys.
[a] Argentina, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela (Bolivarian Republic of).
[b] In purchasing-power-parity (PPP) terms at 2011 prices.

Figure 12
Latin America (16 countries)[a] and subregions: annual equivalent variation in per capita income by percentile, 2002-2014, 2002-2009 and 2009-2014[b]
(Percentages)

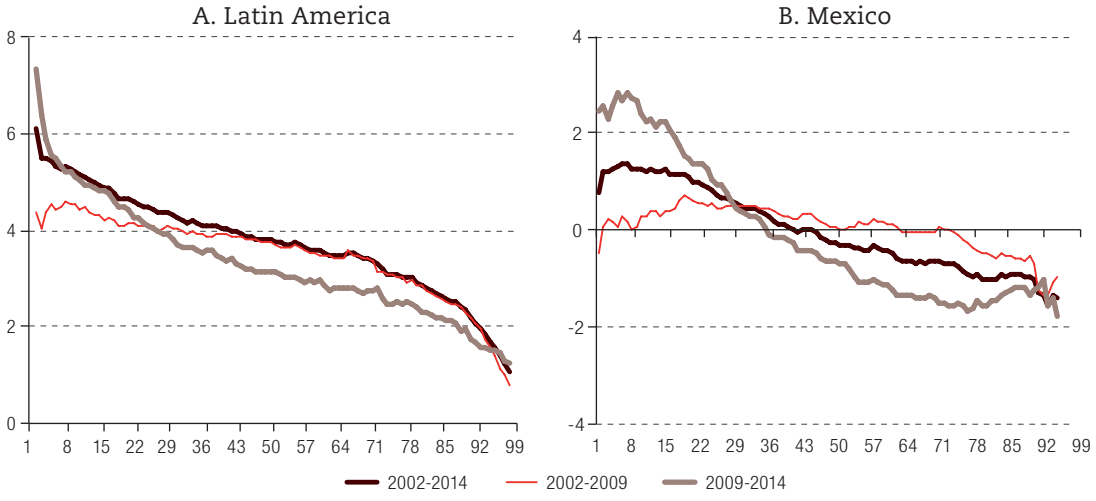
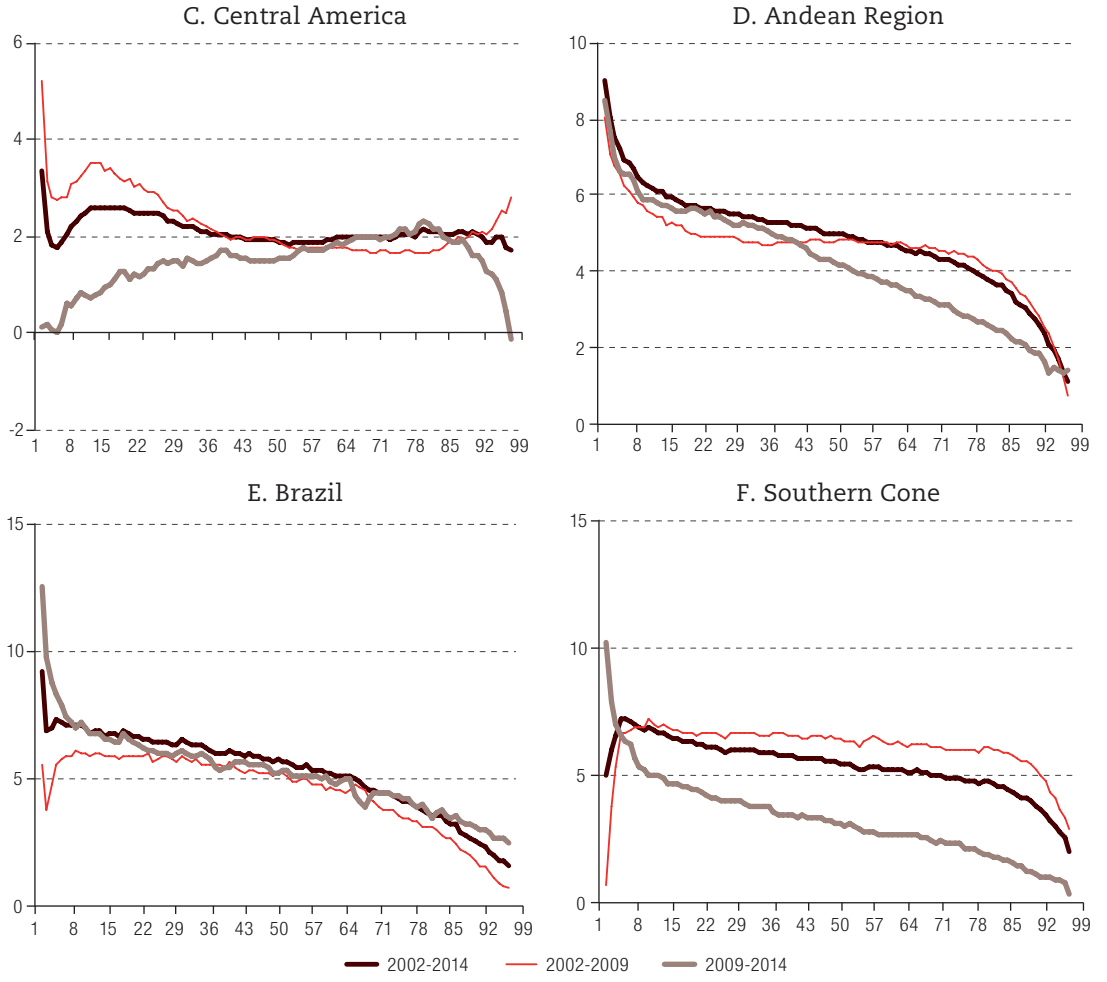


Figure 12 (concluded)



Source: Prepared by the authors, on the basis of household surveys.

[a] Argentina, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela (Bolivarian Republic of).

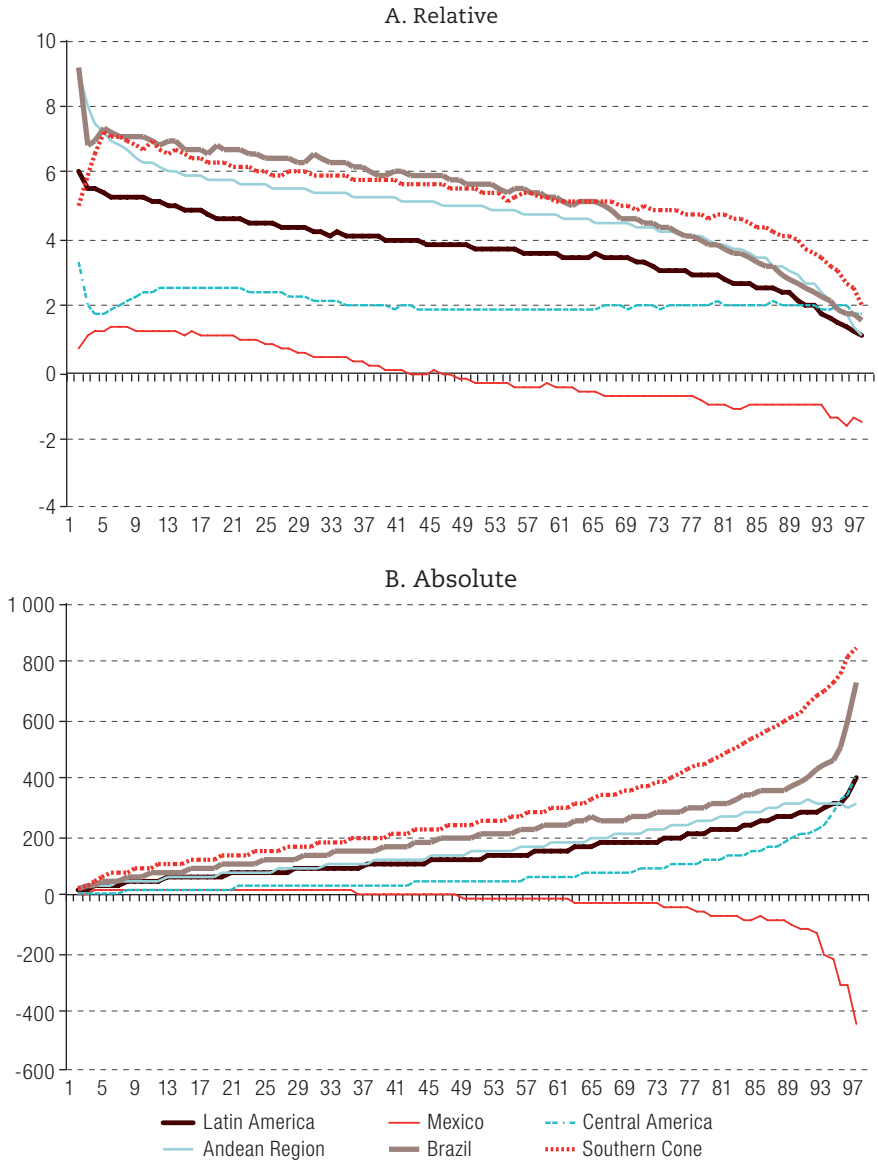
[b] Growth incidence curves; in purchasing power parity (PPP) at 2011 prices.

It is also instructive to analyse the income variation curves in absolute terms. As discussed in ECLAC (2014b), there are two different concepts underlying the notion of income inequality, involving two different value judgments. One refers to relative inequality, which depends on proportional differences in income, while the other refers to income gaps in absolute terms and is usually called "absolute inequality". The distinction between the two has been almost totally lost in the current empirical studies on inequality, which focus on the relative concept; although in the literature on measuring inequality in the last decade, the quantification of absolute inequality has also been discussed (see Chakravarty and Tyagarupananda, 2009; Bosmans and Cowell, 2010). Absolute inequality will only remain unchanged if household incomes vary by the same amount (not in proportion), which is a very demanding condition. If the income of the wealthiest individuals changes by more in absolute terms, then absolute inequality will increase. Clearly, inequality is much more likely to increase when absolute differences are considered. Between the two visions, neither one is theoretically correct or better than the other; both are acceptable and the choice is ultimately a value judgment (Ravallion, 2004; Atkinson and Brandolini, 2010).

Figure 13 shows the growth incidence curves (GICs) that were previously analysed in relative terms, together with the same variations in absolute terms. In the case of absolute curves, the variation

in income is increasing in all subregions, except for Mexico.[15] This means that income grew by more in absolute terms in the richest percentiles than among the poorest in all subregions, even though the absolute increase in income for the latter is proportionately larger. Absolute inequality has thus increased in the Latin American subregions.

Figure 13
Latin America (16 countries)[a] and subregions: relative and absolute variation of per capita income by percentile, 2002-2014[b]
(Percentages and PPP[c] dollars at 2011 prices)

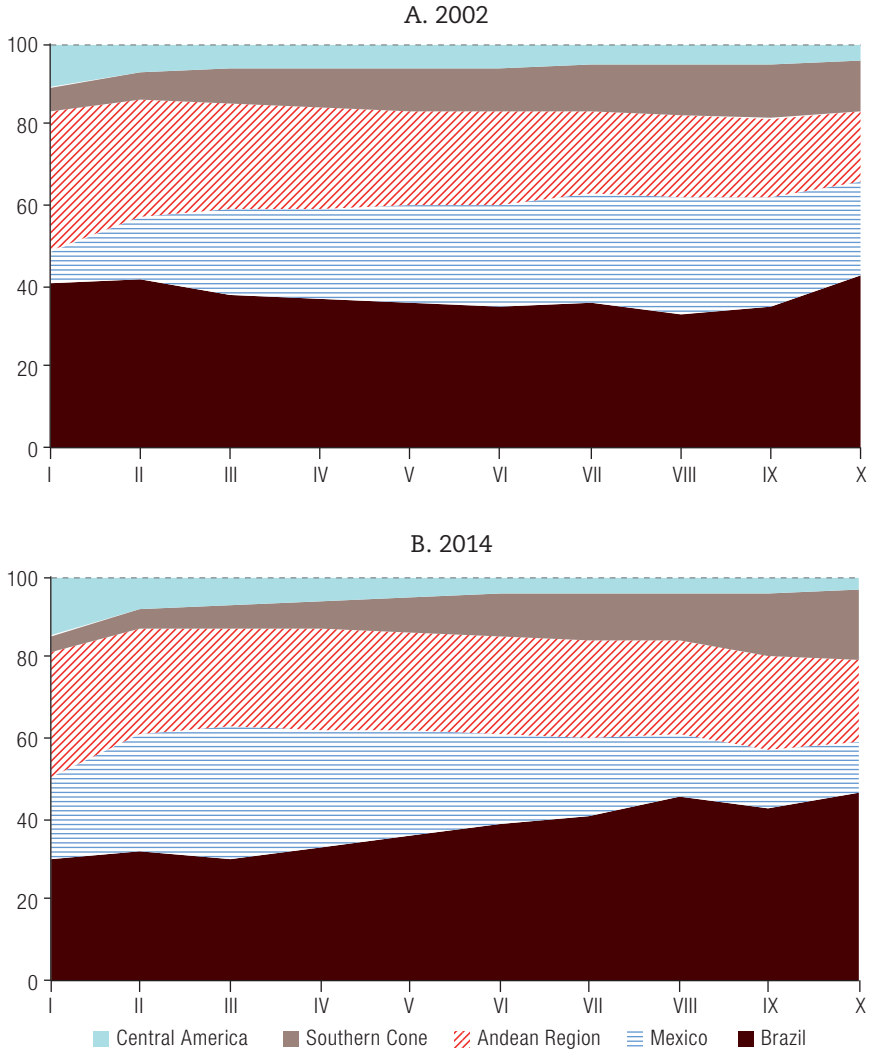


Source: Prepared by the authors, on the basis of household surveys.
[a] Argentina, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela (Bolivarian Republic of).
[b] Growth incidence curves; per capita income in purchasing power parity (PPP) at 2011 prices; annual equivalent relative variation.
[c] Purchasing power parity.

[15] In Mexico the income level of high-income recipients has fallen in absolute terms, which is corroborated if the variations between 2012 and 2013 are analysed, and the starting point is changed to 2000. Nonetheless, the drop in income is greater and more generalized in relation to 2014 (in that year, it can be discerned in the median, whereas, in 2012 and 2013, it can only be detected in the last ventile). No more recent surveys are available to determine whether this is due to a survey problem or a more general drop in income in 2014. Without ignoring these elements, a more in-depth study is needed to understand the factors underlying this development.

The different movements occurring in the subregions cause changes in their shares in the regionwide income deciles, as illustrated in figure 14. Brazil has the largest share in all deciles, and its share in the upper deciles increases in 2014. Mexico, in contrast, loses share in the last income levels and shifts towards the low- and middle-income segments. The Andean Region displays smaller movements, with its presence retreating in the first decile while increasing slightly in the last four. The Southern Cone's share in the region's highest income brackets grows strongly, while Central America's presence among the poorest 20% increases.

Figure 14
Latin America (five subregions): share in per capita income deciles, 2002 and 2014[a]
(Percentages)



Source: Prepared by the authors, on the basis of household surveys.
[a] In purchasing power parity (PPP).

Economic growth in the region has slackened in recent years and, as a result, in 2015 labour markets started to show signs of weakness in terms of job creation, loss of dynamism and a rise in unemployment (ECLAC/ILO, 2016). It is unlikely that these more stretched labour markets will be able to drive additional reductions in inequality in less favorable macroeconomic contexts; and, in fact, inequality among the Latin American economies in 2014 does not differ significantly from the previous

year's levels (ECLAC, 2016). This is a clear sign that the downward trend of earlier years is stalling. Nor does it seem feasible to expect income transfers to reduce inequality further. Firstly, these already have broad coverage in Latin American countries; and, secondly, the fiscal constraints facing the region make it difficult to increase their value, even though they are not large and thus have little redistributive effect, as noted in Amarante and Brun (2016).

A recent paper by Székely and Mendoza (2015) notes that the fate of the region, even in the dimensions most associated with social development, seems to depend heavily on price fluctuations arising from productive specialization; and the recent cycle of declining inequality seems to confirm this. The greater income equality that has been achieved in recent years, especially by boosting the demand for low-skilled workers and hence pushing up their wages, is undoubtedly good news because it means improving the quality of life of millions of people in the region. But this does not yet seem to have established itself as a genuine process of productivity growth that can sustain the increases in equality needed in the long term. Once again, the integration of the social and productive spheres of public policies emerges as a pending task.

VI. Final comments

Inequality on a global scale has not increased in recent decades. On the contrary, quality evidence now shows that living conditions around the world have become more equal, due mainly to significant income growth in China and, to a lesser extent, in India. At the same time, however, income has become less equally distributed within most countries, especially developing ones. The different forces that may be driving this greater dispersion of income include globalization and trade liberalization processes, which are unfolding alongside technological advances with effects that are hard to isolate. Increasing financialization economies and the concentration of returns to capital further accentuate the income concentration process.

One of the exceptions to this generalized increase in inequality has been Latin America. In the last decade, indicators of income inequality have declined significantly, both in the region as a whole and in its individual countries. A favourable confluence of regional macroeconomic factors also cannot be ignored, such as the rise in commodity prices, which has boosted the region's labour markets, fuelled the demand for unskilled labour and increased wages in the lower part of the distribution. Institutional factors have also been in play, with a differential force in each country. There has also been a greater impetus for redistributive policies, such as non-contributory cash transfers to households with children or older adults, or the strengthening of labour market institutions, such as the minimum wage or collective bargaining. The latest available figures have started to signal faltering economic growth and a weaker labour market, with the declining inequality trend stalling. Thus, the extent to which the region will be able to secure its major income-equality gains is an open question, in particular whether it will be able to regain the path towards greater equality.

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Annex A1

Table A1.1
Latin America (16 countries): surveys used to determine regional inequality

Country	2002	2009	2014
Argentina	2002	2009	2012
Bolivia (Plurinational State of)	2002	2009	2013
Brazil	2002	2009	2014
Chile	2003	2009	2013
Colombia	2002	2009	2014
Costa Rica	2002	2009	2014
Dominican Republic	2002	2009	2014
Ecuador	2002	2009	2014
El Salvador	2001	2009	2014
Honduras	2002	2009	2010
Mexico	2002	2008	2014
Panama	2002	2009	2014
Peru	2001	2009	2014
Paraguay	2001	2009	2014
Uruguay	2002	2009	2014
Venezuela (Bolivarian Republic of)	2002	2009	2013

Source: Prepared by the authors, on the basis of household surveys.

Table A1.2
Latin America (16 countries): weight of each country in income and population
(Percentages)

Country	2002		2009		2014	
	Population	Income (PPP)	Population	Income (PPP)	Population	Income (PPP)
Argentina	5.4	6.4	4.8	8.5	4.7	7.5
Bolivia (Plurinational State of)	1.9	1.0	2.0	1.2	2.0	1.2
Brazil	37.4	41.6	37.6	41.8	37.2	43.3
Chile	3.4	4.1	3.3	4.0	3.2	4.2
Colombia	8.7	5.5	8.6	5.7	8.5	6.1
Costa Rica	0.9	0.9	0.9	0.9	0.9	0.9
Dominican Republic	1.4	0.8	1.2	0.6	1.2	0.6
Ecuador	1.8	1.3	2.8	1.6	3.0	1.8
El Salvador	1.5	0.6	1.6	0.6	1.5	0.5
Honduras	22.3	23.3	21.2	19.0	22.0	18.1
Mexico	0.7	0.6	0.7	0.6	0.7	0.7
Panama	1.2	0.9	1.2	0.8	1.2	1.1
Peru	5.9	3.2	6.0	3.8	5.8	4.0
Paraguay	1.8	1.6	1.9	1.7	1.9	1.5
Uruguay	0.6	0.8	0.7	0.9	0.6	0.9
Venezuela (Bolivarian Republic of)	5.4	7.3	5.5	8.3	5.5	7.8

Source: Prepared by the authors, on the basis of household surveys.
Note: PPP: purchasing power parity.

Estimation of factors conditioning the acquisition of academic skills in Latin America in the presence of endogeneity

Geovanny Castro Aristizabal, Gregorio Giménez, Domingo Pérez Ximénez-de-Embún[1]

Abstract

This article identifies the main determinants of skill acquisition in Latin America. Not having repeated a grade, sex, the number of books in the home and the mother's education are defined as individual and family characteristics. In the case of school characteristics, the results are more heterogeneous between countries. The key factors seem to be attending a private school, the number of students per classroom, the quality of the educational materials available, and larger school size and autonomy. The characteristics of the schools explain most of the variability of the results, followed by family characteristics and then individual ones. School-based factors play a particularly crucial role in Argentina, Brazil and Costa Rica; family characteristics are very important in Chile, Colombia and Peru; and individual ones are important in Colombia and Mexico.

Keywords

Capacity-building, academic achievement, education, educational quality, evaluation, educational indicators, educational research, Latin America

JEL classification

C29, I21, I24, I28, I29

Authors

Geovanny Castro Aristizabal is a professor and research fellow in the Department of Economics at Pontificia Universidad Javeriana de Cali (Colombia). Email: gcastro@javerianacali.edu.co.

Gregorio Giménez is a professor and research fellow in the Department of Applied Economics at the University of Zaragoza (Spain). Email: gregim@unizar.es.

Domingo Pérez Ximénez-de-Embún is a professor and research fellow in the Department of Economic Analysis at the University of Zaragoza (Spain). Email: dpxe@unizar.es.

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I. Introduction

The Latin American countries participating in the Programme for International Student Assessment (PISA) 2012 have accepted the challenge of improving educational quality. Public expenditure per student has been increased, and laws have been amended to guarantee the right to education for the least privileged population groups. Although not all countries have progressed at the same pace, they have generally improved and expanded education supply by building schools and creating new teaching posts.

This has led to an increase in the average number of years' schooling and better results achieved on the various international tests in which they have participated (CIPPEC, 2011). A comparison of the results of the Second and Third Regional Comparative and Explanatory Studies (SERCE 2006 and TERCE 2013, respectively) generally reveals a significant increase in scores obtained by 3rd and 6th grade students in the three subject areas evaluated, especially mathematics (Rivas, 2015).[2] Nonetheless, at the secondary school level, the performance of the Latin American region still lags behind global standards. In terms of the three skills evaluated, the eight Latin American countries that took part in the 2012 PISA obtained results that ranked them among the last 20 of the 65 participants.[3]

Although there are many empirical studies on the economics of education generally, which shed light on the factors that condition school performance or skill acquisition, there are few focused on Latin America.

These research projects are based on estimating an education production function (EPF) through a variety of methodologies. In particular, the use of multilevel techniques (or hierarchical models) has gained increasingly broad acceptance as one of the best ways of studying and analysing educational data. This is because the characteristics of the student and the school (the inputs into EPF) are nested through their school performance; in other words, they are hierarchically structured (Gaviria and Castro, 2005).

Nonetheless, these hierarchical models assume the absence of correlation between the independent variables and the model's errors. Yet not all of the EPF inputs are statistically exogenous (zero correlation with the error term), since the model omits variables that cannot be measured directly. For this reason, they may be correlated with the error and cause an endogeneity problem (Hanushek and Woessmann, 2011). In the presence of this problem, multilevel techniques yield inconsistent and biased coefficients, which is why the literature suggests using instrumental variables (Greene, 2012). Nonetheless, this method has seldom been used in the economics of education (see Hanushek and Woessmann, 2011) and never to analyse school performance in Latin America.

In view of the above, this article aims to identify the factors that are decisive for acquiring skills in Latin America, by analysing data from countries participating in the 2012 PISA in the three subject areas evaluated. The education production function is also estimated using the generalized method of moments (GMM), firstly because a problem of endogeneity has been detected and secondly because aggregation at the country level is not possible owing to the lack of regional relative weights in the selected sample.

The article is structured as follows. Following this introduction, section II reviews the literature on factors determining the acquisition of skills in developing countries. A methodological section III describes the model used and its variables, along with the econometric techniques applied to analyse

[2] The scores represent evaluations made by the Latin American Laboratory for the Evaluation of Educational Quality (LLECE) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for Latin American countries, with the aim of measuring the learning outcomes of the region's students in reading, mathematics and science.

[3] The following Latin American countries participated: Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru and Uruguay.

it. Section IV reports the results of the empirical analysis, in which the EPF estimation reveals that the key determinants of a student's school success are not having repeated a grade, sex, the number of books in the home and the educational level of his/her mother. Lastly, section V sets out the conclusions.

II. The literature on academic performance in Latin America

The earliest studies on educational quality and school performance (Alexander and Simmons, 1975; Jencks, 1972; and Coleman and others, 1966) found that family background largely determines students' academic performance. More recently, in the same vein, Woessmann (2010) argued that school performance is strongly related to family background and weakly associated with the characteristics of the school. In Latin America, Cervini (2012) analysed the school effect on academic performance, by applying bivariate multilevel models (at three levels: country, student and school), drawing on results of the 2006 SERCE in mathematics and reading. When extracurricular factors were controlled for, these tests found that the effect of the school on educational performance was very weak.

In recent decades, the number of studies on education and academic performance has increased considerably, with varying results. Some research finds that the characteristics of the student or those of his/her family environment are the key factors. In contrast, there is other empirical evidence that factors associated with schools and institutions have the greatest influence on school performance.

The results found for Latin American countries reflect this ambiguity. Some studies find a strong association between academic performance and the students' individual and family characteristics; but others conclude that features of the school are the most important factors. Nonetheless, relatively few research projects arrive at this second conclusion (see table 1).

Table 1
Latin America: determinants of school performance

Factor		Author(s)	Country or region	Data
Individual	Sex	Cárcamo and Mola (2012); Woessmann (2010); Vegas and Petrow (2007)	Colombia; Argentina; Latin countries in PISA	SABER11 2009; PISA 2000-2003
	Grade repetition (-)	Oreiro and Valenzuela (2013); Méndez and Zerpa (2011); Post (2011)	Uruguay; Uruguay and Chile; Chile, Colombia, Ecuador and Peru	PISA 2003; PISA 2006; SERCE 2006 and Regional employment surveys
	Race (-)	Marteleto (2012); Viáfara and Urrea (2006)	Brazil, Colombia	National survey 1982 and 2007; ENH 2000
Family	Group[a] (+)	Thieme, Prior and Tortosa-Ausina (2013); Donoso and Hawes (2002); Vivas, Correa and Domínguez (2011)	Chile; Chile; Colombia	SIMCE 2008; SIMCE 2000; ECV2003
	Parents' education (+)	Ayala, Marrugo and Saray (2011); Sánchez (2011)	Colombia	SABER11 2010
School	Teachers (+)	World Bank (2005); León, Manzi and Paredes (2004)	Mexico; Chile	PISA 2003; Teacher appraisal system
	School day (+)	Bonilla (2011)	Colombia	SABER11 2009

Source: Prepared by the authors.
Note: SABER11 refers to the results obtained in the tests applied to students in their last year of high school in the National Education Quality Assessment System. PISA refers to the Programme of International Student Assessment. SERCE means Second Regional Comparative and Explanatory Study. ENH is the National Household Survey. SIMCE is the Education Quality Measurement System. ECV stands for the Quality of Life Survey. The symbol in brackets that appears next to each of the factors refers to the relationship between performance and the factor. When sex is measured with a dummy variable that takes the value a 1 if the student is a girl and 0 if a boy, the effect on the score in reading is (+) and in mathematics (-).
[a] Refers to socioeconomic characteristics.

In the case of individual characteristics, sex, grade repetition and race are the factors that most influence school performance; and the following observations can be made (i) on average, girls obtain better results in reading, while boys do better in mathematics and science; (ii) grade repetition negatively affects the average score obtained in each of the areas evaluated; and (iii) black students have more disadvantages than those of other races and, thus, achieve worse results.

In the case of family factors, previous empirical studies of school performance in Latin American countries indicate that family characteristics and the environment jointly benefit student performance. The same is true of the parents' education, in particular, the mother's schooling level.

Lastly, in terms of school characteristics, the quality of the teachers and the type of school day (morning or afternoon) seem to be decisive for students' academic performance (see table 1). Studies that estimate education production functions in Latin America are still few and far between; and those that exist seldom use advanced econometric techniques. This study takes account of these limitations and tries to adopt a new perspective. To this end, techniques are used to impute data for which records are missing, together with estimators that are robust and unbiased in the presence of endogeneity stemming from the dual causation between endogenous and exogenous variables. The use of these techniques shows the greater weight of family characteristics in explaining the variability of performance, with respect to the sample worked with. It also highlights the existence of performance disparities between public and private schools.

III. Methodology

1. Model and description of the inputs of the education production function

The education production function (EPF) is similar to a typical production function. It relates the product (output), in other words the academic results or the marks scored by the students, with the inputs, namely, a set of variables associated with the student and the school. This article follows Hanushek, Link and Woessmann (2013), and Hanushek and Woessmann (2012 and 2011), working with the following EPF:

$$PM_{ij}^{p} = \beta_0 + \sum_{i=1}^{m} \beta_i CE_i^p + \sum_{i=m+1}^{h} \beta_i CE_i^p + \sum_{i=h+1}^{w} \beta_i FE_i^p + \varepsilon_i \quad (1)$$

where PM_{ij}^{p} represents the average value of the five possible results that student i from country p can obtain in skill j (see OECD, 2014); ε_i denotes the model's random error term, which encompasses variables that are not directly observable or measurable, such as learning capacity, the student's innate abilities, or the "peer effect".[4] Lastly, the three summations include the inputs as follows:

- Student characteristics (CE) are encompassed in the first of the summations contained in equation (1). The following variables have been created:

  (i) The variable *sex* which takes the value 1, if the student is female, or 0 if male. It measures inequalities between the sexes by specific skills (see Woessmann, 2010, in relation to reading; García, Hidalgo and Robles, 2010, and Mullis and others, 2007, on mathematics; and Vegas and Petrow, 2007, with respect to science).

[4] The "peer effect" is located in this residual part of the function because it raises certain theoretical and empirical issues that make it difficult to measure. Murnane (1981) demonstrates the difficulty of identifying a student's relevant peer group (same class, same course or same school?). This author also highlights the difficulty of identifying which features of this peer group can really affect each student's school performance (the students' socioeconomic level, racial composition, academic level, sex?). In contrast, other authors, such as Brunello and Rocco (2008) or Angrist (2014), point to empirical problems that limit these results —mainly selection biases, spurious correlations and endogeneity problems.

(ii) The variable *non-repeater*, which takes the value 1, if the student has repeated at least one grade, and 0 otherwise. It is used to measure the impact of what is defined in the literature as "grade retention" (Méndez and Zerpa, 2011; Hong and Yu, 2007).

(iii) The variable *effort*, which takes the value 1, if the student seeks additional information to clarify a topic that she is studying but does not understand, and 0 if she does not perform this search.

(iv) The variable *discipline*, which is given the value 1, if the students pay attention to the teacher in most classes, and 0 otherwise (Post, 2011; Cervini, 2003).

- The second summation collects family characteristics, which make it possible to measure the impact of the household's socioeconomic and cultural status on skill acquisition. For this purpose, the following variables are specifically generated:

  (i) *books*, which takes the value 1, if there are more than 200 books in, and 0 otherwise (Woessmann and others., 2007).

  (ii) *educamother* and *educafather*, which refer to the minimum schooling level of the mother and father, respectively. Following Hanushek and Luque (2003) a bachelor degree gives this variable a value of 1 otherwise it is 0.

  (iii) *empfather*, which takes the value 1, if the father's is employed is part-time or full-time, and 0 otherwise (Hanushek and Woessmann, 2011; Woessmann and others, 2007).

- The last summation includes the school factors, which are the following:

  (i) The ownership of the school, which makes it possible to detect educational disparities between public and private schools. Thus, the variable *public* is created, which takes the value of 1 if the school is publicly owned, and 0 if it is private (Gamboa and Waltenberg, 2012).

  (ii) The student-teacher ratio (STRATIO), the number of students enrolled in the school (SCHSIZE) and the quality of educational materials (SCMATEDU), which are incorporated as proxies of the school's educational expenditure (Hanushek, 2011; Vignoles and others, 2000).

  (iii) The dummy variable autonomy, which is based the proposal by Hindrinks and others (2010), and takes the value 1 if the school director and teachers have decision-making autonomy on important matters related to the institution, and 0 otherwise.

2. Sources of information and treatment of data without registration

The information with which the EPF inputs are constructed and used to estimate model (1) is taken from the 2012 PISA, available from OECD (2015). This takes into account information on both students and schools in Latin American countries that participated in the 2012 PISA tests. In total, 90,799 observations of students are obtained from 3,722 schools, distributed as follows: 9,073 students and 352 schools in Colombia; 5,908 and 226 in Argentina; 19,204 and 839 in Brazil; 6,856 and 221 in Chile; 4,602 and 193 in Costa Rica; 33,806 and 1,471 in Mexico; 6,035 and 240 in Peru and 5,315 and 180 in Uruguay. The observations in question are statistically representative of the population of each of the countries studied (OECD, 2015).

Nonetheless, this database contains numerous missing values, in other words data corresponding to the information that are unrecorded because of a failure to reply to the questionnaires that students and directors of schools are required to complete. This can lead to biases in statistical inference, which is why the absent data must be imputed (Medina and Galván, 2007). Thus, in this study the proposal of the aforementioned authors is followed and the hot-deck method is applied to variables for which more

than 10% of the values are missing in the database. According to Durrant (2009), this nonparametric method maintains the probability distribution of the imputed variables, so it is more efficient than multiple imputation methods.

Table 2 shows the mean and standard deviation of the variables used in EPF. It should be noted that the average scores obtained by Latin American students in reading, mathematics and science in the 2012 PISA (around 500 points in each of the subject areas) are unsatisfactory compared to those of the Organization for Economic Cooperation and Development (OECD). This is reflected in the low positions that these countries occupy in the ranking of the 65 participating economies (34 from the OECD and 31 associates), which are shown to the right of average columns in the table.

Table 2
Latin America (8 countries): means and standard deviations of the variables included in the education production function, 2012[a]

	Mean score: Reading	Rank	Mean score: Mathematics	Rank	Mean score: Science	Rank	*non-repeater*	*sex*	*effort*	*discipline*
ARG	395.98	60	388.43	59	405.63	58	0.62	0.51	0.24	0.09
	90.81		73.28		81.45		0.48	0.50	0.43	0.28
BRA	406.53	55	388.51	58	401.62	59	0.61	0.52	0.21	0.16
	81.48		74.78		74.62		0.49	0.50	0.41	0.37
CHL	441.40	47	422.63	51	444.93	46	0.74	0.52	0.30	0.15
	73.91		77.69		76.03		0.44	0.50	0.46	0.35
COL	403.40	57	376.49	62	398.68	60	0.58	0.53	0.32	0.17
	79.40		70.77		71.77		0.49	0.50	0.47	0.37
CRI	440.55	47	407.00	56	429.35	51	0.65	0.53	0.34	0.19
	69.21		64.72		65.04		0.48	0.50	0.47	0.39
MEX	423.55	52	413.28	53	414.92	55	0.80	0.51	0.26	0.19
	75.42		70.59		65.91		0.40	0.50	0.44	0.39
PER	384.15	65	368.10	65	373.11	65	0.69	0.51	0.27	0.14
	88.31		80.67		73.04		0.46	0.50	0.44	0.34
URY	411.35	54	409.29	55	415.84	54	0.61	0.53	0.30	0.16
	90.83		85.29		90.05		0.49	0.50	0.46	0.37
Total	409.29		393.38		404.85		0.67	0.52	0.25	0.16
	82.12		75.35		74.28		0.47	0.50	0.43	0.37

	books	*educamother*	*educafather*	*empfather*	*public*	*STRATIO*	*SCMATEDU*	*autonomy*	*SCHSIZE*
ARG	0.15	0.64	0.60	0.89	0.66	10.63	-0.54	0.96	519.31
	0.35	0.48	0.49	0.31	0.47	13.60	1.07	0.19	372.21
BRA	0.07	0.45	0.41	0.80	0.83	28.41	-0.58	0.95	979.25
	0.26	0.50	0.49	0.40	0.38	16.47	1.05	0.22	611.51
CHL	0.16	0.67	0.66	0.90	0.36	21.92	-0.38	0.92	902.16
	0.37	0.47	0.48	0.30	0.48	7.29	1.00	0.27	576.66
COL	0.08	0.55	0.57	0.85	0.84	27.01	-1.38	0.89	1455.14
	0.27	0.50	0.49	0.36	0.36	9.08	1.17	0.31	1106.35
CRI	0.10	0.57	0.58	0.88	0.85	20.22	-1.08	0.99	823.54
	0.30	0.50	0.49	0.33	0.36	23.85	1.24	0.11	631.80
MEX	0.09	0.39	0.42	0.85	0.88	30.69	-0.86	0.92	856.37
	0.29	0.49	0.49	0.36	0.33	31.62	1.14	0.27	946.47
PER	0.10	0.53	0.66	0.84	0.76	18.45	-1.16	0.99	672.27
	0.29	0.50	0.47	0.37	0.42	7.62	1.24	0.11	561.77
URY	0.14	0.47	0.45	0.89	0.83	15.48	0.12	0.86	905.73
	0.35	0.50	0.50	0.31	0.37	7.54	1.03	0.35	685.64
Total	0.09	0.48	0.48	0.83	0.80	25.87	-0.76	0.94	921.47
	0.29	0.50	0.50	0.37	0.40	20.84	1.14	0.24	776.33

Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) on PISA 2012 test.

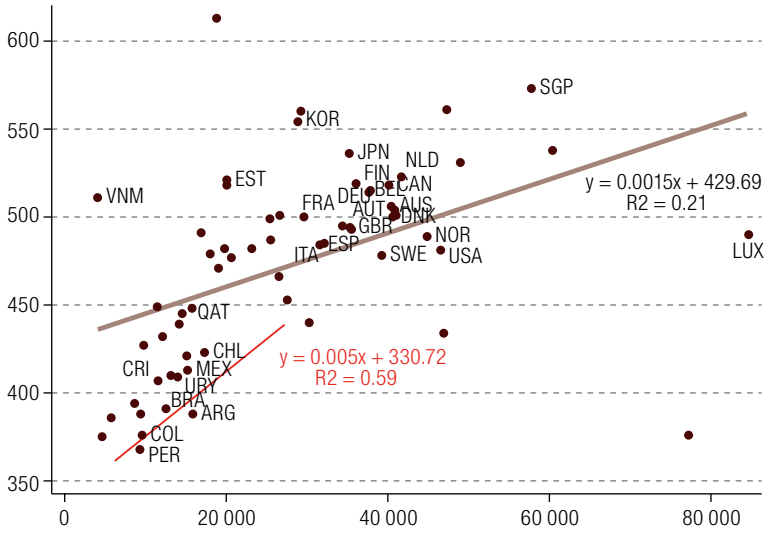
Note: The total has been calculated using the average data for all students in Latin America. The position refers to the country's ranking among those participating in the PISA test.

[a] The mean is shown on the upper line, with the standard deviation below.

The heterogeneity observed in the results may be a reflection of the inputs considered in EPF and shown in the table; but additional factors may also be in play. For example, if school performance is conditioned by socioeconomic circumstances, the circumstances prevailing in Latin American countries are very different from the OECD average. Figure 1 shows the relationship between income and performance in Mathematics (black dotted line), for the 65 economies participating in PISA. This relationship suggests that income differences can explain 21% of the variation among school results in the participating economies. The richest countries thus have a clear advantage.

Moreover, this relationship is stronger when exclusively considering the eight Latin American countries that are the focus of this research (the dashed red line), since 59% of the variability in the countries' results can be explained by their income differences. Average income in the region (US$ 13,175) lies between the extremes of Chile (US$ 17,312) and Peru (US$ 9,350).

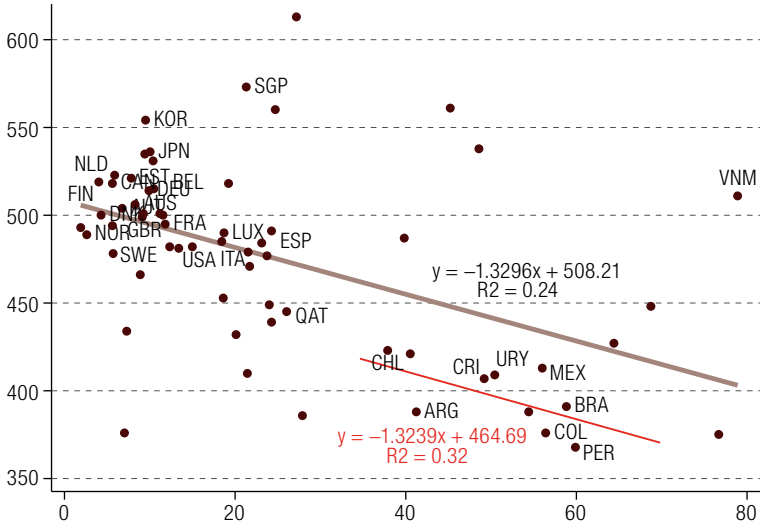
Figure 1
Results in mathematics and GDP per capita of the 65 economies that participated in the PISA tests, 2012
(Average scores and current dollars corrected for purchasing power parity (PPP))



Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) relating to the PISA 2012 test.

Cross-country differences in income level are compounded as a limiting factor by its distribution, since income in Latin America is distributed very unequally; and inequality seriously affects children and adolescents. Countries that have a larger proportion of students with socioeconomic problems face more severe educational challenges. This situation is reflected in figure 2, which shows the relationship between the results achieved in mathematics and the percentage of students who are in adverse socioeconomic circumstances. These appear to have a negative effect on school performance (dashed black line), since the index is associated with 24% of the variability in the results achieved in that subject. The relationship is more intense in the context of Latin American countries (dashed red line): 32% of the variability in the results obtained by students in these countries is associated with differences related to adverse circumstances, since 51% of Latin American students live in unfavourable environments. Peru had the largest proportion of students in this situation (59.9%) and Chile the smallest (37.9%).

Figure 2
Results in mathematics and proportion of students in adverse socioeconomic circumstances in the 65 economies that participated in the PISA test, 2012
(Average scores and percentages)



Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) on PISA 2012 test.

Nonetheless, while income level and the percentage of students in adverse socioeconomic circumstances are important limiting factors, they do not justify the differences between the results obtained in Latin America and those of other countries that participated in the PISA test. In figures 1 and 2, the Latin American countries are below the least-squares regression line, which means that their average result in the mathematics test is lower than expected, even after controlling for their level of income and the percentage of students in unfavourable environments. According to the regression line shown in figure 1, the expected result for Latin American countries would be 449 points, or 58 above the score actually obtained. Similarly, according to the regression line in figure 2, the expected result would be 440 points: 47 higher than actually achieved.

3. The endogeneity problem in the education production function

The EPF inputs are likely to be correlated with the model's error or disturbance term (1), so the correlation between them differ from zero because of omitted variables. Since some factors that determine performance are not directly measurable, not all inputs are statistically exogenous (Hanushek and Woessmann, 2011). For example, non-repeater status (an input corresponding to individual characteristics) may be associated with the student's capacity to learn, innate abilities or motivation. These factors cannot be observed directly, so they are encompassed by the error term, which results in a non-zero correlation between the fact of being a grade-repeater and the disturbance.[5]

[5] Similarly, school characteristics —such as the number of students to a class, and the school's size, ownership and autonomy— may depend on the educational policy and decisions made in administrative institutions, such as education ministries, or else may be decided on by the school's directors and teachers themselves. Consequently, there may be a non-zero correlation between these factors (which are unobservable and included in the error term) and school inputs.

When this correlation exists in at least one of the EPF inputs , the problem of endogeneity arises, which means estimates obtained through ordinary least squares (OLS) or hierarchical (multilevel) models are not appropriate. Nonetheless, multilevel models are still widely used in education, because they offer the advantage of making it possible to avoid possible selection biases in schools. While classical models assume fixed effects, that is effects common to all individuals, multilevel models are composed of two differentiated parts: one that is common and fixed for all contexts, and a second that varies and is estimated according to level. Thus, by simultaneously modelling multiple units of analysis, it is possible to accurately estimate the contribution of the variables of each of the levels (schools in PISA) to the student's academic performance.

As noted above however, the coefficients estimated by multilevel models in the presence of endogeneity will be biased and inconsistent (Wooldridge, 2010). If endogeneity exists, the literature suggests applying propensity score matching (PSM) methodologies or instrumental variables (IV). These methods would be consistent and would also make it possible to deal with the problem of selection biases. The main difference between the PSM and IV methods is that PSM is normally used to compare groups: one of them receives treatment and the other does not. In addition, PSM uses observable factors to construct the weights in the estimates, while the VI method is based on the use of instruments from unmeasured or unobserved factors. Thus, the advantage of using VIs is that the existence of these unobserved factors that are correlated with school results is taken into account. This is of vital importance when working with EPF, since it is inevitable that not all elements that influence the results will be included in the inputs used.

The problem with the VI method is that it does not deliver efficient estimators if endogeneity does not really exist, so the presence of the latter needs to be verified. It can also be difficult to find valid instruments that satisfy the necessary conditions, in other words instruments that correlate with the inputs of EPF but not directly with the schools' results. To detect the problem of endogeneity, this study uses the generalized method of moments (MGM) test statistic. The instruments are identified and analysed using the statistic developed by Hansen (1982) (see Hall, 2005; Baum, Schaffer and Stillman, 2003; and Hayashi, 2000). The following section describes the VI methodology as used in this study to estimate EPF.

IV. Results

1. Analysis of endogeneity

The null hypothesis used to detect this problem is H_0:$cov(X, \varepsilon_i) = 0$ (exogenous EPF inputs). If the p-value associated with the GMM statistic is lower than the significance level, then there is not enough statistical evidence to accept the null hypothesis. This would imply the presence of endogeneity. When applying the statistic to each input, it is found that, at 1% significance, non-repetition status is the only factor correlated with the error term. The other variables do not present problems of endogeneity; this is true for each of the skills evaluated in PISA 2012.

For this reason, the model is instrumentalized using the following instruments: first, the motivation of the student (*motivation*) as measured through the reply given to the following question: "In the last two weeks of classes, how many times did you skip school for a whole day?" (the variable takes the value 1 if the answer is "none"; otherwise, it is 0); second, the average duration of classes in minutes (*minuesp*, *minumat* and *minusci*); and third, the number of hours of reinforcement classes that the

student takes outside school (*clasesp, clasmat* and *classci*). In the case of reading in particular, the instruments used are *motivation*, *minuesp* and *clasesp*; for mathematics, *motivation*, *minumat* and *clasmat*; and for science, *motivation*, *minusci* and *classci*.[6]

To validate the instruments, the hypothesis of their lack of correlation (and that of the other inputs) with the error term is formulated, and then the Hansen test (1982) is applied. The results show that the p-value associated with this statistic is greater than the one-percent significance level in each skill area, so there is not enough statistical evidence to reject the hypothesis. It is therefore concluded that the inputs and instruments are exogenous (see table 3).

Table 3
Latin America (8 countries): endogeneity and overidentification of the education production function, 2012

Endogeneity test	Argentina	Brazil	Chile	Colombia	Costa Rica	Mexico	Peru	Uruguay
H_0: exogenous inputs								
GMM - χ^2 statistic	72.175	82.762	60.005	8.721	27.398	290.462	56.215	9.721
[Reading]	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
MGM - χ^2 statistic	71.061	5.586	26.886	8.311	7.973	353.245	90.597	11.175
[Mathematics]	(0.000)	(0.018)	(0.000)	(0.004)	(0.005)	(0.000)	(0.000)	(0.001)
GM - χ^2 statistic	104.694	89.051	40.532	22.027	26.249	294.152	54.181	3.218
[Science]	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.073)
Instruments test								
Hansen J - χ^2	3.915	0.357	3.361	1.419	0.993	0.504	1.220	0.022
[Reading]	(0.141)	(0.550)	(0.186)	(0.492)	(0.609)	(0.478)	(0.269)	(0.882)
Hansen J - $\chi^2$2	5.337	3.484	2.000	0.590	7.554	0.708	0.374	0.016
[Mathematics]	(0.069)	(0.062)	(0.157)	(0.745)	(0.023)	(0.400)	(0.541)	(0.899)
Hansen J - χ^2	2.311	2.291	3.753	1.188	4.312	0.545	1.058	1.667
[Science]	(0.317)	(0.130)	(0.053)	(0.552)	(0.116)	(0.460)	(0.304)	(0.197)

Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) on PISA 2012 test.

Note: Instrumentalized variable: *non-repeater*. Instruments included: *sex, effort, discipline, books, educamother, educafather, empfather, public, STRATIO, SCMATEDU, autonomy* and *SCHSIZE*. Instruments excluded: *motivation, minuesp, clasesp* and *pre-school*, which takes the value 1 if the student attended pre-school, but 0 otherwise.] Imputation of omitted data through using the hot-deck methodology according to Medina and Galván (2007). p-value in parentheses.

Thus, once the problem of endogeneity has been corrected for (finding instruments correlated with non-repeater status, but not correlated with the model error of the Latin American countries participating in the 2012 PISA. The following sections present and interpret the results. As a measure of robustness, the results of the analysis using PISA 2009 data are reported at the end of the article. It should be noted that the results were similar to those obtained for 2012 (see annex A1).

[6] *clasesp*, *clasmat* and *classci* are dichotomous variables that take the value of 1 if the student attends 2-4 hours of reading, mathematics or science classes, respectively, outside the school, and 0 otherwise.

2. Estimating the education production function

(a) Reading comprehension

Table 4 displays the results obtained in reading.

Table 4
Latin America (8 countries): factors conditioning the acquisition of reading skills, PISA 2012

	Independent variable ↓	Argentina	Brazil	Chile	Colombia	Costa Rica	Mexico	Peru	Uruguay
Individual characteristics	*constant*	187.79	289.97	266.02	320.72	344.40	222.56	256.58	331.23
		(24.995)*	(17.412)*	(19.678)*	(30.813)*	(15.251)*	(13.521)*	(15.222)*	(10.379)*
	non-repeater	268.44	230.79	210.21	155.43	129.51	227.03	180.24	134.17
		(39.553)*	(30.952)*	(28.176)*	(43.896)*	(18.069)*	(15.489)*	(21.903)*	(20.337)*
	sex	7.38	6.61	9.11	1.36	14.17	5.57	3.87	22.01
		(5.533)	(4.087)	(3.158)*	(5.419)	(3.007)*	(1.949)*	(2.877)	(2.758)*
	effort	10.45	-1.17	6.26	7.35	5.35	10.15	5.86	7.21
		(4.493)**	(3.096)	(2.805)**	(2.987)**	(2.389)**	(1.759)*	(3.046)***	(2.428)*
	discipline	-11.10	0.29	5.48	8.59	3.99	4.44	-1.05	6.66
		(6.948)	(3.166)	(3.437)	(3.810)**	(2.927)	(2.021)**	(3.631)	(3.108)**
Family characteristics	*books*	5.21	2.45	28.77	19.12	19.51	13.65	21.94	17.15
		(6.090)	(4.130)	(3.140)*	(5.039)*	(4.089)*	(2.719)*	(4.185)*	(3.379)*
	educamother	13.97	6.45	6.93	11.03	1.21	0.07	9.64	0.97
		(4.408)*	(2.805)**	(4.120)	(4.168)*	(0.321)*	(1.833)	(3.384)*	(0.531)***
	educafather	-5.20	1.77	19.12	10.89	-2.11	9.31	6.26	-1.28
		(4.231)	(2.665)	(3.377)*	(3.157)*	(2.468)	(1.772)*	(3.546)***	(2.387)
	empfather	10.84	1.94	-13.87	2.10	-3.41	6.84	2.31	5.17
		(6.636)	(2.897)	(4.691)*	(4.406)	(3.493)	(2.222)*	(3.478)	(3.583)
School characteristics	*public*	-16.04	-31.47	-0.84	-27.18	-25.48	-2.55	-25.17	-35.41
		(9.854)	(5.903)*	(4.736)	(5.543)*	(4.718)*	(3.160)	(5.036)*	(7.505)*
	STRATIO	-0.08	-0.41	-0.53	-0.37	0.11	-0.11	-0.09	-0.16
		(0.135)	(0.068)*	(0.196)*	(0.152)**	(0.043)**	(0.016)*	(0.194)	(0.1669)
	SCMATEDU	-9.58	-1.64	0.39	3.43	3.54	3.25	10.59	9.15
		(3.224)*	(1.447)	(1.523)	(1.782)***	(1.397)**	(0.893)*	(1.179)*	(1.418)*
	autonomy	35.45	1.94	9.08	0.72	7.56	7.05	3.30	-2.91
		(8.998)*	(5.818)	(5.418)***	(4.265)	(11.100)	(3.185)**	(10.519)	(4.157)
	SCHSIZE	-0.01	0.00	0.01	0.01	0.01	0.00	0.02	0.00
		(0.009)	(0.002)	(0.003)*	(0.001)*	(0.002)*	(0.001)**	(0.002)*	(0.003)
	Observations	5 632	16 573	5 898	8 059	4 281	29 614	5 442	4 754
	Instruments	*motivation minuesp clasesp*	*pre-school minuesp*	*motivation minuesp clasesp*	*motivation minuesp clasesp*	*motivation minuesp clasesp*	*motivation pre-school*	*motivation minuesp*	*motivation minuesp*

Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) on PISA 2012 test.
Note: * significant at 1%, ** significant at 5%, *** significant at 10%. Robust standard deviations in parentheses. Imputation of the omitted data through the hot-deck methodology according to Medina and Galván (2007).

In terms of individual characteristics, the results obtained in reading show that there are gender gaps in favour of women, which concurs with the findings obtained by Woessmann (2010). Thus, in Uruguay and Costa Rica, the countries where the gap is largest, women are 22.1 and 14.1 points above men, respectively. In contrast, in Argentina, Brazil, Colombia and Peru, the gaps are not significant. The non-grade repeater condition is also a decisive factor in the acquisition of this skill in all countries, since it has a positive effect on the average score according to Méndez and Zerpa (2011) and Martin (2011). It should be noted that the effect of the *non-repeater* variable is stronger in Argentina and Brazil. The same applies to students who seek additional information to clarify a topic they study and do not understand (*effort* variable). The effect of this variable is highest in Argentina and Mexico. Lastly, discipline is a positive and significant factor in Colombia, Mexico and Uruguay, but it is not significant in the other countries.

In terms of the socioeconomic and cultural status of the household, the results show that the number of books positively influences the average reading score, as indicated by Crespo, Díaz and Pérez (2012), and Woessmann and others (2007). The greatest impact of this indicator is observed in Chile, with 28.7 points, and in Peru, with 21.9. Positive effects of the mother's education are also observed, such as reported by Hanushek and Luque (2003). Thus, students with mothers whose educational level is high school, at least, obtain a higher average score than those whose mothers lack these studies. In the case of Chile and Mexico, the effect of the mother's education is not significant, which coincides with the result obtained by Meunier (2011) for Switzerland. In the case of the father's education level, the estimates differ between countries. In Chile, Colombia, Mexico and Peru, the relationship is positive and significant, while in the other the countries it is not. Lastly, the effect of the time that the father spends working is very heterogeneous: negative in Chile, positive in Mexico, and not significant in the other countries.

In the case of school characteristics, the relationship between the ownership of the school and the acquisition of reading skills is negative in all countries studied. Students who attend private schools obtain a higher average score than those who attend public schools. Nonetheless, in Argentina, Chile and Mexico, this relationship is not significant. Formichella (2011) obtains the same results for Argentina. Among countries in which this relationship is significant, Uruguay and Brazil display the greatest differences between public and private schools, while Costa Rica and Peru have the smallest (Giménez and Castro, 2017; Fernández and Del Valle, 2013; Gamboa and Waltenberg, 2012; Montero and others, 2012).

The coefficient of the variable that represents the student/teacher ratio is negative, coinciding with the findings reported by Krueger (2003) and Krueger and Whitmore (2001). In the cases of Argentina, Peru and Uruguay, this variable is not significant. The values obtained with respect to school size were not significant in Argentina, Brazil and Uruguay.

The quality of educational materials is also a condition for school performance, except in Brazil and Chile, where the estimated ratio is not significant. Peru and Uruguay are the countries where this type of expenditure has greatest effect.

Lastly, in terms of autonomy, it is seen that the decisions taken by school directors and teachers on all major institutional issues have a positive effect in Argentina, Chile and Mexico; but this effect is not significant in the other countries (Benton, 2014).

(b) Mathematics

Table 5 shows the factors that contribute to the results in mathematics.

Table 5
Latin America (8 countries): factors conditioning the acquisition of mathematics skills, 2012

	Independent variable ↓	Argentina	Brazil	Chile	Colombia	Costa Rica	Mexico	Peru	Uruguay
Individual characteristics	*constant*	243.70	375.54	294.16	349.90	374.86	229.23	273.57	357.42
		(20.223)*	(11.971)*	(17.557)*	(22.527)*	(12.773)*	(14.124)*	(16.109)*	(9.347)*
	non-repeater	221.31	101.05	161.01	121.02	88.22	239.09	193.38	130.63
		(32.461)*	(21.946)*	(24.873)*	(31.947)*	(15.222)*	(16.106)*	(23.282)*	(17.966)*
	sex	-38.68	-27.01	-34.91	-38.63	-30.27	-33.31	-36.06	-23.21
		(4.589)*	(2.801)*	(2.793)*	(4.111)*	(2.441)*	(1.993)*	(2.972)*	(2.489)*
	effort	10.84	6.12	7.75	6.52	5.37	9.33	3.98	9.45
		(3.665)*	(2.009)*	(2.439)*	(2.525)*	(1.947)*	(1.789)*	(3.155)	(2.284)*
	discipline	-6.95	3.78	2.28	7.53	2.75	6.24	-2.31	6.68
		(5.640)	(1.983)***	(2.936)	(3.028)**	(2.489)	(2.051)*	(3.668)	(2.839)**
Family characteristics	*books*	9.70	10.84	34.63	21.61	24.72	16.12	27.43	23.12
		(5.078)***	(2.832)*	(2.851)*	(4.342)*	(3.833)*	(2.740)*	(4.405)*	(3.062)*
	educamother	8.06	10.74	11.30	10.09	0.96	-1.17	4.83	1.41
		(3.614)**	(1.774)*	(3.441)*	(3.404)*	(0.261)*	(1.876)	(3.511)	(0.479)*
	educafather	1.95	6.66	20.49	9.00	0.42	6.69	3.04	-2.13
		(3.475)	(1.666)*	(2.833)*	(2.576)*	(1.972)	(1.814)*	(3.711)	(2.192)
	empfather	8.91	-0.04	-6.03	0.54	-1.37	0.65	-0.98	5.34
		(5.418)	(1.754)	(3.930)	(3.538)	(2.797)	(2.307)	(3.607)	(3.145)***
School characteristics	*public*	-8.66	-51.66	-8.80	-24.03	-28.04	-0.35	-25.88	-30.01
		(8.046)	(3.956)*	(4.092)**	(4.557)*	(4.200)*	(3.257)	(5.435)*	(6.686)*
	STRATIO	-0.10	-0.45	-0.76	-0.59	0.17	-0.10	-0.11	-0.64
		(0.107)	(0.046)*	(0.163)*	(0.127)*	(0.044)*	(0.017)*	(0.205)	(0.170)*
	SCMATEDU	-7.88	3.61	1.37	3.30	6.64	1.47	9.15	7.13
		(2.628)*	(0.956)*	(1.300)	(1.403)**	(1.142)*	(0.910)	(1.229)*	(1.287)*
	autonomy	22.47	2.70	14.19	-4.29	-1.36	5.55	-6.39	-5.18
		(7.158)*	(3.432)	(4.897)*	(3.456)	(9.592)	(3.227)***	(11.135)	(3.778)
	SCHSIZE	-0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.00
		(0.008)**	(0.002)*	(0.003)*	(0.001)*	(0.002)*	(0.001)	(0.003)*	(0.003)
	Observations	5 632	16 968	5 898	8 059	4 281	29 614	5 442	4 754
	Instruments	*motivation minumat*	*motivation minumat clasmat*	*motivation minumat clasmat*	*motivation minumat clasmat*	*motivation minumat clasmat*	*motivation pre-school*	*motivation minumat*	*motivation minumat*

Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) on PISA 2012 test.

Note: * significant at 1%, ** significant at 5%, *** significant at 10%. Robust standard deviations in parentheses. Imputation of the omitted data through the hot-deck methodology according to Medina and Galván (2007).

Considering gender differences, in all of the countries included in this research, boys obtained a higher average score than girls in mathematics, similar to the results obtained by Vegas and Petrow (2007). The largest gap occurs in Argentina, Colombia and Peru. Moreover, the effect of the *non-repeater* variable is positive and significant. This estimate coincides with that found by Oreiro and Valenzuela (2013), and Méndez and Zerpa (2011). The students with greatest academic capacity

(greater effect of the non-repeater variable) are from Mexico and Argentina. Effort, on the other hand, has a positive and significant differential effect, except among Peruvian students. In terms of disciplinery climate, a positive and significant relationship is noted in Brazil, Colombia, Mexico and Uruguay. Thus, students who pay attention to the teacher achieve average scores that are 3.7, 7.5, 6.2 and 6.6 points higher than those who do not, respectively. The effect is not significant in Argentina, Chile, Costa Rica and Peru.

In terms of family characteristics, the number of books is a key factor in skill acquisition, with the greatest effect in Chile and Peru. The gap by educational level of the mother in general is positive and significant, as in Hanushek and Luque (2003). This determines a higher average score for students whose mothers completed high school at least. The countries where the mother's education has the greatest impact are Brazil and Chile. In contrast, this is not significant in Peru or in Mexico.

The effect of the father's educational level is positive and significant only in Brazil, Chile, Colombia and Mexico. In these countries, students whose parents have at least completed high school achieve, respectively, 20.4, 9.0, 6.6 and 6.6 points more than those whose father has not attained this educational level. In the cases of Argentina, Costa Rica and Peru, a positive but not significant relationship is calculated. In the case of Uruguay, the relationship is negative and not significant. Lastly, type of employment contract is not a condition for skill acquisition, since the estimated coefficients are not significant, except in Uruguay.

In school-related variables, there are significant gaps between the performance of public and private schools, except in Argentina and Mexico. Brazil and Uruguay display the greatest divergences, as with reading comprehension. Meanwhile, in Chile and Colombia these differences are minor.

Class size has a negative and significant effect (except in Costa Rica). The size of the school has positive and significant effects in all countries, except Argentina (where it is negative and significant) and in Mexico and Uruguay (not significant).

The results for autonomy are ambiguous. In the case of Argentina, Chile and Mexico, the fact that decisions on major institutional issues are taken by the director and teachers of the school favours the performance of students in mathematics. On average, in these countries, schools where there is autonomy score 22.4, 14.1 and 5.5 points more than that in other schools. In Brazil, Colombia, Costa Rica, Peru and Uruguay, the relationship is not significant.

Lastly, the quality of educational materials is positively related to performance in mathematics. The countries where there is a greatest effect are Peru, Uruguay and Costa Rica. It should be noted that Argentina is a special case, since the impact of educational spending on performance is negative.

(c) Sciences

The key factors determining the acquisition of science skills include sex and non-repeater status among the individual characteristics (see table 6). On gender, significant gaps were estimated, as in Vegas and Petrow (2007), with girls scoring worse. In terms of the second factor, the relationship between non-repeater status and academic performance is positive and significant. Students who do not repeat any grade perform better than those who have done so at least once (see Oreiro and Valenzuela, 2013, and Méndez and Zerpa, 2011).

Table 6
Latin America: factors conditioning the acquisition of science skills, 2012

	Independent variable ↓	Argentina	Brazil	Chile	Colombia	Costa Rica	Mexico	Peru	Uruguay
Individual characteristics	*constant*	193.34	403.52	309.39	298.60	365.93	249.65	286.18	374.63
		(27.767)*	(11.480)*	(15.814)*	(35.901)*	(15.541)*	(12.699)*	(12.842)*	(10.428)*
	non-repeater	299.20	51.37	158.77	214.08	123.92	203.04	145.94	109.86
		(44.942)*	(21.133)**	(21.786)*	(51.400)*	(18.022)*	(14.451)*	(18.886)*	(19.980)*
	sex	-26.43	-5.17	-16.58	-40.42	-22.28	-22.71	-19.28	-9.80
		(6.118)*	(2.658)***	(2.731)*	(6.354)*	(2.870)*	(1.767)*	(2.473)*	(2.673)*
	effort	8.06	8.76	7.21	3.61	3.23	8.34	4.51	10.27
		(4.855)***	(1.914)*	(2.520)*	(3.583)	(2.236)	(1.592)*	(2.599)***	(2.407)*
	discipline	-11.50	6.89	4.67	5.40	-0.58	3.15	-1.63	4.12
		(7.742)	(1.907)*	(3.120)	(4.402)	(2.804)	(1.835)***	(3.079)	(3.080)
Family characteristics	*books*	3.51	10.39	28.47	18.05	17.48	15.52	27.31	21.59
		(6.687)	(2.896)*	(2.967)*	(5.916)*	(3.712)*	(2.469)*	(3.678)*	(3.375)*
	educamother	11.16	12.46	8.10	0.87	0.99	0.44	8.73	1.92
		(4.834)**	(1.738)*	(3.450)**	(4.952)	(0.315)*	(1.680)	(2.886)*	(0.507)*
	educafather	2.21	8.71	19.30	10.89	-2.94	8.37	3.66	0.41
		(4.633)	(1.626)*	(2.998)*	(3.731)*	(2.352)	(1.630)*	(3.050)	(2.321)
	empfather	9.99	1.02	-7.76	2.69	-1.06	2.27	-2.24	-0.70
		(7.234)	(1.705)	(4.042)***	(5.279)	(3.276)	(2.012)	(3.056)	(3.401)
School characteristics	*public*	-3.60	-58.60	-9.37	-8.96	-27.70	-1.32	-19.00	-41.90
		(11.119)	(3.786)*	(3.903)**	(6.617)	(4.583)*	(2.911)	(4.456)*	(7.454)*
	STRATIO	-0.07	-0.49	-0.48	-0.51	0.05	-0.10	0.06	-0.20
		(0.150)	(0.045)*	(0.167)*	(0.183)*	(0.046)	(0.015)*	(0.169)	(0.171)
	SCMATEDU	-16.04	2.91	2.30	0.99	3.41	1.86	8.37	6.25
		(3.548)*	(0.945)*	(1.351)***	(2.126)	(1.314)*	(0.822)**	(1.015)*	(1.379)*
	autonomy	29.06	10.31	14.77	-0.24	3.86	8.86	0.78	-11.87
		(9.171)*	(3.219)*	(4.826)*	(5.143)	(11.766)	(2.917)*	(8.681)	(4.036)*
	SCHSIZE	-0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.01
		(0.011)***	(0.002)*	(0.003)*	(0.002)*	(0.002)*	(0.001)	(0.003)*	(0.004)
	Observations	5 632	16 968	5 898	8 059	4 281	29 614	5 442	4 754
	Instruments	*motivation minucie*	*motivation minucie clascie*	*motivation minucie clascie*	*motivation minucie clascie*	*motivation minucie clascie*	*motivation pre-school*	*motivation minucie*	*motivation minucie*

Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) on PISA 2012 test.

Note: * significant at 1%, ** significant at 5%, *** significant at 10%. Robust standard deviations in parentheses. Imputation of the omitted data through the hot-deck methodology according to Medina and Galván (2007).

Among the socioeconomic and cultural characteristics of the student, the key factors are the number of books in the home (Woessmann and others, 2007) and the mother's education (Hanushek and Luque, 2003). Argentina is an exception in the case of books, and Colombia and Mexico are exceptions in relation to the mother's education, since the coefficients associated with these variables were not significant. In terms of the father's education, although the estimated effect on the acquisition of science skills is positive (except in Costa Rica), it is only significant in Brazil, Chile, Colombia and Mexico. In contrast, the results of the father's type of employment contract are more varied. In some cases, the effect is negative and not significant (Costa Rica, Peru and Uruguay), in others, negative and significant (Chile) and, in others, positive and not significant (Argentina, Brazil, Colombia and Mexico).

In the case of school characteristics, average gaps in school performance were also estimated between public and private schools, favouring the latter; but the gaps are not significant for Argentina, Colombia and Mexico. Brazil and Uruguay are the countries with the greatest differences, as was also the case in reading and mathematics. With regard to the student-teacher ratio, the results are similar to those found in reading and mathematics. The effect on school performance is generally negative and significant, although not significant in the cases of Argentina, Costa Rica, Peru and Uruguay. School size has a positive and significant impact, except in the cases of Mexico and Uruguay.

Positive and significant effects are estimated for school autonomy in Argentina, Brazil, Chile and Mexico. In contrast, the effect is negative and significant in Uruguay, and it is not significant in Colombia, Costa Rica and Peru.

Lastly, the estimated coefficients of the quality of educational materials are positive and statistically significant in all countries, except Argentina (negative and significant) and Colombia (not significant).

(d) Decomposition of the causes of performance differences

The unequal scores obtained by the students may reflect differences in the effort they make, which corresponds to the residual part of EPF, or factors beyond their control, in other words the inputs defined in that function: individual, family and school factors.

If r is the result obtained in the PISA tests and C is a matrix of non-controllable factors, the expected test result, conditional on these factors, will be:

$$\hat{r} = \mathrm{E}[r|C] \tag{2}$$

From (2), the variance of the results in the different areas, $\frac{1}{N}\sum_{i=1}^{N}\left(r_i - \bar{r}\right)^2$, can be decomposed as a function of the relative contribution of each explanatory factor included in EPF. This is obtained using the Shapley-Shorrocks methodology,[7] which is based on the calculation of the variance, considering all possible permutations of the explanatory variables encompassed in EPF. As school PISA results are continuous variables of arbitrary mean and variance, the best option for estimating model (2) will be to use a linear function (Ferreira and Gignoux, 2014).

Table 7 displays the Shapley-Shorrocks decomposition by student, home and school characteristics. The variances of the results in mathematics, reading and science in relation to all observations in Latin America are estimated at 0.186, 0.185 and 0.181, respectively. By country, the minimum variance corresponds to Mexico, 0.141 in mathematics and science, and the maximum variance to Chile, 0.373 in mathematics. The validity of these estimates is supported by the low value of the standard errors of the bootstrap resampling method, which is significant at the standard levels with 100 replicas.

The rest of the table displays the variance decomposition percentages, in other words the extent to which school success is affected by individual, family and school characteristics. On average, individual characteristics appear to explain 12% of the variation in school results, family characteristics 28%, and school factors 60%. Individual characteristics play a particularly important role in Colombia and Mexico, family factors stand out in Chile, Colombia and Peru, and school characteristics are key in Argentina, Brazil and Costa Rica.

[7] For a detailed explanation, see Shorrocks (1982).

Table 7

Latin America (8 countries): Shapley-Shorrocks decomposition of the variance in school results, 2012

(Percentages of the variance)

	Latin America			Argentina			Brazil			Chile			Colombia		
	Read	Mathematics	Science	Read	Mathematics	Science	Read	Mathematics	Science	Read	Mathematics	Science	Read	Mathematics	Science
Individual characteristics	18.32	12.75	5.64	14.31	5.36	1.76	21.52	8.05	4.00	7.60	7.75	2.48	11.91	22.52	14.58
Family characteristics	24.77	28.32	30.84	17.22	25.27	25.90	18.93	21.24	22.85	49.14	47.24	47.00	37.53	34.39	39.36
School characteristics	56.91	58.93	63.52	68.47	69.37	72.34	59.55	70.71	73.15	43.26	45.01	50.52	50.56	43.09	46.06
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Var. results[a]	0.186	0.185	0.181	0.277	0.273	0.262	0.222	0.245	0.207	0.343	0.373	0.313	0.159	0.200	0.162
Bootstrap standard error	0.003	0.002	0.002	0.013	0.009	0.009	0.005	0.006	0.005	0.009	0.010	0.009	0.008	0.009	0.008
Observations		81 062			5 632			16 968			5 898			8 059	
R.R.[b]								100							

	Costa Rica			Mexico			Peru			Uruguay		
	Read	Mathematics	Science	Read	Mathematics	Science	Read	Mathematics	Science	Read	Mathematics	Science
Individual characteristics	17.47	15.72	5.11	22.63	15.39	9.17	5.15	8.36	3.87	17.47	7.19	3.67
Family characteristics	16.41	18.26	18.42	18.37	21.84	25.60	34.62	34.59	39.66	23.03	32.65	31.13
School characteristics	66.12	66.02	76.47	59.00	62.77	65.23	60.23	57.05	56.47	59.50	60.16	65.20
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Var. results[a]	0.220	0.249	0.201	0.169	0.141	0.141	0.289	0.304	0.259	0.252	0.251	0.222
Bootstrap standard error	0.009	0.013	0.009	0.004	0.004	0.004	0.010	0.010	0.010	0.009	0.010	0.010
Observations		4 340			29 760			5 442			4 963	
R.R.[b]								100				

Source: Prepared by the authors.

[a] Variance, Ferreira-Gignoux methodology (unscaled).

[b] Bootstrap resampling replicas.

V. Conclusions

This paper identifies the determinants of academic performance in the Latin American countries that participated in the 2012 PISA. When working with education production functions, the presence of endogeneity problems means that the estimated coefficients are inconsistent and biased. For this reason, estimates obtained through multilevel models are suboptimal. This study's methodological contribution stems from its use of the instrumental variables technique, which makes it possible to correct endogeneity problems.

A decomposition of the variance of school results reveals that school characteristics explain most of the variability of results between students (and about 60% of this variability across Latin America as a whole). The next most important factors are family characteristics (28%) and individual ones (12%). School factors play a particularly important role in Argentina, Brazil and Costa Rica; family characteristics are most important in Chile, Colombia and Peru; and individual ones in Colombia and Mexico. A decomposition to identify the contribution of each factor and verify the importance of school-based factors are an innovation in studies on Latin America as a whole.

In the case of individual and family factors, significant gender disparities were estimated, with girls obtaining a higher average score in reading and boys scoring higher in mathematics and science. Grade retention proved to be a determinant of school performance, along with the number of books in the home and the educational level of the mother.

In the case of school factors, the effects are more heterogeneous. Attending a private school is found to have a positive and significant effect in Brazil, Chile, Colombia, Costa Rica, Mexico, Peru and Uruguay. Smaller class size has a positive effect in the schools of Brazil, Chile, Colombia and Mexico. Higher spending on educational materials appears to produce better results, although apparently not in Argentina; and school size has a positive effect, except in Argentina and Uruguay. Lastly, greater school management autonomy benefits students' results in Argentina, Chile and Mexico.

The presence of endogeneity within the Latin American countries' education production function makes it advisable to use consistent and robust techniques that address these problems. In contrast to other techniques, which are common in earlier studies, but where endogeneity among the model's variables is not considered, the use of instrumental variables makes it possible to approximate the true effect of educational inputs on school results.

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Annex A1

Estimation of the model with PISA 2009 data

As a robustness analysis, the estimates in tables 4 to 6 were replicated with PISA 2009 data. As can be seen, the results obtained do not differ significantly from those found for 2012.

Table A1.1
Latin America (10 countries): factors conditioning the acquisition of reading skills, PISA 2009

	ARG	BRA	CHL	COL	CRI	MEX	PAN	PER	URY	VEN
constant	315.57	348.34	285.51	328.80	335.89	308.30	223.94	231.66	337.17	169.93
	(23.610)*	(11.447)*	(28.735)*	(17.931)*	(27.350)*	(7.893)*	(88.753)**	(21.815)*	(11.573)*	(118.951)
non-repeater	143.21	206.51	235.64	196.66	262.58	204.91	265.79	305.64	147.03	346.66
	(30.962)*	(16.371)*	(44.379)*	(24.569)*	(41.803)*	(11.486)*	(120.424)**	(41.728)*	(14.192)*	(172.670)**
sex	22.59	4.59	0.85	3.49	6.67	8.80	3.90	-4.87	18.95	-16.55
	(4.145)*	(3.266)	(5.030)	(3.866)	(4.687)	(1.930)*	(7.975)	(5.282)	(2.857)*	(17.429)
effort	2.08	6.78	4.48	8.02	-3.04	3.62	-2.11	-4.04	2.69	9.06
	(3.926)	(2.889)**	(4.039)	(3.659)**	(4.721)	(1.787)**	(7.868)	(4.503)	(2.576)	(9.491)
discipline	10.61	5.74	8.30	10.58	-6.65	4.93	-5.23	8.86	8.23	-6.38
	(4.243)**	(3.499)	(4.769)***	(5.350)**	(6.194)	(2.395)**	(10.806)	(6.709)	(3.344)**	(11.131)
books	14.83	3.76	26.47	19.54	13.62	18.87	1.72	9.30	17.53	-1.56
	(7.619)***	(7.428)	(6.115)*	(9.011)**	(11.833)	(4.626)*	(14.197)	(10.965)	(4.432)*	(15.731)
educamother	21.48	2.22	17.02	12.93	-13.34	14.41	3.74	-10.33	14.77	3.43
	(5.091)*	(3.351)	(5.342)*	(4.303)*	(6.748)**	(2.052)*	(10.114)	(9.071)	(3.805)*	(15.708)
empfather	9.52	-0.89	-9.14	3.63	-0.78	7.33	-5.39	-5.65	-3.52	21.92
	(6.767)	(3.374)	(6.431)	(5.068)	(7.134)	(2.728)*	(14.243)	(5.960)	(4.314)	(23.214)
public	-28.86	-49.88	-0.56	-21.31	-20.64	-12.15	22.35	-6.34	-30.29	44.24
	(6.415)*	(6.088)*	(5.300)	(6.471)*	(10.110)**	(4.276)*	(54.604)	(8.586)	(6.365)*	(61.015)
STRATIO	0.03	-0.34	-1.02	-0.95	1.11	-0.29	0.60	-0.99	0.79	-0.54
	(0.091)	(0.099)*	(0.233)*	(0.1999)*	(0.479)**	(0.029)*	(0.562)	(0.307)*	(0.212)*	(0.224)**
SCMATEDU	7.38	4.17	4.46	6.50	3.80	2.01	16.20	8.89	1.36	16.29
	(2.170)*	(1.663)**	(1.701)*	(2.040)*	(2.166)***	(1.118)***	(4.956)*	(2.285)*	(1.269)	(4.329)*
autonomy	-4.96	4.96	-3.03	6.39	-19.53	5.76	5.09	13.54	0.36	-4.89
	(4.252)	(2.837)***	(3.872)	(3.629)***	(5.486)*	(2.094)*	(8.141)	(4.604)*	(2.608)	(12.838)
SCHSIZE	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02
	(0.004)	(0.002)	(0.002)*	(0.001)*	(0.006)	(0.001)	(0.016)	(0.004)*	(0.003)	(0.010)***
Observations	2 485	10 976	3 194	5 866	3 403	27 172	1 950	4 686	3 988	1 660

Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) on PISA 2009 test.
Note: * significant at 1%, ** significant at 5%, *** significant at 10%. Robust standard deviations in parentheses.

Table A1.2
Latin America (10 countries): factors conditioning the acquisition of mathematics skills, PISA 2009

	ARG	BRA	CHL	COL	CRI	MEX	PAN	PER	URY	VEN
constant	344.07	385.70	294.99	329.84	359.21	334.95	267.97	293.87	373.24	243.21
	(16.278)*	(9.064)*	(26.479)*	(15.719)*	(21.377)*	(7.177)*	(78.365)*	(18.268)*	(9.751)*	(85.576)*
non-repeater	107.51	149.90	217.52	176.96	212.80	179.02	220.13	240.25	131.49	211.27
	(23.083)*	(12.893)*	(41.318)*	(21.674)*	(32.489)*	(10.385)*	(111.873)**	(34.484)*	(11.980)*	(124.853)***
sex	-18.72	-33.39	-38.69	-39.02	-31.79	-28.19	-23.10	-39.87	-33.52	-37.60
	(3.862)*	(2.579)*	(4.646)*	(3.349)*	(3.727)*	(1.764)*	(6.926)*	(4.259)*	(2.478)*	(12.108)*
effort	-1.19	3.05	1.94	8.00	-4.74	4.16	4.83	-2.77	-0.74	2.95
	(3.427)*	(2.267)	(3.789)	(3.198)**	(3.733)	(1.610)*	(6.616)	(3.657)	(2.259)	(5.994)
discipline	8.58	4.24	8.55	10.10	-5.29	3.95	-1.50	6.62	5.66	0.01
	(3.894)**	(2.795)	(4.459)***	(4.585)**	(4.974)	(2.159)***	(8.707)	(5.343)	(2.873)**	(7.102)
books	17.87	7.72	31.09	26.57	8.22	20.94	22.08	11.12	24.99	8.50
	(6.487)*	(5.869)	(5.883)*	(7.468)*	(9.007)	(4.208)*	(14.779)	(8.998)	(4.011)*	(10.598)
educamother	15.68	2.62	15.39	13.13	-6.21	13.27	-6.30	-0.62	14.92	20.59
	(4.314)*	(2.665)	(4.996)*	(3.793)*	(5.367)	(1.858)*	(9.299)	(7.291)	(3.368)*	(10.800)***
empfather	9.93	0.21	-4.50	-5.64	-9.46	4.19	-16.69	-10.26	-2.03	9.75
	(5.885)***	(2.612)	(5.924)	(4.254)	(5.733)***	(2.448)***	(13.003)	(4.875)**	(3.709)	(15.496)
public	-19.86	-65.18	0.40	-18.26	-17.75	-10.21	9.92	-18.28	-24.62	41.30
	(5.087)*	(4.861)*	(4.918)	(5.810)*	(8.043)**	(4.170)**	(49.118)	(7.035)*	(5.493)*	(42.045)
STRATIO	-0.01	-0.22	-1.54	-0.85	0.89	-0.24	0.65	-1.33	0.82	-0.60
	(0.065)	(0.076)*	(0.223)*	(0.172)*	(0.377)**	(0.026)*	(0.538)	(0.254)*	(0.187)*	(0.142)*
SCMATEDU	10.05	2.94	4.76	6.27	5.41	3.34	14.45	7.99	3.56	14.62
	(2.013)*	(1.322)**	(1.585)*	(1.802)*	(1.751)*	(1.098)*	(4.004)*	(1.868)*	(1.103)*	(2.790)*
autonomy	-4.40	2.37	1.88	7.09	-16.71	5.62	3.62	8.77	3.39	-4.34
	(3.710)	(2.235)	(3.600)	(3.192)**	(4.283)*	(1.865)*	(7.572)	(3.751)**	(2.281)	(8.751)
SCHSIZE	0.01	0.00	0.01	0.01	-0.01	0.00	0.00	0.01	-0.01	0.03
	(0.004)***	(0.002)	(0.002)*	(0.001)*	(0.004)	(0.000)	(0.016)	(0.003)*	(0.002)**	(0.007)*
Observations	1 994	10 976	3 194	5 866	3 403	27 172	1 903	4 686	3 981	1 660

Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) on PISA 2009 test.
Note: * significant at 1%, ** significant at 5%, *** significant at 10%. Robust standard deviations in parentheses.

Table A1.3
Latin America (10 countries): factors conditioning the acquisition of science skills, PISA 2009

	ARG	BRA	CHL	COL	CRI	MEX	PAN	PER	URY	VEN
constant	317.37	390.64	318.85	367.09	374.51	338.22	149.89	274.51	347.51	242.73
	(30.387)*	(9.809)*	(27.390)*	(15.844)*	(22.095)*	(6.718)*	(169.262)	(18.803)*	(11.098)*	(88.688)*
non-repeater	169.84	167.24	217.65	172.59	207.84	167.99	384.86	253.86	155.80	239.19
	(48.917)*	(13.936)*	(42.761)*	(21.940)*	(33.925)*	(9.701)*	(237.546)	(35.974)*	(13.325)*	(129.713)***
sex	-8.61	-22.94	-26.52	-27.50	-23.94	-20.31	-30.00	-26.64	-22.88	-32.67
	(5.978)	(2.810)*	(4.768)*	(3.390)*	(3.850)*	(1.708)*	(13.680)**	(4.485)*	(2.811)*	(13.220)**
effort	-2.45	4.53	5.12	8.00	-0.13	4.62	-9.72	0.17	1.97	5.72
	(4.308)	(2.483)***	(3.908)	(3.220)**	(3.885)	(1.575)*	(11.934)	(3.847)	(2.551)	(6.877)
discipline	-1.77	4.32	8.85	6.86	-3.25	3.37	-6.73	8.21	10.76	0.21
	(4.826)	(3.021)	(4.569)***	(4.696)	(5.102)	(2.118)	(16.402)	(5.671)	(3.317)*	(7.953)
books	11.39	6.42	31.78	29.05	13.42	21.22	-1.08	8.36	17.62	8.91
	(7.942)	(6.949)	(5.736)*	(7.525)*	(9.424)	(4.092)*	(23.054)	(9.275)	(4.510)*	(11.909)
educamother	20.35	2.93	9.76	10.94	-11.85	16.89	-5.46	-11.13	14.74	15.69
	(7.559)*	(2.918)	(5.091)***	(3.783)*	(5.653)**	(1.823)*	(17.478)	(7.726)	(3.723)*	(12.015)
empfather	2.82	-0.30	-9.71	-4.81	0.68	3.40	-15.58	-7.55	-5.15	26.67
	(8.170)	(2.899)	(6.002)	(4.347)	(5.814)	(2.362)	(24.547)	(5.065)	(4.133)	(16.381)
public	-17.95	-59.28	-2.15	-26.48	-32.77	-15.08	122.05	-14.25	-18.52	15.03
	(9.101)**	(5.150)*	(5.015)	(5.556)*	(8.312)*	(3.769)*	(114.428)	(7.347)***	(6.090)*	(44.987)
STRATIO	0.23	-0.27	-1.25	-1.14	0.74	-0.27	1.22	-0.81	1.00	-0.30
	(0.111)**	(0.087)*	(0.226)*	(0.180)*	(0.391)***	(0.026)*	(1.198)	(0.261)*	(0.205)*	(0.163)***
SCMATEDU	6.39	2.64	3.54	4.50	2.01	2.99	30.17	7.23	1.53	14.88
	(2.825)**	(1.392)***	(1.635)**	(1.765)**	(1.792)	(0.967)*	(9.193)*	(1.959)*	(1.263)	(3.193)*
autonomy	-1.06	1.57	-0.61	2.57	-13.52	7.02	8.93	10.78	0.22	-6.03
	(5.154)	(2.455)	(3.680)	(3.197)	(4.470)*	(1.851)*	(12.664)	(3.918)*	(2.581)	(9.452)
SCHSIZE	0.00	-0.01	0.01	0.00	0.00	0.00	-0.03	0.01	-0.01	0.02
	(0.006)	(0.002)**	(0.002)*	(0.001)***	(0.005)	(0.000)	(0.033)	(0.003)*	(0.003)	(0.008)***
Observations	2 011	10 976	3 194	5 866	3 403	27 172	1 699	4 686	3 929	1 660

Source: Prepared by the authors, on the basis of data from the Organization for Economic Cooperation and Development (OECD) on PISA 2009 test.
Note: * significant at 1%, ** significant at 5%, *** significant at 10%. Robust standard deviations in parentheses.

The impact of fiscal decentralization on growth, inflation and inequality in the Americas

Antonio N. Bojanic[1]

Abstract

This paper analyses the impact of fiscal decentralization on economic growth, inflation and Gini coefficients in 12 countries of the Americas. The findings suggest that the positive impact of this process has been more modest than anticipated, with revenue decentralization having a detrimental effect on economic growth and expenditure decentralization a positive one in developing nations of the Americas. Regarding the impact on income inequality, the results indicate that fiscal decentralization can play an important role in reducing this, particularly on the revenue side, but when decentralization is analysed in developing nations of the Americas only, fiscal decentralization is shown to accentuate rather than mitigate income inequality, which highlights the significant amount of work that is yet to be done before this process delivers on expectations. The findings for the impact of fiscal decentralization on price stability are inconclusive.

Keywords

Fiscal policy, tax administration, decentralization in government, economic growth, inflation, income distribution, price stabilization, measurement, North America, Latin America

JEL classification

E62, H70, O10, O50

Author

Antonio N. Bojanic is professor of practice with the Department of Economics at Tulane University. Email: abojanic@tulane.edu.

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I. Introduction

For most countries in Latin America, the last three decades have been a period of significant devolution of government activities and functions to subnational government structures, particularly at the regional, municipal and local levels. More mature and entrenched democracies with institutions that are increasingly reflecting the demands of specific constituencies, a desire for greater representation of different subgroups and regions within societies, and the realization that there may be efficiency gains from transferring responsibilities to the areas and communities most directly affected by government interventions are among the reasons for this trend towards decentralization of government activities.

The main subject of this study is fiscal decentralization, which occurs when central governments transfer certain revenue and expenditure responsibilities to subnational levels of government. Economic research on this topic has for the most part concentrated on how fiscal decentralization impacts governance and economic growth, but more recent efforts have begun analysing the ways in which it affects poverty, income distribution and fundamental rights, including civil and political rights as well as economic freedom.

Although current research has extensively studied the impact of decentralization on growth, no clear-cut conclusions have emerged, particularly when the process of decentralization is analysed from the perspective of developing nations. The lack of conclusive evidence is even more evident when the impact of decentralization on other variables such as income distribution and economic stability is examined. This paper aims to help bridge some of the gaps in current research by analysing how fiscal decentralization has impacted economic growth, inflation and income inequality in a region of the world where the issue of decentralization has been at the forefront of structural reforms for several decades.

The rest of the paper is organized as follows. Section II presents a brief review of the literature on the relationship between fiscal decentralization, growth, economic stability and inequality. Section III introduces the theoretical arguments for the expected impact of decentralization on the principal variables of interest. Section IV presents the data and methodology and section V the analysis of the empirical results. Section VI summarizes the principal findings and analyses their policy implications.

II. Literature review

One of the main areas of economic research into fiscal decentralization deals with its effects on economic growth. Several studies have carried out cross-country and country-specific analyses of the issue, mostly but not exclusively in developed nations. A related theme is the way decentralization has affected economic stability, and there has also been significant research on this topic. The most recent areas of interest are the impacts on poverty, income inequality and fundamental human liberties. A brief review of some of the most important works on this array of topics is presented below.

Cross-country studies of the way fiscal decentralization impacts economic growth are many. Important early contributions include Davoodi and Zou (1998), who worked with data for 46 countries and found a negative correlation between fiscal decentralization and growth in developing nations, but none in developed economies. Martínez-Vázquez and McNab (2003) concluded that while fiscal decentralization might in fact have an impact on growth, the theoretical underpinnings for this relationship remained underdeveloped and hence no definite answer could be provided. Martínez-Vázquez and McNab (2006) found that when a negative correlation between decentralization and growth was established for developed countries, it could be offset by the positive impact of decentralization on macroeconomic stability. Thornton (2007) worked with data for 19 countries of the Organization for Economic Cooperation and Development (OECD) and found that when fiscal decentralization was measured only by the revenues over which subnational governments had full autonomy, its impact on economic growth was not statistically significant.

More recent works include Rodríguez-Pose and Ezcurra (2011), reviewing a set of 21 OECD countries and finding a significant negative association between fiscal decentralization and economic growth, despite the inclusion of several control variables and adjustments to account for differences in expenditure preferences by subnational governments. Amagoh and Amin (2012) concluded that while there might be benefits from fiscal decentralization, its impact on growth was constrained by a number of factors that depended on the contexts of the societies involved. Baskaran and Feld (2013) found, also for a set of OECD countries, that fiscal decentralization appeared to have a statistically insignificant negative effect on growth when proxied by standard indicators of the Government Finance Statistics (GFS) type, but a statistically significant negative impact when new indicators reflecting the degree of subnational tax autonomy were used. Gemmell, Kneller and Sanz (2013) found for a set of OECD countries that spending decentralization had tended to be associated with lower economic growth and revenue decentralization with higher growth. Blöchliger (2013) found a positive association between fiscal decentralization and GDP per capita in OECD countries, with revenue decentralization having a greater impact than spending decentralization. Representative works for individual countries include Xie, Zou and Davoodi (1999) for the United States, Yifu Lin and Liu (2000) for China and Rao (2000) for India.

On the issue of economic stability and the way fiscal decentralization affects it, representative works include Neyapti (2004), which takes a set of countries with varying levels of inflation and finds that revenue decentralization has a negative impact on inflation in higher-inflation countries if accompanied by both central bank independence and local accountability, while in lower-inflation countries the negative impact on inflation remains without the need for additional factors; Neyapti (2010), which analyses the topic of fiscal discipline and concludes that for a set of 16 countries expenditure and revenue decentralization reduces budget deficits; Rodden, Eskeland and Litvack (2003), which analyses the issue of how fiscal discipline is maintained when lower levels of government take responsibility from national authorities and examines how "hard" and "soft" budget constraints impact economic stability in countries with varying degrees of political and institutional development; and Jalil, Harun and Che Mat (2012), which focuses on price stability for 62 countries and finds that decentralization appears to lower the inflation rate to an extent that depends on the level of corruption in political institutions. Country-specific studies include Bodman and others (2009) for Australia, Iqbal and Nawaz (2010) for Pakistan and Okonkwo and Godslove (2015) for Nigeria.

Concerning fiscal decentralization, poverty and income distribution, significant contributions include Boex and others (2006), which in addition to providing a comprehensive survey of the literature on the topic offers a set of qualitative suggestions for conducting decentralization reforms from a pro-poor perspective; Sepúlveda and Martínez-Vázquez (2011), which takes a large dataset of countries and finds that fiscal decentralization appears to reduce poverty as long as the share of subnational expenditures is no greater than one third of total government expenditures, and also to reduce income inequality, but only if general government represents a significant share of the economy; Goerl and Seiferling (2014), which takes a large dataset of countries and finds that the decentralization of government expenditures can help achieve a more equal distribution of income if a number of conditions are met; and Sacchi and Salotti (2014), which looks at a set of OECD countries and finds that a higher degree of tax decentralization is associated with higher household income inequality. At the individual country level, a sample of works includes Moon (2003) for South Korea, Song (2013) for China and Cavusoglu and Dincer (2015) for the United States.

A recent area of research involves analysis of the impact of fiscal decentralization on what can be described as fundamental human rights, a term that encompasses both civil and political rights and economic freedom. Although this line of research is not new in other areas of the social sciences, as can be seen in the early contribution by Kaufman (1969) and a great many subsequent articles, such as Michels (2011) and Islam (2015), it has been little explored in economics. Notable exceptions include Weingast (2009) and Bojanic (2016).

III. The theoretical foundations for the relationship between fiscal decentralization, growth, inflation and income inequality

Analysis of current research on fiscal decentralization and its impact on a range of indicators leaves an impression of uncertainty about how decentralization will affect variables such as growth, economic stability and income inequality. However, the fact that empirical work has not provided a clear picture in its current state has not prevented economists from hypothesizing about the ways in which decentralization is expected to affect these very variables. The most recent theoretical work will be briefly summarized here and an attempt made to highlight the issues that are likely to play an important role in our understanding of how fiscal decentralization affects growth, price stability and income distribution in the Americas.

Concerning the potential growth impact of fiscal decentralization, there is already a significant body of theoretical work on the subject (see, for instance, Oates, 1993; Brueckner, 2005; Martínez-Vázquez and McNab, 2006), and the answer seems to hinge on whether a central authority is best able to utilize fiscal policy to attain long-term growth, or whether a decentralized structure for administering public funds is more capable of delivering outcomes that will translate into growth. While most researchers seem to agree that a positive correlation between decentralization and growth should be expected, owing to better targeting of growth-enhancing infrastructure and greater incentives to save in decentralized regimes, the important qualifier is that the political and institutional context of the country where decentralization is taking place matters. The inference, then, is that although a positive correlation between fiscal decentralization and economic growth is expected, the state of development of an economy will determine whether the decentralization process is able to resolve into policies that generate growth over time.

As regards the impact of fiscal decentralization on inflation, Martínez-Vázquez and McNab (2006) and Treisman (2000), among others, have developed a theoretical framework for the ways in which decentralization is likely to affect price stability. Without hypothesizing about the specific direction in which price stability is likely to be affected by decentralization, their empirical work tends to show that in (mostly) developed economies there is an inverse correlation between inflation and fiscal decentralization, implying that lower inflation levels are more likely in those nations with more decentralized regimes, while the opposite seems to be true in less developed economies, where decentralization may actually generate higher inflation. From the perspective of countries in the Americas, an important consideration is that one of the principal reasons for the very high inflation rates they have experienced over time is unrestrained government expenditure, with a significant percentage of this occurring at lower levels of government. This draws attention to the very real concern that devolving this specific function to subnational levels of government may once again foster inflationary pressures.

Theoretical work on the way income distribution is affected by fiscal decentralization is not as developed as that for growth and economic stability. An important exception is Beramendi (2003), which offers a theoretical model for analysing how decentralization interacts with the politics of redistribution and inequality and argues that decentralization in itself does not necessarily lead to higher (or lower) levels of income inequality, but rather inequality is to a large extent a function of regions' internal social and political structures. Empirical studies are more numerous and include, among others, Durham (1999), Sepúlveda and Martínez-Vázquez (2011) and, more recently, Goerl and Seiferling (2014). From the perspective of this article, if growth is assumed to be a necessary but not sufficient condition for any increase in income equality, as argued by Kuznets (1995), then fiscal decentralization, to the extent that it is expected to have a positive impact on growth, should also eventually bring greater income equality.

Coupled with the theoretical and empirical findings just described, two important additional factors to consider regarding decentralization in developing nations of the Americas are the limited institutional

ability of subnational levels of government to collect their own revenues and the very real economic, political and cultural disparities that exist within and between countries.

An inability to collect their own revenues makes subnational governments dependent on central government transfers. This situation creates inefficiencies, as these transfers may not be automatic and may be tied to political calculations. The regional disparities within and between countries mean that decentralization in the developing part of the American hemisphere has taken place in very heterogeneous settings, and hence it should not be surprising that the degree of decentralization varies not only between countries but also between regions within each country. Issues of income inequality, the degree of urbanization, territorial imbalances and literacy rates are but a few of the factors that may affect how the process of decentralization is able to take hold in a particular setting. The point is that in the context of decentralization in this part of the world, regional disparities and the dependence of subnational governments on central government for tax collection are likely to play a significant role in the effectiveness and usefulness of fiscal decentralization.

IV. Data and methodology

One of the most significant challenges for a cross-country study of fiscal decentralization is properly measuring the extent of decentralization in several layers of government. A related issue when the study focuses on (mostly) developing nations is the difficulty of finding reliable and credible data. An optimal scenario would be one in which the dataset constructed was fully comparable across countries and truly reflected the autonomous decisions of subnational governments. As might be expected, constructing such a dataset is a formidable undertaking, not least because it requires knowledge of the degree of autonomy of subnational governments over revenue collection and expenditure decisions. It also calls for a thorough understanding of each nation's tax system, and particularly the structure of revenue-sharing between regions, the nature of grants and transfers between the central government and subnational levels of government, and the overall level of regional political autonomy. Given the difficulty of finding decentralization indicators that successfully identify all these, the standard practice in the economics literature has been to utilize data collected by the International Monetary Fund (IMF) and reported in its Government Finance Statistics Yearbook (GFSY)[2] as the primary source for revenue and expenditure data at national (general) and subnational levels of government. Although GFSY does not report the nature of government transfers or identify whether transfers and grants are under the control of the national or subnational levels, and indeed does not currently have disaggregated data for many developing nations, it is also the primary data source for the present study, albeit not the only one, since revenue decentralization data from OECD,[3] the Economic Commission for Latin America and the Caribbean (ECLAC)[4] and, when possible, the national institutes of statistics or comparable government institutions of each country have been used in addition to those of the GFSY.[5]

The standard measures of fiscal decentralization utilized in most decentralization studies are the ratio of total subnational government revenues to general government revenues and the ratio of total subnational government expenditures to general government expenditures. These two fiscal decentralization indicators are also used here. The GFSY, OECD, ECLAC and national data provide

[2] See [online] http://www.imf.org/external/pubs/ft/gfs/manual/comp.htm.

[3] See [online] www.oecd.org/ctp/federalism/fiscal-decentralisation-database.htm.

[4] See [online] http://estadisticas.cepal.org/cepalstat/portada.html?idioma=english.

[5] Decentralization data for the Plurinational State of Bolivia are easily obtainable from the country's National Institute of Statistics (www.ine.gob.bo). Likewise, data on Argentina can be obtained from the Federal Tax Commission of Argentina (www.cfi.gov.ar) and from the Ministry of Treasury and Public Finance of Argentina (www.economia.gob.ar). For the rest of the developing countries of the Americas in this study, obtaining decentralization data from a national government entity was more challenging, so use was made of the data reported by one or more of GFSY, OECD and ECLAC.

information at the consolidated general government level and, for some countries, at the regional, state and local government levels. Revenues (expenditures) at subnational levels of government (regional, state and local) were added together to come up with a single figure for subnational government revenues (expenditures). Of the 23 countries in the Americas (excluding the Caribbean), data disaggregated between the general and subnational levels of government are available for 12 nations, and this study accordingly focuses on this subsample for which data are available.[6] Yearly observations run from 1972 to 2015, although the dates of the data available for the 12 countries do not necessarily coincide. Depending on (i) whether the revenue or expenditure decentralization indicators are used as regressors, (ii) the specific methodology utilized in estimating a regression and (iii) the dependent variable of the model (per capita GDP growth, the inflation rate or the Gini coefficient), the number of observations ranges from a low of 91 to a high of 208. The end result is an unbalanced panel dataset with a maximum of 208 observations for 12 countries of the Americas running from 1972 to 2015. Although there are significant gaps in the dataset, it was decided that no averages or linear approximations should be used to fill in the gaps, with the actual dataset instead being allowed to speak for itself.

The three dependent variables utilized here are per capita GDP growth,[7] the inflation rate and the Gini coefficient. The control variables for the set of regressions relating to fiscal decentralization and economic growth are the inflation rate (expressed as a percentage); gross domestic savings (percentage of GDP) as a proxy for capital formation; openness to international trade ((exports + imports)/GDP, expressed as a percentage); remittances (percentage of GDP); foreign direct investment (FDI) (percentage of GDP); unemployment rate (percentage); general government final consumption expenditures (percentage of GDP) as a proxy for the size of government; urban population (percentage); and a political and civil liberties ratio as a measure of political stability and basic rights.[8] With the inflation rate as the dependent variable, control variables include GDP per capita in levels (at purchasing power parity, in logs), openness to international trade, general government final consumption expenditures, military expenditures (as a percentage of GDP), FDI and remittances. Finally, when the Gini coefficient is the dependent variable, the control variables are GDP per capita in levels and GDP per capita squared, to take account of what Kuznets (1955) hypothesizes about per capita income growth initially increasing inequality but eventually reducing it; urban population; openness to international trade; a political and civil liberties ratio to attempt to capture the extent to which basic human rights affect inequality; remittances; gross domestic savings; general government final consumption expenditures; the inflation rate; Internet users (per 100 people); and the unemployment rate.[9]

The particular specifications for each case conform to previous research on similar topics, but additional control variables have been included where deemed pertinent, namely remittances and a political and civil liberties ratio when economic growth is the dependent variable, remittances when it is the inflation rate, and a political and civil liberties ratio, Internet users and the unemployment rate when it is the Gini coefficient.

Where the model specification is concerned, different regression methodologies were used to deal with information limitations and gaps within an unbalanced panel dataset, the likely correlation of observations within and across sections and the very wide variability of data for the countries in the sample. Specifically, generalized least squares (GLS) and instrumental variables regressions were estimated to

[6] The 12 countries included in this study are Argentina, Brazil, Canada, Chile, Colombia, Costa Rica, El Salvador, Mexico, Paraguay, Peru, the Plurinational State of Bolivia and the United States.

[7] Figures for per capita GDP growth are calculated in purchasing power parity.

[8] The source for this combined ratio is Freedom House, which compiles separate indices of political rights and civil liberties and prepares qualitative assessments of the degree of liberty in each country. Here, the two indices and the qualitative assessments have been combined into a single index of political and civil liberties ranging from 0.18 (most free) to 1.00 (least free). See [online] http://freedomhouse.org/report-types/freedom-world#.VY_fWI1RHcw.

[9] Excepting political and civil liberties, the source for all variables is the World Bank. See [online] http://data.worldbank.org/data-catalog/world-development-indicators.

allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation,[10] as were GLS with fixed and random cross-sectional effects to allow, respectively, for omitted variable bias and for the impacts of time-invariant variables. Additionally, generalized method of moments (GMM) regressions were estimated to reflect the dynamic nature of the relationship between fiscal decentralization, growth, inflation and income inequality.[11]

V. The results of the empirical analysis

As an introduction to the empirical analysis, table 1 reports summary statistics for the 12 countries of the Americas analysed in this study, including the time period covered by each decentralization indicator.

Table 1
The Americas (12 countries):[a] decentralization indicators and summary statistics

Country	Subnational government revenues as proportion of general government revenues *(%)*				Subnational government expenditures as proportion of general government expenditures *(%)*			
	Period	Average whole period	Highest (year)	Lowest (year)	Period	Average whole period	Highest (year)	Lowest (year)
Argentina	1990, 2000, 2005, 2007-2015	37.35	45.59 (2015)	21.17 (2005)	1980-2013	42.52	51.51 (2006)	24.05 (1982)
Bolivia (Plurinational State of)	1985-2014	31.05	46.17 (2003)	15.14 (1985)	1986-2014	27.57	36.98 (1997)	14.95 (1986)
Brazil	2000-2014	54.01	62.47 (2014)	49.19 (2005)	2006-2012	52.34	54.73 (2008)	50.76 (2009)
Canada	1979-2014	72.59	78.10 (2010)	69.35 (1989)	2000-2014	73.30	77.59 (2014)	68.19 (2000)
Chile	1974-2014	8.56	14.06 (2002)	2.75 (1974)	2000-2001	13.35	13.50 (2000)	13.20 (2001)
Colombia	1990, 1998-2003, 2005, 2010, 2014	33.94	46.39 (1999)	20.56 (2005)	1998-2000	39.33	40.16 (2000)	38.76 (1998)
Costa Rica	2000-2014	5.01	6.95 (2007)	3.19 (2000)	2002-2007	3.98	6.35 (2005)	3.08 (2002)
El Salvador	2002-2010	7.61	10.11 (2009)	4.54 (2002)	-	-	-	-
Mexico	1972-2013	29.63	44.76 (2009)	18.96 (1989)	1990-2013	44.58	59.66 (1997)	27.60 (1990)
Paraguay	2005-2012	8.92	10.86 (2012)	7.73 (2010)	2005-2012	9.34	11.17 (2012)	8.02 (2010)
Peru	1995-2012	30.42	39.19 (2009)	21.50 (1998)	1995-2012	30.00	40.88 (2012)	21.08 (1998)
United States	1980-2014	56.13	60.77 (1992)	51.48 (2013)	1990-2014	51.50	59.85 (2000)	46.27 (2011)

Source: Prepared by the author on the basis of data from International Monetary Fund (IMF) [online] http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221; Organization for Economic Cooperation and Development (OECD) [online] www.oecd.org/ctp/federalism/fiscal-decentralisation-database.htm; Economic Commission for Latin America and the Caribbean (ECLAC) [online] http://estadisticas.cepal.org/cepalstat/portada.html?idioma=english; Federal Tax Commission of Argentina [online] www.cfi.gov.ar; Ministry of Treasury and Public Finance of Argentina [online] www.economia.gob.ar; and National Institute of Statistics of the Plurinational State of Bolivia [online] www.ine.gob.bo.

[a] Argentina, Brazil, Canada, Chile, Colombia, Costa Rica, El Salvador, Mexico, Paraguay, Peru, the Plurinational State of Bolivia and the United States.

The summary statistics demonstrate that there is a great deal of variation between the countries of the Americas in their degree of fiscal decentralization. Of all the countries included in the analysis, Canada is the most decentralized, with both the revenue and expenditure indicators averaging well over 70%.[12] Costa Rica, El Salvador and Paraguay are at the other end of the spectrum, with average

[10] With both the GLS and instrumental variables regressions, the Prais-Winsten panel-corrected standard error (PCSE) within estimator was estimated to correct for serial correlation (cross-sectional and between-period correlation).

[11] The GMM regressions were estimated using the PCSE method to take account of cross-sectional and between-period correlation.

[12] As defined in section IV, the revenue (expenditure) decentralization indicator is the ratio of subnational government revenues (expenditures) to general government revenues (expenditures).

decentralized revenues and expenditure alike in the single digits.[13] Between these two extremes, the degree of fiscal decentralization in the rest of the countries is not homogeneous, with nations like Brazil and the United States showing significant degrees of decentralization (revenue and expenditure decentralization indicators at around the 50% level) that do not however approach that in Canada. In the remaining group of countries, Argentina and Colombia seem to tilt towards greater decentralization, with average revenue and expenditure percentile indicators in the high thirties or low forties, while Mexico, Peru and the Plurinational State of Bolivia fall somewhere in between, with both indicators averaging around 30%.[14] Chile leans to a lower level of decentralization, with revenue decentralization in the high single digits and expenditure decentralization in the low teens. It is also noteworthy that while the raw data seem to suggest an increasing degree of decentralization for most countries as time passes, this is not true for all, as demonstrated by the United States, where both revenue and expenditure decentralization indicators seems to show a downward trend over time.

Regression results showing the impact of fiscal decentralization on GDP per capita, inflation and the Gini coefficient are reported in two sets, the first including all 12 countries and the second excluding Canada and the United States, the two nations with arguably the most developed and stable decentralization regimes in the hemisphere. Excluding these two nations has the benefit of showing the fiscal decentralization situation from the perspective of developing countries of the Americas only.

The impact of fiscal decentralization on growth is analysed first. Table 2 presents regression results when all 12 countries are included and the dependent variable is per capita GDP growth.

The five columns in table 2 report estimates for the five methodologies described in section IV. In the first, a GLS model reflecting cross-sectional and intrasectional heteroskedasticity and autocorrelation is presented. The second and third columns report GLS models with fixed and random cross-sectional effects. The fourth and fifth columns report estimates for when the variables are instrumented and when GMM is used. The instrumental variables and GMM specifications were estimated in consideration of both cross-sectional and intrasectional heteroskedasticity and autocorrelation. Additionally, each column contains two regression results: the first shows estimates for when the fiscal decentralization indicator is based on revenue and the second for when it is based on expenditure.

As is evident from the results reported, the revenue-based fiscal decentralization indicator consistently shows a negative impact on economic growth. The coefficients for this variable in all specifications are negative, of approximately equal size, and statistically significant in all cases, excepting the GLS specification with fixed effects. On the expenditure side, the fiscal decentralization variable is mostly positive but only statistically significant when estimated with GMM, which is consistent with the assumptions made in section III, particularly the supposition that decentralized expenditures were more likely to be targeted at growth-enhancing investment projects.[15] Taken as a whole, however, the empirical evidence does not conclusively support the hypothesis that decentralization is conducive to growth, particularly where revenue decentralization is concerned.

[13] In El Salvador, the level of decentralization is only this low on the revenue side.

[14] In Mexico, the degree of decentralization on the expenditure side is quite high, averaging around 45% for the 1990-2013 period. On the revenue side, the indicator averages only around 30%, but this may reflect the longer time period (1972-2013).

[15] When the specification is instrumented, the expenditure decentralization variable is found to be negative and statistically significant at the 10% level, drawing attention to the weakness of the statistical evidence found in this study to support the expected positive impact of fiscal decentralization on economic growth.

Table 2
The Americas (12 countries):[a] fiscal decentralization and GDP per capita

	Generalized least squares to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized least squares with cross-sectional fixed effects and no weights		Generalized least squares with cross-sectional random effects and no weights		Instrumental variables to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized method of moments	
Revenue decentralization *(%)*	-0.057**		-0.066		-0.056**		-0.067***		-0.073**	
	(2.002)		(0.057)		(0.024)		(0.017)		(0.037)	
Expenditure decentralization *(%)*		0.008		0.120		0.001		-0.045*		0.160***
		(0.019)		(0.084)		(0.031)		(0.024)		(0.049)
Inflation rate *(%)*	0.001	-0.005***	0.001	-0.005***	0.001	-0.004***	-0.016	-0.001	-0.004	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.012)	(0.003)	(0.006)	(0.001)
Gross domestic savings *(% of GDP)*	0.295***	0.208***	0.304***	0.148	0.247***	0.148	0.257***	0.242***	0.526***	0.367***
	(0.043)	(0.058)	(0.092)	(0.169)	(0.069)	(0.106)	(0.052)	(0.077)	(0.064)	(0.119)
Openness to international trade ((X + M)/GDP) *(%)*	-0.061**	-0.010	-0.022	-0.005	-0.051**	-0.001	-0.048***	-0.005	-0.226***	-0.111*
	(0.013)	(0.014)	(0.049)	(0.093)	(0.020)	(0.025)	(0.015)	(0.017)	(0.025)	(0.066)
Remittances *(% of GDP)*	0.306***	-0.204	0.044	-0.494	0.285**	-0.289	0.228***	-0.062	0.433*	-0.777***
	(0.067)	(0.190)	(0.359)	(0.487)	(0.118)	(0.336)	(0.084)	(0.262)	(0.258)	(0.249)
Foreign direct investment *(% of GDP)*	-0.055	-0.016	0.121	-0.325	-0.080	-0.088	-0.345***	-0.080	0.133	-0.573***
	(0.070)	(0.077)	(0.143)	(0.203)	(0.110)	(0.147)	(0.117)	(0.116)	(0.088)	(0.079)
Unemployment rate *(% of total labour force)*	-0.203**	-0.220***	-0.232**	-0.443***	-0.274***	-0.327***	-0.143*	-0.150*	-0.372***	-0.476***
	(0.057)	(0.054)	(0.120)	(0.138)	(0.089)	(0.091)	(0.085)	(0.079)	(0.071)	(0.072)
General government final consumption expenditure *(% of GDP)*	0.045	-0.266***	-0.003	-0.574***	0.073	-0.293**	0.025	-0.095	-0.858***	-0.726***
	(0.062)	(0.073)	(0.210)	(0.197)	(0.114)	(0.114)	(0.075)	(0.116)	(0.175)	(0.072)
Urban population *(% of total)*	-0.067**	-0.019	-0.155	-0.051	-0.042	0.004	-0.055*	-0.011	-0.043	0.181
	(0.029)	(0.030)	(0.129)	(0.317)	(0.039)	(0.056)	(0.032)	(0.044)	(0.058)	(0.178)
Political and civil liberties ratio	-4.348**	-2.979*	4.911	-1.406	-2.351	-3.449	-5.218***	-7.611***	7.834***	-3.626
	(1.300)	(1.840)	(3.165)	(4.604)	(1.839)	(2.950)	(1.653)	(2.484)	(1.126)	(2.935)
Observations	208	158	208	158	208	158	187	147	175	136
Adjusted R^2	0.31	0.37	0.14	0.21	0.11	0.18	0.27	0.30	-	-

Source: Prepared by the author on the basis of data from International Monetary Fund (IMF) [online] http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221; Organization for Economic Cooperation and Development (OECD) [online] www.oecd.org/ctp/federalism/fiscal-decentralisation-database.htm; Economic Commission for Latin America and the Caribbean (ECLAC) [online] http://estadisticas.cepal.org/cepalstat/portada.html?idioma=english; Federal Tax Commission of Argentina [online] www.cfi.gov.ar; Ministry of Treasury and Public Finance of Argentina [online] www.economia.gob.ar; National Institute of Statistics of the Plurinational State of Bolivia [online] www.ine.gob.bo; Freedom House [online] http://freedomhouse.org/report-types/freedom-world#.VY_fWI1RHcw; and World Bank [online] http://data.worldbank.org/data-catalog/world-development-indicators.

Note: (*) = significant at 10%, (**) = significant at 5% and (***) = significant at 1%. The dependent variable is per capita GDP growth. All regressions include an intercept term (not shown in table). Generalized method of moments specifications include a one-period lagged dependent variable as regressor (not shown in table).

[a] Argentina, Brazil, Canada, Chile, Colombia, Costa Rica, El Salvador, Mexico, Paraguay, Peru, the Plurinational State of Bolivia and the United States.

The behaviour of the control variables is also noteworthy. With most, the results conform to expectations about their likely impact on growth. For instance, savings have the expected positive impact on the dependent variable regardless of the specification used, while the unemployment rate shows the expected negative impact on growth. Openness to international trade is also shown not to be conducive to growth, which accords with a substantial segment of the economics literature that views the impact of trade with reservations.[16] A similar result is obtained for FDI, as it is shown by the pairing of the instrumental variables and GMM estimates with both the revenue and expenditure indicators of fiscal decentralization to have a strongly negative and significant impact on growth, underlining concerns about the impact of foreign investment in this respect. The impact of remittances is mostly positive and significant, as would be expected, but this variable may have the opposite impact when analysed from a dynamic perspective. Higher inflation, bigger government (as measured by the general government final consumption expenditures variable) and greater urbanization also seem to lead to less growth. Finally, greater political and civil liberties seem to be conducive to higher growth, although the impact of this variable (the political and civil liberties ratio) may have a more nuanced impact in a dynamic setting.[17]

Table 3 presents regression results showing how fiscal decentralization impacts growth when Canada and the United States are excluded from the analysis. The specifications and statistical properties of each regression are the same as in table 2.

As with the full sample of countries, fiscal decentralization on the revenue side is consistently shown to have a detrimental impact on growth. The coefficients for this variable are mostly negative, and they are statistically significant when estimated using GLS (with no effects and with random effects) and instrumental variables. On the expenditure side, the coefficients for the decentralization indicator are positive in all cases and are statistically significant when estimated using GLS (with fixed effects) and GMM, demonstrating that expenditure decentralization does seem to play an important role in generating economic growth in developing nations of the Americas. This result is more conclusive than the one observed with the full sample of countries, revealing that for this set of developing countries in the Americas, decentralization on the expenditure side may indeed have the expected positive impact on growth.

With respect to the control variables, for the most part their behaviour resembles the situation with the full sample of countries. Savings and the unemployment rate are consistently shown to have the expected positive and negative impacts on growth, respectively, while openness to trade, FDI and bigger government show a similar negative impact on growth. Remittances also seem to have a positive impact on growth, but, as with the full sample of countries, the impact of this variable in a dynamic setting might be more nuanced. Inflation is also shown to be (mostly) a negative influence on growth while, by contrast with the cases of Canada and the United States included in the analysis, the degree of urbanization seems to play no role in growth. Finally, greater political and civil liberties seem to foster economic growth, although, once again, the impact of this variable in a dynamic framework seems to be more nuanced.

Tables 4 and 5 analyse the impact of fiscal decentralization on the inflation rate. The regression methodologies are the same as those utilized when growth was the dependent variable. Table 4 presents estimation results for all the countries included in the analysis.

[16] A good survey of findings addressing some of the reservations about the impact of trade on growth is provided by Rodríguez and Rodrik (1999).

[17] The ratio of political and civil liberties ranges from 0.18 (most free) to 1.00 (least free).

Table 3
The Americas (10 countries):[a] fiscal decentralization and GDP per capita

	Generalized least squares to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized least squares with cross-sectional fixed effects and no weights		Generalized least squares with cross-sectional random effects and no weights[b]		Instrumental variables to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized method of moments	
Revenue decentralization *(%)*	-0.074**		-0.065		-0.082**		-0.075*		0.006	
	(0.022)		(0.065)		(0.032)		(0.046)		(0.039)	
Expenditure decentralization *(%)*		0.026		0.183*		0.010		0.008		0.262***
		(0.033)		(0.100)		(0.040)		(0.040)		(0.022)
Inflation rate *(%)*	0.001*	-0.004**	0.001	-0.005**	0.001	-0.004**	-0.011	-0.002	-0.008	-0.005**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.012)	(0.003)	(0.009)	(0.001)
Gross domestic savings *(% of GDP)*	0.191***	0.183**	0.209*	0.128	0.174***	0.126	0.154	0.181*	0.444***	0.269***
	(0.057)	(0.080)	(0.118)	(0.191)	(0.061)	(0.093)	(0.107)	(0.100)	(0.082)	(0.060)
Openness to international trade ((X + M)/GDP) *(%)*	-0.033	-0.009	0.003	-0.036	-0.037*	0.002	-0.030	0.008	-0.225**	-0.101**
	(0.021)	(0.026)	(0.059)	(0.104)	(0.022)	(0.030)	(0.042)	(0.029)	(0.036)	(0.028)
Remittances *(% of GDP)*	0.218***	-0.161	-0.062	-0.457	0.217*	-0.449	0.114	-0.190	0.173	-0.519**
	(0.078)	(0.244)	(0.408)	(0.547)	(0.124)	(0.404)	(0.145)	(0.343)	(0.228)	(0.200)
Foreign direct investment *(% of GDP)*	0.056	-0.111	0.069	-0.514**	-0.001	-0.230	-0.305*	-0.364*	-0.062	-0.810**
	(0.076)	(0.102)	(0.162)	(0.247)	(0.130)	(0.185)	(0.171)	(0.192)	(0.084)	(0.051)
Unemployment rate *(% of total labour force)*	-0.208**	-0.235**	-0.248*	-0.454**	-0.301**	-0.381**	-0.218**	-0.274**	-0.414**	-0.564**
	(0.061)	(0.067)	(0.133)	(0.157)	(0.102)	(0.102)	(0.103)	(0.124)	(0.085)	(0.031)
General government final consumption expenditure *(% of GDP)*	0.067	-0.234**	-0.075	-0.561**	0.072	-	0.011	-0.142	-1.254**	-0.636**
	(0.073)	(0.082)	(0.247)	(0.226)	(0.121)	-	(0.146)	(0.144)	(0.185)	(0.049)
Urban population *(% of total)*	-0.003	-0.030	-0.045	0.003	-	-	0.005	-0.026	0.090	-0.001
	(0.037)	(0.039)	(0.166)	(0.399)	-	-	(0.062)	(0.053)	(0.094)	(0.108)
Political and civil liberties ratio	1.127	-5.116**	5.215	-2.949	1.639	-3.333	-0.869	-11.666*	8.810***	-6.516**
	(1.725)	(2.686)	(3.540)	(5.075)	(2.352)	(3.418)	(2.357)	(4.620)	(1.199)	(2.324)
Observations	163	123	163	123	163	130	144	114	134	105
Adjusted R^2	0.27	0.26	0.09	0.21	0.11	0.15	0.17	0.23	-	-

Source: Prepared by the author on the basis of data from International Monetary Fund (IMF) [online] http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221; Organization for Economic Cooperation and Development (OECD) [online] www.oecd.org/ctp/federalism/fiscal-decentralisation-database.htm; Economic Commission for Latin America and the Caribbean (ECLAC) [online] http://estadisticas.cepal.org/cepalstat/portada.html?idioma=english; Federal Tax Commission of Argentina [online] www.cfi.gov.ar; Ministry of Treasury and Public Finance of Argentina [online] www.economia.gob.ar; National Institute of Statistics of the Plurinational State of Bolivia [online] www.ine.gob.bo; Freedom House [online] http://freedomhouse.org/report-types/freedom-world#.VY_fWI1RHcw; and World Bank [online] http://data.worldbank.org/data-catalog/world-development-indicators.

Note: (*) = significant at 10%, (**) = significant at 5% and (***) = significant at 1%. The dependent variable is per capita GDP growth. All regressions include an intercept term (not shown in table). Generalized method of moments specifications include a one-period lagged dependent variable as regressor (not shown in table). Standard errors are given in parentheses.

[a] Argentina, Brazil, Chile, Colombia, Costa Rica, El Salvador, Mexico, Paraguay, Peru and the Plurinational State of Bolivia.

[b] Random effects estimation requires the number of cross-sections to be greater than the number of regressors. To fulfil this condition, the urban population and/or the general government final consumption expenditures variables were excluded from the specifications.

Table 4
The Americas (12 countries):[a] fiscal decentralization and inflation

	Generalized least squares to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized least squares with cross-sectional fixed effects and no weights		Generalized least squares with cross-sectional random effects and no weights		Instrumental variables to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized method of moments	
Revenue decentralization *(%)*	0.178**		6.102***		4.978***		-0.210**		-0.319***	
	(0.081)		(1.936)		(1.365)		(0.025)		(0.061)	
Expenditure decentralization *(%)*		1.757***		-7.905		6.004**		1.788***		-8.589**
		(0.350)		(5.417)		(3.013)		(0.530)		(1.370)
GDP per capita *(at purchasing power parity, in logs)*	-5.363**	-36.269**	128.446**	24.671	-13.682	-87.547*	-2.063**	-30.795**	-7.795***	-75.204**
	(0.878)	(5.808)	(50.639)	(157.525)	(26.921)	(48.845)	(0.376)	(7.648)	(1.681)	(21.903)
Openness to international trade ((X + M)/GDP) *(%)*	-0.210**	0.344***	-6.754***	-2.697	-1.897**	0.549	-0.087**	0.443***	0.131***	1.045**
	(0.045)	(0.110)	(1.889)	(4.723)	(0.895)	(1.678)	(0.013)	(0.163)	(0.049)	(0.511)
General government final consumption expenditure *(% of GDP)*	-2.710**	-7.516***	-72.671***	-61.180**	-47.331**	-36.530**	0.659***	-6.892***	0.368	-30.593**
	(0.647)	(1.637)	(7.983)	(14.734)	(6.068)	(8.465)	(0.096)	(2.282)	(0.355)	(3.563)
Military expenditures *(% of GDP)*	-2.018**	11.491***	103.508***	113.495	19.987	47.122*	-1.675**	11.178**	-2.147*	52.096***
	(0.749)	(2.842)	(29.548)	(77.874)	(16.982)	(28.418)	(0.222)	(4.603)	(1.232)	(19.519)
Foreign direct investment *(% of GDP)*	-0.660**	-5.327***	-7.410	3.698	-3.934	-12.981	-0.727**	-3.771***	-0.082	9.245***
	(0.179)	(0.964)	(5.397)	(13.523)	(4.630)	(10.670)	(0.165)	(0.925)	(0.173)	(2.362)
Remittances *(% of GDP)*	-0.880**	-10.006**	20.452*	39.263	-1.041	-20.477	-0.552**	-8.706***	-0.479	18.764***
	(0.139)	(2.000)	(11.920)	(29.979)	(4.973)	(21.396)	(0.073)	(1.995)	(0.304)	(5.594)
Observations	178	149	178	149	178	149	159	139	148	129
Adjusted R^2	0.20	0.13	0.39	0.23	0.23	0.12	0.57	0.03	-	-

Source: Prepared by the author on the basis of data from International Monetary Fund (IMF) [online] http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221; Organization for Economic Cooperation and Development (OECD) [online] www.oecd.org/ctp/federalism/fiscal-decentralisation-database.htm; Economic Commission for Latin America and the Caribbean (ECLAC) [online] http://estadisticas.cepal.org/cepalstat/portada.html?idioma=english; Federal Tax Commission of Argentina [online] www.cfi.gov.ar; Ministry of Treasury and Public Finance of Argentina [online] www.economia.gob.ar; National Institute of Statistics of the Plurinational State of Bolivia [online] www.ine.gob.bo; Freedom House [online] http://freedomhouse.org/report-types/freedom-world#.VY_fWI1RHcw; and World Bank [online] http://data.worldbank.org/data-catalog/world-development-indicators.

Note: (*) = significant at 10%, (**) = significant at 5% and (***) = significant at 1%. The dependent variable is the inflation rate. All regressions include an intercept term (not shown in table). Generalized method of moments specifications include a one-period lagged dependent variable as regressor (not shown in table). Standard errors are given in parentheses.

[a] Argentina, Brazil, Canada, Chile, Colombia, Costa Rica, El Salvador, Mexico, Paraguay, Peru, the Plurinational State of Bolivia and the United States.

The results for the effects of fiscal decentralization variables on the inflation rate are inconclusive. When decentralization occurs on the revenue side, the GLS estimates for the decentralization indicator are positive and statistically significant, implying that greater decentralization fosters higher inflation. However, when the specification is instrumented and the relationship is analysed within a dynamic setting, the impact of revenue decentralization is reversed, meaning that it actually has a dampening impact on inflation. With the expenditure decentralization indicator, the results are slightly clearer: GLS and instrumental variables estimates show a positive and statistically significant correlation between expenditure decentralization and inflation, but the relationship is reversed with GMM estimation, implying that the impact of expenditure decentralization on inflation is not entirely clear. The lack of clarity in the results precludes any definite conclusions as to how fiscal decentralization impacts inflation, and hence it cannot be unambiguously stated that it either deters or induces inflation in the countries of the Americas.

Regarding the control variables, per capita GDP growth is consistently associated with lower inflation, an unsurprising result in view of the findings of previous studies, such as Martínez-Vázquez and McNab (2006).[18] Government expenditures and FDI mostly act to quell inflation, while the results for the rest of the variables (openness to international trade, military expenditures and remittances) are inconclusive.

Table 5 presents results for the effects of fiscal decentralization on the inflation rate when Canada and the United States are excluded from the analysis.

As is evident, the results largely confirm the findings presented in table 4. Both fiscal decentralization indicators show the same pattern of behaviour as is observed with the full sample of countries, whence the difficulty of drawing any definite conclusions. Under certain conditions, as reflected in the positive and statistically significant GLS estimates, revenue decentralization seems to foster inflation, while in others, as seen when the specification is instrumented and when it is estimated with GMM, the opposite is true. Likewise, expenditure decentralization seems to be more conducive to higher inflation with GLS and instrumental variables estimates, but in a dynamic setting the opposite is true. As was concluded for the full sample of countries, it cannot be unequivocally stated that fiscal decentralization deters or induces inflation in developing nations of the Americas.

The behaviour of the control variables is slightly better defined with this sample of countries. As expected, GDP per capita is for the most part associated with lower inflation, as are government expenditures and FDI, demonstrating that the size of government and net capital inflows play a positive role in preventing inflation.[19] Military expenditures seem to be conducive to higher inflation, although when coupled with decentralization on the revenue side they may be a deterrent to it. Lastly, the impact of trade openness and remittances is indeterminate.

The last set of regressions is reported in tables 6 and 7. Table 6 presents results for the impact of fiscal decentralization on the Gini coefficient across the full sample of countries.

[18] GLS with cross-sectional fixed effects reverses the overall trend and GDP per capita is shown to have a positive and significant impact on inflation. Since alternative GLS techniques, instrumental variables and GMM consistently generate negative and statistically significant coefficients for this variable, the result of GLS with fixed effects is taken to be an anomaly.

[19] In a dynamic setting, FDI may be conducive to higher inflation, as evidenced in the GMM specification. Likewise, bigger government may also have a positive impact on inflation, as reflected in the instrumental variables estimate when decentralization occurs on the revenue side.

Table 5
The Americas (10 countries):[a] fiscal decentralization and inflation

	Generalized least squares to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized least squares with cross-sectional fixed effects and no weights		Generalized least squares with cross-sectional random effects and no weights		Instrumental variables to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized method of moments	
Revenue decentralization *(%)*	0.840***		6.706***		5.968***		-0.231**		-0.258***	
	(0.301)		(2.275)		(1.663)		(0.072)		(0.069)	
Expenditure decentralization *(%)*		1.816***		-7.900		3.343		3.575***		-6.783***
		(0.447)		(6.684)		(4.643)		(1.308)		(1.536)
GDP per capita *(at purchasing power parity, in logs)*	3.093	-15.348**	148.802**	38.037	45.479	66.310	-1.957*	12.006	-16.445**	-100.882**
	(3.413)	(6.640)	(67.189)	(215.942)	(37.732)	(89.204)	(1.157)	(13.963)	(1.690)	(34.722)
Openness to international trade ((X + M)/GDP) *(%)*	-0.537**	0.028	-6.874***	-0.350	-3.000***	-2.273	-0.108**	0.599	0.192***	3.961***
	(0.130)	(0.173)	(2.178)	(5.933)	(0.939)	(2.678)	(0.030)	(0.391)	(0.043)	(0.956)
General government final consumption expenditure *(% of GDP)*	-0.804**	-11.084**	-75.553***	-57.450**	-56.733***	-55.139**	0.573*	-21.362**	0.330	-18.646***
	(2.085)	(3.136)	(9.086)	(17.974)	(7.563)	(11.727)	(0.303)	(7.886)	(0.387)	(4.124)
Military expenditures *(% of GDP)*	11.085**	37.026***	162.507***	272.964*	85.790***	186.603**	-2.463**	87.810**	-13.181**	234.145***
	(5.421)	(11.515)	(54.611)	(157.370)	(28.124)	(75.437)	(1.227)	(33.873)	(1.725)	(73.216)
Foreign direct investment *(% of GDP)*	-2.173**	-6.474***	-7.775	6.200	-9.297*	-21.243	-0.873**	-8.903**	-0.044	8.988***
	(0.632)	(1.468)	(6.471)	(16.999)	(5.585)	(13.312)	(0.308)	(3.433)	(0.171)	(2.305)
Remittances *(% of GDP)*	-0.332	-4.219*	23.112*	39.296	2.615	9.218	-0.588**	-9.347*	-1.151***	17.554**
	(0.386)	(2.445)	(13.477)	(34.567)	(4.768)	(28.332)	(0.104)	(5.125)	(0.304)	(7.877)
Observations	141	114	141	114	141	114	124	106	115	98
Adjusted R^2	0.17	0.07	0.40	0.23	0.28	0.19	0.25	-	-	-

Source: Prepared by the author on the basis of data from International Monetary Fund (IMF) [online] http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221; Organization for Economic Cooperation and Development (OECD) [online] www.oecd.org/ctp/federalism/fiscal-decentralisation-database.htm; Economic Commission for Latin America and the Caribbean (ECLAC) [online] http://estadisticas.cepal.org/cepalstat/portada.html?idioma=english; Federal Tax Commission of Argentina [online] www.cfi.gov.ar; Ministry of Treasury and Public Finance of Argentina [online] www.economia.gob.ar; National Institute of Statistics of the Plurinational State of Bolivia [online] www.ine.gob.bo; Freedom House [online] http://freedomhouse.org/report-types/freedom-world#.VY_fWI1RHcw; and World Bank [online] http://data.worldbank.org/data-catalog/world-development-indicators.

Note: (*) = significant at 10%, (**) = significant at 5% and (***) = significant at 1%. The dependent variable is the inflation rate. All regressions include an intercept term (not shown in table). Generalized method of moments specifications include a one-period lagged dependent variable as regressor (not shown in table). Standard errors are given in parentheses.

[a] Argentina, Brazil, Chile, Colombia, Costa Rica, El Salvador, Mexico, Paraguay, Peru and the Plurinational State of Bolivia.

Table 6
The Americas (12 countries):[a] fiscal decentralization and income distribution

	Generalized least squares to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized least squares with cross-sectional fixed effects and no weights		Generalized least squares with cross-sectional random effects and no weights[b]		Instrumental variables to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized method of moments	
Revenue decentralization *(%)*	-0.049**		0.012		-0.058**		-0.027		-0.022	
	(0.014)		(0.053)		(0.022)		(0.029)		(0.049)	
Expenditure decentralization *(%)*		-0.004		0.108		-0.016		-0.007		0.008
		(0.027)		(0.068)		(0.028)		(0.052)		(0.040)
GDP per capita *(at purchasing power parity, in logs)*	-1.684	27.187*	-102.864**	-90.425**	5.712	36.777***	-0.489	13.469	-26.533*	-40.762*
	(6.841)	(14.731)	(23.568)	(28.058)	(10.665)	(12.641)	(11.766)	(30.313)	(15.422)	(19.504)
GDP per capita squared *(at purchasing power parity, in logs)*	-0.319	-1.783**	5.051***	4.449***	-0.704	-2.300***	-0.358	-1.011	1.366*	2.049**
	(0.369)	(0.793)	(1.247)	(1.493)	(0.572)	(0.673)	(0.641)	(1.635)	(0.801)	(0.960)
Urban population *(% of total)*	0.232***	-0.084	0.452**	0.995*	0.164***	-0.039	0.444***	-0.040	0.099	-0.055
	(0.036)	(0.085)	(0.218)	(0.539)	(0.046)	(0.063)	(0.086)	(0.153)	(0.107)	(0.347)
Openness to international trade ((X + M)/GDP) *(%)*	0.023*	-0.010	0.024	-0.030	-	-	0.095***	0.017	0.053**	0.105**
	(0.014)	(0.029)	(0.049)	(0.081)	-	-	(0.035)	(0.042)	(0.022)	(0.052)
Political and civil liberties ratio	3.332**	-0.917	-12.170***	-14.835**	0.191	-3.234	9.609***	-2.484	1.866	4.292
	(1.536)	(2.233)	(3.848)	(3.882)	(2.329)	(2.699)	(3.251)	(6.114)	(2.160)	(2.667)
Remittances *(% of GDP)*	-0.403**	0.306	-0.111	-0.423	-0.335**	0.202	-0.804***	0.198	-0.470**	-0.948**
	(0.074)	(0.194)	(0.310)	(0.408)	(0.100)	(0.260)	(0.116)	(0.295)	(0.195)	(0.235)
Gross domestic savings *(% of GDP)*	-0.131**	-0.338***	0.109	0.103	-0.046	-0.333***	-0.380***	-0.431**	-0.108*	0.115
	(0.045)	(0.085)	(0.105)	(0.156)	(0.053)	(0.084)	(0.095)	(0.157)	(0.061)	(0.085)
General government final consumption expenditure *(% of GDP)*	0.422***	0.074	0.168	0.148	0.429***	0.214**	0.504***	0.209	0.076	0.302*
	(0.067)	(0.089)	(0.248)	(0.220)	(0.120)	(0.111)	(0.124)	(0.188)	(0.184)	(0.182)
Inflation rate *(%)*	-0.077**	0.047	-0.080	0.023	-0.133**	-	-0.337***	0.236	-0.070**	-0.147**
	(0.024)	(0.030)	(0.050)	(0.051)	(0.038)	-	(0.097)	(0.171)	(0.018)	(0.033)
Internet users *(per 100 people)*	-0.012	0.049*	-0.041	-0.045	-0.027	0.029	-0.083***	0.016	-0.037*	-0.020
	(0.016)	(0.027)	(0.042)	(0.055)	(0.019)	(0.022)	(0.027)	(0.052)	(0.021)	(0.029)
Unemployment rate *(% of total labour force)*	0.155***	0.164**	0.124	0.439**	0.231**	0.098	0.123	0.063	-0.046	0.143*
	(0.058)	(0.079)	(0.210)	(0.190)	(0.105)	(0.095)	(0.150)	(0.183)	(0.144)	(0.086)
Observations	171	139	171	139	171	139	154	128	142	117
Adjusted R^2	0.81	0.81	0.84	0.81	0.61	0.61	0.78	0.85	-	-

Source: Prepared by the author on the basis of data from International Monetary Fund (IMF) [online] http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221; Organization for Economic Cooperation and Development (OECD) [online] www.oecd.org/ctp/federalism/fiscal-decentralisation-database.htm; Economic Commission for Latin America and the Caribbean (ECLAC) [online] http://estadisticas.cepal.org/cepalstat/portada.html?idioma=english; Federal Tax Commission of Argentina [online] www.cfi.gov.ar; Ministry of Treasury and Public Finance of Argentina [online] www.economia.gob.ar; National Institute of Statistics of the Plurinational State of Bolivia [online] www.ine.gob.bo; Freedom House [online] http://freedomhouse.org/report-types/freedom-world#.VY_fWI1RHcw; and World Bank [online] http://data.worldbank.org/data-catalog/world-development-indicators.

Note: (*) = significant at 10%, (**) = significant at 5% and (***) = significant at 1%. The dependent variable is the Gini coefficient, which ranges from 0 (complete equality) to 100 (complete inequality). The political and civil liberties ratio ranges from 0.18 (most free) to 1.00 (least free). All regressions include an intercept term (not shown in table). Generalized method of moments specifications include a one-period lagged dependent variable as regressor (not shown in table). Standard errors are given in parentheses.

[a] Argentina, Brazil, Canada, Chile, Colombia, Costa Rica, El Salvador, Mexico, Paraguay, Peru, the Plurinational State of Bolivia and the United States.

[b] Random effects estimation requires the number of cross-sections to be greater than the number of regressors. To fulfil this condition, the openness to international trade and/or inflation rate variables were excluded from these specifications.

The impact of fiscal decentralization on the Gini coefficient varies depending on whether decentralization occurs on the revenue or expenditure side. There is substantial evidence that decentralization on the revenue side plays a positive role in creating conditions for greater equality, as evinced by the negative, statistically significant and approximately same-sized coefficients obtained for the revenue decentralization indicator using GLS specifications with no effects and with random effects. The impact of expenditure decentralization, on the other hand, seems to be non-existent, as the coefficients estimated for this variable are in all cases close to zero and statistically insignificant. The general conclusion, therefore, is that revenue decentralization seems to play the expected positive role in generating conditions for greater income equality, whereas decentralization on the expenditure side seems to be ineffective in addressing inequality concerns.

The behaviour of the control variables is also noteworthy. GDP per capita in levels and GDP per capita squared do not seem to follow a clear pattern of behaviour, and hence it is not possible to reach any definite conclusions about the way these variables impact income inequality. The uniform behaviour pattern of the GDP variable suggests, however, that the Kuznets hypothesis, implying greater inequality in early stages of development but less inequality in more advanced stages, may not apply here. There is convincing evidence that greater urbanization, openness to international trade, larger government and higher unemployment worsen income inequality, as reflected in the consistently positive and statistically significant coefficients for these variables. These results fall neatly into line with findings elsewhere (see, for instance, Rodríguez and Rodrik, 1999; Lee, 2005; Martínez, Ayala and Ruiz-Huerta, 2001) that urbanization, open markets, an increasingly active government and higher unemployment are the principal drivers of greater income inequality. Savings and remittances, on the other hand, seem to be conducive to greater income equality, reflected in consistently negative and statistically significant coefficients, a result that is equally unsurprising given the importance of deferred consumption and alternative sources of income as instruments for repressing income inequality. Inflation also seems to assuage inequality, as reflected in negative and statistically significant estimates for this variable with different techniques. This result is consistent with findings elsewhere (e.g. Monnin, 2014) that monetary policies aimed at controlling inflation have operated to the detriment of people in the middle and lower income brackets and have therefore increased income inequality. The argument is that whenever wages accelerate and central banks tighten monetary policy, unemployment rises, implying a worsening of income inequality. The counter-argument, then, is that higher inflation may reduce income inequality by allowing higher wage growth. Lastly, the political and civil liberties and Internet users ratios do not follow any discernible pattern, so that it is not possible to draw any conclusions about their impact on income inequality.

Table 7 reports regression estimates for the impact of fiscal decentralization on the Gini coefficient in countries of the Americas, excluding Canada and the United States.

The impact of fiscal decentralization on the Gini coefficient is clearer with this subset of countries in the Americas. Both decentralization indicators are consistently positive, of similar size and, in several cases, statistically significant, implying that decentralization may actually contribute to greater inequality in developing nations of the Americas. Although this implication seems to be stronger when decentralization occurs on the expenditure side, the general conclusion in both cases seems to be that fiscal decentralization has not delivered on its promise of contributing to greater income equality in these countries, and this, as Brosio and Jiménez (2013) rightly point out, highlights the need to strengthen coordination mechanisms and arrangements between all levels of government to ensure more efficiency and better delivery of outcomes in the decentralization structures of these countries.

Table 7

The Americas (10 countries):[a] fiscal decentralization and income distribution

	GLS to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized least squares with cross-sectional fixed effects and no weights		Generalized least squares with cross-sectional random effects and no weights[b]		Instrumental variables to allow for cross-sectional and intrasectional heteroskedasticity and autocorrelation (no effects specification)		Generalized method of moments	
Revenue decentralization *(%)*	0.037**		0.006		0.030		0.056		-0.005	
	(0.017)		(0.058)		(0.021)		(0.042)		(0.059)	
Expenditure decentralization *(%)*		0.081***		0.048		0.131***		0.170***		-0.051
		(0.030)		(0.090)		(0.034)		(0.056)		(0.032)
GDP per capita *(at purchasing power parity, in logs)*	-90.537*	-88.800**	-29.114	-57.949	-88.140**	-93.186**	-53.609**	-139.377**	1.465	-30.495*
	(9.492)	(19.170)	(36.551)	(57.967)	(19.528)	(36.547)	(17.102)	(34.705)	(24.175)	(18.857)
GDP per capita squared *(at purchasing power parity, in logs)*	5.059***	4.954***	1.436	2.986	4.874***	5.175**	2.922***	7.869***	0.165	1.789*
	(0.531)	(1.072)	(1.903)	(3.029)	(1.106)	(2.063)	(0.968)	(1.904)	(1.263)	(0.967)
Urban population *(% of total)*	-0.077	-0.426***	0.223	0.780	-0.073*	-0.398***	0.114	-0.637***	-0.068	0.395*
	(0.059)	(0.085)	(0.246)	(0.669)	(0.043)	(0.068)	(0.116)	(0.152)	(0.102)	(0.214)
Openness to international trade ((X + M)/GDP) *(%)*	0.003	-0.048*	-0.013	-0.036	-	-	0.048	-0.022	0.044	-0.037
	(0.019)	(0.028)	(0.055)	(0.093)	-	-	(0.052)	(0.052)	(0.037)	(0.029)
Political and civil liberties ratio	-5.682**	-8.775***	-13.183**	-15.995**	-9.956***	-12.356**	-2.497	-8.456*	-5.104*	-3.133*
	(1.712)	(2.189)	(4.133)	(4.472)	(2.407)	(3.225)	(2.535)	(4.873)	(2.940)	(1.758)
Remittances *(% of GDP)*	-0.057	-0.166	-0.403	-0.523	-	-	-0.303**	-0.591	-0.723**	-0.698**
	(0.081)	(0.201)	(0.342)	(0.479)	-	-	(0.127)	(0.447)	(0.244)	(0.109)
Gross domestic savings *(% of GDP)*	0.174***	0.210**	0.090	0.073	0.226***	0.090	0.044	0.557***	-0.126**	0.061
	(0.002)	(0.086)	(0.112)	(0.178)	(0.039)	(0.107)	(0.122)	(0.195)	(0.057)	(0.053)
General government final consumption expenditure *(% of GDP)*	0.589***	0.367***	0.262	0.209	0.549***	-	0.569***	0.626***	-0.051	0.015
	(0.064)	(0.093)	(0.271)	(0.249)	(0.108)	-	(0.119)	(0.191)	(0.237)	(0.096)
Inflation rate *(%)*	-0.127**	-0.022	-0.076	0.052	-	-	-0.402***	-0.120	-0.059**	0.013
	(0.027)	(0.028)	(0.053)	(0.058)	-	-	(0.087)	(0.127)	(0.026)	(0.017)
Internet users *(per 100 people)*	-0.193**	-0.086***	-0.131**	-0.112	-0.193***	-0.052	-0.214***	-0.129***	-0.135**	-0.105**
	(0.011)	(0.028)	(0.055)	(0.080)	(0.025)	(0.037)	(0.023)	(0.045)	(0.029)	(0.019)
Unemployment rate *(% of total labour force)*	0.416***	0.491***	0.298	0.601**	0.507***	0.630***	0.458**	0.917***	0.739***	0.404***
	(0.083)	(0.083)	(0.249)	(0.229)	(0.106)	(0.119)	(0.186)	(0.193)	(0.119)	(0.065)
Observations	141	109	141	109	149	109	126	100	116	91
Adjusted R^2	0.89	0.76	0.67	0.55	0.50	0.39	0.79	0.78	-	-

Source: Prepared by the author on the basis of data from International Monetary Fund (IMF) [online] http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221; Organization for Economic Cooperation and Development (OECD) [online] www.oecd.org/ctp/federalism/fiscal-decentralisation-database.htm; Economic Commission for Latin America and the Caribbean (ECLAC) [online] http://estadisticas.cepal.org/cepalstat/portada.html?idioma=english; Federal Tax Commission of Argentina [online] www.cfi.gov.ar; Ministry of Treasury and Public Finance of Argentina [online] www.economia.gob.ar; National Institute of Statistics of the Plurinational State of Bolivia [online] www.ine.gob.bo; Freedom House [online] http://freedomhouse.org/report-types/freedom-world#.VY_fWI1RHcw; and World Bank [online] http://data.worldbank.org/data-catalog/world-development-indicators.

Note: (*) = significant at 10%, (**) = significant at 5% and (***) = significant at 1%. The dependent variable is the Gini coefficient, which ranges from 0 (complete equality) to 100 (complete inequality). The political and civil liberties ratio ranges from 0.18 (most free) to 1.00 (least free). All regressions include an intercept term (not shown in table). Generalized method of moments specifications include a one-period lagged dependent variable as regressor (not shown in table). Standard errors are given in parentheses.

[a] Argentina, Brazil, Chile, Colombia, Costa Rica, El Salvador, Mexico, Paraguay, Peru and the Plurinational State of Bolivia.

[b] Random effects estimation requires the number of cross-sections to be greater than the number of regressors. To fulfil this condition, the international trade openness, remittances, inflation and, for expenditure decentralization, general government final consumption expenditure were excluded from these specifications.

With respect to the behaviour of the control variables, GDP per capita seems to contribute initially to greater income equality and eventually to a yet further increase, reflected in consistently positive and statistically significant coefficients for GDP per capita squared, a development that clearly goes against Kuznets's prediction. Greater urbanization, remittances and Internet access are all important factors contributing to greater income equality, as reflected in consistently negative and statistically significant coefficients, and this highlights the importance of urban settings, diaspora involvement and access to the World Wide Web as key determinants in lowering income inequality in developing countries. Larger government and higher unemployment, on the other hand, seem to be conducive to greater income inequality, as reflected in consistently positive and statistically significant coefficients, demonstrating that the quality rather than the size of government determines its productivity and highlighting the well-researched fact that unemployment always tends to make matters worse. As with the full sample of countries, and for similar reasons, inflation also seems to have a dampening impact on inequality, while savings may contribute to greater inequality, perhaps because in developing nations of the Americas only a minority are able to save while the majority are simply unable to postpone current consumption. A curious result is the apparent effect of political and civil liberties on income inequality in these countries. The consistently negative and statistically significant coefficients for the political and civil liberties ratio seem to imply that the fewer political and civil liberties there are, the greater the equality of income. This result may reflect the perception in many developing countries of the Americas that strong governments are often needed to pass necessary legislation that may be unpopular at first but that will in time bring benefits, such as greater income equality. Finally, there is some indication that economic openness assuages income inequality.

VI. Conclusions and policy implications

This article analyses the impact of fiscal decentralization on economic growth, inflation and income inequality in a sample of countries in the Americas. Given that most of these countries have undergone a period of gradual decentralization of economic functions to regional levels of government over past years, the results presented here seem timely and relevant.

The main findings are as follows. With respect to the impact of fiscal decentralization on economic growth when all countries are included in the analysis, the revenue-based decentralization indicator consistently shows a negative impact on growth. On the expenditure side, the evidence is inconclusive, and hence it cannot be determined whether decentralization has had a positive or negative impact on growth. When the same analysis is done without Canada and the United States, decentralization on the revenue side is consistently shown to exert a negative influence on growth, confirming the results obtained with the full sample of countries, but the expenditure decentralization indicator seems to show a positive effect on growth, demonstrating that decentralization on the expenditure side is more conducive to growth in developing countries of the Americas. The behaviour of the control variables is similar regardless of the sample of countries being analysed. National saving, for instance, is consistently shown to contribute to growth, while higher unemployment, bigger government and greater openness to trade cause it to diminish. The impact of the remaining control variables is not as clear, and hence their combined effect on growth is indeterminate.

With respect to the impact of fiscal decentralization on inflation, the results are indeterminate, regardless of the sample of countries being analysed and of whether decentralization occurs on the revenue or expenditure side. In all cases, there is no discernible pattern of behaviour allowing unequivocal conclusions to be drawn about the ways in which decentralization impacts price stability. The behaviour of the control variables in both sets of regressions is similar, with the impact of these variables being slightly better defined in the sample of countries that excludes Canada and the United States. A noteworthy

result is that while government expenditures in both samples of countries generally seem to have a dampening influence on inflation, military expenditures seem to be more inflationary in the sample of developing countries of the Americas, highlighting the need to manage this type of expenditure with care. The impact of the remaining control variables is inconclusive.

Regarding the impact of fiscal decentralization on the Gini coefficient, finally, and considering the full sample of countries, the results indicate that decentralization on the revenue side has the expected positive impact in reducing income inequality, as reflected in consistently negative and statistically significant coefficients for GLS estimates (GLS specifications estimated with no effects and with random effects) that point to the importance of fiscal decentralization and its potential benefits in reducing income disparities. On the expenditure side, however, there is no evidence that decentralization has played any role in mitigating income inequalities.

The impact of fiscal decentralization on the dependent variable is somewhat clearer when Canada and the United States are excluded, regardless of whether decentralization occurs on the revenue or expenditure side. Fiscal decentralization indicators are generally positive and in some cases statistically significant (GLS specifications with no effects and with random effects and instrumental variables with no effects), demonstrating that fiscal decentralization has not played its expected role in reducing income inequality in developing nations of the Americas.

With respect to the behaviour of the control variables, the results are mixed. The impact of GDP per capita (in levels or squared values) is unclear when the full sample of countries is observed, but in developing countries of the Americas taken by themselves it seems to decrease income disparities initially but eventually worsen them. Greater urbanization seems, for the most part, to reduce income inequality in developing countries of the Americas, but the opposite seems to be true when Canada and the United States are included in the sample. In all cases, remittances and inflation decrease income inequality and unemployment and bigger government worsens it. Openness to trade seems to increase inequalities for the full sample of countries, but there are indications that it may mitigate it when developing countries alone are taken. Savings seem to decrease inequality in the full sample of countries and to worsen it when Canada and the United States are excluded. Internet access decreases inequality in developing countries of the Americas, but its impact on the full sample of countries is unclear. Finally, weaker political and civil rights seem to be more conducive to growth in developing countries of the Americas only, while the impact on the full sample of countries is indeterminate.

The most important policy implication of the findings presented here is that fiscal decentralization has so far fallen short of expectations in terms of its impact on growth, price stability and income distribution. Although there are some indications that decentralization can positively affect growth, particularly when it occurs on the expenditure side, the assumption was that it was going to be a powerful catalyst for this. Likewise, it was postulated that fiscal decentralization would act as a deterrent to fiscal mismanagement and hence would counteract inflationary pressures, but evidence for this has not yet materialized. Finally, it was presumed that this process would lead to greater income equality, and although there is evidence that this has started to happen (when the full sample of countries is considered and decentralization occurs on the revenue side), it also suggests that much work remains to be done before this goal is accomplished. The principal recommendation, particularly from the perspective of developing nations of the Americas, is that the institutional capacity of subnational levels of government should be strengthened, as should mechanisms for coordination between the different levels of government. With greater institutional capacity and improved coordination between all layers of government, perhaps the positive outcomes anticipated for this process will begin to be realized.

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Foreign direct investment and growth in developing countries: evidence from the countries of the Organisation of Eastern Caribbean States

Nlandu Mamingi and Kareem Martin

Abstract

This paper empirically explores the relationship between foreign direct investment (FDI) and economic growth in the countries of the Organisation of Eastern Caribbean States (OECS). To reach that goal, the paper utilizes panel data consisting of annual data covering the period 1988-2013 from 34 countries, including the six OECS economies, and estimates a dynamic panel growth model using the generalized method of moments (GMM). The empirical results show that although FDI positively affects growth, its impact is minimal when considered in isolation. In other words, its significant effect is rather indirect. There is also a strong and positive interaction between infrastructural development and FDI in enhancing economic growth, but FDI crowds out domestic investment. These findings have policy implications.

Keywords

Foreign direct investment, macroeconomics, economic growth, econometric models, economic indicators, Caribbean region

JEL classification

F21, F43, C23

Authors

Nlandu Mamingi is a professor with the Department of Economics at the University of the West Indies, Cave Hill Campus, P.O. Box 64, Bridgetown BB11000, Barbados. Email: nlandu.mamingi@cavehill.uwi.edu.

Kareem Martin is an economist with the Eastern Caribbean Central Bank, Basseterre, Saint Kitts and Nevis. Email: kareem.martin@eccb-centralbank.org.

I. Introduction

The global economic climate remains unstable, leaving the small, open economies of the Organisation of Eastern Caribbean States (OECS)[1] facing unfavourable economic conditions. The economies have been experiencing a slowdown in growth, mounting debt and fiscal imbalances. It is imperative that adequate policy measures be implemented to dampen these unhealthy trends, that is, policies be adopted that promote innovation, productivity growth, competiveness, and investment. A glimmer of hope has, however, emerged with global foreign direct investment (FDI) returning to growth. Indeed, FDI flows are expected to make a full recovery with projections of US$ 1.75 trillion for 2015 and US$ 1.85 trillion for 2016 (UNCTAD, 2014).[2]

FDI has played a pivotal role in facilitating growth and economic transformation among developing countries, including those of OECS, which have attracted large inflows over the last three decades. Moreover, FDI has become the largest single source of external finance for developing economies; it is an essential vehicle for technology transfer from advanced to developing countries, stimulates local capital investment and facilitates improvements in the human capital stock and institutions of host countries. In the context of small island developing States (SIDS), which are foreign exchange constrained, FDI plays another pivotal role —that of foreign exchange earner.[3] OECS member countries use a single currency, the Eastern Caribbean dollar, which has been pegged to the United States dollar since July 1976. Hence, foreign direct investment supplements reserves and helps the Eastern Caribbean Currency Union (ECCU) maintain its long standing peg.[4]

Most empirical research on the FDI-growth relationship is rooted in neoclassical and endogenous growth theories. The relationship has been explored through four main channels: (i) the determinants of growth; (ii) the determinants of FDI; (iii) the role of multinational firms in host economies; and (iv) the direction of causality between FDI and growth (Chowdhury and Mavrotas, 2005). Neoclassical growth theory credits FDI with making a minimal contribution to growth. Conversely, endogenous growth literature focuses on the fact that FDI contributes to economic growth by creating capital, transferring technology and augmenting the level of knowledge through training and skills acquisition (De Mello, 1997 and 1999; Blomstrom, Lipsey and Zejan, 1996; Borensztein, De Gregorio and Lee, 1998). Empirical studies generally point out that FDI is a vital source of capital that usually complements domestic private investment, enhances human capital, and is associated with new job opportunities and enhancements of technology transfers and spillovers (De Mello, 1997 and 1999). Thus, FDI serves to advance overall economic growth in developing countries.

This paper seeks to answer three questions, one fundamental and two peripheral. First, does foreign direct investment have a positive impact on economic growth in the OECS countries? Second, is the impact direct or accomplished through independent channels such as domestic investment or infrastructural development (i.e. absorptive capacities)? Third, does FDI augment a host country's capital without reducing domestic capital formation?

We specify a dynamic panel data model based on endogenous growth theory and use annual data covering the period 1988-2013 for 34 countries, with a regional dummy variable included to differentiate the OECS countries. Apart from FDI, the variables of the model include lagged per capita

[1] For the purpose of this paper, "OECS" refers to the six sovereign nations of Antigua and Barbuda, Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia and Saint Vincent and the Grenadines.

[2] The United Nations Conference on Trade and Development (UNCTAD) has published an annual report since 1991 covering the latest trends in foreign direct investment around the world.

[3] International tourism receipts are the predominant contributors to foreign exchange reserves in the subregion; however, the tourism industry has been plagued by volatility in recent years.

[4] The Eastern Caribbean Currency Union is a development of OECS. All of the OECS members and one associate member (Anguilla) use the Eastern Caribbean dollar (EC$ 2.70 = US$ 1).

income, domestic investment, trade openness, population growth, infrastructure availability, global financial crisis, government consumption, inflation and interaction terms. The model is estimated using the Arellano-Bond GMM estimator in order to control for potential endogeneity in the growth regression.

The paper makes two contributions to the literature. First, although quite a number of studies have been conducted on the relationship between FDI and economic growth, there is no consensus yet among economists and researchers regarding the nature of the relationship between FDI and economic growth.[5] The ambiguity in the literature highlights the need for further research on the topic, to enhance understanding of the relationship between the two variables. The present paper attempts to add to the potential domestic channels that foreign investment inflows might take to impact growth in the context of small, developing, foreign exchange constrained economies. Second, there is the paucity of studies dealing with the link between FDI and economic growth in the context of the OECS countries. This paper attempts to fill this gap too. This is done concretely by providing evidence on the FDI-growth debate, while simultaneously identifying the channels by which FDI impacts growth in these small developing sovereign States. The study is important as it can inform policymakers on the nature and extent of the relationship between FDI and economic growth in these countries.

The paper's major empirical findings include the following. FDI contributes to economic growth by augmenting capital and interacting with the host country's conditions. Infrastructural development is the channel that allows FDI to have the most impact. FDI tends to crowd out domestic investment at certain levels.

The paper is structured as follows. Section II gives a brief account of the economic conditions in and specifically FDI flows into OECS countries. Section III presents a literature review of the relationship between FDI and economic growth. Section IV sets out the methodology and describes the variables and sources used. Section V contains the results and section VI concludes.

II. FDI in OECS countries: a background

The Caribbean has benefitted tremendously from foreign investment flows. Since the 1970s the region, specifically the OECS subregional grouping, has been the destination for billions of dollars worth of global financial flows. With most of the islands becoming sovereign States between the mid-1970s and the early 1980s, these inflows essentially financed early economic development. During the 1980s and early 1990s, developing countries lowered barriers to foreign flows and offered import exemptions, tax holidays and subsidies to compete for foreign finances globally (UNCTAD, 2002).[6] In recent years these small territories have experienced economic stagnation. Over the period 2008–2013, per capita gross domestic product (GDP) growth rates were negative. In addition, the islands are running recurrent fiscal deficits, are burdened with high debt levels and have sluggish private sectors. Table 1 compiles summary statistics that reflect that economic situation. These conditions have the potential to worsen, given the region's susceptibility to natural disasters and global economic fluctuations.

[5] Although, as pointed out above, the bulk of the literature acknowledges FDI as a growth enhancing entity, there are a number of authors who do not agree.

[6] In its *World Investment Report, 2002* UNCTAD indicated that among 71 countries a total of 208 changes were made to FDI legislation in 2001. Most of these changes sought to liberalize financial markets.

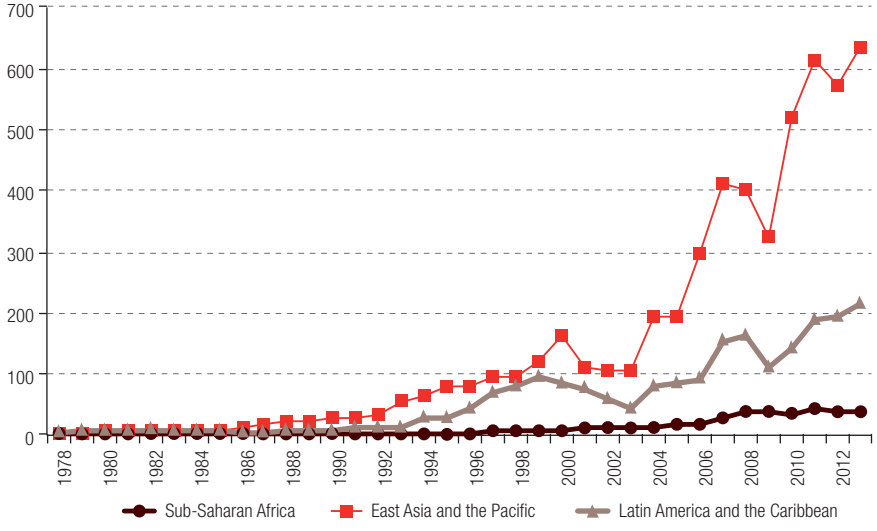
Table 1
Selected Caribbean economies: FDI and some macro-aggregates statistics

	Period Averages					
	Per capita GDP *(current US$)*	Per capita GDP growth *(percentages)*	Real GDP growth *(percentages)*	Inward FDI *(current US$, millions)*	Current account balance *(percentage of GDP)*	Gross public debt *(percentage of GDP)*[a]
Period: 1988-2007						
Antigua and Barbuda	8 885	3.0	4.5	88.6	-10.31	101.6
Dominica	3 843	2.7	2.6	21.5	-14.99	68.5
Grenada	4 020	3.4	3.6	44.8	-16.49	58.5
Saint Kitts and Nevis	7 315	3.3	4.3	53.2	-16.7	111.5
Saint Lucia	4 221	3.4	4.8	72.5	-13.21	39.6
Saint Vincent and the Grenadines	3 278	4.1	3.7	46.7	-15.13	55.6
Period: 2008-2013						
Antigua and Barbuda	13 744	-3.9	-2.8	110.8	-15.83	90.7
Dominica	7 008	0.6	0.8	29.8	-18.388	67.0
Grenada	7 598	-1.1	-0.7	74.4	-23.39	98.1
Saint Kitts and Nevis	13 806	-1.2	0.0	123.0	-17.61	138.2
Saint Lucia	7 039	-0.8	0.4	114.1	-16.94	66.3
Saint. Vincent and the Grenadines	6 298	-0.3	-0.2	115.7	-30.19	66.6

Source: World Bank, World Development Indicators; and International Monetary Fund (IMF), World Economic Outlook (WEO) Database.
[a] Data only available from 1990 onwards.

FDI flows are recovering after the 2007 financial crisis slowed global economic activity. Annual FDI inflows grew exponentially from US$ 208 billion in 1990 to US$ 1.5 trillion during the pre-crisis period of 2005-2007 (UNCTAD, 2014). Figure 1 shows the magnitude of these flows to selected regions.

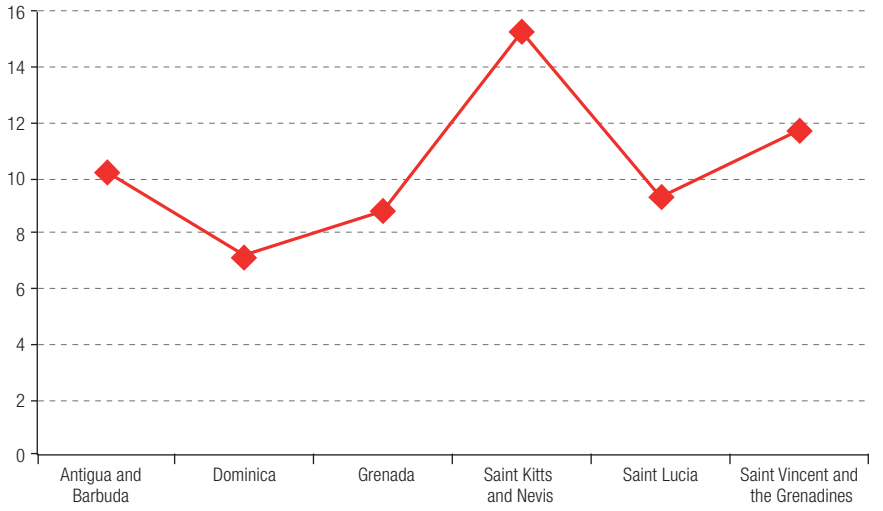
Figure 1
FDI inflows by region, 1978-2013
(Current US$, billions)



Source: World Bank, World Development Indicators.

Flows vary significantly by region, indicating the areas that have offered the highest returns on capital with a reasonable amount of risk. Flows to Central America and the Caribbean increased by 64% in 2013, although this figure excludes offshore financial centres. The OECS countries will once again expect to benefit as these flows boost their slumping growth rates. While the growth miracles these islands experienced during the tourism boom of the 1980s and 1990s are now long gone, that past experience means that increased growth, fuelled by FDI, is a reasonable expectation. Compared to other developing regions, Caribbean economies receive substantial FDI flows relative to their size. According to our sample, foreign investment in Latin America and the Caribbean was equivalent to 4.4% of regional GDP on average. As figure 2 indicates, this metric is frequently above 10% in OECS; it averaged 11.19% for the period covered by this paper. Saint Kitts and Nevis registered the highest FDI to GDP ratio for the period, with 15.59%, followed by Saint Vincent and the Grenadines (13.47%) then Antigua and Barbuda (10.70%).

Figure 2
Average FDI for the period 1983-2013
(Percentages of GDP)

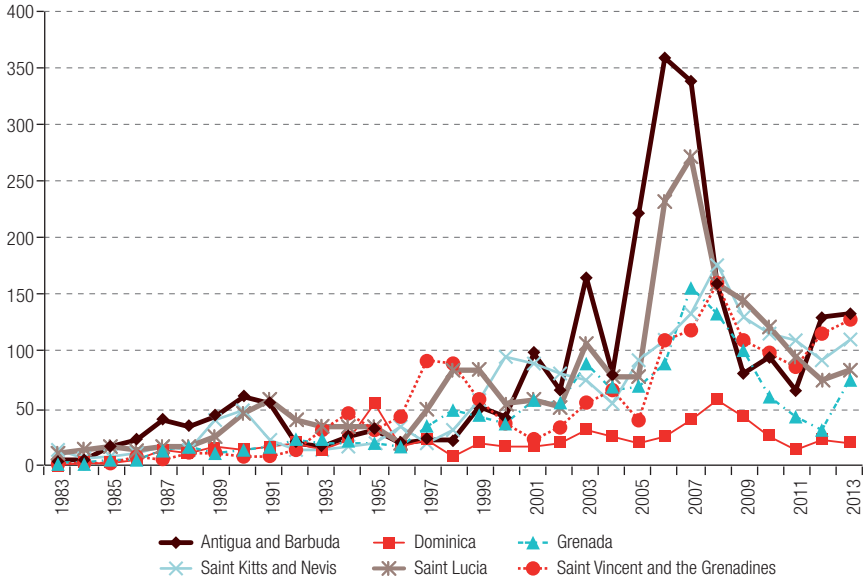


Source: World Bank, World Development Indicators.

Modern growth theory predicts a positive interaction between FDI and economic growth as foreign investment flows improve local conditions (human capital, physical capital, institutions) and transfer productivity-enhancing technology to the host countries. We must model these assumptions to test if these predictions will hold true in this region. This paper therefore provides evidence for and against the plethora of regional policies used to attract FDI. The OECS countries' share of inflows is presented in figure 3, revealing that, on average, flows are not evenly distributed among countries. The main recipients are Antigua and Barbuda and Saint Lucia, with Saint Kitts and Nevis also receiving a stable and substantial flow of inward FDI.

There was a large influx of FDI into the subregion in 2006/2007 in preparation for the ninth edition of the International Cricket Council (ICC) Cricket World Cup, hosted by Antigua and Barbuda, Grenada, Saint Kitts and Nevis, and Saint Lucia. The majority of FDI inflows to the OECS countries have gone into the tourism sector, with very little foreign investment flows reaching other sectors. In addition, these inflows originated in a limited number of countries (specifically Canada, the United States, and the European Union), consequently economic shocks in these countries quickly have a knock-on effect on the small island States.

Figure 3
FDI inflows to the OECS countries, 1983-2013
(Current US$ millions)



Source: World Bank, World Development Indicators.

III. Literature review

There is a broad body of literature that focuses on the links between FDI and economic growth or the impact of FDI on the economy. This literature builds on neoclassical theory, according to which FDI only had an impact on capital accumulation, leaving long-term growth unchanged. Long-term growth was only possible through the exogenous variables of technological progress and population growth. Modern endogenous growth models explore the spillover effects of FDI, which include: (i) technological transfer; (ii) productivity gains; (iii) market expansion and other host country enhancements. Hence, the increased interest in the absorptive capacities of developing countries to exploit the long-term growth potential of FDI inflows.

1. FDI flows and growth

The theoretical literature provides conflicting views concerning the effect of FDI on growth. This conflict has extended into the realm of empirical research and is reflected in divergent findings. Studies such as Schneider and Frey (1985) found positive and statistically significant relationships between FDI and growth. Conversely, Nigh (1986) and Balasubramanyam, Salisu and Sapsford (1996) are among the studies that reported no significant effect of FDI on the path of economic growth. Bornschier, Chase-Dunn and Rubinson (1978) study the effects of foreign investment and aid on economic growth using annual data from 76 less developed countries for the period 1960-1975 and the ordinary least squares (OLS) method. The findings suggest that the stocks of direct foreign investment and foreign aid have the cumulative effect of decreasing the relative rate of economic growth. The effects are small in the short term and larger in the long term. The 1978 study suggested that future studies could focus on the use of longitudinal data sets, the control of initial correlation between foreign

investment and growth, and the use of both stock and flow measures of foreign investment in the models. Modern studies have taken those suggestions into consideration and advanced the empirical analysis.

Undoubtedly, these research suggestions have resulted in even greater insight into the FDI-growth nexus. Fry (1993) posits that the effect of FDI on growth differs markedly from one group of countries to another. Fry (1993) studies the benefits of FDI from a sample of 16 developing countries. Using annual data from 1966-1988, he estimates the real rate of gross national product (GNP) growth with an iterative three-stage least squares. His initial findings indicate that FDI did not exert a significantly different effect from domestic investment on economic growth. However, when the country sample was split, five Pacific Basin countries had a positive and significant FDI-growth relationship. The results of the remaining 11 countries (the control group) were contradictory, with a negative sign attached to the FDI variable. It appears that the FDI-growth link depends on some country-based specifics. Borensztein, De Gregorio and Lee (1998) develop and test a model based on the expanding endogenous growth theory. Their framework is based on an economy where output is a function of the exogenous environment, physical capital and human capital. They tested the effect of FDI on economic growth utilizing annual data on FDI flows from industrial countries to 69 developing countries over the period 1970-1989. Using the seemingly unrelated regressions (SUR) technique, their results indicate that FDI is an important vehicle for technology transfer, contributing to growth more than domestic investment. Another conclusion from their study is that, unless the host country has attained a minimum threshold stock of human capital, FDI will not be more productive than domestic investment. Therefore, the exclusion of human capital and country specific effects in growth regressions tend to alter FDI findings, even in regions with high FDI inflows. A Caribbean-based study by Williams and Williams (1998) lends support to this hypothesis. By developing a macroeconomic model that encompasses investment, savings and trade in growth equations, they evaluated the impact of FDI on the economies in the Eastern Caribbean Central Bank (ECCB) region. The annual data covered the period 1980-1996 and was estimated using an iterative three-stage least squares (TSLS) method. The coefficient of FDI in the growth equation was found to be statistically insignificant. They found that the FDI-growth nexus appears to be channeled through domestic investment, particularly private investment. Consequently, FDI has a positive impact on gross capital formation, imports and a modest positive effect on saving.

According to Carkovic and Levine (2002) the macroeconomic findings on growth and FDI must be viewed with scepticism, as past studies did not control for simultaneity bias, country-specific effects, and the use of lagged dependent variables. In an effort to remedy these methodological shortfalls, they use GMM panel estimators proposed by Arellano and Bover (1995) and Blundell and Bond (1998) to exploit the time-series variation in the data and control for endogeneity. The authors use data from 72 countries (developed and developing)[7] over the period 1960-1995, averaged over seven five-year periods. Their findings suggest that FDI does not exert a robust, positive influence on economic growth, even when the interaction between human capital and FDI is taken into account. Similarly, Griffith, Waithe and Craigwell (2008) analyse the significance of FDI inflows to the development of Caribbean States, with a focus on the relationship between FDI and growth. Their methodology sought to assess FDI-based policy issues in the Barbadian economy. The evidence indicated that although the Caribbean has a relatively high FDI/GDP ratio, FDI had fallen short of expectations; there had been no structural changes that had yielded additional trade and value-added production. The impact of FDI appears to be constrained by limited knowledge transfers and weak research and development spillovers.

Mohan and Watson (2012) provide evidence about the nature and pattern of Caribbean FDI flows. Using a Hausman-Taylor procedure, the researchers estimate a Gravity model with annual panel

[7] Despite its contributions to the literature, this paper was criticized heavily for pooling less developed countries with developed countries in the growth regression (Blonigen and Wang, 2004).

data from 12 Caribbean Community (CARICOM) and eight OECD countries between 2000-2007.[8] The model included variables to measure the distance between the capital cities of countries, GDP, trade, stock market capitalization and private sector credit, among other explanatory variables. The model results suggested that home-country GDP, stock markets, and private sector credit were the most important for increased FDI inflows. The authors recommend, in particular, that all stock markets in the region should be developed, since the empirical study shows that it increases FDI flows. Intra-regional investment flows through CARICOM would benefit from more modern trading systems.

2. FDI: causal linkages and long-term growth

The literature is not limited to the realm of growth regressions. Indeed, other frameworks have also been used to examine the linkages between FDI and economic growth. Braithwaite and Greenidge (2005) examine the impact of FDI on the overall growth of the Barbadian economy. Their annual time series data spanned 1970-2003 and was investigated using cointegration analysis. The researchers estimate an unrestricted vector autoregressive model (VAR), applying the Johansen test for cointegration on the VAR with two lags. The results from the cointegrating vector suggest that real FDI inflows have a significant positive impact on real GDP in the long run. It therefore follows that in the short term such inflows may even slow growth, particularly, as more domestic funds are made available to the private sector meaning that it is less reliant on foreign investment flows.

Motivated by the results and model specification of Carkovic and Levine (2002), Hansen and Rand (2005) test the Granger causal relationship between FDI and growth. They specify a VAR model for the logarithm of GDP and the FDI-to-GDP ratio. Annual data from 31 developing countries (11 from Latin America, 10 from Africa, and 10 from Asia) over the period 1970-2000 were used for the analysis. The results suggest bidirectional causality between FDI and GDP, confirmed by using a fixed effects estimator with country-specific trends. They conclude that FDI is growth enhancing much in the same way as domestic investment. Limiting his focus to two specific regions, Al Nasser (2010) also offers causal evidence on the foreign investment and economic growth relationship, by examining the effects of FDI on economic growth through a comparative study between Latin America and Asia, using annual panel data to analyse 14 Latin American countries from 1978 to 2003. Using Granger causality tests, he explores the link between FDI and economic growth, finding evidence of unidirectional causality that runs from economic growth to FDI for Asian countries, while causality is bidirectional in Latin America. Adeniyi and others (2012) examine the causal linkage between FDI and economic growth in Côte d'Ivoire, Gambia, Ghana, Nigeria, and Sierra Leone. Accounting for financial development over the period 1970-2005, they present a trivariate framework which applies Granger causality tests using a vector error correction model (VECM). Their results show that the level of financial sophistication matters for the benefits of FDI to register on economic growth in small developing countries. Additionally, the causal link between FDI and growth varies across the countries depending on other financial development indicators, an indication of the considerable heterogeneity in the underlying economic structures of those countries.

Mamingi and Borda (2015) examine the determinants of economic growth in the OECS countries, including FDI as an enhancer of growth. Clear distinctions are made between the short- and long-term impacts of the variables. The autoregressive distributed lag (ARDL) bounds testing procedure is used to estimate and test the model. With regard to the FDI component, the results based on the error correction models varied among the countries. For example, it was observed that a positive long-term relationship existed between FDI and growth in Antigua and Barbuda, a negative relationship was

[8] The Caribbean Community (CARICOM) countries used were: Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago. The Organization of Economic Cooperation and Development (OECD) countries represented were: France, Germany, Hungary, Luxembourg, Mexico, the Netherlands, the United Kingdom and United States.

observed in Saint Lucia, while the variable had an insignificant impact on economic growth in Saint Vincent and the Grenadines. The major determinants of growth were found to be trade openness, FDI, government consumption, private consumption, population growth, the fertility rate and inflation.

Whether FDI flows are useful for a country's development or whether they actually cause more harm than benefit remains a matter of debate. Indeed, there is still no consensus among researchers and economists as to the nature of relationship between FDI and economic growth. Based on the literature, it appears that econometric techniques, model specifications and country- or region-specifics tend to significantly influence empirical results on the matter. The ambiguity in the literature highlights the need for further research to enhance our understanding of this economic relationship. It is expected that, as the theoretical underpinnings and statistical techniques expand, the accuracy and consistency of the empirical findings in the FDI-growth literature will improve. There is no lack of research on the relationship between FDI and growth in advanced, emerging and developing countries. There is a knowledge gap with regard to which potential domestic channels that foreign flows might take in order to have the greatest impact on growth, specifically in small island developing States. This paper seeks to fill this gap, among others.

IV. Methodology and data

1. Model

The starting point of our model is a production function where the level of a country's output is estimated using FDI as the main input to capture conceptually the fraction of goods and services produced by foreign firms, and domestic investment as the main input to measure locally produced goods and services. Our model is rooted in the endogenous growth theory formulated by Borensztein, De Gregorio y Lee (1998), according to which FDI contributes to growth through technological advancements, and improvements in human capital, institutions, and infrastructure. To assess empirically the relationship between FDI and growth, we specify the following model:

$$gp_{it} = \gamma + \beta_1 pc_{it-1} + \beta_2 FDI_{it} + \beta_3 \left(FDI * K\right)_{it} + \beta_4 \left(FDI * TL\right)_{it} + \beta_5 \left(FDI * TT\right)_{it} + \beta_6 K_{it} + \beta_7 TL_{it} + \beta_8 TT_{it} + \beta_{9j} X_{itj} + \varepsilon_{it} \quad (1)$$

where i is the cross section unit representing the countries in the sample, t denotes the time dimension, j stands for variable index, gp is the real per capita GDP growth rate, pc_{it-1} is the lagged value real income per capita, FDI is the net foreign direct investment measured as a percentage of GDP, K is our measure of domestic investment (gross capital formation to GDP ratio), TT is trade openness measured as (imports + exports) / GDP, TL stands for telephone lines per 100 people, used as a proxy for infrastructure availability in the host country, X is a matrix of control variables which include population growth (a proxy for financial development), inflation and government consumption, and ε_{it} is the error term which is the sum of the regular error term and the individual random effect error term.

We also include the interaction terms $FDI\ x\ K$, $FDI\ x\ TT$ and $FDI\ x\ TL$ to examine the interactions between FDI and domestic investment, trade and infrastructural development. Our foreign investment by domestic investment term will allow us to measure the extent to which FDI either substitutes or complements domestic investment in enhancing economic growth. The literature suggests that the stock of human capital is important for absorbing knowledge for the growth enhancing spillovers of FDI. Barro and Lee (1994), in particular, have shown the significance human capital (educational attainment) as a source of economic growth. The inclusion of a human capital element in this framework should

improve the explanatory power of the model and align it with the present literature. However, a complete dataset for the relevant human capital proxies, such as mean years of schooling and secondary school enrolment rates, could not be sourced for the countries under consideration.

Two other variants of model (1) were tested in order to check the robustness of the results of the key model (see table 3 below).

2. Growth determinants

Many different factors contribute to economic growth. In this section, we briefly discuss the variables used in the estimation of equation (1). For more detailed discussions of the determinants of economic growth see Barro (1996) and Mamingi and Borda (2015).

(a) Level of GDP

The economic performance of a country or region can be captured by a number of measures, which include widely-used income measurements, such as GDP or GDP per capita (measured either in level or growth terms). However, the measures suffer from some shortcomings, most notably that they do not account for overall welfare and tend to overestimate national wealth. Notwithstanding these issues, we use per capita real GDP growth as the measure of economic activity.

(b) Population growth

According to neoclassical growth models, higher population growth rates have a negative effect on the steady state level of output, because a portion of the economy's investments must go towards the provision of capital for new workers as opposed to raising capital per worker. Thus, population growth was included in the regression to account for this relationship.

(c) Trade openness

In this paper trade openness is measured as total trade (exports plus imports) as a percentage of GDP. The literature suggests that more open economies benefit from the diffusion of technology, economies of scale, and specialization opportunities. These factors ultimately lead to economic growth in the domestic economy.

(d) Inflation

Inflation is negative for many reasons, and obscures the economic decision-making process and, by extension, economic growth. When prices are stable individuals make well-informed consumption and investment decisions and use resources more efficiently. To capture this price volatility, we use the growth rate of the consumer price index. Its relationship with economic growth is expected to be negative.

(e) Government consumption

This variable measures government expenditure on goods and services. Such spending is considered non-productive and to have a dampening effect on the growth rates of GDP per capita. Government consumption expenditure as a share of GDP is used to capture these outlays.

(f) Financial development

The literature suggests that the development of financial markets and institutions are a critical part of economies' growth process (Levine, 1997). Financial systems mobilize savings and facilitate risk management and trading, among other things. These functions, through the channels of capital accumulation and technological innovation, positively affect growth. Therefore, given the links between the financial system and economic growth, we use a proxy (the ratio of private sector credit to GDP) which is expected to be positively related to growth outcomes.

(g) Investment

Studies have shown that investment is an important determinant of economic growth (Barro, 1991). Neoclassical growth models posit that a higher investment to output ratio raises the steady state level of output per worker and, thus, economic growth. Here we measure this domestic investment as the ratio of gross fixed capital formation to GDP. We expect there to be a significant positive relationship with growth.

3. Data

Data for this paper were obtained from two main sources, although FDI and growth data are available from various sources. Data on FDI, GDP, population growth rates, government consumption, domestic capital investment, trade of goods and services were taken from the 2015 edition of the World Development Indicators (WDI) produced by the World Bank. The financial development and infrastructure availability proxies were also obtained from this database. The World Development Indicators are an accurate and world-renowned open source for development and country-specific data, and are widely used by academics, researchers, and policymakers for analytical purposes. The inflation figures for our sample countries were taken from the World Economic Outlook database of the International Monetary Fund (IMF), because the inflation data for the periods covered by our study was not available from the WDI database. The IMF database is another well-known and reliable data source which we also used to corroborate our FDI, growth and other indicators.

Our panel consists of 34 countries (including the six sovereign OECS countries), using annual data for the period 1988-2013.[9] The sample size was enlarged primarily by including the countries of Latin America and the Caribbean in order to generate valid estimates using the Arellano-Bond estimator. The summary statistics of the main variables for the countries under consideration are set out in table 2. FDI averaged 11.19% of GDP.

[9] The countries in the sample are: Antigua and Barbuda, Argentina, the Bahamas, Barbados, Belize, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Costa Rica, Dominica, the Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Honduras, Jamaica, Japan, the Republic of Korea, Mexico, Nicaragua, Panama, Paraguay, Peru, the Plurinational State of Bolivia, Portugal, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, and Uruguay.

Table 2
Summary statistics for the six OECS countries, 1988-2013

Variable	Mean	Standard deviation	Minimum	Maximum
Antigua and Barbuda				
Infrastructure availability (telephone lines per 100 persons)	38.79	9.32	17.59	49.33
		Percentages		
Per capita growth rate	1.42	5.34	-13.01	12.15
Population growth rate	1.34	1.06	-1.50	2.79
Inflation	2.88	1.94	-0.55	6.80
		Percentages of GDP		
Trade openness (total trade)	138.88	30.85	102.03	189.41
Gross capital formation	32.39	7.37	20.88	45.10
Government consumption	18.96	1.87	15.32	22.52
Financial development (domestic credit to private sector)	61.59	9.94	45.10	80.00
Foreign direct investment	10.71	7.23	3.34	31.61
Dominica				
Infrastructure availability (telephone lines per 100 persons)	24.50	5.83	11.15	33.96
		Percentages		
Per capita growth rate	2.22	3.08	-1.96	9.50
Population growth rate	-0.02	0.40	-0.87	0.44
Inflation	2.25	1.98	-0.05	7.67
		Percentages of GDP		
Trade openness (total trade)	102.04	18.77	78.76	135.08
Gross capital formation	23.57	8.12	12.04	41.21
Government consumption	18.41	2.51	14.07	22.03
Financial development (domestic credit to private sector)	50.77	6.09	33.16	59.21
Foreign direct investment	7.79	4.19	2.52	24.14
Grenada				
Infrastructure availability (telephone lines per 100 persons)	24.87	6.12	9.18	32.85
		Percentages		
Per capita growth rate	2.37	4.64	-6.94	12.95
Population growth rate	0.24	0.56	-1.34	1.13
Inflation	2.62	1.81	-0.44	8.03
		Percentages of GDP		
Trade openness (total trade)	94.54	16.71	71.08	127.58
Gross capital formation	32.23	7.01	16.35	46.29
Government consumption	16.03	2.97	11.67	22.44
Financial development (domestic credit to private sector)	63.91	12.33	42.69	84.88
Foreign direct investment	9.72	3.93	3.94	20.64
Saint Kitts and Nevis				
Infrastructure availability (telephone lines per 100 persons)	36.87	8.82	17.19	50.07
		Percentages		
Per capita growth rate	2.28	3.85	-6.73	9.89
Population growth rate	1.04	0.59	-0.75	1.57
Inflation	3.26	2.22	0.23	8.68
		Percentages of GDP		
Trade openness (total trade)	106.33	22.73	76.31	143.68
Gross capital formation	43.57	8.76	26.54	58.79
Government consumption	17.39	2.37	10.81	21.22
Financial development (domestic credit to private sector)	55.27	7.24	38.01	67.72
Foreign direct investment	15.60	6.34	6.89	30.64

Table 2 (concluded)

Variable	Mean	Standard deviation	Minimum	Maximum
Saint Lucia				
Infrastructure availability (telephone lines per 100 persons)	21.53	6.64	8.18	31.91
		Percentages		
Per capita growth rate	2.46	5.34	-4.73	21.55
Population growth rate	1.27	0.26	0.77	1.89
Inflation	2.94	1.96	-0.26	5.86
		Percentages of GDP		
Trade openness (total trade)	124.13	24.27	97.06	182.50
Gross capital formation	26.44	4.19	18.70	37.77
Government consumption	14.80	1.64	12.07	17.88
Financial development (domestic credit to private sector)	77.75	20.24	52.70	113.17
Foreign direct investment	9.84	4.74	3.25	23.78
Saint Vincent and the Grenadines				
Infrastructure availability (telephone lines per 100 persons)	18.16	4.34	7.51	25.26
		Percentages		
Per capita growth rate	3.09	4.34	-3.42	13.92
Population growth rate	0.12	0.17	-0.07	0.60
Inflation	2.74	2.56	0.13	10.12
		Percentages of GDP		
Trade openness (total trade)	107.34	23.47	82.70	158.78
Gross capital formation	27.37	3.34	23.16	35.68
Government consumption	18.56	3.55	15.06	28.48
Financial development (domestic credit to private sector)	45.18	8.04	29.41	55.34
Foreign direct investment	13.48	7.15	3.87	31.55

Source: Prepared by the authors.

V. Empirical results

1. Panel estimation

We apply the generalized method of moments (GMM) to estimate the dynamic panel model. The model contains potentially endogenous regressors; specifically, the literature suggests the presence of bidirectional causality between FDI flows and per capita GDP. Although they share similar traits (colonial history, economic structure, etc.), the OECS countries differ in many aspects (such as their political environments, ideologies, cultures, geographic sizes and compositions, and, to a certain extent, climatic conditions) which justifies the presence of country-specific effects in the regression model. These effects are part of the error term of model (1), i.e. there are random individual effects. In addition, the presence of the lagged dependent variable gives rise to serial correlation. Arellano and Bond (1991) have developed a GMM method that exploits the linear moment restrictions that follow from the assumption of no serial correlation in the errors, in an equation which contains individual effects, no strictly exogenous variables[10] and lagged dependent variables. Using the Arellano-Bond difference GMM estimator solves the aforementioned issues identified in the model.

[10] A Hausman specification test reveals, for example, that FDI is not an exogenous variable in model (1). Result available upon request.

A problem that often arises when the instrumental variable estimation method is used is the issue of weak instruments. Weak instruments will likely cause the instrumental variable estimators to be biased, just as in a least squares estimation for this particular model. The presence of unobserved country-specific characteristics may indicate that our internal instruments are unsuitable; hence lagged levels of the regressors might be invalid instruments for equation (1). However, our difference estimator eliminates the country-specific effects by taking first differences of equation (1). Moreover, by including real GDP growth of the United States and the European Union in the instruments list, the resulting instruments are valid and uncorrelated with the error term. The validity of these instruments is assessed using a Hausman test for endogeneity, which revealed that the selected variables were good instruments. We specify the model for robust standard errors to correct for any possible heteroscedasticity in the data-generating process. Thus, we do not report the Sargan test for overidentifying restrictions, since only in the presence of a homoscedastic error term does the Sargan test have an asymptotic chi-squared distribution. So, under the assumption of the robust standard errors model, the asymptotic distribution of the Sargan statistic is not known and therefore not computed. We also report the Arellano-Bond test for serial correlation in the first-differenced errors, which will provide evidence of the validity of the moment conditions used by the estimator.

According to Granger and Newbold (1974), many economic time series are non-stationary and regression models using this type of data are often qualified as spurious regressions. However, our panel data set has time dimensions that are large enough to study the issue of stationarity. We apply panel unit root testing before we estimate our proposed specification. Recent literature indicates that panel-based unit root tests have higher power than tests based on individual time series. There are five main tests: Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Fisher-type tests based on augmented Dickey-Fuller and Phillips-Perron tests and, lastly, Hadri (2000). In this paper we concentrate on the Levin-Lin-Chu (LLC) unit root test for panels. The LLC test assumes that there is a common unit root process, thus ρ_i is identical across the cross-sections, $\rho_i = \rho = 1$. To repeat, under the null hypothesis there is a unit root, while under the alternative, there is no unit root. The LLC test considers the following basic augmented Dickey-Fuller (ADF) specification:

$$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{P_i} \beta_{ij} \Delta y_{it-j} + \gamma_{mi} d_{mt} + e_{it} \tag{2}$$

where y is the variable of interest, i is unit index, t stands for time index, d represents deterministic elements, m=1,2,3 represents models that contain no constant, a constant (individual specific effects), or both a constant and trend, respectively, $\alpha = 1 - \rho$ is the parameter of interest, and P_i is the lag order. The null and alternative hypotheses referred to above can be expressed as follows:

$$H_0: \alpha = 0 \tag{3}$$

$$H_1: \alpha < 0 \tag{4}$$

We use the Schwarz information criterion to determine the optimal lags. The LLC test results were indicative of stationarity for most of the variables in our panel, with the exception of our financial development proxy and trade openness which are I (1). According to Hayakawa (2009) GMM estimators perform well, even in the presence of non-stationary variables.

2. Results and analysis

Apart from examining the impact of FDI in isolation, this paper also studies its interaction with the stock of infrastructure, trade and domestic investment (physical capital) to identify a channel through which FDI may contribute to growth. We account for pre-existing economic conditions and host country

macroeconomic indicators by including variables such as inflation rate, government consumption and financial development. We present the results of the regressions for all countries in the sample in table 3 and interpret them below.

Table 3
Dynamic panel data estimation results: FDI and real per capita GDP growth

Dependent variable: real GDP per capita growth	Regressions		
Independent variables	1.1	1.2	1.3
Constant	0.717	0.721	1.4
	(2.595)	(2.356)	(1.466)
Lagged per capita income	0.190***	0.145***	0.113**
	(0.054)	(0.057)	(0.055)
Domestic investment	0.191***	0.245***	0.261***
	(0.068)	(0.062)	(0.060)
Foreign direct investment	0.003		-0.028
	(0.040)		(0.108)
Trade openness	0.034*	0.024	0.033*
	(0.019)	(0.018)	(0.019)
Population growth	-1.287**	-1.499***	-1.796***
	(0.514)	(0.525)	(0.465)
Infrastructure		-0.025	0.012
		(0.049)	(0.067)
Cricket World Cup 2007			1.670
			(1.487)
OECS regional dummy			0.226*
			(0.122)
FDI and infrastructure		0.005***	0.005**
		(0.001)	(0.002)
FDI and domestic investment		-0.006*	-0.006*
		(0.003)	(0.003)
FDI and trade openness		0.001	0.001
		(0.001)	(0.001)
Financial intermediation			-0.075*
			(0.040)
Global financial crisis		-1.914***	-1.793***
		(0.655)	(0.614)
Inflation			-0.0003
			(0.0005)
Government consumption	-0.337**	-0.306**	-0.232*
	(0.133)	(0.128)	(0.124)
Observations	816	816	816
Serial correlation test (p-value)[a]	0.195	0.138	0.098
Wald test (chi-square)[b]	100.49	421.47	338.62

Source: Prepared by the authors.
Note: Produced using the Arellano-Bond first difference GMM estimator, time dimension: 1988-2013 and cross-section dimension: 34 countries. ***, ** and * denote significance at 1%, 5% and 10% levels, respectively. Standard errors are reported in parentheses. Equations (1.1), (1.2) and (1.3) are variants of equation (1).
[a] The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.
[b] The null hypothesis is that all parameters except the constant are zero.

In the first specification, using a 10% level of significance, the results of regression (1.1), taking into account the explanatory variables of FDI, trade openness, population growth, domestic investment, government consumption and lagged per capita income, indicate that the impact of FDI is not significant. On the contrary, domestic investment positively and significantly affects economic growth; a 1% rise in domestic investment brings about a 0.191% increase in real per capita growth. At the 10% level

of significance, trade openness also has a positive and significant impact on economic growth, with a 1% increase in trade openness producing a 0.034% increase in economic growth. This result is not surprising as trade liberalisation is known to be a significant contributor to economic growth, for example countries like China and Mexico enjoy strong export-led growth. In the context of the OECS countries, trade importance can be explained by the theory of comparative advantage which holds that trade leads to more efficient usage of a country's resources by importing products and services that are too costly to produce domestically. The practical failures of import substitution and the influence of international bodies, such as the International Monetary Fund (IMF), the World Bank and the World Trade Organization (WTO), have resulted in developing countries favouring outward-looking strategies. As expected, the impact of population growth was found to be negative and highly significant in all model specifications. According to Barro (1996), once the population is growing, a portion of its income must be used to provide capital for new workers, rather than to raise capital per worker. Interestingly, a study by Thacker, Acevedo and Perrelli (2012) found that Eastern Caribbean countries, such as Antigua and Barbuda, could enhance their output per capita by focusing on increasing their capital per worker ratio.

In regression (1.2) we include the interactions between FDI and trade, domestic investment and infrastructure availability, which replace the FDI variable. Including the interaction terms improves the overall fit of the regression. We also control for the impact of the global financial crisis on real growth and capital flows with a dummy variable. At the 10% level of significance, the FDI and domestic investment term enters the regression with a negative impact. There is evidence of the crowding-out effect. The interaction between FDI and infrastructure availability yields a positive and statistically significant impact on economic growth. In isolation, the impact of the variable of host country infrastructure, as measured by telephone lines per 100 people, is negative but not statistically significant. In fact, the majority of public infrastructure development in the region seeks to provide basic amenities and road networks for the growing populations. A smaller fraction aims to create an investment environment with favourable conditions for economic growth. Hence, the findings suggest that infrastructure investment in developing economies, like the OECS countries, has not reached a sufficient level to have growth-inducing effects. The positive and high significance of the interaction term (FDI and infrastructure) indicates that channelling FDI through infrastructure development may spur economic growth. A one unit increase in the value of this FDI-to-infrastructure interaction was found to raise per capita growth by some 0.005 percentage points. The FDI and trade interaction was not found to be statistically significant but entered with a positive sign. Although we would expect FDI to expand trade, the high level of leakage (through imports) might be reducing the expected positive contribution of this channel. Domestic investment is again positive in this regression and remains robust throughout all specifications. Trade is not significant in (1.2) but maintains its positive sign. We re-introduce the FDI variable alongside the interaction terms and other host country characteristics to test whether FDI affects growth directly or through the interactions.

Unlike equation (1.2), equation (1.3), which is the key model, includes financial development (represented by the proxy of domestic credit to the private sector as a percentage of GDP) and inflation, in addition to reintroducing the FDI variable. Equation (1.3) also incorporates a regional dummy variable for the OECS economies to quantify the growth differential between these countries and the others in the sample, and the dummy variable of the 2007 Cricket World Cup to capture the impact of that event on GDP growth in those islands. FDI impact is negative but not significant in this final specification, suggesting that its absolute economic effect is realized through independent channels. Concentrating on the primary effects, a 1% increase in domestic investment boosts economic growth by 0.260%. Once more, trade openness positively affects economic growth. Growth of 1% in trade openness leads to a 0.033% increase in economic growth. The trade openness results are generally consistent across the three variants of the model. Another consistent outcome is the negative and significant impact of population growth; a 1% increase in population growth depresses economic growth by some 1.796%. Unlike regression (1.2), infrastructure availability is positive but again enters with no significance (see above). As expected, the global financial crisis depressed economic growth.

The literature indicates that the growth effects of FDI are influenced by the host country's characteristics such as its fiscal position, financial development and macroeconomic environment, represented by the proxies government consumption as a percentage of GDP, financial development or domestic credit to the private sector, and inflation. All these characteristics negatively affect economic growth. A 1% increase in government consumption depresses economic growth by 0.232%. Financial development was also found to impact negatively on economic growth. This is inconsistent with the literature that indicates a positive correlation between the financial sector and growth (King and Levine, 1993). This could be a result of financial acceleration, where the worsening credit market conditions in the region have lead to adverse growth outcomes. Moreover, the finance-growth nexus in the sample countries displays demand-following as opposed to supply-leading characteristics. The sign of the coefficients measuring financial sector development is largely dependent on the proxy used. Gordon (2009), for example, finds that other financial development measures do enhance economic growth in the CARICOM countries. The impact of inflation on economic growth is negative but negligible. As was suggested above, the rate of inflation indicates the soundness of macroeconomic policies. The sample economies appear to have enjoyed price stability for most of the review period. Interestingly, the OECS economies have enjoyed consistently low inflation because of fixed exchange-rate regime (pegged to the United States dollar). The rate of inflation in those economies is fuelled by import prices, but, overall, price increases have not significantly depressed domestic output. Our dummy variables (the Cricket World Cup and OECS region) entered equation (1.3) with the expected positive signs, but only the OECS regional dummy was statistically significant. The Cricket World Cup dummy was insignificant, suggesting that the capital inflows surrounding the event did not influence growth homogenously in all OECS countries. The significance of the regional dummy variable indicates that, on average, growth in the OECS countries was 0.226 percentage points higher than that of the other groups in the sample. With regard to the interaction of FDI with other variables, two significant impacts were observed with domestic investment and infrastructure availability. It can be argued that the positive impact of FDI on economic growth is essentially achieved through the channel of infrastructure development. This interaction means that the effect of FDI on economic growth varies depending on the different levels of infrastructure available in the host country. The interaction of FDI with trade openness is null. Trade openness seems to evolve independently of FDI. The interaction between FDI and domestic investment is examined below.

3. FDI and domestic investment

We further examine the contribution of FDI to growth by analyzing its relationship with (total) domestic investment. The interaction between FDI and domestic investment was found to be negative, with a statistically significant coefficient. The negative coefficient for the interaction term suggests that domestic investment is crowded-out by foreign investments. The magnitude of the substitution effect was found to be less than 1%. Hence, FDI fosters economic growth by augmenting the capital stock of the host country when the FDI-to-GDP ratio is below 43:50.[11] Above this threshold, FDI completely crowds-out the positive impact of domestic investment on economic growth.

There is undoubtedly a marked reduction in domestic capital investments in the presence of large FDI projects, owing to several factors. Topping the list is local firms' competitive disadvantage compared to efficient multinational corporations. Unlike local firms, multinational corporations tend to benefit from favourable fiscal incentives, placing the former at a competitive disadvantage. The production of substitute goods is also a factor behind this crowding-out effect. The main recipient of foreign investment flows into the OECS countries is the tourism sector; however, given the number of all-inclusive resort projects, investment opportunities in the industry have been limited. Moreover, the

[11] The threshold level for the FDI-to-GDP ratio is obtained by solving the equation 0.261 - 0.006 x = 0. Values greater than the threshold (43:50) would completely nullify the impact of a 1 unit increase in the domestic investment rate on economic growth.

countries have not fully exploited potential backward linkages in the sector. It was hoped that the tourism boom would create links with the local agricultural sector and other light industries, but this policy goal has not been realized; the only factor of production that has been abundantly provided to the sector is labour, and this excludes employees in management and specialist positions.

4. Overall impact of FDI on economic growth

Although we alluded to the impact of FDI on economic growth above, we did not put the primary and secondary effects of FDI together. Using the observations for the OECS countries and concentrating on equation (1.3), we see that FDI enters the regression alone as well as with other variables. The impact of a 1% change in FDI from table 3 is given by

$$\frac{\partial gp_{it}}{\partial FDI_{it}} = -0.028 \ -0.006 * \overline{K} + 0.001 * \overline{T} + 0.005 * \overline{IA} = 0.035 \quad (5)$$

where K stands for domestic investment, TT represents trade openness, IA is infrastructure availability and the bar indicates that they were evaluated at the mean.

The results of equation (5) cannot however be accepted at face value. Some of the coefficients, precisely two, were not found to be statistically significant. Eliminating these expressions give rise to:

$$\frac{\partial gp_{it}}{\partial FDI_{it}} = -0.006 * \overline{K} + 0.005 * \overline{IA} = -0.048 \quad (6)$$

This suggests that a 1% increase in FDI leads to a 0.048% decline in economic growth. Although the impact is small, it is still negative. Braithwate and Greenidge (2005) uncovered a similar result for Barbados, with FDI negatively affecting growth in the short term and positively in the long term.

VI. Conclusions and policy implications

A number of studies indicate that FDI affects economic growth through several important channels. They acknowledge that the effect of FDI is limited by the absorptive capacities of the host countries; therefore the impact differs across regions. This paper has examined the effect of FDI on economic growth in the OECS countries for the period 1988-2013 in an attempt to gain a better understanding of the growth-inducing benefits of FDI.

The main conclusion of the paper is that FDI does positively impact growth when host country conditions are adequate. This impact was not found to be significant when considered in isolation and, when it was evaluated for the OECS countries, it was found to be negative overall, proving the inadequacy of the absorptive capacity of the economies. The interaction between FDI and public infrastructure development was found to positively and significantly influence economic growth. Foreign investment projects usually boost demand for energy and modern telecommunications, road and transport systems. These developments, especially those related to telecommunications, transport and energy, increase productivity and efficiency, leading to a rise in output. Therefore, policies that seek to improve infrastructure could ultimately lead to sustainable development and a higher standard of living for residents. The region must also work to attract FDI that explores alternative business ventures rather than the tourism-based projects to which the region has limited itself for decades.

Efforts should be made to lure research and development, manufacturing and technology-based firms to the region. The industrialization by invitation strategy proposed by Lewis (1950) is still valid today, but has never been explored in the region. In addition to granting fiscal incentives as Lewis

suggested, more attention could be focused on developing human capital stock, infrastructure availability and access to raw materials. The literature suggests a strong positive relationship between FDI and human capital, indicating that investing in human capital could extract better outcomes from foreign investments. Most of the human capital training in the region has not been in growth-inducing fields, such as technology or engineering, so OECS policymakers should increase investments in education and skills training, particularly in the targeted areas of technology and the sciences, in an effort to spur innovation, productivity and, as a result, long-term economic output.

Domestic investment is crowded out by FDI as it reduces investment opportunities and diverts the host country's productive capacities. The cost of credit has had a negative impact on the region for a long time, but recent action by the Eastern Caribbean Central Bank to reduce minimum deposit interest rates was a direct attempt to reduce the cost of borrowing and stimulate local investments.

The OECS countries are quite open with regards to trade and, even though there are no incentives or programmes to bolster exports, this variable still exerts a positive and significant impact on growth. With multiple trade agreements at their disposal, OECS countries can explore export markets for their products. In particular, increasing intraregional trade will reduce foreign dependence and the external vulnerabilities the region faces. The FDI-to-trade channel was not found to be significant, but it is a positive relationship that can be exploited. FDI has augmented trade but the net effect has been more imports (a negative component of GDP). As expected, government consumption negatively influences growth. If not monitored, such expenditure could lead to economic instability. Since the OECS countries already have massive debt-to-GDP ratios and recurrent fiscal imbalances, more prudent fiscal management is needed to promote macroeconomic stability in those countries. Governments' role should be that of a facilitator rather than main economic actor; public expenditure should focus on creating an innovative and entrepreneurial environment that fosters growth and technological advancement.

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The wealth gifted to the large-scale copper mining industry in Chile: new estimates, 2005-2014

Gino Sturla Zerene, Ramón E. López, Eugenio Figueroa B. and Simón Accorsi O.[1]

Abstract

This article estimates the economic rents received by the 10 mines that comprise Chile's large-scale private-sector copper-mining industry. The methodology used produces a conservative calculation and includes two corrections that have hitherto been ignored in the literature: the reimbursement of exploration expenses and the compensation needed for volatility in the copper price. Estimates show that the wealth transferred to these firms between 2005 and 2014 was at least US$ 114 billion. These rents are neutral in terms of investment and production decisions; in other words, if the private mining companies had paid the Chilean Treasury the calculated amount, their total investment and output would have been unchanged, but the country at large could have benefited from the huge voluminous resources in question. Moreover, in the absence of any other distortion, the firms would still have earned returns equivalent to what they would have obtained under perfect competition.

Keywords

Copper, mining, private sector, rent, measurement, natural resources, prices, tax revenues, Chile

JEL classification

Q30, Q32, Q33

Authors

Gino Sturla Zerene is a PhD candidate in Economics at the Department of Economics, Faculty of Economic and Business, University of Chile. Email: gsturla@fen.uchile.cl.

Ramón E. López is a full professor at the Department of Economics, Faculty of Economic and Business, University of Chile. Email: ramlopez@fen.uchile.cl.

Eugenio Figueroa B. is a full professor at the Department of Economics, Faculty of Economic and Business, University of Chile. Email: efiguero@fen.uchile.cl.

Simón Accorsi O. is a PhD student in Economics at the Department of Economics, Faculty of Economic and Business, University of Chile. Email: saccorsi@fen.uchile.cl.

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I. Introduction

"…all Chileans need to consider how an additional peso can be put to best use —an extra peso for a bridge, a school, a public-sector worker, a pensioner…"

Rodrigo Valdés, Minister of Finance of Chile, 2015-2017,
La Tercera *newspaper, 25 August 2016, Santiago.*

"…we must not let this vast and wealthy region become nothing more than a foreign factory…"

José Manuel Balmaceda, President of Chile, 1886-1891,
Message to Congress, 1 June 1889, Santiago.

Chile's large-scale private-sector copper-mining industry consists basically of 10 large transnational corporations which account for around 60% of all copper produced in the country. Most of the copper produced by these firms is exported as concentrate, which implies a minimum level of product processing. In addition to the large private-sector mines, there is a public-sector firm, Corporación Nacional del Cobre de Chile (CODELCO), which generates about one third of Chile's total copper production.

Copper is responsible for a huge share of Chile's tax revenues; yet the bulk of copper's contribution to the Chilean State comes from CODELCO (around 60% of the total), while the 10 large private-sector mining firms contribute less than half of that amount. In other words, CODELCO's effective tax rate per ton of copper produced is nearly four times higher than the rate faced by the large private-sector mining companies.

This provides a major justification for this study: why do large private firms pay much lower taxes than the State enterprise —especially when CODELCO's mines are much older and have a far lower average mineral grade?

Nonetheless, CODELCO's heavy tax burden has not prevented it from maintaining a healthy financial situation in most years. This implies that the private mining firms could contribute much more to the Chilean State than they currently pay, without jeopardizing their economic viability; and they would still earn normal rates of return on their capital.

In other words, it would appear that private mining companies are appropriating large economic rents. This paper attempts to put a value on those rents, using very conservative assumptions in its estimation, in order to provide a lower-bound value.

The article is organized as follows. Section II sets out the conceptual framework to be used, emphasizing the concept of economic rent and its relationship to natural resources and the mining rent. It also makes a brief review of the literature on this subject in the case of Chile. Section III describes the process by which mining rents are estimated by the World Bank, which also provides the data set used in this study. Section IV describes the methodology used to calculate the rents, and section V presents the results. The article concludes with some final thoughts.

II. Conceptual framework

1. Economic rent

The classic definition of economic rent refers to the excess economic return that a specific factor of production receives —that is, an amount above the minimum return needed for it to continue in the same use. When all factors of production are considered together, the economic rent associated

with a productive enterprise can be understood as a payment above the minimum necessary for the enterprise to remain in a given economic activity. The origin and subsequent theoretical development of this concept are discussed in the Letters of David Ricardo, 1810-1815, compiled by Piero Sraffa (Ricardo, 2005), in the literature review by Tollison (1982), and in the studies of Shepherd (1970) and Hammes (1985), among other sources.

In the concept of economic rent, the opportunity cost of all productive resources used is already discounted. Since opportunity costs include the profit that would have been made if the resources employed in a certain activity had been invested in the next best alternative use, economic rent represents a surplus over the profit needed to allocate the resources to the activity in question. More simply, the rent is the surplus value of production after deducting all costs, including a normal return on capital and relevant risk premiums. Wessel (1967) distinguishes between the concepts of Ricardian and Paretian rent, emphasizing that the latter is calculated by deducting opportunity costs. The present study uses the concept of economic rent in its Paretian sense.

2. Economic rent and natural resources

A key feature of natural-resource-based economies is that they tend to generate large economic rents, which can inflate the return earned on the capital that exploits them to levels well above normal rates of return. The economic rent generated by the activities in which the natural resources, whether renewable or non-renewable, are extracted, directly constitutes the *in situ* scarcity value of the resources in question. Hence, the rent is what the owner of the natural resource can legitimately charge entities that use the resource in a productive process. The present study focuses on the calculation of this rent in Chile, specifically, the rent received by the 10 firms that form the large-scale private-sector copper-mining industry *(gran minería privada del cobre)*, hereinafter referred to as GMP-10.

3. Origin of economic rent in the mining industry

Minerals differ from other natural resources, since they require an "exploration" phase prior to extraction or exploitation. Finding minerals has been a historically difficult and expensive task, with slim chances of success. There are two different mineral exploration regimes:

(i) Free-entry exploration: in this mode of operation, there is perfect competition in the exploration market, so the rents accruing to the economic agents that undertake exploration work tend to dissipate in the long run.

(ii) Exploration subject to entry barriers: this situation can involve lobbying mechanisms that impede free access to exclusive exploration concessions, or simply the maintenance and exploitation of the rights derived from concessions previously granted by the State. In both cases, the final de facto effect is the existence of entry barriers to exploration, which also then become de facto entry barriers to the extraction or exploitation of the mineral in question. This situation generates an institutionally-based artificial shortage; and it constitutes a source of rent appropriation by the mineral exploration and extraction firms. Moreover, the rent generated under this regime does not dissipate as it does under free entry: firms that enjoy exclusive access to mineral deposits tend to appropriate these rents; and, given the heterogeneity of the deposits and the natural scarcity of the mineral resource, the existence of these rents does not elicit additional investment. This is because the return on capital obtained from mines currently being operated can seldom be replicated, since the costs of exploring and exploiting new potential deposits are usually greater than those of deposits already discovered and in operation.

This study considers the second of the two regimes, since Chile has legislation that grants exclusive exploration concessions and mining rights, on a cost-free basis and in perpetuity. In 2013, 42% of the country's total area was under concession, encompassing all zones with mining potential (SERNAGEOMIN, 2013). In Chile, therefore, copper is a resource for which the scarcity value is determined by entry barriers to exploration activities, which grant free and exclusive access to a handful of firms. In the case of GMP-10, the firms in question own the exploration and exploitation concession, which enables them to retain the corresponding rents.

4. The nomenclature used in the study

- *WB total mining rent:* the rent calculated by the World Bank in relation to all the mining activity undertaken in Chile. The estimated amounts can be found in World Bank (2016).
- *WB GMP-10 mining rent:* that portion of the WB total mining rent associated with the companies that operate the 10 mines that comprise the large-scale private-sector copper-mining industry in Chile.
- *GMP-10 compensated rent:* the remaining rent, obtained by taking the WB GMP-10 mining rent (in which all production costs have already been deducted from the value of mineral sales) and subtracting two additional compensatory returns that have not previously been considered in any study on Chile. These are:

  (i) the return needed to compensate for the high risk associated with mineral exploration activity; and

  (ii) the return needed to compensate for the high risk associated with the volatility of the price of the raw materials (copper) on the international market.
- *GMP-10 appropriated gratuitous rent:* this is obtained by subtracting the GMP-10 compensated rent from the tax revenue that the State of Chile obtained from the large-scale private-sector copper-mining industry. This corresponds to economic rent as strictly defined; so, if it were taxed away, it would not generate distortions in the economy. This rent is referred to as "gratuitous" because it should pertain to the owner of the mineral ore (the State of Chile), but instead is gifted to the firms that exploit it.

5. Studies of mining rent in Chile

Despite the fundamental importance of mining rents for Chile's economy, few studies exist on the subject. The most important is undoubtedly that done by the World Bank (2011), which is described in greater detail in section III.

Although mining rents have been estimated in recent years, the studies in question contain major methodological errors. For example, when calculating the economic rent, Poblete (2015) considers the sales that the mining firms report rather than the total production of copper and other minerals at market price. This is not consistent with economic theory and generates a serious distortion, since a large proportion of sales is reported at transfer prices, which are generally below the market price (COCHILCO, 2015; Correa, 2016).

None of the recent studies considers exploration expenses, which must be increased ex-ante, since exploration activity entails a high probability of failure which must be economically compensated. A second issue that is ignored is compensation for the volatility of copper prices, which requires the rents to valued at trend prices rather than at the prices observed on the market. Failure to do so may result in rents being overestimated when measured in a mineral price upswing or supercycle period.

6. A modern methodology

The methodology used in this study ensures that the rents estimated correspond to a "lower bound" or minimum value. For that purpose, two important corrections are made which are generally ignored in the literature —even in the estimates by the World Bank and the Organization for Economic Cooperation and Development (OECD)— which significantly reduce the estimated amount of the rent:

(i) *Exploration expenses:* to maintain their long-term production potential, copper mining firms must undertake a lot of exploration work to replace deposits that are becoming depleted. The fact that mineral exploration activities are often unsuccessful means they are subject to a high risk that needs to be rewarded with a higher ex ante rate of return. Thus, when calculating the economic rent, apart from deducting observed exploration costs, the calculation must also include a premium for the ex ante risks of these expenses.

(ii) *Commodity-price volatility:* the prices of raw materials, particularly copper, fluctuate widely, with periods of very low prices and other high-price or boom periods. As a result, rents that may seem excessive during peak periods may, in part, be merely compensating for losses occurring during low-price phases. Measuring rents in periods of very high prices, as at the time of this study, can lead to overestimation; so taxing them away completely would be distorting. This problem is tackled by removing the effect of short-term fluctuations from the copper price and using trend prices instead of those observed in the market. The values thus estimated correspond to long-term rents.

This methodology involves estimating a minimum value of the rent compared to more conventional measures. This can be a disadvantage, since the true value of economic rent tends to be underestimated. Nonetheless, the study aims precisely to estimate the rent as conservatively as possible, to obtain a lower-bound value. From the public-policy standpoint, the risk involved in not taxing all of the rent is likely to have less negative consequences than to tax it in excess as a result of overestimates. In the first case, an underestimation of the rent only causes a distributive effect because less revenue is collected than could otherwise be obtained. In the second case, if the rent is overestimated, taxing it can cause economic-efficiency losses.

The methodological procedure used in this study is as follows. The World Bank measurement of Chile's total mining rent is used to obtain the GMP-10 portion, which is implicit in the WB calculation and amounts to US$ 204 billion in 2005-2014.[2] This is then reduced by deducting the amounts needed to offset the uncertainty of exploration expenditure (just over US$ 18 billion) and to compensate for the volatility of the copper price (nearly US$ 30 billion). The GMP-10 compensated rent is thus calculated as US$ 156 billion. From this amount, the taxes paid by GPM-10 (nearly US$ 42 billion) are deducted to obtain a GMP-10 gratuitous rent of US$ 114 billion. This amount is equivalent to almost six times the total value of Chile's current sovereign wealth funds (Ministry of Finance, 2015).

III. Mining rents according to the World Bank

1. General considerations

In the study *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium* (World Bank, 2011), the World Bank calculated the mining rents of various countries, including Chile; and these have now been updated to 2014. This official database spans a 45-year period and is kept permanently up to date.

The calculation methodology (World Bank, 2011, Brandt, Schreyer and Zipperer, 2013) considers the following:

[2] This article uses United States dollars at October 2016 prices throughout.

- The production of minerals, measured in terms of refined units equivalent, associated with the deposits or mines located in the country.
- The price observed on the international minerals market, for the purpose of estimating sales value, which generally differs from the amount reported by the companies themselves.
- The total costs of mining production in deposits or mines, including the opportunity cost of capital (Brandt, Schreyer and Zipperer, 2013).

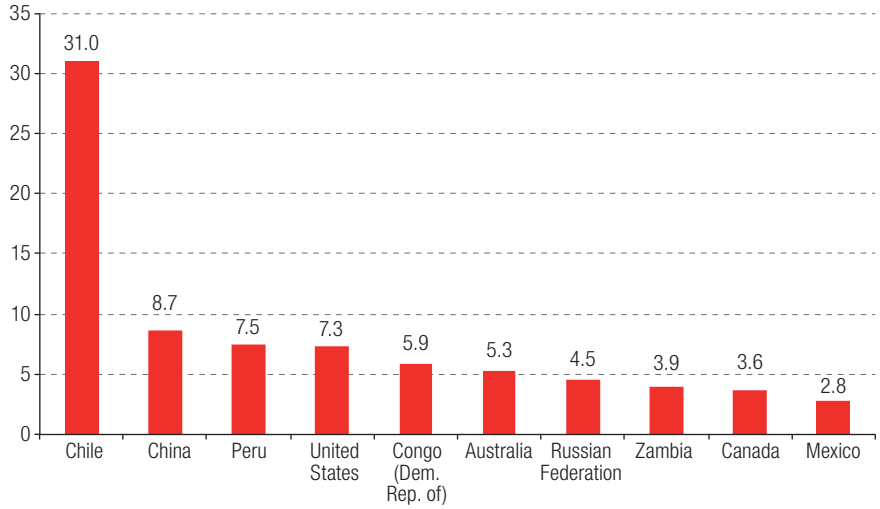
In the case of Chile, this study considers the following mining products in addition to copper: tin, gold, lead, zinc, iron, nickel, silver, bauxite and phosphate. Copper rents are predominant —accounting for over 95%— compared to the rents associated with other minerals, especially in 2005-2014 (Brandt, Schreyer and Zipperer, 2013). Moreover, most of the minerals considered are themselves by-products of the large-scale copper mining industry and are therefore present, although to a lesser extent, in these firms' revenues. It should be noted that the contribution made by these minerals to the calculated rents is underestimated, since the by-products of the large private copper mining sector have been systematically under-reported owing to the lack of measurements by laboratories that are genuinely independent of the mining companies (Castillo, 2015).

It should be noted that the rents measured by the World Bank do not correspond to economic rents strictly defined —as used in this study— since they do not deduct the returns needed to compensate for exploration expenditure risks and the volatility of international mineral prices. These two issues are addressed in this study and the corresponding calculations are made.

2. Mining rents in Chile compared to those of other copper-producing countries

In 2014, 31% of all copper produced in the world was mined in Chile, as shown in figure 1 which reports the global production shares of the 10 countries that extracted the largest amount of copper in that year.

Figure 1
Share of the largest copper-producing countries in global copper production, 2014
(Percentages)

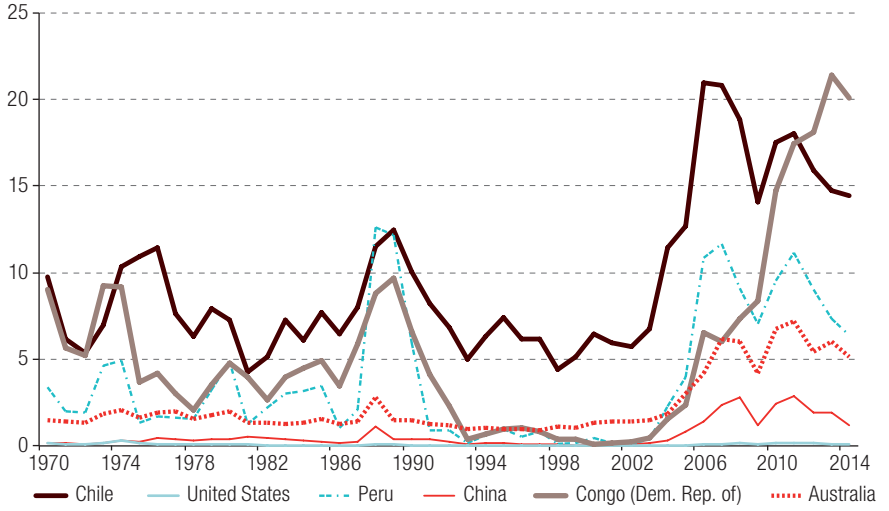


Source: Prepared by the authors, on the basis of World Bank, *World Development Indicators*, 2016.

Figure 2 displays mining rents from 1970 to 2014, as calculated by the World Bank (World Bank, 2016) in the six countries that produced the most copper in the latter year. Rents are expressed as a proportion of gross domestic product (GDP). This figure shows that, in Chile, mining revenues

exceeded 5% of GDP nearly every year, even in periods when the price of copper was very low. This suggests that the generation of economic rents is not merely a cyclical phenomenon, typical of periods of prosperity in the copper market, but clearly a long-term issue.

Figure 2
Annual mining rent as a percentage of GDP in the six countries that produced the most copper in 2014, 1970-2014[a]
(Percentages)

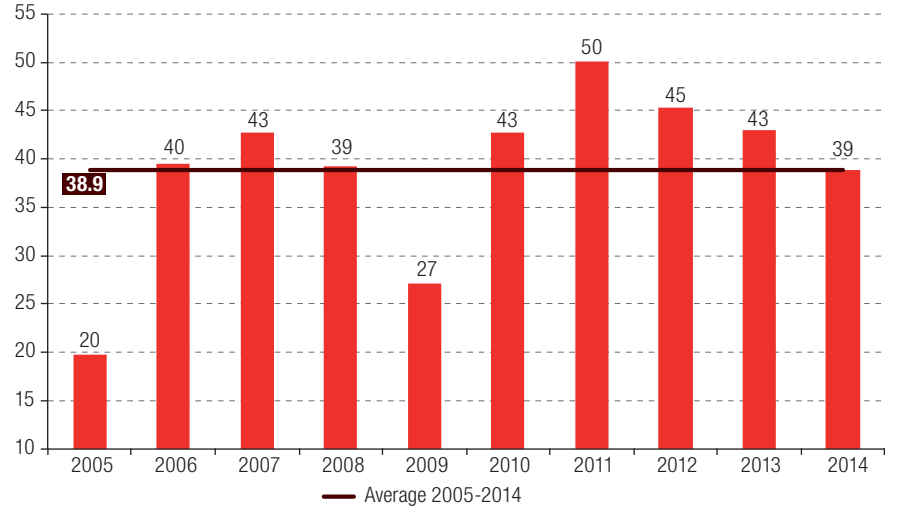


Source: Prepared by the authors, on the basis of World Bank, "*World Development Indicators*", 2016.
[a] GDP means gross domestic product.

3. Mining rents in Chile as estimated by the World Bank

Figure 3 shows the value of mining rents in 2005-2014, as estimated by the World Bank for Chile (World Bank, 2016), totalling US$ 389 billion, with an annual average of US$ 38.9 billion, representing 17% of Chile's GDP.

Figure 3
Chile: annual economic rent from mining, as estimated by the World Bank, 2005-2014
(Billions of dollars)[a]



Source: Prepared by the authors, on the basis of World Bank, "World Development Indicators", 2016.
[a] At October 2016 prices.

IV. Methodology for calculating the GMP-10 appropriated gratuitous rent

1. General considerations

Between 2005 and 2014, GMP-10 has accounted for an average of 57% of Chile's copper production; and when CODELCO is included, the figure rises to 88%. The remaining 12% is produced by smaller mines. Although there are deposits, such as Spence, El Tesoro and Esperanza, which have outputs similar to those of the GMP-10 firms, these are not yet officially listed in this group (COCHILCO, 2015). That is the first reason why these deposits have not been included in this study; the second reason is that two of them only started operating after 2005.

The aim is to estimate the appropriated GMP-10 gratuitous rent in an economically consistent way. This is done in four stages, based on the amounts of total mining rent reported by the World Bank:

(i) determination of WB mining rent (CODELCO + GMP-10)

(ii) calculation of WB GMP-10 mining rent

(iii) estimation of GMP-10 compensated rent

(iv) calculation of GMP-10 appropriated gratuitous rent

This section develops the methodology for the first three of these stages. The last stage merely involves deducting the taxes paid by GMP-10 to the State of Chile from the GMP-10 compensated rent obtained in stage 3.

2. Calculation methodology

The mining rent measured by the World Bank in relation to Chile (World Bank, 2016) corresponds to the total rent generated by the mining sector of the Chilean economy, for which a methodology has been established to obtain the WB GMP-10 mining rent and subsequently the GMP-10 compensated rent. The calculation methodology used is described in this section. A basic element of the methodology is that the value of mineral sales is measured on the basis of the international prices of the metal rather than the sales reported by the firms, as has been done in other studies. This approach follows the method implemented by the World Bank (2011) and by Brandt, Schreyer and Zipperer (2013); and it has the advantage of being independent of company reports, which often understate sales in order to reduce taxes.

(a) CODELCO plus GMP-10

The rent estimated by the World Bank in relation to CODELCO and GMP-10 is assumed equivalent to their share in Chile's total copper production each year. This method of obtaining the rent associated with the large-scale copper mining industry (public and private) is consistent and conservative. Brandt, Schreyer and Zipperer (2013) show that the mining rents associated with the large-scale copper mining industry account for 90% of the rent generated by all natural capital recorded in Chile. Data from the World Bank (2016) show that in 2005-2014, 89% of the country's natural-resource rents came from mining. To obtain the rent from large-scale mining, the rent obtained from medium- and small-scale copper mining should be excluded from this total amount. Accordingly, based on the two studies mentioned above, the following methodological criterion has been defined: each year, the proportion of the mining rent reported by the World Bank, corresponding to the large-scale copper mining industry

(both public and private) will be equivalent to the latter's share in total copper production in Chile. This is a conservative assumption, since rents obtained from large-scale mining tend to be higher than those of small and medium-sized mines, as a proportion of their production.

The mining rent calculated by the World Bank for GMP-10 ($R_{bm,Gmp10}$) and the State-owned CODELCO ($R_{bm,Cod}$) can be expressed as:

$$R_{bm,Gmp10} + R_{bm,Cod} = (1-B) \cdot R_{bm,Total} \quad (1)$$

where

B = the share of total World Bank mining rent that does not correspond to GMP-10 or to CODELCO, and

$R_{bm,Total}$ = total World Bank mining rent.

(b) WB GMP-10 mining rent

The same World Bank procedure (Brandt, Schreyer and Zipperer, 2013) can be used to express the WB GMP-10 mining rent in terms of the WB CODELCO rent, from equation (1), as follows:

$$R_{bm,Cod} = p \cdot q_{Cod} + S_{Cod} - c_{Cod} \cdot q_{Cod} - (r+\delta) \cdot K_{Cod} \quad (2)$$

where,

p = market price of copper,

q_{Cod}= CODELCO production,

S_{Cod}= additional revenue from CODELCO by products,

c_{Cod}= total unit cost of CODELCO operations,[3]

r = normal rate of return to capital,

δ = capital depreciation rate, and

K_{Cod}= CODELCO capital stock.

Thus, it is possible to obtain the following expression for the World Bank GMP-10 mining rent.

$$R_{bm,Gmp10} = (1-B) \cdot R_{bm,Total} - R_{bm,Cod} \quad (3)$$

(c) GMP-10 compensated rent

The GMP-10 compensated rent ($R_{C,Gmp10}$) is the World Bank rent corresponding to GMP-10, with two additional corrections: exploration risk premium (η) and compensation for the volatility of the copper price (ϕ).

$$R_{C,Gmp10} = R_{bm,Gmp10} - \eta - \phi \quad (4)$$

The exploration risk premium for GMP-10 (η) is defined on the basis of López and Figueroa (2014). This premium corresponds to the increase in exploration expenditure, according to the probability of success in the exploration tasks, and the rate of return to capital, less the declared exploration expenditure:

$$\eta = E_{Gmp10}\left[\frac{r}{1-\theta} - 1\right] \quad (5)$$

[3] This total operating cost does not correspond to the direct unit operating cost, c1, referred to below, because corrections have been made to take account of copper sold in concentrate form. Annex A1 describes the methodology used to take account of the fact that CODELCO sold an average of 14% of its copper in unrefined state during the period.

where

E_{Gmp10} = GMP-10 exploration expenditure

$(1-\theta)$ = probability of success in GMP-10 exploration tasks

The compensation for volatility in the copper price (ϕ) is defined from the difference between the market price and the copper trend price (detail in section IV.3.c).

$$\phi = (p - p_T) \cdot q_{Gmp10} \tag{6}$$

where,

p_T = trend price of copper

q_{Gmp10} = GMP-10 copper production

Thus, (4), (5) and (6) give equation (7), in which the GMP-10 compensated rent is expressed in terms of the WB GMP-10 mining rent and additional corrections.

$$R_{C,Gmp10} = R_{bm,Gmp10} - E_{Gmp10}\left[\frac{r}{1-\theta} - 1\right] - (p - p_T) \cdot q_{Gmp10} \tag{7}$$

3. Data for the calculation

(a) General information

To make the required estimates, annual data are needed on the international price of copper and on the total costs and production of GMP-10 and CODELCO. Costs and production levels (copper and by-products) have been obtained from the Chilean Copper Commission (COCHILCO, 2015). The average cost per unit among GMP-10 is US$ 1.60 per pound and that of CODELCO is US$ 1.29 per pound (FCH/Alta Ley/CORFO, 2015). This indicates that the State firm is more efficient, so it will generate higher rents. To calculate the annual economic rent of GMP-10, these production costs may be biased towards understatement, since studies by international consultants indicate that CODELCO's production cost is higher than that GMP-10 (Mining Press, 2013). On the other hand, the average annual production of GMP-10 was 3,070,000 tons of refined copper per year, while that of CODELCO was 1,756,000. The capital stock, of both CODELCO and GMP-10, has been calculated on the basis of the perpetual inventory system formula.

It is also assumed that the normal rate of return on capital required by investors in Chile is 10%. This could also understate the annual GMP-10 rent, however, since it is higher than the normal rate that Brandt, Schreyer and Zipperer (2013) estimate and use in relation to Chile. In fact, some major mining projects use 8% rates of return to gauge the feasibility of investment projects in Chile. An example is the Alto Maipo Hydroelectric Project, whose shareholders expected an 8% return on their investment of over US$ 2 billion.[4] The shareholders were AES Gener and Antofagasta Minerals, the latter being the owner of the Los Pelambres mining company, which is one of the GMP-10 firms.

To calculate untaxed rent, the tax base permitted by the mining legislation is used, including deductions for all variable costs plus financial costs. In addition, capital assets can be depreciated at an accelerated rate, which can be as little as three years in the case of machinery and equipment.

[4] This information was obtained recently from the Chilean newspaper *El Mercurio* (2017), in the context of the near-final decision not to build the hydroelectric power station and the "legitimate return" claimed by its shareholders.

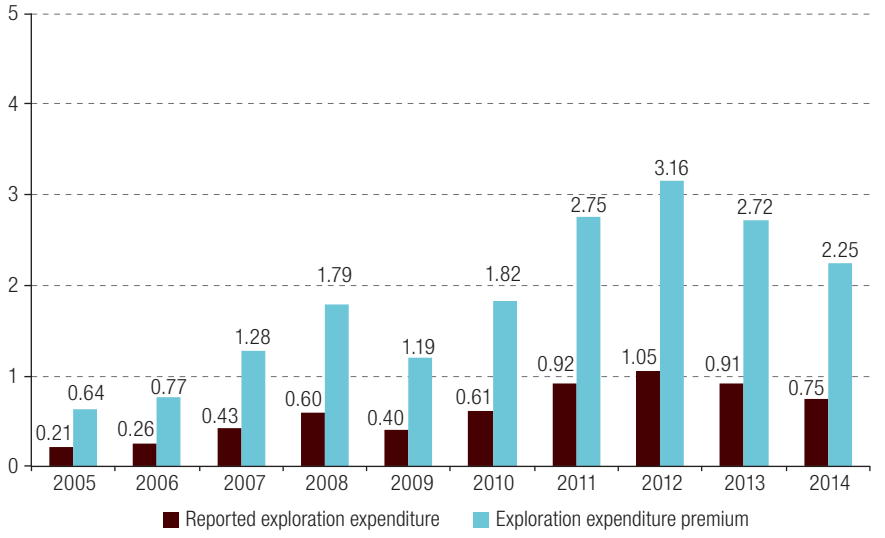
(b) Return on exploration expenditure

To correct for the return on capital that is required in exploration activities, the WB GMP-10 mining rent must be reduced by the exploration expenses that private mining companies are forced to incur to sustain their activity over time. This expense is considered ex-ante, in other words the expected returns must include the probability of succeeding or failing in the exploration activities, in the planning stage. As noted by López and Figueroa (2014), companies should be allowed to legitimately appropriate part of the profits or mining rent, in order to undertake mining exploration activities. The portion in question must be calculated on the basis of the expected profitability of the exploration performed, including the probability of success of the activity.

Bartrop and Guj (2009) define a typology of mining exploration activities. To avoid the economic rent being overestimated; and, following these two authors, Chile's GMP-10 has been typified as an industry that has carried out and permanently undertakes exploration work in search of large deposits in unexplored areas. It is also considered that exploration faces a high level of risk because there is little previous work, the geology is poorly known, the explorable areas are remote, and large-scale exploration programmes are required. The lowest value of the probability of success is 2.5%, which could be considered excessively low for Chile, given current knowledge of the geology of certain areas and the amount of copper thought to exist in the subsoil of certain areas of the country, for example. Nonetheless, this assumption makes it possible to maintain conceptual consistency and avoid the risk of overestimation when calculating the net GMP-10 rent. In view of the above, the premium, *ex ante*, turns exploration expenditure into an investment needed to sustain the mining activity.

Figure 4 reports the annual exploration expenditure of all private mining firms in Chile, which here are assumed to be equivalent to GMP-10, according to the data provided by COCHILCO (2015). It also displays the premium for exploration expenditure, which in the case of this study corresponds to three times the declared expenditure, given a 10% normal rate of return and a 2.5% probability of success.

Figure 4
Chile: annual GMP-10 exploration expenditure and the compensatory return required by this activity, 2005-2014
(Billions of dollars)[a]



Source: Prepared by the author, on the basis of COCHILCO (Chilean Copper Commission), *Anuario de estadísticas del cobre y otros minerales, 1996-2015*, Santiago, 2015.

[a] At October 2016 prices.

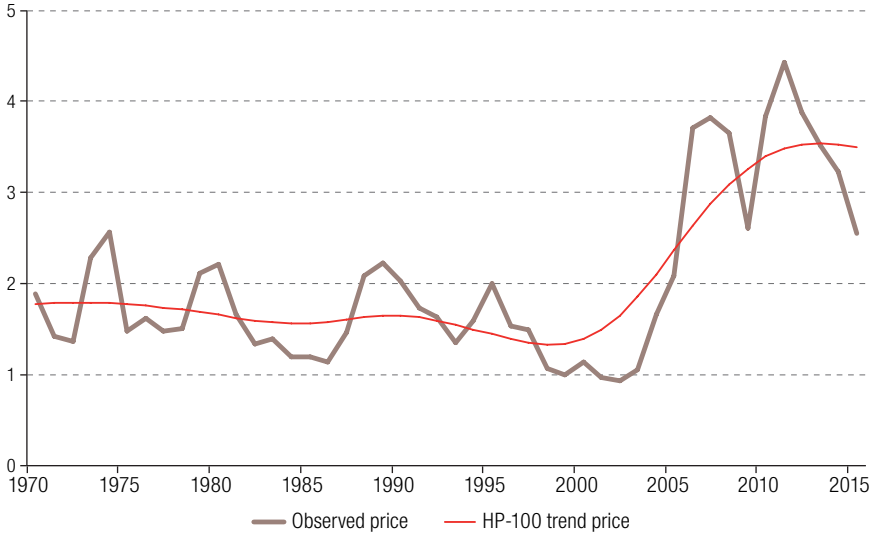
This way of measuring exploration expenses has the potential for overestimation, especially since the data used to calculate them comes from what the firms themselves declare; and the firms have incentives to inflate them artificially. Unfortunately, this is the only available source of data on exploration expenses.

(c) Return for copper price volatility

The price of copper has fluctuated widely over the last 45 years, including a strong upswing at the start of the twenty-first century. This section uses a 45-year series of copper prices spanning 1970-2014, together with time series tools, to determine a long-term or trend price for copper in 2005-2014. The aim is to recalculate the GMP-10 mining rent, using a long-term copper price series, from which the cyclical component has been removed. In other words, the copper prices observed each year are turned into a smoothed long-term trend series, from which short-term fluctuations have been eliminated.

There are several tools available to decompose trend cycles, of which the most basic is linear regression. The time-series literature provides sophisticated statistical methodologies that have computer packages that can be applied to observed time series. The most widely used and validated methodology is probably the HP filter (Hodrick and Prescott, 1997). The present study uses the HP-100 filter, which is recommended for the annual series, to extract a trend price from the observed series. The HP-100 filter makes it possible to decompose the observed price series into a cyclical component and a trend component. Thus, the trend series of the price can be interpreted as the time sequence of the long-term price. Figure 5 shows the evolution of the observed copper price with a solid black line and the long-term trend price with a dashed grey line.

Figure 5
International observed copper price and long-term price obtained using the Hodrick and Prescott filter, 1970-2015
(Dollars per pound)[a]



Source: Prepared by the authors.
[a] At October 2016 prices.

The WB GMP-10 mining rent is recalculated on the basis of the trend copper price in 2005-2014. The costs —including opportunity costs— are exactly the same as before; the only variable that changes is the copper price.[5]

V. Results

1. GMP-10 compensated rent

This section presents the GMP-10 compensated rent, which is estimated by subtracting, from the WB GMP-10 mining rent, both the premium for the risk involved in mining exploration activities and the compensation required for the volatility of the copper price. Figure 6 displays the GMP-10 compensated rent estimated in this way. The adjustment reduces the GPM-10 rent by US$ 29.7 billion in 2005-2014, simply because the prices observed during this period are above trend. In addition, the correction for the deduction of the exploration risk premium reduces the estimated GMP-10 rent by another US$ 18.6 billion in the period considered. Thus, when incorporating both corrections, the estimate of GMP-10 compensated rent is US$ 48.3 billion lower than that of the World Bank in the period as a whole. In other words, the WB GPM-10 mining rent in the period is reduced from US$ 204 billion to about US$ 156 billion. This means that the average annual rent for 2005-2014, corrected after deducting both components, amounts to US$ 15.6 billion, which corresponds to 6.9% of Chile's GDP. This amount is US$ 4.8 billion less than the WB GMP-10 mining rent.

Figure 6
Chile: annual GMP-10 compensated rent, 2005-2014
(Billions of dollars)[a]

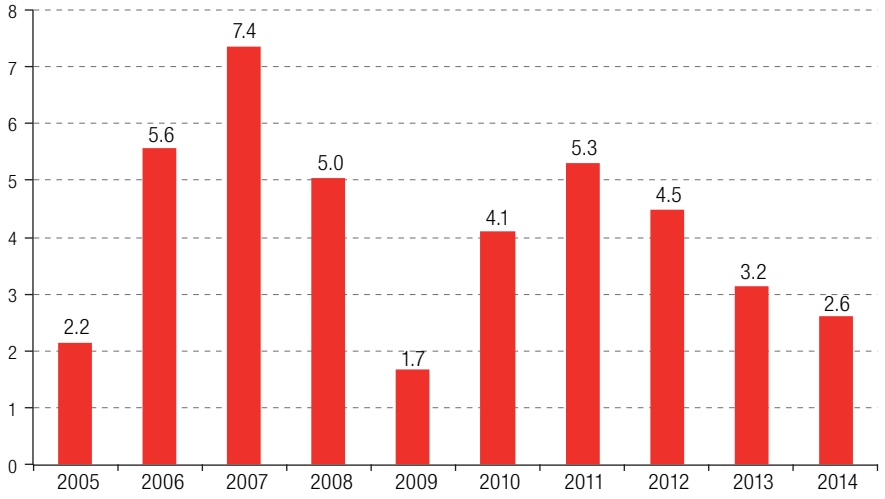
Source: Prepared by the authors.
[a] At October 2016 prices.

[5] The mining companies' net profitability for 2017 was calculated using the methodology described in this study based on trend copper prices. The trend price for 2017 turns out to be US$ 2.82 per pound of copper, slightly higher than the price reported by the Mining Council (US$ 2.70 per pound) but very similar to that predicted by Goldman Sachs (US$ 2.85 per pound). This projection yields an average net pre-tax rate return on capital of nearly 40% in this year for the 10 large private mining companies —equivalent to about US$ 9 billion.

2. GMP-10 appropriated gratuitous rent

Section II.4 defined the GMP-10 appropriated gratuitous rent as GMP-10 compensated rent minus the taxes paid by the large-scale private mining sector in each year of the period studied. These taxes, as defined in the Chilean tax code, are of three types: (i) first category tax, which is levied on the firms' taxable profits; (ii) additional tax, which taxes Chilean-source earnings by natural or legal persons without domicile or residence in Chile; and (iii) the specific mining duty (IEM), which taxes mining activity profits obtained by a mine operator. Figure 7 shows the tax revenue received from GMP-10 by the Chilean Treasury (DIPRES, 2015), which totalled US$ 41.6 billion in 2005-2014.

Figure 7
Chile: tax revenue obtained from GMP-10 by the Chilean Treasury, 2005-2014
(Billions of dollars)[a]

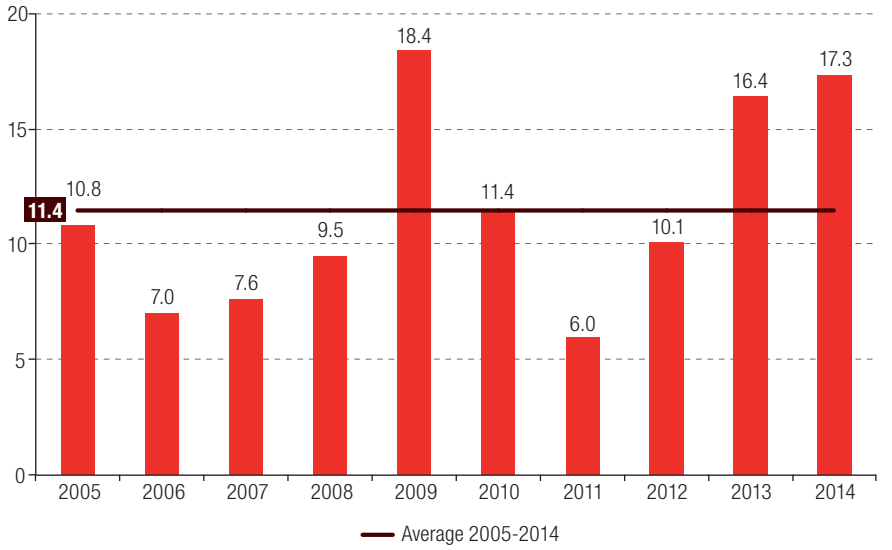


Source: Prepared by the authors, on the basis of Budgetary Affairs Bureau, "Evolución, administración e impacto fiscal de los ingresos del cobre en Chile", Santiago, Ministry of Finance, 2015 [online] http://www.dipres.gob.cl/572/articles-133158_doc_pdf.pdf.

[a] At October 2016 prices.

Subtracting taxes paid from the GMP-10 compensated rent gives the GMP-10 appropriated gratuitous rent, amounting to US$ 114 billion in the study period. This amount represents an average of US$ 11.400 billion per year, equivalent to 5.1% of GDP and 23.3% of public spending during the period. Figure 8 shows the GMP-10 appropriated gratuitous rent, in dollars at October 2016 prices (annex A2 contains figures displaying this rent relative to GDP and as a percentage of public expenditure).

Figure 8
Chile: GMP-10 appropriated gratuitous rent per year, 2005-2014
(Billions of dollars)[a]

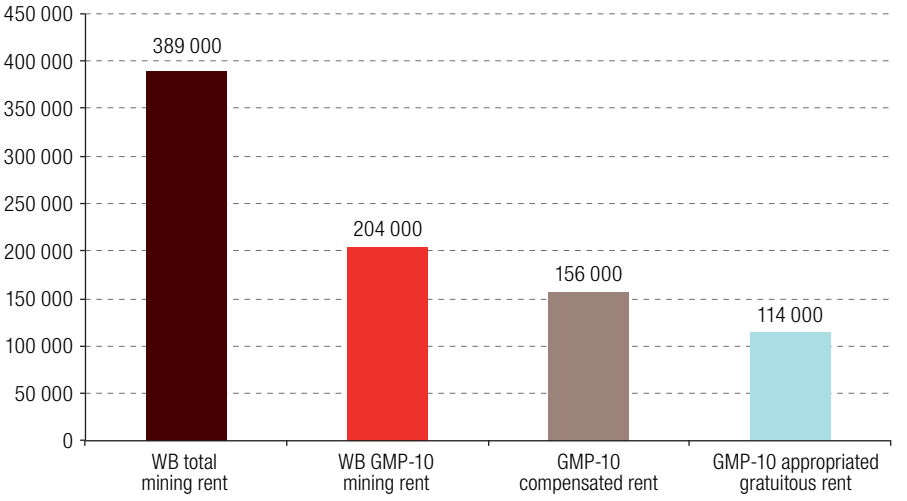


Source: Prepared by the authors.
[a] At October 2016 prices.

3. Summary of results

Figure 9 displays the total amounts of each of the four economic rents defined in this paper, in the period spanning 2005 to 2014. The amounts are expressed in millions of dollars at October 2016 prices (the time trend is shown in annex A3).

Figure 9
Chile: mining rents by type, 2005-2014
(Millions of dollars)[a]



Source: Prepared by the authors.
[a] At October 2016 prices.

4. Sensitivity analysis

As noted above, this study assumes a 2.5% probability of success in exploration, the lowest rate reported in the literature. It is also assumed that knowledge of the geology of the territory is non-existent. Chile is considered a mining location, which means that there is already a considerable knowledge of the geological characteristics of the country (SERNAGEOMIN, 2013). For this reason, recent studies have recommended a probability of 10% to 20%, instead of 2.5% (Bartrop and Guj, 2009).

Moreover, based on a study by the Chilean Production Development Corporation (CORFO) (FCH/Alta Ley/CORFO, 2015), the direct unit costs of GMP-10 are assumed to be higher than those of CODELCO, averaging about US$ 1.60 per pound in the period considered. However, the study by the Mining Benchmark international consultancy (Mining Press, 2013) indicates a unit cost of just US$ 1.21 per pound in the period. This latter estimate is perhaps more credible than that of CORFO, considering the consensus of analysts and the fact that CODELCO's deposits are generally older and of lower grade than private-sector ones.

Although this study has focused on calculating a conservative and lower-bound estimate of economic rent, a sensitivity analysis was performed with more reasonable assumptions for the probability of exploration success and unit costs, based on the studies mentioned above. Table 1 reports GMP-10 appropriated gratuitous rents under different assumptions. The appropriated rent assuming a 10% probability of success and the unit cost indicated by Mining Benchmark amounts to US$ 163 billion, more than 30% above the base estimate of the present study. These simulations provide a quantitative idea of how conservative that estimation is.

Table 1
Chile: GMP-10 appropriated gratuitous rent in six scenarios, 2005-2014
(Billions of dollars)

Probability of exploration success *(percentages)*	Cost (CORFO) *(US$ 1.60 per pound)*	Cost (Benchmark Mining) *(US$ 1.21 per pound)*
2.5	114	145
5.0	126	157
10.0	132	163

Source: Prepared by the authors.
[a] At October 2016 prices.

5. Selected comparisons

This study has estimated that GMP-10 appropriated gratuitous rent totalling US$ 114 billion in 2005-2014, representing an annual average flow equivalent to 5.1% of the country's GDP. The following examples put this in context.

The resources thus gifted averaged US$ 11.4 billion per year between 2005 and 2014. It has been estimated that free education in the country, understood as full State funding at all levels of education, requires additional financing equivalent to almost US$ 5 billion per year. It is also estimated that the recently enacted tax reform will raise US$ 6 billion per year at most.

In other words, the wealth transferred annually to these large transnational companies in 2005-2014, could have financed free complete education, and the remaining US$ 6.4 billion could have been used to definitively upgrade the health-care and pensions systems. All of this could have been done without the need to design and implement a complex tax reform with uncertain effects on investment and economic efficiency.

Lastly, if Chile had saved these US$ 114 billion and invested them as sovereign wealth funds, they would have generated a permanent annual income flow of over US$ 7 billion, assuming a conservative investment pattern. In other words, the country would have a stable annual flow of income each year, irrespective of the fluctuations in the price of copper, equivalent to nearly all public health expenditure, which means that the country's public health services could be doubled permanently.

Lastly, Chile holds an annual telethon —a national solidarity activity to finance the care and rehabilitation of people with chronic or temporary disabilities, which raised roughly US$ 47 million in its 2016 edition. The amount ceded gratuitously to the large-scale mining industry in 2005-2014, could finance about 2,420 telethons of that year.

VI. Final thoughts

Perhaps the most relevant question that emerges from the estimates made here is: who gratuitously cedes these voluminous resources to these firms? The answer must clearly be sought among those in Chile's executive and legislative branches who allow the laws that make this absurd gift possible to persist. The political authorities of today's developed countries, such as Canada, the United States and Norway, changed their laws long ago to make a very large proportion of mining rents and natural resources taxable, which enabled them to stop squandering resources that belonged to all of their citizens and lay the foundations for strengthening their economies and social rights in their countries (Taylor and others, 2004; Guj, 2012; Figueroa, López and Gutiérrez, 2013; Bowie, 2016).

As far as the authors are aware, the fact that Chile is unable to recover these huge rents for all Chileans is also largely due to citizens' relative ignorance of the magnitude of the losses caused by unwillingness of the political and economic authorities to develop the necessary mechanisms to capture these rents. This study is intended to help correct this disinformation.

This article closes by recalling the comment by Minister of Finance, Rodrigo Valdés, quoted at the outset; but the question to be asked of "all Chileans" needs to be broader than what the Minister proposes. Instead of "how to use an additional peso" the question is why Chile does not keep the billions of dollars in rents gifted to private mining companies each year, which would finance many bridges, many schools, the wages of many thousands of public sector workers and pensions for many thousands of pensioners across the country. This should also be asked of the Presidents of the Republic and the parliamentarians of recent decades. Unless the people demand an answer, this huge amount of national wealth will continue to be squandered; and Chileans will continue to ignore President Balmaceda's clear warning, also quoted at the start of this article, of the risk of letting "... this vast and wealthy region become nothing more than a foreign factory..." (Balmaceda, 1889).

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Annex A1

Discounts in respect of copper concentrate sales

Between 2005 and 2014, CODELCO sold an average of 14% of its copper in concentrate form. When calculating sales revenue at market prices, the effect of this should be corrected for, as described below (COCHILCO, 2015):

(i) The amount of copper contained in the concentrate must be reduced to take account of two effects: humidity (10% of the mass), and the cost of smelting and refining (15% of the mass).

(ii) In addition, three costs must be deducted per ton of copper: US$ 140 for *maquila*, US$ 10 for the scale effect, and up to US$ 400 for the losses associated with other minerals contained in the concentrate.

Given the above, the following are defined:

q_b = gross amount of copper in the concentrate;

q_e = effective amount copper in the concentrate, that is, after applying the two corrections described in point (i) above;

q_p = loss or difference between the gross amount and the effective amount of copper, namely

$q_p = q_b - q_e$; and

z = sum of the additional costs specified in point (ii) above, per effective ton of copper in the concentrate.

Thus, the rent associated with CODELCO can be expressed as a function of c1, the direct unit cost. This form is equivalent to that presented in equation (2) of this article. Details of the rent associated with CODELCO are presented, having corrected for copper in the form of concentrate (the other variables are those defined in section IV.2.b.).

$$R_{bm,Cod} = p \cdot (q_{Cod} - q_p) + S_{Cod} - c_1 \cdot q_{Cod} - z \cdot q_e (r+\delta) \cdot K_{Cod}$$

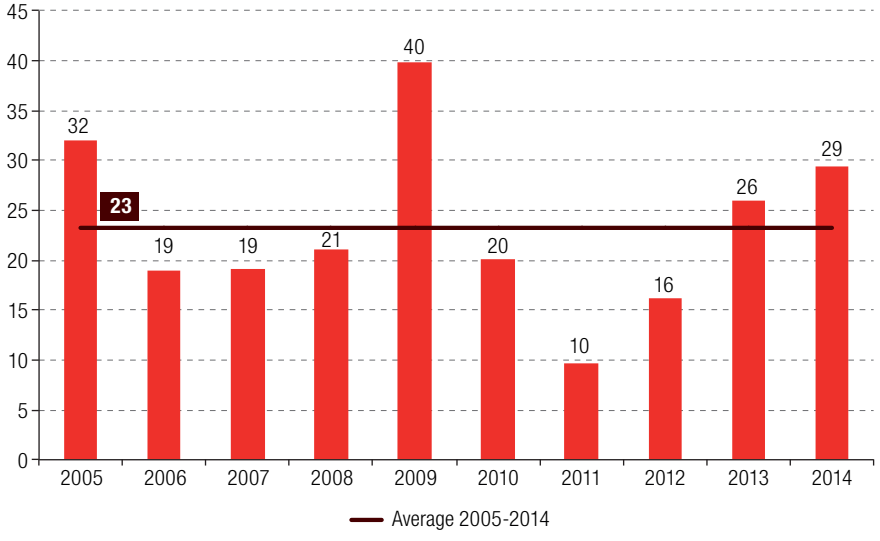
Annex A2

GMP-10 appropriated gratuitous rent

Figure A2.1
Chile: GMP-10 appropriated gratuitous rent per year, as a proportion of GDP, 2005-2014
(Percentages)

Source: Prepared by the authors.

Figure A2.2
Chile: GMP-10 appropriated gratuitous rent per year, as a percentage of public expenditure, 2005-2014
(Percentages)



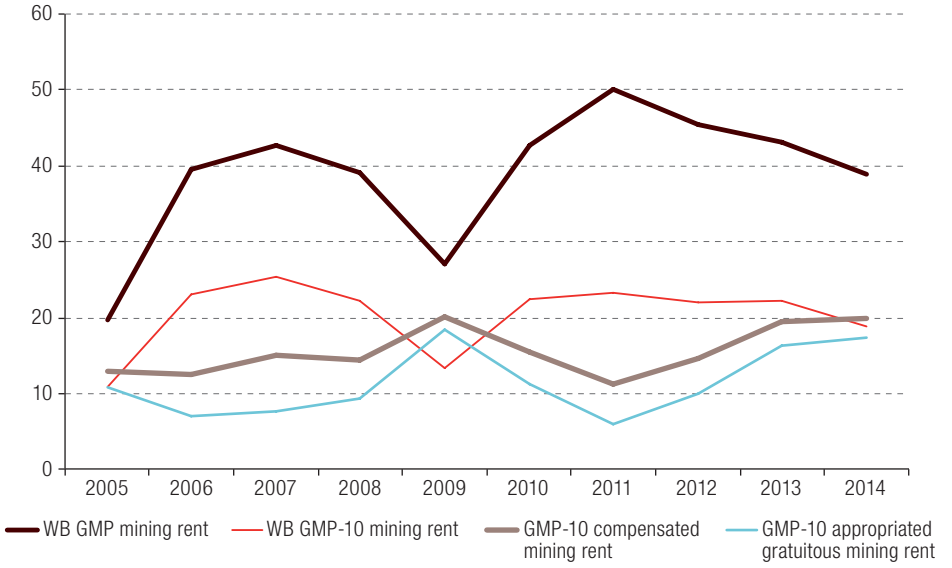
Source: Prepared by the authors.

Annex A3

Time path of four types of rent

Figure A3.1 shows the annual estimates obtained for the four types of economic rent in the period spanning 2005 to 2014, measured in billions of dollars at October 2016 prices. The continuous grey line closest to the horizontal axis represents the GMP-10 appropriated gratuitous rent. This graph demonstrates that the estimation of this rent constitutes a "lower bound" estimate.

Figure A3.1
Chile: comparison of the four types of mining rent estimated in this study, 2005-2014
(Billions of dollars)[a]



Source: Prepared by the authors.
[a] At October 2016 prices.

Sectoral and regional determinants of firm dynamics in developing countries: evidence for low-, medium- and high-tech manufacturing in Argentina

Carla Daniela Calá[1]

Abstract

This study analyses the determinants of firm dynamics in developing countries, using Argentina as an illustrative case. It explains firm entry and exit at the regional level, distinguishing three groups of manufacturing activities: low-, medium- and high-tech. The study finds that both region- and sector- specific determinants explain firm dynamics, but the impact is not homogeneous across sectors. In particular, for low-tech industries, there is a need for explanatory variables as a proxy for the specificities of developing economies (poverty, informal economy and idle capacity). There is also evidence of a core-periphery pattern according to which agglomeration economies and previous entries/exits have different effects in core and peripheral regions. These results are relevant for policymakers in developing countries, who should take into account not only the specificities of such economies, but also the regional heterogeneity both in terms of the level of development and industrial composition within the country.

Keywords

Industrial enterprises, manufacturing enterprises, developing countries, case studies, enterprise development, statistical data, econometric models, Argentina

JEL classification

R12, R30, C33

Author

Carla Daniela Calá is a teacher and researcher at the Faculty of Economic and Social Sciences of the National University of Mar del Plata, Argentina. Email: dacala @mdp.edu.ar.

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I. Introduction

There is extensive literature on the regional determinants of entry and exit of manufacturing firms. This interest is explained not only by the direct impact of new firms on employment and production, but also by their indirect effects on market efficiency, firm productivity, innovation and, ultimately, economic growth (Audretsch and Keilbach, 2005). However, this literature has not been sufficiently complemented by works on sectoral determinants to account for the fact that regional determinants of new firm formation vary among manufacturing industries. Thus, following the seminal work of Audretsch and Fritsch (1999), a number of studies have taken into account both regional and sectoral dimensions to adequately assess the impact of regional characteristics on firm dynamics and to consider heterogeneity at different levels.[2] Those studies confirm that regional factors determining new firm formation do differ between manufacturing industries (Carree, Santarelli and Verhuel, 2011) and that certain regional conditions may stimulate new firm formation in some industries but deter start-ups in others. As a result, certain policy instruments may encourage start-ups, but not necessarily in the types of industries desired by policymakers (Audretsch and Fritsch, 1999).

Remarkably, studies on the regional and sectoral determinants of firm entry and exit are limited to developed countries, while much less research has focused on developing countries even though these countries are expected to become key players in the world economy, since it is widely assumed that they will noticeably increase their share of output over the next decades (Wilson and Purushothaman, 2006). More precisely, studies on developing countries either focus on industry (Lay, 2003; Wang, 2006; Günalp and Cilasun, 2006; Ozturk and Kilic, 2012) or on regional determinants (Naudé and others, 2008; Santarelli and Tran, 2012; Calá, Arauzo-Carod and Manjón-Antolín, 2015 and 2016). Thus, this would appear to be the first attempt to quantify regional determinants of firm entry and exit in different manufacturing industries of a developing country.

The aim of this study is to provide useful information for policymakers in developing economies, who are interested in designing public policies to promote the emergence (and survival) of new firms countrywide. To that end, Argentina is used as an illustrative case to explain firm entry and exit at the regional level, distinguishing three groups of manufacturing activities: low-, medium- and high-tech. First, the study evaluates whether sectoral and regional determinants of entry and exit differ between sectors. Second, it takes into account the specificities of developing countries by adding indigenous factors, such as poverty levels, the size of the informal sector, idle capacity or regional structural heterogeneity.

The study concludes that both region- and sector-specific determinants explain firm dynamics, but the impact is not homogeneous across different groups of industries. In particular, the variables that are a proxy for the specificities of Argentina as a developing country (poverty level, informal sector size and idle capacity) impact mostly on low-tech entries and exits. There is also evidence of a core-periphery pattern that is relevant for all groups of industries. The results suggest that firm formation policies in developing countries should account not only for the specificities of such economies, but also for regional heterogeneity both in terms of the level of development and the industrial composition within the country.

The paper is divided into five sections. The following section briefly reviews the empirical literature on the regional determinants of firm entry and exit in both developed and developing economies. It also examines why some regional factors may have a different impact in developed and developing countries. Section III describes firm dynamics in Argentina during the period of interest, as well as the dataset, the empirical strategy and the econometric model. Section IV presents the main results and section V, the conclusion.

[2] These studies are: Arauzo-Carod and others (2007), focusing on Spain; Carree, Santarelli and Verhuel (2011) on Italy; Fotopoulos and Spence (1998) on Greece; Fritsch and Falck (2007) on Germany; Nurmi (2006) on Finland and Nyström (2007) on Sweden.

II. Determinants of firm entry and exit: theory and evidence

1. Developed countries

The significant variations in regional entry and exit patterns have been explained in the literature by differences in some regional characteristics: labour markets; industrial structure; and spatial concentration of economic activities and individuals.[3]

With regard to differences in the labour market, the focus in the literature has been on the effects of unemployment, wages and the educational level of the workforce. The first observation is that there is no consensus on how unemployment affects firm dynamics. According to the "push hypothesis", unemployment has a positive effect on firm entry to the extent that unemployed individuals can create new enterprises. Similarly, when unemployment increases, self-employed individuals have fewer job opportunities and their firms are thus less prone to exit (Carree and Thurik, 1996; Nyström, 2007; Carree, Santarelli and Verhuel, 2008; Santarelli, Carree and Verheul, 2009). By contrast, according to the "pull hypothesis", an increase in unemployment may curtail entry because the unemployed lack entrepreneurial skills and capital. Likewise, since unemployment is a proxy for the level of economic activity, higher unemployment rates may result in an increase in the number of exits (Brixy and Grotz, 2007). Second, with regard to wages, a rise in the cost of labour discourages the entry of new firms and favours exits (Santarelli, Carree and Verheul, 2009). Third, the availability of qualified labour may foster the entry of new firms in industries that require specific skills[4] (Spilling, 1996).

As regards industrial structure, previous studies have focused on the level of industrial diversification, the industrial tradition, the share of small and medium-size enterprises (SMEs), and the relationship between entries and exits. A more diversified environment promotes both the entry and survival of new firms as it increases the chances of resources being reallocated to new activities when a negative shock occurs (Kosacoff and Ramos, 1999). Furthermore, the industrial tradition may boost current entrepreneurial activities (Rocha and Sternberg, 2005) and deter firm closures, since it is likely that past incumbents developed a favourable business environment and supporting institutions. The share of SMEs is expected to increase regional turbulence, since it fosters both entry and exit. On the one hand, entry costs are lower in areas with a dense network of SMEs, which pay lower wages (thus reducing the opportunity cost of self-employment) and serve as examples for new entrepreneurs (Audretsch, 1995b). On the other hand, as small firms are more likely to exit due to cost disadvantages, exits should be higher in regions with a large proportion of small firms (Fotopoulos and Spence, 1998). This is closely related to the relationship between entries and exits. Entrances may influence exits by increasing the pressure of competition in the market (known as the displacement effect) and, at the same time, firms that abandon the market leave behind niches of unsatisfied consumers, encouraging new companies to enter (the replacement effect). In particular, according to the revolving door phenomenon, many (small) firms exit only a few years after creation (Audretsch, 1995a).

In addition, there tend to be more entries and fewer exits in concentrated areas because firms benefit from local external economies, such as specialized suppliers, thick labour markets and technological spillovers, as well as the physical proximity to consumers (Armington and Acs, 2002; Keeble and Walker, 1994; Littunen, Storhammar and Nenonen, 1998; Reynolds, Storey

[3] There are also a number of factors which, while important in explaining firm dynamics, cannot easily be included in empirical analyses. This is the case of cultural attitudes towards entrepreneurship (Shapero, 1983) and the role of the government, through public spending on infrastructure or public policies (Reynolds, Storey and Westhead, 1994).

[4] It should be borne in mind that people with high human capital are better at discovering and exploiting business opportunities, but at the same time they are more likely to have well-paid jobs and are not necessarily more prone to start new firms (Nyström, 2007).

and Westhead, 1994). However, disagglomeration economies may hamper entry and lead to further exit. This is because a higher density pushes up input prices by increasing competition for scarce resources.[5]

Nevertheless, the impact of these regional characteristics is likely to differ between industries. For example, according to the product life cycle theory (Vernon, 1966), new innovative firms have more to gain from agglomeration economies in the early stages of their existence, since dense urban areas provide better access to capital, skilled labour, infrastructure, information and interaction opportunities with other firms. As their products mature, competition among new firms is based on lower prices, which requires them to lower their input costs. Furthermore, the impact of regional factors such as income levels or unemployment may depend on the elasticity of demand or the level of capital intensity, respectively (Audrestch and Fritsch, 1999). It is perhaps because such differences among industries have been ignored that the relevant literature presents mixed and partly contradictory results (Audrestch and Fritsch, 1999; Fritsch and Falck, 2007).

Only a handful of studies have addressed this limitation (see footnote 2) by considering —in addition to regional variables— some industry-specific factors. In particular, these studies include barriers to entry and exit and have found that the relative importance of location-specific factors is greater in industries with low barriers (Arauzo-Carod and others, 2007; Fotopoulos and Spence, 1998; Fritsch and Falck, 2007; Nurmi, 2006). They also show that while demand for industry-specific products is a key factor in some industries, other activities depend more on the evolution of overall (regional or national) demand. Furthermore, it is unclear how the number of incumbents in the same industry affects firm dynamics. On the one hand, it may attract similar ventures that benefit from positive externalities (known as localization economies); on the other, it may exert a competition effect, preventing entry and increasing exit (Carree, Verheul and Santarelli, 2011).

2. Developing countries

Although there is very limited empirical evidence on what determines firm entry and exit in developing countries, it is increasing rapidly. In particular, Lay (2003) and Wang (2006) analyse the entry of new firms using industry level data in Taiwan; the same was done in Turkey (Günalp and Cilasun, 2006; and Ozturk and Kilic, 2012). Calá, Manjón-Antolín and Arauzo-Carod (2016), Naudé and others (2008) and Santarelli and Tran (2012) use regional level data for Argentina, South Africa and Vietnam, respectively. There have also been studies on the determinants of exit in some countries: Lay (2003) and Ozturk and Kilic (2012) use industry level data for Taiwan and Turkey, Calá, Arauzo-Carod and Manjón-Antolín (2015) use regional level data for Argentina; firm level data are used in studies for Ghana (Frazer, 2005), Colombia (Eslava and others, 2006), and Chile (Álvarez and Vergara, 2010 and 2013; and López, 2006).

Interestingly, there are several features of developing economies that may affect firm dynamics and its determinants, which highlights the need for specific empirical research (Bruton Ahlstrom and Obloj, 2008). First, developing countries are generally characterised by macroeconomic instability and intense cyclical variations (Stiglitz, 1998; Ocampo, Rada and Taylor, 2009). Thus, higher vulnerability to macroeconomic shocks is to be expected. This means that after each crisis, a great number of firms enter the growing markets but many of them exit in the following years; consequently, the "revolving

[5] Exits may also be higher in densely populated areas —see, for example, Buss and Lin (1990), Forsyth (2005) and Huiban (2011) for empirical evidence. There are several reasons for this, including: higher competition in both goods and factors markets (Agarwal and Gort, 1996; Bresnahan and Reiss, 1991); higher chances of finding a job, another entrepreneurial opportunity and/or selling the firms' assets to another venture (Huiban, 2011); and, as discussed below, more exits in large urban areas which attract more entry and have a large share of young firms.

door" phenomenon may be more intense than is typically observed in developed countries.[6] In addition, after an economic crisis, existing firms that exploit their idle capacity may have greater aggregate effects on the satisfaction of demand for new goods than new firms (Calá, Manjón-Antolín and Arauzo-Carod, 2016).

Moreover, macroeconomic volatility may mitigate the effect of variables such as the unemployment rate or the industrial tradition. Long-term unemployed individuals may not have the ability, financial resources and/or social capital needed to start a new business (Fritsch and Falck, 2007). However, changes in the conditions that determine profitability (exchange rate, tariffs, credit access or tax policy) and the lack of continuity in industrial policies may reduce the effect of past (dynamic) localization economies on current entry and exit (Calá, Manjón-Antolín and Arauzo-Carod, 2016).

A less developed industrial structure and less saturated markets may affect the relationship between entries and exits. For example, evidence rejecting the replacement effect has been found for Turkey and Taiwan (Günalp and Cilasun, 2006; Lay, 2003). Moreover, exits may actually reflect negative expectations for the evolution of economic activity, deterring entry (Calá, Manjón-Antolín and Arauzo-Carod, 2016). Similarly, agglomeration does not always have a positive association with start-up rates since increased competition and higher barriers to entry may act as disincentives for entrepreneurial activity in core regions (Naudé and others, 2008).

Further, developing countries usually have large informal sectors (Schneider, 2005). At the regional level, the relationship between the size of the shadow economy and the entry rate may be either positive or negative. It will be positive if subcontracting activities create complementarities or if the informal sector encourages entry by acting as a stepping stone (Bennett, 2010) for entrepreneurs to "test the waters" before deciding whether or not to enter the formal sector. In addition, informality may encourage start-ups as the instability and insecurity typical of informal jobs push people towards entrepreneurship. However, a negative association is likely if informal companies compete with formal firms on the basis of lower prices and non-differentiated goods. With regard to exits, a positive relationship may arise if formal firms compete for the same resources as informal firms and/or they become informal when in difficulty. Conversely, a negative association can be expected if formal firms buy inputs from the informal sector, thus lowering costs and/or increasing flexibility.

Another distinctive characteristic of developing economies is the high level of poverty and income disparity, both among individuals and regions. This may hamper the emergence of new (formal) ventures, since the demand for goods and services is smaller, less stable and less diverse. Poverty also affects the supply of entrepreneurs, since the share of people with access to information, business networks and financial resources is limited (Kantis, Angelelli and Moori Koening, 2005).

Lastly, developing countries show marked regional differences in critical economic indicators, with some areas boasting levels of capitalization, technology, productivity and human capital requirements similar to their counterparts in advanced countries (Sunkel, 1978). A direct implication of this "structural heterogeneity" (Cassiolato, Pagola and Lastres, 2009) is that firm entry/exit determinants may differ across the regions of a country. For example, peripheral areas usually lack the critical mass of related firms to create the conditions for external economies in some sectors. As a result, positive agglomeration effects are expected to arise only in central areas. Previous studies on aggregated entry and exit in Argentina have found that the spatial distribution of aggregated entries and exits exhibit a core-periphery pattern (Calá, Arauzo-Carod and Manjón-Antolín, 2015 and 2016).

[6] However, this may not occur if less competition and greater monopoly power were to weaken turnover rates and slow down the creative destruction process.

III. Firm dynamics in Argentina

1. Empirical strategy and data

In order to identify which regional characteristics affect firm entry and exit, the study develops different equations for the number of entries (and exits) in three groups of manufacturing industries: (i) low-tech; (ii) medium-tech; and (iii) high-tech. A general formulation of these equations is:

$$ENTRY_{ijt} = f(REGION_{it}; INDUSTRY_{ijt}; MACRO_t) \quad (1)$$

$$EXIT_{ijt} = f(REGION_{it}; INDUSTRY_{ijt}; MACRO_t) \quad (2)$$

where $REGION_{it}$ denotes a group of region-specific factors that vary by year and province; $INDUSTRY_{ijt}$ refers to sector-specific determinants that vary by province, year and group of industries and $MACRO_t$ refers to factors at the national level that vary by year alone.

In order to test if the determinants of firm dynamics in developed countries are of similar importance in Argentina, a set of commonly found determinants are taken as the starting point to explain regional entry and exit in those economies, both at the sectoral and regional level. This provides a first analysis of the differences between developed and developing countries (see Fritsch, Brixy and Falck, 2006 and Ghani, Kerr and O'Connell, 2014 for similar strategies). Based on the information in section II.2, some variables explaining firm entry and exit in developed countries can be expected to have weak statistical significance or to show the opposite sign.

Next, the study examines factors such as the size of the informal economy or the level of poverty, which are potentially important in developing countries but are never considered in studies on developed countries. Finally, the existence of a core-periphery structure is explored by including the products of a dummy identifying the richest provinces with variables that are expected to have different effects in central and non-central regions (agglomeration effects and replacement/displacement effects). This constitutes the second test of the differences between developed and developing countries. One expected outcome is for variables that incorporate some of the specificities of developing countries to have substantial explanatory power. Another is for cross products to have different effects in core and lagged regions.

2. Entry and exit

Entry and exit data are taken from the Employment and Business Dynamics Observatory (EBDO) of the Ministry of Labour and Social Security of Argentina. The database contains the number of entries, exits and incumbents based on all manufacturing (formal and private) firms with at least one employee registered with social security. Consequently, the dataset does not contain information on either public or informal employment. Moreover, the Observatory handles changes in firm codes that do not reflect true market entries and exits because a firm is considered closed after 12 consecutive months of not declaring employees. However, spurious exits caused by the displacement of the entire workforce of firms that "exit" to become "new" firms are identified and excluded from the database. Lastly, the analysis is restricted to manufacturing firms declaring that the majority of their workforce is located in the regions under consideration (about 90% of the total firms in 2008). Branch offices or subsidiaries located in other regions are therefore excluded. On the whole, the Observatory provides the most up-to-date, comprehensive, reasonably long-term and spatially disaggregated data currently available for firm demography studies in Argentina.

Data are available for the 23 Argentine provinces plus the federal capital, Buenos Aires, with the province of the same name divided into Greater Buenos Aires and the rest of the province. The province of Río Negro was excluded from the study on account of missing data for most of the explanatory variables considered. Consequently, although there are 25 regions in the database, results are ultimately provided for 24 only. Manufacturing is divided into 23 two-digit industries, based on the taxonomy suggested by Katz and Stumpo (2001) and subsequently adapted to a two-digit disaggregation by Katz and Bernat (2011).[7] These industries are grouped into three categories (high-, medium- and low-tech) according to their level of technological intensity (see annex 1).

The dependent variable is the number of annual entries and exits in each region and group of industries during the period 2003-2008. By using 2003 as the start of the analysis, the study excludes the structural break caused by the economic and political crisis of the end of 2001 that led to the devaluation of the Argentine peso in January 2002 and thus avoids completely distorting the results. The period of analysis ends at 2008, which was the last available year in the EBDO dataset at the time. Table 1 shows the evolution of entries, exits and incumbents over the period of analysis.

Table 1
Argentina: number of entries, exits and incumbents, 2003-2008

Year	Entry	Exit	Incumbents	Entry rate[a]	Exit rate[b]
2003	4 986	2 330	42 754	11.7%	5.4%
2004	5 994	2 326	45 234	13.3%	5.1%
2005	5 486	2 929	48 317	11.4%	6.1%
2006	6 264	3 623	49 987	12.5%	7.2%
2007	5 886	4 358	51 796	11.4%	8.4%
2008	5 389	5 103	52 417	10.3%	9.7%

Source: Prepared by the author, on the basis of data from the Employment and Business Dynamics Observatory.
[a] The entry rate is calculated as the number of entries over the number of incumbents.
[b] The exit rate is calculated as the number of exits over the number of incumbents.

The high values for entries in 2003-2005 are closely related to the recovery of the Argentine economy after the crisis of 2001-2002. Table 1 shows that the high entry rates from 2003 (around 12%) declined only at the end of the period, but still remained high (around 10%). As regards exits, however, after the first two years of stability (2003-2004), the opposite trend was observed, with an average yearly variation rate of 17%. According to the Ministry of Labour, Employment and Social Security (2007), this was largely driven by new ventures in the years immediately following the crisis (both deferred projects and entirely new ventures encouraged by better macroeconomic conditions). Additionally, the slowdown in net entry in 2008 is explained by the international financial crisis, the gradual appreciation of the real exchange rate and domestic tensions (Katz and Bernat, 2011).

Table 2 shows that the spatial distribution of incumbents, entries and exits is not homogeneous, since most are concentrated in the five richest regions (the federal capital city, Gran Buenos Aires, the rest of Buenos Aires province, Santa Fe and Córdoba). Specifically, about 80% of the workers, incumbents, new ventures and exiting firms are concentrated in these regions, which cover roughly 22% of the surface area of the country. This uneven spatial distribution of economic activity is quite characteristic of a developing economy (Scott and Storper, 2007).

[7] This classification is based on the resource used most intensively in the production of goods: natural resources, labour or engineering. It has been adopted by ECLAC and is largely used in Latin American studies (ECLAC, 2007). It differs slightly from the one defined by OECD.

Table 2
Argentina: incumbent firms, entries and exits by group of manufacturing industries in central and peripheral regions, 2003-2008
(Number of firms and percentages)

A. Incumbents by group of industries in central and peripheral regions, average				
	Number of firms		Percentage	
	Periphery	Centre	Periphery	Centre
Low-tech	6 534	22 102	74.8	56.0
Medium-tech	1 420	9 849	16.3	24.9
High-tech	776	7 548	8.9	19.1
Total	8 730	39 500	100.0	100.0
B. Firm entry by group of industries in central and peripheral regions.				
	Number of firms		Percentage	
	Periphery	Centre	Periphery	Centre
Low-tech	5 071	16 805	76.4	62.2
Medium-tech	1 113	6 107	16.8	22.6
High-tech	454	4 098	6.8	15.2
Total	6 638	27 010	100.0	100.0
C. Firm exit by group of industries in central and peripheral regions.				
	Number of firms		Percentage	
	Periphery	Centre	Periphery	Centre
Low-tech	3 088	10 754	78.3	65.1
Medium-tech	576	3 421	14.6	20.7
High-tech	279	2 336	7.1	14.1
Total	3 943	16 511	100.0	100.0

Source: Prepared by the author, on the basis of data from the Employment and Business Dynamics Observatory.
Note: The figures refer to population data.

In addition, the composition of incumbents, entries and exits also differs. In central provinces, the relative importance of medium- and high-tech industries is higher than in peripheral regions (see table 2). This is related to the advantages that central provinces offer to these types of activities: between them, these five regions account for 75% of expenditure in science and technology, 77% of university degrees, 62% of universities and 85% of exports of manufactured products in 2003 (INDEC, 2005). According to Feldman (1994), the geographic concentration of knowledge inputs forms a technological infrastructure that lowers the risks and costs of engaging in activities with higher levels of technological intensity.

3. Explanatory variables

Data from the Employment and Business Dynamics Observatory and the National Household Survey (NHS) are used to construct the vector of explanatory variables. The distinction is important because the information contained in the EBDO database refers to the whole province, while the survey is conducted on samples of families in 31 urban areas. Nevertheless, the NHS data had to be included given the absence of a source of yearly statistical information on the demographic and/or socioeconomic characteristics of the Argentine provinces (population censuses, for example, are performed every 10 years).

It was therefore possible to construct two types of variables: (i) region-specific variables related to the evolution of economic activity, the labour market, the level of education, the industrial structure and the existence of agglomeration economies; and (ii) sector-specific variables that account for the economic conditions faced by the three groups of industries in the different regions, such as market growth, barriers to entry and exit, industrial tradition, agglomeration effects and input prices. As discussed in section II, these factors are widely used in studies on developed countries. Moreover, year dummy variables were included to control for macroeconomic factors.[8]

The next step was to add variables related to poverty level, the informal economy and idle capacity in an attempt to capture the economic and structural singularities of a developing country. The square of the level of poverty and informality was also included to account for possible non-linear effects. The final step was to explore the existence of core-periphery differences by including the products of a dummy identifying the richest provinces with the variables that account for agglomeration effects and the relationship between entries and exits.

Tables 3 and 4 illustrate the definition, statistical sources and descriptive statistics of the explanatory variables. They also contain columns with the expected sign of the associated coefficient for both entry and exit. The methodologies for constructing these variables and determining the expected sign are explained briefly below.

[8] These were preferred to macroeconomic variables such as GDP growth because of the measurement problems involved. The accuracy of GDP growth in local currency cannot be certified because official inflation figures have not been reliable since 2007. Similarly, GDP growth in US dollars would be misleading because of the severe devaluation of the Argentinean peso in 2002 (by more than 200%) and the consequent gradual appreciation.

Table 3
Region-specific explanatory variables: definition, sources, expected signs and descriptive statistics

Variable	Definition	Sector	Source	Expected sign		Mean	Standard deviation	Min.	Max
				Entry	Exit				
Employment variation	Rate of variation in employment in all formal firms		EBDO database	+	-	9.22	5.20	-6.97	22.75
Exit others$_{t-1}$	Number of exits in the previous year in the other sectors	Med-High		+/-		43.92	90.17	0	503
		Low-High				109.49	189.11	4	904
		Low-Med				118.08	202.77	4	934
Entry others$_{t-1}$	Number of entries in the previous year in the other sectors	Med-High			+/-	75.19	150.63	0	771
		Low-High				166.66	285.41	3	1 284
		Low-Med				182.23	311.02	3	1.373
Incumbent others	Number of incumbent firms in the other sectors	Med-High		+/-	+/-	813.67	1 685.90	6	8.134
		Low-High				1 531.76	2 545.41	86	10 075
		Low-Med				1 652.79	2 776.12	84	12 005
HH index	Hirschman-Herfindahl Index (based on employment data)			-	+	24.36	12.00	8.06	62.90
SMEs	Ratio of small and medium industrial firms to total industrial firms (formal)			+	+	39.92	5.77	27.27	57.03
Unemployment rate	Unemployment rate		National Household Surveya	+/-	+/-	8.19	3.81	1.01	18.20
Primary education	Active individuals with primary education *(thousands of persons)*			+/-	+/-	191.36	297.19	7.68	1 554.53
Secondary education	Active individuals with secondary education *(thousands of persons)*			+/-	+/-	281.69	384.37	21.80	1 897.59
University education	Active individuals with university-level education *(thousands of persons)*			+/-	+/-	220.44	279.55	12.34	1 032.11
Density	Log (population/area) *(thousands)*		Military Geographical Institute and National Institute of Statistics and Censuses (INDEC)	+	-	676.91	2 732.61	0.83	13 739.75
Private-to-public	Private employees/public employees		Own calculations from National Household Surveya	+		3.32	1.64	1.22	9.14
Migrants	Migration from other provinces *(thousands of persons)*			+		206.16	294.16	29.93	1 506.10
Poverty	% of households living below the indigence line			-		8.87	6.15	0.40	29.80
Non-registered/ registered	Ratio of non-registered workers to registered workers			+/-	+/-	0.81	0.31	0.16	1.51

Source: Prepared by the author, on the basis of data from the Employment and Business Dynamics Observatory (EBDO), the National Household Survey (NHS), the Military Geographical Institute and the National Institute of Statistics and Censuses (INDEC).

[a] Data refer to the third quarter of every year, except for 2007 (when they refer to the fourth quarter).

Table 4
Sector-specific explanatory variables: definition, sources, expected signs and descriptive statistics

Variable	Definition	Sector	Source	Expected sign		Mean	Standard deviation	Min.	Max
				Entry	Exit				
Incumbents	Number of incumbent firms in the sector	Low	EBDO database	+	-	1 185.44	1 867.28	80	7 096
		Med.				467.35	994.99	2	5 032
		High				346.32	703.33	4	3 102
$Exit_{t-1}$	Number of exits in the sector in the previous year	Low		+		91.82	153.83	3	763
		Med.				26.26	54.18	0	323
		High				17.67	36.81	0	195
$Entry_{t-1}$	Number of entries in the sector in the previous year	Low			+	136.85	229.31	3	1 127
		Med.				45.38	92.65	0	479
		High				29.81	59.66	0	292
Industrial tradition	Incumbent firms in the sector 7 years prior (three-year moving average)	Low		+	-	1 154.14	1 850.12	62.33	7 007.67
		Med.				436.40	950.07	2.67	4 641.33
		High				325.77	674.14	4	2 943.33
Market growth / Idle capacity	Rate of variation in employment in incumbent firms of the sector	Low		+/-	-	6.64	6.97	-22.78	28.79
		Med.				11.88	32.13	-50	350
		High				18.71	62.51	-42.33	725
Wages	Nominal wages paid by registered firms in the sector	Low		-	+	1 532.05	595.47	545.04	3 397.12
		Med.				1 526.54	814.31	366.10	4 782.37
		High				1 944.09	998.10	260.93	6 141.69

Source: Prepared by the author, on the basis of data from the Employment and Business Dynamics Observatory (EBDO).

(a) Region-specific variables

Business cycle. The rate of variation of the employment in all formal firms is used as a proxy for the evolution of economic activity. The coefficient of this variable is expected to be positive for entries and negative for exits, thus reflecting the procyclicality of both processes. In addition, the (lagged) number of exits and entries are included as another proxy of regional dynamism.[9]

Labour. The regional unemployment rate is used to assess the labour market impact on firm dynamics. As mentioned previously, it is impossible to say *a priori* what that impact will be.

Education. The number of persons in the active population with primary, secondary and university-level education is used. It is expected that higher educational levels have more of an impact on high- or medium-tech activities.

Spatial concentration. Population density and its square are used as proxies for agglomeration and disagglomeration economies, respectively. It is expected that the density coefficient will be positive for entries, while both positive and negative signs are possible for exits. For the density squared coefficient, a negative sign is expected for entries and a positive for exits squared. The number of incumbent firms has also been included as an additional measure of the agglomeration of economic activity.

Industrial structure. The Hirschman-Herfindahl (HH) index, which measures lack of diversity, is a proxy for the industrial structure of the province and the share of SMEs. It is expected that the HH index will have a negative impact on entry and a positive one on exit. The proportion of SMEs is expected to have a positive impact on both entry and exit.

Cultural attitudes. The study accounts for the regional cultural differences that may enhance start-ups by including the ratio of private-to-public employees and the number of individuals coming from other provinces. Both variables are expected to have a positive impact on entry.

Poverty. The percentage of households living below the indigence line —the threshold below which income is insufficient to afford a basic food basket, estimated at about US$ 38 per adult in 2003— is used as a proxy for the extent of poverty. Lower entry is expected in poorer regions because the share of entrepreneurs with access to resources is smaller and the demand is lower and less diverse.

Informal economy. The ratio of non-registered workers to registered workers is used as a proxy for the regional production structure (for example, the seasonality and/or low productivity of certain activities may facilitate the growth of the informal sector) and/or the lack of government controls over informal economy. Both positive and negative signs are possible for this variable.

(b) Sector-specific variables

Previous entry/exit. The lagged number of entries (and exits) in the same group of industries are used to account for the interdependence between both processes in the exit (entry) equation. It is expected that past exit (entry) will have a positive impact on current entries (exits) because of the replacement (displacement) effect. However, this impact may be hampered if regional markets are not saturated and, consequently, competition among firms is scarce.

Spatial concentration. The number of incumbents in each group of industries is included as a proxy for the effects of localization economies and/or the level of competition among firms.

[9] Note that the replacement/displacement effects are accounted for entries and exits in the same group of industries.

Industrial tradition. To control for the previous industrial activities carried out in a province, the average number of incumbents in the same sector 7, 6 and 5 years prior is used. Although it is expected that past incumbents encourage entry and discourage exit, high macroeconomic volatility may mitigate this effect.

Wages. The wages in each group of industries are used to assess the impact of labour cost on firm dynamics. They correspond to the average monthly wage of registered workers in the private sector, in nominal terms, given the unreliability of official inflation rates in Argentina since 2007.[10] This variable is expected to have a negative impact on entries and a positive one on exits. However, its significance may be weak in developing countries, where the limitations of the financial system lead many entrepreneurs to use their savings for the initial capital required (Wang, 2006).

Market growth/idle capacity. The study uses the rate of growth of the employees in each group of industries to account for the evolution of sectoral demand. The coefficient of this variable is expected to be positive for entries and negative for exits. However, the use of idle capacity by incumbent firms may mitigate this effect in the case of entries.

4. Econometric modelling

The study uses panel count data models to estimate equations (1) and (2) in section III.1.[11] Panel data make it possible to control for some characteristics of the provinces (observable or not) that do not change much over time, such as endowment in natural resources, institutional setting and entrepreneurial culture. Panel data also give more variability, less collinearity among the variables, more degrees of freedom and more efficiency (Baltagi, 2005).

Panel data models were preferred to cross-section estimates on the grounds of two empirical tests. First, likelihood ratio tests on the variance of the individual effects always yield statistically significant results and thus reject the validity of pooled estimates (Cameron and Trivedi, 2009). Second, the assumption that observations are indeed independent across the considered years was tested by computing the covariance matrix for the year vector of Pearson residuals from the pooled Poisson regression model (see Hausman, Hall and Griliches, 1984 for details). The findings of large values in the off-diagonal elements of the matrix in all the specifications support the independence assumption that sustains panel data models.

To choose between Poisson and negative binomial models, the ratio of the Pearson goodness-of-fit statistic to the degrees of freedom of a Poisson model was computed with province dummy variables. As Allison and Waterman (2002) argue, if this ratio is close to one, there is no evidence of overdispersion in the data and Poisson estimates are efficient. Unfortunately, negative binomial models did not achieve convergence in the low-tech entry model. The study therefore presents the results from the Poisson model —even though the ratio, at 1.42, is slightly above the value proposed by Allison and Waterman (2002). Second, the choice between fixed effects and random effects is based on the Durbin-Hu-Hausman test. For most models, it is not possible to reject the null hypothesis of no correlation between the covariates and the individual effect, which means that the random effects model yields consistent estimates. However, when that hypothesis is rejected, fixed effects models are used since they always provide consistent estimates.

[10] Wages in each group of industries were constructed as a weighted average of the nominal wages in each 2-digit industry, using as weights the share of each 2-digit industry in the total number of incumbents in the group.

[11] See for example, Chappell, Kimenyi and Mayer (1990); Ilmakunnas and Topi (1999); Barbosa, Guimarães and Woodward (2004); Barbosa (2007); and Fritsch and Falck (2007) for applications that use count data models to explain firm dynamics in developed countries.

IV. Empirical results

The estimates from the count models are shown in tables 5 (entry) and 6 (exit). Columns [1] present results from the specification that contains variables which are widely used in studies on developed countries, while columns [2] include variables that capture the specificities of developing countries (poverty, the size of the informal sector and idle capacity), as well as the core-periphery pattern found in Argentina (Calá, Arauzo-Carod and Manjón-Antolín, 2015 and Calá, Manjón-Antolín and Arauzo-Carod, 2016).

Table 5
Argentina: determinants of firm entry by group of industries

		Low-tech		Medium-tech		High-tech	
		[1]	[2]	[1]	[2]	[1]	[2]
		NB FE	Poisson RE	Poisson RE	Poisson RE	Poisson RE	Poisson RE
Region-specific variables used in developed countries	Employment variation	0.0197***	0.0270***	0.0105	0.0063	-0.0161	0.0063
		(0.0044)	(0.0046)	(0.0100)	(0.0104)	(0.0151)	(0.0140)
	Exit in other sectors$_{t-1}$	-0.0007	0.0091**	0.0005	-0.0075**	-0.0009*	0.0035
		(0.0005)	(0.0039)	(0.0004)	(0.0029)	(0.0006)	(0.0029)
	Unemployment rate	0.0123	-0.0033	-0.0022	0.0037	-0.0162	0.0072
		(0.0104)	(0.0094)	(0.0170)	(0.0178)	(0.0204)	(0.0163)
	Primary education	-0.0005	0.0001	0.0008	0.0002	-0.0011	-0.0009
		(0.0006)	(0.0003)	(0.0008)	(0.0006)	(0.0007)	(0.0005)
	Secondary education	0.0003	0.0004	0.0002	0.0001	-0.0006	-0.0003
		(0.0006)	(0.0004)	(0.0007)	(0.0006)	(0.0007)	(0.0006)
	University education	0.0011**	0.0006	0.0002	0.0000	-0.0008	0.0000
		(0.0005)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0006)
	HH index	0.0126	0.0064	-0.0037	-0.0059	-0.0092	-0.0177**
		(0.0087)	(0.0095)	(0.0129)	(0.0118)	(0.0123)	(0.0074)
	SMEs	0.0276***	0.0040	0.0163	0.0045	-0.0026	-0.0342**
		(0.0104)	(0.0090)	(0.0196)	(0.0198)	(0.0236)	(0.0152)
	Private/Public	-0.0315	-0.0114	-0.0049	0.0164	0.0951***	0.0506*
		(0.0207)	(0.0184)	(0.0318)	(0.0302)	(0.0356)	(0.0307)
	Migrants	-0.0005	-0.0001	0.0013**	0.0014**	-0.0001	-0.0004
		(0.0004)	(0.0003)	(0.0006)	(0.0006)	(0.0006)	(0.0005)
	Density	4.4403***	0.6550***	0.8933**	1.0074***	0.7769***	0.9465***
		(1.6456)	(0.1831)	(0.3543)	(0.2302)	(0.2460)	(0.1472)
	Density^2	-0.3860**	-0.1144***	-0.0588*	-0.1649***	-0.1144***	-0.1822***
		(0.1587)	(0.0248)	(0.0329)	(0.0291)	(0.0273)	(0.0120)
	Incumbents in other sectors	0.0001	0.0019	-0.0002	0.0005	0.0011***	0.0025***
		(0.0002)	(0.0016)	(0.0002)	(0.0009)	(0.0002)	(0.0005)
Sector-specific variables used in developed countries	Exit in the sector$_{t-1}$	-0.0005	-0.0020	-0.0016	0.0353***	0.0031	0.0152
		(0.0004)	(0.0017)	(0.0010)	(0.0116)	(0.0029)	(0.0182)
	Incumbents in the sector	-0.0008***	-0.0011	0.0005	-0.0057*	-0.0032***	-0.0161***
		(0.0002)	(0.0009)	(0.0004)	(0.0033)	(0.0009)	(0.0055)
	Industrial tradition in the sector	-0.0006***	0.0017***	0.0001	0.0114***	0.0031***	0.0092**
		(0.0002)	(0.0005)	(0.0003)	(0.0035)	(0.0006)	(0.0046)
	Wages in the sector	-0.0000	-0.0002	0.0000	0.0001	0.0003	0.0003***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Variables for developing countries	Non-registered/registered		0.9801***		-0.8592		-2.1970**
			(0.3652)		(0.9524)		(0.9893)
	Non-registered/registered^2		-0.3497***		0.2510		1.2528**
			(0.1278)		(0.4881)		(0.5451)
	Poverty		-0.0365**		0.0017		-0.0266
			(0.0148)		(0.0289)		(0.0365)
	Poverty^2		0.0007*		-0.0005		-0.0001
			(0.0004)		(0.0010)		(0.0012)
	Employment variation in the sector		-0.0128***		-0.0016		-0.0041
			(0.0029)		(0.0023)		(0.0028)

Table 5 (concluded)

		Low-tech		Medium-tech		High-tech	
		[1]	[2]	[1]	[2]	[1]	[2]
		NB FE	Poisson RE	Poisson RE	Poisson RE	Poisson RE	Poisson RE
Core-periphery pattern	Density x rich dummy		1.2746***		1.4873***		1.1186***
			(0.3090)		(0.3274)		(0.1660)
	Incumbents in other sectors x rich dummy		-0.0021		-0.0010		-0.0022***
			(0.0016)		(0.0009)		(0.0006)
	Incumbents in the sector x rich dummy		0.0009		0.0062*		0.0153***
			(0.0009)		(0.0033)		(0.0056)
	Industrial tradition in the sector x rich dummy		-0.0019***		-0.0120***		-0.0082*
			(0.0006)		(0.0036)		(0.0046)
	Exit in other sectors$_{t-1}$ x rich dummy		-0.0100**		0.0077***		-0.0036
			(0.0039)		(0.0030)		(0.0029)
	Exit in the sector$_{t-1}$ x rich dummy		0.0019		-0.0377***		-0.0147
			(0.0017)		(0.0117)		(0.0185)
AIC		884.57	1 207.37	913.67	880.80	735.47	682.64
LR Test		172.37***	448.47***	98.57***	273.46***	205.53***	5 107.27***
Hausman		142.67***	10.82	(a)	0.93	8.80	27.74*
Pearson ratio		1.85	1.42	1.12	0.95	0.98	0.92

Source: Prepared by the author.
Note: Observations: 144. In high-tech industry the number of observations is 138 in FE models. Standard errors in brackets. Asterisks indicate the statistical significance of the coefficient: *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.1. Year dummy variables are included in all the specifications.
[a] Negative unreported statistic found.

Table 6
Argentina: determinants of firm exit by group of industries

		Low-tech		Medium-tech		High-tech	
		[1]	[2]	[1]	[2]	[1]	[2]
		Poisson RE	Poisson RE	Poisson FE	Poisson FE	Poisson RE	Poisson RE
Region- specific variables used in developed countries	Employment variation	-0.0084	0.0003	-0.0083	-0.0052	-0.0135	0.0063
		(0.0053)	(0.0058)	(0.0145)	(0.0154)	(0.0179)	(0.0168)
	Unemployment rate	-0.0172*	-0.0034	-0.0247	-0.0187	0.0260	0.0300
		(0.0098)	(0.0102)	(0.0251)	(0.0283)	(0.0255)	(0.0212)
	Primary education	-0.0006**	-0.0004	0.0020*	0.0015	-0.0016**	-0.0015***
		(0.0003)	(0.0003)	(0.0012)	(0.0014)	(0.0007)	(0.0006)
	Secondary education	-0.0000	0.0009**	-0.0003	-0.0001	-0.0008	0.0007
		(0.0005)	(0.0005)	(0.0013)	(0.0014)	(0.0010)	(0.0007)
	University education	0.0007*	0.0007*	-0.0006	-0.0003	0.0011	0.0013*
		(0.0004)	(0.0004)	(0.0010)	(0.0010)	(0.0007)	(0.0006)
	HH index	-0.0030	-0.0112**	0.0202	-0.0033	-0.0027	-0.0284***
		(0.0066)	(0.0055)	(0.0247)	(0.0406)	(0.0128)	(0.0099)
	SMEs	-0.0070	-0.0072	0.0818***	0.0923***	0.0280	0.0036
		(0.0098)	(0.0090)	(0.0292)	(0.0347)	(0.0224)	(0.0180)
	Entry in other sectors$_{t-1}$	0.0002	-0.0111***	0.0004	0.0014	-0.0006	0.0009
		(0.0003)	(0.0039)	(0.0006)	(0.0039)	(0.0005)	(0.0040)
	Density	0.5842***	0.5945***	-2.6954	-7.1567	0.5644**	0.3969**
		(0.1387)	(0.1175)	(7.1660)	(8.2045)	(0.2605)	(0.1979)
	Density^2	-0.0727***	-0.1018***	0.8084	0.5324	-0.0945***	-0.1346***
		(0.0160)	(0.0149)	(0.7046)	(1.0326)	(0.0311)	(0.0148)
	Incumbents in other sectors	-0.0001	0.0007	-0.0006	0.0035	0.0011***	0.0029***
		(0.0002)	(0.0013)	(0.0007)	(0.0041)	(0.0003)	(0.0008)

Table 6 (concluded)

		Low-tech		Medium-tech		High-tech	
		[1]	[2]	[1]	[2]	[1]	[2]
		Poisson RE	Poisson RE	Poisson FE	Poisson FE	Poisson RE	Poisson RE
Sector - specific variables used in developed countries	Entry in the sector$_{t-1}$	-0.0004**	0.0057***	-0.0014	0.0215	0.0017	0.0164
		(0.0002)	(0.0019)	(0.0016)	(0.0137)	(0.0021)	(0.0213)
	Incumbents in the sector	0.0006***	-0.0001	0.0009	-0.0259**	-0.0030***	-0.0317***
		(0.0001)	(0.0008)	(0.0013)	(0.0111)	(0.0010)	(0.0072)
	Industrial tradition in the sector	0.0003***	0.0012**	0.0000	-0.0145	0.0025***	0.0237***
		(0.0001)	(0.0005)	(0.0005)	(0.0118)	(0.0006)	(0.0063)
	Wages in the sector	-0.0000	0.0000	0.0004**	0.0002	0.0000	0.0001
		(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)
Variables for developing countries	Non-registered/registered		-0.7609**		0.0321		-0.6109
			(0.3716)		(1.3403)		(1.0707)
	Non-registered/registered^2		0.2633**		0.3837		0.5845
			(0.1307)		(0.6865)		(0.5986)
	Employment variation in the sector		-0.0076**		-0.0054		-0.0017
			(0.0038)		(0.0041)		(0.0027)
Core-periphery pattern	Density x rich dummy		0.9750***		8.4807		1.3593***
			(0.2539)		(9.0378)		(0.1866)
	Incumbents in other sectors x rich dummy		-0.0010		-0.0054		-0.0032***
			(0.0013)		(0.0042)		(0.0008)
	Incumbents in the sector x rich dummy		0.0001		0.0268**		0.0319***
			(0.0008)		(0.0113)		(0.0073)
	Industrial tradition in the sector x rich dummy		-0.0014***		0.0130		-0.0232***
			(0.0005)		(0.0118)		(0.0062)
	Entry in other sectors$_{t-1}$ x rich dummy		0.0116***		-0.0001		-0.0006
			(0.0039)		(0.0038)		(0.0040)
	Entry in the sector$_{t-1}$ x rich dummy		-0.0057***		-0.0217		-0.0160
			(0.0019)		(0.0138)		(0.0213)
AIC		1 063.37	1 041.07	511.04	515.48	641.38	608.10
LR Test LR Test		1 350.86***	1 794.58***	511.45***	522.85***	375.29***	3 421.43***
Hausman		19.25*	20.51	35.22***	110.87***	14.70	19.30
Pearson ratio		1.25	1.07	0.86	0.83	0.88	0.86

Source: Prepared by the author.
Note: Observations: 144. Standard errors in brackets. Asterisks indicate the statistical significance of the coefficient: *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.1. Year dummy variables are included in all the specifications.

Upon analysis of the findings for firm entry (table 5, columns [2]), it becomes apparent that results for low-tech activities, which account for approximately 65% of total entries over the period under consideration, are largely consistent with those found in previous studies on the manufacturing sector as a whole (Calá, Manjón-Antolín and Arauzo-Carod, 2016). However, the impact of the covariates is not homogeneous across sectors. For example, the evolution of regional demand is relevant only to low-tech activities, while structural variables (such as the share of SMEs or industrial diversification), cultural factors (such as the private/public ratio or the share of migrants), or the level of wages are relevant only to medium- and high-tech industries. This implies that a favourable economic environment enhances firm creation only in traditional sectors, but it is not enough to promote regional structural changes driven by firm entries in medium- and high-tech industries.

There are also significant agglomeration and dispersal effects driven by population density. The former are particularly strong in central regions, where a higher population density encourages entry even more than in the periphery. In central provinces, agglomeration economies in medium- and high-tech industries are also driven by the number of incumbents in the same sector (localization economies). Interestingly, agglomeration effects for high-tech activities also emerge from the concentration of firms in other sectors, consistent with the idea of urbanization economies, as in developed countries (Henderson,

Kuncoro and Turner, 1995). This finding suggests the relevance of regional diversification to promoting new high-tech ventures, and it is consistent with the negative impact of industrial concentration on high-tech entries.

Variables that are a proxy for the singularities of Argentina as a developing country are highly significant, particularly in low-tech industries. For example, the negative sign of the poverty variable is consistent with lower purchasing power and fewer financial, human and social capital resources available for entrepreneurs in poor areas. Furthermore, the positive effect of the squared term suggests that high levels of poverty spur the creation of (possibly small) firms with low entry barriers. The impact of the informal economy is also non-linear. A small informal economy encourages entry by either pushing people towards entrepreneurship or providing the opportunity of sub-contracting activities. However, when there is excessive growth of the informal sector, competition with informal firms may impede the entry of formal ventures.[12] Notably, this variable has contrasting impacts on high-tech entries and on low-tech activities. In addition, as employment in the sector increases, fewer low-tech entries are expected, which suggests that the higher sectoral demand is satisfied through the use of idle capacity rather than through new firm formation.

Finally, many variables including replacement effects and past and current agglomeration economies show opposite effects in the core and the periphery, a detail that is overlooked in specifications that do not distinguish between both groups of provinces and thus overlap the positive/negative effects. The findings show that it may be particularly difficult to promote high-tech entry in lagged regions because there are usually not enough related firms to create the necessary conditions for external economies of scale.

Table 6 shows analogous results for firm exit. Once again, results for firm exit in low-tech activities (which account for 68% of total exits) are consistent with those found in previous studies focusing on aggregated exit (Calá, Arauzo-Carod and Manjón-Antolín, 2015). In particular, previous entrants in the sector generate a replacement effect in peripheral regions but prevent exit in the core. This suggests that the revolving door is more intense in poorer regions and the (presumably) shorter survival is possibly related to the small market size in these lagged regions. The above casts doubts on the usefulness in these regions of entry-promoting policies that, ultimately, may only cause more exits. The industrial tradition and entries in other sectors also have opposite effects on both core and peripheral provinces. In particular, the negative impact of previous entry observed in the periphery may be a proxy for the outlook for regional manufacturing activity. In addition, the findings point to a negative effect of the degree of industrial concentration and market growth on exit, while the educational level of the workforce has a positive impact. This may be related to tougher competition in areas with higher levels of human capital.

Dense areas force firms out of the market, although this effect is reversed in areas of very high density. This outcome may be attributed to competition effects and to differences within a given province, for example between dense areas specialized in services (especially public services) and less populated industrial regions, where manufacturing activity is more easily retained. At any rate, this is a topic worthy of future research. The dispersal effect, in particular, is more pronounced in core regions, where population density fosters exit even more than in the rest of the country.

Lastly, the informal economy has much the same impact on low-tech exit as it does on the whole manufacturing as a whole (Calá, Arauzo-Carod and Manjón-Antolín, 2015). Although a small informal economy prevents exit, its effect is the opposite when it grows beyond a certain level. The initial negative effect on exit may be related to the inherently lower costs and/or the greater flexibility of hiring in the informal sector, while a positive impact is expected when formal firms have to compete for resources or market access with informal firms. Remarkably, the links between the formal and the informal sector seem to be relevant only in low-tech industries.

[12] A larger informal sector may also reflect the lack of government controls in certain provinces, which may discourage entrepreneurs from establishing formal firms.

As in the entry process, exits in medium-tech sectors are far less systematic than in the other sectors.[13] There is a positive effect of the share of SMEs, which reflects the "liability of smallness" (Strotmann, 2007). There is also a competition effect driven by incumbents in core areas, while the opposite effect is found in the periphery, where localization economies seem to be more important.

Exits in high-tech industries are largely driven by agglomeration diseconomies arising from population density and the number of incumbent firms in other sectors. However, there are marked differences between the core and the periphery. In the central areas, incumbents in the same sector push firms out of the market (competition effect), whereas in peripheral provinces those incumbents induce localization economies that prevent exit. At the same time, incumbents in other sectors retain firms in core provinces (which is the expected outcome of a dense industrial structure or the existence of urbanization economies), but they foster exit in non-central regions. Industrial tradition in the sector is also relevant and it has the opposite impact in central area (negative) and the periphery (positive). These results suggest that some case studies on high-tech ventures both in core and peripheral regions may shed light on the shortcomings that these firms face in both groups of provinces.

V. Conclusion

This paper analyses the determinants of entry and exit in developing countries, using Argentina as an illustrative case. This is, to our knowledge, the first attempt to explain regional firm dynamics in a developing economy using both regional and sectoral variables.

The results suggest that several specificities of developing economies should be taken into account in order to explain firm dynamics in these countries. In Argentina, for example, the findings reveal a substitution effect between the use of idle capacity and new firm formation, as well as a non-linear impact of the poverty level on entries. The latter means that policies aimed simply at promoting new business creation may have limited bearing, since reducing poverty rates probably requires long-term measures. Moreover, the results indicate that the size of the informal sector has a non-linear effect on both entry and exit with differences for low- and high-tech sectors. This suggests that the links between the formal and the informal sectors may be extremely complex and that more research is needed to understand this strong relationship.

The study also shows that different factors explain firm entry and exit in low- and high-tech industries. In particular, variables specific to developing countries have an impact mostly on low-tech entries and exits. This suggests that policy measures aimed at fostering start-ups and preventing firm exit may succeed only if they take into account the industrial mix of each geographical area.

Lastly, there is evidence of a core-periphery pattern in which many variables have opposite effects in central and lagged provinces. This means that the geographical effects on firm dynamics cannot be adequately assessed if there is no distinction between central and peripheral regions. Consequently, entrepreneurship policies for the whole country should not be based on results and experiences taken only from central regions.

Future extensions of this study should test for the equality of the effects of the explanatory variables on non-local manufacturing firms and on the service sector. Further research should also analyse the impact of regional firm dynamics on some measures of economic performance, such as employment creation or regional innovation.

[13] The fact that medium-tech activities probably share certain characteristics with both low- and high-tech industries makes it more difficult to identify firm dynamics determinants in this group of industries.

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Annex A1

Table A1.1
Argentina: industry classification, 2008
(Percentages)

Group	Code	Industry	Firms	Employees
Low tech	15	Manufacture of food products and beverages	22.6	26.6
	16	Manufacture of tobacco products	0.0	0.4
	17	Manufacture of textiles	4.9	5.5
	18	Manufacture of wearing apparel; dressing and dyeing of fur	6.8	4.5
	19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	3.0	3.3
	20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	5.9	3.2
	22	Publishing, printing and reproduction of recorded media	6.9	4.8
	26	Manufacture of other non-metallic mineral products	3.3	3.4
	36	Manufacture of furniture; manufacturing n.e.c.	5.7	3.4
	37	Recycling	0.3	0.3
Total Low Tech			59.4	55.4
Medium tech	21	Manufacture of paper and paper products	1.5	2.5
	23	Manufacture of coke, refined petroleum products and nuclear fuel	0.1	0.5
	25	Manufacture of rubber and plastics products	5.3	5.4
	27	Manufacture of basic metals	2.1	3.5
	28	Manufacture of fabricated metal products, except machinery and equipment	14.4	8.7
Total Medium Tech			23.4	20.6
High tech	24	Manufacture of chemicals and chemical products	4.1	7.0
	29	Manufacture of machinery and equipment n.e.c.	5.8	5.9
	30	Manufacture of office, accounting and computing machinery	0.3	0.3
	31	Manufacture of electrical machinery and apparatus n.e.c.	1.9	1.9
	32	Manufacture of radio, television and communication equipment and apparatus	0.2	0.4
	33	Manufacture of medical, precision and optical instruments, watches and clocks	1.0	0.7
	34	Manufacture of motor vehicles, trailers and semi-trailers	2.8	6.7
	35	Manufacture of other transport equipment	0.8	1.0
Total High Tech			16.9	23.9

Source: Prepared by the author, on the basis of United Nations, "International Standard Industrial Classification of All Economic Activities, third revision", Statistical Papers, Series M, No.4, Rev. 3 (ST/ESA/STAT/SER.M/4/Rev.3), New York, 1990; data from the Employment and Business Dynamics Observatory; and J. Katz and G. Bernat, "Exit-entry, productivity growth and structural change in response to changes in macroeconomic policy: evidence from Argentina", *Innovation and Development*, vol. 1, No. 2, Taylor & Francis, 2011.
Note: Data = Entry + Incumbent – Exit.

Business cycles, expectations and inflation in Brazil: a New-Keynesian Phillips curve analysis

Elano Ferreira Arruda, Maria Thalita Arruda Oliveira de Olivindo and Ivan Castelar

Abstract

This article analyses Brazil's recent inflation dynamic, considering different expectations environments within the New-Keynesian Phillips curve framework, to observe how the potential for discretionary behaviour by the monetary authority can interfere in economic agents' forward-looking expectations, and how that interference can affect the way inflation responds to its inertial component and to business-cycle fluctuations. To that end, the study estimates the New-Keynesian Phillips curve and its hybrid version, using the heteroscedasticity-and-autocorrelation-consistent (HAC) estimator of the generalized method of moments (GMM). The results suggest that, when economic agents possess lower degrees of foresight, inflation will be more sensitive to business-cycle fluctuations the larger is its inertial component.

Keywords

Economic conditions, business cycles, inflation, economic analysis, econometric models, Brazil

JEL classification

E30, E31, E32

Authors

Elano Ferreira Arruda is a professor at the Department of Applied Economics and a research fellow on the Postgraduate Programme in Economics of the Federal University of Ceará (UFC), Brazil. Email: elano@ufc.br.

Maria Thalita Arruda Oliveira de Olivindo is a PhD candidate on the Graduate Programme in Economics of the Federal University of Ceará, Brazil. thalitaoliveira. Email: sobral@gmail.com.

Ivan Castelar is a professor on the Postgraduate Programme in Economics at the Federal University of Ceará, Brazil. Email: lume1250@yahoo.com.br.

I. Introduction

The Phillips curve, initially represented as the trade-off between wage inflation and unemployment, has undergone major changes over the last few decades, owing both to the evolution of macroeconomic theory and to the emergence of new stylized facts on the relationship between business cycles, expectations and inflation.

The most recent change, based on formulations by Taylor (1980) and Calvo (1983), is known as the New-Keynesian Phillips curve (hereinafter NKPC). This is obtained from a microfounded rational-expectations model, which envisages a relationship between short-term inflation and a measure of firms' marginal cost and highlights the importance of forward-looking expectations. Galí and Gertler (1999) also propose a hybrid New-Keynesian Phillips curve, in which the effect of the backward-looking, or inertial, component is also evaluated.

Both NKPC and its hybrid version are currently a focus of debate on the conduct of monetary policy and the relationship between business cycles,[1] expectations and inflation. This is important because a credible monetary authority can pursue a disinflationary policy at no cost, if inflation is a purely forward-looking process, whereas the cost of such a policy in terms of reduced economic activity could be higher if there is a backward-looking component.

The international literature reveals that studies on the subject are somewhat polarized: some authors show that NKPC is a robust mechanism to explain the inflationary dynamic (Galí and Gertler, 1999; Galí, Gertler and López-Salido, 2001), while others question its empirical relevance (Rudd and Whelan, 2005). In the case of Brazil, several papers present evidence of the importance of the Phillips curve for analysing the behaviour of inflation, although the results are quite sensitive to the estimation methods and proxy variables used in the model (Mendonça, Sachsida and Medrano, 2012; Sachsida, 2013).

The main evidence for the Brazilian economy[2] reveals the statistical significance of the forward- and backward-looking expectations components for the behaviour of inflation, and the fact that a business-cycle variable measured by the output gap cannot easily capture the effect that changes in economic activity have on price trends (Areosa and Medeiros, 2007; Sachsida, Ribeiro and Dos Santos, 2009; Arruda, Ferreira and Castelar, 2011).

Despite the wide-ranging debate over the appropriateness of NKPC, there has been little discussion on how the recent dynamics of inflation in Brazil respond to its inertial component and to cycles of economic activity, considering different levels of agent foresight, or forward-looking expectations, in NKPC and in its hybrid version. Authors such as Mendonça (2002 and 2004), Sicsú (2002) and Mendonça and Santos (2006) show that the credibility of the monetary authority affects economic agents' predictive capacity and that much of the inertia of inflation stems from the government's reputational loss following its failure to observe the rules previously agreed upon.

Accordingly, this study examines the recent behaviour of Brazilian inflation, considering different expectations environments in the framework of NKPC and its hybrid version. The aim is to answer the following questions: how do the estimated coefficients of NKPC and its hybrid version behave in different forward-looking expectations environments? Would inflation be less sensitive to cyclical output fluctuations and its inertial component if economic agents had perfect foresight? Are the costs of a disinflationary policy —in terms of a reduction in economic activity— higher when economic agents have less foresight? Given that authors such as Simonsen (1970 and 1985), Cabello (2014) and Carvalho (2014) warn that persistent or increased indexation has major inflationary feedback repercussions, did the possible recent increase in the degree of indexation of the Brazilian economy affect the impact of inertial inflation?

[1] Business cycles as measured by firms' marginal cost.

[2] For a good review of the main evidence, see Mendonça, Sachsida and Medrano (2012) and Sachsida (2013).

To answer these questions, the study uses monthly data spanning from January 2002 to December 2012[3] to estimate NKPC and its hybrid version for the Brazilian economy, applying the heteroscedasticity and autocorrelation-consistent (HAC) estimator of the generalized method of moments (GMM). The output gap, unemployment gap and firms' real marginal cost[4] are used as business-cycle variables; inflation measured by the lagged National Extended Consumer Price Index (IPCA) is used to represent backward-looking expectations; the future projected IPCA proxies forward-looking expectations under perfect foresight; and, lastly, the average of daily inflation expectations throughout the month following publication of the Central Bank of Brazil's Focus report, serves as a measure of forward-looking expectations in a low-foresight environment.

This study's main contribution is to evaluate how Brazilian inflation responds to oscillations in business cycles and in its inertial component in different forward-looking expectations environments, in addition to testing the unemployment gap as a measure of the business cycle[5] and using a measure of firms' marginal cost, following Galí and Gertler (1999). It should be noted that the marginal cost measure used in this study has not previously been used in applications for Brazil.[6]

The present study is divided into seven sections, including this introduction. Section II describes the history of Brazilian inflation in recent years, and section III discusses some theoretical aspects of NKPC and its hybrid version, and the relationships between business cycles, expectations and inflation with different degrees of agent foresight. Section IV describes and analyses the data, while section V describes the econometric strategy. Section VI analyses and discusses the results, and the concluding section sets forth final thoughts.

II. Recent trend of inflation in Brazil

In an attempt to contain the hyperinflation that devastated the Brazilian economy from the 1980s until the early 1990s, many stabilization plans were implemented without success. Only with the Real Plan, initially based on the tripod of an exchange-rate anchor, a deep fiscal adjustment and rigid monetary base, inflation fell steeply between 1995 and 1998. During that period, the degree of indexation was reduced and, consequently, the inflationary inertia that had been undermining the Brazilian currency eased.

Due to a sharp appreciation of the national currency, Brazil accumulated a large current-account deficit and, thus, became both dependent on international capital inflows and more vulnerable to external shocks (Giambiagi and others, 2011). Following three speculative attacks against the real, during the Mexican crisis (1995), the Asian crisis (1997) and the Russian moratorium (1998), raising interest rates was no longer enough to prevent capital flight, and a steady depletion of reserves forced a devaluation of the real in 1999.

After the exchange-rate anchor had been eliminated, inflation targeting was adopted as a tool to prevent indexation from becoming re-established in the Brazilian economy. Thus, with the defined nominal anchor, the Central Bank set inflation targets for 1999 (8%), 2000 (6%) and 2001 (4%), with a band of tolerance of two percentage points. Contrary to what was expected by those who feared the return of inflation, the currency devaluation had no inflationary effects, and the Extended National

[3] This period was chosen because data on firms' marginal cost were available.

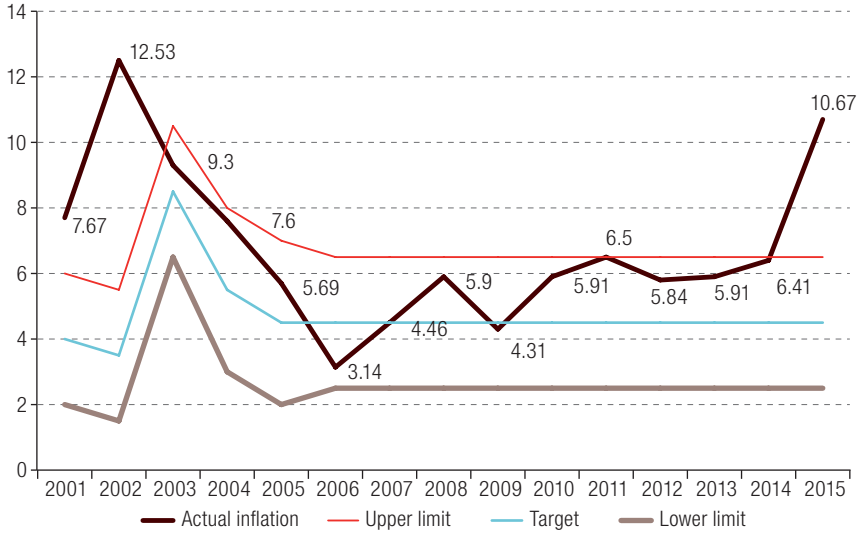
[4] Firms' real marginal cost is measured as the ratio between the wage bill and gross domestic product (GDP).

[5] The unemployment gap as a measure of the business cycle is drawn from Okun's Law, which posits an inverse relation between the output and unemployment cycles.

[6] Normally, the indicators used include the output gap, the unemployment gap and installed industrial capacity utilization; but none of these effectively measures firms' marginal cost.

Consumer Price Index (IPCA)[7] stayed within the range envisaged in 1999 and 2000. From then on, the new tripod would consist of inflation targeting, a floating exchange rate and fiscal responsibility (primary surpluses). Figure 1 shows the behaviour of inflation in that period.

Figure 1
Brazil: trend of inflation (Extended National Consumer Price Index-IPCA) following the establishment of the targeting system, 2001-2015
(Percentages)



Source: Prepared by the authors.

The situation deteriorated during the electoral campaign of 2002, owing to uncertainty as to the course of economic policy from 2003 onwards. The midpoint of the IPCA target range set for 2002 in 2000 was 3.5%. In January 2002, the Brazilian economy recorded a cumulative inflation rate of 7.62% over the preceding 12 months, which gradually rose to 7.93% by September of that year. When Luiz Inácio Lula da Silva won the elections in October, inflation surged from 8.45% in that month to 12.53% by the year-end.

At this point, in January 2003, the central bank set a new inflation target for the year, raising the midpoint of the band from 3.25% to 8%. When the new government started to behave consistently with the previous monetary policy, indicating that the priorities were control of inflation and fiscal responsibility, the crisis of confidence started to ease, and the inflationary downtrend was resumed, having hit 9.3% in 2003.

Bresser-Pereira and Gomes da Silva (2008) note that, although domestic savings replaced external savings on a large scale in 2004, the Central Bank kept the interest rate at a high level, and exports boomed. This fuelled an appreciation of the real, which helped bring the IPCA down and attain the inflation target. From then on, inflation trended down until 2006.

The government consolidated the downward path by setting the target for 2005 at 4.5%; and, between 2004 and 2014,[8] inflation never strayed outside its target range. This result was mainly due to the appreciation of the real. Nonetheless, the 2007-2008 financial crisis paralyzed external credit sources and caused a devaluation, but inflation still remained below target in 2009.

[7] The Extended National Consumer Price Index (IPCA) was chosen as a benchmark measure for the targets since it is naturally affected by seasonal factors and temporary shocks.

[8] The inflation target has held at 4.5% per year, but the band was altered to 2.5%-6.5% in 2006.

The IPCA hit the upper bound of the target range in 2011, owing to rising commodity prices —especially energy and food products— and the rise in the price of international currencies with respect to the real. In the midst of the international crisis of that year, Dilma Rousseff took office as president with a commitment to a new economic framework, characterized by fiscal expansion, abundant credit at subsidized interest rates and a controlled exchange rate. Interest rate cuts began in the second half of 2011 and continued throughout 2012 and early 2013, with the rate falling from 12.42% to 7.11%.

Moreover, the policy of minimum wage hikes in line with inflation increased the degree of indexation in the economy and thus fuelled inertial inflation. During this period, inflation remained far from the centre of the target range; and, in fact, each year it moved closer to its upper bound. Even with a resumption of increases in the Special Liquidation and Custody System (SELIC) rate, in 2014 the IPCA came in at 6.41%.

Accordingly, the inflation targeting system was abandoned in favour of an expansion of public credit at subsidized interest rates. The focus on developmentalism and the neglect of monetary stability and fiscal equilibrium were clear to see. According to Mesquita (2014), Brazil decided to combat inflation through tariff exemptions and artificial control of the prices on which the public authorities had an influence (administered prices). The State also intervened in exchange-rate policy, announcing a continuous programme of exchange-rate hedging in August 2013, involving daily interventions in the market. On the fiscal-policy front, the primary balance deteriorated steadily to generate a deficit of R$ 32 billion in 2014. In this context, inflation breached its target ceiling in 2015.

III. Literature review

1. Traditional Phillips curve

The original version of the Phillips curve depicts an inverse relation between wage inflation and unemployment. In its traditional version, the curve had the following specification:

$$\pi_t = \alpha + \gamma u_t + \varepsilon_t \quad (1)$$

where π_t is wage inflation in period t, u_t is the current unemployment rate, and α and γ are the parameters, with $\gamma < 0$.

According to Phillips (1958), a high unemployment rate would indicate an excess supply of labour, thus putting downward pressure on wages. This meant that economies face a trade-off between inflation and unemployment when formulating and executing economic policies. The IS-LM model was used to analyse the demand side of the economy, while the Phillips curve represented the supply side.

Nonetheless, the idea that a nominal variable (inflation) could affect real variables (the unemployment rate) was heavily criticized in the second half of the 1960s. Authors such as Phelps (1967 and 1969) and Friedman (1968 and 1977) argued that the curve as originally formulated seeks to analyse the growth of nominal wages in relation to unemployment rates, which contradicts the hypothesis that economic agents are rational, since they should be concerned with the behaviour of real variables and not merely with nominal ones. According to these authors, the Phillips curve needed a component to capture inflation expectations.

With low unemployment and thus high inflation, workers would perceive that inflation was higher than expected and would negotiate wages based on this new expectation. Consequently, the unemployment rate would return to its original state, as real wages, having fallen, returned to their former level. This idea initially proposed by Muth (1961) would be called adaptive, or backward-looking,

expectations, since economic agents correct their expectations on the basis of past forecasting errors. In other words, expected inflation, π_t^e, would be modelled as a weighted-average of past inflation rates, with heavier weights attaching to more recent data. The Phillips curve would thus assume the form:

$$\pi_t = \varphi\, \pi_t^e + \gamma\,(u_t - u_n) + \varepsilon_t \tag{2}$$

where π_t is current inflation, and π_t^e is expected inflation in period t, formulated as a weighted-average of past inflation rates, u_t is the current unemployment rate and u_n the natural rate.

This gave agents' expectations a fundamental role in the construction and execution of economic policies. Nonetheless, it was subsequently realized that adaptive expectations would lead economic agents to commit systematic forecasting errors, which is not realistically sustainable.

This finding triggered a revolution in macroeconomic theory between the 1970s and 1980s, driven by the forward-looking rational expectations hypothesis, attributed to Lucas (1972) and Sargent (1971). According to these authors, economic agents predict future inflation by considering all of the information available to them up to the current period, and not just a combination of past data. Thus, expectations become a function of the set of all data available up to t, so the Phillips curve also needs a forward-looking component.

2. New-Keynesian Phillips Curve

A new approach to the Phillips curve has been widely discussed in recent decades. Taylor (1980) and Calvo (1983) laid the foundations for the modern analysis of inflation by examining price and wage choices from the perspective of forward-looking families and businesses. In this version, the curve is deduced as a relation between inflation and firms' marginal cost. This formulation, called the New-Keynesian Phillips Curve, is based on two structural equations, namely:

$$p_t = \theta p_{t-1} + (1 - \theta) p_t^* \tag{3}$$

and

$$p_t^* = (1 - \beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k E_t \{ cm_{t+k}^n \} \tag{4}$$

In equation (3), p_t is the aggregate price level and p_t^* denotes the price level derived from enterprise profit maximization, both in logarithmic form; and θ ($0 < \theta < 1$) is the fraction of firms that do not adjust their prices optimally in t. Equation (3) thus introduces a degree of price rigidity, since only a fraction $(1 - \theta)$ of the firms can optimally adjust their prices in t, while the others retain the prices of the previous period.

Equation (4) can be derived formally by maximizing the present value of firms' expected profits, specifying the optimal price chosen by firms as a function of θ, the real marginal cost, cm_{t+k}^n and a discount factor β (Calvo, 1983). In other words, in the absence of friction or adjustment costs, firms would set their prices equal to marginal cost in each period. In practice, however, firms do not change their prices in every period; so the definition of $p_t^* = cm_{t+k}^n$ is not appropriate in this context. Prices have to be formed on the basis of the expected behaviour of marginal cost, so as to maximize the present value of expected profit. Thus, by defining inflation in period t as $\pi_t = p_t - p_{t-1}$ and combining equations (3) and (4), NKPC can be written as:

$$\pi_t = \lambda cm_t + \gamma_f E_t\{\pi_{t+1}\} \tag{5}$$

In other words, current inflation will be a function of firms' real marginal cost in t and expected inflation, which is constructed on a forward-looking basis. Galí and Gertler (1999) show that there is a relation between the marginal cost and the output gap,[9] which can be expressed as:

$$cm_t = kx_t \tag{6}$$

where k is the elasticity of real marginal cost with respect to the output gap. Substituting this in equation (5) gives:

$$\pi_t = \lambda k x_t + \gamma_f E_t\{\pi_{t+1}\} \tag{7}$$

Consequently, period t inflation, π_t, will be a function of the inflation rate expected for the next period, $E_t\{\pi_{t+1}\}$, which is a forward-looking term, and by a business-cycle measure. Thus, NKPC can be estimated using firms' marginal cost and business-cycle variables.[10]

3. Hybrid New-Keynesian Phillips curve

Nonetheless, NKPC still contains a major flaw, since it does not include an inertial component, or one based on past inflation. This led to the emergence of the version known as the Hybrid New-Keynesian Phillips Curve (Galí and Gertler, 1999). In this context, p_t^* takes the following form:

$$p_t^* = (1 - \omega)p_t^f + \omega\, p_t^b \tag{8}$$

where p_t^f is the price set by firms that use forward-looking expectations, and p_t^b is the price of the set of firms that base their expectations on past experience.[11] The first group of firms behaves exactly as in the model described by Calvo (1983). So, p_t^f will be:

$$p_t^f = \left(1 - \beta\theta\right)\sum_{k=0}^{\infty}\left(\beta\theta\right)^k E_t\left\{cm_{t+k}^n\right\} \tag{9}$$

Prices in firms that base their expectations on the past will be expressed as the price level in the last period corrected by inflation. Formally,

$$p_t^b = p_{t-1}^* + \pi_{t-1} \tag{10}$$

A combination of equations (3), (8), (9) and (10) produces the hybrid version of NKPC:

$$\pi_t = \lambda cm_t + \gamma_f E_t\left\{\pi_{t+1}\right\} + \gamma_b \pi_{t-1} \tag{11}$$

where γ_f is the forward-looking term parameter, γ_f incorporates the past-inflation component, and λ incorporates the contribution of firms' marginal cost/business cycles. It should be noted that γ_b indicates the degree of inflationary persistence; and, if γ_f is statistically equal to 0, the traditional Phillips curve formulation is obtained.

[9] The deviation (in logarithmic form) of output relative to potential, in other words $x_t \equiv \hat{Y}_t - \hat{Y}_t^n$.

[10] This study uses the output gap, the unemployment gap and firms' real marginal cost.

[11] A fraction ω of firms form expectations based on the past, while (1- ω) make forward-looking projections.

IV. Description and analysis of the data

The monthly data used to estimate NKPC and its hybrid version span from January 2002 to December 2012. This sample period was chosen because data are available for the real marginal cost and unemployment gap variables.[12] Table 1 summarizes the variables used.

Table 1
Description of the variables used

Indicator	Variable	Representative variable	Source
Inflation	Inflation	Extended National Consumer Price Index (IPCA)	Brazilian Geographical and Statistical Institute (IBGE)/ National Consumer Price Indices System (SNIPC)
Expectations	Forward-looking expectations	Projected IPCA inflation (perfect foresight)	IBGE/SNIPC
		FOCUS forecast (uncertainty hypothesis)	FOCUS report of the Central Bank of Brazil
	Backward -looking expectations	Lagged IPCA inflation	IBGE/SNIPC
Business cycles	Real marginal cost	Wage bill/gross domestic product (GDP)	Constructed on the basis of data from IBGE and the Central Bank of Brazil
	Output cycle	Output gap	Constructed on the basis of data from the Central Bank of Brazil and the Hodrick-Prescott filter
	Unemployment cycle	Unemployment gap	Constructed on the basis of data from the employment and unemployment survey of the State Data Analysis System Foundation (SEADE) and the Hodrick-Prescott filter

Source: Prepared by the authors.

The Extended National Consumer Price Index (IPCA) proxies for inflation.[13] The information is obtained from the database of the Institute of Applied Economic Research (Ipeadata), sourced in turn from the National Consumer Price Indices System (SNIPC) of the Brazilian Institute of Geography and Statistics (IBGE). This indicator also serves as the government's "official" inflation rate; and it is the index most widely used in studies on Brazil (Schwartzman, 2006; Areosa and Medeiros, 2007; Arruda, Ferreira and Castelar, 2011; Mendonça, Sachsida and Medrano, 2012; Sachsida, 2013).

Two variables were used to consider different forward-looking expectations environments: one of perfect foresight, under rational expectations, in which the projected IPCA is used as a way to model forward-looking expectations (Correa and Minella, 2010; Sachsida, Ribeiro and Santos 2009); and an indicator of weak foresight among economic agents, calculated as the average of daily forecasts for the month following the FOCUS report published by the Central Bank of Brazil (Mendonça, Sachsida and Medrano, 2012; Sachsida, 2013).

The variable that incorporates the inertial, or backward-looking, component of inflation is the lagged IPCA. This measure has traditionally been used in most studies on Brazil (Schwartzman, 2006; Areosa and Medeiros, 2007; Arruda, Ferreira and Castelar, 2011; Mendonça, Sachsida and Medrano, 2012; Sachsida, 2013).

Three business-cycle measures were used in this study: firms' real marginal cost, the output gap and the unemployment gap. The two latter variables were constructed using the Hodrick-Prescott filter. Including the unemployment gap as an alternative is justified by Okun's Law, which invokes an inverse relation between the output and unemployment cycles.

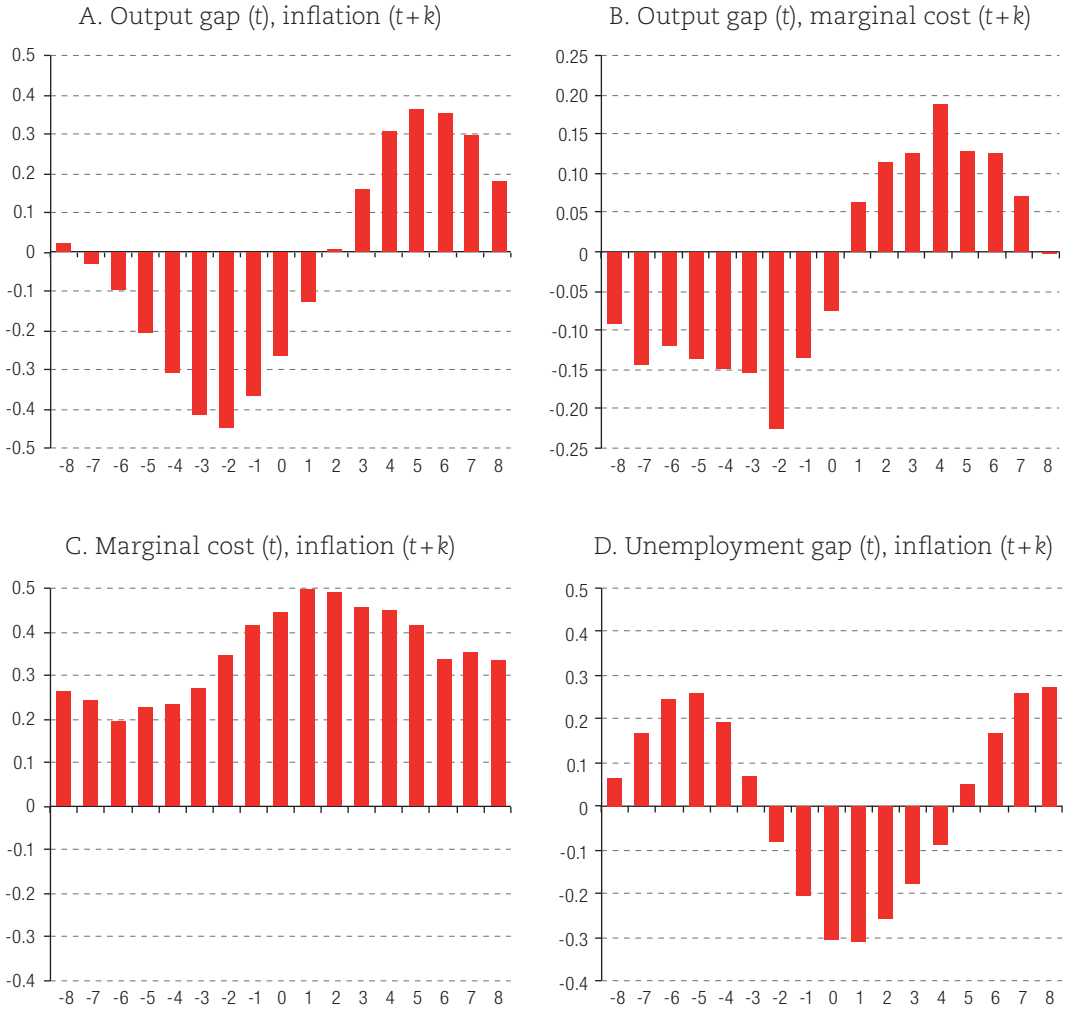
[12] The data needed to construct these proxy variables for Brazil are only available as from October 2001. In the case of unemployment, the methodology was altered, and the new series is also available as from October 2001.

[13] The IPCA target population encompasses families with monthly incomes, from any source, ranging from 1 to 40 times the minimum wage, and includes residents in the urban areas of metropolitan regions.

The firms' real marginal cost was constructed, following Galí and Gertler (1999), on the basis of the product of the series of real average income of employed persons and the total number of employees[14] —produced from the IBGE Monthly Employment Survey (PME) and published by the Central Bank of Brazil— and division of the result by gross domestic product (GDP), also provided by the Central Bank of Brazil.

Figure 2, below, shows the cross-correlogram[15] between some of the variables used in this work, with a view to identifying the direction of the interactions between the business-cycle measures, firms' real marginal cost and inflation. Figure 2.A shows the relation between the output gap and inflation, while Figure 2.B illustrates the relation between the output gap and marginal cost. In figure 2.C, the output gap is replaced by inflation. Lastly, figure 2.D shows the correlation between the unemployment gap and inflation.

Figure 2
Cross correlogram



Source: Prepared by the authors.

[14] Employees are defined as persons who work for one or more employer, fulfilling working hours and receiving compensation in cash or some other form of payment (housing, food, clothing, among others). Employees are classified according to whether or not they have a formal work contract.

[15] The correlogram displays the correlation between the variables. The cross correlations between two series, x and y, are given by: $r_{xy}(l) = c_{xy}(l) \Big/ \sqrt{c_{xx}(0)} \cdot \sqrt{c_{yy}(0)}$, where $l = 0, \pm 1, \pm 2, \ldots$

Figure 2.A indicates that the output gap is positively correlated with future inflation and negatively with past inflation, which justifies the fact that various authors use this lagged measure in empirical models of the Phillips curve (Schwartzman, 2006; Areosa and Medeiros, 2007; Correa and Minella, 2010; Arruda, Ferreira and Castelar, 2011). It should be noted that the negative relation unexpectedly persists until period $t + 1$, which corroborates the argument made by Galí and Gertler (1999) that this variable does not easily capture the effects of business cycles on NKPC.

To correct this problem, Galí and Gertler (1999) suggest a measure of firms' real marginal cost. Figure 2.B shows that the contemporary correlation between this variable and the output gap is negative, while figure 2.C shows a positive relation between firms' real marginal cost and inflation, which justifies using that proxy variable. In figure 2.D, the business-cycle measure investigated is the unemployment gap, which is negatively correlated with current inflation. It is important to note that, according to Okun's Law, that variable behaves countercyclically relative to the output gap.

V. Econometric issues

The generalized method of moments (GMM), proposed by Hansen (1982), is widely used to estimate rational-expectations models, because, under these conditions, the ordinary-least-squares (OLS) method can produce inconsistent estimates, since the error term is correlated with some of the endogenous regressors. Although the instrumental variables method provides an alternative way to estimate these models,[16] Baum, Schaffer and Stillman (2003 and 2007) show that GMM is more appropriate in the presence of heterocedasticity.

To choose the best method for estimating the models used here, the Pagan and Hall (1983) heteroscedasticity test[17] is initially applied in the instrumental variables (IV) estimation, followed by the Cumby and Huizinga (1992) serial autocorrelation test.[18] Thus, as noted above, if the null hypothesis of homoscedasticity is rejected by the Pagan and Hall test (1983), the GMM estimation corrected for this problem is used; and if the presence of serial autocorrelation is also found, an HAC-GMM estimator is indicated. As heterocedasticity was detected in all of the cases analysed in this study, GMM described below was used.

Consider the following equation, in matrix form, to be estimated:

$$y = X\beta + u \tag{12}$$

where X is an (n x K) matrix of regressors,[19] including some endogenous ones; in other words, $E(X_i,u_i) \neq 0$ for some X_i. Partitioning the explanatory variables into sets $[X_1\ X_2]$ with K_1 variables in X_1 considered endogenous and $K_2 = (K - K_1)$ exogenous regressors in X_2 gives:

$$y = [X_1\ X_2]\ [\beta_1\ \beta_2]' + u \tag{13}$$

Define Z as an ($n\ x\ L$) matrix of instrumental variables; in other words, the total number of variables assumed as exogenous, $E(Z_i u_i) = 0$. The instruments are divided as $[Z_1\ Z_2]$, in which L_1 instruments, Z_1, are excluded and the other $L_2 = (L - L_1)$ instruments $Z_1 \equiv X_2$ are the included instruments/exogenous regressors. Diagram 3 summarizes the variables.

[16] Although consistent in the presence of heterocedasticity, the GMM estimator performs poorly in small samples. So, when heterocedasticity is not present, it is preferable to use the instrumental variable (IV) estimator (Baum, Schaffer and Stillman, 2003 and 2007).

[17] A test indicated for the estimation in the presence of endogenous regressors. The null hypothesis consists of homoscedasticity.

[18] Test indicated for the IV estimation. The null hypothesis is no autocorrelation.

[19] Where n is the total number of observations and K the total number of explanatory variables.

Diagram 1
Regressors and instruments

Regressors $X=[X_1\ X_2]=[X_1\ Z_2]$ = [Endogenous Exogenous]

Instruments $Z=[Z_1\ Z_2]$ [Exluded Included]

Source: Prepared by the authors.

The equation is fully identified if $L \geq K$; in other words there must be at least as many excluded instruments L_1 as endogenous regressors K_1, since Z_2 is common to both lists.[20] Hansen (1982) shows that, if the instruments are valid —that is, if they are correlated with the endogenous regressors and not correlated with the error term— the GMM estimators are consistent and asymptotically normal. Therefore, the Hansen (1982) overidentification test[21] is applied, using the joint null hypothesis that the instruments are valid and the Z_1 instruments were correctly excluded in the estimation process. If H_0 is not rejected, the instruments are considered valid and the model is deemed to have been estimated appropriately.

The assumption that the instruments are exogenous can be expressed as $E(Z_i,u_i)=0$. Define $g_i(\beta)$ as the function (L x 1):

$$g_i(\beta) = Z_i' u_i = Z_i'(y_i - X_i\beta) \tag{14}$$

Thus, the exogeneity of the instruments requires that there to be L moment or orthogonality conditions, such that $E(g_i(\beta))=0$. The sample counterpart of that moment condition corresponds to:

$$\bar{g}(\hat{\beta}) = \frac{1}{n}\sum_{i=1}^{n} g_i(\hat{\beta}) = \frac{1}{n}\sum_{i=1}^{n} Z_i'(y_i - X_i\hat{\beta}) = \frac{1}{n} Z'\hat{u} \tag{15}$$

The intuition of the method is to choose an estimator for β that minimizes $\bar{g}(\hat{\beta})$ preferably to zero. Therefore, the GMM estimator for β is the $\hat{\beta}$ that minimizes the objective function $J(\hat{\beta})$:

$$\hat{\beta}_{GMM} = \arg\, min\, J(\hat{\beta}) = n\bar{g}(\hat{\beta})' W \bar{g}(\hat{\beta}) \tag{16}$$

where W is an (L x L) matrix of weights used to construct a quadratic form for the moment conditions. The efficient GMM estimator uses an optimal weight matrix $W = S^{-1}$ that minimizes the asymptotic variance of the estimator. Deriving the first-order conditions of the previous problem gives:

$$\hat{\beta}_{GMM} = (X'ZWZ'X)^{-1}(X'ZWZ'y) \tag{17}$$

Hence, for the GMM estimate of this empirical exercise, the instruments include up to six lags of inflation, the output gap, firms' marginal cost, the unemployment gap and the interest rate, along the lines of Galí and Gertler (1999). The orthogonality conditions of NKPC and its hybrid version are represented by equations (19) and (20), respectively:

$$E_t\left\{(\pi_t - \lambda mc_t - \gamma_f \pi_{t+1})z_t\right\} = 0 \tag{18}$$

$$E_t\left\{(\pi_t - \lambda mc_t - \gamma_f \pi_{t+1} - \gamma_b \pi_{t-1})z_t\right\} = 0 \tag{19}$$

[20] Order condition. If $L = K$, the equation is said to be exactly identified; and, if $L > K$, it is overidentified. It should be noted that the order condition is necessary, but not sufficient for identification.

[21] The GMM estimator uses the J-statistic proposed by Hansen (1982), which follows a X^2_{L-K} distribution. In the IV estimation, the statistic used is nR^2, extracted from an auxiliary regression of the IV residuals over the complete set of instruments; it also follows a X^2_{L-K} distribution.

In summary, the econometric strategy for estimating the models used in this study involves firstly checking for the presence of heteroscedasticity and serial autocorrelation in the estimation of instrumental variables, using the Pagan and Hall (1983) and Cumby and Huizinga tests (1992), respectively.[22] If the H_0 of homoscedasticity is rejected, GMM is used with a correction for this problem. If serial autocorrelation is also detected, a correction for both problems is applied, in the form of HAC-GMM. Lastly, the Hansen (1982) test of the validity of the instruments is performed; and, if H_0 is not rejected, the instruments are considered valid and the model is deemed to have been estimated appropriately.

VI. Analysis and discussion of the results

To study the dynamic of Brazilian inflation in different expectations environments under the NKPC and hybrid NKPC framework, the HAC-GMM method was applied, using monthly data spanning January 2002 to December 2012.

Two forward-looking expectations or foresight environments are thus obtained: perfect foresight —in which the projected IPCA itself is used to form forward-looking expectations— and low foresight —which takes the average of inflation forecasts published in the Central Bank of Brazil's FOCUS report. In addition, each model considers three different business-cycle variables: firms' real marginal cost, the output gap and the unemployment gap. Initially, all the variables were subjected to the augmented Dickey-Fuller and Phillips-Perron unit-root tests, and were stationary at the usual significance levels. The results are summarized in the table 2.

Table 2
Unit root tests

Series	Augmented Dickey-Fuller	Phillips-Perron
	Statistical test on level	Statistical test
	Level	Level
	(p-value)	(p-value)
Inflation (Extended National Consumer Price Index (IPCA))	-4.6799	-4.3583
	(0.0013)	(0.0006)
Marginal cost	-5.7642	-5.6681
	(0.0000)	(0.0000)
FOCUS forecast	-4.3523	-6.3667
	(0.0038)	(0.0000)
Unemployment gap	-4.6979	-2.9700
	(0.000)	(0.0407)
Output gap	-3.4498*	-3.9297
	(0.0112)	(0.0025)

Source: Prepared by the authors.
Note: P-value in parentheses.

Thus, six models are obtained for each forward-looking expectations environment, making a total of 12 models estimated.[23] Tables 3 and 4 summarize the results of the estimates of NKPC and its hybrid version, respectively.

[22] If the errors are homoscedastic, Baum, Schaffer and Stillman (2003 and 2007) show that it is better to use the IV estimator, because GMM performs badly in small samples.

[23] That is, six models for the New-Keynesian Phillips curve and six for the hybrid version.

Table 3
Estimation of the New Keynesian Phillips curve with HAC-GMM

Expectations	Business cycles	Parameters		J-test	Heterocedasticity	Autocorrelation
		λ	γ_f	Hansen	Pagan and Hall	Cumby and Huizinga
Perfect forecast	Marginal cost	0.30	0.39	4.03	$X^2(5) = 29.12$	$X^2(1) = 6.92$
		(0.01)	(0.00)	(0.25)	(0.00)	(0.00)
	Unemployment gap	-0.41	0.34	7.97	$X^2(14) = 21.14$	$X^2(1) = 12.10$
		(0.04)	(0.01)	(0.78)	(0.04)	(0.00)
	Output gap[a]	-1.97	0.59	4.43	$X^2(5) = 15.54$	$X^2(1) = 0.25$[a]
		(0.00)	(0.01)	(0.22)	(0.00)	(0.62)
Focus forecast	Marginal cost	0.38	1.09	3.23	$X^2(5) = 20.19$	$X^2(1) = 43.13$
		(0.00)	(0.00)	(0.35)	(0.00)	(0.00)
	Unemployment gap	-0.91	1.23	7.82	$X^2(15) = 27.13$	$X^2(1) = 43.13$
		(0.00)	(0.00)	(0.85)	(0.02)	(0.00)
	Output gap	-0.24	1.27	5.87	$X^2(15) = 23.55$	$X^2(15) = 46.94$
		(0.52)	(0.00)	(0.95)	(0.05)	(0.00)

Source: Prepared by the authors on the basis of the equation $\pi_t = \lambda x_t + \gamma_f E_t\{\pi_{t+1}\}$.
Note: P-value in parentheses. The autocorrelation and heteroscedasticity tests were applied in the IV estimation.
[a] Model corrected for heteroscedasticity only.

Table 4
Estimation of the hybrid New-Keynesian Phillips curve with HAC-GMM

Expectations	Business cycles	Parameters			J-test	Heterocedasticity	Autocorrelation
		λ	γ_f	γ_b	Hansen	Pagan and Hall	Cumby and Huizinga
Perfect forecast	Marginal cost	0.17	0.30	0.53	5.37	$X^2(10) = 22.35$	$X^2(1) = 15.69$
		(0.01)	(0.00)	(0.00)	(0.61)	(0.01)	(0.00)
	Unemployment gap	-0.26	0.39	0.52	8.77	$X^2(16) = 25.98$	$X^2(1) = 32.75$
		(0.01)	(0.00)	(0.00)	(0.79)	(0.05)	(0.00)
	Output gap[a]	-0.30	0.30	0.55	6.35	$X^2(16) = 25.50$	$X^2(1) = 33.15$
		(0.23)	(0.03)	(0.00)	(0.49)	(0.06)	(0.00)
FOCUS forecast	Marginal cost	0.31	0.22	0.61	9.07	$X^2(17) = 38.83$	$X^2(1) = 0.99$*
		(0.00)	(0.03)	(0.00)	(0.82)	(0.00)	(0.32)
	Unemployment gap	-0.75	0.24	0.63	6.94	$X^2(14) = 28.69$	$X^2(1) = 16.22$
		(0.00)	(0.00)	(0.00)	(0.80)	(0.01)	(0.00)
	Output gap	0.16	0.22	0.67	7.34	$X^2(16) = 35.23$	$X^2(1) = 11.24$
		(0.48)	(0.03)	(0.00)	(0.77)	(0.01)	(0.00)

Source: Prepared by the authors on the basis of equation $\pi_t = \lambda x_t + \gamma_f E_t\{\pi_{t+1}\} + \gamma_b \pi_{t-1}$.
Note: P-values in parentheses. The autocorrelation and heteroscedasticity tests were applied in the IV estimation.
[a] Model corrected for heteroscedasticity only.

Initially, the Pagan and Hall (1983) test indicated the presence of heterocedasticity in all of the models in the IV estimation, so GMM was chosen. Moreover, the Cumby and Huizinga (1992) test verified the absence of autocorrelation only in NKPC models with perfect foresight which used the output gap as a business-cycle variable, and in hybrid NKPC models under uncertainty (FOCUS forecast) which used firms' real marginal cost as the business-cycle variable. In those cases, GMM was corrected for heteroscedasticity only. In addition, the Hansen (1982) test does not reject the H_0 of validity of the instruments in any of the models estimated; so, under these conditions, the models have been estimated appropriately.

The estimated coefficient of the output gap variable is either statistically equal to 0 or else displays the opposite sign to that predicted by theory. This result confirms the evidence reported in the literature, both national (Mazali and Divino, 2010; Mendonça, Sachsida and Medrano, 2012; Sachsida, 2013) and international (Galí and Gertler, 1999; Galí, Gertler and López-Salido, 2001), which corroborates the difficulty of using this indicator as a business-cycle measure to explain the dynamics of inflation.

Nonetheless, for the period analysed, NKPC and its hybrid version served as robust mechanisms to explain the Brazilian inflationary dynamic, since the business-cycle variables —measured by firms' real marginal cost and the unemployment gap— were statistically significant and displayed the signs predicted by theory. The evidence also confirms the statistical significance of the backward- and forward-looking expectations components, and that the impact of the former is relatively greater. This suggests that the recent dynamics of Brazilian inflation still retain a significant inertial component. In other words, according to Simonsen (1970 and 1985), Cabello (2014) and Carvalho (2014), the memory of hyperinflations and the recent increase in indexation in the Brazilian economy may explain this greater influence of inflationary inertia.

The results also seem to indicate that inflation is more vulnerable to the cyclical fluctuations in economic activity in a low-foresight environment, because the absolute impact of these variables is much greater when the FOCUS forecast is used as a forward-looking expectations variable. Thus, as noted by Sicsú (2002) and Mendonça (2002 and 2004), the lower the ability of economic agents to forecast the future, the higher the cost of a disinflation policy in terms of cyclical fluctuations in economic activity.

Lastly, the evidence also suggests that, in a low-foresight environment, inflation is more susceptible to the inertial, or backward-looking component, since the impact of this variable on inflationary dynamics is greater in all of the models considered.

VII. Final thoughts

This study has analysed the dynamics of Brazilian inflation under different expectations hypotheses under the NKPC and hybrid NKPC frameworks, using monthly data spanning January 2002 and December 2012, and HAC-GMM.

In general, the results confirmed the inadequacy of the output gap, but the robustness of the unemployment gap and firms' marginal cost, as mechanisms for capturing the transmission of business cycles to inflation in Brazil during the period analysed. In other words, the firms' real marginal cost measure, as used in this study, provides an alternative for future applications in Brazil. The results also suggest the relevance of backward- and forward-looking expectations, and that the impact of the former is relatively greater, which means that the Brazilian inflationary dynamic still retains a significant inertial component. It can thus be said that NKPC and its hybrid version are suitable frameworks for investigating the recent Brazilian inflation dynamic.

The evidence also suggests that inflation is more sensitive to business-cycle fluctuations, the lower the degree of foresight possessed by economic agents. In fact, as Sicsú (2002) and Mendonça (2002 and 2004) argue, the less ability economic agents have to predict the path of inflation, the higher the economic-activity cost of a disinflation policy.

Lastly, the inertial component of inflation seems to have a greater effect in a lower foresight environment. In other words, the recent increase in the degree of indexation of the Brazilian economy, related to its memory of hyperinflation, seems to influence the inflationary inertia mechanism; and lower foresight imposes a high cost in terms of perpetuating past inflation in the present.

In short, the results obtained show that, the greater the foresight among economic agents, the less costly disinflation policies will be, both in terms of cyclical fluctuations in economic activity and in the inertial transmission of inflation.

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Trade facilitation and its effects on Chile's bilateral trade between 2006 and 2014

Darcy Fuenzalida-O'Shee, Bárbara Valenzuela-Klagges and Alejandro Corvalán-Quiroz

Abstract

This study analyses the effects of trade facilitation on Chilean exports in 2006-2014. It reviews evidence and studies on trade facilitation and its effects, mainly in South America; and it analyses Chile's export basket. An extended gravity model is then estimated for Chile's bilateral trade flow with 89 countries, to measure the effect of trade facilitation during the period analysed. The estimation is performed using static panel data with fixed, random and dynamic effects. The key results show that the estimation that best describes Chile's export behaviour is that which uses static panel data with random and dynamic effects and two lags of the dependent variable (exports). They show that per-container export costs have a negative effect on this trade flow.

Keywords

Trade liberalization, trade facilitation, imports, exports, costs, trade policy, bilateral trade agreements, trade statistics, Chile

JEL classification

F140, F150, F170

Authors

Darcy Fuenzalida-O'Shee is Dean of the Department of Commercial Engineering, Universidad Técnica Federico Santa María, Chile. Email: darcy.fuenzalida@usm.cl.

Bárbara Valenzuela-Klagges is a research fellow at the Institute of International Economics, Universitat Jaume I, Spain. Email: barbara.valenzuelak@usm.cl.

Alejandro Corvalán-Quiroz is an academic in the Department of Industry and Economics of the Faculty of Engineering, Universidad de Playa Ancha, Chile. Email: alejandro.corvalan@upla.cl.

I. Introduction

A successful trade liberalization or integration process is founded on a country's capacity to move goods across borders reliably, quickly and at low cost. Although the cost of land, air or maritime transport, together with tariffs or customs procedures and logistic services, do not change the theoretical foundations of comparative advantage or the benefits of international trade, they can distort the movement of goods or services and influence the direction of trade, the terms of trade, agreements between countries and global competitiveness. Accordingly, transaction costs may differ according to efficiency, exporter integrity, and the public and private entities that participate in the export-import operation (OECD, 2003).

Jaén (2010) argues that efficient transport and logistic services have emerged as strategic elements of trade facilitation in explaining market access: "Trade facilitation means providing a more predictable, secure and efficient international trading environment, through the simplification, standardization and harmonization of administrative formalities" (Jaén, 2010, p. 108). Helble, Shepherd and Wilson (2007) add that the gains of greater predictability obtained from trade facilitation can be perceived in terms of falling trade costs and increasing domestic gains.

A variety of studies recognize that trade facilitation measures, including logistics systems in general, have a positive effect on countries' trade flows and, hence, on their productivity (Batra, Kaufmann and Stone, 2003; Wilson, Man and Otsuki, 2003; Engman, 2005; Nordas and others, 2006; Wilson, 2007; Jean-François and others, 2007; Echeverría, 2007; Hummels, 2007; Iwanow and Kirkpatrick, 2007; Martínez-Zarzoso and Márquez-Ramos, 2008; Servín, 2008; Castro, 2010; Djankov, Freund and Pham, 2010; Portugal-Pérez and Wilson, 2012; Moïsé and Sorescu, 2013; Cordero, 2014; Jordaan, 2014; Sant'Anna and De Souza, 2014; Zaki, 2015). Djankov, Freund and Pham (2010) estimated that an additional day's pre-shipment delay would reduce trade by at least 1%. The Organization for Economic Cooperation and Development (OECD) (Wilson, 2007) notes that countries with lower transaction costs have experienced a larger increase in their gross domestic product (GDP) resulting from an increase in their manufactured exports. Moreover, small reductions in transaction costs significantly increase trade flows. Jean-François and others (2007) concur with this and suggest that developing countries can benefit more from world trade by applying trade facilitation measures and logistics systems; and they recommend upgrading transport infrastructure and implementing information technologies in customs. A study by Iwanow and Kirkpatrick (2007) concludes that a 10% increase in trade facilitation would boost exports by about 5%. Martínez-Zarzoso and Márquez-Ramos (2008) note that trade flows can be increased by reducing transport costs and the number of days needed to conduct trade. Moïsé and Sorescu (2013) find that supplying trade information, simplifying and harmonizing documentation and automating procedures has a major impact on the volumes and costs of a country's trade. Jordaan (2014), in a study focused on South Africa, concludes that improving the customs environment of the importing country provides greater gains in terms of increased trade flows, followed by improvements to the regulatory environment and national infrastructure. Sant'Anna and De Souza (2014) analyse Brazilian foreign trade and confirm that, if trade facilitation increases, so do Brazilian exports. Zaki (2015) shows that a multitude of trade facilitation variables, including the Internet, bureaucracy and corruption, affect import and export transaction times, and conclude that trade facilitation and liberalization are complements rather than substitutes.

In view of the evidence, Moreira and others (2013) consider it worrying that policymakers and researchers in Latin America do not consider the distributive dimension of trade costs arising from trade facilitation. Given the foregoing and the interest in analysing Chilean foreign trade in the global and specific context of trade costs, this study aims to analyse the effects of trade facilitation on Chilean exports between 2006 and 2014.

To that end, the evidence and studies on trade facilitation and its effects in South America will be reviewed, and Chile's export patterns will be analysed, to gain an understanding of the current reality and the opportunities that exist to benefit from a reduction in the domestic costs arising from the export-import process. Subsequently, an extended gravity model will be estimated for Chile's bilateral foreign trade flows with 89 countries, to measure the effect of trade facilitation during the period analysed. This estimation will use static panel data with fixed, random and dynamic effects.

Recently, there has been an increase in the number of articles in which the gravity model is applied to determine export behaviour, which, directly and significantly, include Chile or the Southern Cone countries, the Southern Common Market (MERCOSUR) or the Andean Community (CAN) (Durso and Ochoa, 2003; Giacalone, 2003; Kamil and Ons, 2003; Martínez-Zarzoso and Nowak-Lehmann, 2003; Nicita, Olarreaga and Soloaga, 2003; Vallejo and Aguilar, 2004; Cárdenas and García, 2004; Lewer and Sáenz, 2004; Martínez-Zarzoso and Suárez-Burguet, 2004; Lara and Soloaga, 2005; López and Fernando, 2005; Sandberg, Seale and Taylor, 2006; Sá Porto and Azzoni, 2007; Serrano and Pinilla, 2008; Valenzuela-Klagges, 2011; Ramos-Martínez and others, 2012; Álvarez, Fischer and Natera, 2013; Florensa and others, 2013; Bacaria-Colom, Osorio-Caballero and Artal-Tur, 2013; Hernández, 2014; Valenzuela-Klagges and Espinoza-Brito, 2015). Several of these studies use cross -section data to apply this model; but nowadays there is a tendency to estimate the gravity model using static and panel data with fixed or random effects (De Souza and Burnquist, 2011, and Sant' Anna and De Souza, 2014) and dynamic effects. Nonetheless, there are still few studies that aim to determine the effects of trade facilitation on South American trade, and there are no published studies for the specific case of Chile.

The aim of this study is to contribute to scientific debate by considering current problems in Latin America (World Bank, 2013a and 2013b). The main results confirm that the estimation of static panel data with random and dynamic effects with two lags in the dependent export variable is what best describes Chilean export and import behaviour; and it shows that per-container exports costs have a negative effect on this trade flow.

II. Trade facilitation and the south american reality

According to Izam (2001), trade facilitation affects a wide variety of fields concerned with international transactions in goods or services, and to the movement of capital and business persons. It covers issues such as customs procedures, technical and quality standards, sanitary and phytosanitary measures, transport (land, air, sea, lake, river and rail), customs valuation, infrastructure, intellectual property, trade-related services, taxation, rules of origin, freedom of transit, electronic transmission of trade data, attention provided to business personnel and passengers, customs procedures, transparency, control and simplification, electronic commerce, payment services and insurance on international transactions, and also tariff and non-tariff issues. Moreover, by relating trade facilitation to the modernization of customs and government agencies involved in border inspection, Echeverría (2007) extends the list by adding public-private partnerships, rapid access to information, efficient and integrated transport, and short and agile procedures.

Based on these thematic areas of trade facilitation, recent studies include Wilson, Otsuki and Man (2004); Shepherd and Wilson (2006); Helble, Shepherd and Wilson (2007); Márquez-Ramos and others (2007); Iwanow and Kirkpatrick (2009); Hesketh (2010); DjanKov, Freund and Pham (2010); Márquez-Ramos and others (2011); Zamora and Sierens (2014); Ueki (2015) and Shepherd (2016). These can be subdivided according to the following topics of study:

- *Road access routes and minimum connection distance.* Shepherd and Wilson (2006) present a database corresponding to 138 cities in 27 countries in Europe and Central Asia. They show that the quality of road networks positively affects intraregional trade flows and that improving them could increase trade by 50%.
- *Costs of maritime transport and logistics services.* Márquez-Ramos and others (2007 and 2011) show that a reduction in freight costs and low freight rates can boost exports. They also note that, the larger the size of a port, the lower the cost of freight; and, the larger the number of shipping lines that compete on a given route, the lower are freight charges. The study by Zamora and Sierens (2014) review customs, international transport and logistics services, and find that these three variables directly and significantly affect the logistical competitiveness of international trade.
- *Tariff reduction.* Hesketh (2010) suggests that a reduction in tariffs and non-tariff barriers to world trade may encourage greater use of low-carbon energy technology.
- *Technology use.* DjanKov, Freund and Pham (2010); Helble, Shepherd and Wilson (2007), and Wilson, Otsuki and Man (2004) consider the index of the availability of e-government services.
- Trade barriers generally. Ueki (2015) analyses the impact of trade costs on the propensity to export and the intensity of firms in Southeast Asia and Latin America. It uses World Bank enterprise surveys and concludes that trade barriers do not significantly affect the export intensity of the firms in question.

Since 2014, progress has been made in global trade facilitation with the signing of the Trade Facilitation Agreement by the member countries of the World Trade Organization (WTO). Moreover, Shepherd (2016) notes that the Asia-Pacific Economic Cooperation Forum (APEC) continues to focus on trade facilitation and suggests analysing countries that have achieved a sharp reduction in international transaction costs, such as Taiwan Province of China. The author identifies three general areas for improving trade facilitation in APEC-member countries: physical connectedness, institutional connectedness and connectedness among peoples.

Table 1 lists ten articles that describe the reality of Latin America and the Caribbean in recent years. Of these, nine highlight excessive documentation and inefficient customs procedures; eight suggest the need to renew and expand port, land and road infrastructure in general; four analyse public management and the need to introduce modernizing reforms that guarantee trade facilitation without undermining security; three raise concerns about the number of days of paperwork or shipment delays needed to export two highlight the need to implement information technologies; and one considers private management. There are no commercial facilitation studies focusing on Chile.

A total of 104 countries that have maintained export and import flows with Chile continuously throughout 2006-2014 were selected for analysis. Of these 33 belong to Europe, 18 to Africa, 15 to Asia, 13 to the Middle East, 13 to North America and the Caribbean, 9 to South America and 3 to Oceania. In 2010, these 104 countries required an average of seven documents to import (see figure 1, which display 132 countries, including the 104 covered by this study). Chile was below the average, with six documents. Countries requiring fewer import-export documents include France, with two, Sweden and the Republic of Korea, with three, and Canada, with four. Cameroon and Kazakhstan (12), Russia (11), and Cambodia, Laos, Mozambique, Paraguay and Puerto Rico (10) are the countries that required the most import documents (World Bank, undated). Between 2012 and 2014, Chile has led the way in South America by cutting the number of required export documents to five. In contrast, the Bolivarian Republic of Venezuela and Paraguay both require nine.

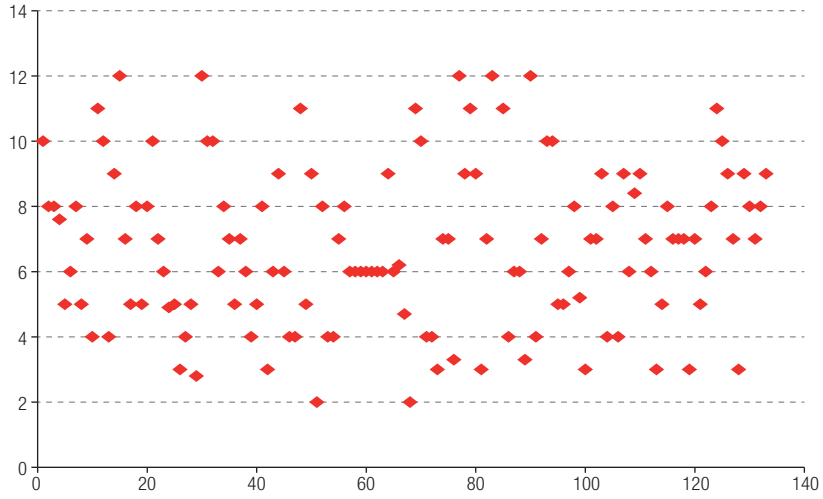
Table 1
Review of evidence in Latin American and Caribbean countries

Author	Year	Countries in the study	Conclusions and suggestions
Batra, Kaufmann and Stone	2003	Latin America	The average time needed to complete an export or import process in Latin America ranges from 2 to 48 days, compared to 1-24 days in other countries.
Ueki, Tsuji and Cárcamo	2005	Latin America	Burdensome trade procedures constitute considerable barriers for small and medium-sized enterprises (SMEs) wishing to export their products. Inefficient handling of trade documents supervised by government departments raises the cost of international trade. The following recommendations are made to the region: create a network of researchers to observe SMEs; provide distance education on trade and industry; form virtual conglomerates; build commercial telecommunications infrastructure; unify technological standards and information and communications technology (ICT) security, and adopt trade facilitation measures.
Nordas and others	2006	Dominican Republic	Recognizes the importance of logistics systems in general and trade facilitation measures in particular.
Servín	2008	Paraguay and European Union	The study recommends forging commitments to promote mechanisms that facilitate foreign trade between Paraguay and the European Union, in particular to modernize ports, develop ICTs and simplify and expedite customs procedures.
Castro	2010	Central America and Panama	The following problems are highlighted: excessive time and inspections needed to obtain special permits, limited institutional support, problems in the training of customs personnel, excessive procedures and systems, and infrastructure shortcomings. As part of the improvement actions, emphasis is placed on the need to implement electronic transmission systems and review procedures to simplify bureaucracy. In addition, recommendations are made to strengthen the institutions supporting MSMEs.
Barbero	2010	South America	Priority actions are identified to improve trade facilitation: increase the provision of basic infrastructure and infrastructure services targeted more directly on logistics; improve services provided by exclusively the State, particularly customs and para-customs management; improve the performance of private companies, including training for smaller firms, and promote quality policies in logistics performance.
Stark	2011	El Salvador and Guatemala	This study highlights the need to formulate a strategy of international engagement that affords consistency to programmes and actions within a long-term country vision, shared by the main national actors. This strategy must be based on innovation and the permanent creation of new and quality goods and services, as well as productivity growth. Trade facilitation measures need to be included in these processes.
Fuentes and Del Castillo	2012	Mexico	The results show that the proposed tariff reduction policy does not have a significant effect on economic growth or on the distribution of income across social groups. The tariff reduction policy only implies a change in the components of the trade balance and in the composition of employment.
Cordero	2014	CARICOM and Central America	Complementarity between Central America and the Caribbean Community (CARICOM) is feasible thanks to productive specialization; but access routes need to be created to maintain competitiveness. It is also necessary to increase trade facilitation to reduce the costs and time of import-export processes.
Cortes	2014	Colombia	Colombia is not a trade-competitive country because of its obsolete logistics organization, mainly in aspects related to infrastructure, traceability, the customs regime, corruption and security, which increases export costs.

Source: Prepared by the authors.

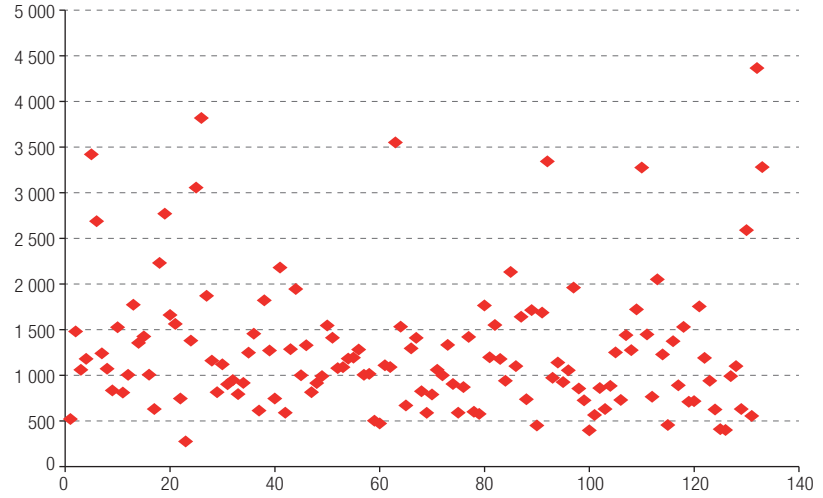
In the 104 countries selected for this study, the average cost of exporting a container was US$ 1,092.00 in 2010 (see figure 2). Chile was below the average, with a cost of US$ 745. Asian countries are among those with the lowest per-container export cost, especially Singapore (US$ 456), Malaysia (US$ 450) and China (US$ 500), while the countries with the highest per-container export cost are Kazakhstan (US$ 3,005), Zambia (US$ 2,664) and the Bolivarian Republic of Venezuela (US$ 2,590). In 2013 and 2014, the per-container cost in Singapore was further reduced to US$ 440, while the Bolivarian Republic of Venezuela and Zambia saw considerable increases to US$ 3,490 and US$ 6,369, respectively.

Figure 1
Number of documents required to import in 132 countries, 2010[a]
(Number of documents and countries)



Source: Prepared by the authors, on the basis of data from World Bank, "World Bank Open Data" [online] https://data.worldbank.org/.
[a] Countries that maintained export and import flows with Chile continuously throughout 2006-2014.

Figure 2
Export costs in 132 countries, 2010[a]
(Dollars and countries)

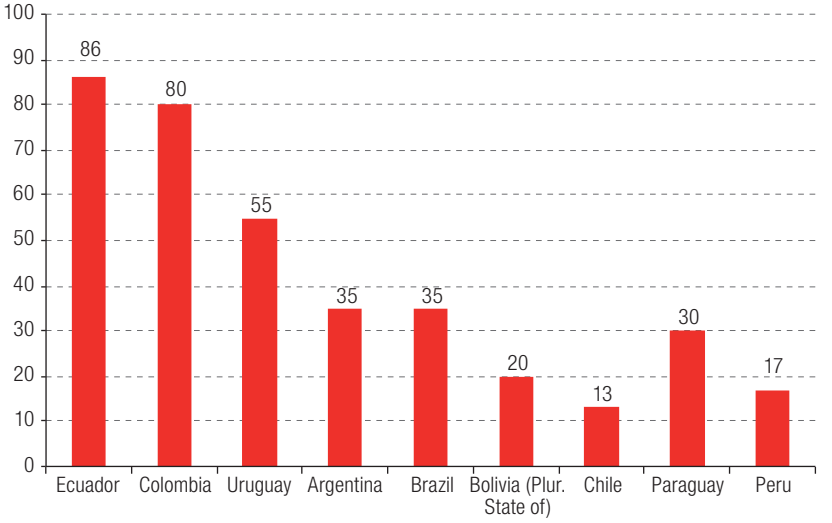


Source: Prepared by the authors, on the basis of data from World Bank, "World Bank Open Data" [online] https://data.worldbank.org/.
[a] Countries that maintained export and import flows with Chile continuously throughout 2006-2014.

The average export cost in the Southern Cone countries rose from US$ 966.67 per-container in 2005 to US$ 1,772.9 in 2014, driven particularly by costs in the Bolivarian Republic of Venezuela, Brazil and Colombia. In 2005, these countries had the lowest per-container export costs, along with Peru; but in 2007, 2008 and 2009, costs rose drastically. In particular, between 2012 and 2014, there was a significant increase in per-container export costs in the Bolivarian Republic of Venezuela (US$ 3,490), Brazil (US$ 2,414), Colombia (US$ 2,355), Paraguay (US$ 1,850) and Argentina (US$ 1,650). Chile and Peru have succeeded in maintaining the lowest costs per-container in South America: in 2014, the average cost was US$ 890 in Peru and US$ 980 in Chile.

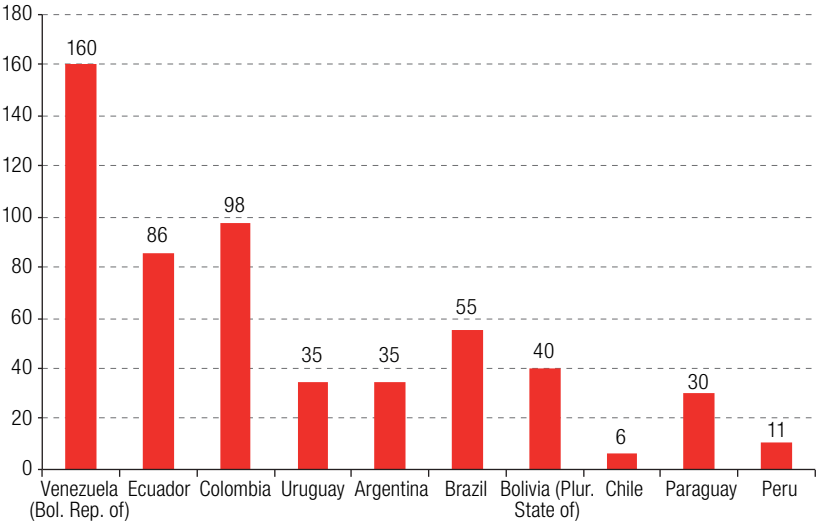
Figures 3 and 4 show the maximum applied tariff in the countries of South America in 2009 and 2014 (no information is available for the Bolivarian Republic of Venezuela in 2009). In 2014, the Bolivarian Republic of Venezuela, Colombia and Ecuador are the countries with the highest applied tariffs, of 160%, 98% and 86%, respectively (WTO/ITC/UNCTAD, 2015). Chile and Peru have the lowest maximum applied tariffs in 2009 and 2014; and Chile has the lowest indicator of all: 13% in 2009 and 6% in 2014. The maximum applied tariffs in 2014 in the South American countries are below the average of those applied worldwide (175.3%), as stated in the report *World Tariff Profiles* (WTO/ITC/UNCTAD, 2015). The countries with the highest applied tariffs are Egypt, Fiji, Malaysia and Norway.

Figure 3
South America (9 countries): maximum applied tariff rate, 2009
(Percentages)



Source: Prepared by the authors, on the basis of data from World Trade Organization (WTO)/International Trade Centre (ITC)/United Nations Conference on Trade and Development (UNCTAD), *World Tariff Profiles, 2010* (UNCTAD/WTO/2010), Geneva, 2010.

Figure 4
South America (10 countries): maximum applied tariff rate, 2014
(Percentages and countries)



Source: Prepared by the authors, on the basis of data from World Trade Organization (WTO)/International Trade Centre (ITC)/United Nations Conference on Trade and Development (UNCTAD), *World Tariff Profiles, 2015* (UNCTAD/WTO/2015), Geneva, 2015.

III. Characteristics of the chilean export basket

Table 2 lists the main categories of goods exported by Chile in 2006 and 2014. In recent years, the export basket has continued to be highly concentrated in copper and its derivatives, which represent 57% of total exports in 2006 and 51% in 2014. The drop in this percentage is probably a direct reflection of the fall in the real price of the product, since the real historical price of refined copper attained a level of 328.2 U.S. cents per pound in 2006, but had fallen to 299.3 cents in 2014 (Sociedad Nacional de Minería).[1]

Table 2
Chile: main exportable goods, 2006 and 2014
(Percentages of total)

Exportable goods	2006	2014
Cathodes and cathode sections	28.84	23.02
Copper ores and concentrates	20.45	22.2
Copper for refining	4.98	3.91
Concentrates	2.41	1.95
Others	43.32	48.92

Source: Prepared by the authors, on the basis of Latin American Integration Association (LAIA), "Estadísticas de comercio exterior", 2016 [online] http://consultawebv2.aladi.org/sicoexV2/jsf/comercio_exterior_item_arancelario.seam?cid=10711.

Table 3 reports the share of the main destinations for Chilean exports in 2006 and 2014. Market diversification remained poor during the period, although exports to China increased from 15.71 of the total in 2006, to 24.55% in 2014. If Chile's main export markets in 2014 are grouped by continent, Asia is the leading destination, accounting for just under 44.7% of the total.

Table 3
Chile: main destinations for exports, 2006 and 2014
(Percentages of total)

Partner country	2006	Partner country	2014
United States	16.01	China	24.55
Japan	10.81	United States	11.75
China	8.84	Japan	10.46
Netherlands	6.83	Republic of Korea	6.15
Republic of Korea	6.09	Brazil	5.44
Italy	5.03	India	3.47
Brazil	4.94	Netherlands	2.9
Other	41.45	Others	35.28

Source: Prepared by the authors, on the basis of Latin American Integration Association (LAIA), "Estadísticas de comercio exterior", 2016 [online] http://consultawebv2.aladi.org/sicoexV2/jsf/comercio_exterior_item_arancelario.seam?cid=10711.

This reality of Chilean foreign trade, which is characterized by the extraction of natural resources for export mainly to China and other Asian countries, is replicated elsewhere in Latin America. Dingemans and Ross (2012) show that export growth in the Latin American countries has partly occurred on the intensive margin rather than extensively; so expansion towards new products and trade partners has been limited. Meller, Poniachik and Zenteno (2012) show that the international commodity price boom in 2011 and 2012 brought significant benefits to Latin American countries, however; and in relation to China: "The large increase in the commodity share" in the Latin American export basket has aroused fears of a return of the "natural resource curse" (Meller, Poniachik and Zenteno, 2012, p. 2).

[1] http://www.sonami.cl/index.php?option=com_content&view=article&id=224&Itemid=117.

An analysis of the reality of Latin American countries, including Chile, shows that the extractive model used to participate in world trade has led to the exhaustion of economic growth and social development.

IV. Model specification

This research builds an extended gravity model, using pool and static panel data with fixed, random and dynamic effects (Arellano-Bond and Arellano-Blundell), to analyse the effects of trade facilitation on Chilean exports between 2006 and 2014. The first authors to use the gravity model to analyse international trade were Tinbergen (1962), Pöyhönen (1963) and Linnemann (1966). In the studies by Anderson (1979), Bergstrand (1985) and Helpman and Krugman (1985), gravity equations were derived from international trade models based on product differentiation and increasing returns to scale; and rigorous theoretical support was provided. Mátyás (1997), Cheng and Wall (1999), Bayoumi and Eichengreen (1998), Breuss and Egger (1999) and Egger (2000) provide econometric specifications. In recent decades, the gravity model has been one of the most widely used to analyse international trade, migration or foreign investment flows, due to their properties, their theoretical and empirical support, and their flexibility and adaptability to different regional realities or to that of a particular country.

For this study, the extended linear gravity model will be specified by the following equation expressed in natural logarithm form:

$$\begin{aligned} ln\left(E_{ijt}\right) = \beta_0 + \mu_1 ln\, y_{it} + \mu_2 ln\, y_{jt} + \xi_1 ln\, Arancel_{it} + \xi_2 ln\, Arancel_{jt} \\ + \alpha_1 ln\, D_{ij} + \phi_1 ln\, Doce_{it} + \phi_2 ln\, Doci_{jt} + \eta_1 ln\, Cose_{it} + \eta_2 ln\, Cosi_{jt} \\ + \nu_1 ln\, TCE_{it} + \sum_k \delta_h P_{ij} + u_{ijt} \end{aligned} \quad (1)$$

where:[2]

i, j and t represent the exporting country, importing country and year, respectively;

E_{ij} represents the export flow from country i to j;

$Y_{i,j}$ denote the real GNP of country i and j, respectively;

$Arancel_i$, $Arancel_j$ represent the weighted average applied tariff rates of country i and j (in percentages);

D_{ij} is the geographical distance between the capitals of countries i and j in kilometres;

$Doce$ is the number of documents required by the exporting country for an export;

$Doci$ is the number of documents required by the importing country for an import;

$Cose$ represents the per-container export cost, in dollars;

$Cosi$ represents the per-container import cost, in dollars;

TCE_i denotes the exporting country's effective exchange rate.

In addition, equation (1) includes dummy variables represented by $\sum_h \delta_h P_{ij}$ which assume the value 1 in the the event in question occurs or 0 otherwise. The individual dummies variables are as follows:

F_{ij}: common border between country i and country j;

IC_{ij}: common language between country i and country j;

[2] The following databases will be used: Latin American Integration Association (LAIA) (www.aladi.org) —amounts exported from Latin American countries in millions of dollars FOB and amounts imported from non-Latin American countries in millions of dollars CIF; www.wcrl.ars.usda.gov/cec/java/lat-long.htm— distance in kilometers between the capitals of the countries under study; and World Bank, statistical data (http://datos.bancomundial.org/).

NAFTA-CL: trade between Chile and the member countries of the North American Free Trade Agreement (NAFTA), namely the United States, Canada and Mexico;

MERCOSUR-CL: trade between Chile and the member countries of the Common Market of the South (MERCOSUR), namely Argentina, Brazil, Paraguay, Uruguay and, since 2014, the Bolivarian Republic of Venezuela;

China-CI: trade between China and Chile;

UE-CI: trade between Chile and member countries of the European Union (EU);

2006-2007: time variable representing the years 2006 and 2007;

2009: time variable that represents the year 2009, and

2013-2014: time variable representing the years 2013 and 2014.

Theoretically, the larger the real GNPs of the exporting and importing countries, the stronger the gravitational attraction between them; in contrast the greater the geographical distance, the less the attraction. The number of documents required to export and import, in conjunction with the per-container cost of exports and imports and tariff rates, are used to represent trade facilitation and quantify its effects on Chilean foreign trade. Chile's trade accords, along with its free trade agreements with the member countries of NAFTA, MERCOSUR, the EU and China, will make it possible to assess whether these agreements facilitate bilateral trade.

The exporter's effective exchange rate is included as a variable in the gravity equation to determine its potential impact on export volumes. According to Bernat (2015), to the extent that the cost structure of a country's production is light in non-tradable inputs, movements in the real exchange rate can be expected to have little influence on most of that country's exports.

A dummy variable representing a common border seeks to distinguish the border effects of trade with neighbouring countries from the rest of Chile's bilateral trade. This variable will also measure the majority use of land transport with these countries. Time dummy variables are included to capture temporary effects and events characteristic of those years, such as the subprime mortgage crisis in 2009 and the fall in copper prices in 2013 and 2014.

This study will include 89 countries that trade with Chile, classified by geographical area, as follows: 31 countries from Europe; 10 from Africa; 15 from Asia; 7 from the Middle East; 2 from North America; 11 from Central America and the Caribbean; 11 from South America, and 2 from Oceania. These countries accounted for 91% of Chile's export destinations during the study period. A few countries have been excluded owing to the small volume or absence of trade for one or more consecutive years in that period. The total number of observations per year is 178, making a total of 1,602 observations.

Since a large sample of countries and years is generally used when applying a gravity model, some observations of the endogenous variables (such as export, import or total trade) have a zero value. To address the problem of zero observations in trade, Piani and Kume (2000), Zago de Azevedo (2001) and Wall (2003) have replaced them by small values (0.001) in the dependent variable (amount exported by the trading partners); and Eichengreen and Irwin (1998) and Wall (2003) have added 1 to all observations. Nonetheless, Santos-Silva and Tenreyro (2006) draw attention to a problem related to the analogy between Newtonian gravity and trade, since the gravitational force may be very small, but it is never 0; yet trade between several pairs of countries can indeed post zero values. An additional problem is the use of logarithms in the linear form of the gravity equation. Faced with this problem and the methods available to address it, the authors suggest that adding 1 to the dependent variable or using a Tobit estimator can produce inconsistent estimators.

In this study, one of the recommendations made by Santos-Silva and Tenreyro (2006) was followed, and it was decided to use a sample of countries whose flow of bilateral trade with Chile did not record zero observations in the study period. For this, the export and import amounts were reviewed in detail and not in thousands of dollars; and trading partner countries with zero in the dependent variable, in one or more years, were excluded. Accordingly the sample was determined by 89 countries covering 91% of the total amount exported by Chile during the period under study. Equation (1) will be estimated using static panel data with random effects, where the intercept of the regression will be random (β_0) and defined as $\beta_0 = \beta + u_1$. In other words, instead of considering β as a fixed intercept, it is projected as a random variable with mean value β and a random deviation from the mean.

Equation (1) is adapted for estimation with fixed effects panel data, to give equation (2), in which all the fixed variables that are maintained throughout the study period are excluded. This estimate makes it possible to observe intersections of all pairs of trade partners, discarding a shared constant.

$$\begin{aligned} ln\left(E_{ijt}\right) &= \beta_{ijt} + \mu_1 ln\, y_{it} + \mu_2 ln\, y_{jt} + \xi_1 ln\, Arancel_{it} + \xi_2 ln\, Arancel_{jt} \\ &+ \phi_1 ln\, Doce_t + \phi_2 ln\, Doci_t + \eta_1 ln\, Cose_t + \eta_2 ln\, Cosi_t + \nu_1 ln\, TCE_{it} + u_{ijt} \end{aligned} \tag{2}$$

where β_{ijt} is a fixed number for each pair of trading partners.

Given the potential endogeneity of the phenomenon being studied, it is advisable to use panel data with dynamic effects. Arellano and Bover (1990) argue that one of the ways in which using a panel is positive and decisive with respect to a cross-sectional sample is the possibility of modelling dynamic responses with microdata: equations can be specified with lagged endogenous and exogenous variables, thereby making it possible to explain adjustment processes (Arellano and Bover, 1990, p. 5).

Equation (1) is adapted to perform the estimation with dynamic panel data (equation (3)).

$$\begin{aligned} ln\left(E_{ijt}\right) &= \beta_0 + \beta_1 ln\left(E_{ijt-1}\right) + \beta_1 ln\left(E_{ijt-2}\right) + \mu_1 ln\, y_{it} + \mu_2 ln\, y_{jt} + \\ &\xi_1 ln\, Arancel_{it} + \xi_2 ln\, Arancel_{jt} + \alpha_1 ln\, D_{ijt} + \phi_1 ln\, Doce_t + \phi_2 ln\, Doci_t \\ &+ \eta_1 ln\, Cose_t + \eta_2 ln\, Cosi_t + \nu_1 ln\, TCE_{it} + \sum_k \delta_h P_{ij} + u_{ijt} \end{aligned} \tag{3}$$

where E_{ijt-1} represents the first lag of the dependent variable and E_{ijt-2} denotes the flow of exports from country i to country j. This equation will be estimated using the Arellano-Bond and Arellano-Blundell techniques.

V. Results

Table 4 shows the results obtained using static panel data with random and fixed effects (equations (1) and (2), respectively), and with dynamic effects (equation (3), Arellano-Bond and Arellano-Blundell). The Hausman test is applied to observe the differences between the fixed and random effects coefficients, and Prob> χ^2= 0.051 is obtained. This confirms that the random effects method is superior to the fixed effects method in explaining Chilean exports of manufactured goods to the countries in the sample. Nonetheless, the coefficient of determination obtained in the estimation with random effects (0.77) is quite high. The Durbin, Wu and Hausman test detected endogeneity, so it is better to use the dynamic panel.

Table 4
Results of the estimation of equations (1), (2) and (3)

Variables	Fixed effects (equation (2))	Random effects (equation (1))	Dynamic effects (equation (3), Arellano-Bond)	Dynamic effects (equation (4), Arellano-Blundell)
Ln (Exp -1)			0.23 (0.06)***	0.36 (0.06)***
Ln (Exp -2)			-0.14 (0.03)***	-0.11 (0.03)***
Ln (GNP exporting country)		1.57 (0.08)***	3.0 (0.5)***	0.87 (0.2)***
Ln (GNP importing country)	2.5 (0.2)***	1.19 (0.08)***		
Ln (geographic distance)			-6.5 (1.2)***	
Ln (DOCE)				
Ln (DOCI)				
Ln (export cost)		-1.2 (0.18)***	-1.1 (0.42)***	-1.0 (0.4)**
Ln (import cost)				
Ln (export tariff)		-0.1 (0.05)*		
Ln (import tariff)				
Ln (effective exchange rate)				
Common border				
Common language		2.93 (0.32)***		
NAFTA-Chile agreement				24.6 (11.06)*
MERCOSUR-Chile agreement		1.77 (0.6)***		-19.8 (7.7)**
CHINA-Chile agreement				
EU-Chile agreement				
Years 2006 and 2007		-0.39 (0.07)***		
Year 2009		-0.22 (0.08)***		-0.36 (0.06)***
Years 2013 and 2014				
Constant	-54.4 (6.0)***	-51.9 (3.1)***		-14.4 (5.4)***
R^2	0.18	0.77		
Number of observations	1 602	1 602	1 602	1 602

Source: Prepared by the authors.
Note 1: Values corrected for heteroscedasticity.
Note 2: Significance level: *** = 0% error; ** = 0% < P ≤ 2.5%; * = 2.5% < P ≤ 5%.
Note 3: Standard errors in parentheses.

Table 4 reports the results obtained when estimating equation 3 for panel data with dynamic effects and two lags of the dependent variable, using the Arellano-Bond and Arellano-Blundell techniques. The coefficients estimated through panel data with dynamic effects (equation (3), table 4) show that endogeneity decreases and is consistent with the relevant theory. The results indicate that the first lag of the dependent variable is positive and significant, while the second lag is negative and significant.

The estimates through random and dynamic effects (Arellano-Bond and Arellano-Blundell) show that the coefficient of the exporting country's real GNP is positive and significant, while the coefficient on export costs is negative and significant.

The dynamic effect using the Arellano-Blundell technique significantly reduces endogeneity. The NAFTA-Chile agreement is seen to positively affect Chile's bilateral trade, while the agreement between MERCOSUR and Chile has negative effects. The subprime mortgage crisis is shown to have had a negative effect on Chile's bilateral trade. There is no significant effect from the variables representing the number of export and import documents required, import costs, tariffs in the exporting and importing countries, the effective exchange rate, a common border, a common language, the China-Chile agreement, the EU-Chile agreement, and the dummy time variables for 2006 and 2007, and 2013 and 2014.

VI. Conclusions and recommendations

As Chile is embedded in the Latin American reality, the effects of trade facilitation on its exports and imports in 2006-2014 were analysed by firstly reviewing case studies and evidence on trade facilitation in Latin American countries, including Chile, and comparing with countries from other continents. Statistical data on trade facilitation in Chile and its main trading partners were then analysed in terms of the documents required to import and export, per-container export and import costs, and maximum applied tariff rates. The Chilean export basket and its implications were also analysed. Lastly, a gravity model was specified and applied using panel data to measure the effects of trade facilitation on Chile's exports.

Studies focused on Latin America highlight excessive export and import documentation, the high costs involved in exporting a container, the inefficiency of logistics services and customs procedures, inadequate port infrastructure and the ponderous response of public institutions in general, which affect the price of the exported good and undermine competitiveness in the destination country. Evidence from recent years shows a gradual increase in per-container export costs in Latin America, mainly in the Bolivarian Republic of Venezuela, Brazil and Colombia. In contrast, Chile and Peru are recognized as the only countries in which low export costs per-container have been maintained. Nonetheless, while these are below the world average, they are still twice those observed in Asian countries.

This reality calls for reforms to rationalize customs procedures and target public and private investment on projects that increase or improve port, land and road infrastructure to enhance the region's comparative advantages and improve its competitiveness. This would generate increased exports of traditional and non-traditional goods in South America. Based on the evidence reported by Iwanow and Kirkpatrick (2007), Jean-François and others (2007) and Zaki (2015), reducing bureaucracy and levels of perceived corruption, in conjunction with the use technological tools, would reduce the time it takes to import and export, particularly the number of days' bureaucracy in Latin America. This would lower per-container export costs and enhance the competitiveness of regional exports. Several studies, such as Márquez-Ramos and others (2007 and 2011), which focus on the cases of Spain and Latin America, argue that reducing per-container export costs and freight charges in the transportation chain helps to boost volumes exported.

Chile's exports remain relatively undiversified, in terms of both the goods exported and the destination markets. Heavy dependence on copper and its derivatives, as the main and predominant export products, constitutes a potential vulnerability in trade and the national economy that needs to be addressed in the short term. This dependence probably discourages the application of trade facilitation measures, which hinders the diversification of exportable goods and also conditions export behaviour in the subsequent year. Several studies (Wilson, 2007; Moreira and others, 2013, for example) show that the lower the export costs, the greater the production of manufactured goods, and this evidence should be included in the debate on Chile's public policies and economic sectors which aim to promote exports with greater technological content.

When estimating the gravity model using static panel data with fixed and random effects, the results confirm that it is preferable to do the calculation using panel data with random and dynamic effects with two lags in the dependent variable, although the estimation using dynamic panel data (Arellano-Blundell) best describes Chilean export behaviour and is consistent with the evidence and theories that have been put forward on trade facilitation. These results reveal the following:

- The greater the previous year's exports, the smaller the exports of two years earlier. This indicates that Chile's export and import behaviour is dynamic and fluctuating, with negative effects every two years, but with an upward trend. Another finding is that, the higher the real GNP of the exporting country and the lower the per-container export cost, the greater the trade flow between Chile and its trading partners. The coefficient representing the impact of the per-container export

cost is larger than the coefficients on the lagged variables and the exporting country's real GNP. Accordingly, the per-container export cost needs to be reduced to facilitate Chile's trade. This means confronting the reality of Chilean ports and investing in infrastructure and port capacity, which are very limited, improving logistics services, carrying out infrastructure projects that optimize land and highway connections, and cutting waiting times in ports and in public and private warehouses.

- The average tariff rates of the importing and exporting countries do not affect the trade flow between Chile and the sample countries. A possible explanation for this is that Chile's weighted-average tariff has been declining and was already very low during the study period. According to data from the Santiago Chamber of Commerce (CCS, 2016), Chile's effective import tariff dropped from 8% to 2.1% between 1999 and 2004, and then to 1.2% in 2009, where it has remained until 2015.
- The Free Trade Agreement (FTA) signed between the NAFTA member countries and Chile has facilitated trade, while the economic complementation agreement with MERCOSUR member countries has been negative for the trade flow between Chile and those countries. The other agreements, such as those concluded with China and the EU, do not show significant effects during the period analysed. These results show the importance of the FTAs signed with NAFTA members, the first of which was Canada (1996), then Mexico (1998) and, lastly, the United States (2003). This suggests that the recent Pacific Alliance formed by Chile, Colombia, Mexico and Peru could facilitate Chilean foreign trade in the coming decades. In contrast, the integration of Chile with the member countries of MERCOSUR is becoming counterproductive for Chile's bilateral trade. According to García (2013), the Pacific Alliance can be seen as a new stage of Latin American integration, which is departing from models that are more ideological than integrationist and characteristically closed, as is the case of MERCOSUR. The lack of significance of the coefficient on the China-Chile FTA may reflect the fact that it is a recent agreement, only signed in October 2006, so its effect on bilateral trade cannot yet be discerned empirically. It may also be because copper and its derivatives are Chile's main export to China, so it would not be the agreement that deviates or creates trade, but the exporting country's GNP, which in this study displays a positive and significant coefficient.
- The variables representing geographical distance, common border and common language do not influence the Chilean export-import process, probably because Chile's export-import trade is concentrated in Asian countries, which implies a great geographical distance and different languages.
- The real effective exchange rate of the exporting country appears not to be significant, which confirms that Chilean exports are not based on technological intensity but on natural resource extraction. This result is consistent with the claim made in Bernat (2015).
- The subprime mortgage crisis had a negative effect on Chile's bilateral trade, thereby confirming the vulnerability of the country's exports, especially owing to the reliance on copper and its derivatives.

Although the variable representing the number of documents required to import and export did not prove significant in the estimated model, their number should be reduced further, to increase the provision of basic infrastructure and infrastructure services, as suggested by Barbero (2010), with the aim of reducing per-container export costs, increasing public funds and encouraging private investments that upgrade the quality of domestic and international road networks.

Chilean ports need to be expanded to reduce freight costs, as proposed by Márquez-Ramos and others (2011); and, according to Salgado and Cea (2012), the ports of Iquique, San Vicente and Valparaíso need strengthening since they provide exporters with greater access to logistics

chains better suited to their products. Feasibility studies should be performed for new port projects, since the southern ports are easier to access from the sea and could attract more shipping lines to that area.

Lastly, medium-term planning should be designed to guarantee the national overland connection (especially railways), review the staffing of customs services, and consider programmes of training and support for public- and private-sector personnel involved in the logistics process, while promoting quality policies on logistical performance.

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Gender equity in the Argentine tax system: an estimation of tax burdens by household type[1]

Darío Rossignolo

Abstract

The purpose of this paper is to introduce the gender dimension into the analysis of tax incidence in Argentina. To that end, the impact of direct and indirect taxes on income and distribution by gender is calculated to establish the progressivity of taxes and the effects on gender equity when household classifications are analysed. The findings show that while the tax system is moderately progressive and the heaviest burden falls on households with male breadwinners, differences emerge when the impact of indirect and direct taxes is considered separately. The indirect tax system is heavily regressive and female-breadwinner households bear the largest burden, since they are concentrated in the lower income brackets. Households with children bear the highest direct tax burden, particularly male-breadwinner and dual-earner households.

Keywords

Fiscal policy, taxation, gender, households, income, gender equality, Argentina

JEL classification

H2, I3, D3

Author

Darío Rossignolo is an associate professor at the University of Buenos Aires and a researcher and consultant for different international organizations. Email: darossignolo@gmail.com.

[1] A number of the findings of this paper are based on Rossignolo (2016), forthcoming.

I. Introduction

One of the main requirements of tax policy design is to know how the total tax take is distributed across different income levels. A tax system satisfies the "vertical equity" criterion when sectors with a greater tax payment capacity actually pay a greater proportion of tax than others, while "horizontal equity" exists when sectors with the same level of well-being, or ability to pay, do in fact pay the same proportion of tax (Lambert, 1993).

Tax systems have major implications for class and gender equity, since effective tax collection is a necessary, albeit not sufficient, condition for the amelioration of gender-based poverty and inequality. Low aggregate tax collection has implications for gender equity because it prevents the establishment of programmes to counteract the market distribution of income, in which women are generally disadvantaged. Not only do they provide the bulk of unpaid care work, but such paid work as they do is more likely than men's to take place in the informal sector, and if they do work in the formal sector they tend to be employed in smaller enterprises and to earn less than men (Grown and Valodia, 2010).

Gender analysis studies the impact of taxes and tax policies on intra-household welfare. The aim of this paper is to analyse the impact of the tax system on gender equity in Argentina. The analysis will be performed using the National Household Expenditure Survey (ENGHo) conducted by Argentina's National Institute of Statistics and Censuses (INDEC) from March 2012 to February 2013. Consequently, the tax codes employed will be those applicable in 2012.

The present study is structured as follows. Section II presents theoretical considerations regarding the incidence analyses and the gender evaluation of tax systems, together with a brief description of the Argentine context in terms of the gender dimension and a review of the results of previous studies on this issue. Section III introduces the overall tax situation, showing the composition of tax revenues and its evolution. Section IV presents the conceptual framework for the analysis of the intra-household impact of taxes, the legal framework for the tax system in Argentina and the methodology used to calculate economic and gender incidence. Section V shows the results of the incidence analysis of income and gender inequality. Section VI summarizes and concludes.

II. General theoretical considerations and empirical background

The tax incidence analysis performed in this paper is consistent with the partial equilibrium literature and is known as the accounting approach, the aim being to analyse who pays what taxes to the State. It is worth noting that the concept of "incidence" used in this paper refers to the amount of taxes paid by each household. Although that information is sometimes obtained directly from sample surveys, inference may be necessary at other times, as taxes may not be directly observed in surveys and may have to be worked out indirectly. In accordance with Bourguignon and Da Silva (2003), indirect methods involve applying official income tax schedules or imputing payment of indirect taxes by observing spending.

Accounting approaches, however, ignore possible behavioural responses by agents that may modify the amounts they actually pay or receive; an accounting approach would not detect tax evasion prompted by an increase in income tax rates, for example. These approaches are limited to first-round effects and do not consider second-round effects attributable to behavioural responses, which behavioural approaches do try to take into account.

In the case of goods taxes, the calculation of tax incidence should ideally entail estimation of the compensating variation, indicating by how much real income declines as a result of the tax. In accordance with Sahn and Younger (2003), the method used approximates that calculation from the compensating variation. When there is a marginal change in the price of a good, this variation is simply the change in the consumption budget that is necessary to keep the consumption basket constant. In other words, the demand response to the tax may be ignored as a first approximation (Sahn and Younger, 2003).

In order to develop methodologies consistent with the theoretical background, the burden generated by taxes on goods and services is assumed in this study to be fully passed on to consumers, so that what is considered are the statutory rates on each of the expenditure items surveyed. The tax burden represented by direct taxes, conversely, is shifted backwards to the income source by reducing earners' disposable income.

The key variable for analysing taxes paid by each quintile and household category is the tax burden, i.e. the ratio of taxes to pre-tax per capita income. A tax will be progressive if the ratios increase with rising welfare levels; conversely, it will be regressive if the burden decreases with per capita income (through statistical significance).

1. Analysing gender bias in tax systems

In her analysis of the existence of gender biases in tax systems, particularly in the case of personal income tax, Stotsky (1996) points out that this sort of discrimination can be explicit, implicit or both. While explicit gender bias is a feature of many tax systems, being expressed in the language used in the tax code or tax regulations, implicit gender bias is more difficult to identify, since it arises from the different implications that the provisions of tax law and regulations have for men and women, which in turn derive from value judgments regarding desirable social and economic behaviour. Although individual filing systems are usually more gender-equitable than joint ones, they still often contain explicit and implicit gender biases.

According to Grown (2010), one manifestation of explicit gender bias is the allocation of deductions, exemptions and other tax preferences on the basis of sex. For instance, deductions may be different depending on whether the income earner is in the formal sector or self-employed. Since men are more likely to be employees and less likely to form a single-parent household than woman, they are more likely to be in households with a lower personal income tax burden. These provisions of the law constitute implicit biases against women, who account for the bulk of self-employed single-parent households. Additionally, it is important to point out that tax codes provide exemptions for interest or dividend payments. Considering that men are more likely to own stocks and equities than women, this constitutes another form of implicit gender bias.

When it comes to indirect taxes, a factor not considered in the discussion of personal income tax has to be taken into account: gender differences in consumption patterns. It might be, for instance, that the incidence of indirect taxes is in fact lower for female-headed households than for others because women tend to purchase and consume less of the types of goods subject to the highest indirect taxes (e.g. alcohol and tobacco).

Stotsky (1996) argues that a system of indirect taxation in which taxes are higher for alcohol than for many other goods is biased against men. She takes the view that an unbiased system requires that goods and services which are disproportionately consumed by males should not be taxed at a different rate from goods which are disproportionately consumed by females. Likewise, higher rates of value added tax (VAT) on medical care are implicitly biased against women, because these goods are disproportionately consumed by them.

This argument stems from Stotsky's view that bias comes from treating women and men differently, when they should be treated the same (i.e. violating the principle of horizontal equity). But this implies that consuming alcohol and tobacco and consuming medical care are equally socially valuable forms of behaviour, and equally a matter of personal, utility-yielding choice.[2]

However, it is widely regarded as justifiable to tax merit goods and basic necessities at a lower rate than demerit goods and luxuries. Consequently, to have higher tax rates for goods disproportionately consumed by men (and lower tax rates for goods disproportionately consumed by women) does not violate the principle of equity between women and men if the goods consumed disproportionately by men are "demerit" and/or luxury goods and the goods disproportionately consumed by women are "merit" goods and/or basic necessities. The relevant principle here is that of vertical equity, which permits people in differing situations to be treated in appropriately different ways.

In view of the likely impact of the two taxes on the behaviour of women and men and the possibility of men shifting the burden of alcohol taxes on to other household members, this needs further consideration. Typically, consumers of alcohol do not reduce their alcohol purchases if the price rises. There is a danger that men will respond to a rise in the price of alcohol by cutting back on spending on goods that benefit other household members. Likewise, if there is a rise in VAT on daily necessities (e.g. soap, salt, kerosene) that women have responsibility for buying, there is evidence to suggest that the resulting rise in their prices tends to lead women to cut back on their own consumption and spend more of their time producing home-made substitutes.

There is considerable evidence that women's bargaining power within households tends to be weaker than men's (Doss, 2011). This suggests that a plausible hypothesis is that men have a greater capacity to transfer the burden of indirect consumption taxes (such as excise duties and VAT) on to other household members than do women. If this is the case, indirect consumption taxes will have a substantially unequal impact on women and men, with a greater impact on women than on men.

2. Analysis of gender bias in the Argentine personal income tax code[3]

Argentina has adopted the principle of individual filing: each taxpayer must file a personal tax return (where applicable)[4] irrespective of civil status and pay taxes on his or her taxable income. Income deriving from personal activities, personal property and property acquired with the proceeds of the spouse's profession, employment, etc., should be allocated as appropriate to each spouse.

Under an individual tax regime, however, gender bias can be found in three different cases. First, there is the allocation of non-employment income. Employment income is allocated to the employee, but the allocation of other source income, such as real estate income, is not so clear. Different countries' tax regimes allocate these types of income in different ways: they may be allotted to the spouse with higher income; they may be distributed equally between the spouses; the spouses may be allowed to decide on the allocation; or the income may be allocated to the spouse who owns the real estate generating it.

[2] It would be helpful for updated research to be produced on these issues to confirm the persistence of these consumption patterns across different societies.

[3] This section is based on Rodríguez Enríquez, Gherardi and Rossignolo (2010).

[4] As will be discussed later, personal income tax may be paid through tax returns, by being withheld from wages and salaries or under the simplified *monotributo* regime.

Second, tax exemptions may be applied differently depending on the tax regime followed. Tax provisions generally admit tax exemptions on different grounds, including the need to provide for a dependent spouse and young children. Under an individual tax return regime, the distribution of these exemptions between the spouses may not be fair; e.g. certain exemptions may be admitted for husbands with a dependent wife, but not for wives with a dependent husband. Third, some countries apply different rates to men and women, and tax rates are higher for married women than for married men.

Of these three possible types of discrimination, the third does not apply in Argentina, as men and women are subject to the same tax rates; the first two, however, should be assessed in relation to the application of personal income tax. This is because, in the case of married couples, a number of exemptions allocate certain common types of source income to the husband, examples being income from community property, which is wholly allocated to the husband in almost all cases; income from joint property has to be filed in the husband's tax returns.

It is generally accepted that the current regime is not quite the individual taxation regime that it appears to be, but rather a hybrid, as it contains cases where the spouses are subject to a kind of joint taxation. However, it is worth noting that this bias does not imply an economic penalty for women.

3. The gender equity context in Argentina

The average population growth rate in Argentina is 1.1% a year. Family organization has been changing very slowly. Population growth has been slowing, and is projected to be below a cumulative 1% a year by 2040. This is because of a reduction in the average family size as couples have fewer children, an increase in one-parent households, the relative decline of large extended families and the corresponding pre-eminence of the nuclear family. The nuclear household predominates in Argentina (57.5% of total households) and the great majority (85.8%) of such households are headed by a man. In contrast, women head 58.7% of one-person households and 75.5% of one-parent households.[5]

The unemployment rate was 7.6% in 2013 (6.6% for men and 9.0% for women). Among adults aged 15 to 64, unemployment was higher for women (6.9%) than for men (4.5%) as of 2013, while among the young (aged 15-24) the female unemployment rate was 24% and the male rate 18%.

The proportion of informal workers was still in excess of 39% of the economically active population in 2013. A higher proportion of women (42.4%) than of men (36.8%) were in informal employment.[6] The figures show that women enter and leave the labour force more frequently than men, which means that their participation is more discontinuous and they are more likely to be in part-time and seasonal jobs, while a larger proportion of men are in full-time positions.

In Argentina, as shown in table 1, the male labour force is larger and more stable than the female one. The situation is not homogeneous across different income levels, since labour force participation is substantially lower among lower-income women than among those earning more, implying that the gender gap progressively widens down the income quintiles (Rodríguez Enríquez, Gherardi and Rossignolo, 2010). The presence of small children in the home continues to be one of the main factors precluding women's entry into the labour market, and becomes more of an obstacle the lower a household's income level.

[5] SEDLAC (CEDLAS and the World Bank).

[6] SEDLAC (CEDLAS and the World Bank). The definition of informality employed here deems all wage workers in small firms, the non-professional self-employed and zero-income workers to be informal.

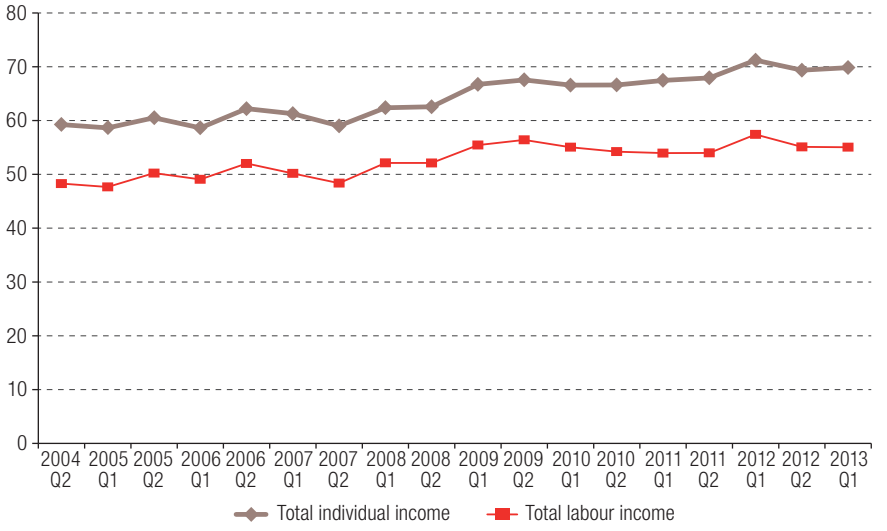
Table 1
Employment indicators for the population aged 14 and over
(Percentages)

	2003 Q2	2004 Q1	2004 Q2	2005 Q1	2005 Q2	2006 Q1	2006 Q2	2007 Q1	2007 Q2	2008 Q1	2008 Q2	2009 Q1	2009 Q2	2010 Q1	2010 Q2	2011 Q1	2011 Q2	2012 Q1	2012 Q2	2013 Q1
Labour force[a]	62.3	62.2	62.2	61.5	61.9	62.1	61.8	61.6	60.4	60.7	60.9	61.2	60.9	60.6	60.4	60.9	60.9	60.2	60.9	60.3
Male	75.4	75.1	75.8	75.1	75.5	75.0	75.4	75.6	74.1	74.3	74.4	74.4	74.1	74.1	74.2	74.4	74.7	73.5	74.5	73.9
Female	50.9	50.7	50.2	49.5	49.9	50.7	49.9	49.4	48.2	48.7	48.9	49.4	49.2	48.6	48.1	48.5	48.6	48.4	48.7	48.2
Employment rate[b]	52.7	53.2	54.4	53.8	55.4	55.3	56.1	56.0	55.8	55.7	56.3	55.9	55.7	55.7	55.9	56.4	56.6	55.9	56.5	55.7
Male	65.0	65.7	67.4	67.0	68.6	68.1	69.7	70.2	69.7	69.3	69.7	68.6	68.4	69.0	69.5	69.6	70.2	68.9	70.2	68.9
Female	42.0	42.2	42.9	42.2	43.7	44.0	44.2	43.7	43.5	43.8	44.3	44.5	44.4	44.0	43.9	44.4	44.4	44.4	44.2	43.8
Unemployment rate[c]	15.4	14.3	12.6	12.5	10.6	10.9	9.3	9.1	7.5	8.2	7.6	8.7	8.6	8.0	7.4	7.4	7.2	7.1	7.2	7.6
Male	13.8	12.5	11.1	10.8	9.2	9.1	7.7	7.1	5.9	6.8	6.3	7.8	7.7	6.9	6.4	6.5	6.0	6.2	5.8	6.6
Female	17.5	16.8	14.6	14.7	12.5	13.3	11.5	11.6	9.8	10.2	9.4	9.9	9.8	9.5	8.7	8.6	8.7	8.3	9.3	9.0

Source: National Institute of Statistics and Censuses (INDEC), Permanent Household Survey.
[a] Proportion of all adults available for work.
[b] People employed as proportion of total population.
[c] Unemployed as proportion oflabour force.

Secondly, individual income is lower for women than for men. Although the official statistics show that the gap is narrowing, female earnings are still less than about 60% of men's, rising to 70% when income from all sources is considered. This demonstrates that men's earnings are more likely to derive from formal employment than women's (see figure 1). Women's lower incomes, i.e. the continuing income gap between women and men, can be explained by higher unemployment, unstable employment and the higher proportion of women in less formal jobs.

Figure 1
Women's income as a proportion of men's
(Percentages)



Source: Prepared by the author on the basis of National Institute of Statistics and Censuses (INDEC), Permanent Household Survey.

Third, women predominately work in informal employment, which excludes them from the income tax net (Grown, 2010). Women's employment profile, involving discontinuous employment, lower earnings and a predominance of informal employment, mean they tend to lack access to benefits provided to formal employees through the tax system.

Women in Argentina not only hold fewer of the available jobs than men, but are still more likely to be in poor-quality jobs.[7] Women are overrepresented in (i) part-time work, (ii) informal wage work, (iii) low-skilled jobs, (iv) temporary or time-limited work and (v) domestic work (Rodríguez Enríquez, Gherardi and Rossignolo, 2010).

In addition to having fewer available employment options than men, women continue to be overrepresented in lower-quality and less-skilled jobs. While 36.8% of male wage earners were in informal jobs in 2013, the share was 42.4% for women. As for less-skilled jobs, segregation into specific occupations persists. While 44.1% of all active women work in social services, men are still predominant in construction and manufacturing. Furthermore, domestic service continues to be the largest source of female employment, accounting for 17.2% of active women and 22.7% of female wage earners. This continues to be a highly insecure and poorly paid job option.

The reasons given above explain the earnings gap referred to earlier. This gap is the combined result of the different types of discrimination outlined (lower participation, higher unemployment and underemployment, horizontal and vertical segregation) and the fact that women work fewer hours than men because of a number of restrictions, such as the presence of small children in the home.

[7] In 2013, 33% of men's work time was spent on unpaid work, while this took up 73% of women's total working time (CEPALSTAT).

The fact that women find it more difficult than men to participate fully in the labour market translates into greater income vulnerability. This is particularly important because women are overrepresented in the types of households that struggle most, such as single-parent households. Male-headed households of these types have almost 30% more income than female-headed ones. All this translates in turn into differences in the tax-paying capacity of men and women, which impacts the tax structure in various ways.

There are also differences in consumption expenditure patterns across household types. Compared to men, women tend to spend a higher proportion of the income under their control on goods such as food, education and health care that enhance the well-being and capabilities of children; these patterns affect tax incidence.

4. The findings of previous studies on Argentina

Although some tax incidence analysis has been done in Argentina, very few studies have included a gender perspective. Gasparini (1998) performs an analysis of the distributional impact of the tax system in 1996, taking per capita income and per capita consumption expenditures as welfare indicators. Taxes are highly regressive when considered in relation to the former but moderately progressive when per capita consumption is considered. Gómez Sabaini, Santiere and Rossignolo (2002) analyse the impact of taxes on income distribution for 1997, the welfare measure taken being per capita income adjusted for underreporting. The incidence is regressive in this case, with VAT and indirect taxes leading this impact.

Gómez Sabaini, Harriague and Rossignolo (2013) consider the incidence of taxes for 2008, again on the basis of per capita income. They find them to be proportional or slightly progressive, with the main impact coming from export taxes and an increased role for income tax and payroll taxes, as measured by the Gini coefficient. However, differences are greater at the extremes (decile 10 versus decile 1), prompting the conclusion that the system remains regressive in that respect.

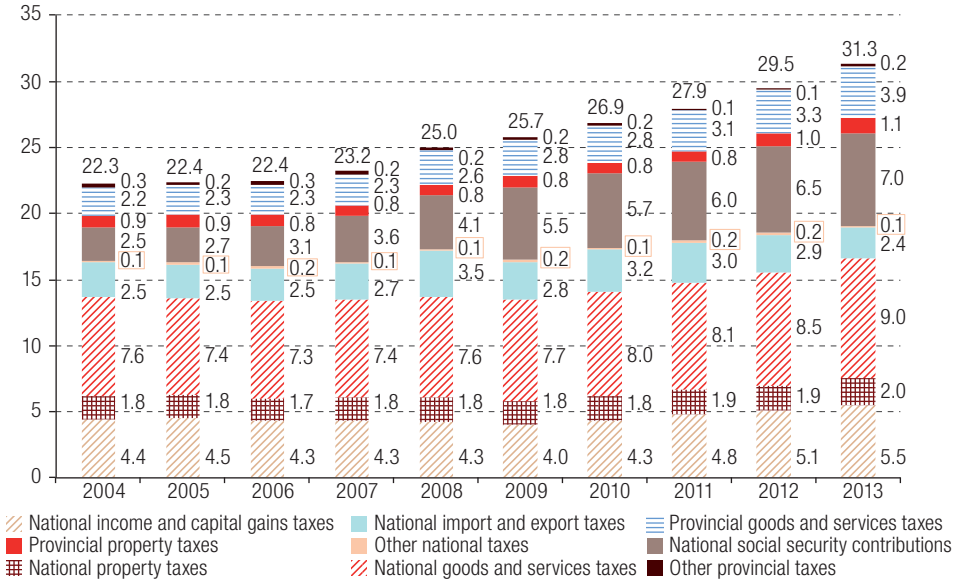
Rodríguez Enríquez, Gherardi and Rossignolo (2010) is the only example of an incidence analysis with a gender perspective. The analysis performed covered only indirect taxes at a national level, using per capita consumption expenditure as a welfare indicator, and was based on information for 2005. The tax burden was found to be highest for dual-earner households, male-breadwinner households and male-majority households. The distribution impact of indirect taxes was the combined result of VAT that was somewhat regressive, excise duties that were strongly regressive and a fuel tax that was strongly progressive. Indeed, for all household types, the first expenditure quintile was found to bear a larger VAT burden than the other quintiles.

III. The overall tax structure in Argentina

The Argentine public sector has a long history of structural imbalances (Gómez Sabaini and Rossignolo, 2009). Taking the last 10 years, the average public sector surplus declined from 3.2% of GDP between 2004 and 2008 to 0.5% of GDP between 2009 and 2013, while the average primary balance declined from a surplus of 1.6% of GDP to a deficit of 1.2% of GDP. Although the tax burden rose steadily (as will be shown in the next section), public expenditure increased by even more, with the result that deficits became the rule at both levels of aggregation from 2012 onward.

The tax burden in Argentina has grown exceptionally strongly over the last decade, reaching 31.2% of GDP in 2013,[8] as taxes that were used sporadically in previous periods, such as duties on exports (withholdings) and banking transactions, have been made permanent, while other provisions with an impact on corporate income tax and personal income tax have been applied, so that financial statements and thresholds are no longer adjusted for inflation, for example. This is illustrated in figure 2, where the banking transactions tax is included together with property taxes in accordance with the International Monetary Fund (IMF) classification of taxes. Export taxes have become substantial, but their share of the total has declined due to the fall in international commodity prices.

Figure 2
Gross national and provincial tax burden, 2004-2013
(Percentages of gross domestic product)



Source: Ministry of Treasury and Public Finance.

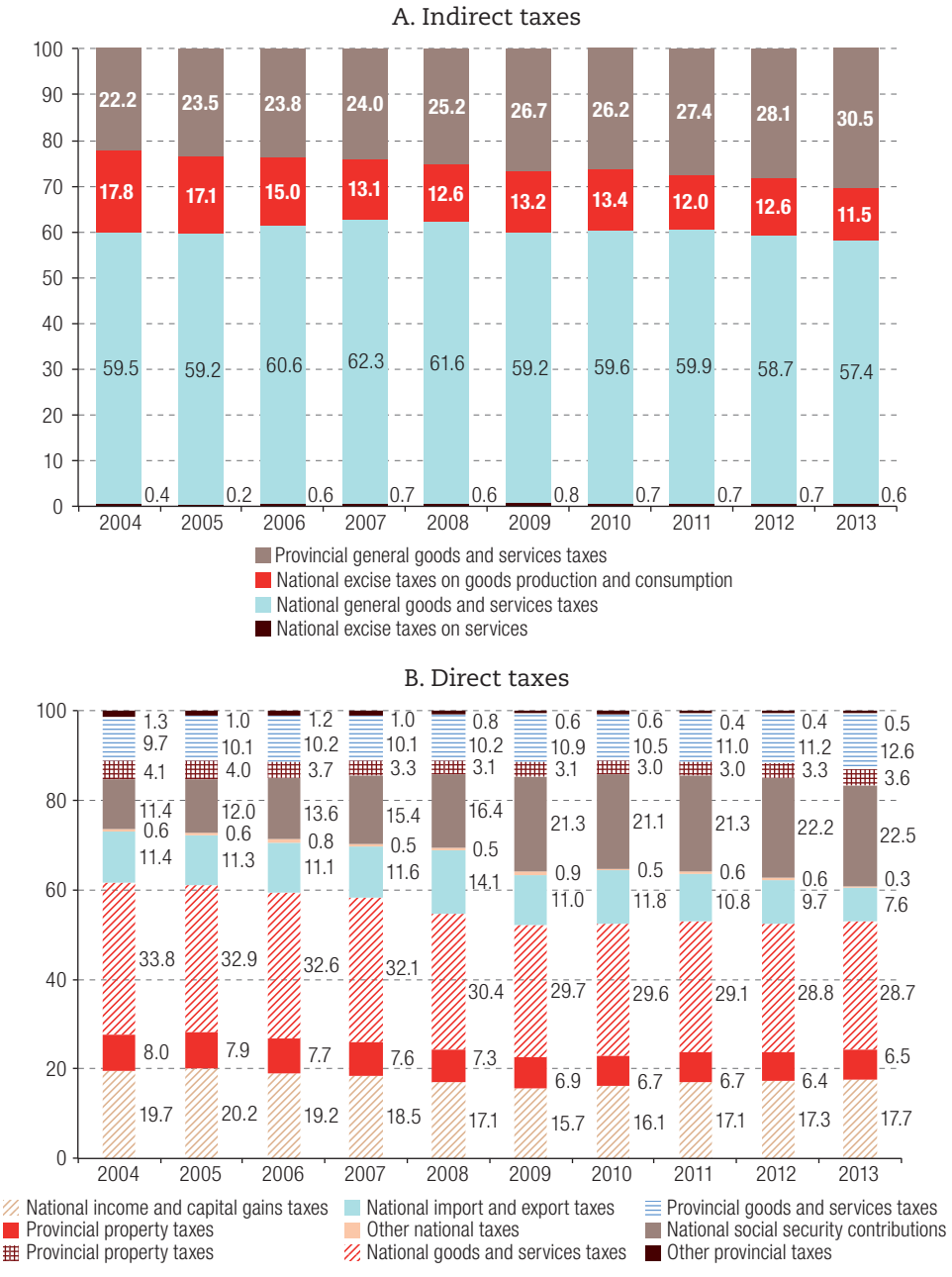
The bulk of this tax burden consists of indirect taxes; however, the relative shares of different kinds of taxes have changed slightly. As can be seen in figure 3, taking revenue from national and provincial goods and services taxes together, almost 42% of tax revenue came from indirect taxes in 2013. Among them, general consumption taxes (principally VAT) continued to account for by far the largest share (around 60%). When excise taxes alone are considered, fuel taxes accounted for the greatest share (around 60%), with tobacco ranking second (24%), although its share has been declining.

Revenues from social security contributions increased their share in 2008 to become the largest source of direct tax revenues. This was due to the abolition of the capitalization system set up in the 1990s, all of whose resources were taken over by the government to create a pay-as-you-go system.

In short, the increase in the tax burden has been largely accounted for by a number of what may be considered extraordinary or emergency taxes. In addition, the emphasis during this decade has been on tax administration measures. It is therefore clear that the Argentine tax reforms were intended to avoid fiscal imbalances rather than improve gender equity.

[8] Gross tax burden, excluding reimbursements. Revenue from health insurance contributions has been added to tax revenues in the case of formal sector workers, for whom they are compulsory. These figures are substantially lower, however, than those available before the official GDP recalculation (taking 1993 as the base year). The new figures reduced official nominal GDP (taking 2004 as the base year) and the tax burden by some 5% of GDP.

Figure 3
Composition of national and provincial taxes, 2004-2013
(Percentages)



Source: Ministry of Treasury and Public Finance.

IV. Tax incidence analysis: methodological considerations

The present paper not only updates previous research on the subject by using information from the ENGHo for 2012/2013, but also includes indirect taxes levied at the provincial level. Additionally, it includes calculations that take per capita income as a welfare indicator in addition to estimating the incidence of direct taxes.

The main source of information for this report was the ENGHo, a large-scale survey that obtains detailed answers from about 20,960 households across the country drawn from a population of some 36.1 million.[9] The units analysed by the survey are individual households and its main study variables are household expenditure and income, but it also includes information on demographic, occupational and educational variables and on housing characteristics, transfers in kind received and household goods.[10]

1. Distribution of the welfare indicator

Traditional incidence studies rank the analysis unit by current income. However, if someone's consumption shifts between periods, their welfare will be better related to permanent income. This issue can be solved if people are ranked by permanent income or its best proxy, consumption.

From a gender point of view, the impact of taxes on poorer households is of greatest interest, given that women tend more than men to be grouped into lower-income households. Income will therefore be taken as the welfare indicator, despite the enormous difficulty of obtaining accurate values for this variable from household surveys, which may cast doubt on the reliability of the data reported. Income thus includes the earnings of wage workers, employers, self-employed workers, recipients of capital income, social security beneficiaries, pensioners and beneficiaries of public transfers.

While the aim is to capture pre-tax income distribution, the income reported in household surveys includes public transfers, so that they provide a post-tax measure (adjusted for differences between regional prices). To calculate pre-tax income, public transfers (monetary and non-monetary) should be excluded. These include pensions, and in cases where a pension is someone's only income, subtracting this item would leave the household with zero income, making it look as though it were paying taxes and purchasing items despite having no income, and overstating the impact of taxes. To avoid these drawbacks, public pensions have been kept in the definition of disposable income and treated as part of pre-tax income.

This applies to monetary and non-monetary transfers as well. Dropping these transfers from income would imply that individuals did not use income from this source for consumption and therefore pay taxes. However, the household survey does not distinguish what type of transfer a household is receiving, so these transfers have been kept in the income definition and in the welfare indicator. This definition has been used in the calculation of quintiles and for the whole of the incidence analysis.

[9] The ENGHo uses a representative sample of 86.8% of the population, as it excludes only towns with less than 5,000 inhabitants. Reach the whole population of the country would mean taking account of the portion of the urban population that is not included in the sample as well as rural areas, which are explicitly excluded because of the high operating costs that incorporating them would entail. No official statement has been made about the reliability of the survey.

[10] See INDEC (2013) for the definitions of income and expenditure used in the survey.

2. Gender analysis through a household typology

In order to carry out the gender analysis, the quintiles were calculated as described and divided into different categories by household composition within each quintile. The classification presented here is related to the occupational characteristics of household members and is aimed at identifying income and consumption expenditure patterns for a specific household composition in terms of gender. Occupational status is associated with the receipt of personal income by adult members of each household. Households are classified by the number of employed and unemployed men and women in them (Grown and Valodia, 2010), with inactive members being considered unemployed. The classifications are:

- Male-breadwinner households: at least one employed male in the household and no employed females, with and without children.
- Female-breadwinner households: at least one employed female in the household and no employed males, with and without children.
- Dual-earner households: at least one employed male and one employed female, with and without children.
- Non-employed households: no-one employed, with and without children.

The first two categories are of single-earner households, the third of dual-earner households and the last of households where no-one is employed, with each of these categories being divided between households that do and do not include children (under 18). Table 2 breaks down the different types of household by the number of people therein.

Income distribution is shown in table 3 for comparative purposes. The incomes reported there are not taken straight from the household survey but have been reconstructed to arrive at pre-tax amounts, since reported income for formal workers is after taxes.

What is analysed is the household income distribution, which is divided into household per capita income quintiles. The first quintile accounts for 4.1% of total income and the top quintile for approximately 53.5%. Average monthly income per household is around US$ 681 in current dollars at the 2012 exchange rate. Male-breadwinner households contain 46.3% of all individuals in the first per capita income quintile, female-breadwinner households 16.4% and dual-earner households 25.5%.

Table 3 shows the percentage structure of household per capita income by quintile of individuals, grouped by aggregated income sources before taxes. The information in this table must be combined with that in the previous one, which shows the number of individuals in each category.

Female-breadwinner households and non-employed households generally represent the smallest proportions of total income (16.5% and 10.5%, respectively). Male-breadwinner households with children account for 10.0% of total income in the lowest quintiles and those without for 0.9%, while dual-earner households with children account for 3.6% and those without for 0.3%.

Much the largest income shares in each quintile are for dual-earner households and households with at least one female employed, in both cases without children, with figures of 78% and more for the former and 71% and more for the latter.

Comparing these figures with those of table 2 shows that female-breadwinner households (with and without children) received 12.8% of total family income and contained 12.4% of all individuals, while male-breadwinner households accounted for 32.1% of income and 36.9% of individuals. Thus, although total family income was lower in female-breadwinner households, male-breadwinner households had lower per capita income. Dividing the corresponding figures yields per capita incomes before taxes of US$ 435 for male-breadwinner households with children and US$ 1,035 for those without children. For female households, the corresponding figures were US$ 463 and US$ 1,118.

Table 2
Composition of households by employment status and income quintile
(Numbers of people and percentages)

Quintile	Description	Male-breadwinner households			Female-breadwinner households			Dual-earner households			Non-employed households			Totals		
		With children	Without children	Total	With children	Without children	Total	With children	Without children	Total	With children	Without children	Total	With children	Without children	Total
1	People	3 130 594	219 446	3 350 040	1 093 308	91 627	1 184 935	1 756 011	87 038	1 843 049	683 478	165 856	849 334	6 663 391	563 967	7 227 358
	Vertical structure	32.02	6.15	25.10	37.91	5.67	26.33	15.86	2.32	12.43	73.78	6.53	24.49	27.02	4.91	20.00
	Horizontal structure	43.32	3.04	46.35	15.13	1.27	16.40	24.30	1.20	25.50	9.46	2.29	11.75	92.20	7.80	100.00
2	People	2 651 200	458 638	3 109 838	621 563	139 870	761 433	2 492 350	279 757	2 772 107	146 433	436 358	582 791	5 911 546	1 314 623	7 226 169
	Vertical structure	27.11	12.86	23.30	21.56	8.65	16.92	22.52	7.45	18.70	15.81	17.17	16.81	23.98	11.45	20.00
	Horizontal structure	36.69	6.35	43.04	8.60	1.94	10.54	34.49	3.87	38.36	2.03	6.04	8.07	81.81	18.19	100.00
3	People	1 901 494	663 258	2 564 752	474 041	343 133	817 174	2 358 734	533 627	2 892 361	36 411	918 582	954 993	4 770 680	2 458 600	7 229 280
	Vertical structure	19.45	18.60	19.22	16.44	21.22	18.16	21.31	14.21	19.51	3.93	36.15	27.54	19.35	21.41	20.00
	Horizontal structure	26.30	9.17	35.48	6.56	4.75	11.30	32.63	7.38	40.01	0.50	12.71	13.21	65.99	34.01	100.00
4	People	1 115 927	1 011 971	2 127 898	415 965	420 962	836 927	2 524 305	954 819	3 479 124	48 401	735 575	783 976	4 104 598	3 123 327	7 227 925
	Vertical structure	11.41	28.37	15.95	14.43	26.03	18.60	22.80	25.42	23.47	5.22	28.95	22.61	16.65	27.20	20.00
	Horizontal structure	15.44	14.00	29.44	5.75	5.82	11.58	34.92	13.21	48.13	0.67	10.18	10.85	56.79	43.21	100.00
5	People	978 420	1 213 514	2 191 934	278 714	621 371	900 085	1 937 721	1 901 263	3 838 984	11 614	284 864	296 478	3 206 469	4 021 012	7 227 481
	Vertical structure	10.01	34.02	16.43	9.67	38.43	20.00	17.51	50.61	25.89	1.25	11.21	8.55	13.00	35.02	20.00
	Horizontal structure	13.54	16.79	30.33	3.86	8.60	12.45	26.81	26.31	53.12	0.16	3.94	4.10	44.36	55.64	100.00
Total	People	9 777 635	3 566 827	13 344 462	2 883 591	1 616 963	4 500 554	11 069 121	3 756 504	14 825 625	926 337	2 541 235	3 467 572	24 656 684	11 481 529	36 138 213
	Vertical structure	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Horizontal structure	27.06	9.87	36.93	7.98	4.47	12.45	30.63	10.39	41.02	2.56	7.03	9.60	68.23	31.77	100.00

Source: Prepared by the author on the basis of National Institute of Statistics and Censuses (INDEC), *Encuesta Nacional de Gastos de los Hogares 2012/2013. Resumen metodológico*, Buenos Aires, 2013, and D. Rossignolo, "Gender equity in taxation in Argentina: the case of indirect and direct taxes", *IDB Working Paper*, Washington, D.C., Inter-American Development Bank (IDB), forthcoming.

Note: The figures corresponding to vertical structure and horizontal structure are expressed as percentages.

Table 3
Household per capita income by employment status and income quintile
(Current dollars, millions of dollars and percentages)

Quintile	Description	Male-breadwinner households		Female-breadwinner households		Dual-earner households		Non-employed households		Total
		With children	Without children	With children	Without children	With children	Without children	With children	Without children	
1	Per capita income *(dollars)*	137.04	155.71	138.38	154.20	146.28	153.25	114.06	164.49	138.92
	Total income *(millions of dollars)*	429 002	34 169	151 291	14 129	256 874	13 339	77 960	27 281	1 004 045
	Vertical structure	10.0	0.9	11.3	0.8	3.6	0.3	42.2	1.8	4.1
	Horizontal structure	42.7	3.4	15.1	1.4	25.6	1.3	7.8	2.7	100.0
2	Per capita income *(dollars)*	280.18	286.11	289.81	284.85	289.34	289.40	284.47	305.97	286.64
	Total income *(millions of dollars)*	742 821	131 220	180 138	39 842	721 143	80 961	41 655	133 512	2 071 292
	Vertical structure	17.3	3.6	13.5	2.2	10.2	1.7	22.6	8.9	8.4
	Horizontal structure	35.9	6.3	8.7	1.9	34.8	3.9	2.0	6.4	100.0
3	Per capita income *(dollars)*	443.40	456.48	452.75	458.47	451.24	456.07	421.21	444.56	449.46
	Total income *(millions of dollars)*	843 130	302 761	214 621	157 316	1 064 359	243 371	15 337	408 369	3 249 263
	Vertical structure	19.6	8.4	16.1	8.7	15.1	5.0	8.3	27.2	13.2
	Horizontal structure	25.9	9.3	6.6	4.8	32.8	7.5	0.5	12.6	100.0
4	Per capita income *(dollars)*	673.40	722.70	711.54	713.88	710.71	745.81	711.00	700.17	710.43
	Total income *(millions of dollars)*	751 460	731 355	295 975	300 517	1 794 042	712 114	34 413	515 027	5 134 903
	Vertical structure	17.5	20.2	22.1	16.6	25.5	14.7	18.6	34.4	20.9
	Horizontal structure	14.6	14.2	5.8	5.9	34.9	13.9	0.7	10.0	100.0
5	Per capita income *(dollars)*	1 569.00	1 990.92	1 773.45	2 086.98	1 653.56	1 993.87	1 306.50	1 455.90	1 821.82
	Total income *(millions of dollars)*	1 535 144	2 416 009	494 285	1 296 791	3 204 140	3 790 862	15 174	414 735	13 167 140
	Vertical structure	35.7	66.8	37.0	71.7	45.5	78.3	8.2	27.7	53.5
	Horizontal structure	11.7	18.3	3.8	9.8	24.3	28.8	0.1	3.1	100.0
Total	Per capita income *(dollars)*	439.94	1 013.65	463.42	1 118.51	636.05	1 288.60	199.21	589.84	681.46
	Total income *(millions of dollars)*	4 301 556	3 615 515	1 336 309	1 808 595	7 040 558	4 840 647	184 539	1 498 924	24 626 642
	Vertical structure	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Horizontal structure	17.5	14.7	5.4	7.3	28.6	19.7	0.7	6.1	100.0

Source: Prepared by the author, on the basis of National Institute of Statistics and Censuses (INDEC), *Encuesta Nacional de Gastos de los Hogares 2012/2013. Resumen metodológico*, Buenos Aires, 2013, and D. Rossignolo, "Gender equity in taxation in Argentina: the case of indirect and direct taxes", *IDB Working Paper,* Washington, D.C., Inter-American Development Bank (IDB), forthcoming.

Note: Per capita income is expressed in dollars; the total income is expressed in millions of dollars; and the figures corresponding to vertical structure and horizontal structure are expressed as percentages.

3. Regulatory and methodological considerations concerning the taxes subjected to incidence analysis

This section deals with the characteristics of the indirect and direct taxes analysed here, considering in each case the tax regulation structure, rate system and exemptions and the methodological procedure used. The indirect taxes considered were VAT, excise taxes, fuel taxes and provincial turnover taxes; the direct taxes analysed were personal income tax, payroll taxes and other minimum taxes on income (the *monotributo*). These taxes yielded about 71% of total tax revenues (national and provincial) in 2012, while the estimates provided here cover about 80% of the revenue from the universe of taxes taken into consideration (assuming no tax evasion).

(a) Indirect taxes

VAT is a consumption tax levied on the equivalent of value added at every stage of production. It is levied on imports in much the same way as on domestic production, but exports are zero-rated (via offsetting rebates). The 21% general rate is usually applied to taxable events, but there is also a 27% rate, mainly applicable to public services provided to companies subject to tax, and a 10.5% rate for a limited number of goods and services. VAT-related regulations include a list of exemptions.[11] The trend in the design of this tax has been dictated by successive reforms aimed at broadening its base and increasing rates. VAT-exempt consumption amounted to 15% of total expenditure in 2006 (see Gómez Sabaini and Rossignolo, 2009).

The procedure for estimating the VAT contribution of each household in the ENGHo sample was to apply the relevant rates to each taxable or exempt item in the survey in accordance with the household's consumption pattern. Considering that the survey measures consumption expenditure, that no price data are included and that VAT is an ad valorem tax, if there are no other taxes affecting the tax base then the tax is calculated as:

$$taxpaid_{ij} = rate_j * \left(expend_{ij} / \left(1 + \sum_j rate_j \right) \right)$$

where $taxpaid_{ij}$ is the tax paid by household i on item j, $rate_j$ is the tax rate on item j and $expend_{ij}$ is the reported expenditure for household i on item j. Tax incidence for the i^{th} household on the k^{th} commodity group ($\bar{\theta}_i^k$) is defined as the ratio between the per capita yearly tax (VAT) outlay of the i^{th} household on the k^{th} commodity group ($\bar{T}_i^k$) and the per capita income of the i^{th} household (Y_{i_i}) (in the case of VAT).[12]

$$\bar{\theta}_i^k = \bar{T}_i^k / \left(Y_{i_i} \right), \text{ where } \bar{T}_i = \sum_k \bar{T}_i^k \text{ and } \bar{T}_i^k = \sum_j \bar{T}_{ij}, j \in k$$

Excise tax is levied on the domestic sale and import of some specific goods: tobacco, alcoholic beverages, beer, carbonated and other non-alcoholic beverages, motor vehicles and diesel. In all cases where goods are taxed, the tax base includes the tax itself. As the actual tax may not be subtracted from the tax base, the effective tax rate is different from the nominal tax rate. Products made in Argentina and exported are exempt. DNIAF (2013) gives the rates for the main products.

[11] The 10.5% rate includes fresh, refrigerated and frozen fruits, legumes and vegetables, grains, bread and domestic passenger transportation services, among other things. The main exemptions are for natural water, milk without additives and medicines.

[12] The 1997 input/output table was used for exempt goods, taking data from 1993. For each exempt good the taxable proportion of inputs was estimated, the incidence of taxable inputs in the sales value of exempt goods was calculated and this structure was applied to the total for VAT purchases deriving from the consumption of exempt goods.

For excise taxes on goods and services, each item was classified in accordance with tax regulations so that it could be matched to a similar item in the ENGHo, the usual assumption being made that these taxes are fully transferred to the price of the corresponding products.

In the case of fuel tax, liquid fuel and compressed natural gas were taxed as of 2012. DNIAF (2013) gives the products taxed, tax rates and minimum amounts per unit of measurement. Although there is no reliable study in Argentina determining the percentage of fuel costs going to form part of the transportation cost transferred to the consumer, it has been assumed that 30% of the tax is transferred at present, essentially because transport and fuel subsidies distort relative values.

The provincial turnover tax is a very important source of revenue for subnational governments and is applied by all provinces. It is levied at all stages of goods and services production and distribution, applies to gross income without deduction for tax already paid and accumulates through successive purchases. Each province's tax code lays down the basic principles of the tax, together with rates. In general, the highest rates are levied on commerce and services and financial intermediation (4.5% to 5%), followed by industry and then the primary sector.

In order to calculate tax incidence, the tax rates were applied to reported consumption data. According to several authors (see, for instance, Rossignolo, 2015), effective tax rates are at least twice as high as rates for final consumption, and rates on retail consumption have accordingly been increased by 150% to reflect this. This tax is the closest to input costs and should be included in calculations of the tax base for VAT and excise taxes.

(b) Direct taxes

It is commonly assumed that for personal income tax and other taxes related to income, the economic incidence is the same as the statutory incidence. For payroll taxes, it is assumed that the burden is completely borne by employees through a reduced wage. Household surveys report net income for wage workers, i.e. earnings after social security contributions.

Surveys rarely report how much respondents paid in income taxes. For formal workers, after-tax income is reported, which means that reported earnings ought to be grossed up to arrive at pre-tax income. For non-formal wage workers, employers, self-employed workers, recipients of capital income, social security beneficiaries, pensioners and beneficiaries of public transfers, reported income reflects earnings before taxes. Arriving at the tax burden means calculating tax revenues from all these sources, assuming they represent taxable income (except for transfers).

Personal income tax applies to manifold types of income and is structured with progressive rates; its tax base has been expanded by numerous resolutions. The Income Tax Act[13] sets forth four categories of income by source, namely land rent, capital gains, corporate and certain business brokers' income, and personal income. A single taxpayer may generate income in more than one income category at the same time. Taxable income is calculated from income and expenses in the four categories and from holdings in companies or activities. Net taxable income is calculated by deducting costs,[14] allowable personal expenses, dependency allowances, the minimum non-taxable income threshold and the special deduction from income. The monthly earnings of wage workers are subject to withholdings made by employers, who are responsible for paying the tax owing to the tax authorities.

[13] Income tax is governed by Law No. 20628, which was enacted in 1973 and subsequently amended and regulated on numerous occasions.

[14] Authorized expenses are those "incurred to obtain, maintain and preserve the income subject to the tax" and are subtracted from the income produced by the source giving rise to them.

There are exemptions for interest on saving account deposits and term deposits, income from securities, shares, bonds, bills of exchange, notes and other paper issued or to be issued in the future by a government authority and the rental value of owner-occupied residences, among other things. Pensions, retirement payments, subsidies and pay received during medical leave are not exempt.

For formal workers, tax rates depend on the taxable net income bracket their earnings fall into. The system is based on a sliding scale consisting of a fixed amount plus the amount calculated by applying a rate ranging from 9% to 35% on the excess over the base level of each income bracket (see DNIAF, 2013). Pre-tax income is reported for all other earners, so that thresholds and deductions should be applied in accordance with the tax bracket this income falls into in order to calculate the amount of tax collected.

There is a group of "small taxpayers" whose gross income does not exceed US$ 65,800 annually and who are taxed under the simplified *monotributo* regime, paying a fixed amount of tax each month in a single payment that replaces personal income tax and VAT plus social security and health insurance contributions. The income tax included in the single payment is based on income bracket, with earnings being estimated from turnover, the surface area of production facilities, the use of power during production or a combination of these (see DNIAF, 2013), and no rules for assessing income, standard deductions, dependents or special deductions are applied. A fixed amount of tax is levied in accordance with the *monotributo* category into which taxpayers fall.

Incidence was calculated by taking the individual earnings of self-employed people and employers and checking whether their reported (pre-tax) income was below the threshold established by the tax code. All the taxpayers selected were to be excluded from the personal income tax base.

Payroll taxes and social security contributions were also included for formal and non-formal workers. They were calculated in two parts: revenue generated by formal workers and the amount paid by self-employed workers. The household survey provides information on the former by reporting whether the employer has withheld employee contributions at source, thus paying both the employer's and the employee's dues. In the case of the self-employed, since no evasion is assumed, the calculations assume that they are contributing to the social security system as long as they have not been included in the *monotributo* regime.

In the case of the formal sector, incidence was estimated using statutory rates (see DNIAF, 2013) by "grossing up" wage workers' income as reported in the survey, net of personal income tax. In the case of the self-employed (whose earnings are reported pre-tax), the calculation used progressive tax rates differing between professionals and traders, who were identified in the household survey by years of education.

V. Estimation results

This section presents the incidence analysis results. The variable used in the analysis is tax as a percentage of pre-tax per capita income; all tables show mean values. The results will be presented separately for indirect and direct taxes and the different pre-tax per capita income quintiles.[15]

Table 4 shows the overall incidence of the tax system. Taxes are progressive overall, since the progressivity of direct taxes more than compensates for the regressivity of indirect ones; the average aggregate tax burden is 33.4%.

[15] Standard errors are available from the author upon request.

Table 4
Taxes as a share of pre-tax income, by tax and per capita income quintile
(Percentages)

Quintile	Total indirect taxes	Value added tax	Turnover tax	Excise tax	Fuel tax	Total direct taxes	Personal income tax	Payroll taxes	Minimum/ other direct taxes	Total tax system
1	22.43	13.41	6.85	1.47	0.69	5.97	0.00	5.25	0.72	28.40
	0.44	0.24	0.15	0.09	0.05	0.42	0.00	0.43	0.04	0.58
2	16.93	9.98	5.22	0.97	0.76	13.52	0.00	12.93	0.59	30.46
	0.48	0.28	0.15	0.04	0.06	0.49	0.00	0.51	0.03	0.65
3	13.70	8.09	4.32	0.70	0.75	16.74	0.00	16.21	0.53	30.61
	0.28	0.16	0.09	0.03	0.05	0.50	0.00	0.51	0.04	0.51
4	12.33	7.17	3.84	0.56	0.77	20.54	0.37	19.63	0.54	32.87
	0.21	0.12	0.07	0.02	0.04	0.44	0.09	0.44	0.04	0.43
5	8.64	4.95	2.68	0.32	0.68	36.02	10.06	25.43	0.53	44.66
	0.17	0.10	0.06	0.01	0.03	0.55	0.30	0.36	0.05	0.53
Total	14.84	8.72	4.58	0.80	0.73	18.56	2.09	15.89	0.58	33.40
	0.17	0.10	0.05	0.02	0.02	0.26	0.09	0.22	0.02	0.26

Source: Prepared by the author on the basis of National Institute of Statistics and Censuses (INDEC), *Encuesta Nacional de Gastos de los Hogares 2012/2013. Resumen metodológico*, Buenos Aires, 2013, and D. Rossignolo, "Gender equity in taxation in Argentina: the case of indirect and direct taxes", *IDB Working Paper*, Washington, D.C., Inter-American Development Bank (IDB), forthcoming.

It can be observed that the indirect tax burden for all households averages 14.8% of income. Most of that results from the large impact of VAT, whose average incidence overall is 8.7%, while the aggregate tax burden of the turnover tax is 4.5%. The incidence of excise and fuel taxes is similar at around 1.2% of per capita income. The largest burden is borne by female-breadwinner households (16.2%).

Indirect taxes are very regressive in the aggregate: the burden is 22.4% in the first quintile, decreasing to 8.6% in the highest quintile. To take the taxes separately, VAT is regressive, with the first quintile having a burden of 13.4% and the fifth one of 4.9%, and so are excise taxes, with burdens of 1.5% and 0.3%, respectively. The differences are statistically significant in all cases. The fuel tax is more or less proportional, with both the first and fifth quintiles having burdens of 0.6%.

Table 5 and figure 4 present the estimated aggregate incidence of direct, indirect and total taxes by household type, while table A1.1 of the annex presents the results disaggregated by type of tax. None-employed households without children in the first quintile bear the largest indirect tax burden (31.8%), while female breadwinners with children show the most regressive burden. Dual-earner households without children have the smallest average burden over all quintiles.

VAT incidence by household type and quintile is what most heavily influences overall tax behaviour, and it is particularly strong in the lower segments of the distribution. Although non-employed households without children in the poorest quintile face the largest VAT burden, female-breadwinner households in that quintile still bear a larger burden than male-breadwinner or dual-earner households.

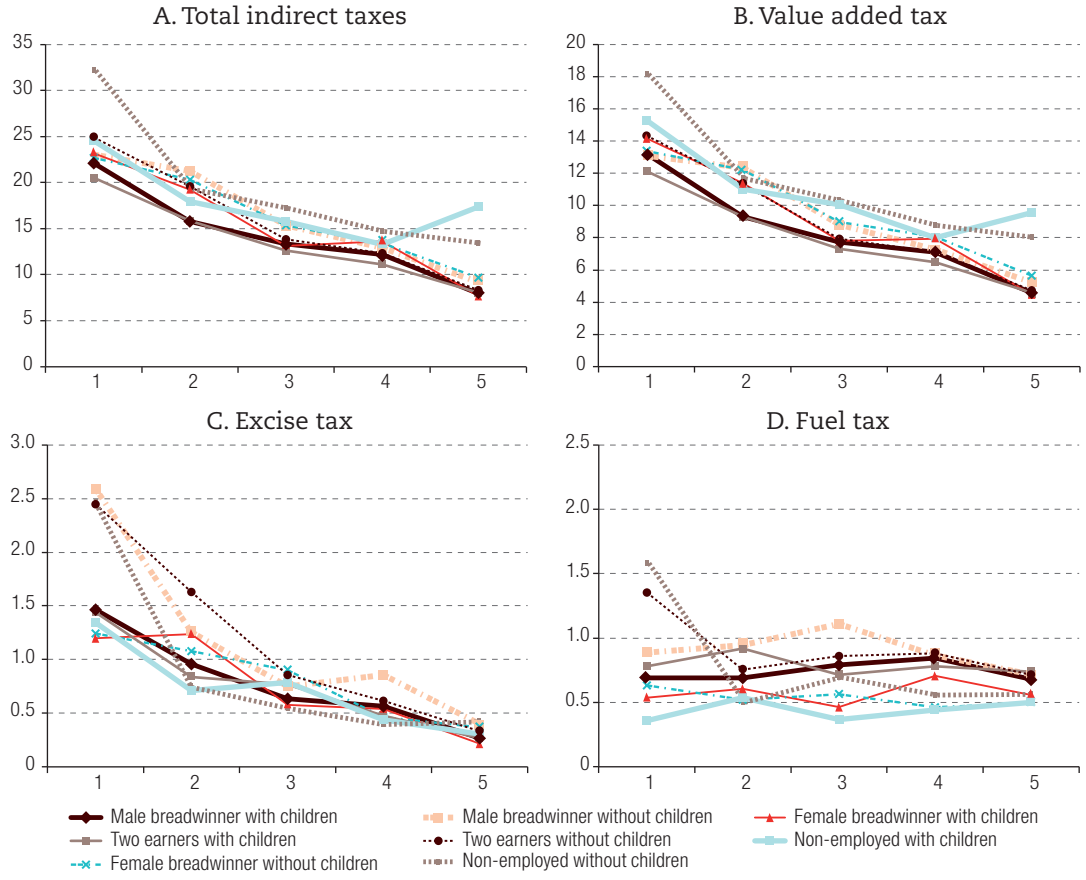
Male-breadwinner households without children exhibit the greatest regressivity in the first quintile, only to be displaced in the second quintile by dual earners in the case of excise taxes. In the fourth and fifth quintiles, male-breadwinner households once again have the largest tax burden.

Table 5
Taxes as a share of pre-tax income, by household type and per capita income quintile
(Percentages)

	Quintile					
	1	2	3	4	5	Total
			Total direct taxes			
Male breadwinner with children	8.07	19.42	25.78	26.82	50.52	20.98
Male breadwinner without children	6.68	5.57	8.77	16.13	30.24	17.62
Male breadwinner	7.98	17.37	21.38	21.74	39.30	20.08
Female breadwinner with children	5.66	10.35	20.21	25.02	45.43	15.70
Female breadwinner without children	1.72	5.22	8.92	14.04	29.94	17.60
Female breadwinner	5.36	9.41	15.47	19.49	34.73	16.38
Two earners with children	5.39	13.88	19.76	26.52	40.12	21.26
Two earners without children	5.11	6.85	12.94	19.70	34.05	24.71
Two earners	5.37	13.17	18.50	24.65	37.11	22.13
Non-employed with children	0.15	0.05	0.59	1.04	1.89	0.22
Non-employed without children	0.23	0.00	0.01	0.12	1.68	0.24
Non-employed	0.17	0.02	0.03	0.17	1.69	0.24
Total	5.97	13.52	16.74	20.54	36.02	18.56
			Total indirect taxes			
Male breadwinner with children	22.13	15.80	13.32	12.21	7.94	16.15
Male breadwinner without children	23.02	21.24	15.32	12.90	9.19	13.78
Male breadwinner	22.19	16.60	13.83	12.54	8.63	15.52
Female breadwinner with children	23.19	19.22	13.13	13.66	7.69	17.81
Female breadwinner without children	22.69	20.29	15.32	13.42	9.68	13.50
Female breadwinner	23.16	19.42	14.05	13.54	9.06	16.26
Two earners with children	20.55	15.88	12.64	11.13	8.05	13.48
Two earners without children	24.90	19.56	13.83	12.31	8.32	11.34
Two earners	20.76	16.25	12.86	11.46	8.18	12.93
Non-employed with children	24.57	17.93	15.79	13.29	17.39	22.49
Non-employed without children	31.86	19.00	16.91	14.43	13.15	17.11
Non-employed	25.99	18.73	16.87	14.36	13.32	18.55
Total	22.43	16.93	13.87	12.33	8.64	14.84
			Total tax system			
Male breadwinner with children	30.21	35.22	39.10	39.04	58.46	37.13
Male breadwinner without children	29.70	26.81	24.09	29.03	39.43	31.41
Male breadwinner	30.17	33.98	35.22	34.28	47.92	35.60
Female breadwinner with children	28.86	29.57	33.34	38.68	53.13	33.51
Female breadwinner without children	24.41	25.51	24.24	27.46	39.61	31.10
Female breadwinner	28.51	28.82	29.52	33.03	43.80	32.65
Two earners with children	25.94	29.76	32.39	37.65	48.17	34.74
Two earners without children	30.01	26.42	26.77	32.01	42.37	36.04
Two earners	26.13	29.42	31.36	36.11	45.29	35.07
Non-employed with children	24.72	17.98	16.38	14.32	19.28	22.72
Non-employed without children	32.10	19.00	16.92	14.54	14.83	17.35
Non-employed	26.16	18.75	16.90	14.53	15.01	18.78
Total	28.40	30.46	30.61	32.87	44.66	33.40

Source: Prepared by the author on the basis of National Institute of Statistics and Censuses (INDEC), *Encuesta Nacional de Gastos de los Hogares 2012/2013. Resumen metodológico*, Buenos Aires, 2013, and D. Rossignolo, "Gender equity in taxation in Argentina: the case of indirect and direct taxes", *IDB Working Paper*, Washington, D.C., Inter-American Development Bank (IDB), forthcoming.

Figure 4
Indirect taxes as a share of pre-tax income, by household type and per capita income quintile
(Percentages)



Source: Prepared by the author on the basis of National Institute of Statistics and Censuses (INDEC), *Encuesta Nacional de Gastos de los Hogares 2012/2013. Resumen metodológico*, Buenos Aires, 2013, and D. Rossignolo, "Gender equity in taxation in Argentina: the case of indirect and direct taxes", *IDB Working Paper*, Washington, D.C., Inter-American Development Bank (IDB), forthcoming.

Fuel taxes are fairly proportional, with the highest burden in the first quintile being for dual-earner and non-employed households, while in the case of turnover tax the pattern is regressive except for non-employed households with children, which display a U shape. These households have the largest fuel tax burden.

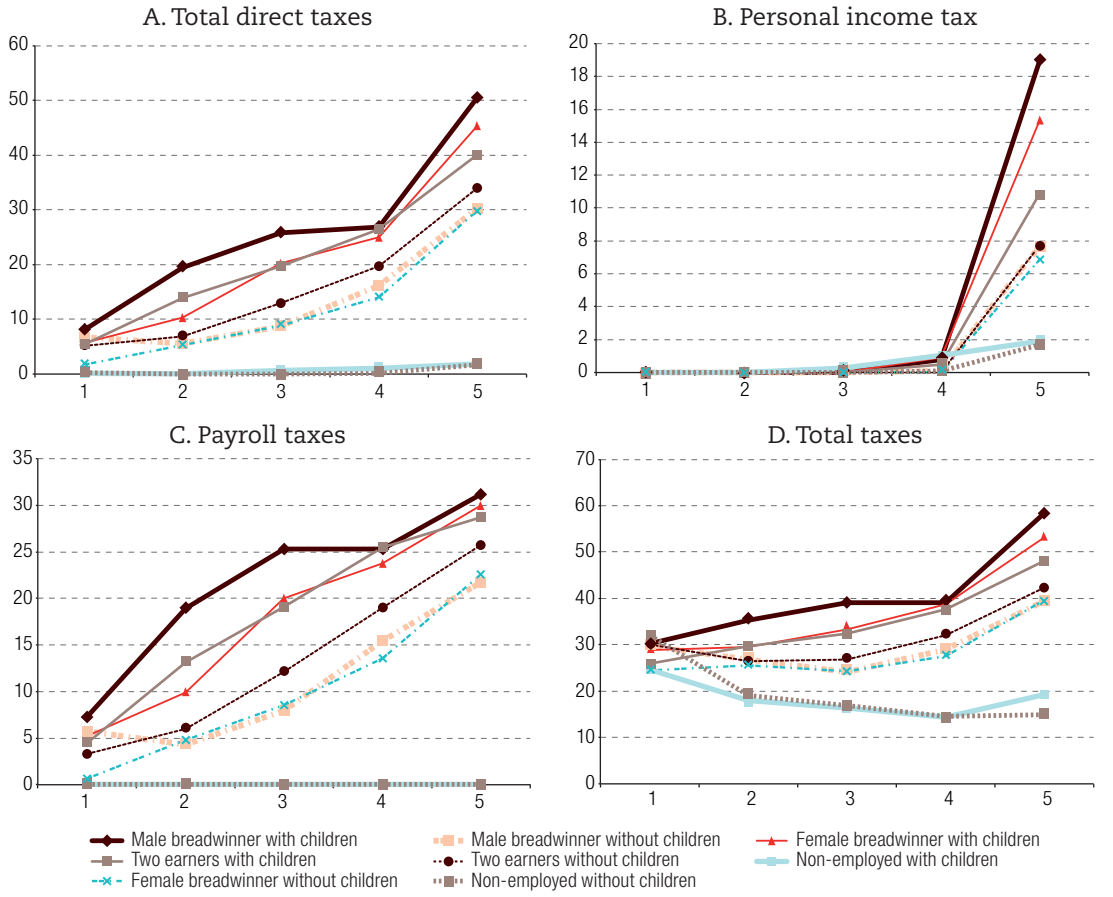
In the case of direct taxes, the estimations included personal income tax, payroll taxes and minimum or presumptive taxes on income. The burden of personal income tax is low by the standards of countries in the Organization for Economic Cooperation and Development (OECD) (Gómez Sabaini, Jiménez and Rossignolo, 2012), which reduces the redistributive effect that can be expected of it. It is heavily concentrated in the highest income quintiles, with the lowest brackets being outside the personal income tax net. These lower-income individuals, and many of those included in higher-income quintiles but working on their own account, are meant to pay the minimum or presumptive tax (*monotributo*), whose impact on the distribution of the tax burden is a matter of debate.

In table 4, it can be observed that the burden for all households and taxes is 18.5%. Most of that results from the large impact of payroll taxes, whose total average incidence is 15.8%. On aggregate, direct taxes are markedly progressive, with a burden of 5.9% in the lowest-income quintile, rising

to 36.0% in the highest quintile. However, the analysis by tax shows that while personal income tax and payroll taxes are progressive, the *monotributo* is moderately regressive, as the first quintile bears a burden of 0.7% and the fifth one of 0.5%. All differences in tax burdens across quintiles and within household classifications are statistically significant (tables 5 and A1.1 of the annex).[16]

Figure 5 shows aggregate results for the estimated incidence of the direct taxes under consideration, by household type. The largest burden is borne by dual-earner households (22.1%). All taxes except the *monotributo* follow a similar pattern, and almost all household types exhibit a similar progressivity up the first four quintiles, with a peak in the fifth due to the personal income tax. The largest burden is borne by male-breadwinner households in all income quintiles, and the tax burden is invariably heavier for households with children.

Figure 5
Direct and total taxes as a share of pre-tax income, by household type and per capita income quintile
(Percentages)



Source: Prepared by the author on the basis of National Institute of Statistics and Censuses (INDEC), *Encuesta Nacional de Gastos de los Hogares 2012/2013. Resumen metodológico*, Buenos Aires, 2013, and D. Rossignolo, "Gender equity in taxation in Argentina: the case of indirect and direct taxes", *IDB Working Paper*, Washington, D.C., Inter-American Development Bank (IDB), forthcoming.

[16] All tests for significance across the different household classifications and the different quintiles within each household classification are available from the author upon request.

Almost all personal income tax is paid by households in the fourth and fifth quintiles. Households with children bear the largest burden of this tax, as they account for a higher proportion of total income than those without children, and male breadwinners have the heaviest burden in the fifth quintile.

High thresholds and deductions mean that personal income tax is paid by few people, and this makes it progressive, with most of the burden falling on the highest quintile. Male-breadwinner and female-breadwinner households have the largest burden, while households where no-one is employed, being outside the formal sector, have the smallest.

The incidence of payroll taxes as a share of pre-tax income is also progressive, it once again being male-breadwinner households with children that bear the largest burden. The *monotributo*, on the contrary, is moderately regressive. The largest burden is borne by male-breadwinner households without children, but this tax is most regressive for dual-earner households without children.

The largest average burden of personal income tax is borne by male-breadwinner households without children (2.6%), while in the fifth quintile male-breadwinner households with children pay the most. The largest *monotributo* burden falls on male-breadwinner households with children, particularly in the richest quintile. Female-breadwinner households bear a larger burden than male-breadwinner households in the first quintile, as they are more likely to be own-account workers who do not pay personal income tax.

On aggregate, and as far as the taxes analysed are concerned, the tax system is progressive. The tax burden falls most heavily on male-breadwinner, female-breadwinner and dual-earner households and is higher for all types of households with children except those where no-one is employed. The burden for households without children tends to be quite proportional, whereas the burden for households where no-one is employed is more regressive. As mentioned earlier, these results stem from the fact that male-breadwinner households have lower per capita income than female-breadwinner ones.

VI. Summary and conclusions

The main aim of this research was to analyse how the tax system affected gender equity in Argentina, and specifically whether it promoted it. Argentina's tax system has undergone significant and very frequent changes over the past two decades. However, these have not been part of a comprehensive reform but have been designed as stopgap resource-raising measures to cover budget deficits, and very few have been intended to improve equity.

The analysis of indirect taxes included VAT, excise taxes, fuel tax and provincial turnover taxes, while the direct taxes included were personal income tax, payroll taxes and minimum or presumptive taxes. The welfare indicator employed was pre-tax per capita income, and the analysis was carried out for per capita income quintiles and household categories based on employment status, with individuals being ranked in the same way.

When the burden of indirect taxes on income is analysed, striking differences emerge. For instance, female-breadwinner households bear the largest burden, since they are concentrated in a lower part of the income distribution than other household types, such as the male-breadwinner and dual-earner types. The indirect tax system is heavily regressive overall and in the specific cases of VAT, excise taxes and the turnover tax; while fuel taxes, unlike these, are fairly proportional, they are not enough to not offset this effect. Households without children have a larger share of the tax burden, particularly female-breadwinner ones.

Personal income taxation in Argentina has strengths and weaknesses when it comes to gender equity. The individual taxation principle is one of the system's strengths because it does not a priori discourage women from earning; nevertheless, there is formal discrimination against women insofar as they have no tax liability for joint income.

An important aspect of Argentina's personal income tax system is its segmentation into three different categories of taxpayers (wage workers, high-income self-employed and low-income self-employed paying the *monotributo*) subject to different thresholds and deductions. Another type of discrimination arises from the personal income tax code in Argentina, which simultaneously entails horizontal and vertical inequity, in the form of provisions for exemptions. People obtaining their income from their own work have to pay income tax, assuming they earn above the threshold. Conversely, people obtaining their income from capital (e.g. by participating in the stock market) do not have to pay income tax. People with high incomes, especially men, are overrepresented among the latter.

Households with children have the highest direct tax burden, particularly male-breadwinner and dual-earner households. The low impact of personal income tax, which is only paid by the top 30% or so of earners, reduces the scope for using this tax to pursue equity-oriented policies.

A number of policy measures for reducing the burden of indirect taxes on the poorest female-breadwinner households can be suggested. Cutting the VAT rate on a basket of selected foods, public transportation and children's clothing while increasing excise taxes on luxury goods would make indirect taxes more equitable. In the case of direct taxes, broadening the personal income tax base to cover capital income, most of which is received by male-breadwinner households, would also improve gender equity.

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Annex A1

Table A1.1
Taxes as a share of pre-tax income, by household type and per capita income quintile
(Percentages)

	Quintile						Quintile					
	1	2	3	4	5	Total	1	2	3	4	5	Total
	Personal income tax						Turnover tax					
Male breadwinner with children	0.00	0.00	0.00	0.78	18.94	1.98	6.77	4.82	4.16	3.72	2.41	4.95
Male breadwinner without children	0.00	0.00	0.00	0.10	7.69	2.65	6.45	6.69	4.64	3.91	2.84	4.20
Male breadwinner	0.00	0.00	0.00	0.46	12.71	2.16	6.75	5.10	4.28	3.81	2.65	4.75
Female breadwinner with children	0.00	0.00	0.01	0.93	15.33	1.62	7.30	5.98	4.28	4.48	2.44	5.64
Female breadwinner without children	0.00	0.00	0.00	0.01	6.88	2.65	7.44	6.46	4.87	4.44	3.17	4.39
Female breadwinner	0.00	0.00	0.00	0.47	9.50	1.99	7.31	6.07	4.53	4.46	2.94	5.19
Two earners with children	0.00	0.00	0.00	0.46	10.88	2.01	6.18	4.82	3.85	3.41	2.45	4.10
Two earners without children	0.00	0.00	0.00	0.01	7.74	3.92	6.77	5.88	4.16	3.70	2.55	3.42
Two earners	0.00	0.00	0.00	0.34	9.33	2.49	6.21	4.93	3.91	3.49	2.50	3.92
Non-employed with children	0.00	0.00	0.29	1.04	1.89	0.09	7.60	5.68	4.57	4.41	7.04	7.00
Non-employed without children	0.00	0.00	0.00	0.10	1.68	0.22	9.86	6.29	5.56	4.88	4.33	5.63
Non-employed	0.00	0.00	0.01	0.16	1.69	0.18	8.04	6.13	5.52	4.85	4.43	6.00
Total	0.00	0.00	0.00	0.37	10.06	2.09	6.85	5.22	4.32	3.84	2.68	4.58
	Payroll taxes						Excise tax					
Male breadwinner with children	7.28	18.91	25.27	25.31	31.21	18.38	1.46	0.96	0.63	0.56	0.27	0.94
Male breadwinner without children	5.71	4.30	7.99	15.43	21.71	14.15	2.59	1.26	0.75	0.86	0.40	0.84
Male breadwinner	7.18	16.76	20.80	20.61	25.95	17.25	1.54	1.00	0.66	0.70	0.34	0.92
Female breadwinner with children	5.23	9.95	20.02	23.77	29.97	13.74	1.20	1.24	0.58	0.54	0.21	0.91
Female breadwinner without children	0.66	4.78	8.55	13.60	22.57	14.48	1.24	1.08	0.90	0.46	0.37	0.62
Female breadwinner	4.88	9.00	15.20	18.66	24.86	14.01	1.20	1.21	0.71	0.50	0.32	0.81
Two earners with children	4.46	13.17	19.06	25.48	28.68	18.56	1.44	0.84	0.77	0.48	0.27	0.74
Two earners without children	3.31	5.98	12.10	19.00	25.76	20.11	2.45	1.63	0.86	0.62	0.33	0.62
Two earners	4.41	12.44	17.77	23.70	27.23	18.95	1.49	0.92	0.78	0.51	0.30	0.71
Non-employed with children	0.00	0.00	0.00	0.00	0.00	0.00	1.34	0.71	0.79	0.44	0.31	1.16
Non-employed without children	0.00	0.00	0.00	0.00	0.00	0.00	2.46	0.75	0.54	0.39	0.42	0.65
Non-employed	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.74	0.55	0.40	0.41	0.78
Total	5.25	12.93	16.21	19.63	25.43	15.89	1.47	0.97	0.70	0.56	0.32	0.80
	Minimum/other direct taxes						Fuel tax					
Male breadwinner with children	0.79	0.50	0.51	0.74	0.37	0.61	0.69	0.69	0.79	0.84	0.68	0.73
Male breadwinner without children	0.97	1.27	0.78	0.60	0.84	0.82	0.89	0.95	1.11	0.87	0.72	0.87
Male breadwinner	0.80	0.62	0.58	0.67	0.63	0.67	0.71	0.73	0.87	0.85	0.70	0.77
Female breadwinner with children	0.43	0.40	0.19	0.32	0.14	0.34	0.54	0.61	0.46	0.71	0.56	0.57
Female breadwinner without children	1.06	0.44	0.37	0.42	0.48	0.47	0.63	0.52	0.56	0.46	0.49	0.51
Female breadwinner	0.48	0.41	0.26	0.37	0.38	0.39	0.54	0.59	0.51	0.58	0.51	0.55
Two earners with children	0.93	0.72	0.70	0.58	0.55	0.69	0.78	0.92	0.71	0.78	0.74	0.79
Two earners without children	1.80	0.87	0.84	0.70	0.55	0.68	1.35	0.76	0.86	0.88	0.71	0.79
Two earners	0.97	0.73	0.73	0.61	0.55	0.68	0.81	0.90	0.74	0.81	0.73	0.79
Non-employed with children	0.15	0.05	0.30	0.00	0.00	0.13	0.36	0.54	0.37	0.44	0.50	0.39
Non-employed without children	0.23	0.00	0.01	0.01	0.00	0.02	1.56	0.48	0.67	0.54	0.54	0.64
Non-employed	0.17	0.02	0.02	0.01	0.00	0.05	0.59	0.49	0.66	0.53	0.54	0.58
Total	0.72	0.59	0.53	0.54	0.53	0.58	0.69	0.76	0.75	0.77	0.68	0.73

Table A1.1 (concluded)

	Quintile						Quintile					
	1	2	3	4	5	Total	1	2	3	4	5	Total
	Value added tax						Total tax system					
Male breadwinner with children	13.21	9.33	7.74	7.09	4.58	**9.53**	30.21	35.22	39.10	39.04	58.46	37.13
Male breadwinner without children	13.09	12.34	8.82	7.26	5.23	**7.87**	29.70	26.81	24.09	29.03	39.43	31.41
Male breadwinner	13.20	9.77	8.02	7.17	4.94	**9.09**	30.17	33.98	35.22	34.28	47.92	35.60
Female breadwinner with children	14.16	11.40	7.82	7.94	4.49	**10.69**	28.86	29.57	33.34	38.68	53.13	33.51
Female breadwinner without children	13.38	12.23	8.98	8.06	5.65	**7.99**	24.41	25.51	24.24	27.46	39.61	31.10
Female breadwinner	14.10	11.55	8.31	8.00	5.29	**9.72**	28.51	28.82	29.52	33.03	43.80	32.65
Two earners with children	12.15	9.30	7.30	6.46	4.59	**7.85**	25.94	29.76	32.39	37.65	48.17	34.74
Two earners without children	14.33	11.30	7.95	7.11	4.72	**6.50**	30.01	26.42	26.77	32.01	42.37	36.04
Two earners	12.25	9.50	7.42	6.64	4.66	**7.51**	26.13	29.42	31.36	36.11	45.29	35.07
Non-employed with children	15.27	11.00	10.06	8.00	9.54	**13.94**	24.72	17.98	16.38	14.32	19.28	22.72
Non-employed without children	17.98	11.49	10.14	8.62	7.86	**10.19**	32.10	19.00	16.92	14.54	14.83	17.35
Non-employed	15.80	11.37	10.14	8.58	7.93	**11.19**	26.16	18.75	16.90	14.53	15.01	18.78
Total	13.41	9.98	8.09	7.17	4.95	**8.72**	28.40	30.46	30.61	32.87	44.66	33.40

Source: Prepared by the author on the basis of National Institute of Statistics and Censuses (INDEC), *Encuesta Nacional de Gastos de los Hogares 2012/2013. Resumen metodológico*, Buenos Aires, 2013, and D. Rossignolo, "Gender equity in taxation in Argentina: the case of indirect and direct taxes", *IDB Working Paper*, Washington, D.C., Inter-American Development Bank (IDB), forthcoming.

Fiscal sustainability and the cyclically adjusted balance policy: methodology and analysis for Chile

Mauricio G. Villena, Cristóbal Gamboni
and Andrés Tomaselli

Abstract

This paper sets forth a framework for analysing fiscal sustainability in the Chilean economy. It starts by making an ex post calculation of indicators of vulnerability and fiscal sustainability, based on the estimation of a sustainable debt level, with public finances considered in stationary state. It then develops an ad hoc dynamic fiscal sustainability model for Chile's public finances, which for the first time incorporates the dynamic of the Pension Reserve Fund (FRP) with its accumulation and disbursement rules, together with the cyclically adjusted balance policy. Lastly, the study simulates the path of the budgetary central government's net debt up to 2025, using the projections made in the 2018 Public Finance Report, under a macroeconomic trend scenario and another adverse scenario, all framed by the cyclically adjusted balance rule.

Keywords

Tax administration, fiscal policy, public finance, macroeconomics, public debt, economic indicators, economic trends, Chile

JEL classification

E62, H6, O23, O11

Authors

Mauricio G. Villena is a full professor in the Business School at Adolfo Ibáñez University, Santiago, Chile. Email: mauricio.villena@uai.cl.

Cristóbal Gamboni is Senior Economist at BBVA Research, Chile. Email: cristobal.gamboni@bbva.com.

Andrés Tomaselli is a student enrolled in the master's programme in public policy of the University of Chile. Email: aptomaselli@gmail.com.

I. Introduction

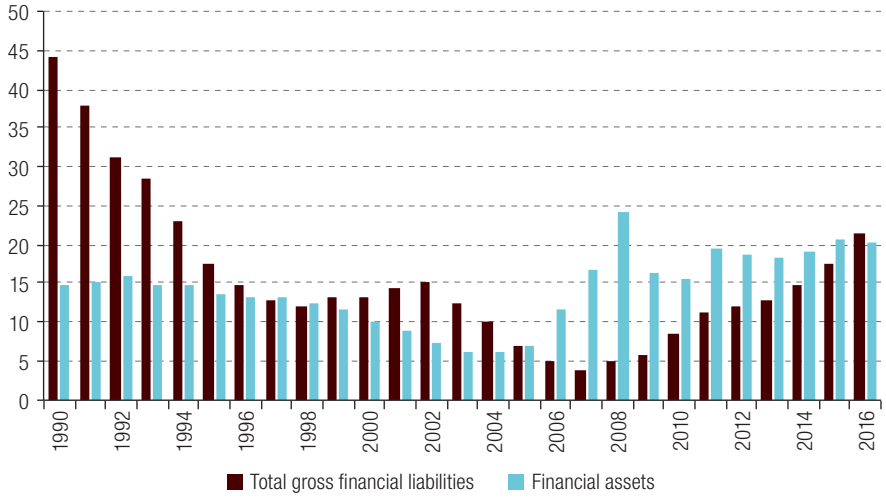
High and rising debt levels undermine a country's credit rating, thereby generating greater uncertainty in financial markets and driving up the risk premium. This forces the country in question to spend more on debt service, thereby putting greater pressure on other expenditure. In many cases, the only way to reduce the deficit in the short term is by cutting back on public spending, which has negative social consequences.

The dynamics and sustainability of the public debt depend on the behaviour of the public deficit and its interrelationship with the different phases of the business cycle, its vulnerability or volatility in the face of exogenous shocks, capital markets, domestic and external interest rates, and the real exchange rate. A country's net public debt represents accumulated past fiscal outturns, while future balances incorporate the resulting interest income and expenses. Systematic fiscal imbalances will thus generate future interest expenditure, which in turn will contribute to the accumulation of new debt.

For nearly two decades, Chilean fiscal policy has been based on a cyclically adjusted balance (CAB) rule applicable to total central government, which is consistent with the medium-term macroeconomic equilibria —in other words with a level of public debt that is sustainable through time.[1] In practice, this implied a decreasing trend in the accumulation of gross liabilities by the budgetary central government[2] until 2010, which has tended to reverse more recently but without returning to the levels of pre-rule years. Figure 1.A shows that, on average, the gross debt/GDP ratio fell from 22.6% in 1990-2000 to 11.1% in 2001-2016.

Figure 1
Central government debt, 1990-2016

A. Central government financial assets and total gross financial liabilities, 1990-2016
(Percentages of GDP)

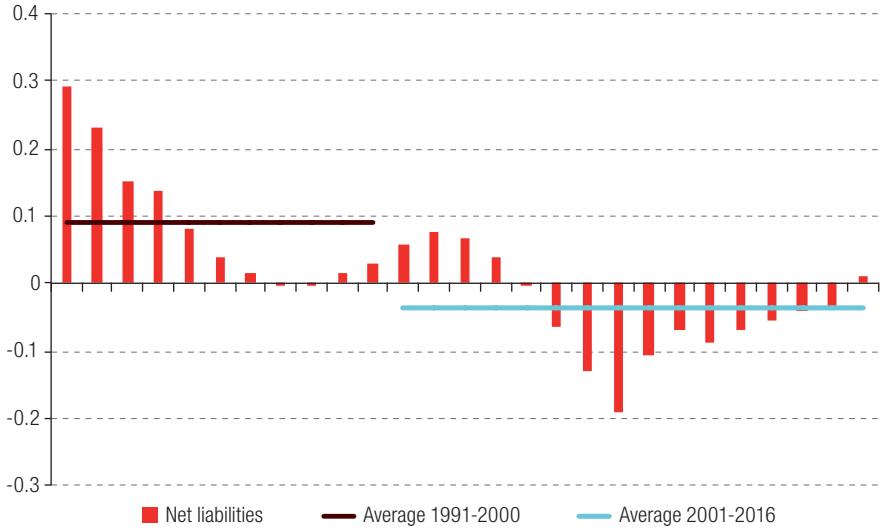


[1] The total central government encompasses institutions that are subject to the same budgetary planning and execution rules, which are closely related to the Executive Branch, plus the extra-budgetary operations associated with this level of government.

[2] Although this paper considers income and expenditure flows for total central government, it analyses both gross and net debt stocks for the budgetary central government. The perimeter of the latter excludes unpaid recognition bonds for reasons explained below.

Figure 1 (concluded)

B. Central government net financial liabilities, 1990-2016
(Percentages of GDP)



Source: Prepared by the authors, on the basis of information from the Ministry of Finance and the Central Bank of Chile.

Thus, while the CAB rule has been in force, the budgetary central government moved from a net debtor position in 2000 to become a net creditor in 2005; and it maintained that status until 2015 (see figure 1.B). This trend of net borrowing has enabled Chile to improve its credibility as a debt issuer, both domestically and internationally.

Despite these fiscal-policy achievements, Chile's fiscal accounts have come under heavy pressure in the last decade —first and foremost because of the international financial crisis of 2008-2009 and the February 2010 earthquake and tsunami. In recent years, however, fiscal policy has also been exposed to a number of imbalances that have resulted in five consecutive years of budget deficits, with a consequent increase in debt. The sustained deterioration of the fiscal situation meant that, after 12 years as a creditor, Chile became a net debtor again in 2016, with a net debt of 1% of GDP. This fiscal position takes the country back to 2004, when its net debt represented 4% of GDP; and it is consistent with the growth of gross debt, which reached 21.3% of GDP in 2016, its highest level since the 22.9% attained in 1994 (see table 1). As a result of the increase in net debt, interest expenses are now over US$ 1 billion greater than in 2009 (DIPRES, 2017d).[3] This fiscal deterioration has been internalized by the risk rating agencies, with Standard & Poor's downgrading Chile's long-term foreign currency risk rating for the first time in 25 years, from the AA- gained in 2012 to A+ (see Arellano, 2017, p. 14).

Although the current levels of Chile's central government net debt do not seem unduly high compared to those of other countries in the region or in the Organization for Economic Cooperation and Development (OECD), the spending pressures projected for the coming years could render its fiscal position increasingly vulnerable. A question that arises in this scenario is the extent to which Chile's long-term fiscal sustainability is compromised in the event of potential turbulence in the economy.

This article contributes to discussion on this issue by proposing a framework for analysing fiscal sustainability in the Chilean economy. To that end, it starts by making an ex post calculation of vulnerability and fiscal sustainability indicators adapted to the Chilean fiscal reality, based on an estimated sustainable debt level, considering public finances in stationary state. This makes it possible to quantify the evolution of Chilean fiscal sustainability and shed light on the impact of recent crises.

[3] See DIPRES (2017d).

Secondly, as the indicator analysis is static and does not make it possible to simulate the potential effects of an economic crisis on Chile's public finances, this study develops a dynamic model of fiscal sustainability. Its specific contribution to the literature is to develop an ad hoc model for Chilean public finances, which for the first time incorporates the dynamics of the Pension Reserve Fund (FRP) set up in 2006, with its accumulation and disbursement rules, together with the structural-balance policy currently in force (Larraín and others, 2011; DIPRES, 2017a).

Lastly, to exemplify the functioning of the proposed dynamic model, the study simulates the path of the net debt of Chile's budgetary central government up to 2025, evaluating both a macroeconomic trend scenario and an adverse one, all framed by the CAB rule. The trend scenario considers the initial position of the 2018 budget and the public-sector financial projection for 2019-2021 (see DIPRES (2017b)), with convergence to its trend values. In the adverse scenario, the public-sector financial projection is also considered as a basis, but an external demand crisis is simulated from 2018 onward, which seriously undermines GDP growth in the ensuing years. Following the activity slowdown, a steady recovery period is envisaged, culminating in convergence to the trend values by the end of the projection period.

This article is organized as follows; section II makes a brief review of the economic literature on fiscal sustainability models; and section III reviews the cyclically adjusted balance indicator, which is the cornerstone of Chilean fiscal policy and, hence, the basis of the fiscal sustainability evaluation. The first part of section IV discusses selected indices of vulnerability and fiscal sustainability for 1990-2016, while the second applies the proposed dynamic model. Lastly, section V sets forth final comments and recommendations.

II. Literature review

Fiscal sustainability models can be divided into three broad categories. The first consists of long-term models, based on the calculation of a sustainable level of debt with stationary-state public finances and future information without uncertainty. The category includes the indicators proposed by Blanchard (1990) and Buiter (1985). The second set of models recognizes the intertemporal changes to which government budget constraints are susceptible, for which they explore the time-series properties of fiscal balance and whether they satisfy the conditions for keeping public finances on a sustainable path (non-Ponzi condition). Models of this type include those developed by Hamilton and Flavin (1986), Chalk and Hemming (2000) and Bohn (1998 and 2005). The latter model, which is also used by the International Monetary Fund (IMF, 2003), regresses the primary balance against net debt, to search for evidence that the debt/GDP ratio is subject to mean reversion. The third and last category introduces uncertainty into variables on the income side (especially for economies that depend on commodity sales) and in the financial market. Studies that have explored this type of model include Calvo, Izquierdo and Talvi (2003), which evaluates changes in relative prices for the Argentine economy; Barnhill and Kopits (2003), which incorporates uncertainty with the value-at-risk (VaR) methodology; and Mendoza and Oviedo (2006), which develops a dynamic stochastic general equilibrium (DSGR) model to calculate the natural debt limit for Mexico. Mendoza and Oviedo (2009) present a cut-down version of this model, which incorporates tax-revenue uncertainty and calculates the natural debt limit for four Latin American countries.

This third group also includes the IMF model for developing countries (IMF, 2002, 2003 and 2010), which makes assumptions about short-term variables to be able to gauge their impact on fiscal sustainability. In terms of formal empirical measurements that specifically analyse the Chilean case, there are at least two studies that follow an approach similar to the IMF model. Vergara (2002) estimates the primary balance that is consistent with a net-public-debt-to-GDP ratio of 20% for different growth rates and long-term real interest rates; and Crispi and Vega (2003) dynamically assesses the

sustainability of Chile's fiscal policy, using a methodology for projecting central government net debt and analysing the effect of applying the CAB rule on the path of the net-debt-to-GDP ratio under three alternative scenarios: a base scenario, a cyclical base scenario and a historical scenario. The current study is aligned with this type of analysis and contributes to the literature by developing a dynamic sustainability model, updated according to the main fiscal-policy guidelines currently prevailing in Chile. The study innovates by being one of the first to incorporate the dynamics of FRP, which can legally be considered as an important debt component until 2016, since it only had an accumulation rule until that year. In addition, the CAB rule is modelled using its latest methodological update (DIPRES, 2017a).

III. The cyclically adjusted balance rule

Since 2001, Chilean fiscal policy has been guided by a CAB rule, known in the literature as the total central government structural balance. The policy has a medium-term perspective, unlike the traditional analysis based mainly on the actual balance, which represents a specific conjuncture.

The CAB policy broadly consists in estimating central government revenues adjusted for the business cycle, and authorizing public expenditure consistent with those revenues. This seeks to overcoming the traditionally procyclical behaviour of fiscal policy.[4] The policy entails accumulating savings when economic activity is booming, and incomes are higher owing to the phase of the cycle, to be spent either when the economy contracts and tax revenues fall, or when situations that require additional expenditure arise.

Application of the CAB rule and its institutional framework have been considered successful and crucial to Chile's strong fiscal performance, attracting cross-cutting support from broad sectors of society. It has also become an international benchmark for fiscal responsibility.[5] The International Monetary Fund (Dabán, 2011) considers the rule to be the "cornerstone of Chile's impressive fiscal performance".

The benefits of Chile's CAB policy include the fact that it has made a key contribution to: reducing fiscal and macroeconomic volatility, increasing public saving during business-cycle upswings, reducing risk perceptions of the Chilean economy, reducing interest-rate volatility and helping to sustain a more competitive and less volatile real exchange rate. This has made it possible to underpin the competitiveness of the export sector, despite a pronounced upward trend in the price of copper at the start of this decade.[6]

In its nearly 20 years of implementation, the CAB policy has undergone revisions and changes in its institutional framework, in its policy target, and in the concept and method of measuring the cycle.

The current policy is based on three pillars (Larraín and others, 2011):[7]

(1) A CAB indicator, consisting of the set of equations and variables needed to calculate a balance, with business-cycle effects stripped out.

(2) A policy target, defined independently of the measurement of the CAB indicator, which establishes the net liabilities accumulation path, free from business-cycle effects.

(3) An institutional and transparency framework which supports the proper functioning of the rule.

[4] See Gavin and others (1996), Alberola and Montero (2007) and Ilzetzki and Végh (2008).

[5] For more details see IDB (2008), IMF (2010) and OECD (2010). See also Frankel (2011).

[6] See, for example, Costa and Lagos (2001), Larraín and Parro (2006), Le Fort (2006), Rodríguez, Tokman and Vega (2006), Kumhof and Laxton (2009), Ffrench-Davis (2010), Chan-Lau and others (2010), Marcel (2010), OECD (2010), Schmidt-Hebbel (2010), Ter-Minassian (2010), Velasco and others (2010), Frankel (2011), Tapia (2015) and Caputo and Valdés (2016).

[7] See also Corbo and others (2011).

From these three elements, only the characteristics of the CAB indicator are now reviewed for subsequent incorporation into the sustainability model.

Basically, the CAB indicator consists in defining a level of expenditure consistent with an income level purged of cyclical fluctuations in GDP and copper prices, over which the authority has no direct control. The underlying aim is to obtain a balance that allows automatic stabilizers to operate to the full. Any other type of fluctuation in income is not adjusted, so as to avoid different interpretations of what is permanent or transitory and what is not, and to prevent discretionary actions by the authority.

In practice, this means not correcting income for transitory tax measures or operations that change income on a once-only basis. On the other hand, tax measures that automatically reverse themselves are corrected for —these being understood as measures that have cash flow effects on tax revenues, in other words those that merely involve advances or delays in tax payments. Variations associated with events unrelated to the cycle are not adjusted for and, as such, could generate certain levels of volatility in cyclically-adjusted revenues (for example, variations in inflation or exchange rates).

The institutional coverage of the indicator corresponds to the global balance of total central government, since this is the aggregate on which fiscal policy is formulated and executed. Although public enterprises, municipalities and State universities fall outside this perimeter, much of the fiscal policy influence exerted through these institutions involves transfers either from them or to them, which are recognized in the central government budget.

To estimate the structural balance, the sum of the cyclical adjustments of the different income items is subtracted from total measured or actual income, using the following formula:

$$BCA_t = BEf_t - AC_t \quad (1)$$

$$AC_t = ITNM_t^c + ICS_t^c + ITM_t^c + ICC_t^c \quad (2)$$

where BCA_t corresponds to the cyclically adjusted balance (CAB) in period t; BEft represents the actual balance reported in period t; and AC_t denotes the cyclical adjustment to income in period t, which corresponds to the sum of the cyclical components expressed by the superscript c of the following items: (1) non-mining taxes $(ITNM)$, (2) social-security contributions (ICS), (3) taxation of large-scale private-sector mining (ITM); and (4) CODELCO transfers in respect of copper (ICC).

The non-mining tax revenue item, along with the adjustment for social security contributions, is obtained with the standard methodology used by international organizations, which consists of multiplying actual income by the output gap with an elasticity exponent.[8] Moreover, the adjustment for taxation of large-scale private-sector mining and the CODELCO transfers takes account of the difference between the reference price of copper and its current price.

No cyclical adjustments are made for interest on financial assets or liabilities; and other tax revenues are also not adjusted because they are only weakly related to the output cycle. Moreover, as there are no expenditure components that respond automatically to the business cycle, spending does not need adjustment. A detailed review of the methodology for calculating the CAB indicator can be found in DIPRES (2017a).

[8] See Giorno and others (1995), Hagemann (1999) and Larch and Turrini (2009).

IV. Fiscal sustainability of the Chilean economy

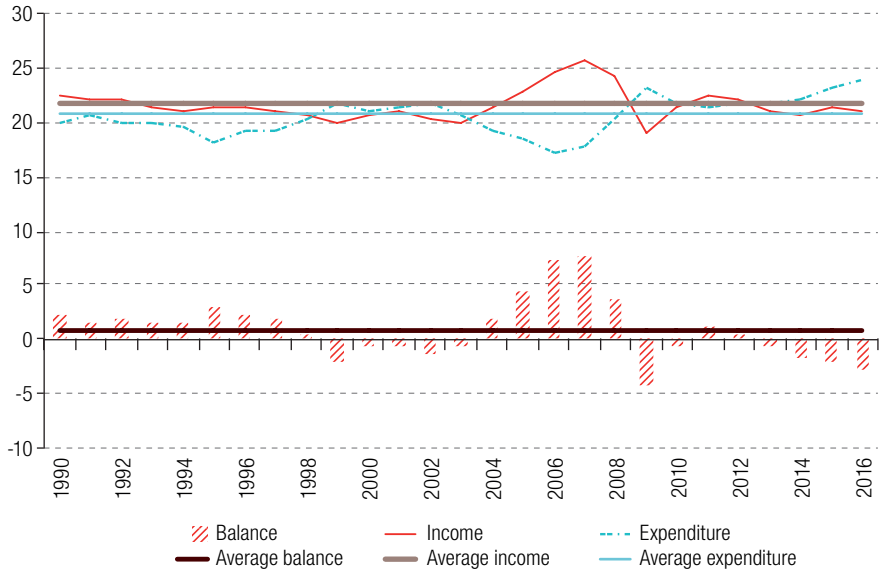
1. Static indicators of vulnerability and fiscal sustainability

The following paragraphs discuss the ex post calculation of selected indicators of vulnerability and fiscal sustainability adapted to the Chilean reality.[9]

The debt measurement presented below covers the budgetary central government,[10] thereby excluding from the analysis the assets and liabilities of the Central Bank of Chile, public enterprises, universities and municipalities. The measurement of the gross liabilities of the budgetary central government also excludes the stock of unpaid recognition bonds, which represent a liability owed to affiliates of the old pension regime who transferred to the pension fund management (AFP) system. As the stock of recognition bonds is judged to be a different type of liability than the traditional concept of central government debt, and in keeping with international practices, these statistics are presented in a complementary manner and tend not to be consolidated into central government debt statistics.

Figure 2 depicts the evolution of central government finances as a percentage of GDP from 1990 to 2016, which initially give rise to the government's debt situation and thus directly impact fiscal sustainability levels. Prior to the application of CAB, the global balance was already in surplus. The deficit years are generally associated with turbulence in the economy, particularly 2009, which reports the largest deficit of the entire period analysed (which included the international financial crisis and the fiscal stimulus plan). The deficit has also been trending upwards, marginally since 2013, at a rate of 0.6%, but much faster in the last three years, by an average of 2.1%.

Figure 2
Central government income, expenditure and balance, 1990-2016
(Percentages of GDP)



Source: Prepared by the authors, on the basis of information from the Budgetary Affairs Bureau (DIPRES).

[9] The formula for calculating these indicators is presented in annex A1.

[10] For an analysis that considers the central government together with public enterprises and the central bank, see Vergara (2002).

Table 1, below, reports the behaviour of the fiscal sustainability indicators, together with the impact on Chile's fiscal position and debt sustainability caused by the 2008-2009 international financial crisis and the February 2010 earthquake and tsunami. The last row of the table shows the critical value or desirable range of each indicator, as a benchmark for comparison with each of the values recorded annually. Various criteria were used to obtain these values or ranges. The reference values published by the IMF were used when available; otherwise the value obtained from the definition of the indicator itself was assigned as a critical value.

Table 1
Chile: static indicators of vulnerability and fiscal sustainability, 1990-2016[a]
(Percentages)

Year	Gross debt/GDP	Net debt/ GDP	Debt service	(IV) Debt service acid test	(V) Primary balance (IMF methodology)	(VI) Primary balance (DIPRES methodology)	(VII) Structural primary balance
1990	44.0	29.4	23.5	29.7	5.4	5.4	
1991	38.0	22.9	24.9	27.9	4.5	4.6	
1992	31.2	15.1	19.5	21.4	4.4	4.5	
1993	28.6	13.6	20.7	21.6	3.5	3.6	
1994	23.0	8.2	15.6	16.8	3.4	3.4	
1995	17.5	4.0	21.6	24.6	4.6	4.7	
1996	14.8	1.5	16.7	18.1	3.5	3.5	
1997	12.9	-0.4	11.8	12.9	3.2	3.2	
1998	12.2	-0.3	12.8	13.2	1.6	1.6	
1999	13.3	1.6	12.0	12.3	-0.8	-0.9	
2000	13.3	3.1	8.5	9.0	0.5	0.5	
2001	14.4	5.6	10.0	10.4	0.6	0.6	2.3
2002	15.2	7.7	13.6	14.0	-0.1	-0.1	1.9
2003	12.6	6.5	12.2	12.8	0.7	0.6	1.9
2004	10.3	4.0	13.5	16.2	3.0	2.9	2.0
2005	7.0	-0.1	15.2	19.4	5.2	5.0	1.8
2006	5.0	-6.6	8.0	12.3	8.0	7.7	1.8
2007	3.9	-13.0	6.7	9.9	8.3	7.8	1.1
2008	4.9	-19.3	6.3	8.2	4.4	3.7	2.9
2009	5.8	-10.5	6.3	7.3	-3.8	-4.3	-2.9
2010	8.6	-7.0	4.1	5.2	0.0	-0.2	-1.5
2011	11.1	-8.6	4.7	5.7	1.8	1.5	-0.5
2012	11.9	-6.8	6.2	7.2	1.1	0.8	-0.6
2013	12.7	-5.6	6.9	7.7	0.0	-0.3	-1.3
2014	14.9	-4.3	8.0	8.8	-1.0	-1.2	-1.5
2015	17.4	-3.5	8.6	9.1	-1.5	-1.7	-1.0
2016	21.3	1.0	42.3	43.0	-2.0	-2.3	-1.0
AVERAGE	15.8	1.4	13.3	15.0	2.2	2.0	0.3
Critical value or desirable range	25-30 (IMF)	42.8[b]	25-35 (IMF)	25-35 (IMF)	Value = 0	Value = 0[c]	Value = 0

Source: Prepared by the authors, on the basis of information from the Budgetary Affairs Bureau (DIPRES) and the Central Bank of Chile.

[a] When measuring the indicators, the interest rate has been calculated as the implicit nominal rate on both loans and deposits.

[b] Average of OECD countries (1993-2010), general government.

[c] As this is a sustainable indicator, its average during the period constitutes a reference value for each year.

The figures show gross debt trending down from 1990 until the financial crisis of 2009, when the trend reverses, after which net debt as a percentage of GDP rises again every year. These results are reflected in the behaviour of net debt as a percentage of GDP, which is calculated by subtracting

central government assets (Economic and Social Stabilization Fund, Pension Reserve Fund and others) from the gross debt. The latter declines steeply from 1997 to 2008, owing both to reductions in gross debt and to asset growth, largely reflecting the significant cyclical component of revenues from copper, the price of which surged towards the middle of the decade of 2000 and thus allowed for a large increase in savings pursuant to the fiscal rule. In 2009, in the framework of the countercyclical policy partly financed with FEES funds, the trend reversed although it stayed negative. Under the current administration, the fiscal deterioration has continued, and in 2016 Chile ceased to be a net creditor for the first time in a decade.

In keeping with the above, debt service also decreased substantially. In simple average terms, prior to the operation of the CAB rule, these expenses absorbed about 18% of central government current income, or up to 20% if copper revenues are excluded. Between 2000 and 2015, debt service fell to a simple average of 9% of current income, or 10% excluding copper. In 2016, however, there was an abrupt increase in debt service which absorbed about half of central government current income, mainly owing to the repayments made in that year.

The declining debt trend meant that the primary balance, which excludes interest expenses under the IMF methodology, tended to converge with the global balance, as interest decreased as a proportion of total expenditure. Prior to 2014, the primary balance posted deficits in just three years, all of them associated with external financial crises. Since that year, greater spending pressures have generated two deficits in three consecutive years, which is unprecedented in the fiscal accounts of the last two decades. A similar pattern can be seen if the primary balance is calculated according to the methodology of the Budget Affairs Bureau (DIPRES), which also excludes income obtained from interest on central government financial assets.

When income is corrected for the business cycle, the primary CAB remains positive and relatively stable until 2008, with a structural balance target of 1% of GDP until 2007 and one of 0.5% in 2008. Then, the fiscal package that was implemented in 2009 resulted in a cyclically adjusted deficit of 3.1% of GDP, and the primary CAB turned negative. Since that year and with a convergence target in place, this indicator has displayed negative values.

In short, the indicators improved during the first few years in which the fiscal rule was in place, when it targeted a structural surplus of 1% of GDP. Since 2009 with the international financial crisis, 2010 with the earthquake and tsunami, and 2011 with growing fiscal expenditure pressures, the figures have tended to deteriorate, although they remain stronger than in the early 1990s.

2. The dynamics of fiscal policy and its sustainability within the framework of the cyclically adjusted balance policy

This section analyses the dynamics of fiscal sustainability under the fiscal rule applied in Chile.

(a) Methodological background

Projecting future balances and, hence, future debt, is a key part of studying public-finance sustainability. As noted in several countries, fiscal imbalances can lead to severe crises, with effects lasting many years. This makes it necessary to analyse both the stock of debt held by a country and the flow generated each year. In this case, the flow is determined by deficits or surpluses recorded year by year in the government's fiscal accounts.

The next section describes a model that analyses the path of the debt, considering both stocks and flows and emphasizing ex post variables.[11]

(i) Economics of sustainability models

The fiscal sustainability literature is based on the following equation, which describes the intertemporal relationship between the debt and the government's operating deficit in nominal terms:

$$D_t = \left(1 + i_t\right) D_{t-1} - BP_t - \Delta M_t \tag{3}$$

where D_t denotes the cumulative debt stock at the end of period t, i_t is the nominal interest rate, ΔM_t is the growth of the monetary base at the end of period t (seigniorage) and BP_t is the primary balance[12] in period t. To reflect the change in the debt in a given year, D_{t-1} is subtracted from both sides of the equation, to obtain:

$$D_t - D_{t-1} = \left(1 + i_t\right) D_{t-1} - BP_t - \Delta M_t - D_{t-1} \tag{4}$$

$$\Delta D_t = i_t D_{t-1} - BP_t - \Delta M_t$$

Lastly, to express the change in debt as a percentage of GDP, the equation is written as follows:

$$\Delta d_t = \frac{r_t - g_t}{1 + g_t} d_{t-1} - bp_t - \Delta m_t \tag{5}$$

Where lowercase indicates variables expressed as a percentage of GDP, r_t is the real interest rate in period t, and g_t is the real growth rate of output in period t. Writing this equation as a function of the observed balance gives:

$$\Delta d_t = \frac{1 + i_t}{1 + \gamma_t} \gamma_t d_{t-1} - \Delta m_t - bef_t \tag{6}$$

where i_t and π_t are the nominal interest rate and inflation in period t, respectively, and γ_t is equal to the sum of $\pi_t + gt + \pi_t g_t$.

In the Chilean case there are three other characteristics to be considered when analysing fiscal sustainability: (1) the cyclically adjusted balance rule; (2) the importance of copper revenues; and (3) the country's sovereign funds policy. The next section analyses these items and how they are taken into account in the fiscal sustainability calculation.

(ii) Characteristics of the Chilean economy

Under the Chilean fiscal rule, government spending is set according to the CAB target, defined as a percentage of each year's GDP. This means that the primary balance outturn will be determined fundamentally by the cyclical adjustment and the CAB target for the year.

As noted in equation (1), the CAB is equal to the actual balance minus the cyclical adjustment of revenues. This makes it possible to define the following:

[11] This simulates the macroeconomic variables that determine Treasury revenue and expenditure and then analyses debt movement through time. An ex-ante analysis would be more rigorous, but much less simple: the variables that are considered here are usually endogenous and uncertain, in other words they are determined by their joint movement and do not have a clear future path. A documented example is the influence of public spending on the exchange rate (Arellano and Larraín, 1996). Despite this simplification, the ex post algebra of sustainability models remains a powerful tool for identifying possible future risks (Law, 2010).

[12] Although only interest expenses are subtracted in this section, the DIPRES definition of the primary balance is implicitly being used, since interest is calculated on the net debt. Thus, as noted below, interest may be negative, if interest income exceeds the interest payable on the accumulated gross debt.

$$BCA_t = BEf_t - AC_t$$
$$BEf_t = IT_t - GT_t$$
$$BCA_t = \left(IT_t - GT_t\right) - AC_t$$
$$BCA_t = \left(IT_t - GT_t\right) - \left(IT_t - IT_t^*\right)$$
$$BCA_t = IT_t^* - GT_t$$

Where BCA_t represents the cyclically adjusted balance; BEf_t is the observed balance; AC_t is the cyclical adjustment of income; IT_t is total reported income; GT_t is total government expenditure and IT_t^* denotes cyclically adjusted income.

The cyclical adjustment of income will be simplified in this model and defined as follows:

$$AC_t = ITNM_{t,i} \cdot \left(1 - \left(\frac{Y_t^*}{Y_t}\right)^{\eta}\right) + \left(VC_t \cdot \left(P_t^C - P_t^*\right) + \right) \cdot e_t \cdot 2.204{,}62$$
$$+ \left(P_t^{BML} - P_t^*\right) \cdot \tilde{\tau}_t \cdot Q_t \cdot e_t \cdot 2.204{,}62$$

In this case, all non-mining tax revenues (along with health insurance contributions) are grouped under the $ITNM_t$ term, and an average aggregate elasticity η is used. Y^* represents trend output.

The formula used in this model to cyclically adjust CODELCO revenues is identical to that described in DIPRES (2017a), where P_t^C and P_t^* are the actual and reference copper prices, respectively, VF is the physical production (sale)[13] of copper and et denotes the nominal exchange rate of the period.

The cyclical adjustment made to the taxation of large-scale private mining firms is also simplified. Instead of separately adjusting the three types of taxes that these companies pay, an average rate τ_t is used to represent the tax burden borne by the mining companies on their production Q in year t. That average rate is calculated by weighting the rates of each type of tax, namely the excise duty, and first category and additional income tax. In addition to taking into account the effect of remittances on the additional tax, this rate must consider the changes in the specific tax on mining activity.[14]

Lastly, it should be recalled that the Chilean fiscal rule fixes government spending in line with cyclically adjusted revenues and the CAB target. So, if the structural result is set by target, expenditure is determined as follows:

$$GT_t = IT_t^* - \overline{BCA_t}$$

In conjunction with the above, a large portion of total central government income is sourced from copper sales. Nonetheless, the price of copper has followed a pronounced cycle throughout history; and this has been reflected in fluctuating amounts of revenue collected by the government (Borensztein and others, 2010). So, both the income transferred from CODELCO and the tax revenue collected from the large-scale private mining firms are treated in the model as a component that is distinct from other government income and then adjusted according to the copper-price cycle.[15]

For purposes of the model, income and expenses will be disaggregated as follows:

$$IT_t = ITNM_t + ITM_t + Codelco_t + i_t^R \cdot FRP_{t-1} + resto_t$$
$$GT_t = GOtros_t + i_t \cdot D_{t-1} + GPrev_t$$

[13] Quantity produced is considered the best indicator for projecting sales.

[14] Although income tax and excise duty are paid for production and sales at *t-1*, making τ depend on *Qt-1* would not allow for the additional tax to be taken into account. However, making everything depend on *t* does make it possible to capture the effect of income and excise taxes, through the monthly advance payments they make during the year.

[15] This natural resource is not expected to run out for many decades. See Borensztein and others (2010).

Where $ITNM_t$ are non-mining tax revenues and health contributions in period t; ITM_t denotes revenue from mining taxes; $Codelco$ represents income transferred from CODELCO and $i^R FRP_{t-1}$ is FRP interest income; all income sources that are not a function of the macroeconomic variables specified in this model are assumed exogenous and are encompassed in the variable $resto$.

The term $i_t D_{t-1}$ denotes interest payments on the net debt[16] in period t; $GPrev_t$ represents pension expenditure, which is exogenous and depends on demographic factors; and $GOtros$ is other expenditure. The latter serves as the adjustment variable to ensure that total expenditure is equal to the cyclically adjusted revenues minus the structural balance target.

Government revenues are a function of macro variables as follows:[17]

$$ITNM_t = ITNM_{t-1} \cdot \left(1 + \frac{\Delta P}{P_{t-1}}\right)\left(\frac{\Delta Y}{Y_t}\right)^n$$

$$ITM_t = \tilde{\tau}_t \cdot Mg_t^P \cdot Q_t \cdot e_t \cdot 2.204{,}62$$

$$Codelco = \left(Mg_t^C \cdot VF_t\right) \cdot e_t \cdot 2.204{,}62$$

$$Mg_t^P = P_t^{BML} - c_t^P$$

$$Mg_t^C = P_t^C - c_t^C$$

Where c^P and c^C are the unit costs of the large-scale private-sector mining firms and CODELCO, respectively.

Lastly, the Fiscal Responsibility Law (Law 20.128) was passed in September 2006, establishing, among other things, the requirement to save assets in the Pension Reserve Fund (FRP) and the Economic and Social Stabilization Fund (FEES). As of 31 August 2017, the funds in question, which have their own objectives and accumulation rules, had grown to US$ 10,155 million and US$ 14,769 million, respectively.[18]

The Pension Reserve Fund was designed to finance the central government's pension liabilities. In particular, the amounts that could be withdrawn from FRP were, until 2016, limited to the return it generated. After 2016, the maximum withdrawal will be equivalent to one third of the difference between pension expenditure in year t and the equivalent expenditure in 2008. The fund's accumulation rule obeys the following formula:

$$P_{t-1}\, Y_{t-1} \cdot \min\left\{0.5\%;\, \max\left(0.2\%;\, BEf_{t-1} / P_{t-1}\, Y_{t-1}\right)\right\} \tag{7}$$

where P_{t-1} Y_{t-1} and BEf_{t-1} are the nominal GDP and actual balance of the last period, respectively. This means that the minimum contribution to the fund will be equivalent to 0.2% and the maximum equivalent to 0.5% of the previous year's GDP, depending on the balance actually recorded. Clearly, the existence of FRP, together with the interest it generates and its accumulation and disbursement rules, will be a central part of the future sustainability debate. Moreover, in the model, the periodic flows of contributions into this fund (which, as a stock, is an asset) are initially (up to 2016) treated as one more component of debt, since there is only an accumulation rule up to that date, although it may be treated as another source of funding after 2016.

[16] If the net debt is negative, this expression will also be negative, which means interest income outweighing interest expenses.

[17] On this point, see chapter VIII of DIPRES (2013), which applies similar formulas to project long-term tax revenues. See also the annexes in Crispi and Vega (2003) and Larraín and others (2011) for an explanation of these functional forms.

[18] For a review of the potential objectives of sovereign wealth funds and their different types, see IMF (2008) and Kunzel and others (2010). For the legal framework and operation of Chilean funds, see Contreras and others (2008).

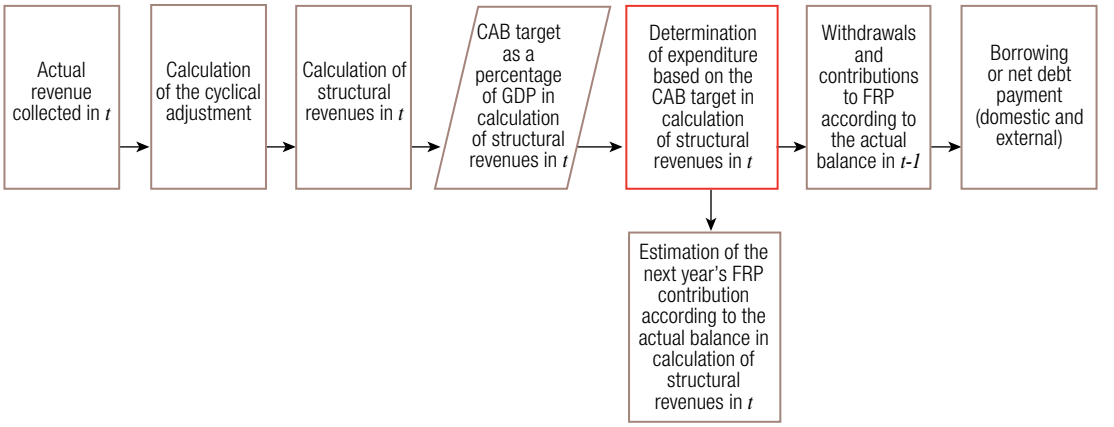
For its part, FEES is designed to act as a public expenditure stabilization fund, in the CAB policy framework. As expenditure is set according to the medium-term criteria of the Chilean fiscal rule, the actual budget outturn can be either positive or negative, depending on the phase of the cycle. FEES accumulates resources from the actual surplus in excess of 0.5% of current-year GDP and serves as an additional deficit-financing tool apart from debt. As shown in Walker (2011), this fund has a long-term expected value of zero, and has no pre-established draw-down rules, such as those of FRP. In a deficit scenario, the government can choose between drawing on FEES funds, selling other assets or borrowing, either domestically or abroad. This is a discretionary decision of the authority and is usually associated with the macroeconomic conditions prevailing at the time. So, in a simplified model such as the one presented in the next section, the effect of including FEES as an asset element in net external debt is not relevant to this analysis. In other words, unlike FRP, FEES will not be modelled as a variable that is independent of net debt.

(iii) Fiscal sustainability model in the context of the Chilean economy

Following Talvi and Végh (2000), who emphasize the fiscal deficit more than the government's operating deficit, coverage will be restricted to total central government. Accordingly, the money creation variable, ΔM_t, is dispensed with in the equations.

To determine the need for government financing, that is, whether new debt must be issued or existing debt can be amortized, the ex post calculation is performed as shown in the following flowchart:

Diagram 1
Model calculation flowchart



Source: Prepared by the authors.

As noted above, for the purposes of this analysis, central government revenues are divided into five categories: (1) non-mining tax revenue; (2) mining tax revenue; (3) transfers from CODELCO; (4) interest generated by FRP; and (5) other income. Of these, the first three are adjusted by the GDP or copper-price cycle, as appropriate. The cyclically adjusted revenues and target are then used to determine the government's expenditure, divided into three categories: (1) pension expenditure, (2) interest payments on the debt[19] and (3) other expenses. According to the IMF Government Finance Statistics Manual (2001), these movements can be classified as "above-the-line" operations. In contrast, "below-the-line" (financing) operations include contributions and transfers to FRP and the issuance (or amortization) of

[19] As this involves net debt, interest expense may turn out to be negative, meaning that the interest generated by the assets outweighs the interest payable on the liabilities.

debt. If the actual balance is positive, it serves as a source of funds; otherwise, it is added to the uses of the resources obtained through debt.[20]

Having specified the movements that occur "above the line" and "below the line", the equation to determine the stock and flow of the debt takes the following form:[21]

$$\begin{aligned} D_t &= \left(1 + i_t\right) \cdot D_{t-1} + \Delta FRP_t - BP_t \\ D_t &= \left(1 + i_t\right) \cdot D_{t-1} - BP'_t \text{ with } BP'_t = BP_t - \Delta FRP_t \\ \Delta D_t &= i_t D_{t-1} - BP'_t = -BEf'_t \end{aligned} \tag{8}$$

Where $\Delta FRPt$ is the variation in FRP in period t. It can then be seen that FRP is separate from the net debt component in dollars. Thus, the variation of the debt stock for a year as a percentage of GDP is given by the equation:

$$\Delta d_t = \frac{r_t - g_t}{1 + g_t} d_{t-1} + \frac{\Delta FRP_t}{P_t Y_t} - bp_t \tag{9}$$

By performing a decomposition similar to equation (5), and given that the actual balance is equal to the CAB plus the cyclical adjustment of income, the debt movement as a percentage of GDP can be related to the CAB target as follows:

$$\Delta d_t = -\frac{1 - i_t}{1 + \gamma_t} \gamma_t d_{t-1} + \frac{\Delta FRP_t}{P_t Y_t} - \left(\overline{bca_t} - ac_t\right) \tag{10}$$

where $\overline{bca_t}$ is the CAB target as a percentage of GDP in year t, and ac_t is the cyclical adjustment as a percentage of GDP in year t.

(b) Projections of net debt to 2025

To exemplify the functioning of the dynamic model developed in the foregoing sections, the Chilean central government's net debt path is simulated to 2025. The initial values of the main variables used in this exercise are consistent with the 2018 budget and the public-sector financial projection for 2019-2021, as reported by the Ministry of Finance in the Public Finance Report (DIPRES, 2017b).

The following describes the two alternative macroeconomic scenarios used in the analysis:[22]

(i) Trend scenario: the projected position in the 2018 budget and the public-sector financial projection for 2019-2021 and convergence to its trend values are considered as the initial position. Among other things, it is assumed that:

[20] On the terms "Sources" and "Uses", see information provided in the footnote of Table I.17 of the report *Evaluación de la Gestión Financiera 2017* (DIPRES, 2017c).

[21] Treasury liabilities recorded "below the line" include recognition bonds (Arenas and others, 2009). Following Vergara (2002) it was decided to only count recognition bonds already issued within the debt. Thus, the sustainability exercise remains valid, since non-payment of a recognition bond is the same as default on another type of bond, in terms of government solvency.

[22] The macroeconomic variables used in the simulation of each scenario are presented in annex A3. For further analysis of the model used, see Bravo and others (2014).

a. The gap between effective and trend GDP stays at zero as from 2022.

b. The price of copper would reach its reference value of US$ 2.77 per pound by 2021.

c. The structural balance target converges from -1.2% of GDP in 2019 to a zero balance in 2024, at an annual rate of 0.25% of GDP.

(ii) Adverse scenario: this alternative scenario considers very weak output growth in 2018, of just 0.5% per year in real terms. The origin of this sharp slowdown is external, since it assumes a fall in the copper price to US$ 1.5 per pound, with a depreciation of the peso and a rapid response in terms of interest rate cuts in both domestic and external economies.

The drag of the slowdown continues in 2019 and GDP starts to grow at rates above 2% in 2021, converging towards an output gap of 1.8% in 2025.

In this scenario, no changes in the value of financial assets are simulated, so the impact on net indebtedness is only given by the simulated fiscal impulse. Lastly, this scenario simulates the results of different structural balance targets to face the slowdown and the effect on the net debt of each of these alternatives.

Lastly, given the pattern observed with social security expenditure in recent years, this exercise dispenses with FRP as a long-term income source for both scenarios, with pension expenditure growing at real rates of around 1.5%. In other words, neither the interest that this fund generates nor any draw-downs that can be made as from 2016 are used.

(i) Results

Next, figure 3 shows the movement of net debt, both on its own and including FRP, in the trend scenario.

Figure 3
Trend scenario

A. Net debt, excluding the Pensions Reserve Fund (FRP)
(Percentages and millions of pesos)

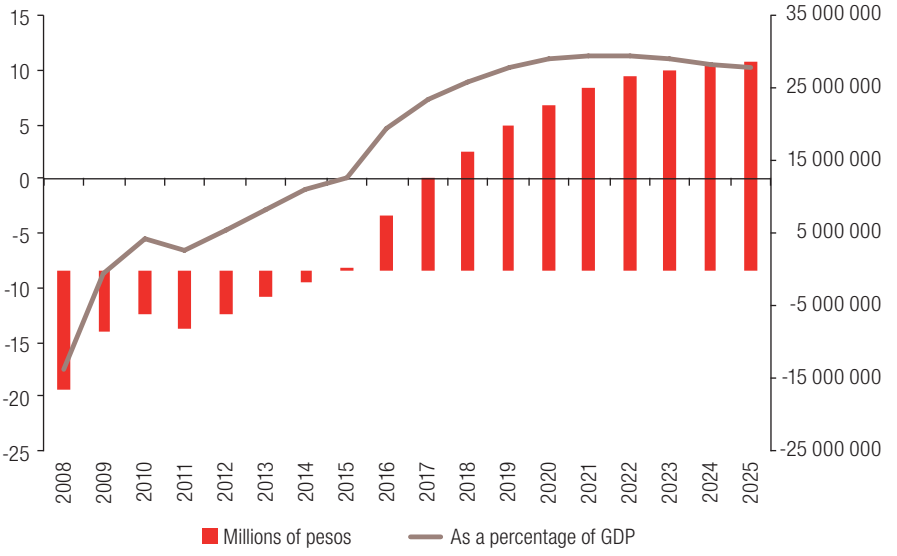
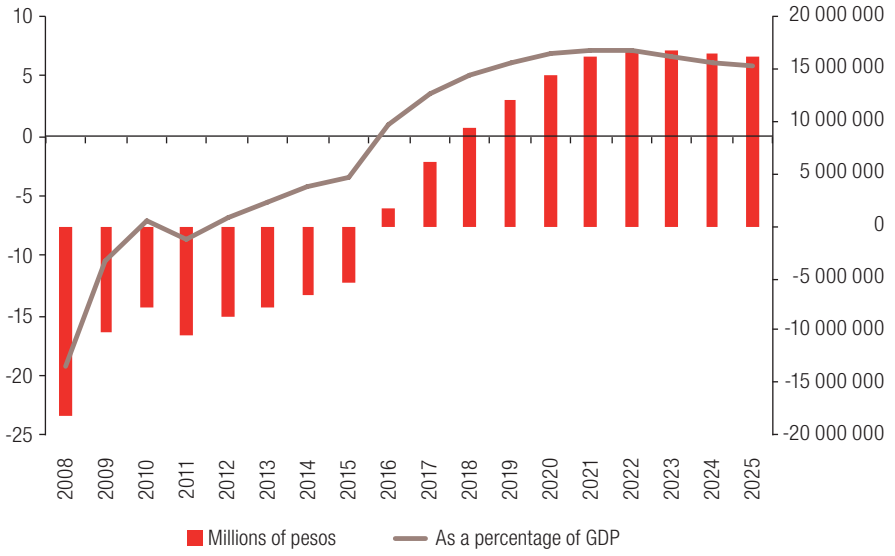


Figure 3 (concluded)

B. Net debt, including the Pensions Reserve Fund (FRP)
(Percentages and millions of pesos)



Source: Prepared by the authors.

As shown in figure 3, in the initial situation, central government net debt is close to equilibrium, in other words, in 2016 gross debt slightly exceeds the level of assets. This happens even when the net debt only includes FEES and other central government assets.

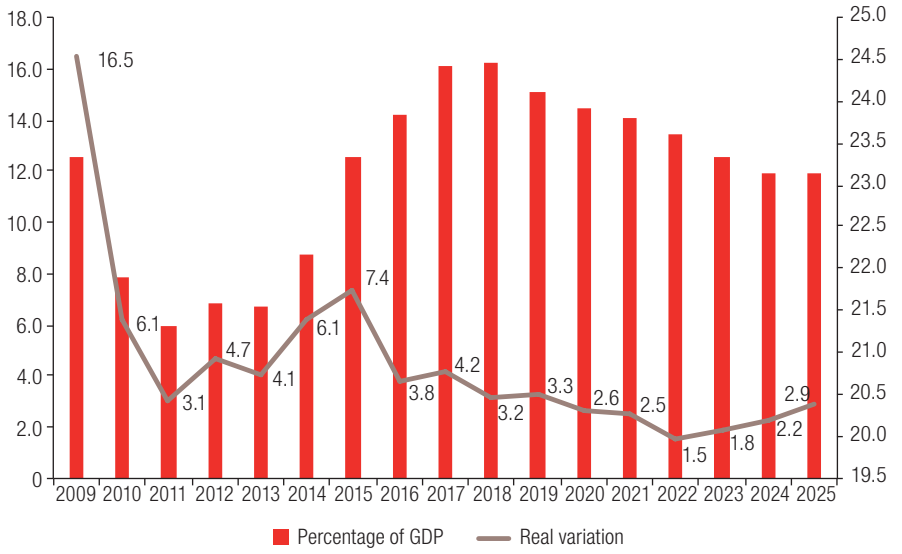
The projection envisages a gradual increase in net debt, which stabilizes as a percentage of GDP as from 2021. Given the assumed scenario, where the output gap closes in 2022, and with the differences between the actual and the cyclically adjusted balance explained by developments in the mining market, where the differences between current and trend prices are also narrowing, cyclically adjusted deficits also imply actual deficits, which means accumulating debt or selling assets (either from FEES or elsewhere). Figure 4, below, illustrates the effect on government spending of adhering to the cyclically adjusted balance target, in terms of real spending growth and its measurement as a percentage of GDP. There is a gradual reduction in spending as a percentage of GDP as from 2018, which is in line with a cyclically adjusted balance target that tends towards equilibrium. In this scenario, real variations in spending would be around 2.5% per year.

Table 2 applies the calculation of indicators II, VI and VII, which are shown in table 1,[23] to the simulation.

The simulation shows a net debt tending towards equilibrium around 11% of GDP if FRP is excluded and around 7% of GDP if it is included. In both cases, the debt is expected to decrease slightly towards the end of the period. In contrast, repeated actual primary fiscal deficits are projected, which when corrected by the output cycle would produce structural primary surpluses close to 1% of GDP by the end of the projection period.

[23] Not all of the indicators presented in the foregoing sections are simulated, because the model as described does not make it possible to estimate all variables. For example, although the primary balance using the IMF and DIPRES methodology was presented earlier, this part of the document only considers the indicator constructed by DIPRES, since the model only separates interest income from FRP.

Figure 4
Total expenditure: real growth and GDP in trend scenario
(Percentages)



Source: Prepared by the authors, on the basis of information from the Budgetary Affairs Bureau and the Ministry of Finance.

Table 2
Static indicators of vulnerability and fiscal sustainability, projection 2018-2025[a], trend scenario
(Percentages)

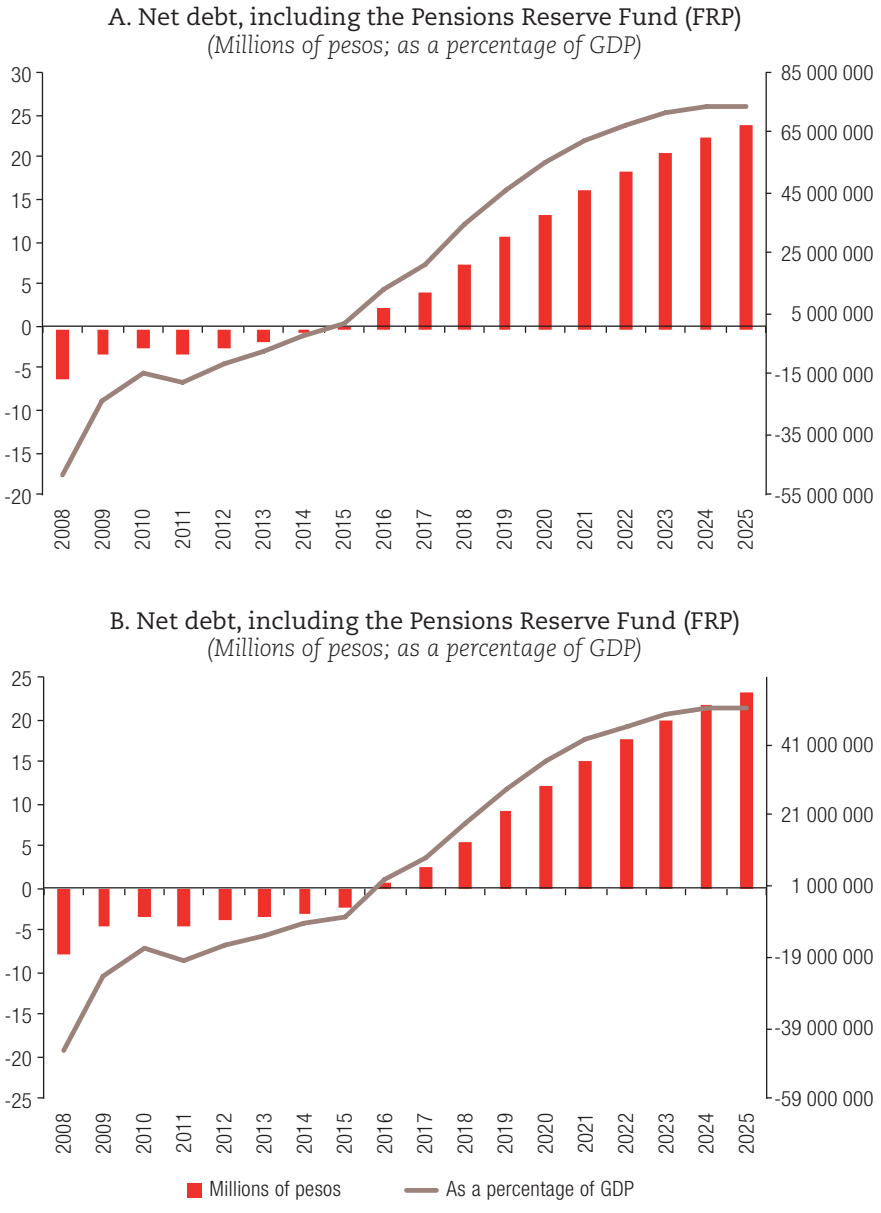
Year	(II) Net debt (excluding FRP) / GDP	(II) Net debt (including FRP) / GDP	(VI) Primary balance (DIPRES methodology)	(VII) Structural primary balance
2018	8.9	5.0	-2.6	-0.7
2019	10.1	6.2	-2.4	-0.3
2020	11.0	6.9	-2.1	0.0
2021	11.4	7.2	-1.8	0.2
2022	11.3	7.1	-1.3	0.5
2023	11.0	6.7	-1.0	0.7
2024	10.5	6.2	-0.8	0.8
2025	10.1	5.7	-0.8	0.8

Source: Prepared by the authors.
[a] The figures are consistent with the assumptions made when preparing the 2018 budget bill.

Figure 5 shows the results under the adverse scenario.[24]

[24] Corresponding to scenario (ii) of section (b) of this document.

Figure 5
Adverse scenario

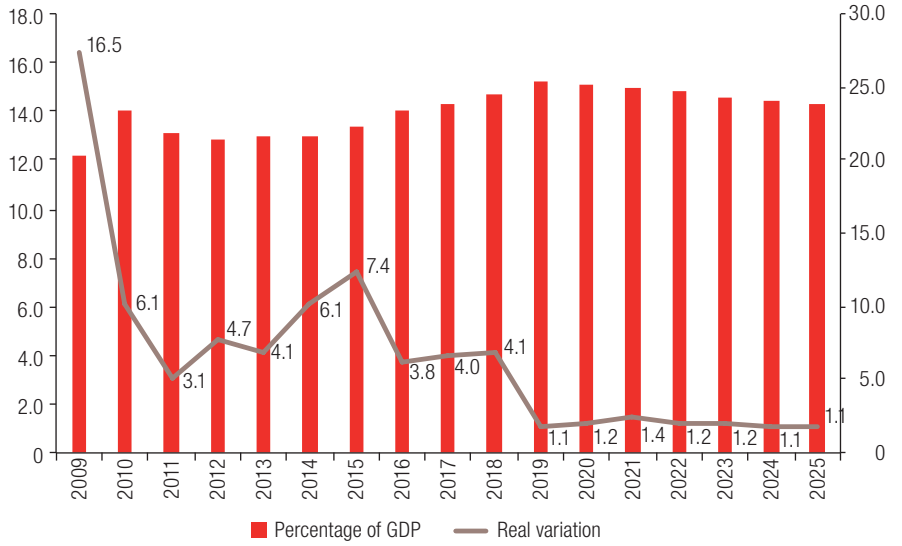


Source: Prepared by the authors.

As expected, an adverse activity shock fuels greater indebtedness (either by taking on more gross debt or by selling assets). A scenario in which activity slows sharply in 2018 could lead to net debt in excess of 20% of GDP in 2021 and trending up to reach 26% of GDP by the end of the projection period. This mainly reflects the fact that an adverse scenario, such as the one described, causes real GDP to dip below trend, thereby widening the output gap. Thus, the central government is forced to borrow or sell assets to meet its commitments and, at the same time, attain the CAB target.

An important assumption is that the path of the target structural balance is the same as in the trend scenario, which means less room for spending growth. Figure 6 projects a gradual reduction in spending relative to GDP from 2019 onwards, which is in keeping with a cyclically adjusted balance target that tends towards equilibrium. In this scenario, variations in expenditure would be around 1.2% per year in real terms.

Figure 6
Total expenditure: real growth and GDP in trend scenario
(Percentages)



Source: Prepared by the authors, on the basis of information from the Budgetary Affairs Bureau and the Ministry of Finance.

As was done for the trend scenario, the trend of the simulated indicators to 2025 is also presented in this case. Table 3 shows a generalized deterioration of Chile's fiscal position, with primary deficits recorded in all years of the projection. In contrast, the structural primary deficits are smaller than the actual deficits, as a result of the cyclical adjustment of income, and they move into surplus as from 2024.

Table 3
Static indicators of vulnerability and fiscal sustainability, projection 2018-2025[a], adverse scenario
(Percentages)

Year	(II) Net debt (excluding FRP) / GDP	(II) Net debt (including FRP) / GDP	(VI) Primary balance (DIPRES methodology)	(VII) Structural primary balance
2018	12.0	7.5	-5.6	-1.7
2019	16.0	11.7	-5.4	-1.5
2020	19.4	15.0	-5.2	-1.1
2021	22.0	17.5	-4.9	-0.7
2022	23.8	19.3	-4.4	-0.4
2023	25.1	20.5	-4.0	-0.1
2024	25.8	21.2	-3.6	0.2
2025	26.1	21.4	-3.1	0.5

Source: Prepared by the authors.
[a] The figures are consistent with the assumptions made when preparing the 2018 budget bill.

V. Final comments and man results

Various studies, both national and international, have recognized the systematically orderly behaviour of Chile's public finances.

The use of fiscal sustainability indicators showed that Chile's fiscal situation improved steadily until 2009. Thereafter, the international financial crisis, followed by the earthquake and tsunami and growing pressures for increased fiscal spending eroded the country's fiscal position. In 2016 the central government ceased to be a net creditor and became a debtor. This fiscal position recalls 2004, when net debt represented 4% of GDP; and it is consistent with the growth of gross debt, which in 2016 amounted to 21.3% of GDP, its highest level since 1994. This deterioration of the fiscal accounts was one of the reasons why the rating agencies downgraded Chile's rating for the first time in 25 years —from AA- obtained in 2012 to A+. Nonetheless, the figures can still be considered healthy in the international context.

The second part of this article puts forward a dynamic model to evaluate the long-term fiscal sustainability of the country. In particular, the study contributes to the literature by developing an ad hoc model for the Chilean economy; and it is the first to incorporate the dynamic of FRP, whose interest and accumulation and disbursement rules are crucial for projecting central government debt levels. Moreover, the calculation of the cyclically adjusted balance indicator is formalized in the empirical model, albeit in simplified form, taking account of the most recent changes introduced by the tax authority.

To exemplify the operation of the dynamic model, a macroeconomic trend scenario and a more adverse one in terms of activity were estimated. Table 4 summarizes the results of the simulation.

One conclusion of this exercise is that, considering a trend scenario based on the 2018 Budget Law, together with a fiscal policy consistent with the CAB rule and following the convergence goals proposed by the authority, Chile would attain net debt levels of around 10% of GDP in 2025. This would entail total fiscal expenditure averaging 2.5% through 2018-2025, together with an average economic growth rate of 3.2% and a copper price averaging US$ 2.90 per pound in that period (see macroeconomic assumptions in annex A3). The analysis shows that, in this case, Chile would achieve a zero structural primary balance in 2020, a primary surplus in 2021 and a zero structural balance in 2024.

On the other hand, in an adverse scenario with average growth of 2.1% and an average copper price of US$ 2.2 per pound in the period analysed, the country would reach levels of net indebtedness of around 26% of GDP in 2025. For this, total fiscal expenditure would need to average 1.6% per year in 2018-2025. This would mean attaining a structural primary surplus of 0.22% of GDP in 2024, a primary balance of -3.14% of GDP in 2025 and a structural balance of -1.2% of GDP in 2025. This adverse situation would leave the country with a fiscal situation very similar to that pertaining in the early 1990s, in conditions of vulnerability to new external crises and with high expenses associated with government debt service, diverting significant resources from social policy, It should be remembered, for example, that Chile paid more in interest than it spent on education and health between 1990 and 1993 (Arellano, 2017, p. 13) —a reality faced by many countries in the region that have been unable to properly manage their fiscal policy. That is why it is crucial for Chile to adhere to and reinforce its fiscal rule, since this is a very successful economic policy instrument that has afforded it a fiscal position that is an example even for countries of higher economic development levels.

Table 4
Fiscal sustainability projection 2018-2025
(Percentages)

Trend scenario	2018	2019	2020	2021	2022	2023	2024	2025
Net debt (excluding FRP) *(% GDP)*	8.94	10.14	10.96	11.35	11.27	10.97	10.54	10.14
Real change in total spending	3.22	3.26	2.59	2.50	1.54	1.84	2.24	2.92
Primary balance (DIPRES methodology)	-0.65	-0.29	-0.02	0.23	0.47	0.70	0.81	0.77
Structural primary balance	-0.70	-0.30	0.00	0.20	0.50	0.70	0.80	0.80
Adverse scenario	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Net debt (excl. FRP) *(% GDP)*	11.98	16.03	19.40	21.97	23.77	25.05	25.80	26.06
Real change in total spending	4.05	1.07	1.24	1.43	1.18	1.24	1.13	1.09
Primary balance (DIPRES methodology)	-5.60	-5.42	-5.20	-4.86	-4.38	-3.98	-3.57	-3.14
Structural primary balance	-1.67	-1.48	-1.05	-0.69	-0.35	-0.05	0.22	0.47

Source: Prepared by the authors.

Lastly, it should be noted that the model developed in this study allows for multiple alternative simulations, with changes in the basic assumptions and the scenarios to be evaluated. One shortcoming is that the methodology presented is not set in an intertemporal standard macro model that would make it possible to separately analyse the stabilization virtues of this type of fiscal policy over time and its effects on growth, compared to alternative fiscal policies. Good starting points for such a study would be Kumhof and Laxton (2013) and Medina and Soto (2007), which do this kind of analysis on a partial basis, but without considering the improvements described in this article, namely incorporating the dynamics of FRP and calculating the CAB indicator according to the most recent changes introduced by the Chilean fiscal authority.

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Annex A1

Fiscal vulnerability and sustainability indicators

Government debt (indicators I and II)

$$D_t = \frac{debt\ stock_t}{GDP_t}$$

Debt service indicator (III and IV)

$$SD_t = \frac{Amortisations_t + Interest\ payment_t}{Current\ income_t}$$

$$SD_t\left(acid\ test\right) = \frac{Amortisations_t + Interest\ payment_t}{Current\ income_t - Copper\ income_t}$$

Primary balance indicator

(a) Traditional IMF methodology (indicator V)

$$bp_t = \frac{Total\ income_t - \left(Total\ expenditure_t - interest\ payments_t\right)}{GDP_t}$$

(b) DIPRES methodology (indicators VI and VII)

$$bp_t = \frac{\left(Total\ income_t - Interest\ income_t\right) - \left(Total\ expenditure_t - interest\ payments_t\right)}{GDP_t}$$

Annex A2

Formal details of the fiscal sustainability model

1. Variation in net debt as a percentage of GDP

Firstly, the Fisher equation is defined as follows:

$$\left(1+r_t\right)=\left(1+i_t\right)/\left(1+\pi_t\right)$$

Dividing net debt/nominal GDP (P*Y) of period t, gives:

$$\frac{D_t}{P_t Y_t}=\frac{\left(1+i_t\right)\cdot D_{t-1}}{P_t Y_t}-\frac{BP_t}{P_t Y_t}-\frac{\Delta M_t}{P_t Y_t}$$

$$d_t=\frac{\left(1+i_t\right)}{\left(1+g_t\right)\left(1+\pi_t\right)}d_{t-1}-bp_t-\Delta m_t$$

$$\Rightarrow d_t=\frac{\left(1+r_t\right)}{\left(1+g_t\right)}d_{t-1}-bp_t-\Delta m_t$$

Subtracting the debt of the past period as a percentage of GDP on both sides of the equation, gives:

$$d_t-d_{t-1}=\Delta d_t=\frac{\left(1+r_t\right)}{\left(1+g_t\right)}d_{t-1}-d_{t-1}-bp_t-\Delta m_t$$

$$\Delta d_t=\frac{r_t-g_t}{1+g_t}d_{t-1}-bp_t-\Delta m_t$$

2. Decomposition: domestic and external debt, tradable and non-tradable GDP

Government debt can be divided into domestic debt (superscript "i") and external debt (superscript "e"). Each type of debt must pay interest according to the internal and external interest rate, respectively. Equation (A9) incorporates this decomposition into the law of debt movement.

$$D_t=D_t^i+e_t\cdot D_t^e$$

$$D_t=\left(1+i_t^i\right)D_{t-1}^i+e_t\left(1+i_t^e\right)D_{t-1}^e-BP_t-\Delta M_t \qquad \text{(A9)}$$

where e_t is the exchange rate (pesos per dollar) in period t. The following variables are also defined (Ley, 2010):

$$\alpha_t^i = \frac{D_t^i}{D_t}$$
$$\alpha_t^e = \frac{e_t \cdot D_t^e}{D_t}$$
$$\alpha_t^i + \alpha_t^e = 1$$

it is us possible to arrange equation (A9) to express it on the same terms as equation (13) presented in the body of the paper.

$$D_t = \left(1 + i_t^i\right) D_{t-1}^i + \left(1 + i_t^e\right) e_t D_{t-1}^e - BP_t - \Delta M_t$$
$$D_t = \left[\left(1 + i_t^i\right)\alpha_{t-1}^i + \left(1 + i_t^e\right)\left(1 + \varepsilon_t\right)\alpha_{t-1}^e\right] D_{t-1} - BP_t - \Delta M_t$$
$$D_t = \left[1 + i_t^i \alpha_{t-1}^i + \alpha_{t-1}^e \left(i_t^e + \varepsilon_t + i_t^e \varepsilon_t\right)\right] D_{t-1} - BP_t - \Delta M_t$$
$$D_t = \left(1 + i_t\right) D_{t-1} - BP_t - \Delta M_t$$

where ε_t is the rate of depreciation of the exchange rate. The nominal interest in period t is equal to:

$$i_t = i_t^i \alpha_{t-1}^i + \alpha_{t-1}^e \left(i_t^e + \varepsilon_t + i_t^e \varepsilon_t\right)$$

Just as it is possible to divide debt into its domestic and external components, GDP can be decomposed between tradable output (superscript "*i*") and non-tradable output (superscript "*e*").[25]

$$P_t Y_t = P_t^i Y_t^i + e_t P_t^e Y_t^e$$

Defining the following variables:

$$w_t^i = \frac{P_t^i Y_t^i}{P_t Y_t}$$
$$w_t^e = \frac{e_t P_t^e Y_t^e}{P_t Y_t}$$
$$g_t = \frac{\Delta Y_t}{Y_{t-1}}$$

and following an algebraic procedure similar to that applied for debt, nominal GDP in period t can be written as a function of nominal GDP in the previous period:

$$P_t Y_t = \left(1 + g_t\right)\left(1 + w_{t-1}^i \pi_t^i + w_{t-1}^e \left(\pi_t^e + \varepsilon_t + \pi_t^e \varepsilon_t\right)\right) P_{t-1} Y_{t-1}$$
$$P_t Y_t = \left(1 + g_t\right)\left(1 + \pi_t\right) P_{t-1} Y_{t-1}$$

where inflation in period t is defined as:

$$\pi_t = w_{t-1}^i \pi_t^i + w_{t-1}^e \left(\pi_t^e + \varepsilon_t + \pi_t^e \varepsilon_t\right)$$

[25] See the separation proposed by Restrepo and Soto (2006) for calculating the tradable and non-tradable shares of GDP.

3. Compilation of the sustainability model for the Chilean economy

The variation in net debt, separating FRP from government assets, is described as follows:

$$\Delta D_t = \Delta FRP_t - BEf_t$$
$$\Delta D_t = -BEf_t'$$
$$\text{with } BEf_t' = BEf_t - \Delta FRP_t$$

FRP is separated from other government assets through its pre-established accumulation and disbursement rules. Contributions to FRP are expressed by the following formula:

$$AFRP_t = P_{t-1} Y_{t-1} * min\left\{0.5\%; max\left\{0.2\%; BEf_{t-1}/P_{t-1} Y_{t-1}\right\}\right\}$$

So the variation in FRP after 2016 is defined as:

$$FRP_t = FRP_{t-1} + AFRP_t - \tfrac{1}{3} * \left(GPrev_t - GPrev_{2008}\right)$$
$$FRP_t - FRP_{t-1} = AFRP_t - \tfrac{1}{3} * \left(GPrev_t - GPrev_{2008}\right)$$
$$\Delta FRP_t = AFRP_t - \tfrac{1}{3} * \left(GPrev_t - GPrev_{2008}\right)$$

In view of the above, debt as a percentage of GDP is defined as:

$$\frac{D_t}{P_t Y_t} = \frac{\left(1 + i_t\right) * D_{t-1}}{P_t Y_t} - \frac{BP_t'}{P_t Y_t}$$
$$d_t = \frac{\left(1 + i_t\right)}{\left(1 + g_t\right)\left(1 + \pi_t\right)} d_{t-1} - bp_t'$$
$$d_t = \frac{\left(1 + r_t\right)}{\left(1 + g_t\right)} d_{t-1} - bp_t' \qquad \text{(A10)}$$

and the variation in the debt as a percentage of GDP is given by:

$$\Delta d_t = \frac{r_t g_t}{1 + g_t} d_{t-1} - bp_t' \qquad \text{(A11)}$$

Following the decomposition of Ley (2010), the following interest and inflation rates are defined:

$$\hat{i}_t = \propto^{i}_{t-1} i_t^i + \propto^{e}_{t-1} i_t^e$$
$$\hat{\pi}_t = \omega^i_{t-1} \pi_t^i + \omega^e_{t-1} \pi_t^e$$

So the nominal interest rate and inflation are described as follows:

$$i_t = \hat{i}_t + \varepsilon_t \propto^{e}_{t-1} \left(1 + i_t^e\right)$$
$$\pi_t = \hat{\pi}_t + \varepsilon_t w^e_{t-1} \left(1 + \pi_t^e\right)$$

Substituting in equations (A10) y (A11) gives:

$$d_t = \frac{\left(1+\hat{i}_t+\varepsilon_t \propto^{e}_{t-1}\left(1+i^e_t\right)\right)}{\left(1+g_t\right)\left(1+\hat{\pi}_t+\varepsilon_t w^e_{t-1}\left(1+\pi^e_t\right)\right)} d_{t-1} - bp'_t$$

$$\Delta d_t = \left[\frac{\left(1+\hat{i}_t+\varepsilon_t \propto^{e}_{t-1}\left(1+i^e_t\right)\right)}{\left(1+g_t\right)\left(1+\hat{\pi}_t+\varepsilon_t w^e_{t-1}\left(1+\pi^e_t\right)\right)} - 1\right] d_{t-1} - bp'_t$$

$$\left(1+r_t\right) = \frac{\left(1+\hat{i}_t+\varepsilon_t \propto^{e}_{t-1}\left(1+i^e_t\right)\right)}{\left(1+\hat{\pi}_t+\varepsilon_t w^e_{t-1}\left(1+\pi^e_t\right)\right)}$$

$$r_t = \frac{\left(\hat{i}_t-\hat{\pi}_t\right)+\varepsilon_t\left(\propto^{e}_{t-1}\left(1+i^e_t\right)-w^e_{t-1}\left(1+\pi^e_t\right)\right)}{\left(1+\hat{\pi}_t+\varepsilon_t w^e_{t-1}\left(1+\pi^e_t\right)\right)}$$

$$\Delta d_t = \left[\frac{\frac{\left(\hat{i}_t-\hat{\pi}_t\right)+\varepsilon_t\left(\propto^{e}_{t-1}\left(1+i^e_t\right)-w^e_{t-1}\left(1+\pi^e_t\right)\right)}{\left(1+\hat{\pi}_t+\varepsilon_t w^e_{t-1}\left(1+\pi^e_t\right)\right)} - g_t}{\left(1+g_t\right)} - 1\right] d_{t-1} - bp_t'$$

$$\Delta d_t = \frac{r_t - g_t}{1+g_t} d_{t-1} - bp_t'$$

which thus defines the real interest rate. In contrast, making the dynamic of the debt a function of the actual balance relative to GDP, gives:

$$\Delta d_t = \frac{r_t - g_t}{1+g_t} d_{t-1} - bp_t'$$

$$\Delta d_t = \frac{i_t - \gamma_t}{1+\gamma_t} d_{t-1} - bp_t'$$

$$\Delta d_t = \frac{i_t - \gamma_t}{1+\gamma_t} d_{t-1} - i_t d_{t-1} + i_t d_{t-1} - bp_t'$$

$$\Delta d_t = \frac{i_t - \gamma_t}{1+\gamma_t} d_{t-1} - i_t d_{t-1} + i_t d_{t-1} + \frac{\Delta FRP_t}{P_t Y_t} - bp_t$$

$$\Delta d_t = \frac{1+i_t}{1+\gamma_t} \gamma_t\, d_{t-1} + \frac{\Delta FRP_t}{P_t Y_t} - bef_t$$

The actual balance as a percentage of GDP can also be expressed in terms of the CAB target:

$$bef_t = \frac{IT_t}{P_t Y_t} - \frac{GT_t}{P_t Y_t}$$

$$\frac{GT_t}{P_t Y_t} = \frac{IT^*_t}{P_t Y_t} - \overline{bca_t}$$

$$bef_t = \frac{IT_t}{P_t Y_t} - \left(\frac{IT^*_t}{P_t Y_t} - \overline{bca_t}\right)$$

$$\Rightarrow bef_t = \overline{bca_t} - ac_t$$

Thus, substituting the actual balance term, it is possible to write the debt dynamics equation as a function of the structural balance target:

$$\Delta d_t = -\frac{1+i_t}{1+\gamma_t}\gamma_t d_{t-1} + \frac{\Delta FRP_t}{P_t Y_t} - \overline{bca_t} - ac_t$$

where ac_t, the cyclical adjustment as a percentage of GDP, is calculated as follows:

$$ac_t = \frac{ITNM_t}{P_t Y_t} \cdot \left(1 - \left(\frac{Y_t^*}{Y_t}\right)^n\right) + \frac{\left(VC_t \cdot \left(P_t^C - P_t^*\right) + VM_t \cdot \left(PM_t - PM_t^*\right)\right) \cdot e_t \cdot 2.204,62}{P_t Y_t} + \frac{\left(P_t^{BML} - P_t^*\right) \cdot \tilde{\tau}_t \cdot Q_t \cdot e_t \cdot 2.204,62}{P_t Y_t}$$

Annex A3

Simulated macroeconomic scenarios

Both scenarios are based on what was published in the October 2018 Public Finance Report. Therefore, although in that report there were projections of figures whose actual value to date is already known, the fact that the information is in the public domain makes it easier to repeat the exercise.

Table A3.1
Trend scenario
(Percentages)

	2018	2019	2020	2021	2022	2023	2024	2025
GDP								
Real variation rate (actual GDP)	3.0	3.3	3.5	3.5	3.4	3.0	3.0	3.0
Real variation rate (trend GDP)	2.6	2.7	2.8	2.9	3.0	3.0	3.0	3.0
Output gap	2.2	1.7	1.0	0.4	0.0	0.0	0.0	0.0
CPI								
Variation (ave./ave.)	2.6	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Peso / dollar exchange rate								
Nominal value	650	650	650	650	650	650	650	650
Price of copper in US$ per pound								
Nominal valu-London Metal Exchange	2.9	2.8	2.8	2.8	2.9	2.9	2.9	2.9
Reference price	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Tax variables								
Structural balance target *(% GDP)*	-1.4	-1.2	-0.9	-0.7	-0.4	-0.2	0.0	0.0

Table A3.2
Adverse scenario
(Percentages)

	2018	2019	2020	2021	2022	2023	2024	2025
GDP								
Real variation rate (actual GDP)	0.5	1.5	2.0	2.5	2.8	2.5	2.5	2.5
Real variation rate (trend GDP)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Output gap	4.0	4.6	4.6	4.1	3.3	2.8	2.3	1.8
CPI								
Variation (ave./ave.)	0.04	0.02	0.025	0.03	0.03	0.03	0.03	0.03
Peso / dollar exchange rate								
Nominal value	750	700	695	690	685	680	675	670
Price of copper in US$ per pound								
Nominal value-London Metal Exchange	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6
Reference price	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Tax variables								
Structural balance target *(% GDP)*	-2.5	-2.7	-2.5	-2.2	-2.0	-1.7	-1.5	-1.2

Source: Prepared by the authors, on the basis of DIPRES, *Informe de finanzas públicas del proyecto de ley de presupuestos del sector público*, 2018, Santiago, 2017.

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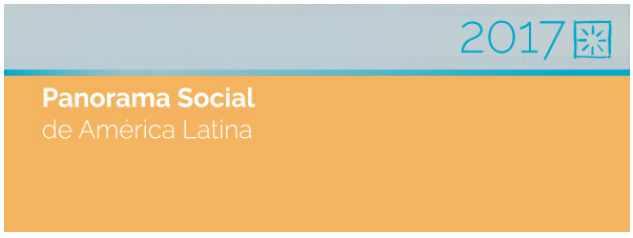

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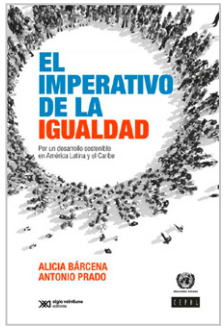

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