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ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN

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The *CEPAL Review* was founded in 1976, along with the corresponding Spanish version, *Revista CEPAL*, and it is published three times a year by the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), which has its headquarters in Santiago, Chile. The *Review*, however, has full editorial independence and follows the usual academic procedures and criteria, including the review of articles by independent external referees. The purpose of the *Review* is to contribute to the discussion of socioeconomic development issues in the region by offering analytical and policy approaches and articles by economists and other social scientists working both within and outside the United Nations. The *Review* is distributed to universities, research institutes and other international organizations, as well as to individual subscribers.

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This publication, entitled the CEPAL Review, is covered in the Social Sciences Citation Index (SSCI), published by Thomson Reuters, and in the Journal of Economic Literature (JEL), published by the American Economic Association

ARTICLES

Explanatory notes

The following symbols are used in tables in the *Review*:

… Three dots indicate that data are not available or are not separately reported.

(–) A dash indicates that the amount is nil or negligible.

A blank space in a table means that the item in question is not applicable.

(-) A minus sign indicates a deficit or decrease, unless otherwise specified.

(.) A point is used to indicate decimals.

(/) A slash indicates a crop year or fiscal year; e.g., 2006/2007.

(-) Use of a hyphen between years (e.g., 2006-2007) indicates reference to the complete period considered, including the beginning and end years.

The word "tons" means metric tons and the word "dollars" means United States dollars, unless otherwise stated. References to annual rates of growth or variation signify compound annual rates. Individual figures and percentages in tables do not necessarily add up to the corresponding totals because of rounding.

CEPAL Review marks its fortieth anniversary

The first issue of CEPAL Review was published in the first half of 1976. Forty years have now passed since that inaugural edition, under Raúl Prebisch's direction, burst onto the academic debate on the development of Latin America and the Caribbean, with novel and heterodox approaches to different facets of, and policies for addressing the region's problems. These have been four decades of fruitful work which aimed to portray, as accurately as possible, the historical reality of each stage in the development process, together with the structural complexities, the specific conjunctures, and the emergence of new national, regional and global phenomena involved in this process.

During these 40 years, CEPAL Review has published over a thousand articles, opening its pages to contributions from the most distinguished economists, sociologists, political scientists and academics from Latin America and farther afield, affiliated to the main specialized agencies in the economic, societal and environmental areas of development.

CEPAL Review has brought to light a collection of 118 regular issues, with corresponding versions in English and Spanish. The collection also includes five special editions, including the 1998 issue commemorating the fiftieth anniversary of the Economic Commission for Latin America and the Caribbean (ECLAC), two issues in French (2005 and 2010), one in Portuguese (2010) and one in Mandarin Chinese (2012).

Our journal has served as a vital tool for spreading the key ideas conceived within the academic debate as a contribution to regional development. Such has been the case since its earliest articles on the nature of peripheral capitalism and the styles of development during the 1970s —written by Prebisch and Aníbal Pinto (the Review's second editor), respectively— followed by the critical examination of the environmental impacts of such styles, the debt crisis and the "lost decade" of the 1980s, and the dissemination of ideas relating to changing production patterns with social equity and neostructuralist reformulations since the 1990s, which have continued under an approach of equality and inclusive development in the present decade.

Issue number 95, published in August 2008, marked the inclusion of CEPAL Review in the Social Sciences Citation Index (SSCI) published by Thomson Reuters, which stands out as one of the milestones of Oscar Altimir's tenure as editor. This landmark achievement has enriched the Review's pool of contributing authors, its editorial line and its impact, leading to its becoming one of the most frequently cited journals in academic publications within the region. The eight-year editorship of André Hofman, who has now taken retirement after almost 30 years of dedicated service to ECLAC, saw the establishment of an Editorial Board, consisting of renowned specialists in development issues from Latin America and the Caribbean and other world regions. This period has been especially fruitful for us, as CEPAL Review has ventured into new subject areas, such as the recent international financial crises, inequality and its many faces, global warming, the care economy and gender issues in the development process, among others. Our geographical coverage has also expanded with the inclusion of new analyses, especially with regard to the development of Andean and Caribbean economies.

This special edition of CEPAL Review, commemorating our fortieth anniversary, provides a perfect example of a thematic and geographical collage, and deals with many of the aforementioned topics. The editorial team wishes to take this opportunity to thank Alicia Bárcena, Executive Secretary of ECLAC, for her steadfast support for our efforts. Likewise, we wish to share this rich and satisfying editorial experience with our readers, renewing our commitment to raising new contributions on development problems in Latin America and the Caribbean, with academic independence and, in this manner, firmly committed to our content policy and editorial quality standards.

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Raúl Prebisch and economic dynamics: cyclical growth and centre-periphery interaction

Esteban Pérez Caldentey and Matías Vernengo

ABSTRACT   Prebisch believed that understanding the evolution of capitalist economies over time and in different contexts required a general cycle approach, encompassing all the different areas of economic activity, which he labelled "economic dynamics." This theory, developed between 1945 and 1949, stemmed from a critique of both neoclassical and Keynesian theories, which Prebisch viewed as static representations of capitalism. It was applied first to a closed economy and then to a centre-periphery context. The theory combined the notion that profit is the driving force of economic activity, with a process of forced savings and the idea that the time lag between income circulation (and the resulting demand) and the completion of the production process are the main source of cyclical fluctuations. Prebisch's dynamics theory, which he never completed, influenced his "development manifesto" (Prebisch, 1950).

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I

Introduction

Raúl Prebisch (1901-1986) argued that the cycle is the natural way in which capitalist economies evolve and grow over time. He also asserted that the cycle took a particular form, that of a wave motion. Moreover, he thought that this type of movement characterized all the different facets of economic activity, including production, employment and distribution. Following his departure from the Central Bank of Argentina in 1943, Prebisch set to work developing a general cycle approach that could account for the wave motion in capitalist economies. He termed this approach "economic dynamics."

Prebisch developed his views in two stages. The first stage, from 1943 to 1948, focused on a critique of the existing body of economic theory at the time. Prebisch maintained that both classical and Keynesian analyses had failed to grasp and incorporate the essential cyclical features of capitalism and, thus, that such analyses were removed from the working reality of free-market economies. Classical economics viewed capitalism through a static framework bounded by the trend towards the full utilization of resources through variations in relative prices and, in particular, in the rate of interest.

According to Prebisch, Keynes's economics suffered from the same flaw. In spite of his statements to the contrary, Keynes was never able to escape the mental habits of the classical mode of thinking. His analysis, particularly in his *General Theory of Employment, Interest and Money* (1936), also remained anchored in a static conception of capitalism. Keynes replaced the relative price adjustment of classical economics, and more specifically the adjustment of interest rates, with an approach based on income variations (the multiplier) which brought about instantaneous equality between investment and savings.

Prebisch articulated these critical thoughts in part through a series of lectures that took place in Buenos Aires between April 1945 and October 1948 under the title "Political Economy (Economic Dynamics)." The first lectures offered a critique of classical economics and of Keynes's General Theory. These lectures bore the title "The Crisis in Political Economy: Keynes and the Classical Economists."[1] As part of the development of

his dynamic theory, Prebisch's analyses of Keynes led him to publish his *Introducción a Keynes* [Introduction to Keynes], which laid out the main ideas of the General Theory (Prebisch, 1947a).

In a second stage, from 1948 until he joined the Office of the Executive Secretary of the Economic Commission for Latin America (ECLA) in 1949, Prebisch began to pull together the main building blocks of an alternative approach that could explain the wave motion in capitalist economies, thus capturing precisely the element missing from classical and Keynesian analyses. Most of the ideas that led Prebisch to his alternative model were developed during a series of lectures delivered at the University of Buenos Aires in 1948 and at the National School of Economics in Mexico City in February and March 1949.[2] The Buenos Aires lectures were titled "Economic Dynamics" and the Mexico City lectures, "Dynamic Theory of Economics" (with particular application to Latin American economies).

Prebisch's dynamic model consists of a two-class (the working class and the businessmen) economy with two spheres of activity (production and circulation) producing final consumer goods mainly with circulating capital. The model also includes a banking system that adapts passively to demand for credit. The introduction of a time dimension makes the model dynamic.

Time intervenes in the model in the production process, since a period of time must elapse between the start of a given production process and its completion. Time also intervenes in the circulation sphere. The wage bill is entirely spent on final consumer goods, but it returns as income to the businessmen with a lag, only after a certain period of time. Prebisch maintained that the duration of the production and the circulation processes differs: the production process is longer than

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[1] In 1947, the programme for the Political Economy (Economic Dynamics) course included 11 separate sections. The first four sections

focused on the gold standard, Bretton Woods and the value of money and inflation. Sections six to eleven dealt with the theories of the cycle and their empirical verification with a focus on Argentina, including the policies followed by its Central Bank under Prebisch's leadership. See Prebisch, 1947b.

[2] The first lecture in Mexico was given on 18 February 1949 and the last on 1 March 1949 (Prebisch, 1993a, vol. 4. pp. 410-489). See footnotes to "Teoría dinámica de la economía (I)" [Dynamic Theory of Economics (I)] (Prebisch, 1993b) and "Introducción al curso de dinámica económica" [Introduction to the Course on Economic Dynamics] (Prebisch, 1948a). See also Prebisch, 1948c.

the circulation process. It is precisely this disparity in the length of the two processes that generates the wave motion in a capitalist economy, i.e. its dynamics.

Prebisch's dynamic analysis was meant to show that, if the wave motion in capitalist economies is correctly understood, economic forces would never lead to an equilibrium point, but rather to a series of upturns and downturns within which the economy was growing. This was his understanding of cyclical growth. He eventually extended his dynamic analysis to include the relationship between the centre and the periphery.

In March 1949, at the end of his lectures on economic dynamics, Prebisch was convinced, that his theory was general rather than specific to a particular setting and circumstance. However, probably due to time constraints and pressing commitments, he never fully developed his dynamic theory. In 1949 he joined the then Economic Commission for Latin America (ECLA), first as a consultant and then, two years later, as its Executive Secretary. By then, his interest had turned to the problem of industrialization in Latin America, as attested by the publication of *The Economic Development*

of Latin America and its Principal Problems (Prebisch, 1950), his "development manifesto", and "Crecimiento, desequilibrio y disparidades: interpretación del proceso de desarrollo económico" [Growth, disequilibrium and disparities: interpretation of the process of economic development] (Prebisch, 1951b), which nevertheless were clearly influenced by his cycle and dynamic analyses.

This paper provides a systematic and critical exposition and analysis of Prebisch's economic dynamics. It is divided into eight sections. Following this Introduction, section II discusses his critique of the neoclassical theory and Keynes's General Theory as static representations of capitalist development. Sections III to VI lay out the building blocks of Prebisch's dynamic theory and its development. Section VII follows Prebisch's application of his dynamic theory to the centre and the periphery and argues that, according to Prebisch himself, his dynamic theory was a general theory rather than a specific one, and thus it was capable of incorporating different assumptions and varying parameters and situations without altering its core analysis and foundations. The conclusions are found in section VIII.

II

Neoclassical theory and Keynes's General Theory: two static representations of capitalism

Prebisch believed that the growth process in capitalist economies was eminently cyclical. As he put it: "The cycle has historically been, and continues to be, the typical manner of growth for capitalism. Economic activity... expands and contracts continually in an interrupted succession of phases of growth in income, employment and production, which are followed by phases of decline, with a consequent decrease in production and employment" (Prebisch, 1948a).[3] His understanding of capitalism is typical of many authors of this period. For Prebisch, the cyclical reality of capitalist growth undermines the whole notion of equilibrium, understood in the Smithian sense as a centre of gravity, and all the more so when considered in terms of the neoclassical notion of allocative efficiency. As Prebisch argued: "There is no resting point: an upswing is followed by a

downswing, only to be followed by another upswing… In this movement there is no equilibrium point; this movement is a continual succession of disequilibria" (Prebisch, 1948a). This idea applies to both static and dynamic equilibria.

Prebisch came to be highly critical of the prevailing economic theory because it was anchored in equilibrium analysis and was, thus, divorced from capitalist reality. In his view, both neoclassical and Keynesian theories suffered from the same flaw.

His critique of the neoclassical theory focuses on the marginal productivity theory. Prebisch argued that the marginal productivity theory implied that the evolution of a market economy could only be characterized by a regular line of advance and, in more modern terms, that it was only compatible with steady-state growth, a concept and expression that became a fundamental part of the mainstream toolkit only a decade later. Prebisch correctly understood that steady-state growth is determined by

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[3] See also Prebisch, 2003a.

the population growth rate and technical innovation.[4] For Prebisch, the notion of steady-state growth was antithetical to the very nature of capitalist evolution.

Prebisch illustrates his point with an implicit model comprising an investment and consumer goods sector. The application of the marginal productivity theory to this type of model meant that if output expands in a steady-state manner, both investment and consumption also have to expand at a steady- state growth rate and, thus, maintain a given ratio over time. In other words, the marginal productivity theory presupposes a balanced process of growth, implying that the competitive conditions ensure that the output of capital maintains a given relationship relative to consumer goods, which is determined by the population growth rate, technical innovation and preferences. Any divergence from that investment/consumption ratio is eliminated through changes in resources brought about by the difference between the marginal product of capital and the rate of interest. If the ratio of investment to consumer goods exceeds (falls short of) the ratio compatible with balance growth, the marginal product of capital would be below (above) the rate of interest, causing a shift of resources from the production of capital (consumption) to consumer (investment) goods. This would lead the marginal product of capital to increase (decline) until it reached equality with the interest rate. As explained by Prebisch:

"The logical relationship between capital and consumer goods industries derives from the population growth rate, technical innovation and the savings preferences of the community. Thus, if for any reason greater capacity were to be created in a given industry than was justified by the level of consumption, since investment is simply an advance of expected consumption, if there is excess capacity, the productivity of the increase in capital brought about by this excess would be lower than the interest rate, and this would eliminate the excess. Accordingly, excess capacity for the production of articles or capital goods cannot be conceived of in either specific cases or specific sectors of the economy..." (Prebisch, 1948f).

In this view, the interest rate acts as a centre of gravity for the marginal product of capital and is the central coordinating mechanism of economic activity. Prebisch viewed the interest rate, as defined by the neoclassical authors, as an artifice, albeit a useful artifice, for it allowed neoclassical theory to remain within the

confines of static equilibrium theory even when analysing a capitalist production-type economy. For Prebisch, the process of production requires the passage of time or a period of time during which savings must be generated and transformed into capital. As he puts it:

"… a more or less lengthy period of time elapses between the initiation of operations and the termination of the final product to be made available to the consumer. Meanwhile the factors of production involved in this intermediate production phase that creates —as time goes by— the final product, need to consume and if they do not save, i.e. if they stop consuming —even to a small degree— other factors within the community must forego consumption so that they can consume. To forego consumption is to save and transfer what is not consumed to those working in intermediate production. It is to invest these savings in intermediate production, i.e. to invest these savings in capital formation, since intermediate production —all that is being transformed into final products, a more or less lengthy process— is capital" (Prebisch, 1948b, p. 272).

The classical theory allows the process of transforming savings into capital to be perfectly synchronized by changes in the interest rate. The interest rate is the "theoretical artifice", as Prebisch termed it, for the required synchronicity. According to Prebisch, neoclassical theory holds that it is "… not possible to invest without having an equivalent and simultaneous amount of savings" (Prebisch, 1948b). In other words, the interest rate regulates savings in such a way as to make the act of saving and that of investing a simultaneous occurrence.

After laying out his critique of neoclassical theory, Prebisch turns the focus of his analysis to John Maynard Keynes. He argues that Keynes was never able to free himself completely from the fetters of the classical theory and remained attached to the neoclassical notion of equilibrium. Having disparaged the neoclassical theory of interest rates, which he criticized profusely in his General Theory, Keynes used an alternative artifice as a means of disregarding time, asserting that the multiplier and the associated changes in income would generate the required savings to "finance" investments. Prebisch interprets the multiplier as an "instantaneous multiplier". As he puts it:

"The revolutionary aspect of Keynes, from a theoretical point of view, is his famous theory of the multiplier, which is another theory of economic equilibrium very similar in its structure to the old quantity theory of money. Such is the strength of that mental habit, from which Keynes would never

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emancipate himself. He thus followed the classical economists where he should have followed them the least: in the search for laws of equilibrium, which is, in my opinion, the greatest obstacle to the progress of political economy from a theoretical point of view. If these obstacles are not forcefully removed, we will continue to formulate constructs that are disconnected from reality" (Prebisch, 1948a). He went on to explain:

"That is, given an increase in investment, income will grow in the amount required to produce an increase in savings in the community equivalent to the increment in investment. It is clear that such reasoning could only come from a theoretician who disregards time. Why? Because time is indispensable in order for an increment in investment to trigger an increment in income, so ultimately, Keynesian thinking is to say: in order to invest today, we will use savings that will be made in the future (...). Such reasoning is possible only if the future is confounded with the present and the time factor is eliminated completely from the process. This is one of the great logical inconsistencies that invalidate Keynesian theory"[5] (Prebisch, 1948b, p. 277).

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[5] Schumpeter (1946) put forward a similar critique of Keynes's General Theory.

III

Main elements of Prebisch's dynamic theory

Having argued that the static constructs of the neoclassicists and Keynes are not relevant to the understanding of capitalism, Prebisch emphasizes the need to formulate a dynamic theory capturing the time dimension and the wave motion in capitalism, with the understanding that this theory would encompass the entire spectrum of economic activity. In his own words:

"I am increasingly convinced that the cycle is the way in which a capitalist economy grows. A capitalist economy expands only in a wave motion, it has moved only in that manner and any perturbation of the economy as a whole gives that motion a wave form. Therefore, if the cycle is the way in which the economy grows and moves, and if the economy moves incessantly in this manner, it would seem that all the phenomena occurring in the economy as a whole —not just those relating to production and employment, but also those relating to distribution— should be included in a general dynamic theory" (Prebisch, 1993b, p. 414).

A dynamic theory should explain not only the rationale for the alternating phases of prosperity and depression that characterize capitalist economies, but also the processes of production and distribution.[6]

Prebisch's dynamic analysis is presented in terms of a model comprising two social classes, businessmen and workers, with two spheres of activity, production and circulation. He assumes, furthermore, that the banking system reacts passively to demand for credit, that the economy produces final consumer goods and that workers' wages are spent entirely on final consumption such that businesses recoup the money spent on production.

The time variable enters into the production and circulation processes in a fundamental way. A production process does not take place instantaneously; it takes some time. Between the start of any production process and its end result (the output of finished goods), a value is added to the process at every interval, so that the whole production process consists in a sum of values added. Alongside the process of creating value added

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[6] As Prebisch notes, The theory of economic dynamics purports to explain this [cyclical] way in which phenomena occur and to identify their uniformities, in order to formulate the principles or laws that govern that movement. Likewise, he affirms that the dynamic theory also plays a fundamental role in the analysis of three of the main characteristics of a free-market economy: the instability of the economic system, the inequality in income distribution and persistent unemployment. In this sense, Prebisch shares some of Keynes's views on investment and on the flaws of capitalism, namely "its failure to provide full employment and its arbitrary and inequitable distribution of wealth and incomes" (Keynes, 1943). See Prebisch, 1948b; 1948e; 1948f, and 1947a. Prebisch adds instability to that list (Prebisch 1948b and 1948e).

(a production process) there is a process of income generation. Means of production have to be purchased, and participants in the production process earn an income for their contribution.

Some wages and profits are distributed before the end of the production process. The time span between the period during which earnings are distributed (circulation sphere) and the period required to complete the production process (production sphere) creates a disparity between aggregate demand and aggregate supply and is the source of profits and of the cycle. In other words, the fact that the monetary and real spheres operate in different time periods explains why economies evolve through a series of disequilibrium positions rather than tending towards an equilibrium position (Prebisch, 1948a).

The upward phase of the cycle is characterized by an excess of income over value added, i.e. an excess of aggregate demand over aggregate supply. This in turn translates into higher expenditure, prices, profits and investment. The flow of investment expenditure then eventually returns to the businessmen in the form of profits.

In the downward phase of the cycle, as aggregate supply exceeds aggregate demand, prices and profits decline, leading to a process of disinvestment. As upward and downward phases alternate, Prebisch maintained that "… a capitalist economy is characterized by a continuous process of investment and disinvestment, with this peculiarity: in general, in the disinvestment process not everything that has been invested is disinvested; otherwise, there would be no economic growth" (Prebisch, 1993b, p. 425).

IV

Schematic representation of Prebisch's analysis

Prebisch expands his analysis of dynamics through a graphic representation consisting of a plane divided into two right triangles of equal area. The first triangle (ADF) represents production in process. The second triangle (FDK) represents finished production. Prebisch considers only circulating capital at this stage. The two-triangle plane is meant to capture three dimensions of the production process: the time elapsed during this process; real output, including both production in process and final production (the quantity of production); and the money income paid to the factors involved in the production process. Prebisch assumes that there are nine production processes and that each one takes nine months to produce one unit of final output.

Further, he assumes that wages are only paid while production is in process, that such wages are spent on final consumer goods and that there are no profits at this stage. Businesses recapture the income they pay to workers (their wage bill) through the sale of final commodities. Prebisch assumes, furthermore, that business earnings are, in turn, reinvested in the production process.

The base of the ADF triangle (AD) represents the stages of a production process, which Prebisch divides into nine equal time periods (or months). The hypotenuse of the triangle (AF) represents both the incomes paid for

production in process and the sequential start of each of the series (or nine stages) of the nine production processes. The hypotenuse of the FDK triangle (DK) represents the incomes paid for the finished goods (see figure 1).

At the end of the first nine months, the first production process (denoted by ABCD in the first (AFD) triangle) produces one unit of finished goods (denoted by CDH in the second (FDK) triangle), which is equivalent to ABK. These goods are sold and the proceeds are then reinvested and added to the production in process (ADF). At this point, businesses begin the second production process, which will take nine months. After this is completed, the finished output appears as ICHJ in the second (FDK) triangle. ICHJ is equivalent to the sum of the reinvested proceeds (CDH), plus the addition to final output resulting from the second production process, but without taking into account the proceeds reinvested from the final output of the first production process (ICHK). Thereafter, the process is repeated until the nine production processes are completed, with each one contributing the same volume in process to the final output. At the end of the entire process, total income paid will be equal to total income received for final output (AF = DK or $\alpha = \beta$).

This steady-state system (comprising workers who receive wages that are then paid to businesses

for the purchase of final commodities and businesses which reinvest those proceeds) can only expand if the incomes paid for production in process exceed the incomes received by businesses for the sale of final output. This is shown by the displacement of AF to AL, which leads to an increase of incomes paid to factors for production in process over and above final output (DK) ($\alpha = \beta$ and $\alpha_1 > \beta$).
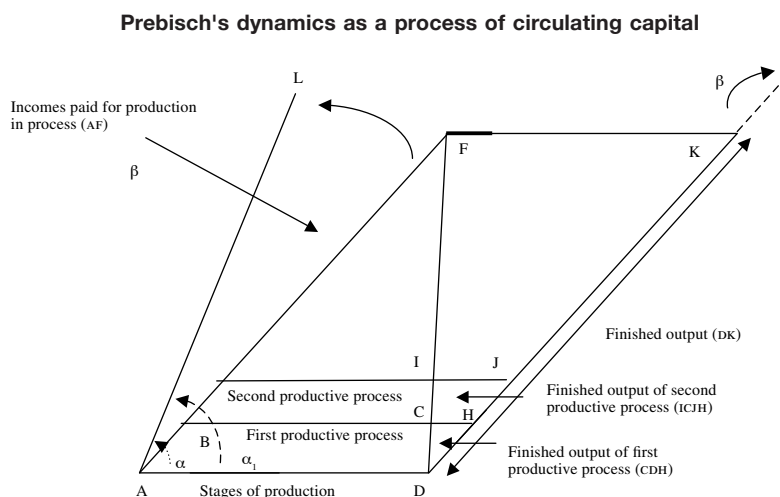
Prebisch's dynamics as a process of circulating capital

Source: Prepared by the authors, on the basis of R. Prebisch, "Teoría dinámica de la economía (II)", *Raúl Prebisch: Obras*, *1919-1948*, vol. 4, Buenos Aires, Raúl Prebisch Foundation, 1993.

V

Profits and forced savings

At a later stage, Prebisch proceeds to introduce profits into his analysis. In fact, they constitute the pivot on which Prebisch's dynamic theory is built. Profits derive from forced savings.

As Prebisch puts it:

"... the largest portion of investment in fixed capital is covered indirectly by an increase in money, not by recourse to the market in accordance with the laws of supply and demand in classical economics...How does the increase in money work?... the increase in money put into circulation by people to pay for investment causes prices to rise... The increase in prices implies a fall in real wages... in order to compel those who pay the highest prices to save, transferring these savings to the businessmen in the form of consumer goods; the businessmen in turn transfer the savings to those engaged in capital formation... most savings are not the result of a

mechanism of incentives and preferences, but of a mechanism of compulsion. Saving is compelled when there is not enough spontaneous saving" (Prebisch, 1948c).

Prebisch firmly believes that savings precede investment, and that the undertaking of investment necessarily required a prior act of savings. As he argues (Prebisch, 1948c): "I am convinced that foregoing consumption is essential in order to capitalize investments. In this point I agree with the reasons espoused by the classical school and I disagree with Keynes."

Nonetheless, Prebisch views the notion of forced savings as incompatible with the neoclassical orthodox idea of savings, which conceives it as the result of individual preferences. He expresses it as follows: "A large portion of investment has historically been undertaken, and continues to be undertaken, by a mechanism very different from supply and demand for savings, and a

large portion of the savings that are invested is not the result of what the community spontaneously decides on the basis of its inclinations and tastes and the interest rate" (Prebisch, 1948b).

According to Prebisch, profits result from an excess of demand over supply and materialize from the beginning to the end of the production process. The profit transmission mechanism encompasses the spectrum of different businesses involved from the beginning to the end of the production process: raw material producers, industrialists, wholesalers and retailers. Prebisch assumes that prices for retailers are fixed, while prices for wholesalers, manufacturers and raw material producers are flexible. In addition, retailers aim for a certain normal level of inventory.

Faced with an increase in demand for final products, retailers reduce their inventories below their normal level, which leads to increased demand for products from wholesalers and to higher prices and profits. Wholesalers, in response to the higher prices and profits, then expand their operations, and their demand for products from industrialists increases. The same mechanism leads to increased demand from industrialists for products from raw material producers. The rise in demand and the higher prices and profits are thus transmitted throughout the production and distribution process. At every stage, the rise in demand, prices and profits is accompanied by a concomitant increase in the wage bill (Prebisch, 1993c and 1993d). This process yields a rise in wages and profits, which are then incorporated into the prices charged by all types of businesses to each other and to final consumers. Hence, the primary products sold to industrialists, the wholesale products sold to retailers and the final products sold to consumers will have incorporated the new profit level, itself the result of an imbalance between aggregate supply and aggregate demand.

Prebisch thought that once a higher level of profits was incorporated into the whole production process, those profits could not be squeezed, nor could they act as the adjustment mechanism in case of a decline in demand. Thus, just as profits and the anticipation of profits act as the trigger to boost production and incomes, they are also an important source of rigidity in the system which prevents it from operating in the way the classical economists theorized. As Prebisch puts it:

"… profits that have accumulated during the production process are irreversible, and therefore even if the conjectures made by businesses regarding future demand, which have given rise to this advance

crystallization of profits during the production process, fail to materialize, the product that is offered in the market already incorporates those profits in such a way that they cannot be reduced, because they have been paid at the various stages… Thus, as a result of the crystallization of profits, the levels of supply in the production process acquire a rigidity that will trigger a cyclical contraction when demand, after the point of convergence, is insufficient to absorb supply" (Prebisch, 1993c).

In accordance with this reasoning, the level of profits per unit produced for each category of business, with the exception of raw material producers, is determined by the profit margin between the different stages in the production process, which in turn depends on the degree of competition (or as Prebisch (1993d) expresses it: "competition and mobility").

On the other hand, the level of profits is determined by the time elapsed between when the desired level of demand is reached and when a product is brought to the market. For commodity producers, the level of profits depends only on the duration of the interval between the purchase of a product and its sale. In the case of retailers and wholesalers, the time elapsed between purchase and sale involves the different transactions that are undertaken in the circulation sphere of the production process not in the production sphere per se as in the case of manufacturers (industrialists) and raw material producers.

More specifically, the level of profits accruing to retailers (π_{RT}) will be determined by a profit margin over and above the profit level of wholesalers (π_{WT}) and the time elapsed between purchase of products from wholesalers and sales to the final consumer. In turn, the level of profits accruing to wholesalers (π_{WT}) will be determined by a profit margin over and above the profit level of industrialists (π_I) and by the time span between purchase and sale. The level of profits of industrialists (π_I) will be determined by a profit margin over and above the profit level of raw material producers and by the duration of the manufacturing process. In the case of raw material producers, profits are determined only by the time elapsed between planning and extraction of raw materials and their sale to the manufacturer. Formally,

$$\begin{aligned}
\pi_{RT} &= \mu_1 \pi_{WT} + \theta_{RT} \\
\pi_{WT} &= \mu_2 \pi_I + \theta_{WT} \\
\pi_I &= \mu_3 \pi_{RM} + \theta_I \\
\pi_{RM} &= \theta_{RM}
\end{aligned} \tag{1}$$

where μ_i and θ_i represent the respective profit margins and duration of the production process for each business or producer category (retailers, wholesalers, industrialists and raw material producers). Successive substitution means that the level of profits in the retail sector depends on the different mark-ups applied at each stage of production and distribution weighted by the time elapsed between purchase and sale of raw materials, manufactured products and wholesale goods and by the time required to bring raw materials to the market for sale. That is:

$$\pi_{RT} = \mu_1 [\mu_2 \mu_3 \theta_{RM} + \mu_2 \theta_I + \theta_{WT}]_+ \theta_{RT} \qquad (2)$$

Under conditions of perfect competition, $\mu_i = 0$ and the existence of profits for retailers is only explained by θ_{RT}. In the opposite case, $\mu_i = 1$, profits arise out of the time elapsed for all production and distribution processes. As equation (2) illustrates, the retailer (under the assumption that he will realize his planned sales) obtains his own profits and also recaptures all the other profits made and paid at each stage of the production process. Even prior to the final sale of a product by the retailer, profits are earned and incorporated into the price charged by every business that intervenes in the process. As retailers face fixed prices, an increase in demand for final consumer goods will reduce the retailer's inventory. As explained above, this will trigger an increase in demand from retailers for wholesale products, from

wholesalers for manufactured products, and from manufacturers for raw materials. As these businesses operate in flex-price markets, the rise in demand will result in a price increase and an expansion of profits throughout the production chain. Higher profits (and profit expectations) will result in increased demand for investment, labour and all the types of goods used in the process from raw material producers to wholesalers. This greater demand for labour and goods will translate into higher wages and goods prices.

Prebisch explains this in the following way: "We already know that profits have built up during the different stages of the production process. When the retailer acquires products from the wholesaler, the former pays the latter all the earlier profits; and when these articles are sold, the retailer recovers all of those profits... and also obtains his own profit... In other words, the consumer pays the retailer's profits and also returns all of the profits realized earlier in the production process. Meanwhile, in the upward phase, at the same time that the retailer recovers the profits that he had previously paid out, he is paying greater profits; there is thus an increase in profits. This increase will give rise immediately to an adjustment at all stages because as the production process proceeds from business to business each receives a part of the increment [in profits]" (Prebisch, 1993d, p. 443).

VI

General aspects of Prebisch's dynamic theory

Prebisch's overall view of dynamics can be summarized with the aid of one of the figures found in his "Teoría dinámica de la economía (I)" [Dynamic Theory of Economics (I)] (Prebisch, 1993b) (see figure 2). The figure shows the demand and supply sides of the production process and their interaction in the upward and downward phases of the economic cycle. Demand is determined by earned and spent income. Supply is determined by production output (whether of production in process or final production). Figure 2 shows three parabolic curves: incomes paid by producers of final goods to factors of production; finished production (output of finished goods) and demand (D) for final goods. The three curves rise and

evolve at different speeds, illustrating the time structure of production.

On the demand (income) side, the incomes paid to the means of production (I_{pfp}) give rise to the demand curve for final goods (D), which in turn translates into income that returns to businesses (I_{re}). In other words, demand (D) is equivalent to income returning to businesses (I_{re}). During the production process, producers pay wages and profits for production, which return to them as income (i.e. profits) in a circular flow. On the supply side, production in process (P_p) gives rise to the finished production (P_T) curve and, by construction, P_p is equivalent to the incomes paid by producers of final goods to the factors of production (I_{pfp}).
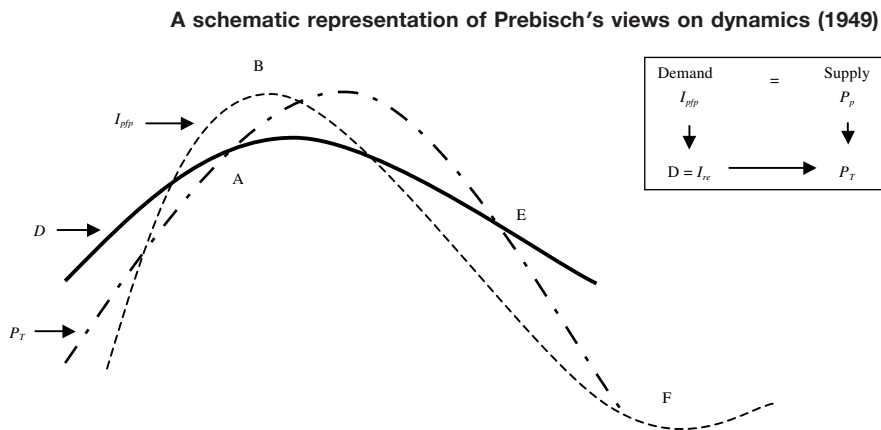
FIGURE 2

A schematic representation of Prebisch's views on dynamics (1949)

According to figure 2, starting with the upward phase of the cycle, incomes are paid to the means of production (I_{pfp}) and thus production in process (P_p) tends initially to outpace finished production (P_T), owing to the lag in the production structure up to point A. As a result, demand (D) during this phase is higher than finished production or supply. At point A, demand (D) and finished production output (P_T) intersect. Yet, according to Prebisch, A is not an equilibrium point. This is due to the fact that producers are still undertaking production in process (P_p) and, as a result, even at the point of convergence of the two curves (A), finished production (P_T) is increasing at a faster rate than demand (D) (i.e. the slope of P_T at A is steeper than that of D). Finished production surpasses D and continues to expand even after demand has begun its decline.

The end result is the accumulation of inventories by businesses and, thus, a reduction in their plans for production in process. This is illustrated by the decline in the slope of I_{pfp} and thus of P_p. Its point of inflection at B is the beginning of the downward phase of the cycle. As I_{pfp} slows down, P_p and D follow suit.

The decline in D, I_{pfp} and P_T continues until the continual depletion of inventories leads again to a point of convergence (E) between demand for final goods (D) and finished output (P_T). Again E is not an equilibrium point for demand (D), which declines at a slower pace than finished production (P_T). The depletion of inventories

will slowly lead businessmen to renew orders for their production process, putting a break on the decline in P_p and I_{pfp} and on demand. Eventually, P_p will begin to turn around (point F) and will pull I_{pfp} and thus D towards a new upswing of the cycle.[7]

Prebisch's schematic representation illustrates, once again, that the hallmark of the evolution of a capitalist economy is not a convergence towards equilibrium, but recurrent states of disequilibrium. Disequilibrium is continuous, and a situation in which supply exceeds demand leads to one in which demand exceeds supply (Prebisch, 1993b). In addition, there is nothing to guarantee that the fluctuations occur around an optimal level of utilization of the means of production. As relevant and original as Prebisch's analysis of cyclical dynamics was, it is important to note that his extension of capitalist dynamics to deal with the interaction between centre and periphery was unique.

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[7] In Prebisch's diagram (Prebisch, 1993b, p. 419) finished production (P_T) and production in process ($P_p = I_{pfp}$) have a similar slope in their decline, but D has a shallower slope. We believe that this is a slip on Prebisch's part. The depletion of inventories (which is considered production in process) will lead businessmen to expand orders for inputs needed for production in process before final production recovers. Moreover, since the demand (D) curve is derived from the production-in-process curve (P_p) and D declines at a slower rate than finished production (P_T), so must production in process (P_p). Hence, in figure 2 above, P_p declines at a slower rate than P_T.

VII

From the closed economy to centre-periphery dynamics

Prebisch uses the previous framework to analyse the relationship between centre and periphery. He had made extensive use of this analytical dichotomy when, during his earlier analysis of the Argentine economy, he realized that the cycle was part of a global process comprising a cyclical centre and a periphery.[8]

The centre-periphery dynamic theory assumes that the periphery is wholly specialized in the production of raw materials, which are exported to the centre in exchange for manufactures. Profits in the final, retail and wholesale sectors are earned and spent in the centre. Profits from the production of raw materials are realized in the periphery and spent in the centre (i.e. transferred to the centre). As a result, businesses in the centre face demand originating both in the centre and in the periphery. In addition, it is assumed that the centre issues the reserve currency, which constitutes the only currency in the periphery. In other words, the periphery is "dollarized," which might be an extreme assumption, but it reflects the fact that peripheral countries' imports must be paid for in the key currency of a central country. Insofar as the periphery does not have policy autonomy, it plays a passive role and constitutes the space for the circulation of incomes sent from the centre (Prebisch, 1993h). According to Prebisch, the assumption of passivity on the part of the periphery is a realistic one.

Prebisch applies his dynamic analysis for a closed economy to the centre and to the periphery, according to which in the upward phase of the cycle demand tends to outstrip supply because of the difference between the time it takes for incomes to return to businesses (as demand) and the time it takes for output to be finished (supply). This difference triggers an increase of both prices and profits, which in turn justifies additional production commitments..

The application of this framework to a centre-periphery model implies that the undertaking of the production process by the centre necessarily results in positive net demand (an injection) in the centre. Hence, the centre experiences excess demand. However, at the same time the centre also experiences leakages equivalent to the value of imports of raw materials from the periphery. This constitutes the income flow paid to businesses and workers in the periphery for the production and export of raw materials sold to the centre. In turn, businesses and workers in the periphery purchase the final goods produced in the centre. Hence the flow of income spent by businesses from the centre in the periphery returns to the centre.

On the one hand, Prebisch postulates that, as in his previous analysis, the time period over which incomes return to businesses is shorter than the time period required to bring the finished products to the market. On the other, it takes longer for incomes to return from the periphery to the centre (demand from the periphery) than for final production in the centre to be brought to the market and sold (in the centre) (Prebisch, 1993f). As a result, at the same time that there is excess demand originating in the centre, there is insufficient demand for final goods in the periphery.

The interplay between the forces and factors determining the excess demand in the centre and the insufficiency of demand in the periphery constitutes the core of Prebisch's dynamics as applied to the centre-periphery dichotomy. At the beginning of an ascendant phase, demand exceeds supply, leading to an increase in prices and profits. Concomitantly, part of the increased income leaks out to the periphery, reigning in the pressure on net aggregate demand. The greater the leakage coefficient is, the smaller the excess net demand will be and, hence, the smaller the profit and the incentives for continued expansion in the centre.

Prebisch contends that the net excess demand will wane over time owing to an increase in the income elasticity of imports for products from the periphery demanded by the centre. The flow of profits (from the centre to the periphery and back) acts as the equilibrating force between demand and supply in the centre. As he puts it:

> "…there is an excess of net demand over supply in the cyclical centre, which has the effect of diminishing the inventories of final businessmen, causing a rise in demand among businessmen in order

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[8] See Prebisch, 2003c and 1993b, and Pérez Caldentey and Vernengo, 2011.

to increase production, which leads to an increase in profits, which, under the hypothesis that we are considering, go mostly to the periphery. That is, as long as the point of convergence is not reached, there will be a continuous depletion of inventories, a continuous rise in demand among businessmen, a continuous expansion of profits and a displacement of profits towards the periphery. Profits continue to be displaced in greater and greater measure to the periphery until their amount creates an insufficiency equal to the excess. This is the spontaneous interplay of the system" (Prebisch, 1993f).

This mechanism is reinforced by the assumption that businesses need more time to recoup their earnings from the periphery than to bring their final production to the market and sell it. Precisely for this reason, Prebisch argues that the point of convergence or equilibrium between the excess demand in the centre and the insufficiency of demand in the periphery would be very hard to reach, especially when —as he assumed in his model— the leakage coefficient in the centre is significantly greater than that of the periphery. He provides a specific example in which the leakage coefficient has a value of 0.50 and 0.20, respectively, for the centre and the periphery (Prebisch, 1993g): "The leakage coefficient, that is, the

one that gives us the recoup of earnings, is, according to what we already explained, much higher in the overall income generated in the centre than in the overall income generated in the periphery."

Prebisch further assumes that incomes in the centre would increase by a constant 100 units, whereas in the periphery incomes would rise by 20 units (see figure 3). The result is a widening gap between the amount that the centre spends in the periphery and the amount that the periphery spends in the centre, denoted by the distance between the dotted line and solid black line (between points A and B). The dotted line at the top shows the evolution of leakages for the centre with successive increases of 100 units in income and an import coefficient of 0.50. The solid black line at the bottom plots leakages for the periphery under the assumption of successive increases of 20 units in income and an import coefficient of 0.20. But even if incomes in both the centre and the periphery expanded by the same amount, say 100 units, the gap would still increase (albeit to a lesser extent). In figure 3, this is shown by the difference between the dotted line at the top and the two lines below it, which plot leakages for the periphery under the assumption of successive increases of 100 and 200 units in income, with an import coefficient of 0.20 for both.

FIGURE 3
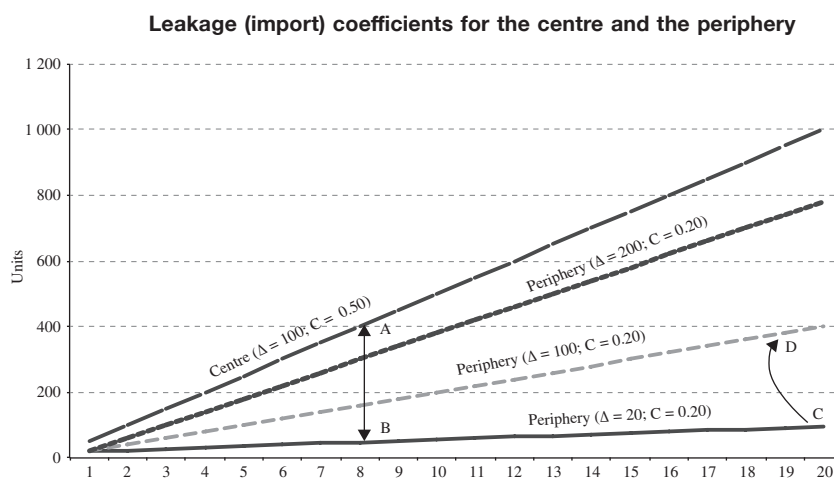
Leakage (import) coefficients for the centre and the periphery

Source: Prepared by the authors, on the basis of R. Prebisch, "Teoría dinámica de la economía (VI)", *Raúl Prebisch: Obras, 1919-1948*, vol. 4, Buenos Aires, Raúl Prebisch Foundation, 1993.

The fact that Prebisch assumes, at least until his seventh lecture on economic dynamics (Prebisch, 1993h), that the import coefficient is larger in the centre than in the periphery seems a stark contradiction to his thinking.

A key tenet of Prebisch's work, and of the structuralist school, is that the import elasticity of income in the periphery is higher than in the centre (see, for example, Prebisch, 1950). From the point of view adopted in this

study, this contradiction can be explained by means of two hypotheses.

First, Prebisch was aware that, since around 1926, developing countries had been experiencing declining terms of trade and that this was a relative price effect. But he did not specifically address the differences in income effects between centre and periphery, even when he addressed the issue of trade between a developed and a developing country in a 1948 lecture entitled "El esquema clásico del comercio internacional y el oro en la realidad" [The Classical Scheme of International Trade and Gold in Reality], as part of his course on economic dynamics.[9] Perhaps Prebisch began to be explicitly aware of the importance of income effects in the external sector around the time he was developing his dynamics, but in 1948 those effects were not fully incorporated into his model.[10] The second hypothesis, a less credible one, is that Prebisch used the example of a greater coefficient of imports in the centre than in periphery only as an expository device to facilitate the presentation of his theory. Still, when Prebisch dropped this assumption, he did not develop the opposite scenario in detail (i.e. the scenario in which the import coefficient is higher in the periphery than in the centre).

In accordance with the working of Prebisch's dynamics, the widening expenditure gap leads eventually to a greater redistribution of profits to the periphery and, hence, to an increase in incomes in the periphery and a narrowing of the gap. In other words, starting from a situation where the leakage coefficients are 0.50 and 0.20, respectively, in the centre and the periphery, with increases of 100 and 20 units in income, as denoted by the respective lines, the widening gap would eventually begin to narrow as a result of the redistribution of profits, (leading to a shift from C to D in figure 3).

Prebisch thought that this dynamic process would lead to greater profit and income expansion in the periphery than in the centre (Prebisch, 1993f). This, in conjunction with lesser leakage of periphery incomes to the centre (relative to the leakage from the centre to the periphery), would eventually more than offset the excess net demand in the centre, creating a situation of excess net supply. As final goods producers found themselves with a greater level of inventory than planned, they would reduce orders and demand, which would have a cascade effect in the chain of producers. Lower demand, prices and profits would cause a recession in the centre, and lower demand in the centre for products from the periphery would reduce profits and the level of activity in the periphery.

As Prebisch explains it:

"When there was excess net demand, business inventories declined and this led businessmen first to increase demand among themselves and then to increase production. And when there is insufficient net demand, unsalable inventories in the hands of businessmen increase, prompting them to reduce production. If we accept this relationship between variations in inventories and the behaviour of businessmen, it is inconceivable that businessmen will keep paying the factors of production in the centre and buying the same amounts in the periphery when unsold production is accumulating..." (Prebisch, 1993g, p. 469).

The relationship between inventories and demand is a crucial link in the transmission mechanism and a fundamental element of Prebisch's dynamics and of his arguments against "equilibrium economics." He explains this in the following way: "If we could completely eliminate the effect of inventories on demand, we would reach an equilibrium position. But this would mean suppressing the only means of action that a businessman has in a capitalist regime; it would mean eliminating one of the system's vital parts. As long as that vital part exists and the reactions of businessmen –not all of them– occur, the system will not reach the equilibrium." Inventory build-up (reduction) reflects, in turn, the importance of expectations as a determinant of decisions to expand (shrink) production. In the upturn, when as a result of increased demand, "...businessmen see a decline in inventories, not only do they seek to increase production in order to meet the new level of demand that they expect, but they also anticipate possible growth rates in accordance with the circumstances of the market… The same occurs in the downturn" (Prebisch, 1993g).

According to Prebisch, his theory was general and not confined to specific cases and assumptions. He therefore

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[9] This text appears with the title "Progreso técnico y comercio internacional" [Technical Progress and International Trade] in Prebisch's collected works (Prebisch, 1948g, pp. 363-374). Nonetheless he was well aware of the import dependency of developing countries, as his analysis of the effects of the Great Depression demonstrates. Focusing on income effects after the Great Depression, he argued that imports increase because a considerable part of the direct consumption in a country, or the machinery and materials for its industries, comes from abroad, and the increase in income is reflected in higher levels of imports (Prebisch, 1991b).

[10] See Mallorquín's interview with Ifigenia Martínez, who worked with Prebisch between 1949 and 1950. She mentions that when Prebisch visited Mexico in 1949 he was very much concerned with the external sector and the tendency towards disequilibrium in that sector as a country develops and changes its economic structure. She also maintains that the ECLAC development model, especially with regard to the external sector, was based on the Mexican experience (Mallorquín, 1998, p. 147).

made three modifications to his model: he introduced fixed capital, allowed for an autonomous expansion of demand in the periphery via the creation of credit and considered the possibility of a higher import coefficient in the periphery than in the centre.

The use of both circulating and fixed capital goods in the production of final goods makes the production process longer than it would be if only circulating capital goods were used. In his model, Prebisch assumes that the creation of credit ("forced savings") finances the production of circulating capital and that "voluntary savings", in the form of funds hoarded during a period of contraction, finances investment in fixed capital goods. Hence, the introduction of investment in fixed capital into Prebisch's model adds an additional source of demand to that originating from investment in circulating capital. Incomes and profits paid in the course of producing fixed capital are added to those distributed in the process of producing circulating capital (Prebisch, 1993e). The additional source of demand, income and profits will be tempered by the amount of leakage to the periphery. As Prebisch puts it:

> "Investments are also made by taking raw materials and articles in process from the periphery. Thus, only a part of the profits of the cyclical centre will become income for the factors of production in the centre; the other part will become payments for articles being produced in the periphery. In other words, when profits are used for fixed investment, a part of these profits will leak immediately to the periphery and that part will be subject to the rate of return in the periphery" (Prebisch, 1993h).

Prebisch assumes that total investment initially runs ahead of profits, until businessmen exhaust the savings used to finance capital goods. Thereafter, businesses only invest in circulating capital goods, using savings and the creation of credit to finance new investments, and profits exceed investment. The "excess profits" may either be consumed as final goods or be saved and reinvested to increase circulating capital. The more excess profits are saved and reinvested, the less businesses rely on credit creation. Since some profits are spent in the periphery, the demand for final goods slows down. Nonetheless, by the mechanism described above, the point of convergence between excess demand originating in the centre and the insufficiency of demand will eventually be reached. The introduction of fixed capital does not alter the basic premises of Prebisch's analysis; it simply introduces a detour in the path to the point of convergence.

The second modification introduced by Prebisch implies that the periphery does not play a passive role and does not depend completely on the centre's currency, but instead relies to some extent on its own increase in credit creation to finance its production activities. In this scenario, in contrast to that in which the periphery plays only a passive role, demand will be greater in both the centre and the periphery. However, Prebisch did not develop this hypothesis in detail. He considered it more of a curiosity than an hypothesis with practical applicability or one that reflected capitalist development (Prebisch, 1993i).

The final modification, in which the periphery has a higher import coefficient than the centre, simply shortens the time required to reach the point of convergence. Prebisch did not consider this an important assumption, even though it played a crucial role within the logic of *The Economic Development of Latin America and its Principal Problems*, which he published a few months after completing his last lecture on economic dynamics.

VIII

Conclusion

The long process of development of Prebisch's economic ideas began in the 1920s and stretched into the late 1940s with his dynamic theory of economics. The essence of Prebisch's dynamic analysis, in which cycle and growth go hand in hand, is the introduction of the difference between the time required for incomes to circulate in the production process and the time required for final production to be brought to and sold in the market. In that respect, he is part of a broad tradition of authors who sought to formalize macro-dynamics in the wake of the Keynesian revolution. Prebisch maintains elements that are Keynesian in spirit alongside others that are decidedly neoclassical, while at the same time introducing elements of the old classical school, as was to be expected in a

period of transition in the economics profession. It was also to be expected of an author who was brought up in a rather intellectually eclectic environment.

Nevertheless, Prebisch stands alone among his contemporaries in seeking to explain the cyclical growth of the global economy as the result of the interaction between centre and periphery, in which the international division of labour matters. Not only does he explore the specificity of the problems of managing the peripheral economy, but he is unique among the economists who dealt with cyclical growth in addressing the importance of the shift in the global centre from the United Kingdom of Great Britain and Northern Ireland to the United States of America during the inter-war period.

His conception of the institutional and historical specificity of economic dynamics would eventually develop into what structuralists at ECLAC would refer to as the historical-structural method of analysis, which examined the process of structural transformation of developing economies from a historical perspective. Prebisch's understanding of capitalist dynamics, in the period just before he wrote his development manifesto and became Executive Secretary of ECLAC, was based on a theory that was intended to be general and all-encompassing —going well beyond the problems of peripheral countries with declining terms of trade— and which became the hallmark of his contributions to economic analysis.

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Inequality in Latin America: a global measurement

Verónica Amarante, Marco Galván and Xavier Mancero

ABSTRACT

This article combines individual data from household surveys in the Latin American countries to obtain a regional income vector and analyse its distribution and recent changes. It investigates whether distributive changes in the countries over the past decade have improved income distribution between individuals or widened gaps. The region's indicators of global inequality declined significantly during 2003-2012. This drop in global inequality is explained essentially by the reduction of inequality within Latin American countries. The incomes of the inhabitants of Latin America are now more equal in relative terms than a decade ago, although differences in the countries' average incomes have increased.

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I

Introduction

The study of inequality has long been central to research on Latin American countries, especially since they have figured among the world's most unequal for as long as reliable statistics based on microdata have been available (see, for example, Alvaredo and Gasparini, 2015). A number of studies on inequality in Latin America have concentrated on inequalities within countries, and in this way there has grown up a large literature (summarized in section II of this article) studying inequality from different perspectives and seeking to understand its determinants and evolution, focusing on the reversal of the upward trend of income inequality in the region since 2002.

A question that has been raised less often in relation to Latin America, though, is how different the incomes of the region's inhabitants are when the region is considered globally, and how this inequality has evolved over the last decade, during which inequality has diminished in most of the region's countries. This article aims to address that question, since it is relevant to complete the diagnosis of the recent evolution of inequality in Latin America. With this in view, different indicators for the evolution of individual incomes in the region as a whole are presented, with the evolution of inequality in particular being analysed. The article seeks to ascertain whether distributive changes within the region's countries over the past decade have been matched by improvements in income distribution between Latin Americans, or whether gaps have widened. The analysis is based on a combination of data from household surveys in the region, using similar criteria to process the data from the different countries, and specifically to calculate household incomes, so that the resulting vector is consistent between countries.

The article is organized as follows. After this Introduction, section II presents a brief overview of developments in the discussion and measurement of global inequality in the literature. Section III summarizes the evolution of inequality within the different countries of the region in recent years, together with the explanations put forward for this. Section IV presents the data used in the article and describes the methodologies chosen to measure inequality at the regional level. After this, the main findings of this study are set forth: section V discusses average income differences in the region, and section VI shows the evolution of the incomes of Latin Americans and their distribution, comparing information from the early 2000s (specifically 2003, when the inequality trend changed in most of the region's countries) with the most recent information available, which is for 2012. Lastly, section VII offers some final comments.

II

Global inequality

The importance of studying inequality can be argued for on grounds originating in theories of social justice, and also on purely instrumental grounds of economic efficiency. Concern about inequality stemming from considerations of social justice has not gone undebated (Feldstein, 1999; Milanovic, 2007, among others), and one of a number of moot issues is whether the real concern is inequality of opportunity (as suggested by Roemer, 1998) or inequality of outcomes, including income. In a recent publication, Atkinson (2015) gives three reasons for economics to remain concerned about the distribution of outcomes, including income. First, on moral grounds, the situation of the most disadvantaged individuals cannot be ignored, even in the

hypothetical event that equality of opportunities were guaranteed.[1] Furthermore, the structure of final prices or returns is so unequal that it warrants concern about outcomes, while also accounting for the consensus over the need to ensure equality of opportunities. Lastly, inequality of outcomes in the present affects equality of opportunities for future generations. Concerns about limited social mobility and the need to ensure equality of opportunities mean there is a need to reduce inequality of outcomes in the present. If the purely instrumental arguments are considered, the empirical debate and controversy centre on the link between income inequality and economic growth, and more specifically on the potential adverse effects of inequality on growth via a number of channels that include political economy, conflict and capital market flaws, among other things (see, for example, Alesina and Rodrik, 1994; Alesina and Perotti, 1996; Persson and Tabellini, 1994; Barro, 2000).

For the reasons given, it is important to study inequality. The result has been a large literature, usually focusing on developments in one country or comparisons between countries. However, some studies have concentrated on analysing global inequality. According to Milanovic (2005), it is possible to distinguish three different concepts used in the effort to capture inequality at the world level. The first is found in the oldest studies on this issue, which estimated global inequality by considering the level that would prevail if the world were populated by representative individuals from each country, each receiving their country's average income. This is known as the international inequality approach, and basically consists in comparing average incomes in the different countries without weighting them by their respective populations. The second concept also addresses international inequality, but considers differences in country size, yielding an indicator similar to the first one but weighted by each country's population. The third concept deals with what is known as global inequality and restores the individual as the unit of analysis, ignoring national borders. This is the approach applied in this study, which seeks to capture income differences between individuals in the region.

A number of studies have sought to engage with this third concept, which reflects global inequality, by deriving worldwide distribution from per capita gross domestic product (GDP) data and summary measures of inequality within countries (Schultz, 1998) or combining information from household surveys and per capita GDP data (Berry, Bourguignon and Morrison, 1983; Bourguignon and Morrison, 2002; Sala-i-Martin, 2006, among others). Other studies have examined global inequality on the basis of information from household surveys alone, deriving worldwide income distribution from these (Milanovic, 2005).

More recent studies on global inequality in recent decades (Milanovic, 2012; Lakner and Milanovic, 2013; Niño-Zarazúa, Roope and Tarp, 2014; Anand and Segal, 2015) combine information from household surveys and consider quantiles of income distribution (usually ventiles) in each country, imputing the average per capita income to each quantile and constructing a database containing the quantiles of the world's different countries.[2] These studies all agree that the level of global inequality is very high, comparable indeed to that of the world's most unequal countries, and that it presents relatively minor variations over time.

As regards regional inequality, Gasparini and others (2008) report that, when household survey data from the region are combined, global inequality is found to have followed much the same pattern as inequality within countries: an increase in the 1990s and a decline from the early years of the 2000s.[3] Another study dealing with Latin America is Gasparini and Gluzmann (2012), which uses information from the 2006 Gallup World Poll, conducted in 132 countries that year. Although these polls do not capture income as accurately as household surveys, they can be used to analyse global inequality. The authors estimate indicators of inequality by region, finding the Gini coefficient for Latin America to be 0.525 in 2006, a much higher figure than for Western Europe (0.402), North America (0.438) or Eastern Europe and Central Asia (0.497). However, inequality was lower in the Latin America region than in South Asia (0.534), the Caribbean (0.591) or East Asia and Asia and the Pacific (0.594). The authors argue that Latin America is composed of countries with high and similar levels of inequality, but that taken as a whole the region is not the world's most unequal. Although Latin American countries

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[1] In the words of Milanovic (2007), the income of others enters each person's utility function, so that high levels of inequality affect individual welfare, although he acknowledges the possibility that individuals might be motivated by good feelings, like the subjects referred to by Atkinson (2015), or by bad feelings such as envy.

[2] Quantiles are points taken at regular intervals in the distribution function of a random variable. By way of example, when the income distribution is divided into 20 groups, they are called ventiles. Thus, the first ventile contains the poorest 5% of individuals.

[3] These estimates are for 12 countries in the 1990-2006 period.

are highly unequal in relative terms, the dispersion of income between them is smaller than in other regions of the world.

Among the main aspects deemed by Anand and Segal (2008) to justify the study of global inequality are moral factors and also the consequences that can ensue from global inequality. With regard to the former, the disparities between individual incomes at the global level can be considered unfair, and this is a reason for analysing how different individuals' incomes are when considered globally and not in relation to their nationality.[4] On the other hand, evidence on inequality at the world level is interesting for the scope it provides to analyse the predictive power of theories: according to neoclassical growth theory, incomes between countries and indeed between individuals should converge in the long run, while dependency theory predicts divergence.

Studies on global inequality have been motivated essentially by the need to assess the extent to which globalization, while perhaps increasing inequality within

countries, might also have caused it to decline at the global level. This would mean that differences between individuals around the world were growing smaller, and could be the result of poorer (and more populous) countries having grown more quickly than richer (and less populous) ones. These studies also set out to analyse whether the rules governing the interactions between rich and poor countries impact global inequality. The more integration there is between countries, the more factor mobility there is across borders and the more the perceptions and aspirations of a given country's people are influenced by the living conditions of other countries'. All these aspects make inequality an issue of relevance beyond national borders.

In a global inequality analysis covering the countries of Latin America, the focus of interest is not the linkages between the consequences of globalization and inequality, as when the world as a whole is considered, since the bulk of trade and financial flows takes place between the region and the world rather than within the region, and could be affecting all the countries similarly. The main interest lies in understanding the relative situation of individuals in the region and showing the extent to which the recent decline in income inequality in most of the region's countries has been accompanied by convergence or divergence in individual welfare at the regional level.

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[4] Here, Milanovic (2015) argues that, by being born in a particular country, people receive two "public goods": the country's average income and the inequality of its distribution. Over half the variability of global income is explained by circumstances of birth, including average income and income inequality in the country of birth.

III

The recent evolution of inequality in the countries of Latin America

Income inequality indicators in Latin America have shifted substantially in the last 10 years. Since 2002 or 2003 (depending on the country), levels of income inequality have been dropping in most of the region's countries. The changes have been gradual and all but imperceptible from one year to the next, but come out clearly when longer periods are compared. If the 2002-2012 period is taken, Gini coefficients declined, indicating improvements in distribution, in 16 of the 17 countries included in this study (see figure 1). The exception is Costa Rica, whose Gini coefficient was higher in 2012 than in 2002. This recent downward trend

is statistically significant and has taken place in a context of sustained economic growth and poverty reduction in the region. The downward trend in inequality has gathered pace since 2008 (ECLAC, 2013).

The changes revealed by the decline in Gini coefficients have also been reflected in the share of total income going to the top and bottom quintiles.[5] In most of the countries (the exceptions are the Dominican

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[5] The figures cited for the quintile shares refer to quintiles of households ranked by per capita income.

Republic, Paraguay and Honduras), the share of total income going to the poorest quintile increased between 2002 and 2012 (see figure 2). At the other extreme, the share of the richest quintile fell in almost all the countries, the exception being Paraguay (see figure 3). The most recent data available indicate that the poorest quintile (i.e., the lowest-income 20% of households) receives an average of 5% of total income, with the share ranging from 4% in the Dominican Republic, Honduras and Paraguay to 10% in Uruguay, while the share of total income going to the richest quintile averages 47%, ranging from 35% in Uruguay to 55% in Brazil (ECLAC, 2013).

This change in the trend of income inequality has been interpreted in various ways. Labour income, the main source of household income, has driven this decline in inequality. Notwithstanding the positive repercussions of rising employment, falling dependency ratios and redistributive cash transfers, the factor that accounts for most of the decline of income inequality has been the narrowing of the wage differential between skilled and unskilled workers (ECLAC, 2012).

The decline in the skill premium, as manifested in narrowing differentials relative to the group without education, evinces a clear and consistent pattern across countries (see figure 4). At the same time, education levels in the population (and among those in work) have risen. However, it is difficult to gauge whether the evolution of this wage differential is mainly due to changes in the relative demand for skilled workers or changes in the relative supply. While some authors have stressed the importance of the increase in the relative supply of skilled workers (López-Calva and Lustig, 2010; Azevedo and others, 2013), others have emphasized the possible role of higher relative demand for unskilled workers in the context of an increasing supply of skilled labour (Gasparini and others, 2012; De la Torre, Messina and Pienknagura, 2012).

FIGURE 1

Latin America (18 countries): Gini coefficient, around 2002 and 2012
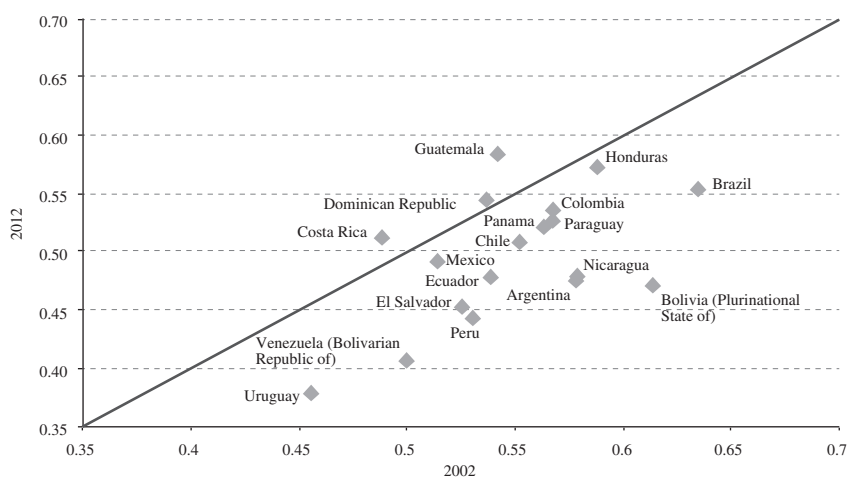
Source: Prepared by the authors, on the basis of Economic Commission for Latin America and the Caribbean (ECLAC), CEPALSTAT database.

FIGURE 2
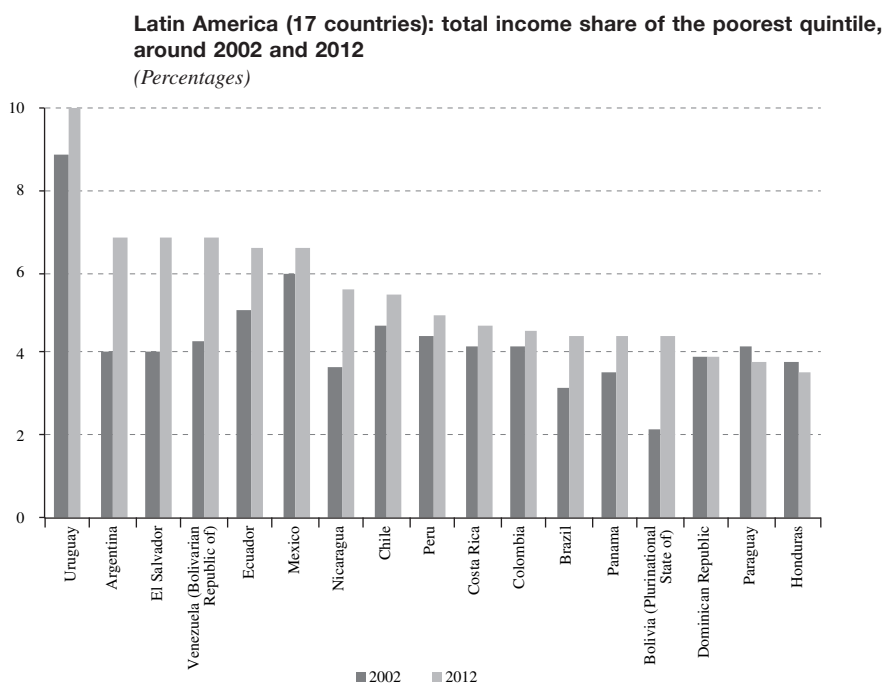
Latin America (17 countries): total income share of the poorest quintile, around 2002 and 2012

(Percentages)

■ 2002   ■ 2012

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Social Panorama of Latin America 2013* (LC/G.2580), Santiago, 2013.

FIGURE 3

Latin America (17 countries): total income share of the richest quintile, around 2002 and 2012

(Percentages)

■ 2002   ■ 2012
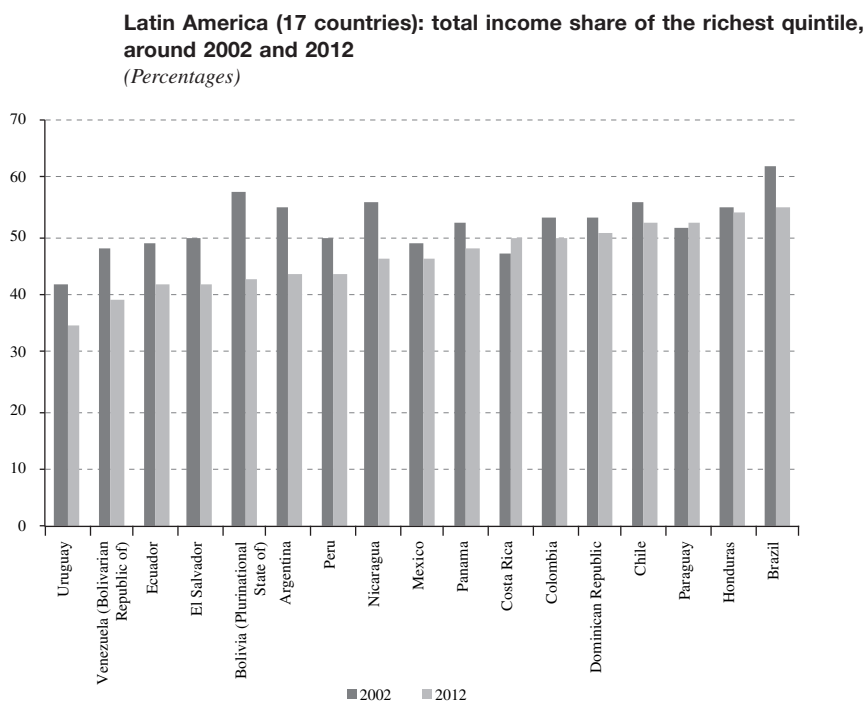
Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Social Panorama of Latin America 2013* (LC/G.2580), Santiago, 2013.

FIGURE 4

Latin America (18 countries): skill premium relative to the group with no education, 2002 and 2011

(Percentages)

A. Complete secondary education
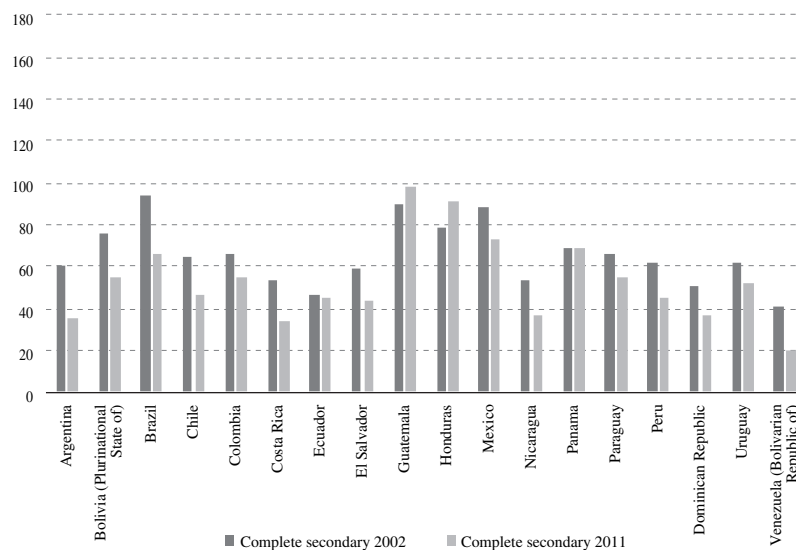
Complete secondary 2002 ■ Complete secondary 2011 ■

B. Tertiary education

Tertiary 2002 ■ Tertiary 2011 ■
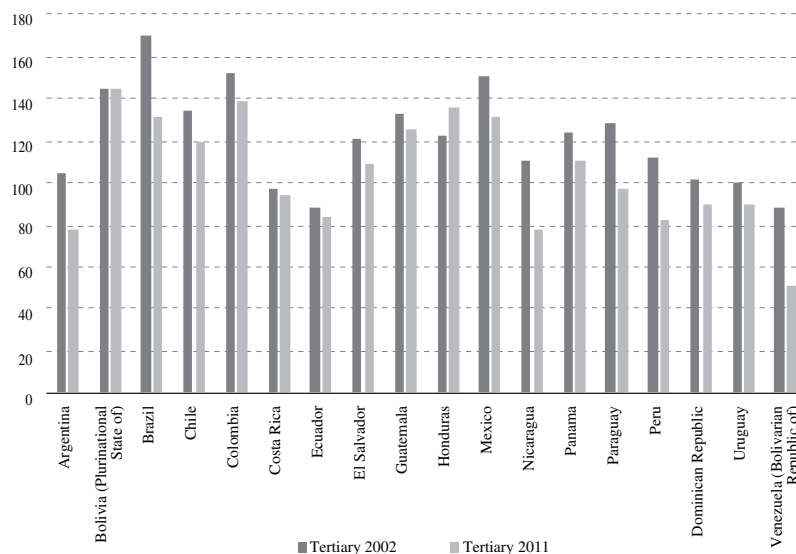
Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Compacts for Equality: Towards a Sustainable Future* (LC/G.2586(SES.35/3)), Santiago, 2014.

These distributive changes have taken place in a different political context to that of earlier decades. Democratic life has resulted in new electoral preferences and greater prominence for social demands. One consequence has been that, in a positive cycle of economic stability, governments have responded to these demands for social inclusion with policies of a more redistributive cast (Roberts, 2014). Other authors have preferred to speak of reforms inspired by the idea of "prudent redistribution with growth" (Cornia, 2010), involving progressive fiscal, labour and transfer policies. Redistributive policies and social reforms have not been the exclusive preserve of left-wing governments in the region. Rather, the institutionalization of electoral competition in contexts of high economic and social inequality seems to have led parties and governments of different ideological hues to strive to meet popular demands for equality and social inclusion (Roberts, 2014).

Thus, improved distribution may well be the most distinctive feature of the last decade in Latin America. This article will now go on to analyse whether these distributive changes within the region's countries over the last decade have been accompanied by any improvement in the income distribution between Latin Americans, or whether gaps have widened.

IV

Data for calculating regional inequality

To estimate regional inequality, a database was constructed out of a combination of variables from household surveys in 18 countries of the region at two points in time, around 2002 and around 2012.[6] These 18 countries contain 96% of the total population of Latin America. Details of sample sizes, population distribution by country and survey years can be found in table 1. The essential variables taken from these surveys are those relating to household income, and they have been standardized by the Economic Commission for Latin America and the Caribbean (ECLAC) so that they can be used to estimate factors like the incidence of poverty in the region.[7] Two income vectors are considered. The first is per capita household income, corrected for estimated survey non-response and adjusted for purchasing power parity (PPP).[8]

As an alternative way of equalling out households' purchasing power and so enabling the robustness of the results to be analysed, the poverty lines calculated by ECLAC to estimate regional poverty are used as price deflators. These lines represent the cost of purchasing a basket of staple foods and goods required to meet other basic needs, and can therefore be assumed to reflect differences in the cost of attaining a similar level of well-being across countries. To maintain consistency with the way these lines are employed by ECLAC to calculate poverty, use is made in this case of the per capita household income vector adjusted to national accounts values (see ECLAC, 2013).[9]

It is important to stress that the choice of price vector for carrying out comparisons between countries is an important methodological step. Measurements of global inequality and poverty are sensitive to the price vector used to compare incomes across countries (Chen and Ravallion, 2010; Ravallion, Chen and Sangraula, 2009; Milanovic, 2012). The new PPP vector for 2005, calculated by the International

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[6] Haiti and Cuba were not included in the analysis because the necessary information sources are not available.

[7] Another way of capturing household welfare is to consider household consumption rather than income. Income and spending surveys, which measure consumption spending by households, are also carried out periodically in the region. They are not available at the same points in time for a large set of countries, however, whereas household surveys are.

[8] Incomes were taken up to 2005 by considering the change in each country's general consumer price index (CPI) so that the PPP factors estimated for that year could be applied. In the case of Argentina, a simple average of price indices from five provinces was used as the deflator from 2007 onward. See World Bank, World Development Indicators [online] http://data.worldbank.org/data-catalog/world-development-indicators.

[9] There are two databases that compile household surveys from the region, constructing standardized income variables for the different countries. One is the ECLAC database, which the present study relies on, and the other is the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) maintained by the Centre for Distributive, Labour and Social Studies (CEDLAS) of the National University of La Plata and the World Bank.

Comparison Programme, involved higher price estimates for most poor countries, with the result that global inequality levels were calculated to be over five points higher than with the previous PPP vector (Milanovic, 2012). As will be seen later, the results presented in this article are robust to both of the price vectors used in the study to carry out comparisons between countries.

TABLE 1

Latin America: household survey sample sizes and populations[a]

Around 2002	Sampling cases (*thousands*)	Percentage distribution of sampling cases	Expanded cases (*thousands*)	Percentage distribution of expanded cases	Population (*thousands*)	Percentage distribution of population
Argentina 2002	22 832	4	24 546	5	36 906	7
Bolivia (Plurinational State of) 2002	5 746	1	8 488	2	8 362	2
Brazil 2002	105 984	20	173 104	36	174 506	33
Chile 2000	65 007	13	15 033	3	15 455	3
Colombia 2002	129 164	25	39 767	8	39 900	8
Costa Rica 2002	11 094	2	3 991	1	3 930	1
Dominican Republic 2002	5 720	1	8 553	2	8 575	2
Ecuador 2002	6 030	1	8 288	2	12 567	2
El Salvador 2001	11 953	2	6 415	1	5 959	1
Guatemala 2002	2 759	1	11 556	2	11 204	2
Honduras 2002	22 010	4	6 668	1	6 236	1
Mexico 2002	17 167	3	101 522	21	101 721	20
Nicaragua 2001	4 191	1	5 193	1	5 101	1
Panama 2002	13 404	3	2 991	1	3 053	1
Paraguay 2001	8 131	2	5 333	1	26 004	5
Peru 2001	16 515	3	26 660	6	5 350	1
Uruguay 2002	18 421	4	2 678	1	3 321	1
Venezuela (Bolivarian Republic of) 2002	53 124	10	25 767	5	24 408	5
Latin America	519 252	100	476 556	100	521 429	100
Around 2011						
Argentina 2012	69 293	10	25 351	5	40 370	7
Bolivia (Plurinational State of) 2011	8 851	1	10 691	2	9 995	2
Brazil 2012	114 906	16	196 723	36	195 153	33
Chile 2011	59 084	8	16 941	3	17 149	3
Colombia 2012	228 662	33	45 029	8	46 448	8
Costa Rica 2012	11 374	2	4 661	1	4 669	1
Dominican Republic 2012	8 163	1	10 077	2	9 907	2
Ecuador 2012	19 840	3	14 676	3	15 018	3
El Salvador 2012	21 710	3	6 245	1	6 218	1
Guatemala 2006	13 686	2	12 966	2	14 334	2
Honduras 2010	7 043	1	8 041	1	7 619	1
Mexico 2012	9 002	1	117 284	21	115 301	20
Nicaragua 2009	6 515	1	5 755	1	5 813	1
Panama 2011	12 379	2	3 624	1	3 676	1
Paraguay 2011	4 894	1	6 465	1	29 272	5
Peru 2012	25 091	4	30 533	6	6 458	1
Uruguay 2012	43 839	6	3 373	1	3 373	1
Venezuela (Bolivarian Republic of) 2012	37 643	5	28 819	5	29 039	5
Latin America	701 975	100	547 256	100	590 082	100

Source: Prepared by the authors, on the basis of data from household surveys in the respective countries and Latin American and Caribbean Demographic Centre (CELADE) - Population Division of ECLAC, Population database.

[a] Further details on the databases used can be found at [online] http://interwp.cepal.org/badehog/acercade.asp.

V

The average incomes of Latin Americans

An initial approach to GDP and average incomes in the region's countries brings some major differences to light (see table 2). The ranking of the countries is similar in both cases, although not identical (see figure 5). If data from 2011 are taken, Chile is the country with the highest per capita GDP in the region (US$ 21,011 a year at PPP), while Uruguay has the highest per capita household income (US$ 554 a month at PPP).

The per capita GDP ratio between the richest country and the poorest (Chile and Nicaragua, respectively) rose from 4.0 to 5.5 between 2002 and 2011. Average differences in per capita household income have also widened, with the ratio rising from 3.0 in 2002 (between Chile and Nicaragua) to 3.7 in 2012 (between Uruguay and Nicaragua). Chile is the country with the highest ratio between per capita household income and the poverty line (3.6 in the starting year and 4.2 in the end year), while this ratio is lowest in Honduras (0.9 and 1.0 in the starting and end years, respectively). The ratio between the highest and lowest per capita incomes relative to the poverty line fell over the period. The coefficient of variation of the three variables increased over the period (albeit only slightly in the case of income relative to the poverty line).

TABLE 2

Latin America: per capita gross domestic product (GDP) and household income, 2002, 2011 and 2012

	Per capita GDP (*in 2005 PPP dollars*)		Per capita household income (*in 2005 PPP dollars*)[b] (*monthly*)		Per capita household income (*in poverty lines*)[b]	
	2002	2011	2002	2012	2002	2012
Argentina[a]	7 948	…	281	482	2.1	3.7
Bolivia (Plurinational State of)	3 229	4 936	189	273	1.4	1.9
Brazil	7 395	11 515	316	445	3.0	4.2
Chile	10 413	21 001	363	427	3.6	4.2
Colombia	6 154	9 973	213	311	1.8	2.4
Costa Rica	7 491	12 074	327	433	3.0	3.3
Dominican Republic	5 539	9 617	247	228	1.8	2.0
Ecuador	5 954	9 155	290	311	1.7	2.0
El Salvador	4 920	6 785	228	189	1.5	1.4
Guatemala	3 717	4 914	189	223	1.3	1.6
Honduras	2 724	4 031	174	171	0.9	1.0
Mexico	10 361	16 044	305	335	2.0	1.9
Nicaragua	2 572	3 797	143	151	1.1	1.2
Panama	7 190	14 756	318	356	2.4	3.0
Paraguay	4 025	6 112	252	333	1.3	1.6
Peru	5 219	10 076	190	304	1.4	2.2
Uruguay	7 819	14 970	430	554	3.1	3.7
Venezuela (Bolivarian Republic of)	7 997	12 534	172	289	1.6	2.2
Simple average	6 148	10 135	257	323	1.9	2.4
Highest	10 413	21 001	430	554	4	4
Lowest	2 572	3 797	142.74	151.4	0.9	1
Ratio highest/lowest	4.0	5.5	3.0	3.7	4.3	4.0
Coefficient of variation	0.39	0.47	0.30	0.35	0.40	0.42

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

[a] Per capita GDP figures in PPP have not been published for Argentina since 2007.

[b] The 2002 figures include data from 2000 in Chile and from 2001 in El Salvador, Nicaragua, Paraguay and Peru. The 2012 figures include data from 2011 in Chile, Panama, Paraguay and the Plurinational State of Bolivia, 2010 in Honduras and 2006 in Guatemala.

FIGURE 5
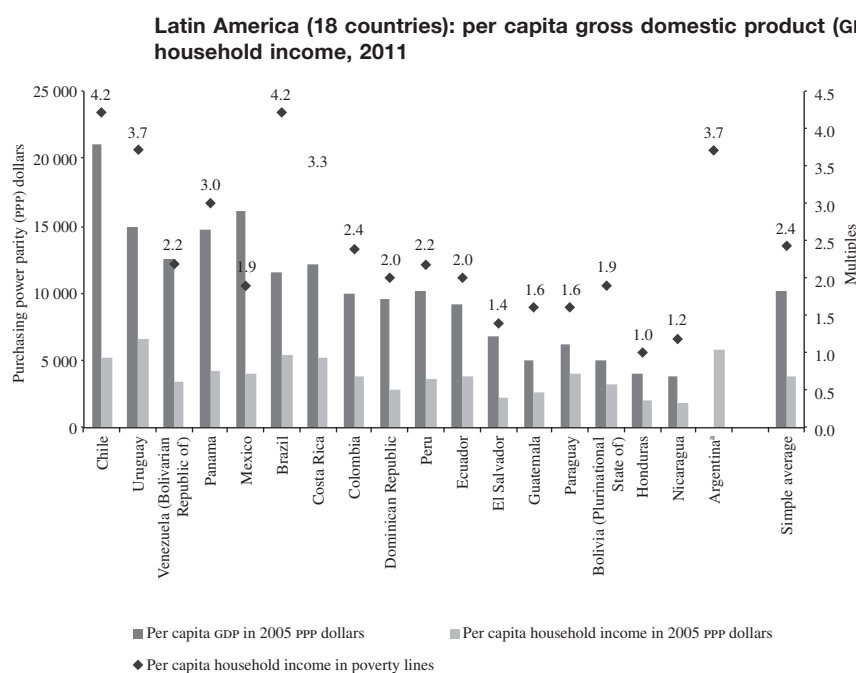
Latin America (18 countries): per capita gross domestic product (GDP) and household income, 2011

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

[a] Per capita GDP figures in PPP have not been published for Argentina since 2007.

The widening of average differences in per capita GDP and income between the region's countries, then, does not support the idea that the average situation is one of convergence between them. As will be seen in the following section, though, if the borders between countries are ignored and individuals are taken as the unit rather than country averages, the differences have narrowed.

VI

Income distribution between Latin Americans

The analysis of global inequality uses the traditional statistical tools employed to analyze income inequality between households at a national level. As discussed earlier, the first step is to construct an income vector that is comparable across the region's countries. The results presented below were obtained by considering income values in PPP dollars. The results obtained using the ECLAC poverty line as the measurement unit are given in the annex, since they are generally similar to those shown below.

The distribution of the countries' populations within these global quintiles is an initial indicator of the income differences between countries (see figure 6 and table A.1 of the annex). In countries such as Argentina, Brazil, Chile, Costa Rica and Uruguay, over half the population is in the top two quintiles of the regional distribution. At the other extreme, over half the population in El Salvador, Guatemala, Honduras and Nicaragua (and to a lesser extent the Dominican Republic, Mexico and the Plurinational State of Bolivia) is in the bottom two quintiles of the regional distribution. As was to be expected, the larger countries, which weigh more heavily in the construction of the quintiles, have more homogeneously distributed populations. The results obtained when incomes are compared using the poverty line as the unit of measurement are similar (see table A.2 of the annex).

FIGURE 6
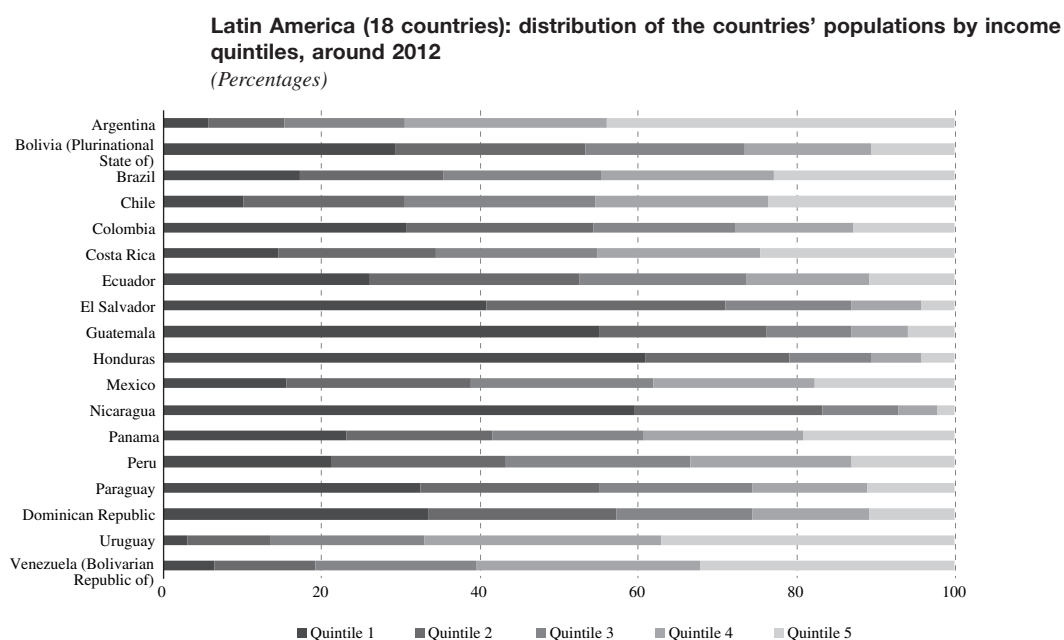
Latin America (18 countries): distribution of the countries' populations by income quintiles, around 2012
(Percentages)

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

Between 2002 and 2012, the average per capita income of the region's inhabitants, expressed in PPP, grew by 28%. If income is measured in poverty lines, the growth in the period was 30%. The strongest growth was at the bottom of the distribution, as illustrated in figure 7, which presents changes by decile and percentile. In terms of both PPP-adjusted income and income relative to the poverty line, it can be seen that the increase tails off up the income scale. In the terminology of Ravallion and Chen (2003), the growth incidence curve is indicative of pro-poor growth. This evolution is more marked in the case of PPP-adjusted income, which shows higher growth than poverty line-adjusted income for households in the bottom half of the income distribution. This higher growth in the incomes of individuals in the lower part of the regional distribution is thus a first indication of a decline in global inequality in the region.

Aggregated for the whole set of countries, this growth curve masks differences in the behaviour of groupings. This can be better appreciated if countries are clustered in four groups based on changes in their average incomes in the period considered (see figure 8). Changes in income and the classification of the countries into groups are presented in table A.3 of the annex. While some countries show a growth pattern

that is clearly favourable to the poor (Argentina, the Bolivarian Republic of Venezuela, Paraguay and Uruguay are the extreme cases), in others the curve rises with income, with this showing stronger growth in the upper part of the distribution (Guatemala, Honduras and Nicaragua). Once again, both income vectors used yield similar results.

All the global inequality indicators calculated for the region show a similar pattern: inequality levels are higher when measured for Latin America as a whole than they are in most of the region's countries taken individually (see table 3), a finding also yielded by calculations of global inequality at the world level (see, for example, Anand and Segal, 2015; Lakner and Milanovic, 2013). In the second place, between 2002 and 2012, a period when inequality declined steadily in most of the region's countries, indicators of global inequality also dropped significantly, with the Gini coefficient, the Theil index and the 90/10 ratio all presenting a considerable decline. The Theil index fell by more than the Gini coefficient, since the former gives greater weight to what happens at the bottom of the distribution, which, as already seen, is where the greatest improvements occurred. The findings point in the same direction whether income is adjusted for PPP or for the poverty line.

FIGURE 7

Latin America: changes in real incomes, 2002-2012
(Percentages)
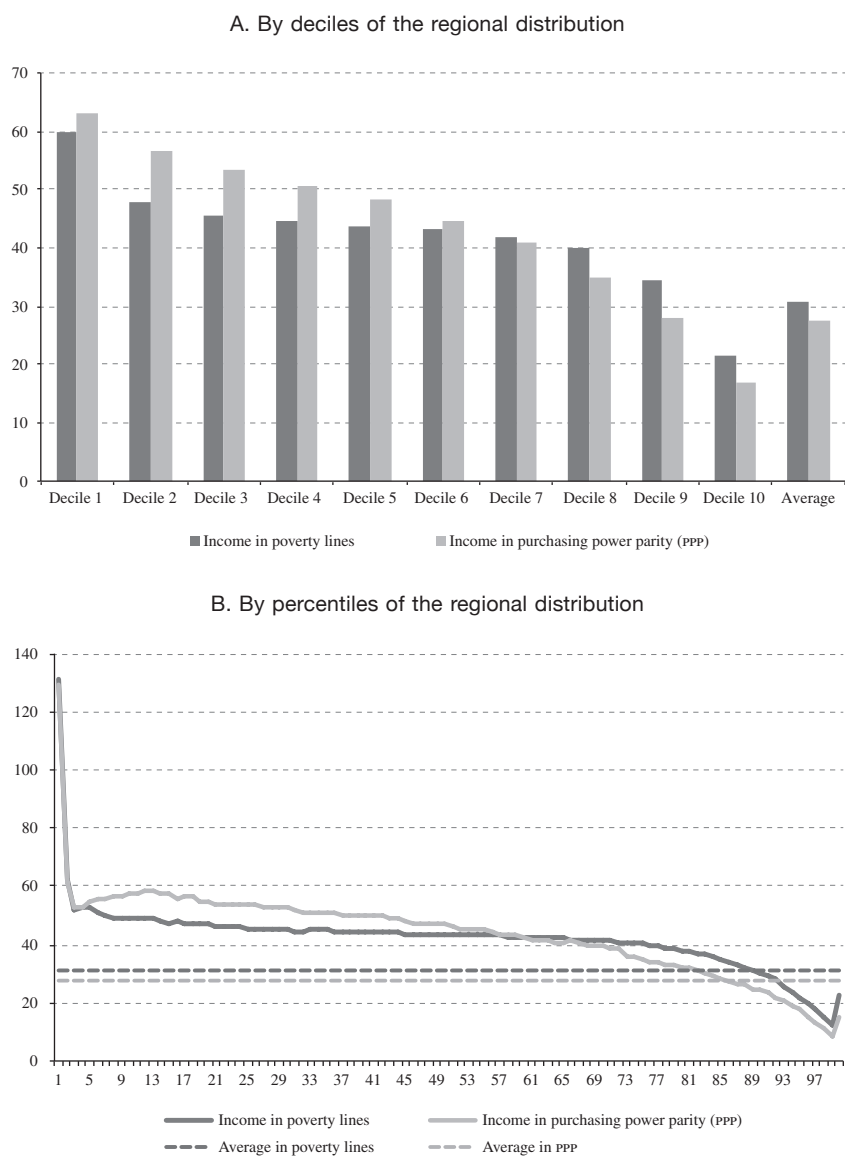
A. By deciles of the regional distribution

■ Income in poverty lines   ■ Income in purchasing power parity (PPP)

B. By percentiles of the regional distribution

—— Income in poverty lines   —— Income in purchasing power parity (PPP)
– – – Average in poverty lines   – – – Average in PPP

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

FIGURE 8

Latin America: income changes by country grouping, 2002-2012

A. Income in purchasing power parity (PPP)

—— Chile and Panama	—— Dominican Republic, El Salvador, Ecuador and Mexico
—— Bolivia (Plur. State of), Brazil, Colombia, Costa Rica and Peru	—— Argentina, Paraguay, Uruguay and Venezuela (Bol. Rep. of)
—— Guatemala, Honduras and Nicaragua	

B. Income in poverty lines

—— Chile and Panama	—— Dominican Republic, El Salvador, Ecuador and Mexico
—— Bolivia (Plur. State of), Brazil, Colombia, Costa Rica and Peru	—— Argentina, Paraguay, Uruguay and Venezuela (Bol. Rep. of)
—— Guatemala, Honduras and Nicaragua	

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

TABLE 3

Latin America: global inequality indices, 2002 and 2012

Income in purchasing power parity (PPP)	2002	2012	Percentage change
Gini coefficient	0.587	0.539	-8
Theil index	0.760	0.658	-13
90/10 ratio	14.4	11.3	-21
Income in poverty lines			
Gini coefficient	0.580	0.546	-6
Theil index	0.768	0.703	-8
90/10 ratio	12.1	10.6	-12

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

The income share captured by the richest percentiles in the region fell over the period, although the decline was very small, especially when PPP-adjusted income is taken (see figure 9).[10] Once again, the results indicate that the gaps between people in the region as a whole are smaller than a decade ago, reaffirming the finding

of a decrease in regional inequality when this is considered globally.

Income inequality between individuals in the region can be broken down into inequality between countries and inequality within countries. The former is equivalent to considering inequality between all individuals in the region, assuming that each has an income equal to his or her country's average per capita income. Inequality within groupings or within countries, meanwhile, is a weighted average of national inequality indicators, the weights being each country's income as a share of the Latin American total.

[10] This indicator is calculated on the basis of household survey information and consequently underestimates the true share of wealth captured by the highest percentiles, whose incomes tend not to be fully reflected in surveys of this type.

FIGURE 9

Latin America: income shares captured by the top percentiles, 2002-2012
(Percentages)
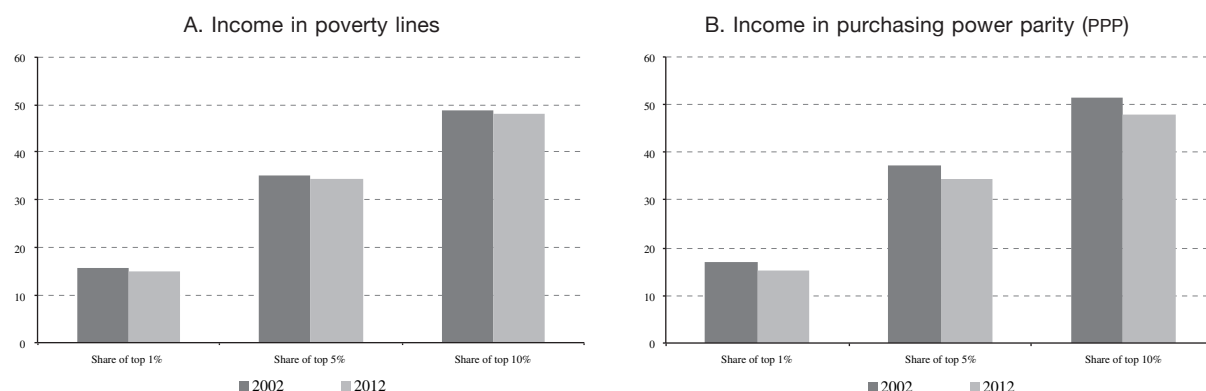
A. Income in poverty lines

B. Income in purchasing power parity (PPP)

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

The Theil index is used to display this decomposition of global inequality in the region, as it meets the requirements for this. A first aspect that emerges from this decomposition is that the bulk of regional inequality is within countries (see table 4). About 90% of global inequality in the region is the result of differences within

countries. This finding is different from that yielded by worldwide decompositions, which indicate that between 80% and 90% of global inequality at the world level (depending on the measures and years taken) derives from differences in average incomes between countries (Anand and Segal, 2015). Restricting the analysis to

Latin American countries reveals greater homogeneity between these, as might be expected from the smaller number of countries in the calculation; in turn, inequality within countries explains almost the entirety of regional inequality. These results indicate that the internal dynamics of countries, associated with their social, institutional and political situations, are more relevant to regional inequality than dynamics between countries (associated with migration or trade, for example). Again, it is worth recalling that each country's contribution to inequality depends mainly on its share of the total income of the region's households, so that Brazil and Mexico feature very prominently (see table A.4 of the annex).

A second aspect to be highlighted in this decomposition exercise is that the reduction in global inequality in the region during the period is mainly explained by the decline in inequality within countries. Once again, this result is strongly influenced by the distributive improvements that have taken place in Brazil and Mexico. The importance of inequality between countries (reflecting differences in average income by country) has consistently increased with the trend towards greater divergence in average incomes discussed in section V. Inequality between countries accounts for a small but growing share of global inequality in the region. These results indicate that the living conditions of Latin America's inhabitants are more egalitarian in relative terms now than a decade ago, although the differences between the countries' average incomes are greater. The findings regarding the decrease in global inequality in the region, and the absolute predominance of inequality within countries, with its deconcentrating effect, are similar to (although more pronounced than) those reported in Gasparini and others (2008) for the 1992-2006 period.

TABLE 4

Decomposition of the Theil index for Latin America, 2002 and 2012

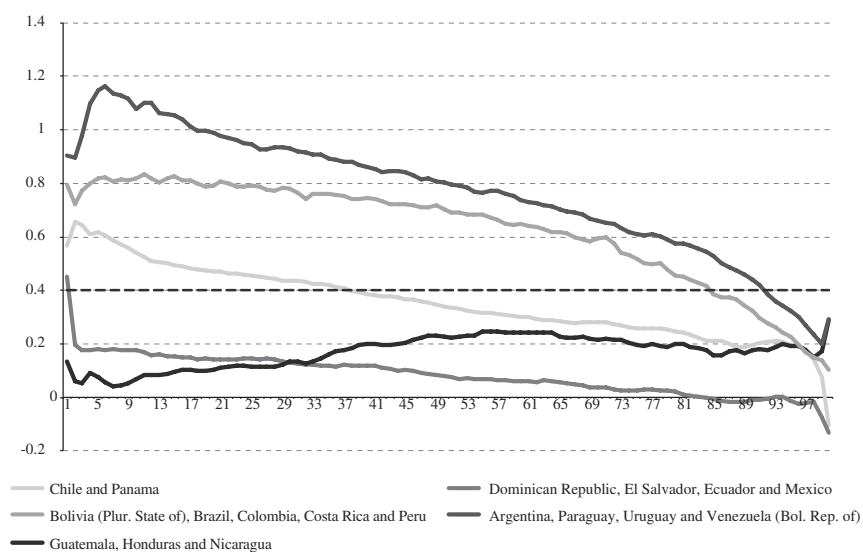|	Theil index		Importance of the components (*percentage share*)		Percentage change
	2002	2012	2002	2012	2012-2002
Income in poverty lines					
Within countries	72.4	63.2	94	90	-13
Between countries	4.5	7.1	6	10	60
Theil index	76.8	70.3	100	100	-8
Income in purchasing power parity (PPP)					
Within countries	72.9	61.7	95	88	-15
Between countries	3.1	4.1	4	6	33
Theil index	76.0	65.8	100	100	-13

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.
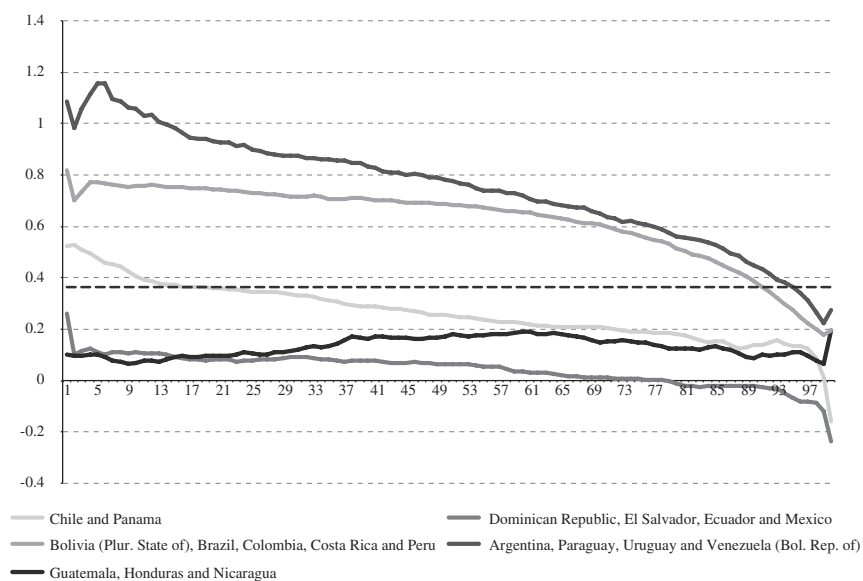
VII

Final comments

Notwithstanding differences between countries, the income growth experienced by Latin American households in the last decade has been highest among households and individuals in the bottom stratum of the distribution. Global inequality in the region declined between 2002 and 2012 as a result, indicating that the living conditions of the inhabitants of Latin America were more equal at the end of those 10 years than at the start. These findings are robust to both price vectors used to compare income between countries.

Although the incomes of individuals in Latin America as a whole are less unequal now than a decade ago, this finding is the outcome of two opposing effects: a decline in inequality in most of the countries and a widening of the differences between the countries' average incomes. Although the second effect is very slight, it is apparent that widening income gaps between the region's countries can become a factor that works against the reduction of inequality from a regional perspective.

TABLE A.1

Latin America (18 countries): distribution of the population by regional income quintiles[a], 2002 and 2012

(Percentages)

		Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Total
Argentina	2002	14.1	17.1	19.1	22.7	27.1	100.0
	2012	5.6	9.5	15.4	25.4	44.0	100.0
Bolivia (Plurinational State of)	2002	39.8	22.2	15.8	12.7	9.6	100.0
	2011	29.1	24.1	20.1	16.0	10.6	100.0
Brazil	2002	22.0	20.0	19.0	18.3	20.6	100.0
	2012	17.3	18.0	19.9	21.9	22.9	100.0
Chile	2000	9.5	18.5	22.7	24.3	25.0	100.0
	2011	10.0	20.4	24.2	21.8	23.6	100.0
Colombia	2002	30.5	24.6	19.4	14.3	11.1	100.0
	2012	30.8	23.4	18.0	15.0	12.8	100.0
Costa Rica	2002	10.7	13.7	21.3	26.4	27.9	100.0
	2012	14.4	20.0	20.4	20.5	24.7	100.0
Dominican Republic	2002	20.8	22.5	22.4	19.5	14.7	100.0
	2012	33.3	24.0	17.2	14.6	11.0	100.0
Ecuador	2002	17.8	23.4	24.3	20.9	13.6	100.0
	2012	26.2	26.5	20.9	15.6	10.9	100.0
El Salvador	2001	29.6	23.0	20.1	16.3	11.1	100.0
	2012	40.7	30.3	15.8	9.0	4.3	100.0
Guatemala	2002	31.4	27.1	17.1	14.0	10.5	100.0
	2006	55.0	21.0	10.8	7.1	6.0	100.0
Honduras	2002	53.6	19.9	13.0	8.3	5.3	100.0
	2010	60.8	18.3	10.3	6.4	4.2	100.0
Mexico	2002	8.3	17.7	22.0	26.2	25.8	100.0
	2012	15.4	23.4	23.1	20.2	17.9	100.0
Nicaragua	2001	51.0	24.0	13.2	7.7	4.2	100.0
	2009	59.4	23.8	9.5	4.9	2.4	100.0
Panama	2002	23.4	17.8	18.2	20.6	19.9	100.0
	2011	23.1	18.4	19.1	20.0	19.4	100.0
Peru	2001	29.5	24.2	21.0	15.7	9.6	100.0
	2012	21.1	22.2	23.1	20.5	13.0	100.0
Paraguay	2001	27.3	21.7	21.7	16.5	12.8	100.0
	2011	32.3	22.6	19.4	14.5	11.2	100.0
Uruguay	2002	3.4	12.3	20.0	29.2	35.1	100.0
	2012	3.0	10.4	19.4	30.1	37.1	100.0
Venezuela (Bolivarian Republic of)	2002	11.1	15.4	21.2	25.3	27.0	100.0
	2012	6.5	12.7	20.2	28.1	32.3	100.0

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

[a] In 2005 purchasing power parity (PPP) dollars.

TABLE A.2

**Latin America (18 countries): distribution of the population
by regional income quintiles[a]**

(Percentages)

		Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Total
Argentina	2002	23.2	19.5	19.1	19.3	18.9	100.0
	2012	9.6	13.4	19.9	26.1	31.0	100.0
Bolivia (Plurinational State of)	2002	38.5	21.4	15.4	13.7	10.9	100.0
	2011	26.9	23.8	21.7	17.5	10.1	100.0
Brazil	2002	18.4	17.0	18.0	20.8	25.7	100.0
	2012	13.2	14.5	17.6	23.7	31.1	100.0
Chile	2000	6.2	11.7	18.8	27.3	36.0	100.0
	2011	6.6	13.5	21.9	27.7	30.3	100.0
Colombia	2002	23.7	23.0	20.9	17.9	14.5	100.0
	2012	24.3	22.2	20.6	18.1	14.7	100.0
Costa Rica	2002	8.2	10.0	17.3	27.7	36.8	100.0
	2012	12.1	16.2	21.3	23.3	27.0	100.0
Dominican Republic	2002	22.2	21.2	21.2	20.0	15.4	100.0
	2012	32.6	21.5	17.7	16.3	11.9	100.0
Ecuador	2002	22.4	23.4	22.7	18.5	13.0	100.0
	2012	22.3	25.2	23.8	18.1	10.6	100.0
El Salvador	2001	24.6	21.4	20.9	19.7	13.4	100.0
	2012	33.2	29.9	20.4	11.6	4.9	100.0
Guatemala	2002	30.6	26.5	17.8	14.5	10.6	100.0
	2006	44.9	23.7	14.4	9.9	7.0	100.0
Honduras	2002	55.2	20.0	12.3	7.7	4.8	100.0
	2010	58.8	18.3	11.7	6.9	4.2	100.0
Mexico	2002	13.0	22.8	23.9	21.9	18.3	100.0
	2012	25.7	28.0	22.3	14.1	9.9	100.0
Nicaragua	2001	43.5	23.6	15.8	11.0	6.2	100.0
	2009	46.8	25.9	15.5	8.0	3.8	100.0
Panama	2002	19.0	15.5	18.0	22.1	25.4	100.0
	2011	18.9	16.7	19.9	22.9	21.6	100.0
Peru	2001	27.3	24.1	21.9	16.3	10.4	100.0
	2012	18.0	21.3	24.7	22.7	13.3	100.0
Paraguay	2001	31.9	24.3	19.5	14.7	9.7	100.0
	2011	40.4	23.0	17.9	11.8	6.9	100.0
Uruguay	2002	3.4	10.1	17.6	29.8	39.1	100.0
	2012	3.4	8.9	18.3	32.6	36.9	100.0
Venezuela (Bolivarian Republic of)	2002	23.7	21.7	20.8	19.3	14.5	100.0
	2012	16.1	22.3	24.6	24.1	13.0	100.0

Source: Prepared by the authors, on the basis of data from household surveys in the respective countries.

[a] Income in poverty lines.

TABLE A.3

Latin America (18 countries): country groupings and changes in per capita household income in purchasing power parity (PPP)

(Percentages)

Grouping	Country	Changes in per capita income in PPP[a], 2002-2011
1	El Salvador	-10
1	Dominican Republic	-2
1	Ecuador	0
1	Mexico	3
2	Guatemala	6
2	Honduras	7
2	Nicaragua	7
3	Panama	11
3	Chile	16
4	Peru	31
4	Costa Rica	32
4	Brazil	32
4	Bolivia (Plurinational State of)	33
4	Colombia	46
5	Venezuela (Bolivarian Republic of)	52
5	Uruguay	53
5	Paraguay	53
5	Argentina	76

Source: Prepared by the authors on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

[a] In purchasing power parity (PPP) dollars.

TABLE A.4

Latin America (18 countries): contribution to intra-group inequality, 2002 and 2012

	2002			2012		
	Theil index	Percentage income share	Percentage contribution to intra-group inequality	Theil index	Percentage income share	Percentage contribution to intra-group inequality
Argentina	0.487	5	4	0.322	6	4
Bolivia (Plurinational State of)	0.742	1	1	0.391	1	1
Brazil	0.735	41	49	0.614	44	52
Chile	0.570	4	4	0.450	4	3
Colombia	0.660	6	7	0.570	7	8
Costa Rica	0.465	1	1	0.501	1	1
Dominican Republic	0.533	2	1	0.420	1	1
Ecuador	0.565	2	2	0.434	2	2
El Salvador	0.505	1	1	0.368	1	0
Guatemala	0.596	2	2	0.680	1	1
Honduras	0.768	1	1	0.617	1	1
Mexico	0.486	23	18	0.469	20	18
Nicaragua	0.824	1	1	0.440	0	0
Panama	0.612	1	1	0.529	1	1
Paraguay	0.655	1	1	0.588	1	1
Peru	0.619	4	4	0.404	5	4
Uruguay	0.357	1	1	0.247	1	0
Venezuela (Bolivarian Republic of)	0.400	3	2	0.273	4	2

Source: Prepared by the authors, on the basis of World Bank, World Development Indicators, and household survey data from the respective countries.

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Foreign direct investment and income inequality in Latin America: a sectoral analysis

Macarena Suanes

ABSTRACT

This paper analyses the relationship between foreign direct investment (FDI) and income inequality in Latin America. In particular, it estimates the effect of FDI from a sectoral perspective, identifying three major sectors: the primary sector, manufacturing industry and services. Using a data panel for 13 economies in the 1980-2009 period, empirical evidence was found for a positive effect of FDI on income inequality in the service and manufacturing sectors.

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I

Introduction

Since the 1990s, Latin America has been a leading destination for foreign direct investment (FDI), according to data from the United Nations Conference on Trade and Development (UNCTAD, 2011). During the 1995-2009 period, FDI as a share of gross domestic product (GDP) was more than three times as great as it had been in the 1980s. This process has been accompanied in the region by substantial economic growth (especially in the five-year period from 2004 to 2009, when it averaged 5% a year) and by great and persistent income inequality. The latter has become one of the main concerns of economic policymakers, owing both to its scale and to its persistence over time.

Although most of the literature dealing with the effects of FDI on economic growth points to it having had a positive effect on this in developing economies (De Mello, 1997 and 1999; Borensztein, De Gregorio and Lee, 1998; Li and Liu, 2005; Herzer, Klasen and Nowak-Lehmann, 2008; De Vita and Kyaw, 2009), the relationship between FDI and income inequality is not so obvious and has received less attention in the literature. Many studies estimating the relationship between FDI and income inequality have found it to be positive (Tsai, 1995; Velde, 2003; Choi, 2006; Basu and Guariglia, 2007; Herzer, Hühne and Nunnenkamp, 2012), while others have found it to be negative, or have been unable to find any relationship (Milanovic, 2003; Sylwester, 2005). At the microeconomic level, however, a large branch of the literature has found that when FDI is present, the wage gap between skilled and unskilled workers increases, as therefore does income inequality (Lipsey and Sjöholm, 2004; Mah, 2002; Velde, 2003; Aitken, Harrison and Lipsey, 1996; Feenstra and Hanson, 1997). Consequently, while there is no consensus, the empirical evidence does seem to point to income inequality being increased by FDI flows.

Another aspect that may prove relevant when it comes to analysing the effect of FDI on income inequality and that has received little attention in the literature is the effect the sectoral distribution of this investment may have. FDI tends to go to different economic sectors depending on the characteristics and attractions of each economy, examples being abundant cheap labour, plentiful natural resources and fiscal or institutional benefits. The

hypothesis put forward in this study is that the channels through which FDI can affect inequality are connected to the sectors of the economy in which this investment is made in each country.

In fact, the sectoral distribution of FDI in the Latin American economies varies greatly by country. According to data from UNCTAD (2006), in 2006 manufacturing FDI accounted for an average of 26% of the regional total, being concentrated in more developed countries such as Argentina, Chile, Costa Rica and Mexico. In many other Latin American countries, the mining and oil sectors account for a large share of all FDI, this being the case with the Plurinational State of Bolivia, Chile and Colombia, where in 2006 these sectors accounted for between a third and a half of total FDI. Meanwhile, FDI in the agricultural sector is insignificant in most of the region's countries. Lastly, the service sector has taken on an increasing preponderance everywhere in recent years, accounting for 50% of total FDI in Latin America as a whole, with particular prominence for financial services, transport and telecommunications, and electricity, gas and water distribution.

Although there is no empirical evidence for the macroeconomic impact of FDI by sector on income inequality in developing economies generally, and the region in particular, there is evidence for the effect of FDI by sector on economic growth and productivity. Thus, Tondl and Fornero (2010) find evidence for a positive effect of FDI on productivity in all sectors of activity in the economies of Latin America, with this being greatest in the primary sector and financial services.

Against this background, the present article analyses and provides empirical evidence for the impact that FDI by sector is having on income inequality in the countries of Latin America. The dearth of literature studying the effect of FDI on income inequality in the region, together with the major trends seen there in the last decade (substantial economic growth, increased FDI flows and persistent income inequality), are the main reasons for this study, whose most innovative contribution is that it differentiates the effects of FDI by the sector in which it takes place.

To do so, it conducts two types of analyses. In the first, it considers the effect of FDI at the aggregate level

on income inequality, while in the second it analyses this relationship separately for the main sectors of the economy that have been recipients of FDI (the primary sector, manufacturing and services).

Figure 1 illustrates the relationship between FDI as a share of GDP and income inequality (measured by the Gini coefficient) in the economies of Latin America, taking the averages of these variables for the 1980-2009 period. That there is a positive relationship between the two variables can be intuitively appreciated from this chart.

However, when the relationship between income inequality and FDI disaggregated by sector of activity

is looked at, as in figure 2, the relationship is found to vary somewhat by sector. Thus, while there does seem to be a positive relationship in the primary and service sectors, there appears to be no clear relationship in the manufacturing sector.

The rest of this paper is organized as follows. Section II presents a brief review of the literature on the relationship between FDI and income inequality, with a particular emphasis on sectoral analysis. Section III describes the data and the main trends of the variables of interest in the region. Section IV lays out the empirical strategy, and section V discusses the results. Lastly, section VI presents conclusions.

FIGURE 1
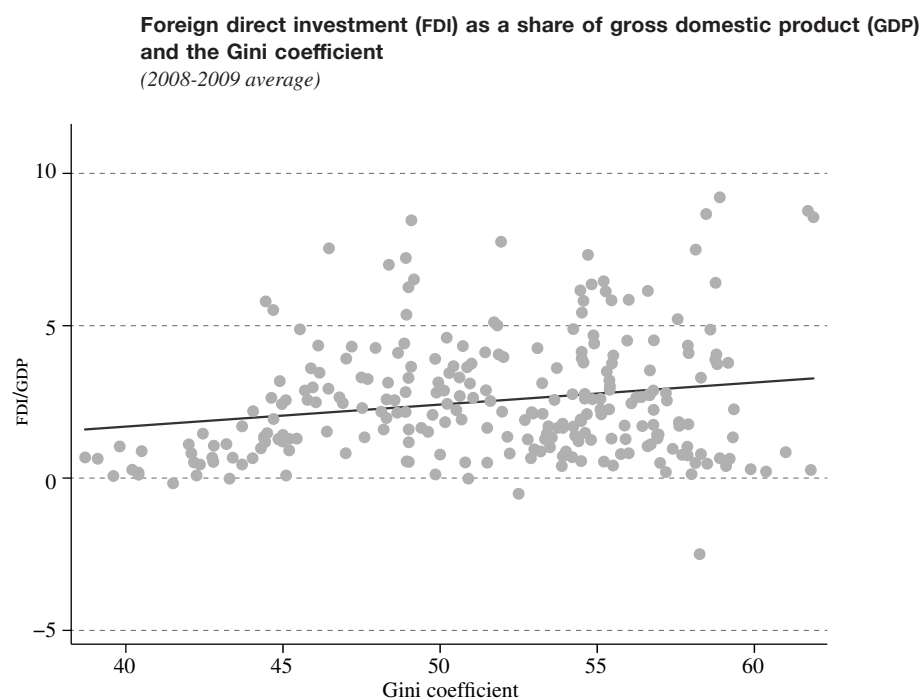
Foreign direct investment (FDI) as a share of gross domestic product (GDP) and the Gini coefficient
(2008-2009 average)

Source: Prepared by the author, on the basis of data from World Institute for Development Economics Research (UNU-WIDER), World Income Inequality Database, and World Bank, World Development Indicators.

FIGURE 2

Gini coefficient and foreign direct investment (FDI) by sector of activity, 2008-2009 averages

(FDI as a share of sectoral gross domestic product (GDP))
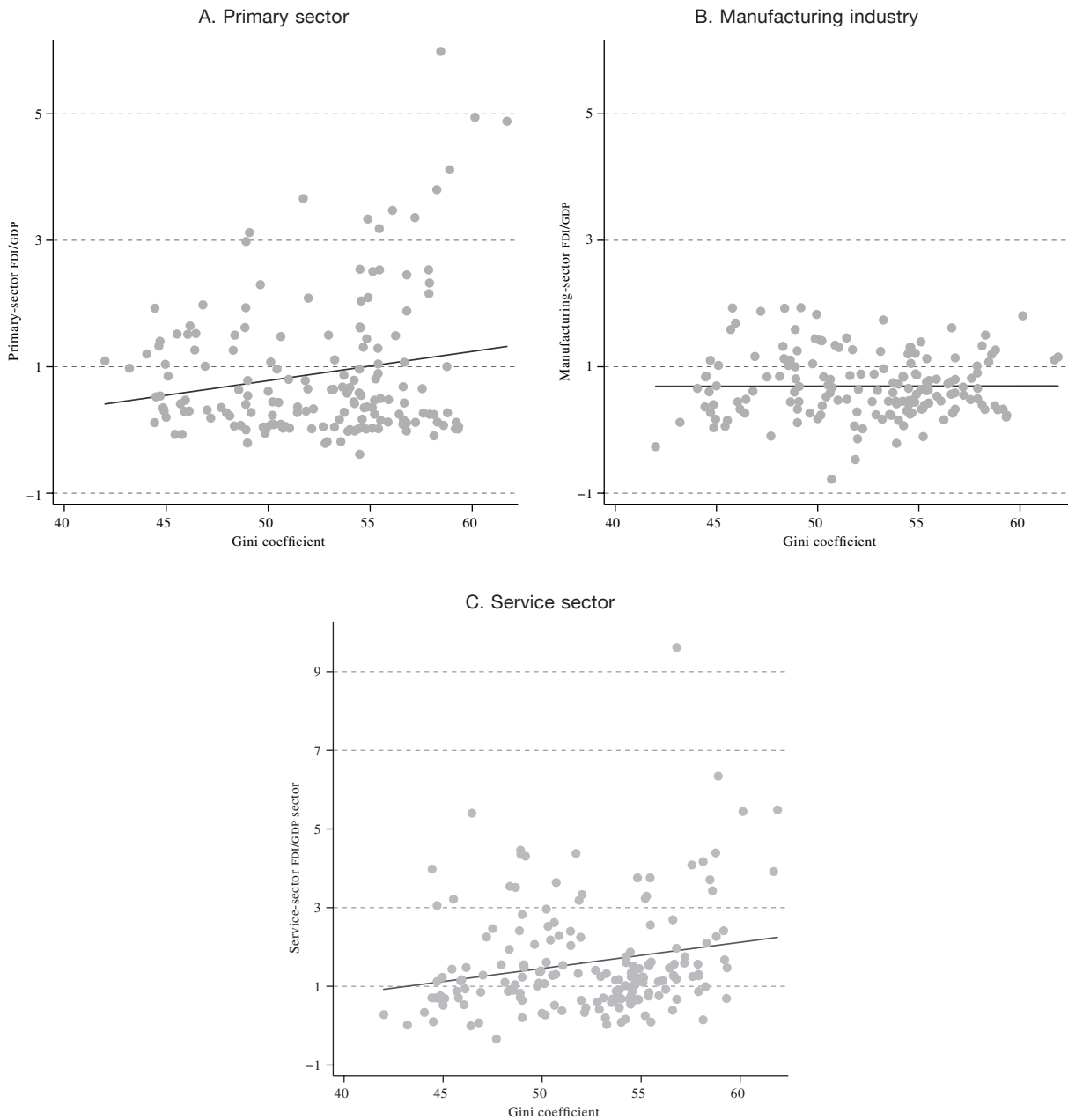
A. Primary sector

B. Manufacturing industry

C. Service sector

Source: Prepared by the author, on the basis of data from World Institute for Development Economics Research (UNU-WIDER), World Income Inequality Database.

II

Literature review

This section presents a summary of both the theoretical and the empirical literature, focusing on the relationship between FDI and income inequality and on the effect of sectoral FDI on income inequality, identifying the main sectors of activity where this investment is found.

1. Foreign direct investment (FDI) and income inequality

The relationship between economic growth and FDI began to receive more attention in the literature during the 1990s because of the major trade liberalization process undergone by developing economies in that period. There is a degree of consensus in the empirical literature regarding the positive impact of FDI on economic growth in developing countries (De Mello, 1997 and 1999; Borensztein, De Gregorio and Lee, 1998; Li and Liu, 2005; Herzer, Klasen and Nowak-Lehmann, 2008; De Vita and Kyaw, 2009). Conversely, the effect of FDI on income inequality, particularly in developing economies, has received less attention, very probably because of data limitations and the dearth of literature studying possible theoretical links between the two variables.

The main contributions dealing with the possible channels whereby FDI might influence income inequality will now be detailed. Jensen and Rosas (2007) suggest two channels through which this investment might affect inequality. First, FDI brings capital into a country, thus reducing the total returns to capital and increasing the returns to labour. Foreign capital competes with local capital to capture domestic workers, raising wages and reducing the profitability of local firms. This effect would tend to reduce income inequality by narrowing the gap between wage rents and capital rents. The second way in which FDI might have an impact on inequality is that foreign firms tend to pay a wage premium for skilled workers in particular, widening the income gap between skilled and unskilled workers and thence increasing inequality. If these foreign firms also paid a wage premium to unskilled workers, FDI would tend to reduce income inequality by increasing the income of worse-off workers.

Velde (2003), drawing together other contributions, refers to three possible channels through which FDI may affect wage inequality in developing countries. First, he

identifies a "composition effect" resulting from the fact that foreign firms tend to set up in sectors that are more intensive in skilled labour, thus improving the position of these workers relative to the unskilled (Feenstra and Hanson, 1997). Second, FDI can affect the supply of skilled workers via training and specific contributions to general education (knowledge transfer). Lastly, as advanced by Berman, Bound and Machin (1998), FDI can probably induce faster labour productivity growth both in foreign firms (technology transfer) and in local ones (secondary effects), and if productivity growth is skewed towards skilled sectors, then the gap between the sectors will grow. Velde (2003) uses a cross-section analysis for four economies of Latin America (Chile, Colombia, Costa Rica and the Plurinational State of Bolivia) in the 1978-2000 period and finds empirical evidence of FDI increasing wage inequality, and thence income inequality, in the region. Furthermore, a number of country studies support the hypothesis that FDI is associated with greater inequality in wage earnings, especially in developing economies. Some examples are Indonesia (Lipsey and Sjöholm, 2004), the Republic of Korea (Mah, 2002) and Mexico (Aitken, Harrison and Lipsey, 1996; Feenstra and Hanson, 1997), although it should be stressed that much of the empirical evidence also shows FDI to be associated with higher wages for workers of all kinds (Overseas Development Institute, 2002).

However, the empirical literature on the relationship between FDI and inequality at the macroeconomic level is not conclusive. Thus, Tsai (1995), using a cross-section analysis for 53 economies, estimates a positive and significant relationship between FDI and inequality, although when he uses dummy control variables (Latin America and Asia) he finds that this positive relationship could be capturing differences in inequality between economies rather than any role played by FDI. Choi (2006), using a panel of 119 countries in the 1993-2003 period, finds evidence that an increase in FDI increases inequality. A similar finding is indicated by the work of Basu and Guariglia (2007), who, using a panel of 119 developing economies for the 1970-1999 period, report a positive relationship between FDI, economic growth, income inequality and human capital. In a recent study, Herzer, Klasen and Nowak-Lehmann (2008) use

cointegration techniques to analyse the impact of FDI on long-run income inequality for five economies of Latin America (Chile, Colombia, Mexico, the Plurinational State of Bolivia and Uruguay), showing that FDI has a significant and positive effect on income inequality in almost all these economies. By contrast, Milanovic (2003), employing household survey data for 129 countries from 1988, 1993 and 1998, finds FDI to have no effect on income distribution. Lastly, Sylwester (2005), using a panel of 29 developing economies for the 1970-1990 period, finds no evidence of a positive relationship between these variables. In summary, while the empirical evidence for the relationship between FDI and inequality in developing economies is not conclusive, in no case does it indicate that such investment has the effect of reducing inequality, but rather the opposite.

2. Foreign direct investment (FDI) by sector and income inequality

The literature studying the relationship between FDI and income inequality has paid little attention to an aspect that may be important for an understanding of the impact of FDI on developing economies, namely the effect of its sectoral composition. It seems reasonable to hypothesize that FDI will not have the same impact whatever sector of the economy receives it, but this is something that aggregate analysis cannot determine. Thus, the channels through which FDI affects inequality are likely to differ depending on which sector receives it.

The literature does identify some differential effects of FDI on income inequality by economic sector. The manufacturing sector is usually labour-intensive, and foreign firms investing in it in developing countries are usually seeking cheap labour and lower costs. Indeed, most theories about the distributive effects of FDI deal implicitly with investment in labour-intensive manufacturing. The conclusion they reach is that foreign investors reduce income inequality in economies with plentiful low-wage labour by increasing the demand for unskilled workers and paying higher wages than prevail in the domestic economy. According to this

perspective, FDI should improve income distribution in recipient countries (Cornia, 2011). However, the empirical evidence is inconclusive and does not demonstrate this. For example, Velde and Morrissey (2004) found that FDI increased wages at all skill levels in four of the five East Asian countries analysed. In Mexico, conversely, the rise in wages in the presence of FDI was significantly smaller for unskilled workers than for skilled ones (Alarcón and McKinley, 1996).

On the other hand, FDI in the primary sector tends to exacerbate inequality, since ownership of natural resources is concentrated in a few hands and the rents from them are captured by those at the top of the distribution. Lastly, the service sector as a whole cannot be classified as labour- or capital-intensive, so the effects on inequality are not so obvious. To analyse the effects of capital flows in this sector, it is necessary to study its subsectors. For example, telecommunications are capital-intensive and employ skilled labour, while the tourism sector, for example, is more intensive in unskilled labour. Thus, FDI can be expected to increase inequality in the first case but reduce it in the second (Cornia, 2004).

Empirical macroeconomic studies do not usually identify the effect of FDI on inequality by economic sector. However, other branches of the literature do include disaggregation of FDI by sector in their analysis. For example, Aykut and Sayek (2007) find that the sectoral composition of FDI does matter when it comes to explaining productivity growth in developing countries and conclude that a large share for agriculture in the FDI total has a negative effect on growth in an economy, while a large share for manufacturing FDI has a positive effect. For their part, Nunnenkamp and Spatz (2004) find that aggregate growth is higher if a large share of a country's FDI is in the electrical machinery and equipment industry, rather than the food, chemical and metallurgical industries. Likewise, Tondl and Fornero (2010) identify FDI as having positive effects on productivity in all sectors of Latin American economies, although they may depend on specific conditions or be time-limited. The direct productivity effects are highest in the primary sector (agriculture, mining and oil production) and in financial services.

III

The data

To estimate the impact of FDI on income inequality by sector, an unbalanced panel was constructed with data for the 1980-2009 period in 13 economies of Latin America. The countries included in the sample were Argentina, Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Ecuador, Honduras, Mexico, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay. These countries were chosen because they had FDI data available by sector. Two analyses were conducted, one using annual and the other triennial data. This twofold approach was adopted because the use of annual data allowed the limited information available to be maximized, while triennial data were also included because no major changes were expected from one year to the next in some of the macroeconomic variables, such as inequality, and because this reduced short-term fluctuations and thence the influence of the business cycle, allowing attention to be focused on the long-term relationship.

The FDI measure used is the net inflow of foreign capital as a share of GDP. Aggregate data were obtained from the World Development Indicators database. As can be seen in figure 3, FDI more than trebled in the second subperiod analysed (1995-2009) relative to the previous period (1980-1994). This was due partly to the liberalization process initiated in the region in the early 1990s, which was also accompanied by major reforms and far-reaching privatization of public enterprises and services in a number of the region's countries, and partly to the sharp declines in interest rates between 2002 and 2008, which encouraged investors in economies with a large amount of accumulated capital to go in search of more profitable investments, for example in Asia and Latin America. The economies receiving most FDI in the second period included Chile, the Plurinational State of Bolivia and Honduras, while Paraguay, Brazil and Uruguay had the lowest ratio of FDI to GDP. In absolute terms, however, Brazil and Mexico continued to be the economies that received by far the most FDI in millions of dollars (see table A.1 of the annex). When Latin America is compared to other regions, it is found, along with Asia, to be among the developing regions which received the greatest flows of FDI and where this investment grew most in the period analysed (see table A.2 of the annex).

FIGURE 3

Latin America (13 countries): foreign direct investment (FDI)
(Percentages of gross domestic product (GDP))

■ 1980-1994 average ■ 1995-2009 average
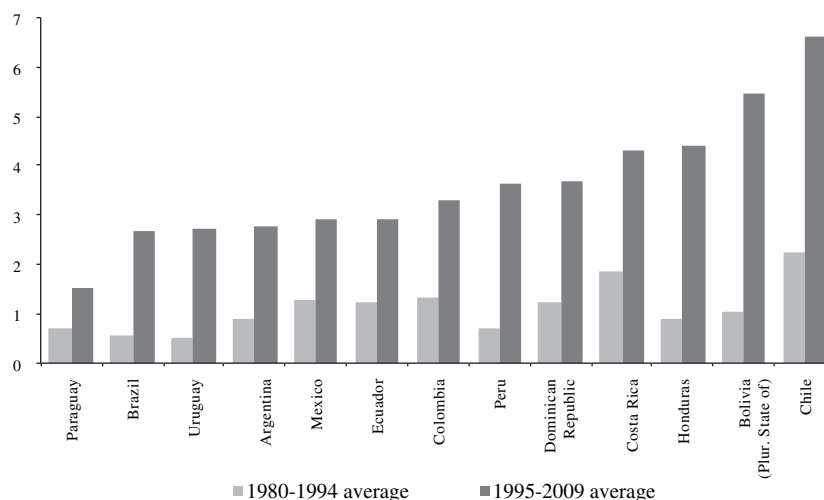
Source: Prepared by the author, on the basis of World Bank, World Development Indicators.

Like aggregate FDI, sectoral FDI was calculated by taking net flows into each sector as a share of GDP. The data sources for sectoral FDI vary by country, as no institution has attempted to systematize an FDI data series by sectors of activity.[1] In general, the sources used in this paper to prepare these data series were each country's central bank, institutes of statistics and, in some cases, institutes or organizations set up specifically to promote investment of this type (see table A.5 of the annex). Because the country information available was so heterogeneous, and with a view to preparing a data series that would be as homogeneous and comparable as possible, the decision was taken to group the data into three major sectors: the primary sector (including agriculture, mining and extractive industries), manufacturing industry and services.

As can be seen in figure 4, when averages for 1980-2009 are taken, the most important sector in explaining the evolution of FDI in the region is the service sector, which accounts for between 45% and 50% of total FDI flows into the region. The countries where service-sector FDI is particularly high as a share of total FDI

flows are Paraguay, the Dominican Republic, Uruguay, Honduras and Brazil. According to data from UNCTAD (2004), service-sector FDI quadrupled in developing economies between 1990 and 2002, while it doubled in the particular case of Latin America, mainly as a result of privatization and a new openness to foreign investment in telecommunications, public services and finance.

The income inequality indicator used was the Gini coefficient obtained from the World Income Inequality Database,[2] which often reports more than one estimate of the Gini coefficient per country per year. Thus, with a view to using the most homogeneous and comparable data possible, the observations were selected, first, in the light of the quality classification prepared by the World Institute for Development Economics (UNU-WIDER), to eliminate lower-quality observations (ranking 4).[3] Other controls were the income definition used (preference was given to disposable income), coverage by geographical area and population, and the source employed. For some countries, lastly, the inequality data were updated using the Socio-Economic Database for

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[1] Since 2005, the Economic Commission for Latin America and the Caribbean (ECLAC) has presented some statistics by sectors of activity in its annual report on FDI in Latin America.

[2] World Income Inequality Database version 2.0c of May 2008, prepared by the World Institute for Development Economics Research (UNU-WIDER).

[3] These observations are eliminated.

FIGURE 4

Latin America (13 countries): sectoral distribution of foreign direct investment (FDI), averages for 1980-2009

(Percentages of gross domestic product (GDP))
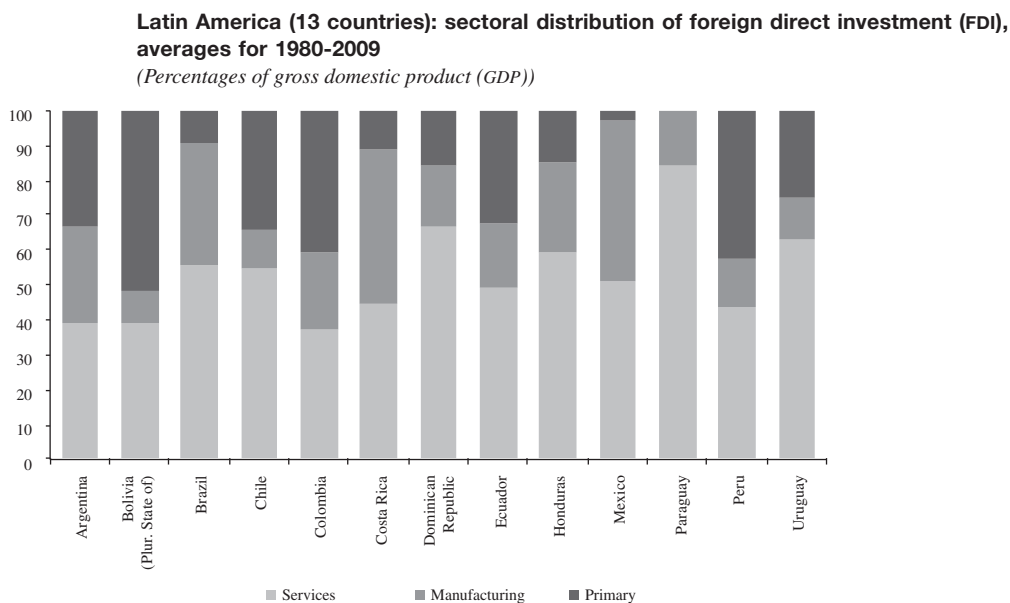
Source: Prepared by the author, on the basis of information from the respective countries.

Latin America and the Caribbean (SEDLAC),[4] maintaining the selection criterion mentioned above. Figure 5 presents the averages of the inequality coefficients by country for the two subperiods of the sample: 1980-1994 and 1995-2009.

Figure 5 reveals that Uruguay, Costa Rica and Argentina are in the group of countries that present lower

coefficients of inequality, while the Plurinational State of Bolivia, Brazil and Colombia present the highest index values. As regards evolution over time, while inequality tends to be highly persistent, Paraguay, Ecuador, Argentina and the Plurinational State of Bolivia experienced a significant increase during the period analysed, with Mexico, Brazil and Peru the only countries to present a significant reduction. This difference in evolution could be partly due to the implementation of specific policies in each countries.

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[4] See [online] http://sedlac.econo.unlp.edu.ar/.

FIGURE 5

Latin America (13 countries): Gini coefficient by country

■ 1980-1994 average   ■ 1995-2009 average
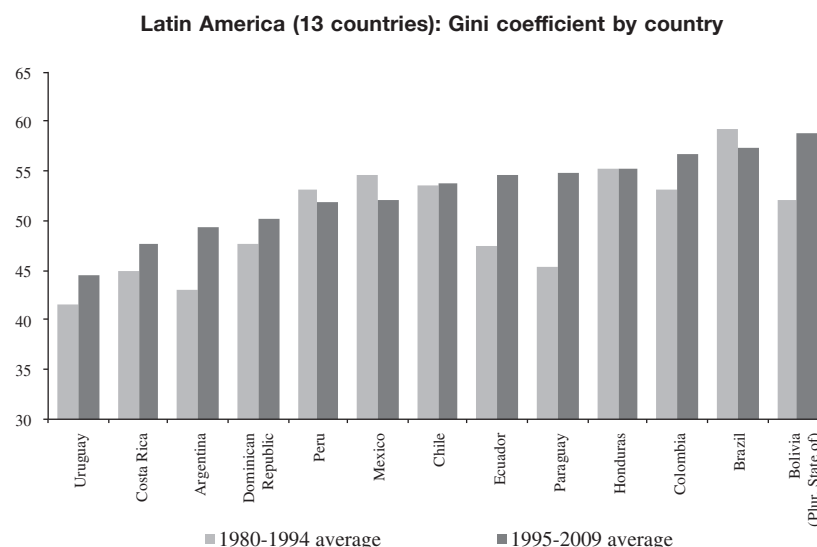
Source: Prepared by the author, on the basis of World Institute for Development Economics Research (UNU-WIDER), World Income Inequality Database, and the Socio-Economic Database for Latin America and the Caribbean (SEDLAC).

IV

The empirical strategy

In order to determine the effect of FDI on income inequality, and following the studies by Basu and Guariglia (2007), Choi (2006) and Tsai (1995), two equations were estimated, one with aggregate FDI data and one including FDI disaggregated by sectors of activity (primary, manufacturing and services). The purpose of conducting these two analyses was to find evidence as to whether FDI produced different effects on income inequality depending on the sector of activity it was in.

1. The effect of FDI on income inequality

The impact of FDI on income inequality in the aggregate is described in the following equation:

$$inequality_{it} = a_0 + a_1 FDI_{it} + a_2 X_{it} + u_i + e_{it} \qquad (1)$$

where the dependent variable is a measure of income inequality (the Gini coefficient) for country i in period t,

FDI_{it} is expressed as a percentage of GDP in country i at time t, and X_{it} is a vector that includes the main control variables. The term u_i represents fixed effects by country and e_{it} is the error term.

In accordance with the literature, the control variables that could affect either income inequality or FDI were introduced, as omitting them could result in biases in the estimation of the impact of FDI on income inequality. The control variables included are: trade as a share of GDP, human capital, population growth and public spending as a share of GDP.

In the first place, the data for the trade explanatory variable, which measures economies' external trade using the trade openness indicator (the sum of total imports and exports as a share of GDP), come from the World Development Indicators database. Traditional trade theory, such as the Heckscher-Ohlin model, suggests that as trade increases, wage inequality in developing countries, which tend to have a relative abundance of unskilled labour, tends to diminish. The more open an economy is to international trade, the more apparent the effect on wage inequality should be. However, the literature studying the relationship between FDI and inequality predicts the opposite effect, as it assumes that FDI will tend to go to sectors with more skilled workers, thereby increasing the wage gap between unskilled and skilled workers (Velde, 2003).

Second, the average number of years' secondary education was used as a proxy for the human capital variable. The data come from the database of Barro and Lee (2013). The literature on the relationship between inequality and human capital argues that a higher level of education in the population reduces income inequality (see, for example, Castelló and Doménech, 2002). In the third place, public spending is included on the basis that it is an important variable in the determination of income inequality and to control for the impact of fiscal policy on this inequality. According to the literature, higher public spending should be expected to result in a lessening of income inequality (Atkinson and Brandolini, 2006). Lastly, population growth is included to control for the size of economies. The descriptive statistics and the definitions and sources of the variables are presented in tables A.3 and A.4 of the annex.

Equation (1) was estimated with different specifications to test the robustness of the results. First, a fixed effects country model was estimated to control for the presence of unobservable heterogeneity between countries and the possible omission of relevant variables. The problem with models of this type is that

they implicitly assume FDI to be strictly exogenous to inequality. This may be too great an assumption if FDI is correlated with other observable or unobservable variables affecting inequality and not controlled for in the model, or if FDI is a function of inequality rather than a determinant of it. Controlling for country fixed effects would deal with the latter problem, assuming that the correlation of FDI with the error term is fixed in time. In the second place, the equation was estimated using the two-stage least squares (TSLS) method with a view to controlling for the existence of endogeneity between the dependent variable and the explanatory variables. For the annual data, the lags of the variables themselves were used as instrumental variables, while in the case of the triennial variables, the variables at the start of the period were used as the instrument, as they were expected to be uncorrelated with the errors.

Lastly, the model was estimated using the first-difference generalized method of moments (GMM) developed by Arellano and Bond (1991) and Arellano and Bover (1995). This technique provides a way of taking unobserved heterogeneity within the country into account while also controlling for the possible existence of endogeneity, using variables lagged by one or more periods as instrumental variables. To evaluate when the model was well specified, use was made of the Sargan test, which measures whether the model is properly specified and the instruments are valid, and the M1 and M2 tests, which measure the existence of serial correlation in the first- and second-order residuals, respectively (Arellano and Bond, 1991; Blundell and Bond, 1998).

2. The effect of FDI by sector on inequality

To investigate the relationship between sector-disaggregated FDI and income inequality, the following equation was estimated:

$$inequality_{it} = a_0 + a_1 IEDprim_{it} + a_2 IEDind_{it} + a_3 IEDserv_{it} + a_4 X_{it} + u_i + e_{it} \qquad (2)$$

Once again, the dependent variable is a measure of income inequality for country i in period t (Gini coefficient); $FDIprim_{it}$, $FDIind_{it}$ and $FDIserv_{it}$ represent FDI as a percentage of GDP in country i at time t in the primary, manufacturing industry and service sectors, respectively; X_{it} is a vector that includes the main control variables correlated with inequality; u_i is country fixed effects; and e_{it} is the error term.

To estimate equation (2), the same empirical strategy was used as for equation (1), and it was estimated under three different specifications: fixed effects, TSLS and the first-difference GMM. Just as with equation (1), the strategy was replicated with the triennial data as a robustness method. The same control variables were used as in the first equation: trade, human capital, public spending and population growth.

V

Results

This section presents the empirical results obtained for the panel of data from 13 economies of Latin America during the 1980-2009 period for the two analyses selected. First the results from the estimation of the effect of aggregate FDI on income inequality are presented, then the effect of FDI on this inequality by sector of activity is shown.

1. Foreign direct investment (FDI) and income inequality

Table 1 shows the main results from the estimation of the relationship between FDI and income inequality at the aggregate level. The different estimates in table 1 bear out the central hypothesis of this study: the relationship between FDI and income inequality in the Latin American economies is positive and significant in all the specifications considered (fixed effects, TSLS and GMM). These findings are in line with other studies in the literature (Tsai, 1995; Basu and Guariglia, 2007; Choi, 2006; Herzer, Hühne and Nunnenkamp, 2012). FDI can affect two components of income, capital or wages. A possible interpretation of the social effect derives from the effect on workers' wages; as noted by Velde (2003), one of the main causes of the greater inequality of the income generated by FDI in Latin America is that transnational firms tend to set up in sectors with highly skilled labour, and it is these that absorb most of the benefits of FDI, namely technology transfer, knowledge transfer and higher productivity. As a result, the wage gap between skilled and unskilled workers is found to widen, and thus income inequality to increase, in these economies. Column 1 of table 1 presents the results of the fixed effects estimation for the annual data. A change of one percentage unit in FDI for all the countries increases the Gini coefficient by 0.40 of a percentage point. This finding is particularly important when the stability of the Gini coeficient over time is considered. As mentioned in the previous section, the model was

also estimated by TSLS using lags of the explanatory variables as instrumental variables in order to take account of the possible existence of endogeneity. The results presented in column 2 of table 1 confirm the positive and statistically significant relationship between FDI and income inequality. Lastly, the model was estimated dynamically by employing the first-difference GMM estimator (see column 3 of table 1). As in the previous specifications, FDI continues to present a positive sign and is significant. The order of magnitude of the FDI coefficient is fairly similar between the fixed effects and TSLS, while with the GMM estimator it is lower.

As regards the control variables, the public spending variable has a negative effect on inequality and is significant. This result is in line with the literature on the impact of fiscal policy on inequality, finding that higher public spending results in lower income inequality (Li, Xie and Zou, 2000; Afonso, Schuknecht and Tanzi, 2010; Muinelo-Gallo and Roca Sagalés, 2011 and 2013). Similarly, the human capital variable has a negative impact on income inequity, and this finding is robust under the different specifications. The literature shows that greater investment in human capital translates into a drop in income inequality, especially in developing economies (see Basu and Guariglia, 2007; Blomstrom and Kokko, 2003; Castelló and Doménech, 2002). This last finding is important, since education is highlighted by several studies as one of the most effective instruments for reducing poverty and inequality in developing economies, and should thus be treated as a relevant factor by public policymakers, especially when the policies concerned are redistributive in character.

As a robustness measure, the same models were estimated again, but using triennial data (see columns 4, 5 and 6 of table 1). As can be appreciated, the results are similar to those obtained with annual data, since FDI has a positive sign and is statistically significant in all three specifications considered. In contrast with

TABLE 1

Gini coefficient and foreign direct investment (FDI)

Dependent variable: Gini coefficient	Annual data			Triennial data		
	Fixed effects (1)	TSLS (2)	First-difference GMM (3)	Fixed effects (4)	TSLS (5)	First-difference GMM (6)
FDI	0.403***	0.544***	0.199**	0.464***	0.449***	0.405***
	(0.074)	(0.113)	(0.096)	(0.113)	(0.115)	(0.075)
Trade	-0.002	-0.0003	-0.021	0.012	0.041	0.0236
	(0.012)	(0.017)	(0.022)	(0.029)	(0.033)	(0.034)
Population growth	-1.123	-1.201	-1.044	-1.787*	-0.654	2.299
	(0.827)	(0.922)	(0.755)	(1.033)	(0.947)	(1.997)
Public spending	-0.292***	-0.259**	-0.133	-0.269*	-0.251	-0.403
	(0.083)	(0.108)	(0.175)	(0.165)	(0.212)	(0.348)
Human capital	-0.859	-1.599**	-1.133**	-2.088*	-1.896**	-1.843*
	(0.615)	(0.823)	(0.512)	(1.138)	(0.814)	(1.017)
Constant	56.765***	57.617***		59.007***	54.979***	
	(2 536)	(1 718)		(3 562)	(3 269)	
Sargan test (*p*-value)			0.520			0.124
M1 test (*p*-value)			0.000			0.003
M2 test (*p*-value)			0.625			0.181
Observations	258	254	158	117	117	87
Adjusted R^2	0.83	0.82		0.82	0.81	
Countries	13	13	13	13	13	13

Source: Prepared by the author.

Note: All the estimations include the standard errors corrected for heteroskedasticity. The Sargan test is for overidentifying instruments in GMM models, and the M1 and M2 tests are for first- and second-order serial correlation in the residuals, respectively.
*** Significant at 1%; ** significant at 5%; * significant at 10%.

the previous case, when the TSLS estimator was used, the variables at the start of the period were selected as instrumental variables, on the basis that they would have little correlation with errors. The results for the control variables are also similar to those obtained with the annual data model. The most striking result is the one for the human capital variable, as it is the only robust finding in the three specifications and two samples, with a negative impact on inequality. Public spending and population growth present a negative sign and are statistically significant in the fixed effects estimation, but these findings are not so robust.

2. FDI by sector and income inequality

Table 2 shows the results of the estimation of the FDI effect by sectors of activity on income inequality in Latin America for the two samples and under the three specifications. As explained in the previous section, FDI was identified in three major sectors of activity: the primary sector, manufacturing industry and services.

As can be seen from table 2, FDI presents a positive sign and is statistically significant in both manufacturing and the service sector. Manufacturing presents the highest coefficient for the impact of FDI on inequality,

although it is the service sector that displays the most robust estimates for the three specifications and two samples, with a coefficient similar to that for aggregate FDI, some 0.40. This last finding is still more important for these economies if account is taken of trends over the last decade, with service-sector FDI more than doubling between 1990 and 2002, bringing this sector to the fore as the main recipient of such investment.[5] The literature studying the effect of services in developing economies is inconclusive as regards the impact this sector can have on different aspects of the economy, while policymakers are not convinced that opening the doors to service-sector FDI would have positive effects (Banga, 2005). It is important to note that subsectors within this sector cannot be distinguished for all the countries, because of data limitations. This is a major constraint when it comes to capturing the effect of the service sector on the economy, particularly considering that the financial sector is one of the key subsectors accounting for the evolution of FDI in Latin America, especially since the 1990s.

[5] It has become an attractive destination, in particular, for FDI in the tourism, telecommunications and information technology subsectors (UNCTAD, 2004).

TABLE 2

Gini coefficient and foreign direct investment (FDI) by sector

Dependent variable: Gini coefficient	Annual data			Triennial data		
	Fixed effects (1)	TSLS (2)	First-difference GMM (3)	Fixed effects (4)	TSLS (5)	First-difference GMM (6)
FDI_primary sector	0.194	0.171	-0.049	0.492***	0.552***	-0.143
	(0.147)	(0.135)	(0.165)	(0.166)	(0.197)	(0.249)
FDI_manufacturing sector	0.396*	0.422	0.341	0.901**	2.197***	0.875**
	(0.243)	(0.270)	(0.363)	(0.345)	(0.719)	(0.381)
FDI_service sector	0.408***	0.412***	0.198**	0.437***	0.325***	0.468***
	(0.078)	(0.079)	(0.090)	(0.121)	(0.084)	(0.160)
Trade	0.039***	0.042*	-0.012	0.036	0.057*	0.010
	(0.015)	(0.024)	(0.035)	(0.024)	(0.033)	(0.023)
Population growth	0.875	0.836	-0.893	-1.771	2.388*	0.199
	(0.883)	(1.137)	(0.928)	(1.505)	(1.439)	(1.780)
Public spending	-0.362***	-0.313***	-0.186	-0.327*	-0.126	-0.059
	(0.120)	(0.118)	(0.197)	(0.179)	(0.204)	(0.172)
Human capital	-2.332***	-2.621**	-1.203**	-1.883***	-1.790***	-2.417***
	(0.756)	(0.928)	(0.566)	(0.533)	(0.466)	(0.690)
Constant	55.626***	55.755***		52.546***	75.684***	
	(2 903)	(3 455)		(4 853)	(2 556)	
Sargan test (*p*-value)			0.339			0.178
M1 test (*p*-value)			0.000			0.017
M2 test (*p*-value)			0.684			0.659
Observations	171	170	121	74	68	57
Adjusted R^2	0.87	0.87		0.90	0.90	
Countries	13	13	13	13	13	13

Source: Prepared by the author.

Note: All the estimations include the standard errors corrected for heteroskedasticity. The Sargan test is for overidentifying instruments in GMM models, and the M1 and M2 tests are for first- and second-order serial correlation in the residuals, respectively.

*** Significant at 1%; ** significant at 5%; * significant at 10%.

Public spending and human capital stand out among the control variables, being significant and of negative sign, in line with the main findings of the literature. Thus, both human capital investment and fiscal policy may be considered effective economic policy instruments for combating the persistent income inequality found in these regional economies. This last result is very robust both in the different specifications and at the two levels of analysis chosen, the aggregate one and the sectoral one. As for the trade variable, this is found to have a positive and statistically significant effect on inequality. This runs counter to the findings of traditional trade theory using the Heckscher-Ohlin model but is in line with the literature studying the effect of FDI on income inequality, which finds the opposite effect, i.e., an increase in income inequality when trade grows, as was explained in section II.

Finally, the results were tested for robustness by replicating the sectoral-level estimations with an alternative series of sectoral FDI data. Because the data sources for the aggregate FDI series and the sectoral FDI series are different, the totals present some differences too. In an effort to control for the possible effect of these, the sectoral data series were reconstructed in such a way that the sum of these would match the FDI total at the aggregate level. The results obtained with these new sectoral FDI series confirm that FDI in the manufacturing and service sectors increases income inequality, as the signs and significance of the variables are maintained under the three specifications taken and with the two samples used.[6]

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[6] The results are not presented in the article but were used to control for the robustness of the findings.

VI

Conclusions

This study uses an unbalanced panel of data for 13 economies to analyse the relationship between FDI and income inequality in Latin America. One of the main findings confirms that there is a positive relationship between FDI and income inequality, in line with a number of studies in the literature (Basu and Guariglia, 2007; Choi, 2006; Herzer, Hühne and Nunnenkamp, 2012; Velde, 2003; Tsai, 1995). Again, when the effect of FDI by sector of activity is analysed, the results show that FDI in both the service sector and manufacturing industry increases income inequality, which explains the previous finding. The positive effect of these sectors on the inequality variable is particularly salient because they are the sectors that have played the greatest part in the evolution of FDI over the last decade in the economies of the region studied, according to data from UNCTAD (2004).

Given the characteristics of the region's economies, most of which display persistent income inequality over time, these findings are very important from an economic policy perspective, since they provide empirical evidence for the distributive implications associated with FDI and thus open up an opportunity for governments to try to channel or guide external resources in such a way that FDI reaches the most disadvantaged sections of society, or at least to design and apply redistributive policies that enable the benefits from FDI to spread and enhance the welfare of the population.

In summary, this study is a contribution to the empirical literature, principally for the evidence it provides on the effect of sectoral FDI on income inequality in Latin America, showing that the sector FDI is implemented in matters from the point of view of its distributive effects. Thus, it highlights a differential impact depending on whether FDI is carried out in the service and manufacturing sector, or in the primary sector.

ANNEX

TABLE A.1

Latin America (13 countries): net inflows of foreign direct investment (FDI)
(Millions of current dollars)

	1980-1994 average	1995-2009 average	1980-2009 average
Paraguay	42	120	89
Honduras	31	433	240
Bolivia (Plurinational State of)	55	485	282
Ecuador	158	568	357
Uruguay	56	651	413
Costa Rica	121	864	524
Dominican Republic	102	1 118	649
Peru	286	2 912	1 820
Colombia	592	4 687	2 761
Chile	723	6 958	4 224
Argentina	1 399	6 968	4 302
Mexico	3 190	19 110	11 626
Brazil	1 730	23 863	14 105

Source: Prepared by the author, on the basis of World Bank, World Development Indicators.

TABLE A.2

Net inflows of foreign direct investment (FDI) by region, 1980-2009
(Millions of dollars and percentages)

Region	FDI inflows in millions of dollars			FDI as a share of the world total		
	Average 1980-1994	Average 1995-2009	Average 1980-2009	Average 1980-1994	Average 1995-2009	Average 1980-2009
Developed economies	94 579	646 398	370 488	73.0%	65.7%	66.5%
Developing economies	34 454	306 436	170 445	26.6%	31.1%	30.6%
Oceania	176	663	420	0.1%	0.1%	0.1%
Africa	2 915	23 915	13 415	2.3%	2.4%	2.4%
Western Asia	2 533	28 146	15 339	2.0%	2.9%	2.8%
South, East and South-East Asia[a]	8 988	62 188	35 588	7%	6%	6%
Latin America and the Caribbean	9 770	95 553	52 662	7.5%	9.7%	9.5%
China	10 073	95 971	53 022	7.8%	9.7%	9.5%

Source: Prepared by the author, on the basis of data from the United Nations Conference on Trade and Development (UNCTAD).

[a] Excluding China.

TABLE A.3

Descriptive statistics

Variable		Mean	Standard deviation	Minimum	Maximum
Gini coefficient	Overall	51.63	5.340	38.70	61.88
	Between groups		4.340	43.23	58.02
	Within groups		2.883	41.15	58.50
Foreign direct investment (FDI)	Overall	2.363	2.155	-2.499	12.20
	Between groups		0.855	1.112	4.431
	Within groups		1.992	-3.388	11.31
Primary-sector FDI	Overall	0.861	1.099	-1.858	6.295
	Between groups		0.710	-0.0429	2.556
	Within groups		0.872	-3.553	6.291
Manufacturing-sector FDI	Overall	0.804	0.701	-2.573	3.761
	Between groups		0.347	-0.0539	1.359
	Within groups		0.625	-1.716	3.842
Service-sector FDI	Overall	1.691	1.528	-0.482	9.132
	Between groups		0.632	0.958	2.647
	Within groups		1.393	-1.439	8.491
Human capital	Overall	1.936	0.585	0.708	3.658
	Between groups		0.451	1.181	2.869
	Within groups		0.392	1.023	2.835
Population growth	Overall	1.789	0.630	-0.151	3.133
	Between groups		0.539	0.482	2.503
	Within groups		0.358	0.962	2.551
Trade	Overall	53.42	26.18	11.55	136.8
	Between groups		22.38	20.34	90.85
	Within groups		14.90	-0.510	103.5
Public spending	Overall	8.176	4.638	2.578	22.59
	Between groups		4.592	3.346	17.90
	Within groups		1.412	3.087	13.30

Source: Prepared by the author, on the basis of data from World Bank, World Development Indicators; World Institute for Development Economics Research (UNU-WIDER), World Income Inequality Database; Penn World Tables; and R.J. Barro and J.W. Lee, "A new data set of educational attainment in the world, 1950-2010", *Journal of Development Economics*, vol. 104, Amsterdam, Elsevier, 2013.

TABLE A.4

Data sources

	Definition of variables	Sources
Inequality	Gini coefficient	World Income Inequality Database version 2.0c
Foreign direct investment (FDI)	Foreign direct investment as a percentage of GDP	World Development Indicators
Human capital	Share of the population with secondary education is 25% or more of the total	Barro and Lee (2013)
Public spending	Government spending as a percentage of GDP	Penn Table version 7.0
Population	Population growth rate	World Development Indicators
Trade	Imports plus exports as a percentage of GDP	World Development Indicators

Source: Prepared by the author, on the basis of data from World Bank, World Development Indicators; World Institute for Development Economics Research (UNU-WIDER), World Income Inequality Database; Penn World Tables; and R.J. Barro and J.W. Lee, "A new data set of educational attainment in the world, 1950-2010", *Journal of Development Economics*, vol. 104, Amsterdam, Elsevier, 2013.

Note: GDP: Gross domestic product.

TABLE A.5

Data sources (by country)

Sectoral foreign direct investment (FDI) by country	Sources
Argentina	National Institute of Statistics and Censuses (INDEC) International Accounts Office (DNI)
Bolivia (Plurinational State of)	National Institute of Statistics (INE) Central Bank of Bolivia
Brazil	Central Bank of Brazil
Chile	Foreign Investment Committee (CIE)
Colombia	Central Bank of Colombia
Costa Rica	Ministry of National Planning and Economic Policy
Ecuador	Central Bank of Ecuador
Honduras	Central Bank of Honduras
Mexico	Secretariat of Economic Affairs
Paraguay	Central Bank of Paraguay
Peru	Central Bank of Peru
Dominican Republic	Central Bank of the Dominican Republic
Uruguay	Central Bank of Uruguay

Source: Prepared by the author.

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The use of key indicators to assess Latin America's long-term economic performance

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ABSTRACT

Official statistics and key indicators are essential for observing countries' economic and social progress, determining the structural drivers of their growth and shaping priorities. Using the methodology of Khramov and Lee (2013), key indicators from the System of National Accounts (SNA), as well as balance of payments, monetary and financial, and public finance statistics, it is proposed to use a composite indicator to assess Latin America's economic performance. An examination of long-term trends finds that this index generally captures the major economic shocks and periods of robust performance during the period 1990-2013. It construction enables the measurement of specific indicators that determine overall economic behaviour. While the usefulness of the index for analysing macroeconomic dynamics is high in comparison with alternative benchmark values, caution should be exercised when selecting a time frame for estimating the relative weights of each component.

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I

Introduction

This paper analyses the use of key indicators to assess macroeconomic performance in the countries of Latin America and aims to concisely interpret international data from the system of macroeconomic statistics in the form of an index. The importance of official statistics is highlighted first through a discussion of the main components of the integrated system of national statistics, and second through the construction of a composite index identified as the Latin American performance index. The abundance of available statistics is critical for monitoring national economic progress, shaping political priorities and assessing countries' economic and social development. Official statistics, when compiled in accordance with standardized international definitions and benchmarks, also allow for the comparative analysis of economic and social performance across countries (OECD, 2005; IMF, 2007).

A well-constructed system of national statistics also allows researchers, policymakers, academics and the broader public to understand more clearly the dynamics of economic progress in a particular country, region or locality. Statistical data that are published freely, regularly and promptly also help to keep governments accountable to their citizens. Through an astute and careful analysis of official statistics, it is possible to form a comprehensive picture of the recent economic performance of a given country and understand more fully what its drivers have been.

The field of international statistics is undoubtedly complex, and definitions, coverage and indicators tend to vary between countries, introducing a certain level of interpretation bias and difficulty for many users of these data. What is needed is a concise and easily interpreted composite indicator that captures the economy's overall health. In methodological terms, and in accordance with the Economic Performance Index (EPI) devised by Khramov and Lee (2013), this paper proposes a relatively straightforward indicator, adapted for Latin America, which —as the results presented herein show— captures the main economic developments over time, and also enables the various aspects of production underlying development to be identified and compared. The objective of this paper is therefore to provide a tool that facilitates the evaluation of economic performance in Latin America.

This paper is organized as follows. Section II discusses the main objectives of the system of macroeconomic statistics, by examining the integrated formulation of the System of National Accounts (SNA), balance of payments statistics, monetary and financial statistics, and those concerning public finances. Together, these pillars make up the international system of statistical information and provide a wealth of data for countries to monitor and be held accountable for in their performance. Through the identification of selected key indicators from each of the main pillars, analysts can begin to understand the inputs needed to conduct a more nuanced analysis of overall macroeconomic development.

Section III presents the methodological framework of the EPI in Latin America. Drawing on the theoretical foundations of this index, this study constructs a modified index that measures the overall performance of the region's economies against their long-term trend. By capturing key indicators from each of the pillars of macroeconomic statistics, the index provides a concise and easily understandable snapshot of economic progress. This section also examines the robustness of the indicator in comparison with alternative benchmarks. Section IV illustrates the use of the index for macroeconomic analysis by comparing different historical episodes in respect of the same country and analysing a common episode across countries, and demonstrates the existing potential for a deeper analysis of recent macroeconomic performance in different countries in the region. Section V presents conclusions regarding the main findings of the research, and ends with a set of considerations for the future.

II

Key objectives of macroeconomic statistics and relevant indicators for measuring performance

Accurate, timely and relevant statistical information is necessary to assess and monitor progress favourable to social and economic development goals (ECLAC, 2010). As noted above, statistics are a fundamental input for individual and collective decision-making at the local, national and international level. Data and information serve as key tools for good governance, making it possible to keep politicians, policymakers and the public informed and accountable for their actions. They can also contribute to setting quantitative targets for national policy and allow for a more precise evaluation of programmes and progress towards their achievement.

Macroeconomic statistics are also crucial for making comparisons between countries. In this regard, international institutions perform two significant functions to enhance the availability and comparability of statistics. First, they provide methodological guidelines so that individual countries can follow uniform rules and arrive at broadly comparable results. Second, they codify the accounting rules for macroeconomic statistics with the aim of providing a harmonized structure and system of reporting. Standardization allows for greater and more effective international comparisons and monitoring (OECD, 2005).

Macroeconomic statistics rest on four pillars: the System of National Accounts (SNA), balance of payments statistics, monetary and financial statistics, and public finance statistics. When viewed as an integrated system, they make up the structure of national statistics. These accounts highlight the relationships between the main sectors of the real economy and allow recent economic developments to be monitored. An important feature of macroeconomic statistics is the use of the same core concepts. Although the specific needs of each set of accounts preclude full integration, linkages across the system reflect many common features which, when viewed together, provide a fuller assessment of the performance of a national economy at a given time.

The SNA offers a comprehensive and systematic framework for collecting, presenting and analysing macroeconomic statistics. The framework presents details of how an economy works and how its economic agents interact, and enables users to analyse the production

and use of goods and services and to measure gross domestic product (GDP). It also permits the analysis of the incomes generated by that production and earned from the ownership of assets, and how they are redistributed within the economy. Users are also able to identify the capital and financial flows that take place. In summary, the SNA provides information not only about economic activity but also about an economy's productive assets and the wealth of its inhabitants. Within the SNA, the following indicators emerge as important statistical components: the level and growth rate of GDP (even by component and by type of economic activity), the level and growth rate of per capita GDP, employment and unemployment rates, and remuneration levels.

Following a similar structure to the SNA, balance of payments (BOP) statistics cover all economic transactions with the outside world. There are three types of BOP accounts: (i) the current account, which records transactions with non-residents in goods and services, income and current transfers; (ii) the capital account, which takes note of transactions in capital transfers and non-produced non-financial assets, such as contracts, leases and licences, and (iii) the financial account, which records transactions in external financial assets and liabilities. One of the most important features of the BOP is the information presented in the current account, which helps provide a succinct assessment of the country's relationship with the international community. The most important key indicators from within the BOP framework are perhaps the current account balance (often reported as a share of GDP), the capital account balance, exports of goods and services, imports of goods and services, national income and expenditure, and their components. Figures reflecting the level of current transfers to a country, including remittance flows and foreign direct investment (FDI), are also easily gleaned from the BOP framework.

The third pillar of the national statistical system is the set of monetary and financial statistics, which consist of comprehensive stock and flow data on the financial and non-financial assets and liabilities of that sector of the economy. Primary indicators from these statistics provide relevant information on monetary aggregates, the level of credit to various sectors, and the level of foreign

financial assets and liabilities. In addition, they provide valuable links to government finance and the BOP. This type of data is generally available on a more frequent basis than other sets of macroeconomic statistics and are important for the analysis, formulation and implementation of monetary and macroprudential policy. In this regard, key indicators include monetary aggregates, the leading interest rate or monetary policy rate, the level of credit and credit growth in a given economy, as well as measures of the health of the financial system.

Public finance statistics comprise the final pillar of the integrated system of national statistics. Economists and statisticians have long found it useful to separate the activities of government from those of the rest of the private sector for a clearer picture of the health of national treasuries, and to gather more detailed information on public-policy-related expenditures. From the set of public finance statistics, perhaps the fiscal balance (the sum of revenues minus the sum of expenditures) and the level of national debt are the most relevant for macroeconomic analysis in a broad sense. Included in this set of key indicators would be the level of tax revenue and its components, public income and expenditure, internal debt, external debt and debt service. It is also important to note the scope of public finance statistics, which may be measured at the central or federal

government level, as well as at the State, local or other subnational level.

Using the large set of relevant statistical indicators captured by macroeconomic statistics, it is possible to construct a matrix of available information detailing the actual performance of a given economy over a specific period, as well as to capture and analyse shifts in performance over a long or short time frame. However, despite the abundance of statistics available today, many individuals —including policymakers, business leaders and members of the larger public— remain confused about the best way to understand and interpret data, leaving them unable to properly assess their country's economic performance. A consistent and transparent indicator of the economy's overall performance could help guide economists, policymakers and the general public in making more informed decisions by providing a broader picture of the economy. This is where composite indicators have a role to play, since they make it possible to diagnose the overall health of an economy from a single headline figure. The creation of a composite index on the basis of the large panel of available statistical indicators presented in this section (drawing on indicators from each key pillar of economic statistics) would help to simplify and condense a large amount of data into a single, powerful diagnostic number.

III

The Latin American economic performance index

In a recent working paper, Khramov and Lee (2013) proposed a composite index for assessing the economic performance of the United States. This is a single, simple, yet informative metric that enables the assessment of a country's general macroeconomic performance in a methodologically straightforward and intuitive way. In its original formulation, the indicator measures the activity of the economy's three primary institutional sectors (households, firms and the government) by looking at GDP growth, consumer price inflation, unemployment and the government fiscal balance. The index is calculated using the weighted sum of deviations of each indicator from a given benchmark, where the weightings reflect the relative variability of each of the components.

The index proposed herein is based on the methodology of the EPI. However, in order to make the indicator relevant to the economies of Latin America, it has been modified along the lines set out below.

Since the Latin American economies are relatively small in comparison with the United States, and are highly integrated into the world economy, developments in the external sector have profound repercussions for their macroeconomic performance, which are particularly felt through trade flows and often through remittances flows. Accordingly, this study draws on balance of payments statistics through the inclusion of the current account balance —expressed as a proportion of nominal GDP— as an additional input. From a macroeconomic perspective, the relevance of the current account balance is that it

summarizes the domestic economy's transactions with the rest of the world and any changes in the country's investment position.

Much as the recent financial crisis highlighted the vulnerability of the world economy to imbalances in the financial sector, so several Latin American countries have recently experienced their own domestic financial crises. The main challenge for incorporating this dimension into the Latin American performance index is the broad availability of information from monetary and financial statistics. Candidate indicators include measures of the health of the banking sector, such as capital ratios, and measures of the degree of banking penetration, such as the ratio of the M2 monetary aggregate to GDP. Considering that the seeds of financial crises are in many instances sown by the excessive growth of credit, this study has incorporated share of bank credit to the private sector as an input to the Latin American performance index, which has the added advantage of allowing comparison across countries.

Although labour market developments are of the utmost importance in assessing the performance of an economy, coverage of the measures of unemployment varies significantly across countries, and is unavailable for some countries in the region. For that reason, unemployment has been excluded from the estimation of the index, while GDP growth and consumer price inflation are maintained as broad measures of trends in the volume and prices of the goods and services produced.

Lastly, on the basis of government finance statistics, the analysis focuses on the primary balance of the central government, which is the balance of revenues minus expenditures, excluding interest payments. This indicator was chosen because it provides the most relevant measure for assessing the long-term sustainability of public finances. The focus was on the central government because it is the level at which it is certain that fiscal policy shifts can be detected across countries, and because it is a measure that is available and comparable across the majority of countries in the region.

By combining these individual key indicators, it was possible to construct a composite index that captures salient features from each of the four pillars of macroeconomic statistics and, from the perspective of this research, more fully reflects the depth and dimension of the Latin American economies.

Khramov and Lee (2013) argue that their choice of benchmarks reflects the optimal level for each indicator, meaning that deviations from the reference value of 100 reflect decreases in performance. It should be stressed that this interpretation is dependent on the benchmarks

chosen. One of the advantages of the relative simplicity of the indicator is that its benchmarks can be adjusted to reflect different uses. For example, benchmarks can be chosen so as to reflect the levels of performance needed to close gaps in, for instance, job creation.

In this paper, the selected benchmarks indicate the historical long-run performance of Latin American economies. Thus, deviations above (below) the reference value of 100 reflect performance that is better (worse) than the long-term average according to certain criteria. Regarding the benchmark for GDP growth, the study proposes the existence of a potential growth rate. Since this variable is unobservable and notoriously difficult to estimate, standard practice is adopted and its trends approximated using the Hodrick-Prescott filter (Hodrick and Prescott, 1997), with a smoothing parameter equal to 6.25, which is the yearly equivalent of the commonly used value of 1,600 for quarterly data (Ravn and Uhlig, 2002). To account for the distortion introduced by the asymmetric nature of the filter at the end of the sample, the modification devised by Kaiser and Maravall (1999) was applied, and the time series extended using forecasts before estimating the smoothed series. Forecasts are obtained using the automatic routine in the TRAMO program (Caporello and Maravall, 2004; Gómez and Maravall, 1994).

Although in standard monetary policy models a zero target for inflation is optimal from a welfare perspective (see, for example, Galí (2003) for a brief overview), once it is recognized that the actual environment in which policy is implemented is characterized by incomplete markets and substantial heterogeneity across agents, a zero target for inflation becomes suboptimal (Bhattacharya, Haslag and Martin, 2005). Considering Latin America's history of relatively high inflation levels, benchmark inflation is set at 5% and only deviations above the target are penalized in the computation of the performance index.

Regarding public finance and the external sector, the benchmark value of the central government primary balance and the current account balance was set at zero. In the case of the primary balance, this target was chosen because it is consistent with the long-term budget balance of the public sector, and in the case of the current account balance, because it reflects a situation where all investment during a given year is financed from domestic savings.

As regards the financial sector, considering the volatility of the series for bank credit to the private sector, expressed as a proportion of nominal GDP, a penalty was applied for year-to-year changes in the ratio that exceeded the value of the standard deviation

of the series over the previous 10 years. The idea is to capture sudden changes in the provision of credit that could signal future imbalances. That is to say, one-off events in credit growth are not necessarily problematic. Rather, sustained episodes of low or excessive credit growth are penalized.

In this study, the modified performance index is constructed in accordance with the following formula:

$$LAPI = 100 + \theta_y\left(\Delta_y - \Delta_y^*\right) - \theta_\pi\left[\iota_\pi\left(\pi - \pi^*\right)\right] + \theta_G\left(G - G^*\right)$$
$$+ \theta_{CA}\left(CA - CA^*\right) - \theta_{Credit}\left[\iota_{Credit}\left(\Delta Credit - \Delta Credit^*\right)\right]$$

where Δy denotes annual GDP growth, π is yearly average consumer price inflation, G and CA are the central government primary and current account balances, respectively, both expressed in terms of GDP, and $\Delta Credit$ is the variation in credit provided by banks to the private sector as a proportion of GDP. The starred variables denote the respective benchmarks, while ι_j, where $i \in \{\pi, Credit\}$, are conditional indicator variables which take the value of one (1) if the respective statistic exceeds the value of its benchmark, and zero (0) otherwise. Lastly, θ_i, where $i \in \{y, \pi, G, CA, Credit\}$, are the weightings for each component, which are computed as the product of the inverse of the standard deviation of each component's deviation from their respective benchmarks, multiplied by the average of the individual component's standard deviation. All standard deviations are computed for the sample period under consideration. As in Khramov and Lee (2013), the logic behind the choice of weightings is to rescale the importance of the most volatile components so as not to distort overall fluctuations in the index.

By combining the key statistics into a single composite indicator, the Latin American performance index makes it possible for a broad audience to gauge the overall macroeconomic health of the economy. Moreover, analysing the contribution of each component to changes in the index provides additional tools for dissecting the sources of fluctuations in macroeconomic performance. The index was constructed to enable its simple mathematical calculation, and allows for each variable to be presented in the same unit of measurement, in this case a percentage.

1. Application to Latin America

To illustrate the use of the Latin American performance index, as well as to assess its sensitivity as regards choice of benchmarks, the rest of this section will analyse the macroeconomic performance of Chile between 1990 and 2013. This choice reflects the fact that recent economic developments in Chile are conducive to highlighting some of the main features of the index, notwithstanding that it may be used with reference to any country in the region, and that its robustness in terms of choice of alternative benchmarks applies to all countries.

Figure 1 illustrates Latin American performance index trends in Chile and the contributions of the individual components during the period 1991-2013. While the general uptrend in the index until the mid-2000s reflects the gains in macroeconomic performance achieved by Chile during this period, the fluctuations point to a more nuanced story than would be obtained from a single indicator such as GDP.

It can be seen, for example, that during most of the 1990s, as monetary policy struggled with the effect of relatively high capital inflows, inflation was consistently above its benchmark, so that the indicator shows a downtrend. On the other hand, the positive contributions of the government finance component reveal the commitment of the Government of Chile to the achievement of primary surpluses.

Current account trends are particularly relevant to Chile and to Latin America in general. During the 1990s when the international price of copper, one of Chile's main exports, reached a historic low, the resulting current account deficits impinged on macroeconomic performance. However, as the price of copper rose thanks to renewed demand for commodities from China, the contribution of the current account turned significantly positive, in particular during the period 2004-2007.

Lastly, the spectacular rise in bank credit to the private sector observed from 2007 explains much of the decrease in macroeconomic performance that persisted until 2010, when GDP began to grow faster than its long-term trend.

As the above discussion shows, while the Latin American performance index is a useful tool for establishing trends in macroeconomic development, it is the contributions made by the different components that provide the inputs for a detailed analysis of its determinants. Continuing with the example of Chile, the next subsection investigates the sensitivity of the index to the choice of alternative benchmarks.

FIGURE 1
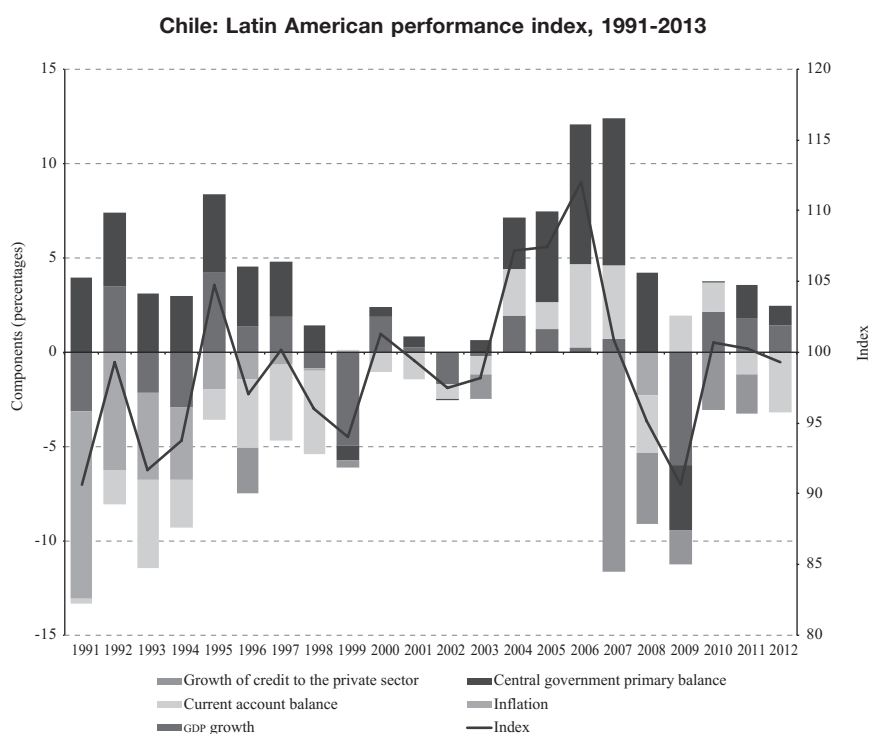
Chile: Latin American performance index, 1991-2013

Source: Prepared by the authors, on the basis of official data.
Note: GDP: Gross domestic product.

2. Sensitivity analysis

As detailed above, in this analysis the choice of benchmarks gives an account of countries' long-term performance. Two types of benchmark were used: those that are fixed (such as those selected for inflation the current account balance and the central government primary balance); and those that fluctuate (such as the long-term GDP trend (see figure 3) and the standard deviation of changes in credit to the private sector, which are computed on a rolling basis).

Regarding the fixed benchmarks, alternative values will shift the Latin American performance index upwards or downwards, depending on whether the new value is lower or higher. Figure 2.A illustrates the effect of setting the benchmark for the government primary balance at

a surplus of 5%, while figure 2.B shows the effect of a deficit of the same magnitude; taken together they show that the overall dynamics of the composite index remain constant. In other words, phases of improved performance, stagnation and decline, as well as the magnitude and direction of index changes, remain the same. What does change, however, is the relative importance of the individual components, leading again to the assertion that interpretation of the sources of fluctuations in the index is dependent on the choice of benchmarks. With respect to the original benchmarks (see figure 1), raising the benchmark for the central government primary balance (figure 2.A) changes the sign and reduces the relative weight of this component, whereas the opposite happens when the benchmark is lowered (as in figure 2.B).

FIGURE 2

**Chile: Latin American performance index, using alternative benchmarks
for the central government primary balance, 1991-2013**
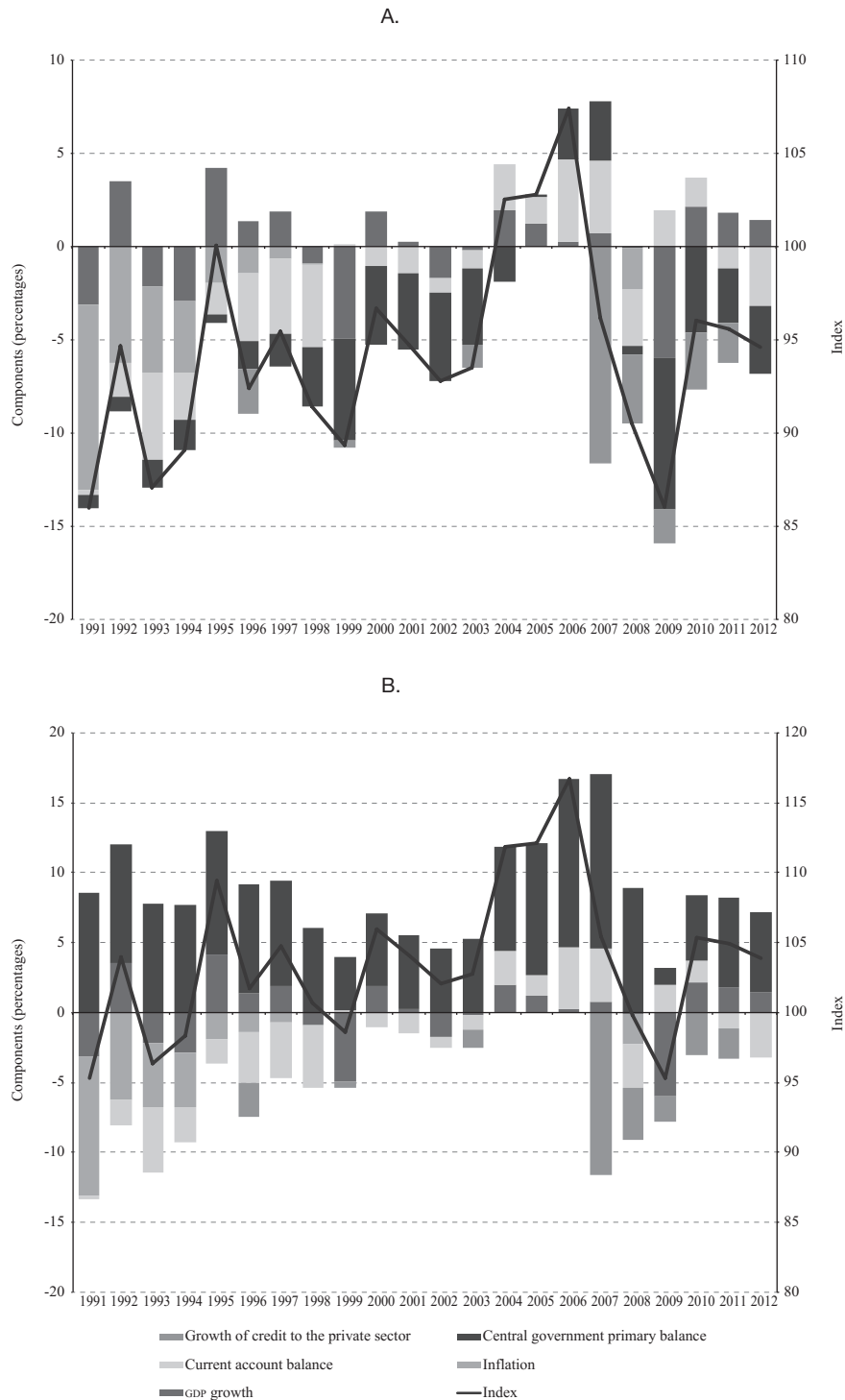
A.

B.

Growth of credit to the private sector   Central government primary balance
Current account balance   Inflation
GDP growth   Index

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

Note: GDP: Gross domestic product.
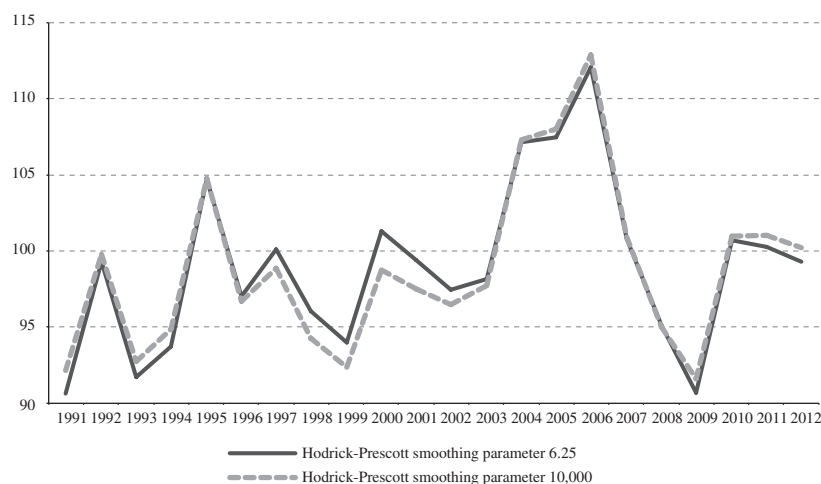
FIGURE 3

Chile: Latin American performance index, using alternative benchmarks for GDP growth, 1991-2013

Hodrick-Prescott smoothing parameter 6.25
Hodrick-Prescott smoothing parameter 10,000

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

Note: GDP: Gross domestic product.

Table 1 compares the contribution of each component under the alternative smoothing parameters from 1997 to 2003, the period during which the composite index was most sensitive to the benchmark smoothing parameter for growth. It is apparent that the lower index values yielded by the alternative benchmarks are explained by the higher penalization of GDP growth deviations from a smoother series. Despite the effect on both the absolute and relative magnitudes, the contributions of the other components are quite robust to changes in the benchmark value. In the case of credit to the private sector, a similar effect would be observed by adjusting the length of the period under consideration to compute the standard deviation of the benchmark. Longer lengths will mean that the latter has a smoother evolution, implying that sudden changes will usually be more heavily penalized.

TABLE 1

Chile: percentage contribution of components using alternative benchmarks for GDP growth, 1997-2003

	1997	1998	1999	2000	2001	2002	2003
Index (original)	100.1	96.1	93.9	101.3	99.4	97.4	98.1
GDP growth	1.9	-0.9	-5.0	1.9	0.3	-1.7	-0.2
Inflation	-0.7	-0.1	0.0	0.0	0.0	0.0	0.0
Current account balance	-4.0	-4.4	0.1	-1.1	-1.4	-0.8	-1.0
Central government primary balance	2.9	1.4	-0.8	0.5	0.6	-0.1	0.6
Growth of credit to private sector	0.0	0.0	-0.4	0.0	0.0	0.0	-1.3
Index (alternative)	98.9	94.3	92.3	98.8	97.5	96.5	97.7
GDP growth	0.7	-2.6	-6.6	-0.6	-1.6	-2.6	-0.5
Inflation	-0.7	-0.1	0.0	0.0	0.0	0.0	0.0
Current account balance	-4.1	-4.6	0.1	-1.1	-1.5	-0.8	-1.0
Central government primary balance	3.0	1.5	-0.8	0.5	0.6	-0.1	0.6
Growth of credit to private sector	0.0	0.0	-0.4	0.0	0.0	0.0	-1.3

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

Note: GDP: Gross domestic product.

The general conclusion is that while the dynamics of the composite index are found to be quite robust to the specification of alternative benchmarks, the sign and relative magnitude of individual components' contributions should always be interpreted as dependent on the chosen benchmark. Lastly, it should be noted that some countries, such as Brazil and Nicaragua, were still struggling to contain inflation at the beginning of the 1990s. Caution should therefore be exercised when choosing the period under study in these cases, since the inclusion of hyperinflationary periods, or other extreme values in general, will excessively distort the estimation of the weightings of each of the components.

3. Scope of the Latin American performance index

In evaluating and contextualizing the scope of the Latin American performance index, it is not possible to make qualitative claims regarding the long-term success of the Latin American economies. For example, no assessment is made of whether a particular country's growth rate or level of credit available to the private sector is appropriate or insufficient. In the same vein, while the choice of zero as the benchmark value for the balances of the public and external sectors penalizes deficits, this selection carries no implicit judgement of the benefits of current account or primary surpluses.

It is important to recognize what the Latin American performance index is, and what it is not. Its principle objective, as stated, is to serve as a summary measure of headline economic development. However, this index also takes into account the availability of a diverse cross-section of macroeconomic indicators and seeks to incorporate and balance the influence of each component. Another relevant aspect of the index is that, owing to its composition and the fact that the selected indicators are captured in the same units, the contribution of each input to the overall headline figure can be isolated and observed.

It is essential to recognize the limitations of a composite macroeconomic indicator and to define the scope of the index, which was not conceived or designed as a tool for assessing public policy or political goals. Neither was it constructed so as to give meaningful commentary on the state of equality or inequality in a given economy. However, it does represent a relevant measure for assessing the overall performance of an economy, particularly in Latin America, and can be used as a complementary tool for analysing overall levels of national development, along with other composite indicators such as the Human Development Index (HDI) of the United Nations Development Programme (UNDP), or the Better Life Index of the Organization for Economic Cooperation and Development (OECD), which focus on the social and human aspects of development.

As stated, the Latin American performance index is a very relevant tool for macroeconomic analysis across countries and time frames. Through the construction of a sensitivity analysis, the chosen benchmarks and indicators have shown their robustness in capturing variations in overall performance, while permitting the comparison of each indicator's contribution and influence in the overall index. Thus, the Latin American performance index allows for a deeper understanding of the factors driving economic development across the countries of the region and, as the following section will show, may also serve as a highly useful tool for macroeconomic analysis.

IV

Examples of application of the Latin American performance index

This section demonstrates some applied uses of the index through an analysis of three situations that are commonly encountered in the practice of macroeconomic evaluation: the comparison of different historical episodes in respect of the same country; the analysis of a common episode across countries; and the analysis of current conditions.

1. Comparison across time

One way to test the validity of the Latin American performance index is to see if it captures economic recessions, both across time and in terms of their relative severity. The value of analysing economic development over time resides in the possibility of observing its

long-term trend. As figure 4 shows, the modified Latin American performance index clearly captures the overall rhythm of the Mexican economy, including the sharp fall in 1994 and its severe impact in 1995, as well as the recession of 2009 following the onset of the global economic crisis.

FIGURE 4
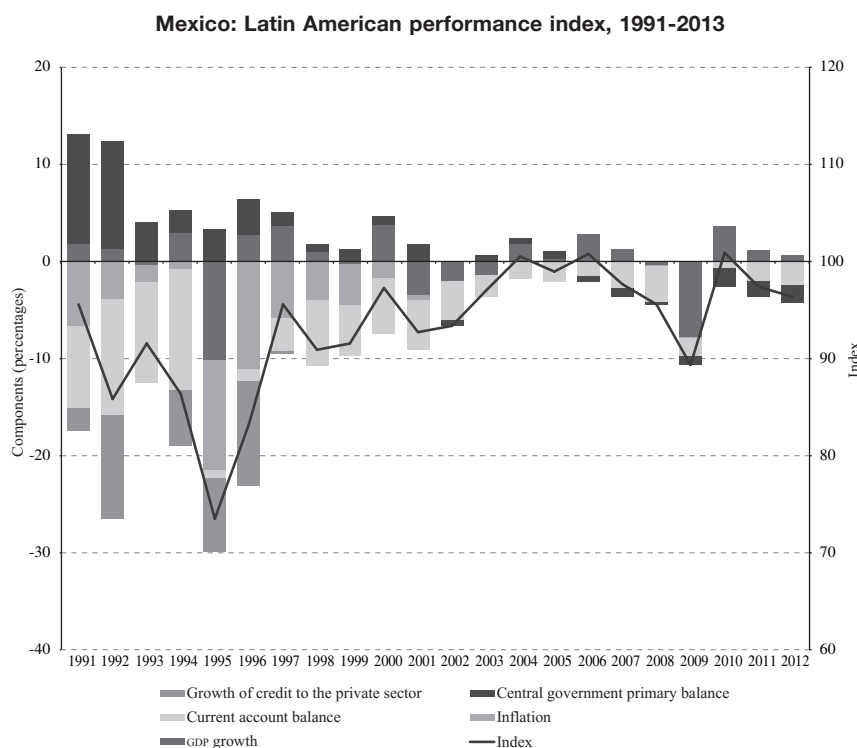
Mexico: Latin American performance index, 1991-2013

Source: Prepared by the authors, on the basis of official data.
Note: GDP: Gross domestic product.

While GDP growth fell significantly in both years, the results for the other variables are very different for 1995 and 2009, reflecting the fact that the 1995 crisis was a homegrown balance-of-payments crisis, which caused Mexico to abandon its crawling peg to the dollar (a fact that largely accounts for the figures for inflation, credit growth, and the current account balance for 1995), whereas the 2009 recession was a consequence of the international financial crisis and the contraction in global economic activity, as shown by the sharp fall in the contribution of GDP growth to the overall index. Throughout the 1990s, the government primary balance was a positive factor on the whole, though it began to perform below target in the years leading up to the 2009 crisis. Government intervention during the crisis swelled the primary deficit, although —as can be seen from its impact on the Latin American performance index for Mexico— the primary deficit persists. While the country has recovered somewhat from the large deficits of the early 1990s, the current account has continued to perform below its benchmark target. After bouts of high inflation during and immediately following the 1995 crisis, the role of inflation in the country's overall economic performance seems to be moderating.

In a similarly positive vein, GDP growth has tended to lead Mexico's overall macroeconomic dynamics. Notwithstanding sharp falls in 1995 and 2008-2009, GDP growth as compared to its long-term trend has played a leading role in Mexico, contributing positively to the overall Latin American performance index score. As noted in previous examples, the selection of the time frame for evaluation has a significant repercussion on the magnitude of the index.

2. Comparison across countries

The Latin American performance index may also be employed to analyse the impact of a common event on a group of countries. For illustrative purposes, an analysis was conducted on the performance of the countries of Central America and the Dominican Republic in the face of the recent global crisis.

Figure 5 shows the relative performance of the countries in this subregion during the period 2006-2013. For comparison purposes, the initial period was normalized to 100 and the fluctuations in the individual Latin American performance indexes were computed. Contrary to what was observed in the region, where the brunt of the recent financial crisis was felt in 2009 (ECLAC, 2010), the financial crisis actually provided some relief through its effect on international food and energy prices, given that the subregion is a net importer of these commodities. It is observed that the impact of the global crisis was actually most severe in the subregion in 2008, and while all countries experienced a dip in their overall index scores in that year, the falls were particularly sharp in the Dominican Republic and Costa Rica.

Table 2 shows the impact of each component during the period. The rise in commodity prices, which peaked in 2008, caused a significant deterioration in the subregion's current account balances, as well as a notable uptick in inflation. The worsening current account balance also played a role in the deceleration, and in some cases, the contraction of economic activity in 2008. The sharp drop in activity as a result of the collapse in demand for commodities caused by 2009 global financial crisis partially reversed the adverse economic conditions in the subregion, which was reflected in an improvement in current account balances and an easing of inflationary pressures. These developments acted as a buffer to the slowdown in economic activity in response to the crisis. In the aftermath of the crisis, the economic climate was initially favourable but became less so around 2011 as a result of concerns regarding the sovereign debt crisis in the eurozone, which once again dampened demand for the subregion's exports; moreover, large current account deficits continued to be detrimental to its overall economic performance. However, on a positive note, inflation is no longer a significant drag on subregional performance. Once again, it is clear that the selection of study periods influences the weight and magnitude of inflation in the Latin American performance index.

FIGURE 5

Central America and Dominican Republic: Latin American performance index, 2006-2013
(2006 = 100)
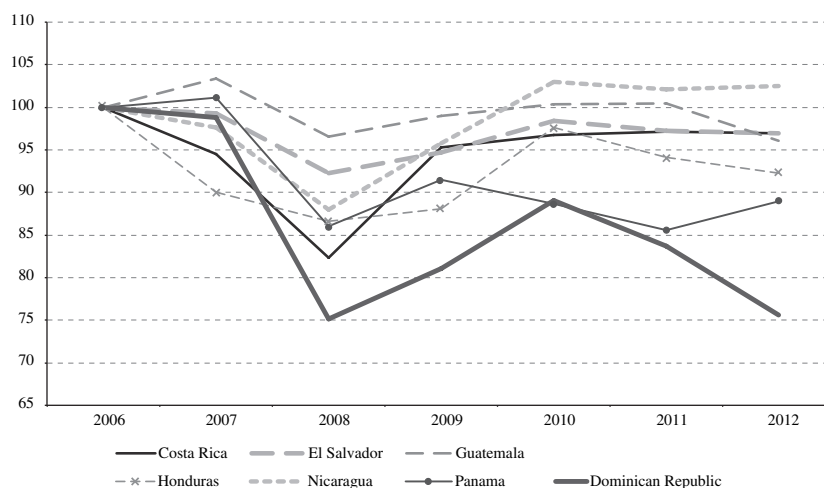
Source: Prepared by the authors, on the basis of official data.

TABLE 2

Central America and the Dominican Republic: Latin American performance index and contribution of each component to the index, 2006-2013

	2006	2007	2008	2009	2010	2011	2012	2013
Costa Rica	95.4	87.0	75.0	88.7	88.5	89.6	89.7	87.6
GDP growth	3.3	3.0	-1.7	-5.1	1.5	0.8	1.4	-0.4
Inflation	-2.9	-2.0	-3.8	-1.3	-0.3	0.0	0.0	-0.1
Current account balance	-7.1	-9.7	-14.6	-3.1	-5.5	-8.4	-8.3	-7.7
Central government primary balance	4.0	5.4	3.5	-1.9	-4.5	-2.8	-3.4	-4.2
Growth of credit to private sector	-1.9	-9.7	-8.4	0.0	-2.7	0.0	0.0	0.0
El Salvador	100.8	99.9	94.8	91.9	97.6	96.6	96.2	91.3
GDP growth	1.6	2.1	-0.1	-4.9	0.5	1.2	0.4	-0.1
Inflation	0.0	0.0	-1.1	0.0	0.0	-0.1	0.0	0.0
Current account balance	-3.8	-5.6	-6.6	-1.4	-2.3	-4.4	-5.0	-6.0
Central government primary balance	3.0	3.4	2.6	-1.8	-0.6	-0.1	0.8	0.9
Growth of credit to private sector	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.4
Guatemala	93.4	98.8	92.3	90.5	93.4	94.5	84.3	95.7
GDP growth	3.1	5.5	-0.5	-6.0	-0.5	2.2	-0.9	0.4
Inflation	-0.6	-0.7	-2.4	0.0	0.0	-0.5	0.0	0.0
Current account balance	-5.9	-6.2	-4.2	0.8	-1.6	-3.9	-3.1	-3.2
Central government primary balance	-1.4	0.1	-0.6	-4.3	-4.6	-3.3	-2.2	-1.5
Growth of credit to private sector	-1.8	0.0	0.0	0.0	0.0	0.0	-9.6	0.0
Honduras	92.4	79.5	78.2	78.5	90.6	86.6	83.4	79.0
GDP growth	2.0	2.6	1.0	-8.3	1.5	1.4	1.6	-0.9
Inflation	-0.2	-0.8	-2.6	-0.2	0.0	-0.7	-0.1	-0.1
Current account balance	-4.1	-10.0	-17.0	-4.2	-4.8	-8.8	-9.4	-10.6
Central government primary balance	-0.2	-4.0	-3.2	-8.8	-6.1	-5.3	-7.1	-9.2
Growth of credit to private sector	-5.1	-8.3	0.0	0.0	0.0	0.0	-1.6	-0.3
Nicaragua	98.3	98.2	90.1	92.9	99.4	99.9	96.3	96.2
GDP growth	0.5	1.8	0.1	-4.6	0.2	1.7	0.6	0.1
Inflation	-2.2	-2.5	-6.5	0.0	-0.4	-1.6	-1.1	-0.9
Current account balance	-1.5	-2.7	-3.5	-1.8	-0.8	-2.1	-2.5	-4.0
Central government primary balance	1.6	1.6	0.0	-0.7	0.4	1.9	2.0	1.0
Growth of credit to private sector	0.0	0.0	0.0	0.0	0.0	0.0	-2.7	0.0
Panama	97.6	99.3	82.1	90.8	91.0	90.3	90.9	82.2
GDP growth	0.3	4.3	1.0	-5.0	-2.8	2.9	2.4	0.7
Inflation	0.0	0.0	-11.4	0.0	0.0	-2.7	-2.1	0.0
Current account balance	-8.3	-10.9	-11.7	-6.1	-6.3	-8.4	-8.3	-7.5
Central government primary balance	5.6	5.8	4.2	1.8	0.1	-1.5	-1.0	-3.1
Growth of credit to private sector	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-7.9
Dominican Republic	114.4	112.5	81.4	89.2	99.9	93.7	83.5	91.8
GDP growth	6.7	3.8	-3.4	-6.0	6.2	-2.1	-2.6	-0.1
Inflation	-0.9	-0.4	-2.0	0.0	-0.5	-1.2	0.0	0.0
Current account balance	5.0	2.3	-6.6	-0.8	-3.6	-2.8	-4.9	-6.9
Central government primary balance	3.6	6.9	-6.5	-4.0	-2.2	-0.2	-9.0	-1.2
Growth of credit to private sector	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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

Note: GDP: Gross domestic product.

It is interesting to note that, in contrast to the rest of the subregion, which has more or less regained pre-crisis levels of economic performance, the index for Panama presents a persistent overall downtrend, while the Dominican Republic, whose overall performance improved moderately in 2013, continues to post far lower growth rates. Table 2 shows that the most influential factor in Panama has been the deterioration of its current account balance, reflecting the increase in imports associated with expansion of the Panama Canal. Although the negative trend in the Dominican Republic is also the result of a widening current account deficit, it stems from the suspension of gold exports in 2007 and the sizeable fiscal deficits posted from 2007 onwards, which are partly explained by the fiscal cost of persistent energy subsidies.

3. Drivers of recent economic performance

Figure 6 depicts the changes in Latin American performance index scores from 1996 to 2013 for some of the region's main economic players: Chile, Colombia, Mexico and Peru.[1]

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[1] It is interesting to perform a cross-cutting analysis of the region's economies. The countries selected for this purpose were Chile and

Overall index scores for Chile and Peru, South America's largest resource-dependent export economies, follow a marked upward trajectory from the mid-1990s, due in large part to rising commodities prices and an increase in global demand for their exports, which helped to boost growth and set up a positive fiscal balance. Despite sharp falls at the height of the crisis, Chile and Peru have both rebounded relatively strongly. Their growth remains fairly stable despite some moderation in their overall Latin American performance index scores in 2013, especially owing to deteriorations in the current account balances in both countries, and fluctuations in the supply of credit to the private sector in the case of Peru. After a buoyant recovery from the crisis, Mexico's performance continued to weaken in 2013 amid meagre GDP growth and a widening current account deficit.

Peru, which rely heavily on natural resources and extractive industries to shape their economic structure; Colombia, whose economy derives a large portion of revenue from agro-industrial processes; and Mexico, which is a major manufacturing exporter and a significant contributor to the region's overall economic performance. Argentina and Brazil were not included due to strong fluctuations in inflation with respect to the long-term trends, which preclude their selection for a longer-term evaluation.

FIGURE 6

Chile, Colombia, Mexico and Peru: economic performance index, 1996-2013
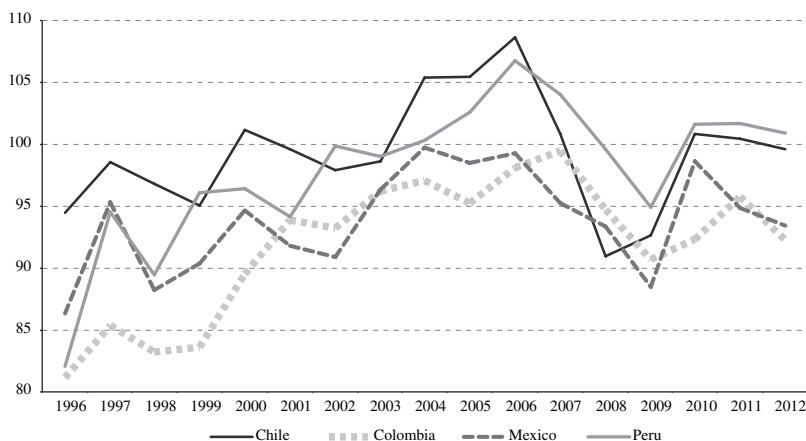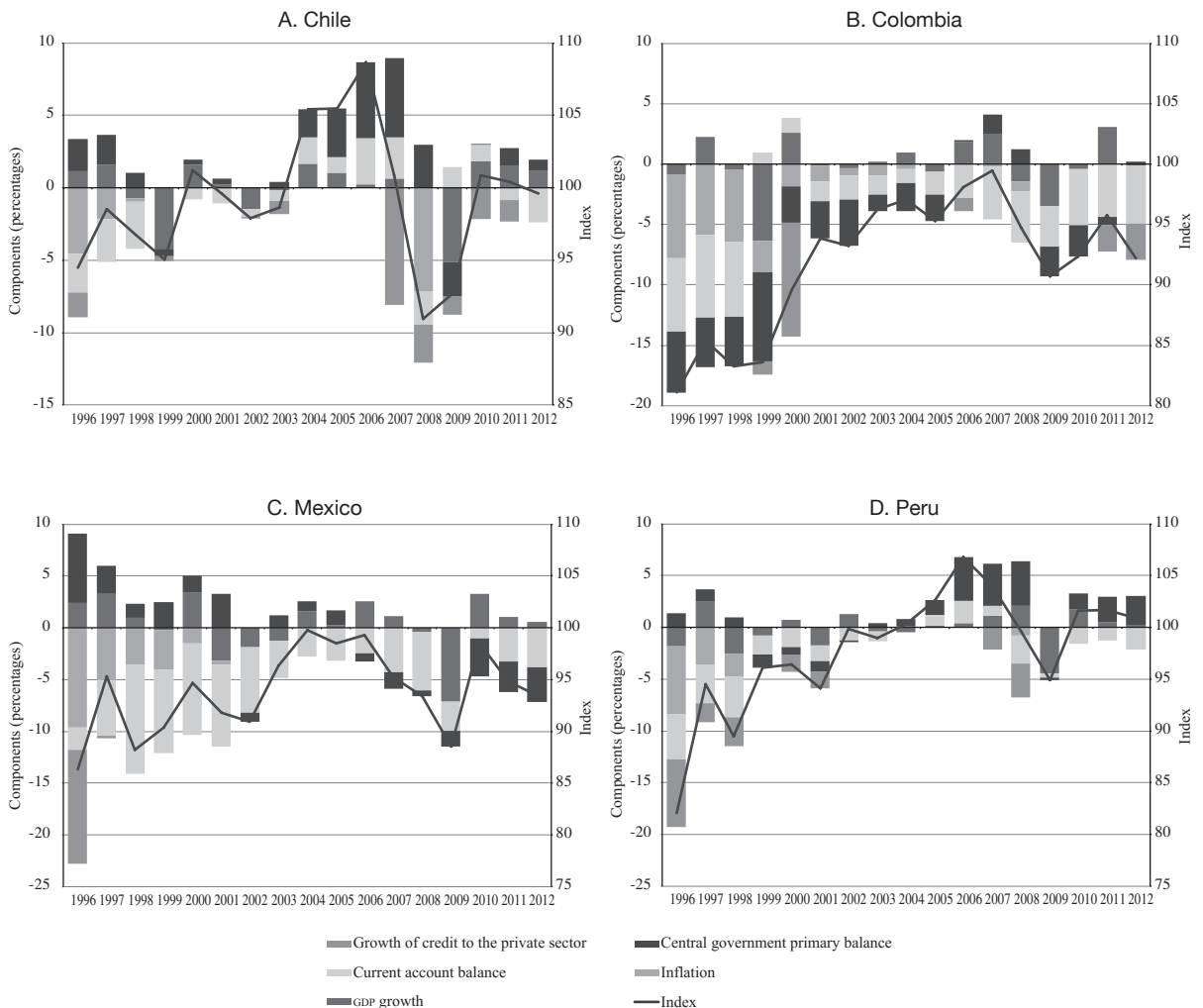

Source: Prepared by the authors, on the basis of official data.

As figure 7 shows, the composition of recent performance varies significantly across countries during the period under study. While overall index scores improved in the majority of countries, a notable trend is the region's chronic current account problem. Poor performance in this area, as shown by the impact of the current account component, particularly in Mexico and Colombia in the years leading up to the global financial crisis in 2009, is a major trigger for the recent decline in economic performance, and continues to hold countries back from achieving higher sustained overall growth. Given the importance

of exports in each of these economies, the overall slowdown in world trade had a significant effect on current account dynamics. The role of public finance in recent economic performance is also interesting, although its contribution in large economies has varied somewhat in recent years. In the metal- and mineral-rich economies of Chile and Peru, public finances —as shown by the positive contributions of the primary balance compared to the long-term trend— served as a shield against the adverse effects of the financial crisis, creating a buffer space for these countries to enact more strategic policies.

FIGURE 7

Chile, Colombia, Mexico and Peru: economic performance by component, 1996-2013

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

Note: GDP: Gross domestic product.

Overall, it is observed that the current account balance and growth have been the strongest drivers of the Latin American performance index. Public finance has also been crucial, albeit to a lesser extent, in different countries. Inflation, once the thorn in the side of Latin American macroeconomic performance, has interestingly played only a minor role in determining the overall trend in the region, compared with other index components.

Credit growth has also played a somewhat volatile role for the main economic players. In Chile and Peru, particularly in the years preceding the 2009 crisis, growth in credit to the private sector weighed negatively on overall economic performance, perhaps serving as an early sign of inherent financial sector weakness. In the case of Colombia, credit growth to the private sector was not a major factor in the fall during the recent economic crisis, though it has tended to deviate from its long-term trend as the economy has recovered.

Another value added of the Latin American performance index is its contribution to highlighting variations in long-term economic development. Thanks to the way it is constructed and to the long-term benchmarking of certain values, the this index could serve as an early warning system for economies, highlighting weak or problematic performance in key variables, before these combine to produce a decline in overall performance or even a recession. For the region's large economies in particular, added insight into the structural dynamics of economic development could help in the formulation of more strategic policy initiatives to address economic shortcomings.

V

Conclusions and future outlook

This document places emphasis on the need for a set of comprehensive and transparent national statistical indicators, and acknowledges the role that statistics play in monitoring progress on the economic, social, and environmental fronts and in the analysis of a country and a region's macroeconomic outlook. It has been observed that there is a wide variety of macroeconomic statistics, though their availability tends to vary across countries.

The advantages and benefits of constructing composite indicators for macroeconomic analysis have also been highlighted. What is most important to underscore regarding the contribution of composite indicators is their power to combine information yet maintain the underlying richness of diverse statistical indicators, which when needed, can be broken down into their contributory parts. The simple construction of the Latin American performance index, which in turn is an adapted version of the EPI, has demonstrated the value of this type of statistical analysis for understanding the overall macroeconomic development of the Latin American economies.

The constructed index evidently serves as a straightforward and easily interpretable indicator of the overall health of a country's economy. Its applicability has been demonstrated in a variety of circumstances, whether for the comparison of similar episodes across groupings of countries, or in the use of a lengthier study period to benchmark a country's economic performance over its historical trend. The proposed index has broad potential and its utilization could be expanded to cover economic performance across regions and subregions, among other possible applications.

An additional strength of the Latin American performance index is its usefulness for revealing the performance of underlying indicators, in this case the components of the index. By analysing the impact of each component, those that drive overall economic development are more clearly discernible. This aspect of the index may have diagnostic potential in the evaluation of future economic performance, since it highlights elements of the overall economic system that may be performing below their long-term trend levels. It could therefore signal potential sources of macroeconomic weakness, before the overall health of the economy is impacted.

The need for statistics is paramount. The authors of this paper, as economic analysts, as policymakers, and as active citizens, need to know where we have come from, and, even more importantly, where we stand in order to understand how the economy will perform in the future.

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Does the contribution made by early education to later academic achievement differ in Latin America?: PISA 2009-2012

Luis Fernando Gamboa and Natalia Krüger

ABSTRACT

This article provides evidence regarding differences in the performance on academic tests in secondary school between students who had attended preschool and those who had not. A non-parametric method based on the generation of counterfactuals to decompose gaps between observable and unobservable factors is used to analyse data gathered by the Programme for International Student Assessment (PISA) between 2009 and 2012 for a number of Latin American countries. This analysis reveals the existence of socioeconomic segregation in terms of access; considerable score differentials (conditional on the controls used), which increase in line with the length of time spent in early childhood education; and significant differences across countries with regard to those differentials, which also tend to be greater in the case of reading test scores than in mathematics test scores.

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I

Introduction

The delivery of comprehensive care during early childhood, which is recognized as one of the rights of the child and as a social investment of key importance, is now promoted by a wide range of international agencies, agreements and standards. The commitments assumed by signatories of the World Declaration on Education for All, which was adopted in Jomtien in 1990, and the formulation of the Education for All Goals in Dakar in 2000 reflect the existence of a consensus regarding the importance of education during the early years of life.

This stage is considered to be crucial for the physical, mental and emotional development of individuals (ECLAC, 2008; SITEAL, 2010), and ensuring that all children receive quality care is therefore essential for social justice. A variety of disciplines have highlighted the positive impact that the cognitive and non-cognitive skills acquired in preschool have on people's educational performance in later years (Ministry of Education of Brazil, 2013). According to Heckman (2000), these effects translate into high rates of return on investments in early education. Likewise, interventions during childhood would result in future resource savings in social policy, as well as facilitate women's integration into the workforce and foster economic and social development globally.

arly education is closely linked to social equity because of its intrinsic and instrumental value.[1] Inequality in access to early education constitutes a violation of the rights of the child, especially in settings marked by a high degree of heterogeneity. It is also a source of future inequity, given its repercussions on a wide array of social and economic outcomes.

The differences in socioeconomic, cultural and institutional contexts between and within countries translate into very different conditions in terms of the supply and demand for preschool education in Latin America. In addition, it is not at all clear to what extent inequalities in access may undermine equality of educational opportunities over a person's lifetime, since, at the regional level, the empirical literature on the influence exerted by early education on later learning is quite scant.

This article aims to illustrate the degree of equity in access to preschool education and to evaluate the way in which this affects academic achievement in the medium term. Our empirical strategy involves quantifying the performance differentials at the secondary level — conditional on a series of control variables— between students who attended preschool and those who did not. The objective is not only to gauge the size of these differentials in the Latin American countries but also to compare them.

Achievement levels are measured using students' scores on the tests administered by the Programme for International Student Assessment (PISA) of the Organization for Economic Cooperation and Development (OECD). This information is drawn from the 2009 and 2012 rounds for the seven Latin American countries that participated in both series of examinations: Argentina, Brazil, Chile, Colombia, Mexico, Peru and Uruguay.[2]

In order to identify the benefits of preschool attendance, a non-parametric method developed by Ñopo (2008) is used to compare groups of students who have quite similar personal and contextual characteristics. This method allows us to estimate the performance gap —the average score differential in each domain— between students who attended preschool and students who did not and then to decompose the relevant observable and unobservable factors. This makes it possible to determine how much of the "gross" gap can be attributed to the effect of other variables associated with access to early education and to variables associated with performance on academic examinations and then, on that basis, to calculate the "net" gap (i.e., the extent of the gap that is not associated with the influence of those factors). This type of decomposition offers the advantage, over the traditional Blinder-Oaxaca decomposition, of avoiding any bias that could be conveyed by differences in the supports for the distributions of the characteristics of the two groups.

The analysis indicates that sizeable performance gaps do indeed exist, even after controlling for a comprehensive set of factors associated with the students' family and

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[1] Several terms are used to refer to this level of education in different countries based on their varying curricular and institutional objectives (Diker, 2003). In this study, the terms "preschool", "early" and "early childhood" education are used as synonyms.

[2] Costa Rica also participated in the programme, but it conducted the PISA examinations for the 2009 round in 2010; it was therefore excluded from this study in order to ensure that the results are fully comparable over time.

school environments. In other words, the results suggest that early education generates a significant differential in the educational achievement of 15-year-olds. The data also indicate that spending more time in preschool yields greater future benefits.

The study is structured as follows. Following this Introduction, section II provides a description of the current situation and recent trends in early education coverage in Latin America. Section III offers an overview of the available information regarding the impact of preschool attendance on subsequent educational performance. The methodology used in this study is discussed in section IV. Section V describes the data and selected variables. Section VI outlines the study findings and lastly, section VII details the conclusions that have been reached.

II

Preschool attendance in Latin America: goals and inroads

The Educational Goals for 2021, which were adopted by the Ibero-American Conference on Education and reaffirmed in 2010, include ambitious objectives relating to early education, thus reflecting the political importance that the issue has taken on in recent years in the region. As noted by Margarita Poggi (SITEAL, 2013), however, interest in this subject has been growing over the course of several decades.

Historically, the delivery of childcare services was irregular and primarily channelled through private, welfare-based programmes. Then, in the 1960s and 1970s, these services began to be regulated, and greater efforts were made by the State to expand childcare services while placing greater emphasis on their pedagogic aspects (Diker, 2003). The implementation of ongoing comprehensive programmes during that period paved the way for considerable progress in expanding access to such services, responding in part to demand pressure generated by women's entry into the labour market.

It was not until the 1990s, however, that the universalization of at least the final year of preschool spread as a goal throughout Latin America (Albergucci, 2006), which increased the supply of early childhood services and preschool enrolment significantly. In general, school attendance is now mandatory from the age of 5 onward —as is the case in Colombia, for example— although in some countries mandatory attendance begins at the age of 4 (Argentina, Uruguay and Brazil) or even at the age of 3 (Mexico and Peru). In Chile, on the other hand, attendance is not compulsory until children begin first grade (SITEAL, 2009). Generally speaking, the laws on compulsory education continue to focus on the age groups immediately preceding entry into the primary education cycle, thereby leaving aside the child population between the ages of 0 and 3 (Ministry of Education of Brazil, 2013).

These initiatives have fostered a steady increase in educational coverage for children between the ages of 3 and 5. According to information drawn from the Socio-Economic Database for Latin America and the Caribbean (SEDLAC), in the early years of this decade, approximately 70% of children in this age group were attending school in the seven countries covered by this study, with a somewhat lower figure being recorded for Colombia (52%). In the past 20 years, an increase in attendance of nearly 10% has been achieved in Mexico, for example, but the expansion has been greater than 100% in countries such as Argentina and Chile.

The existence of a diverse array of formal and informal programmes and the lack of sufficient information have interfered with efforts to implement policies designed to improve the quality of preschool education. It is often the case that the conditions under which initiatives are developed in terms of physical, human and pedagogical resources result in limited and poorly targeted outcomes (Cordero, 2004; SITEAL, 2009). In fact, the evidence points to a failure to attract highly qualified human capital to this sector, largely because of the low wages received by preschool teachers (Mizala and Ñopo, 2012).

Sharp differences in access continue to be linked to socioeconomic status and area of residence in the region. Table 1 shows the attendance rates for different groups of 5-year-olds around the year 2000 —which is approximately when the students who participated in the 2009 or 2012 PISA examinations were that age— and around 2011.

TABLE 1

Gross school enrolment rates, by related factors, for children 5 years of age, 2000 and 2011

(Percentages)

	Gender		Learning environment in the home[a]			Per capita household income[b]			Area	
	Female	Male	Low	Intermediate	High	Low	Middle	High	Rural	Urban
Around 2000										
Argentina	73.6	73.8	64.3	72.9	81.3	70.8	80.6	86.9	…	73.7
Brazil	66.9	65.0	57.4	70.3	85.3	62.1	74.9	87.9	48.3	70.1
Chile	70.6	73.0	52.3	69.1	82.0	70.9	76.9	86.3	45.1	76.4
Colombia	…	…	…	…	…	…	…	…	…	…
Mexico	85.0	85.5	71.0	91.0	97.8	83.1	93.4	93.3	76.6	88.6
Peru	70.6	79.4	61.2	80.2	93.4	74.6	78.1	94.3	66.1	80.9
Uruguay	91.9	91.8	89.0	91.1	97.1	90.0	92.5	99.0	…	91.9
Around 2011										
Argentina	93.5	93.7	76.3	93.1	97.1	92.0	94.9	98.5	…	93.6
Brazil	87.3	85.9	80.7	88.7	94.5	84.8	91.4	95.4	78.8	88.3
Chile	86.9	87.0	89.7	94.1	94.3	93.1	97.7	95.2	88.3	94.8
Colombia	92.8	94.9	79.6	89.3	98.6	89.9	90.0	93.7	73.4	90.7
Mexico	97.3	98.6	89.8	97.5	99.7	95.4	98.6	99.5	93.9	97.3
Peru	91.0	92.0	80.6	92.8	99.0	94.2	94.7	99.4	79.5	95.7
Uruguay	96.8	95.8	93.3	96.6	96.3	95.4	96.1	97.4	98.3	96.0

Source: Organization for Economic Cooperation and Development (OECD), *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014; and *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014.

[a] Average years of education of household members aged 18 or over: Low: Fewer than 6 years; Intermediate: 6-12 years; High: 12 years or more.
[b] Low: Households with incomes in the bottom 30% of the distribution; Middle: Households with incomes in the thirtieth to sixtieth percentiles; High: Households with incomes in the top 40% of the distribution.

During both periods, the cultural capital of the students' families, measured in terms of the learning environment in the home, was of pivotal importance in determining school enrolment. While significant inroads have been made since the start of this century, large attendance differentials associated with the educational level of household members continue to exist, and this is especially true in Argentina, Colombia and Peru. A similar, if somewhat less marked, trend is observed in relation to per capita household income, showing Brazil with the largest gaps.

Place of residence has historically been a significant factor, since 5-year-olds in rural areas tend to have lower school attendance rates. This is mainly due to the more limited supply of educational services in many rural areas, although socioeconomic and cultural factors also come into play. Coverage has certainly improved in rural areas during the period under study, but access continues to be more limited in rural zones, especially in the cases of Colombia, Peru and Brazil.

There does not appear to be a gender bias in preschool attendance, as the differentials between boys and girls are quite small, with the rates for girls being slightly higher in some cases and the rates for boys being slightly higher in others.

In sum, the expansion of early education coverage in recent decades has been driven mainly by the introduction of new laws in Latin America, yet the persistence of segregation in terms of access shows that the impacts of legislative initiatives and policy commitments are constrained by existing social and economic inequalities. As things now stand, there are three major challenges to be met: (i) incorporating younger children (those between 0 and 4 years of age) into early education; (ii) raising attendance rates among children in vulnerable social sectors and children residing in rural areas, and (iii) improving and assessing the quality of the educational services being offered.

III

Recent evidence and a survey of the literature

Access to early education is one of a child's fundamental rights, but it is also a means of establishing a first link with the school system. During the first years of life, children develop the main cognitive and non-cognitive skills that will influence their academic performance (Glewwe and Jacoby, 1995; Burchinal and others, 1997; Currie, 2001; Berhman, Cheng and Todd, 2004; Barnett and Lamy, 2006; Cunha and others, 2006; Nores and Barnett, 2010; Skibbe and others, 2011; and Hazarika and Viren, 2013). The impact of early education may vary in the short and long terms owing to variations in the quality of the corresponding programmes. Ultimately, therefore, the main obstacle to be overcome in analysing the types of effects associated with preschool attendance has to do with the available information on the quality of instruction.[3]

An examination of the literature shows that a number of different methodologies analyse the influence exerted by early education. Employing a meta-analysis to synthesize the various studies' findings, Camilli and others (2010) find that early childhood education has an immediate effect equivalent to approximately 0.50 standard deviations in terms of cognitive development,

which equates with an increase from the thirtieth percentile to the fiftieth percentile on standardized achievement tests. The social and emotional effects were smaller but still significant (0.33 standard deviations). These findings provide support for the argument advanced by Heckman (2000 and 2008), who maintains that the biggest gains in investment in education are realized during the first years of life.

A particularly notable study conducted by Arteaga and others (2014), who used inverse propensity score weighting to analyse data for a cohort of 1,500 students in the Chicago Longitudinal Study who were enrolled in the 1980s, shows that children who had attended a preschool programme for two years were less likely to require special education assistance and less likely to commit crimes later on in life than those who had attended preschool for just one year. These findings strengthen the evidence on the beneficial long-term effects of preschool attendance for longer periods of time. Magnuson, Ruhm and Waldfogel (2007a and 2007b) use data from the Early Childhood Longitudinal Study to analyse the effect of preschool attendance on children's academic skills. They find that those who attended such programmes had stronger reading and mathematics skills when they started school (0.18-0.12 deviations) —although those effects tended to dissipate during the first year— but that they also had a greater tendency to exhibit behavioural problems that persisted for some time after school entry. These authors do not provide any evidence of causation, however, and their conclusions should therefore be viewed with caution.

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[3] The kind of information needed in order to evaluate the quality of these programmes is generally unavailable in Latin American countries. This is not the case in developed countries such as the United States, where data on programmes such as State Pre-K, Head Start and Preschool Special Education make it possible to track the progress of complete cohorts while controlling for unobservable factors.

IV

Methodology

In this study we use a methodology based on the non-parametric approach devised by Ñopo (2008). As well as allowing us to quantify the existing gap in terms of the outcome variable (for example, PISA scores), this method yields a decomposition based on the characteristics of the target populations that are being compared. In the absence of an experimental or

quasi-experimental design, a methodology based on the generation of counterfactuals reduces possible biases, but the results must be interpreted with caution, since there are observable and unobservable factors (such as the quality of preschool programmes or changes in the faculty) that may influence them. This method reduces the bias generated by unobservables but it does not have

the scope that an experimental exercise using a random sample would, and a causal effect, in a strict sense, can therefore not be identified. Unlike propensity score matching systems, this approach matches up individuals based on certain characteristics rather than their scores.

Let Y represent the score obtained by a student on a test as a function of a vector of characteristics X. The expected score for a student, conditional on his or her characteristics and the fact that the student had attended preschool (P), would be given by $E[Y|P,X] = g^P(x)$, while the expected score for students who had not attended preschool (NP) will be $E[Y|NP,X] = g^{NP}(x)$. Thus, the performance gap between those who attended preschool and those who did not (the score differential) will be given by equation (1):

$$\Delta = E[Y|P,X] - E[Y|NP,X] \qquad (1)$$

Assuming that $F^P(\cdot)$ and $FNP(\cdot)$ represent the conditional distribution functions of individual characteristics X and that they are functions that extend from vector space R^n to R, it is possible to define the probability measure over the support of distribution S in $dF^P(\cdot)$ and $dF^{NP}(\cdot)$ as:

$$\mu^P(S) = \int_S dF^P(x)$$

$$\mu^{NP}(S) = \int_S dF^{NP}(x)$$

Bearing these two expressions in mind and substituting them in equation (1), we obtain:

$$\Delta = \int_{S^P} g^P(x) dF^P(x) - \int_{S^{NP}} g^{NP}(x) dF^{NP}(x) \qquad (2)$$

The main challenge in obtaining the unbiased score differential stems from the fact that the support of the distributions of the characteristics may be different[4] and therefore they have to be made comparable. To this end, Ñopo (2008) proposes splitting each integral

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[4] In other words, there may be students who attended preschool and who have values for a given characteristic X, such as the parents' level of education, for which there is no match in the group of students who did not attend preschool, and vice versa.

into two parts: one on the intersection of the supports (the common support) and the other out of this support. This step consists of replacing S^P with $S^P \cap S^{NP}$ and $\overline{S^{NP}} \cap S^P$ and doing the same thing for S^{NP}.

$$\Delta = \left[\int_{\overline{S^{NP}} \cap S^P} g^P(x) dF^P(x) + \int_{S^{NP} \cap S^P} g^P(x) dF^P(x) \right] - \left[\int_{S^{NP} \cap S^P} g^{NP}(x) dF^{NP}(x) + \int_{S^{NP} \cap \overline{S^P}} g^{NP}(x) dF^{NP}(x) \right] \qquad (3)$$

In addition, given that $dF^P(\cdot)$ y $dF^{NP}(\cdot)$ are by definition null values out of the support, the domain of the integrals extends to $\overline{S^P}$ and $\overline{S^{NP}}$. By replacing $\mu^{NP}(S^P)$ with $1 - \mu^{NP}(\overline{S^P})$ and $\mu^P(S^{NP})$ with $1 - \mu^P(\overline{S^{NP}})$, we obtain an expression that can be used to decompose the total gap. The final step is to add and take away the necessary element in order to be able to evaluate the counterfactual, i.e., the score that the student who did not attend preschool would have obtained if he or she had actually done so.

The total expression is therefore:

$$\Delta = \left[\int_{\overline{S^{NP}}} g^P(x) \frac{dF^P(x)}{\mu^P(\overline{S^{NP}})} - \int_{S^{NP}} g^P(x) \frac{dF^P(x)}{\mu^P(S^{NP})} \right] \mu^P(S^{NP})$$
$$+ \int_{S^P \cap S^{NP}} g^P(x) \left[\frac{dF^P(x)}{\mu^{NP}(S^{NP})} - \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} \right](x)$$
$$+ \int_{S^P \cap S^{NP}} \left[g^P(x) - g^{NP}(x) \right] \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} \qquad (4)$$
$$+ \left[\int_{S^P} g^{NP}(x) \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} - \int_{\overline{S^P}} g^{NP}(x) \frac{dF^{NP}(x)}{\mu^{NP}(\overline{S^P})} \right] \mu^P(\overline{S^{NP}})$$

Bearing each of these terms in mind, we have:

$$\Delta_P = \left[\int_{\overline{S^{NP}}} g^P(x) \frac{dF^P(x)}{\mu^P(\overline{S^{NP}})} - \int_{S^{NP}} g^P(x) \frac{dF^P(x)}{\mu^P(S^{NP})} \right] \mu^P(S^{NP}) \quad (5)$$

Δ_P is the part of the gap that derives from differences in the characteristics of two groups of students who attended preschool: those who are in and those who

are out of the common support (that is, those whose characteristics can be matched up with those in the *NP* group and those whose characteristics cannot be matched up).[5]

The second term, Δ_x, is the portion of the total gap between those who attended preschool and those who did not that can be explained by differences in the distribution of the characteristics of the population that is in the common support. Formally, this portion will be:

$$\Delta_X = \int_{S^P \cap S^{NP}} g^P(x) \left[\frac{dF^P(x)}{\mu^{NP}(S^{NP})} - \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} \right](x) \quad (6)$$

The third term of equation (4), Δ_0, is defined over the common support —which contains the students from the two populations that are being compared— and is of the greatest interest for this study. As in the case of a traditional Blinder-Oaxaca decomposition, Δ_0 (defined in equation (7)), this is the portion of the score differential that cannot be accounted for by differences in the observable characteristics of the students who did and did not attend preschool. In other words, this is the portion of the score differential that remains when the two groups *P* and *NP* are compared, taking into account those persons who have very similar values for a series of attributes *X*, and to which it is therefore possible to attribute the actual effect of having attended preschool, along with any remaining unobservables (level of effort, genetic factors, physical condition, faculty changes, quality of the education received and so forth).

$$\Delta_0 = \int_{S^P \cap S^{NP}} \left[g^P(x) - g^{NP}(x) \right] \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} \quad (7)$$

The last term, Δ_{NP}, accounts for the differences in the characteristics of the two groups of students who did not attend preschool: Those who can be matched up with students who did attend preschool and those who cannot.

$$\Delta_{NP} = \left[\int_{S^P} g^{NP}(x) \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} - \int_{\overline{S^P}} g^{NP}(x) \frac{dF^{NP}(x)}{\mu^{NP}(\overline{S^P})} \right] \mu^P(\overline{S^{NP}}) (8)$$

Bearing these definitions in mind and rearranging the terms to represent the portion of the gap that is explained by the method and the portion associated with unobservables, the aggregate or gross gap is as follows:

$$\Delta = \left(\Delta_P + \Delta_X + \Delta_{NP} \right) + \Delta_0 \quad (9)$$

A five-step matching algorithm underlies the empirical procedure used in order to arrive at this decomposition. This algorithm is designed to compare individuals who attended preschool and ones who did not but whose observable characteristics are as alike as possible.

First of all, a student in the comparison group of people who attended preschool (*P*) and who is taking the PISA exam is selected at random. Then, all the individuals who did not attend preschool but who are similar to the student chosen in the first step, because they share a given characteristic with that student, are selected. The third step is to create a synthetic individual (*NP*) based on the sample of people who did not attend preschool; this individual has a performance equivalent to the average score obtained by all individuals in that sample on the corresponding PISA test (mathematics or reading). When a student who attended preschool and another who did not do so exhibit similar characteristics, they are matched up. In the final step, this process is repeated for all the other students who attended preschool so that each of them is matched with a synthetic individual for purposes of comparison. This last step is done with replacement, thereby avoiding order-based biases. The matched sample is then used to find the average differential in the expected score and hence the outcome gap.

The main advantage of this methodology over the traditional Blinder-Oaxaca decomposition (Blinder, 1973; Oaxaca, 1973) is that it takes into account the differences in the supports of the distributions of attributes *X*, thereby avoiding possible biases in the estimation of the gap between the two groups. This estimate is not conditional on a specific functional form, with all the requirements that this imposes on the variables in question.

There is also a drawback to this method, however. On the one hand, a comparison of students who attended preschool and students who did not will be more accurate if the set of variables used in the matching exercise is larger. Yet, on the other hand, if a large number of attributes *X* are used, then, given the size of the sample, the number of students used to create the synthetic individual will be smaller and the result

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[5] Δ_p would be zero (0) if all the students who attended preschool could be matched up with students who did not. For further information about this method, see Ñopo (2008).

may therefore be less reliable. In other words, there is a trade-off between the two objectives, and the control variables therefore need to be chosen carefully in order to end up with a small but highly informative set. Given this limitation, no direct reference to a causal effect of preschool education can be made. In order to be as sure as possible that the results have not been skewed by sample biases, a simulation exercise was undertaken in order to assess the significance of the size of the performance gaps.[6]

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[6] The bootstrapping exercise used 200 random subsamples corresponding to 95% of the original sample.

V

Data and variables

The PISA test evaluates 15-year-olds who are in grade seven or above. The programme's sample is arrived at using a two-step process: first, a stratified sample of schools is obtained and, then, a group of students in each school is randomly selected. This design ensures that the sample will be representative of the target population in each country, although the coverage will vary. For the participating Latin American countries, the coverage of the sample of students —once it has been weighted appropriately— ranges from 58.5% of the total population of 15-year-olds as of 2009 (Colombia) to 85.2% (Chile) (OECD, 2012 and 2014).

PISA tests in mathematics, science and reading have been administered once every three years since the year 2000, with the primary focus shifting from one to the other of these domains on a rotational basis (with each one being referred to as a "wave"). In addition, supplementary questionnaires are filled out by students and school administrators that supply information about the personal and family situations of the students and about the various schools' characteristics (Adams and Wu, 2002).

These data can be used to construct the *Preschool variable*, which signals whether the student: (i) never attended preschool; (ii) attended preschool for one year or less, or (iii) attended preschool for more than one year. Preschool access for persons in the sample clearly differed across countries, with access being greater in Argentina, Mexico and Uruguay (see table 2).[7]

The performance gaps are measured using the PISA reported "plausible values," which represent the range of skills that a student may have in the various subject areas and are comparable across countries and years. The 2009 and 2012 rounds were selected for this study because information on preschool attendance was not compiled in earlier rounds. The mathematics and reading tests were chosen because the programme waves for those years were focused on these subject areas.

A comparison of the PISA test scores using the *Preschool variable* with no controls reveals a positive correlation between early education —and its duration— and academic performance at the secondary education level in all the countries (see table 3). The margin by which students who had attended preschool for more than one year out-performed the group of students who did not was generally greater in Argentina, Uruguay and Peru, both in 2009 and in 2012. At the other extreme, the countries with the smallest average differentials were Chile, in 2009, and Colombia, in 2012.

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[7] Since the PISA tests are administered only to young people who are in secondary education and are close to the appropriate grade level, the results for the sample overestimate the actual attendance rate for the total population.

TABLE 2

Description of the preschool variable, 2009 and 2012

(Percentages)

	2009				2012			
	Valid values			Lost or missing values	Valid values			Lost or missing values
	Did not attend	Attendance ≤ 1 year	Attendance > 1 year		Did not attend	Attendance ≤ 1 year	Attendance > 1 year	
Argentina	4.7	29.1	66.2	2.6	6.2	22.6	71.2	2.3
Brazil	21.3	33.4	45.3	6.8	19.1	33.6	47.3	3.5
Chile	15.0	52.8	33.2	3.5	9.2	56.5	34.3	2.3
Colombia	18.5	53.3	28.2	1.6	14.2	52.4	33.3	1.7
Mexico	10.3	19.5	70.2	1.5	9.5	18.7	71.8	1.1
Peru	15.1	26.3	58.6	7.3	13.8	25.0	61.2	2.9
Uruguay	12.8	15.9	71.3	2.9	16.2	14.1	66.7	4.3
Total	15.7	31.7	52.6	4.4	14.1	31.0	54.9	2.5

Source: Organization for Economic Cooperation and Development (OECD), *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014; and *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014.

TABLE 3

Average PISA test scores, total and by category of preschool variable, 2009 and 2012

	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
2009							
Mathematics							
Total	388.1 (0.74)	385.8 (0.82)	421.1 (0.69)	380.8 (0.82)	418.5 (0.42)	365.1 (1.27)	426.7 (1.07)
Did not attend	334.7 (2.21)	358.0 (0.93)	392.9 (1.56)	349.2 (1.23)	375.1 (0.91)	335.7 (2.03)	373.1 (2.13)
Attendance ≤ 1 year	369.6 (0.87)	386.4 (1.13)	419.9 (0.83)	386.1(1.42)	416.2 (0.82)	363.7 (2.12)	410.8 (2.05)
Attendance > 1 year	403.3 (1.06)	407.8 (0.97)	441.2 (1.23)	394.5 (1.02)	426.9 (0.33)	383.5 (1.06)	442.8 (1.15)
Reading							
Total	398.3 (0.99)	411.7 (0.55)	449.4 (0.83)	413.2 (0.55)	425.3 (0.65)	369.7 (0.95)	425.8 (0.61)
Did not attend	331.5 (4.02)	378.9 (0.78)	418.5 (1.50)	380.1 (1.04)	378.2 (1.24)	336.9 (1.78)	368.4 (1.33)
Attendance ≤ 1 year	379.1 (1.41)	414.1(1.16)	452.4 (1.19)	418.8 (0.87)	424.2 (0.91)	367.8 (1.41)	404.7 (1.23)
Attendance > 1 year	415.7 (1.21)	438.7 (0.57)	465.3 (1.02)	428.7 (1.36)	434.2 (0.55)	391.5 (0.98)	444.5 (0.85)
2012							
Mathematics							
Total	388.4 (1.16)	388.5 (0.66)	422.6 (0.69)	376.5 (0.40)	413.3 (0.33)	358.1 (0.71)	409.3 (0.45)
Did not attend	337.2 (2.25)	365.6 (0.74)	381.4 (2.54)	350.5 (1.01)	378.0 (0.99)	327.5 (1.60)	369.7 (0.73)
Attendance ≤ 1 year	365.8 (1.44)	382.7 (0.69)	422.6 (0.76)	379.5 (0.94)	411.2 (0.45)	360.4 (1.46)	389.9 (1.07)
Attendance > 1 year	402.8 (1.28)	404.9 (0.91)	435.7 (0.90)	384.8 (1.08)	419.3 (0.38)	383.6 (0.81)	426.3 (0.77)
Reading							
Total	395.9 (1.24)	406.5 (0.62)	441.4 (0.71)	403.4 (0.44)	423.5 (0.42)	384.1 (1.11)	411.3 (0.55)
Did not attend	336.7 (3.11)	378.9 (1.04)	401.4 (2.97)	374.4 (1.63)	383.3 (1.27)	342.1 (2.07)	367.7 (1.82)
Attendance ≤ 1 year	372.7 (1.94)	400.9 (0.83)	442.6 (0.69)	406.6 (0.30)	422.4 (0.68)	374.4 (2.14)	396.1 (1.46)
Attendance > 1 year	411.9 (1.26)	425.9 (0.88)	452.5 (1.10)	413.5 (1.16)	430.2 (0.48)	401.8 (1.11)	430.2 (0.56)

Source: Organization for Economic Cooperation and Development (OECD), *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014; and *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014.

Note: The mean differences between the categories "Attendance ≤1 year" and "Did not attend" and between "Attendance > 1 year" and "Did not attend" are statistically significant at 1% in all cases; the standard errors for the estimates are shown in brackets.

In view of the fact that the differentials are determined by personal and contextual factors linked both to preschool access and secondary-school performance (which are, generally speaking, beyond an individual's control), the following control factors are used in the matching process:[8,9]

•   Individual characteristics:

Nuclear family: this variable (denoted as 1 if the student lives with both parents and 0 otherwise) may be related to cognitive achievements (Calero and others, 2007; Krüger, 2013) and non-cognitive ones (Krüger, Formichella and Lekuona, 2015). In a number of countries, there was a greater likelihood of preschool attendance for students from nuclear families.[10]

In order to control for the families' socioeconomic level, the PISA index for economic, social and cultural status is used. This index synthesizes information on three main aspects of the household: the highest level of education attained by both parents; the highest occupational ranking; and access to wealth and to cultural and educational assets (OECD, 2012). All these factors are significantly related to prospects for scholastic success (Krüger, 2013), and they also appear to be significant determinants of access to early education and continued preschool attendance.

•   School characteristics:

Public school: students attending private schools generally perform better on standardized tests. It is not clear, however, that their stronger performance is specifically attributable to the type of school management; in fact,

it seems more likely that test performance is associated with the types of student populations in these two kinds of educational establishments (Formichella and Krüger, 2013). This variable is included to represent a wide range of school- and family-related factors that could influence students' performance and could also have had a significant impact on their earlier educational path.

Urban location: access to preschool is usually associated with a person's area of residence, as can be observed from an analysis of the PISA sample. This is also a proxy for the availability of physical and human resources, which tend to be more abundant and of better quality in urban areas.

Average score of peers: this last variable is used in an attempt to capture qualitative differences between schools. Given the possibility that families that decide —or are able— to send their children to preschool may then be able to send them to better secondary schools, it is necessary to control for this factor in order to avoid erroneously attributing this effect to preschool attendance. The quality of the school attended by a given student is approximated by computing the average score on the PISA mathematics or reading test obtained by that student's classmates. This score ought to reflect both the influence exerted by classmates' academic level and the correlation between the school's practices and resources and the student's own test performance. Given the methodology used, this variable is expressed in quintiles.

There are two drawbacks associated with the use of this database. First, no information is available on the type of preschool or primary school that was attended. Second, there is a selection problem in that students (whether they attended preschool or not) who dropped out before reaching 15 years of age, or who are in a grade below seventh grade, are excluded from the sample. If preschool attendance also influences the progress or completion of a student's education, then the assessment of PISA score differentials will be underestimating the total effect on academic attainment, and this point needs to be stated explicitly.

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[8] While gender is often regarded as a possible determinant of academic achievement, it has been omitted here because prior estimates indicate that it is not an explanatory variable for preschool access.

[9] The description is available upon request.

[10] The database includes observations with missing data which, in the case of the controls that were used here, tend to predominate in the *nuclear family* variable. However, when a number of simulations were run with and without this variable, the results were statistically equivalent. Full information on these simulations may be obtained from the authors.

VI

Findings

This analysis of the PISA sample indicates that 15-year-olds in the region have had differentiated access to early education as a function of socioeconomic status (with the assumption that their socioeconomic level is similar

to what it was during their early childhood). Those who attended preschool for one year or more are more likely to belong to a family in a high-status socioeconomic group, followed by those who attended for one year or less. In

addition, preschool attendance and the duration of that attendance are positively associated with residence in an urban area and with attendance at a private school, or a better-quality school, as reflected by the average score of students' classmates.

These influences are reflected in a reduction in the size of the common support and in an increase in the explained component of the performance gap (Δ_x) as more and more matching variables are added. The analysis of the individual effect of each control shows that average peer scores explain more than 50% of the gap, with this impact being stronger in 2012; the inclusion of the families' socioeconomic level (SEL) explains more than 30%. The public/private school variable alone appears to explain between 15% and 30% of the gap except in Mexico. Location is a significant factor in Peru, Colombia and Mexico but is less influential in the rest of the region. Finally, family structure is the least influential factor, accounting for less than 10% of the initial difference in most cases, although it had a considerably greater impact in 2012 than it did in 2009.[11]

The coefficients of greatest interest are the gross performance gap (Δ, equation (1)) and the unexplained portion (Δ_0, equation (7)) (see tables 4 and 5). A reading of the estimates in each area involves two components: the first reflects the gross score gap —the average difference between groups— while the second includes the controls, which start with location and then incorporate the other factors one by one. The average performance gap between students who had attended preschool for less than one year and those who had not is 9.9% for 2009 and 7.8% for 2012, with the unexplained difference amounting to 3.5% and 2.3%, respectively (coefficient "+mean peer score" in tables 4 and 5, second-to-last row).

The estimated gross performance gaps are noteworthy in all the countries: on average, students who had attended preschool out-performed those who had not done so on the PISA tests by between 4% and 26%, depending on the year, country and number of years of preschool attendance (greater exposure to educational experiences). The longer the student was exposed to early education, the greater the gap.

After controlling for all the various family and school characteristics, the unexplained portions of the gaps continue to be positive and, in many cases, substantial. Taking all seven countries as a group, the largest gap between those who attended more than one year of preschool and those who did not was in reading (4.2%)

in 2009, while the smallest gap between the results for those two groups was in mathematics (1.9%) in 2012. At the individual level, these gaps (Δ_0, equation (7)) range between 0.1% and 11% of the scores, with students who had attended preschool achieving the higher score in each case.

The portion of the gross gap that remains unexplained after all the controls have been applied (Δ_0/Δ) averages 30%. The percentage is smaller for preschool attendance lasting more than one year, which indicates that the socioeconomic factors that have been considered are more significant determinants of access when the amount of time spent in school exceeds the mandatory period of attendance.

Substantial differences are found between countries in terms of both the initial size of the gaps and their size after matching. An examination of the gross score differentials indicates that Argentina is generally the country in which students who had access to early education have the greatest advantage. For 2009, it is followed by Uruguay and Mexico, while Chile has the smallest performance gaps. For 2012, Uruguay and Chile have the largest gaps after Argentina, while Colombia and Brazil have the smallest. In other words, apart from Argentina, no set pattern is apparent when comparing the various countries' gross performance differentials.

The net gap, i.e., the portion of the gap that remains unexplained after all the control variables have been applied, is the largest in Argentina and Uruguay for both periods. For example, 10.6% of the score gap in reading in Argentina in 2012 between those who attended preschool for over a year and those who did not must be accounted for by other factors. This difference of approximately 36 points is certainly significant, since it represents 9% of the average score of all PISA participants in the country and is equivalent to nearly one half of its standard deviation.

At the other extreme, Chile, Colombia and, in some cases, Peru display the smallest differentials. For example, for 2009, Chile had the narrowest gap (1.6%) in mathematics between the scores of students who had attended preschool for one year or less and those of other students. This amounts to some six points, or approximately 1.5% of the average score of students in that country on the mathematics tests. These differences in the unexplained portions of these gaps point to the existence of heterogeneous unobservable effects that are resulting in differing sizes of final performance gaps in terms of future cognitive results.

As for the extent of exposure to "treatment" (one year or less as compared to more than one year in early

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[11] These calculations may be obtained from the authors.

TABLE 4

Decomposition of PISA score gaps, 2009

(Percentages)

"Attended preschool for over 1 year" compared with "Did not attend preschool"

	All countries	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Mathematics								
Δ (gross gap)	15.0 (0.05)	20.5 (0.59)	13.9 (0.15)	12.3 (0.19)	13.0 (0.24)	13.8 (0.13)	14.2 (0.24)	18.7 (0.23)
Δ_0 (net gap)								
Controls								
Urban location	13.2	18.7	12.7	11.0	9.6	11.9	8.4	17.1
+Public school	11.3	15.0	8.9	8.8	7.6	11.6	7.5	14.3
+Nuclear family	10.7	14.9	8.5	8.8	7.1	10.9	7.4	13.2
+Household SEL	7.8	9.9	6.4	4.0	2.6	8.2	4.6	9.2
+Mean peer score	3.9 (0.04)	6.1 (0.45)	4.6 (0.14)	3.6 (0.21)	1.5 (0.26)	5.1 (0.11)	3.0 (0.19)	6.9 (0.20)
Reading								
Δ (gross gap)	14.5 (0.06)	25.4 (0.77)	15.8 (0.16)	11.2 (0.19)	12.8 (0.26)	14.8 (0.17)	16.2 (0.28)	20.6 (0.28)
Δ_0 (net gap)								
Controls								
Urban location	12.7	23.3	14.4	10.0	9.3	12.7	10.0	18.8
+Public school	10.7	18.7	10.8	7.8	7.3	12.4	9.1	15.9
+Nuclear family	10.2	18.7	10.4	7.6	6.8	11.7	9.1	14.8
+Household SEL	7.1	13.5	7.9	3.2	2.1	8.7	5.9	10.6
+Mean peer score	4.2 (0.05)	7.9 (0.53)	5.8 (0.15)	2.9 (0.21)	1.5 (0.25)	4.9 (0.13)	3.6 (0.21)	8.6 (0.21)

"Attended preschool for over 1 year" compared with "Did not attend preschool"

	All countries	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Mathematics								
Δ (gross gap)	8.9 (0.05)	10.4 (0.53)	7.9 (0.15)	6.9 (0.16)	10.6 (0.20)	10.9 (0.14)	8.3 (0.26)	10.1 (0.29)
Δ_0 (net gap)								
Controls								
Urban location	8.2	9.5	7.6	6.2	9.3	9.4	5.8	9.8
+Public school	7.1	9.6	6.1	4.9	8.6	9.4	5.4	9.4
+Nuclear family	6.6	9.5	5.4	4.7	8.1	8.6	5.4	8.4
+Household SEL	5.2	8.4	4.6	2.6	5.8	7.9	3.3	7.7
+Mean peer score	3.1 (0.04)	7.5 (0.46)	2.8 (0.12)	1.6 (0.16)	4.6 (0.21)	4.2 (0.12)	2.1 (0.23)	6.5 (0.28)
Reading								
Δ (gross gap)	9.9 (0.06)	14.3 (0.75)	9.3 (0.15)	8.1 (0.17)	10.2 (0.26)	12.2 (0.17)	9.2 (0.32)	9.9 (0.34)
Δ_0 (Net gap)								
Controls								
Urban location	9.1	13.1	8.9	7.5	8.6	10.3	6.3	9.5
+Public school	8.0	13.2	7.5	6.0	7.9	10.3	5.8	9.1
+Nuclear family	7.4	13.2	6.9	5.8	7.4	9.4	5.8	8.0
+Household SEL	5.9	12.1	6.0	4.0	5.2	8.5	3.3	7.5
+Mean peer score	3.5 (0.05)	7.9 (0.59)	4.0 (0.13)	3.1 (0.18)	3.3 (0.24)	3.9 (0.15)	1.3 (0.24)	6.5 (0.30)
N (number of students)	88 683 (7.7)	4 774 (4.6)	20 127 (9.0)	5 669 (13.2)	7 921 (9.1)	38 250 (7.2)	5 985 (1.9)	5 957 (3.7)

Source: Prepared by the authors, on the basis of Organization for Economic Cooperation and Development (OECD), *PISA 2009 Technical Report*, Paris, OECD Publishing, 2012.

Note: The differences in the gross and net gaps across countries are statistically significant at 1% in all cases when using bootstrapping with 200 replications. Both for the gross gap (Δ, equation (1)) and for the final Δ_0 (the net gap after applying all the controls, equation (7)), the standard error for the gap is shown in brackets. N indicates the size of the sample; the percentage of observations lost when all the controls are included is shown in brackets. SEL stands for the socioeconomic level of the household.

TABLE 5

Decomposition of PISA score gaps, 2012
(Percentages)

"Attended preschool for over 1 year" compared with "Did not attend preschool"

	All countries	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Mathematics								
Δ (gross gap)	12.3 (0.08)	19.5 (0.38)	10.8 (0.11)	14.2 (0.23)	9.8 (0.23)	10.9 (0.12)	17.1 (0.25)	15.3 (0.21)
Δ_0 (net gap)								
Controls								
Urban location	11.1	19.0	9.4	12.4	8.3	9.3	13.3	13.3
+ Public school	9.4	16.4	7.0	9.4	6.5	8.9	10.1	10.6
+Nuclear family	8.6	15.4	6.2	8.8	6.1	8.0	9.7	9.3
+Household SEL	6.4	11.9	4.7	3.0	2.3	6.0	5.8	6.9
+Mean peer score	3.3 (0.06)	8.1 (0.33)	3.1 (0.09)	0.7 (0.23)	0.9 (0.24)	3.7 (0.09)	3.8 (0.22)	4.6 (0.18)
Reading								
Δ (gross gap)	12.8 (0.08)	22.4 (0.51)	12.4 (0.15)	12.7 (0.23)	10.4 (0.27)	12.2 (0.13)	17.4 (0.23)	17.0 (0.27)
Δ_0 (net gap)								
Controls								
Urban location	11.4	21.7	11.0	10.6	8.8	10.2	12.9	14.6
+Public school	9.8	18.4	8.8	8.0	6.8	9.8	10.1	12.0
+Nuclear family	9.0	17.4	8.0	7.4	6.4	8.9	9.8	10.7
+Household SEL	6.7	14.1	6.8	2.4	2.4	6.7	5.5	8.7
+Mean peer score	3.9 (0.06)	10.6 (0.52)	4.5 (0.12)	0.6 (0.24)	0.1 (0.29)	4.7 (0.12)	2.3 (0.24)	6.6 (0.26)

"Attended preschool for over 1 year" compared with "Did not attend preschool"

	All countries	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Mathematics								
Δ (gross gap)	6.7 (0.08)	8.5 (0.35)	4.7 (0.12)	10.8 (0.22)	8.3 (0.21)	8.8 (0.14)	10.1 (0.24)	5.5 (0.26)
Δ_0 (net gap)								
Controls								
Urban location	6.0	8.0	4.4	10.4	7.3	7.6	7.9	4.9
+Public school	5.2	8.5	3.6	8.8	7.2	7.5	6.5	3.9
+Nuclear family	4.4	7.5	2.8	8.0	6.4	6.4	6.1	3.3
+Household SEL	3.4	6.8	2.6	4.4	4.1	5.6	3.3	2.7
+Mean peer score	1.9 (0.06)	3.2 (0.44)	0.8 (0.11)	2.6 (0.23)	2.2 (0.21)	2.9 (0.13)	1.7 (0.28)	0.68 (0.26)
Reading								
Δ (gross gap)	7.8 (0.09)	10.7 (0.44)	5.8 (0.15)	10.3 (0.21)	8.6 (0.24)	10.2 (0.14)	9.4 (0.27)	7.7 (0.32)
Δ_0 (net gap)								
Controls								
Urban location	7.0	10.1	5.5	9.5	7.4	8.6	7.0	6.9
+Public school	6.1	10.8	4.8	8.0	7.2	8.5	5.8	5.9
+Nuclear family	5.4	10.0	3.9	7.2	6.5	7.4	5.5	5.4
+Household SEL	4.5	8.7	3.2	3.8	3.9	6.6	2.8	5.0
+Mean peer score	2.3 (0.07)	7.7 (0.53)	1.3 (0.14)	2.1 (0.22)	2.7 (0.25)	4.0 (0.14)	0.15 (0.29)	3.5 (0.30)
N (number of students)	86 197 (18.9)	5 908 (20.4)	19 204 (18.1)	6 856 (14.5)	9 073 (26.5)	33 806 (19.0)	6 035 (13.6)	5 315 (18.6)

Source: Prepared by the authors, on the basis of Organization for Economic Cooperation and Development (OECD), *PISA 2009 Technical Report*, Paris, OECD Publishing, 2012.

Note: The differences in the gross and net gaps across countries are statistically significant at 1% in all cases when using bootstrapping with 200 replications. Both for the gross gap (Δ, equation (1)) and for the final Δ_0 (the net gap after applying all the controls, equation (7)), the standard error for the gap is shown in brackets. N indicates the size of the sample; the percentage of observations lost when all the controls are included is shown in brackets. SEL stands for the socioeconomic level of the household.

education), the results are as expected: the gross gaps were wider when the period of preschool attendance was longer. This could be due both to the direct effect of having been in preschool for a longer period and to the impact of the socioeconomic factors that influence both the duration of attendance in early education and performance on the PISA tests.

With the exceptions of Colombia and Chile, this ratio remains in evidence after controlling for the influence of these factors, as may be seen from the evaluation of the countries' net performance gaps (Δ_0, equation (7)). For example, in the case of the 2012 round, taking the entire sample into consideration, students who had attended preschool for more than one year scored, on average, 3.3% higher on the mathematics examination than those who had not, while students who had attended preschool for one year or less out-performed the latter group by 1.9%. This lends strength to the argument that not only access to early education, but also the duration of preschool attendance, is important and that school entry at younger ages should therefore be encouraged.

An examination of how the results for the two PISA rounds compare indicates that, with some exceptions, both the gross and net gaps have narrowed. This could be evidence of the fact that the increase in early education programmes seen since the late 1990s in the region (the period of time during which these cohorts were of preschool age) has helped to reduce inequalities in access. On the other hand, it could be that attendance in early education is simply having less of an impact on academic performance. In any event, since the amount of time between the two rounds was fairly short, at this point it would be ill-advised to advance hypotheses leading in either of these two directions.

Finally, a comparison of the explained and unexplained portions of the performance gaps found in the two PISA domains of interest here suggests that the effect of preschool attendance and of its associated factors is generally greater in the area of reading than it is in mathematics. This finding points to the importance of interaction with persons of the same age in the development of language skills during these stages of life.

VII

Conclusions

The situation in Latin America with respect to early education coverage and to progress in expanding that coverage in recent decades has been highly variable. A political and academic consensus on the subject has led countries to sign international agreements that have translated into a series of policies designed to open up access to early education. As a result, attendance at this level has become compulsory in most of the countries of the region since the late 1990s, and school attendance rates among younger children have therefore been on the rise.

Nevertheless, many disadvantaged children who reside in rural areas and/or come from families with a low socioeconomic level still do not have access to early education. Addressing these inequalities in access is a priority for any policy designed to attain greater equity, even though differences in access have been slowly narrowing. The analysis presented here suggests that initial estimated score differentials diminish when other selected attributes are included in the assessment. However, not all of the considered factors seem to have the same explanatory power, as the households' socioeconomic level and secondary-school quality

reduce the unexplained portion of the gap more than family structure or area of residence do.

In response to the scarcity of empirical research on this subject in the region, the analysis presented here provides evidence regarding the influence exerted by early education on later academic achievement. The chief conclusion to be drawn is that, even when controlling for fundamental contextual variables, in many cases the unexplained component of these performance gaps amounts to a sizeable percentage of the total gap and therefore represents a significant score differential. This analysis cannot be described as a causational study because students were not randomly assigned to a treatment group (preschool attendance) or a control group (no preschool attendance), which would have ensured that the estimates were bias-free. This type of exercise is very expensive to conduct, and there have been no earlier initiatives that could pave the way for such an effort. Be that as it may, the controls used in this matching exercise reduced the effect of observables and unobservables that would have skewed the results. The main attributes that could condition early education access

and that, judging from the specialized literature, have an impact on academic performance at the secondary-school level have been taken into account. It should also be pointed out that, assuming that members of the more vulnerable sectors of the population are less likely to have access to early education and more likely to drop out of school, the results underestimate the size of the effect; in other words, they provide a clear indication of the type of effect but demarcate no more than the lower limit of its actual magnitude.

The findings of this study have obvious policy implications. First of all, they lend support to the argument for universalizing early education in the region and for monitoring differences in quality, especially regarding vulnerable sectors of the population. In view of the instrumental value of early education which has been analysed here, as well as its intrinsic value, it is important to pursue efforts to include children in the more vulnerable sectors of the population in the early education system and, once they have entered it, to promote their continued participation in the education system.

Second, the differences in score gaps across countries suggest that the role played by other factors (institutional arrangements, characteristics of education markets and budget allocations) should also be analysed. The effect of preschool attendance becomes more diluted in some systems than in others as students go on to primary and then secondary school, perhaps because of major differences in the quality of the programmes offered by public and private schools. This points to the need for greater emphasis on improving, standardizing and assessing the various educational programmes on offer at this level. Finally, it was found that not only is preschool attendance important, but the duration of such attendance is influential as well. This finding is in line with the results obtained by Barnett (1995) and Reynolds (1995) and provides support for those who are calling for greater efforts and more effective policies aimed at expanding the coverage of education for children at a very young age.

In conclusion, the commitments made by the Latin American countries in this connection notwithstanding, major challenges remain to be met in order to close the gap between the aspirations embodied in recent legislation and the actual results on the ground.

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South-South trade and South-North trade: which contributes more to development in Asia and South America? Insights from estimating income elasticities of import demand

Thomas Bernhardt

ABSTRACT

The experience of the global economic crisis led developing countries to intensify the diversification of sources of growth, seeking alternative models of economic development. The expansion of South-South trade assumed greater significance in the context of this search. Yet how promising a strategy is this? In attempting to answer this question, this paper documents the evolution of South-South trade and puts forward some theoretical considerations. It then undertakes an econometric analysis to estimate the income elasticities of import demand in bilateral trade relationships among developing Asian and South American countries and two key Northern markets. On applying an ARDL model, the analysis yields mixed results in terms of whether South-South trade presents higher income elasticities than South-North trade. Still, the findings show that South-South trade can be an alternative source of growth, especially if South-North income and import growth differentials persist.

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I

Introduction

The dramatic breakdown of world trade in the wake of the recent global financial and economic crisis has called into question the sustainability of the prevailing export-led growth regime pursued by a number of developing and emerging economies (Griffith-Jones and Ocampo, 2009; Ocampo, 2009). Traditionally, and also in the recent past, many developing countries have relied for their exports mainly on primary commodities and resource-based products, which they have generally traded for imports of more technology- and skill-intensive manufactures, primarily from rich countries in the global North (UNCTAD, 2005, p. 129). The recent crisis made clear the necessity for export-dependent countries to diversify their sources of growth. One element of this could include the diversification of their export destinations. An increase in South-South trade, i.e., of trade between developing countries, might not only offer one way out of the crisis in the short run but also, from a longer-term perspective, be an element of a more reliable and sustainable development strategy for lower-income countries (Milberg and Winkler, 2010).[1]

Indeed, early developmentalist economists such as Myrdal (1956) and Lewis (1980) were already pointing to the potential of South-South trade as a driver of economic development. They emphasized that South-South integration could help developing countries to reduce their dependence on Northern markets and also overcome bottlenecks related to resource endowments and the size of domestic markets, thereby promoting industrialization. Later on, scholars such as Amsden (1987)

and Lall (1987) noted the increasingly industrialized nature of South-South trade, characterized as it was by a higher share of capital- and skill-intensive goods than developing countries' exports to the North, and "saw [South-South] trade in sophisticated manufactures as a potential catalyst for dynamic gains aiding industrialization and technology transfer within the South" (Dahi and Demir, 2008, p. 267). More recently, a number of international development agencies, especially those belonging to the United Nations system, have shown renewed interest in South-South cooperation and trade as a vehicle for addressing various of the world's development challenges, and as an ever more promising avenue towards development (see UNCTAD, 2005, 2010 and 2011; UNIDO, 2006; ADB, 2011; World Bank, 2011; UNDP, 2013, chap. 2).

So how do South-South trade figures react to changes in economic activity and income in the developing countries concerned? How does this compare to the implications of an increase in income in their rich-country trading partners? Can South-South trade be shown, on the basis of econometric estimations of income elasticities, to be a (more) promising source of demand and economic growth overall?

This paper attempts to answer these questions by taking a look at the empirics of certain segments of South-South trade, specifically both interregional and intraregional trade between Asian and South American economies, and comparing this to the trade of these countries with representatives of the rich global North, namely the eurozone and the United States. To this end, the paper tries to find out whether South-South trade is typically characterized by higher income elasticities and is therefore a more promising source of growth than developing countries' exports to rich countries, by focusing on a sample of bilateral Asia-South America trade relationships.

To document changes in international and regional trade patterns, this Introduction is followed in section II by a brief empirical account of the magnitude of South-South trade and its development over the past decades. Next, section III examines how South-South trade could be beneficial for developing countries, while section IV discusses why the income elasticities of import demand can serve as a useful indicator of the potential for South-South

[1] The "South" is defined here as all countries classed as developing economies by UNCTADstat. This includes all countries on the African continent, all Asian countries except Israel, Japan and the countries of the former Soviet Union, the Middle East, and the whole of the Americas excluding Bermuda, Canada, Greenland, Saint Pierre and Miquelon and the United States. See [online] http://unctadstat.unctad.org/EN/Classifications/DimCountries_DevelopmentStatus_Hierarchy.pdf.

trade to become a driver of economic development in Asia and South America. Section V outlines the econometric model and the empirical approach, section VI sets out the focus of the analysis and presents the regression results and section VII compares the potential of South-South trade and South-North trade to drive income growth in Asia and South America; lastly, section VIII refers to policy consequences and offers some final reflections.

II

An empirical account of South-South trade: magnitude, developments and patterns

The purpose of this section is to give a brief empirical account of the magnitude of South-South trade and its development over the past decades. In doing so, it seeks to examine the driving forces of South-South trade. What do South-South trade flows look like, and what is the geographical composition and structure of such flows?

The general export performance of developing countries is the starting point for this analysis. Figure 1 plots the long-run trend of exports from the South since the Second World War. It reveals three distinct phases. First, in the two and a half decades that followed the conflict, the world trade share of exports from the South declined from over 30% to less than 20%. The second phase, dominated by high commodity prices from the mid-1970s on, saw a dramatic increase in the South's share of world exports, which shot up to almost 30% and remained at over 25% until the mid-1980s, before a decrease in oil and commodity prices brought it back

down to 21% by 1987. Since then, the South's export share has experienced a continuous upward trend, reaching a record level of 44% in 2012 (representing an export value of US$ 6.14 trillion).[2] As figure 1 reveals, this upward trend has been driven above all by the economies of developing Asia. Importantly, the growth of exports from developing countries in this current phase since the mid-1980s has involved a rise not only in trade values but also in volumes. Shirotori and Molina (2009, p. 2) reported that the volume of exports from the South to the world had quintupled since the 1980s, while world exports had increased only threefold. On average, exports from the South grew by 7% a year from 1980, exceeding the average annual rate of growth in world exports overall (6%).

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[2] Average annual growth rates during these three phases were 6%, 14% and 11%, respectively.

FIGURE 1

Exports from the South as a share of total world exports, 1948-2012
(Percentages)
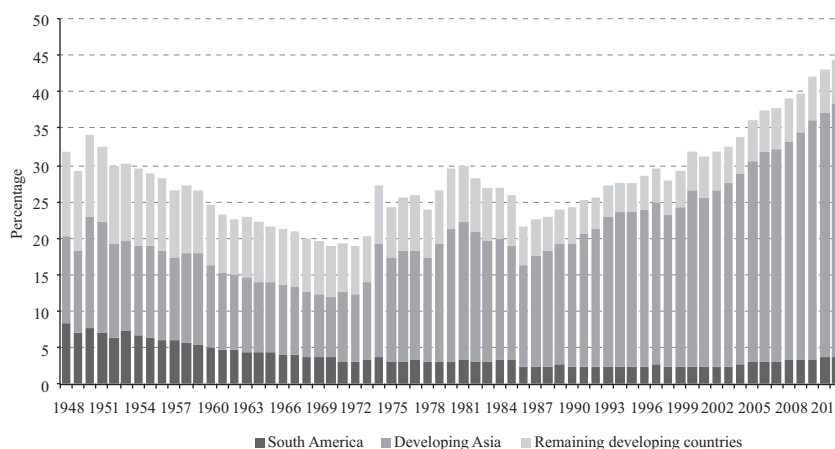
Source: Prepared by the author, on the basis of data from the UNCTADstat database.

The greater part of the growth in exports from the South can be explained by the expansion of South-South trade (see Hanson, 2012). This is particularly true for the past decade. In 2011, total South-South exports amounted to US$ 4.3 trillion, accounting for 55% of total exports from the South. The significant growth of South-South exports becomes evident when they are compared to exports from the South to the rest of the world. Figure 2 shows that, between 1995 and 2011, the average annual growth of South-South exports was a remarkable 13%, far exceeding the annual growth of exports to the rest of the world, put at 9.5%. Comparing these figures with older data reported by Shirotori and Molina (2009, p. 3) reveals that the growth gap has actually widened over the past few years: in the 10 years from 1995 to 2005, developing countries' exports to other developing countries rose by an annual average of 11.5%, while their exports to the rest of the world grew by an annual 9.3%, yielding an annual growth differential of 2.2 percentage points that pales beside the 3.5 percentage point export growth gap for the period from 2005 to 2011.[3] As can be seen in figure 2, this surge in exports to Southern markets has been a shared feature across continents, with developing Asia recording the highest annual growth rates (averaging 13.1% between 1995 and 2011) and developing Africa and the developing countries of the Americas being more or less in lockstep (about 12.6% annually in both cases).

However, there are certain regional differences as regards the weight of the South as an export market. In 2011, developing Asia shipped considerably more than half of its total exports (59%) to other countries in the global South. In other regions, the share was lower. In Africa, exports to the South accounted for 43% of the total. The overall figure for the Americas was 39%, although for the South America subregion the figure was much higher, at 54%.

Two further aspects are worth noting. First, South-South trade is clearly dominated by Asia, which has acted as a "locomotive of South-South trade" (UNCTAD, 2008, p. 3). Indeed, Asia is both the largest exporter and the largest importer in South-South trade, with its exports (including intraregional exports) accounting for 84% of total South-South trade in 2012. This predominance can be explained by Asia's sheer economic size, but also by its function as the world's most important hub for international trade and by the fact that it has a greater share of this trade than the other two developing regions, Africa and the Americas (Shirotori and Molina, 2009).[4] Second, interregional trade is currently only a rather minor component of South-South trade, which mostly takes place between countries belonging to the same region. Asia once again plays the leading role, with its high degree of regional integration, often in the form of regional supply chains, being a major reason.

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[3] All data reported in this section were drawn from the UNCTADstat database [online] http://unctadstat.unctad.org.

[4] Many export-oriented production networks are concentrated in Asia, with China, Japan and the Republic of Korea at their centre. This phenomenon is known as "Factory Asia."

FIGURE 2

Average annual export growth rates, 1995-2011
(Percentages)
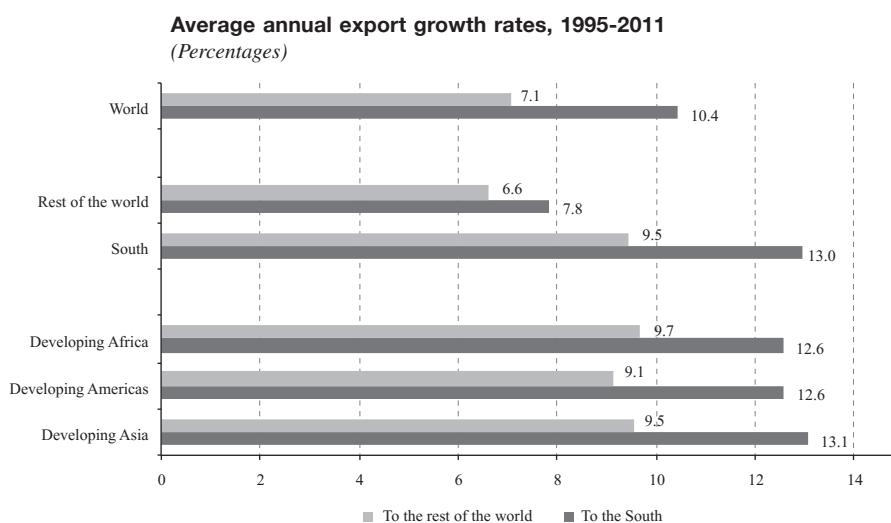
Source: Prepared by the author, on the basis of information from the UNCTADstat database.

The rapid expansion of South-South trade cannot be understood without proper recognition of the increasingly important role of global and also regional production networks, something that, in turn, also goes a long way towards explaining the predominance of Asia in South-South trade (and indeed in global trade). For Shaffaeddin (2008), the rapid growth of trade between Asian countries has, above all, been the result of industrialization and industrial collaboration in the region in the form of production-sharing. Athukorala (2011, p. 12) points out that, in Asia, the elaborate "intercountry division of labor within production networks has contributed significantly to strengthening trade complementarity among countries in the region," thereby further accelerating intraregional trade. The analysis that follows will seek to acknowledge these different aspects of South-South trade by looking at both interregional trade between and intraregional trade flows within Asia and South America.

III

Why should South-South trade be beneficial for developing countries?

Is South-South trade more advantageous than South-North trade for developing countries? And why should a shift from the traditional South-North trade scheme to more South-South trade bring benefits for lower-income countries? Theoretically, at least three reasons can be found.

Firstly, South-South trade can potentially imply an increase in export volume growth. Indeed, for much of the past 30 years (and particularly the past decade), economic growth has been far more dynamic in the poorer countries of the global South —particularly the large "Asian driver economies" (Kaplinsky and Farooki, 2010, p. 11) of China and India— than in the rich countries of the North. The sheer growth performance of developing economies and the growth gap between them and the advanced economies make the former promising and appealing export markets, not least for outward-oriented developing countries. Accordingly, Fugazza and Vanzetti (2008) find that the potential gains from removing South-South trade barriers would be considerably higher than those from opening up Northern markets (see also ADB, 2011; IMF, 2011, and Wignaraja, Ramizo and Burmeister, 2012). Indeed, there has already been an impressive expansion of South-South trade, especially during the last two decades, with a higher rate of growth than world trade (Shirotori and Molina, 2009). Such larger export volumes are potentially income-generating. However, a certain portion of this South-South trade has happened only on paper. The increasing integration of Southern producers into international production networks (often called global value chains) has led to a fragmentation of production processes and a new pattern of trade, in which goods travel between various locations before reaching the final consumer. Therefore, South-South trade statistics include a certain degree of double-counting and thus have to be interpreted with caution (ADB, 2011, p. 50).

A second way in which South-South trade can potentially be advantageous for participating countries is via an increase in the technological content of the typical goods in their export baskets. In other words, South-South trade can potentially benefit developing countries if it allows or even promotes industrial upgrading in their production structures. In particular, this could involve a shift from exporting goods with low skill intensity and low value added to goods with high(er) knowledge intensity and high(er) value added. Yet the evidence for this hypothesis is mixed. Shirotori and Molina (2009), for example, point out that the dominant sector in South-South trade is manufacturing, and Dahi and Demir (2008) that the share of manufacturing exports in total South-South exports has more than doubled in the last 30 years. Klinger (2009) finds that for some developing countries, particularly in Africa, Latin America and Central Asia, exports to the South are more sophisticated and provide more learning effects than exports to the North. This supports Dahi and Demir's (2008) observation that Southern exports of technology- and skill-intensive manufactures destined for Southern markets have grown faster than exports to Northern markets, so that South-South trade in manufactures is now characterized by higher capital, technology and skill intensity than South-North trade. On the other hand, UNCTAD (2005) revealed that the most dynamic sector in terms of export value in

South-North trade over the previous three decades had been medium-skill-intensive manufacturing, whereas in South-South trade it was labour- and resource-intensive manufactures that registered the most dynamic growth. Moreover, Kaplinsky, Terheggen and Tijaja (2010), and Kaplinsky and Farooki (2010) predict that the shift from Northern to Southern final demand sources (expected as a consequence of recent global economic dynamics and particularly the recent crisis) will entail a change in the structure and nature of import demand, with product and production standards losing importance in global value chains and with suppliers in developing countries being forced to focus more on unprocessed products (with less value added and less potential for learning and upgrading).

Thirdly, South-South trade could potentially benefit developing countries by enhancing the reliability of the demand for their exports, which would be of great help in their struggle for macroeconomic stability. One underlying reason for this could be export diversification. It is a widespread phenomenon among developing countries that their basket of export goods and their export markets are highly concentrated. Export diversification would reduce this concentration and thereby make developing countries less dependent on one or a few export goods, destinations or both. Another explanation could be that South-South trade flows are characterized by a higher income elasticity of import demand than South-North trade flows. That is what the remainder of this paper will focus on.

IV

The income elasticity of import demand: does South-South trade benefit development in Asia and South America?

Basically, the income elasticity of demand measures the responsiveness of the quantity demanded of a good to changes in the income of the economic agents who consume it. In the context of international trade, the income elasticity of import demand thus indicates the responsiveness of import flows to changes in the income of the importing country. The higher the elasticity, the more responsive the demand for imports will be when the importing country's income rises.

The main purpose of this paper is to arrive at some basic estimates for the income elasticities of import demand in South-South trade by comparison with South-North trade. The key question is: which of these elasticities is greater?

The hypothesis that income elasticities of import demand are higher in South-South trade can be based on both supply-side and demand-side arguments. The supply-side dimension relates to the second factor noted in section III, namely the composition of developing countries' export baskets. As discussed above, there are indications that South-South trade flows include a

higher share of goods that are usually expected to be characterized by a higher income elasticity of demand. For example, agricultural or food products are usually said to have a low (or even negative) income elasticity of demand; additional income, especially at higher levels, is expected to be decreasingly spent on food. On the other hand, most manufactures are generally expected to have a high income elasticity of demand. If the typical basket of goods that a developing country imports from another developing country contains more manufactures relative to primary commodities (or more high-skill-intensive goods relative to low-skill-intensive goods) than the typical basket of goods that an advanced economy imports from that developing country, then South-South trade can be expected to be characterized by a higher income elasticity of import demand than South-North trade. As mentioned above, the most traded sector in overall South-South trade is manufacturing, although this does not necessarily hold true for each and every country involved. There is, in fact, quite a degree of variation across regions, and while it is true that manufacturing is

the most traded sector in total South-South trade, with a share of 58%, this result is driven by the dominance of Asia, where manufacturing accounts for 64% of all South-South exports. The share in the other regions is much lower (developing countries of the Americas 35%, South America 28%, Africa 16%).[5]

The demand-side dimension, on the other hand, refers to the complementarity of production structures and trade. Due to differences in their stage of development in general and industrialization in particular, developing countries typically differ from advanced economies in the structure and nature of demand (Kaplinsky and Farooki, 2010). Specifically, the ongoing rapid industrialization of the dynamic Asian economies in particular entails growing demand for raw materials, metals and energy. Moreover, urbanization and changing lifestyle and preference patterns also mean an increasing demand for imported food and agricultural goods, which can be quite sizeable given the huge size of the Chinese and Indian populations (UNCTAD, 2005, chap. 2). All this suggests that these industrializing Southern countries offer promising export markets to other developing countries that specialize in the export of commodities, at a time when production structures in industrial countries of the North are increasingly shifting from industry to services, implying reduced demand for raw materials and industrial inputs there. At the same time, the growing integration of developing countries into regional and global production networks means that their demand for intermediate and manufactured goods is also rising. Athukorala (2011) argues that the increasing integration of the South into regional and global value chains has contributed not only to the diversification of production structures there but also to growing trade complementarity among Southern economies. Hitherto, however, the demand for the final goods produced in such global value chains has been chiefly from Northern countries. This might change now as a result of the far-reaching repercussions of the recent global economic crisis.

Yet a shift of export markets from the North to the South will have significant implications for the structure and nature of demand. While consumers' preferences

in the North are increasingly based on product quality, innovation and differentiation, in developing countries the most important determinant of demand is very often simply the price of a good (Kaplinsky and Farooki, 2010). Moreover, the structure of demand is different not only for consumer goods but also for capital goods. In fact, "South-South trade offers developing countries access to affordable capital goods that are often more appropriate to their needs than are capital goods from richer countries and that are therefore more likely to be acquired, adopted and imitated" (UNDP, 2013, p. 46). The widespread expectation that economic growth will be much more dynamic in the South than in the North, at least in the short to medium run, implies that there will be rising demand for this type of goods. Since such goods are predominantly produced in developing countries, import demand from the South complements export supply from the South, thus lending further momentum to South-South trade. This is confirmed by Shirotori and Molina (2009), who find that sectoral specialization in South-South trade and thus trade complementarity are indeed increasing. In a similar vein, while focusing more narrowly on trade between low-income countries (LICs) and the BRICs (Brazil, Russian Federation, India and China), an International Monetary Fund (IMF) paper finds strong economic complementarities between these two groups of countries based on complementarities in resource endowments and production structures. Indeed, using a trade complementarity index, the paper shows that "export complementarity is generally higher between LICs and China or India than between LICs and the United States or the EU" (IMF, 2011, p. 14).

To sum up, the hypothesis that South-South trade is characterized by higher income elasticities of import demand than South-North trade may derive from the assumption that the former is based on different export portfolios (with a higher share for manufacturing and more sophisticated goods) and that it features higher trade complementarity (import demand meets export supply). Of course, a higher income elasticity of Southern import demand will make the expansion of South-South trade particularly beneficial to developing countries if the first condition mentioned above, namely the existence of a growth gap between the South and the North, remains true.

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[5] It is also interesting that this share has gone down in all regions since the year 2000 (when it stood at 42% in South America, for example), most probably reflecting the commodity price boom.

V

Empirical approach and model

With regard to the econometric model to be estimated, this study employs a standard import demand function based on the imperfect substitution model as outlined by Goldstein and Khan (1985), where foreign and domestic products are assumed to be imperfect substitutes. This can be written as follows:

$$ln M_t^j = \alpha + \beta \, ln Y_t + \gamma \, ln E_t^j + \varepsilon_t \qquad (1)$$

where ln represents the natural logarithm function, M is the demand for imports from country j, Y is real domestic income, E is the real bilateral exchange rate between the home country and country j at time t (defined as the number of units of domestic currency per unit of foreign currency adjusted for domestic and foreign price levels) and ε_t is the random error term.[6] The hypothesis is that higher income is related to higher import demand, i.e., that parameter β is positive. Parameter γ is expected to be negative, implying that a real appreciation of the domestic currency is associated with higher import demand.

The analysis then follows the approach pursued by Milberg and Winkler (2010), Bahmani-Oskooee and Kara (2005) and Bahmani-Oskooee, Goswamil and Talukdar (2005). These authors estimate long-run income elasticities of import demand for the United States, Canada and a number of different countries, respectively, employing an autoregressive distributed lag (ARDL) approach to cointegration which, according to Pesaran, Shin and Smith (2001), yields consistent estimates of the long-run coefficients irrespective of whether the regressors are stationary or not (i.e. whether they are integrated of order 0 or 1, or higher: I(0) or I(1)).[7] This approach

is thus convenient as it does not require pre-testing for unit roots and as it also possesses desirable small sample properties (see Pesaran and Shin, 1999, or Panopoulou and Pittis, 2004, for example), which is of relevance for the undertaking here.[8] The ARDL approach includes lagged level variables and adds short-run dynamics (by including contemporaneous and lagged differenced variables) to a long-run estimation equation like the one given above, yielding:

$$\Delta M_t^j = \alpha + \sum_{i=1}^{n} \beta_i \Delta \, ln Y_{t-i} + \sum_{i=1}^{n} \gamma_i \Delta \, ln E_{t-i}^j$$
$$+ \sum_{i=1}^{n} \delta_i \Delta \, ln E_{t-i}^j + v_1 \, ln Y_{t-1} + v_2 \, ln E_{t-1}^j \qquad (2)$$
$$+ v_3 \, ln M_{t-1}^j + \epsilon_t$$

In equation (2), the lagged level variables for Y, E and M constitute the (lagged) error correction term.

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[6] Two caveats have to be mentioned here. First, this model mixes data in volumes (gross domestic product) with data in values (imports). This may somewhat bias the estimates of income elasticities. Second, as imports are measured in value terms, increases may be driven by rises in goods prices. This is of particular importance for South American exports, whose growth between 2004 and 2011 was propelled to a significant extent by rising commodity prices. Future econometric estimations should thus seek to capture such price fluctuations too.

[7] The underlying issue is that most of the variables included in the import demand function can be expected to have non-stationary time series (i.e., be integrated of order 1 or higher), which, when used in a standard ordinary least squares (OLS) regression, can lead to misleading results and fallacious inferences in what is known as the "spurious

regression" problem. To avoid this problem, several cointegration estimation techniques have been developed in the econometric literature, one of which, the ARDL framework, is applied here.

[8] Because of its desirable properties as outlined above, the ARDL framework has been employed in a number of recent papers that investigate and estimate trade elasticities, including Bahmani-Oskooee and Kara (2005), Bahmani-Oskooee, Goswamil and Talukdar (2005), and Milberg and Winkler (2010), as well as Chang, Ho and Huang (2005) for the Republic of Korea, Uz (2010) for Turkey, Yin and Hamori (2011) for China, and Grullón (2012) for the Dominican Republic. Earlier empirical literature estimating income elasticities of import demand also applied other econometric methods, though not all made use of cointegration techniques. Kwack and others (2005), for example, conduct a simple OLS panel estimation for a number of countries. Thorbecke and Komoto (2010) present estimates of aggregate trade elasticities for the United States and a number of Asian countries, using the dynamic ordinary least squares (DOLS) estimator developed by Stock and Watson (1993), which adds lags and leads of the regressors. Uz (2010) actually draws on five different methods to estimate long-run (cointegrating) trade relationships for Turkey, including DOLS and ARDL. Yin and Hamori (2011) estimate long-run income elasticities for China using not only the ARDL framework but also the DOLS technique. The present study, however, refrains from using the DOLS approach, since adding lags and leads for the explanatory variables requires the availability of long time series for the variables in the model, a condition not easily met for developing countries, including those that will be the focus of analysis in this paper.

Depending on the F-statistic, this lagged error correction term should be retained or excluded from the equation, with Pesaran, Shin and Smith (2001) providing critical value bounds. If the F-statistic is greater than the upper critical value bound reported by these authors, the null hypothesis of $v_1 = v_2 = v_3 = 0$ is rejected, i.e., the lagged level variables are cointegrated and kept in equation (2).[9]

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[9] See annex 1 for information on data sources and annex 2 for further details on the estimation procedure.

VI

Focus of the analysis and regression results

The central analysis of this paper will focus on one particular intercontinental (or interregional) segment of South-South trade, namely the trade between Asian and South American countries, as well as on intracontinental trade within these two regions. The reason for this choice is that it promises to be a particularly interesting example given that the "scope for exploiting interregional trade (…) is particularly evident between Asia and the Americas" (Shirotori and Molina, 2009, p. 11). Indeed, trade complementarity between Asia, Central America and South America seems to be particularly pronounced (UNCTAD, 2008, p. 14). Taking a look at the list of the sectors that are most traded between the two regions provides some support for this notion. While Asia's exports to the Americas largely consist of products from the manufacturing sector, South America's exports to Asia are dominated by natural resource-based and agricultural products. In addition to analysing interregional trade between Asia and South America, it is also interesting to compare the income elasticities of import demand in interregional and intraregional trade. In line with the gravity model literature, which emphasizes the importance of factors such as geographical proximity, shared borders, a common language, cultural familiarity, etc., as drivers for trade (see Kwack and others, 2005, for example), it can be hypothesized that elasticities are higher in intraregional trade than in interregional trade. This is checked here by analysing elasticities in trade within Asia and within South America.

As stated above, intraregional trade is very important for developing Asia. In fact, 51.8% of all developing Asian exports go to fellow Asian countries within the region (up from 42.2% in 1995). In South America, on the other hand, intraregional trade is not as significant. While intraregional exports have grown fast, and indeed quadrupled during the last 15 years, they have not kept pace with South America's overall exports to the world (which quintupled in the same period), so that the share of intraregional exports in total exports dropped from 24.7% in 1995 to 19.3% in 2011.

The analysis here will concentrate on key players in the two regions, namely China, India, Indonesia and the Republic of Korea as representatives of developing Asia, and Argentina, Brazil, Chile and Peru as representatives of South America. In the final step, it will examine how income elasticities in South-South trade compare with those in South-North trade, as proxied by these countries' trade with the United States and the eurozone (those countries within the European Union (EU) that have adopted the euro as their common currency).

1. South-South trade

The objective of the first set of regressions is to estimate the income elasticities that characterize the different bilateral trade relations in both interregional South-South trade (i.e., between South American countries on the one hand and Asian countries on the other) and intraregional South-South trade (i.e., within South America and Asia, respectively). The coefficients estimated for the income elasticities of import demand for all bilateral trade relations can be found in table 1.

(a) *Income elasticities of South American import demand*
   This study will initially look at bilateral trade flows into South American countries, be they from Asia or from fellow South American countries. As stated above, the income elasticities of South American import demand for goods from Asian or South American trading partners are of particular interest. The estimation results for the corresponding coefficients delivered by the final regression models are shown in rows 1 to 4 of table 1.[10]

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[10] More detailed estimation results, not included in this paper owing to space constraints, are provided in a supplementary annex (annex C). This information is available from the author upon request.

TABLE 1

Estimated coefficients for the income elasticities of bilateral import demand

Importer	Trade partner							
	Argentina	Brazil	Chile	Peru	China	India	Indonesia	Republic of Korea
Argentina	…	0.173***	0.470***	0.394**	0.222**	0.185***	0.255***	0.549***
Brazil	0.629***	…	0.424***	0.407***	0.560***	0.890***	0.599***	0.427***
Chile	0.490	0.715***	…	0.247**	1.543***	0.811***	0.591***	0.628***
Peru	0.517***	0.386***	0.528***	…	0.526***	1.502***	0.494***	0.529***
China	0.375**	0.899***	0.613***	0.465***	…	1.577a (0.705***)	0.936***	0.500a (0.239***)
India	0.254***	1.564***	1.316***	1.797***	0.676a (0.232)	…	0.402***	1.549a (0.737**)
Indonesia	0.761***	0.999***	1.165**	0.285***	0.841***	2.020***	…	0.344***
Republic of Korea	0.751***	0.649***	0.656***	1.118***	0.674***	1.214***	0.500***	…
Eurozone	0.261**	1.126***	0.124	0.532*	0.685***	0.295***	0.462***	1.192***
United States	1.128***	0.913***	1.740***	1.609***	2.606***	0.244	0.288**	0.0218

Source: Prepared by the author.

[a] The short-run income elasticity of import demand, calculated as the sum of all statistically significant short-run coefficients, i.e. $\sum_{i=1}^{n} \beta_i$ (see Debelle and Vickery (1998) or Chatelain and Tiomo (2001)). In accordance with Milberg and Winkler (2010, p. 66), the coefficient estimated for the first differenced income variable is also reported (in brackets).

* Significant at 10%; ** significant at 5%; *** significant at 1%.

Table 1 shows that the income elasticities of import demand in interregional trade flows from Asia to South America range from a minimum of 0.19 (in the case of Argentine imports of Indian merchandise) to a maximum of 1.54 (for Chilean imports from China). More precisely, the income elasticities of Argentine imports from China, India, Indonesia and the Republic of Korea are 0.22, 0.19, 0.26 and 0.55, respectively, indicating that a 1% increase in Argentine income will increase imports from China by 0.22%, from India by 0.19%, from Indonesia by 0.26% and from the Republic of Korea by 0.55%. Meanwhile, a 1% increase in Brazilian income will boost Brazil's imports from China by 0.56%, from India by 0.89%, from Indonesia by 0.60% and from the Republic of Korea by 0.43%. Income elasticities for Chile are quite high at 1.54, 0.81, 0.59 and 0.63 for its imports from China, India, Indonesia and the Republic of Korea, respectively. Finally, if Peruvian gross domestic product (GDP) grows by 1%, the largest impact will be on Peru's imports from India (1.50%) and the smallest on its imports from Indonesia (0.49%). On average, a 1% increase in the income of the four South American countries leads to a 0.644% increase in bilateral imports from the four Asian economies. In other words, bilateral trade flows from Asia to South America are characterized by a simple (unweighted) average income elasticity of import demand of circa 0.6.

Looking now at intraregional trade, table 1 shows that the income elasticities of import demand in trade flows within South America vary from a minimum of 0.17 (in the case of Argentine imports from Brazil) to a maximum of 0.72 (for Chilean imports from Brazil). Trade elasticities are particularly low in the case of Argentina's imports from its fellow South American partners, and only slightly higher for imports by Brazil, Chile and Peru. The simple, unweighted average of income elasticities of import demand in intraregional South-South trade between South American countries is a mere 0.555 (see table 2). Consequently, intraregional trade in South America is generally characterized by lower income elasticities than the subregion's extraregional imports from Asia (which average 0.644), contradicting the hypothesis of this study.

TABLE 2

Simple average of the income elasticities of import demand in South-South and South-North trade

Importer	South-South trade	
	Trade partner	
	Asia	South America
Asia	0.940	0.854
South America	0.644	0.555
Importer	South-North trade	
	Trade partner	
	Asia	South America
Eurozone	0.658	0.511
United States	0.790	1.347

Source: Prepared by the author.

(b) *Income elasticities of Asian import demand*

The second part of this study of South-South trade consists in looking at bilateral trade flows into Asia. Rows 5 to 8 of table 1 report the estimated coefficients representing the income elasticities of Asian import demand for goods from both South American and fellow Asian trading partners.

As table 1 shows, the income elasticities of import demand in interregional trade flows from South America to Asia range from a minimum of 0.25 (for India's imports of Argentine merchandise) to a maximum of 1.80 (for Indian imports from Peru). In general, the income elasticities of the demand for imports from South America seem to be highest on average in India among the Asian countries in the sample. More precisely, the estimated income elasticities of Indian imports from Argentina, Brazil, Chile and Peru are 0.25, 1.56, 1.32 and 1.80, respectively. Meanwhile, a 1% increase in Chinese income is estimated to trigger increases of 0.38%, 0.90%, 0.61% and 0.47% in the country's imports from Argentina, Brazil, Chile and Peru, respectively. In the case of Indonesia, a 1% increase in GDP will raise its imports from Chile the most (1.17%) and those from Peru the least (0.29%). Finally, if income in the Republic of Korea grows by 1%, its imports from Peru will increase by 1.12% but those from Brazil only by 0.65%. On average, a 1% rise in the income of the four Asian countries included in the sample generates a 0.854% increase in their bilateral imports from the four South American economies, i.e., interregional trade flows from South America to Asia are characterized by an average income elasticity of bilateral import demand of circa 0.9.

Before turning to intraregional trade within Asia, a note of caution is warranted in that, in fact, not all the values in table 1 are strictly comparable. In four cases (China's imports from India and the Republic of Korea and India's imports from China and the Republic of Korea), econometric exercises indicated specification problems which led to the abandonment of the error correction term included in the original model.[11] For these four cases, table 1 gives only the short-run effects of income changes on import demand (i.e., the effects of $\Delta lnY_{t\text{-}i}$), while all other entries in table 1 represent long-run income elasticities of import demand. In fact, table 1 reports two figures for these four cases. First, it indicates the sum of all statistically significant short-run coefficients, i.e., $\sum_{i=1}^{n} \beta_i$, as an approximation to the long-run income effects (which is in line with Debelle and Vickery (1998), and Chatelain and Tiomo (2001), for example). Additionally, it reports (in brackets) the coefficient estimated for the first differenced income variables (β_1), following the approach taken by Milberg and Winkler (2010, p. 66).

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[11] In all four cases, as reported in tables C.5 and C.6 of annex C, the F-statistics exceed the upper critical value bound at the 10% significance level as specified by Pesaran, Shin and Smith (2001), indicating that the lagged error correction term should be excluded from the equation. However, since it is the coefficient for the lagged level variable for Y (which is part of the error correction term) that gives us the long-run "equilibrium" income elasticity of import demand, it is only possible to report the short-run income elasticities for these four bilateral trade relationships. For further details, see the explanations provided in annex C.

As can be seen in table 1, income elasticities of import demand in intraregional trade flows within Asia range from a minimum of 0.34 (in the case of Indonesian imports from the Republic of Korea) to a maximum of 2.02 (for Indonesian imports from India). In general, Indonesia reports the highest trade elasticities for its intraregional imports, followed by China, with a 1% increase in Chinese income leading to an estimated 1.58% increase in its imports from India, a 0.94% rise in imports from Indonesia and a 0.50% rise in imports from the Republic of Korea. Meanwhile, income elasticities are also comparatively high in trade between India and the Republic of Korea: a 1% rise in India's income is estimated to expand its imports from the Republic of Korea by 1.55%, while if the Republic of Korea's real GDP grows by 1%, its imports from India will increase by 1.21%. Broadly speaking, intraregional trade between Asian economies is therefore fairly income-elastic. The simple average of the income elasticities of import demand in intraregional South-South trade within Asia is calculated to be 0.94. This value not only exceeds the average elasticities for Asia's extraregional imports from South America (at 0.85), as expected, but is also higher than average income elasticities in intraregional trade within South America (at 0.64) (see table 2), with the latter fact arguably reflecting the more advanced economic integration and more refined production-sharing among Asian countries.

2.   South-North trade

Since this paper is ultimately interested in comparing the promise held out by South-South trade relative to South-North trade, some idea of the income elasticities of import demand in South-North trade is required. As such, the second set of regressions will seek to estimate the income elasticities that characterize the various bilateral trade relations between the eurozone and the United States on the one hand, and Asian and South American countries on the other.

(a)   *Eurozone imports from Asia and South America*
The first step in the analysis of South-North trade looks at trade flows from Asia and South America to the eurozone. The estimation results for the income elasticities of eurozone import demand for Asian and South American goods are reported in row 9 of table 1. There it can be seen that income elasticities are highest for the eurozone's demand for imports from the Republic of Korea (at 1.19) and Brazil (at 1.13), and lowest for imports from Chile (at 0.12) and Argentina (at 0.26),

while also being fairly low for imports from Peru (at 0.53), the fourth South American country included in the sample. Meanwhile, as table 1 reveals, a 1% increase in eurozone income will generate a 0.69% rise in eurozone imports from China, a 0.30% expansion in imports from India, and a 0.46% increase in imports from Indonesia. Overall, income elasticities are thus higher for the eurozone's demand for imports from Asia (averaging 0.66) than from South America (averaging 0.51) (see table 2).

(b)   *United States imports from Asia and South America*
In order to get a more complete picture of South-North trade, the final step of the present analysis consists in estimating the income elasticities of United States import demand for Asian and South American merchandise. The results of the corresponding regressions are exhibited in row 10 of table 1, which shows that the income elasticities of import demand in trade flows from the South to the United States are highest for China (at 2.61) and rather low for the other Asian countries considered here: 0.29 for Indonesia, 0.24 for India and a mere 0.02 for the Republic of Korea. Meanwhile, United States imports from the sample of South American countries are characterized by quite high income elasticities. More precisely, the income elasticities for United States imports from Argentina, Brazil, Chile and Peru are 1.13, 0.91, 1.74 and 1.61, respectively. On average, a 1% expansion in United States income will increase United States imports from the four South American economies by 1.35% but imports from the four Asian countries by just 0.79%. In other words, and contrary to the findings obtained for eurozone imports, average income elasticities are higher for United States demand for imports from South America than for imports from Asia (see table 2).

Comparing the two Northern markets analysed here, it can be observed that, overall, United States import demand is characterized by higher income elasticities than eurozone import demand. While this does not hold true for every single bilateral trade relationship, the simple, unweighted averages reported in the lower panel of table 2 show that average United States income elasticities exceed those of the eurozone for import demand from both Asia (0.79 versus 0.66) and South America (1.35 versus 0.51). Comparing South-North trade flows across regions of origin, one finds that, strikingly, the average income elasticities of Northern demand for imports from South America exceed elasticities in trade flows to the global North originating from developing Asian countries (0.93 versus 0.72).

Before undertaking a comparison and discussion of income elasticities in South-South versus South-North trade in section VII below, it is worth briefly cross-checking the above results with those of other empirical studies. However, in making such comparisons across studies, it is important to keep in mind that there are certain differences in the approaches, methodologies and data used which can explain many of the disparities in their findings. Overall, however, the income elasticities of import demand estimated in this study are similar in magnitude to the results obtained by Bahmani-Oskooee and Kara (2005), who report long-run income elasticity estimates ranging from 0.14 for Japan to 2.10 for the United States. The estimates given herein are also consistent with those of Milberg and Winkler (2010), who find (statistically significant) long-run income elasticities of import demand of 0.77 for Taiwan Province of China, 1.24 for Brazil and 1.86 for Germany, while their estimates for China and India comfortably exceed those reported in this paper.

Meanwhile, Grullón (2012), Yin and Hamori (2011) and Chang, Ho and Huang (2005) report estimates of long-run import elasticities that, on average, are slightly higher than those found here, ranging from 1.37 for the Dominican Republic to 1.86 for the Republic of Korea and 2.66 for China. The same goes for Thorbecke and Komoto (2010), who estimate the long-run income elasticities of different countries' import demand in a range from 1.32 for the Republic of Korea and 1.45 for Taiwan to 2.14 for the United States. Similarly, the

regressions undertaken by Kwack and others (2005) yield coefficients that are somewhat higher than those reported above, ranging from a minimum of 1.05 for Singapore to a maximum of 3.28 for the Philippines. Yet it is important to emphasize that the findings from all these studies are not entirely comparable with those of the present research, since for each country in their sample they estimate "global" income elasticities of demand for imports from all trading partners of the country in question, whereas the income elasticities estimated in this paper are bilateral. Moreover, the latter two of the above-mentioned studies use annual data (in contrast to the quarterly data employed herein), and their dependent variable is real imports in levels, not in first differences as in the present case.

The studies by Bahmani-Oskooee, Goswamil and Talukdar (2005) and Uz (2010) each investigate income elasticities in bilateral trade relations, using quarterly data and the ARDL approach. Both yield estimates that, in general, are higher than those reported in this study. However, these analyses refer to countries that are not included in the present sample, namely Canada and Turkey. While it is difficult to uncover what explains the differences between the findings of these studies and those set out in this paper, it has to be pointed out that Bahmani-Oskooee, Goswamil and Talukdar (2005) employ the ARDL framework but retain the error correction term (including the lagged level variables) regardless of the F-statistics, so that not all of the coefficients they report are statistically significant.

VII

Past and future: a comparison of South-South and South-North trade

The previous section presented the results of an econometric analysis of income elasticities in South-South trade and in South-North trade. They provide mixed evidence for the hypothesis that South-South trade is typically characterized by higher income elasticities of import demand than South-North trade. On the one hand, economic activity in the United States, which is one of the key Northern markets, is characterized by comparatively high income elasticities for imports from the global South and thus

represents an attractive export destination. Indeed, income elasticities of demand for imports from South America (as represented by Argentina, Brazil, Chile and Peru) are highest in the United States, i.e., higher than in intraregional South-South trade (within South America), in interregional South-South trade (from South America to Asia) and in South-North trade from South America to the eurozone (see table 2). When it comes to imports from Asia (as represented by China, India, Indonesia and

the Republic of Korea), United States income elasticities are topped only by those found in intraregional South-South trade within Asia. On the other hand, certain segments of South-South trade are characterized by relatively high income elasticities. This is particularly true for trade flows to Asia. In fact, Asian importers have higher income elasticities for imports from fellow Asian countries than have importers in the global North (the eurozone and the United States) and extraregional trading partners in the global South (South America). Also, the (unweighted) average income elasticity of demand for imports from South America is higher for Asian importers than for the eurozone (while it is lower for the United States, the other key Northern importer). In other words, Asia is quite an attractive destination (in terms of import elasticities) in both intraregional and interregional South-South trade. This does not apply to the same extent to South America, where income elasticities for intraregional trade are higher than those for eurozone imports from South America, but lower than those for Asian and particularly United States imports of South American products. Also, for trading partners in Asia, South America is a less attractive destination (in terms of income elasticities of import demand) than Northern markets.

These findings carry some important implications. For one thing, they indicate that strengthening trade ties with other countries of the global South might indeed be a promising path for developing countries to achieve diversification in growth sources and export markets as well as more stable and sustainable development. This notion is strongly reinforced by the recent export performance of developing countries (see figures 1 and 2), as well as forecasts for their future growth performance and import demand (see figure 3 and table 3). Figure 3 shows economic growth projections, the consensus among economists being that emerging and developing economies will grow considerably faster in the near future than advanced economies. Table 3 fleshes out this prediction by specifying the real GDP growth forecasts made by the IMF for a number of countries in the global North and the global South. Both the chart and the table indicate that in the years to come, developing countries, and particularly those of Asia, will outpace industrial countries in terms of economic growth, in some cases by a large margin. According to the IMF forecasts, economic growth rates will be about twice as high on average in emerging and developing economies as in the advanced economies from 2015 to 2019. While real GDP is predicted to grow at annual rates of between just 1.46% and 1.54% in the eurozone and between 2.22% and 3.03% in the United States, forecasts for major Southern powers such as China and India put growth there as high as 7.28% and 6.77%, respectively. Table 3 reveals that growth forecasts for the industrial countries fall short of those for almost all the developing

FIGURE 3

Selected country groupings: growth forecasts for real GDP and imports, 2016-2020
(Percentages)
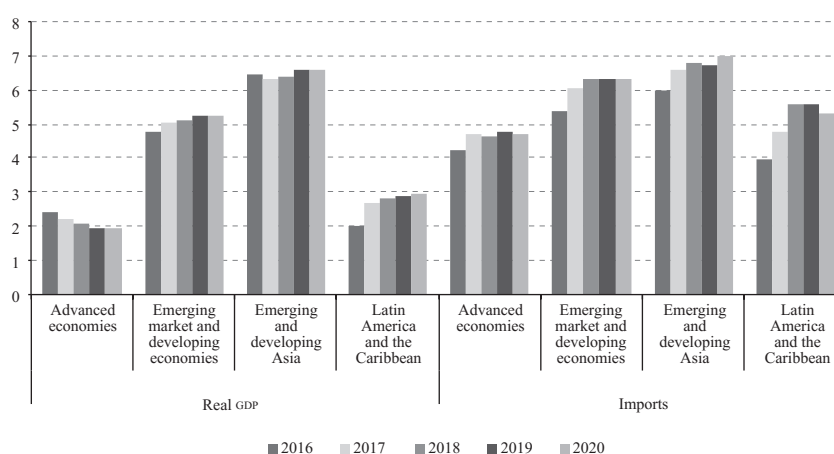
Source: Prepared by the author, on the basis of data from the International Monetary Fund (IMF), World Economic Outlook (WEO) database, April 2015.

Note: GDP: Gross domestic product.

TABLE 3

Selected countries: real GDP growth forecasts, 2015-2019
(Percentages)

Country	2015	2016	2017	2018	2019	Average
Argentina	1.00	1.50	2.00	2.00	2.00	1.70
Brazil	2.65	3.00	3.15	3.34	3.51	3.13
Chile	4.05	4.23	4.50	4.50	4.50	4.36
China	7.28	6.97	6.76	6.63	6.52	6.83
India	6.35	6.48	6.65	6.73	6.77	6.60
Indonesia	5.80	6.00	6.00	6.00	6.00	5.96
Republic of Korea	3.80	3.78	3.82	3.75	3.76	3.78
Peru	5.81	5.80	5.80	5.81	5.80	5.80
Eurozone	1.46	1.54	1.54	1.53	1.53	1.52
Japan	0.97	0.67	0.99	1.01	1.13	0.95
United States	2.95	3.03	2.91	2.59	2.22	2.74

Source: Prepared by the author, on the basis of data from the International Monetary Fund (IMF), World Economic Outlook (WEO) database, April 2015.

countries considered here (the exception is Argentina, whose growth outlook has been significantly revised downward recently) for every single year for which forecasts are available. This has important implications for import demand: higher growth countries or regions are expected to exhibit a faster-growing appetite for imports as well. Indeed, as shown in figure 3, import growth is projected to be consistently between 1.0 and 1.6 percentage points higher in developing countries than in advanced economies over most of the coming years. Wherever they coincide with higher income elasticities, these higher import growth rates indicate that the potential spillover effects from economic activity in one Southern country to another are larger than those for South-North relationships.

However, while the above figures strongly suggest that South-North growth differentials (in terms of both economic activity and imports) will persist, two important caveats have to be borne in mind. First, these are just forecasts, and growth figures may turn out worse than estimated. Some observers, such as ECLAC (2014), are in fact less optimistic, suggesting the world has entered a new period of slow growth that may continue for some

time. Ongoing changes in the world economy, most notably the shift in China's growth model from exports to domestic demand (which has dampened its import demand and its role as an engine of growth for other countries), may well affect import demand elasticities. Second, it is important to keep in mind the difference between levels and rates of change. That is, even if both income elasticities and import growth rates for a given South-South trade relationship are higher than for a South-North relationship involving the same Southern exporting country, the increase in imports triggered by an increase in income in the Northern importing country may exceed the increase in imports triggered by a rise in income in the Southern importing country *in absolute terms* if the difference in the base levels (of income and imports) between the two importing countries is sufficiently large. While this applies to several of the bilateral trade relationships analysed above, the reasoning set out in the concluding section emphasizes the South-North differential in dynamics when assessing, from a policy perspective, the promise that expanding South-South trade holds for the economic development of the countries involved.

VIII

Policy implications and concluding remarks

This paper has put forward some theoretical arguments for strengthening South-South trade links, not least in the context of widespread economic stagnation in the global North and the lessons provided by the recent global economic crisis. It has also documented the dynamic evolution of South-South trade in past decades and presented some indications that this dynamism is likely to continue in the future, further outpacing trade flows involving advanced economies. Meanwhile, the econometric analysis contained in this document, which focused on trade flows concerning a sample of Asian and South American countries and two key Northern markets (the eurozone and the United States), yielded mixed results with regard to the question of whether South-South trade is generally characterized by higher income elasticities of import demand than South-North trade. While relatively high income elasticities of import demand make developing Asia an attractive destination for both intraregional and interregional South-South trade, this is not the case with South America. Moreover, economic activity in the United States, one of the key Northern markets, is characterized by comparatively high income elasticities for imports from the global South, especially from South America, exceeding in many cases the income elasticity estimates for South-South trade relationships. However, the same is not true of the eurozone, where growth in real income triggers only relatively modest increases in imports from the Asian and South American countries studied here.

In terms of policy, the above findings suggest that developing countries should seek to strengthen and expand trade relations with other developing countries and to remove barriers to South-South trade. Accordingly, Fugazza and Vanzetti (2008) find that the emphasis on gaining access to Northern markets represents a missed opportunity for developing countries, as the potential gains from a removal of barriers to South-South trade are much higher (see also Anderson and Strutt, 2011). The main reason for these potential gains resides in the similarity of their stages of development and competitiveness levels, meaning that the countries involved do not have to fear being swamped by imports after trade liberalization. UNCTAD (2008, p. xviii) echoes that argument, stressing that "South-South RTAs [regional trade agreements] can form part of a strategic scenario for enhancing (…)

economic gains for developing countries." Moreover, tariffs, other trade barriers and infrastructure obstacles are often higher for South-South than for South-North trade flows, so there is still quite some scope to facilitate trade flows between developing countries. Liberalization and facilitation of South-South trade can thus further strengthen economic ties between Southern countries, and indeed the number of free trade agreements between developing countries has grown considerably in recent years (see Wignaraja, Ramizo and Burmeister, 2012). Moreover, Athukorala (2011, p. 44) finds that "South-South trade is largely complementary to, rather than competing with, South-North trade", which further reinforces the argument that seeking to expand South-South trade is a sensible strategy for policymakers in developing countries. At the same time, they should strive to diversify and increase the technological content of South-South trade in order to maximize development dividends. This is particularly important in South American countries, as their exports to Asia are often largely confined to a few commodities, which creates vulnerability and limits the contribution of exporting to industrial upgrading, employment creation and broader economic development.

The evidence and arguments presented above provide some theoretical and empirical foundations for such policy recommendations. As has been observed, both economic growth and international trade promise to be more dynamic in the developing hemisphere than in the industrial world. Moreover, to repeat the central finding of the econometric analysis undertaken herein, for certain segments and certain bilateral trade relationships —particularly those involving Asian countries—, South-South trade is characterized by higher income elasticities than import demand from the North. In these cases, further increases in the importing Southern countries' incomes will also benefit their Southern trading partners, which will see demand for their exports grow (with this growth being faster than if incomes in their Northern export markets expanded at the same rate as in the Southern importing countries). This relationship is likely to strengthen further as South-South trade barriers are gradually dismantled.

Taken together, these results suggest that the payoffs from fostering South-South integration might often be

higher than those to be reaped from a further deepening of South-North trade relationships. The findings of this study thus indicate that promoting South-South trade can be a sensible and viable way for developing countries to make foreign trade a more promising and sustainable source of their economic growth. However, further research is needed to substantiate and refine these results, for example across countries and regions. In particular, similar analyses should be carried out for a larger sample of countries, covering South-South

trade flows that involve African economies especially. Moreover, the robustness of the empirical findings needs to be further tested through the application of different estimation methods. South-South trade and cooperation have received renewed attention in the past few years and can be expected to remain high on the agenda of policymakers in developing countries, so any additional empirical analysis will be welcome in their struggle for evidence-based decision-making.

Data sources

Import data were sourced from the Bureau of Economic Analysis (BEA) for the United States and from the IMF Direction of Trade Statistics (DOTS) for the eurozone and the eight developing countries in our sample. Data on exchange rates and GDP deflators or, alternatively, consumer price indices (CPIS) were drawn from the IMF

International Financial Statistics (IFS) database, while GDP data were sourced from the IMF World Economic Outlook (WEO) and IFS databases and from the OECD Statistical Database (OECDStat). All data are quarterly. The number of observations varies for the different bilateral trade estimations, ranging from 43 to 206 (see also annex C). The typical time period covered is from the mid-1990s to 2011 or 2012, but in some cases data reach back to the 1940s.

The estimation process

The first step in the estimation of the coefficients for each individual bilateral trade relationship was to run a regression on the full-fledged equation, i.e.:

$$\Delta M_t^j = \alpha + \sum_{i=1}^{n} \beta_i \Delta \ln Y_{t-i} + \sum_{i=1}^{n} \gamma_i \Delta \ln E_{t-i}^j$$

$$+ \sum_{i=1}^{n} \delta_i \Delta \ln E_{t-i}^j + v_1 \ln Y_{t-1} + v_2 \ln E_{t-1}^j$$

$$+ v_3 \ln M_{t-1}^j + \epsilon_t$$

where ln is the natural logarithmic form, M is demand for imports from country j, Y is real domestic income, E is the real bilateral exchange rate between the home country and country j at time t (defined as the number of units of domestic currency per unit of foreign currency adjusted for domestic and foreign price levels) and ε_t is the random error term. The second step consisted of a reiterative process of eliminating statistically insignificant differenced variables while retaining the lagged level variables. In a third step, an F-test was performed for linear restrictions on the final model, checking whether the coefficients for the lagged level variables for Y,

E and M, which constitute the so-called lagged error correction, were equal to zero, i.e., whether the term $v_1 = v_2 = v_3 = 0$. The results of these F-tests, as reported in the tables in annex C, informed the decision on whether to retain the lagged error correction term or exclude it from the equation. Pesaran, Shin and Smith (2001, p. 300) provide critical value bounds for the F-statistic. If the F-statistic is greater than the critical value bound, the null hypothesis of $v_1 = v_2 = v_3 = 0$ is rejected (the lagged level variables are cointegrated). In table CI(iii), they specify that the critical value bounds for the case with three variables in the lagged error correction term are 3.77 at the 10% level, 4.35 at the 5% level, 4.89 at the 2.5% level and 5.61 at the 1% level, respectively (Pesaran, Shin and Smith, 2001, p. 300). Comparing the results of our F-tests with these critical values, it was decided on a case-by-case basis whether to retain or exclude lagged error correction terms from the equation. In the event that the lagged error correction term is retained, the coefficient for the lagged level variable for Y, i.e., v_1, gives the long-run "equilibrium" income elasticity of import demand for the bilateral trade relationship under consideration. If, however, the lagged error correction term has to be excluded (going by the F-statistic), then only the short-run effect of a change in income on import demand is obtained.

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A multidimensional time use and well-being index: a proposal for Colombia, Ecuador, Mexico and Uruguay

Evelyn Benvin, Elizabeth Rivera and Varinia Tromben

ABSTRACT

This article aims to develop a multidimensional index by integrating time use and well-being dimensions and proposes a conceptual framework based on the assets and the human capabilities approaches. The components of the index identify deprivations, which are understood to be barriers to the development of human capabilities and social justice. The optimum objective is to look beyond monetary metrics when identifying indicators that can better explain how the population, rather than the economy, is progressing and being guided by the principles of distributive justice. This study implements the Alkire-Foster identification and aggregation method (2007 and 2013) and shows the results for four Latin American countries (Colombia, Ecuador, Mexico and Uruguay), using time-use surveys and distinguishing by household type.

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I

Introduction

This article aims to develop a multidimensional index by integrating time use and well-being dimensions and proposes a conceptual framework based on the assets and the human capabilities approaches. The proposed index integrates normative and political aspects of the sexual division of labour, which is understood to be the unequal distribution of activities relating to unpaid work (UW) —including unpaid domestic and care work— and paid work (PW) between women and men. This requires taking a gender– and human-capabilities-based approach in conceptualizing, establishing and measuring "time poverty" and living conditions. First, the daily activities of an individual are identified (by grouping them under UW or PW). Second, minimum or maximum thresholds that an individual must reach in order to be classified as non-poor in terms of real time distribution are defined. Thresholds are also established to identify the population with deprivations in the other dimensions of the index.

Conceptually speaking, one challenge of this article is to explain the implications of treating time as an

asset and to build these theoretical consequences into a multidimensional index from a human capabilities perspective that integrates time and living conditions. Another key challenge is to generate arguments in favour of using multidimensional indices on time use and living conditions as a way to complement income poverty indicators with a view to designing and tracking poverty reduction strategies. Such an index can contribute to public policies through monitoring policies related to unpaid care work, the family (family benefits), employment, transport, fiscal policy and other areas. It can also provide evidence of some of the barriers that women face in terms of their economic autonomy, as well as the lack of distributive justice within the household.

This article is structured as follows. Following the Introduction, which has offered an account of the rationale, relevance and objectives of the proposed multidimensional index on time use and living conditions, section II develops the conceptual aspects related to time use. Section III focuses on the methodology used to develop the index, that is, the unit of analysis, and introductory dimensions and notions regarding the definition of the established thresholds. Section IV presents the results of the index using time-use surveys for Colombia, Ecuador, Mexico and Uruguay. Lastly, section V offers some final reflections on the potential and limitations of this index.

II

Why does time matter for well-being and the development of human capabilities?

1. Time as a key aspect of well-being

Well-being is a multidimensional concept that involves both tangible and intangible factors. Time, one of the intangible factors, refers to an individual's freedom and opportunities to allocate his or her time to the activities he or she considers to be essential for his or her well-being and capacity-building (Robeyns, 2003). In this

regard, time is a high-impact resource for the creation and accumulation of assets and other resources; and restrictions on time[1] represent barriers to the conversion of capabilities[2] into effective functionings. These restrictions

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[1] Restrictions such as the sexual division of labor and the monopoly of power in household decision-making.

[2] The concepts of capabilities and functionings are defined later.

come from social, cultural and historical constructs that have effects at the individual, the household and the social levels[3] (Carrasco, Borderías and Torns, 2011). "Time poverty" is thus understood as a restriction on an individual's freedom and opportunity to establish the amount of time to devote to the activities that he or she values, with negative impacts on his or her present and future well-beings.

Time poverty, arising from the excessive burden demanded by paid work, can negatively affect the well-being of a household, because it restricts the time that can be devoted to unpaid domestic work and care of dependent household members (Robeyns, 2003). However, the opposite can also be argued: an overburden of unpaid work is what generates "time poverty", especially given the unequal distribution between men and women. This situation affects mainly those who usually bear the largest share of domestic work-women.

The vulnerability caused by time poverty has differentiated effects depending on the time constraints it places on an individual, who must rely on his or her own characteristics and capabilities to cope with the limitations arising from time deprivations (Ballet and others, 2014). In other words, an individual's degree of vulnerability is part of his or her heterogeneous responses to time poverty and the way it restricts individual and family well-being. Bittman and others (2005) emphasize the link between time poverty and social exclusion, which is an inverse relationship insofar as a smaller allotment of free time can increase social exclusion.

A different current of thought may argue that the gender inequalities caused by the sexual division of labour have an unclear impact on well-being, given that women's overburden of domestic work in the household could arise from a free, informed and consensual decision among the members of the household. This overburden may represent the highest value activity among those from which an individual has the opportunity and freedom to choose. In this case, the overburden of paid work may not imply a constraint of the factors of transformation of capabilities into effective functionings and thus may not harm individual well-being.[4] However, in this study this is considered to be a conservative interpretation of the capabilities approach, because it assumes that an

individual's well-beings will not be affected when he or she makes free and informed decisions based on his or her individual preferences. Even when decisions are free and informed, individual decisions may be highly influenced by cultural norms and social expectations regarding traditional gender roles and the sexual division of labour, which confine women to the private sphere and exclude or discourage them from participating in the public world.

2.   Time as a resource

In the 1970s, most of the conceptual discussion on time poverty defined time as a "resource." Vickery (1977) and Gronau (1977) defined time in their models as a resource that can be used for production activities in the market, as unpaid work in the form of unpaid care work within the household or invested in personal leisure and rest. Time considered an asset is a particular kind of asset, because it is a fixed resource that is egalitarian for the entire population (Goodin and others, 2008). Although time and income differ in this regard, Johnstone (1960) argued that they have the same problem: how can they be efficiently and successfully allotted on a day-to-day basis in accordance with the preferences of each person or household? This question must be understood in a context in which most of the population has limited time and income that must be distributed among a variety of spending and investment needs and alternatives.

Bardasi and Wodon (2009) suggest that, unlike with income, assigning more time to an activity is not always better. Given that time is a limited resource, assigning more of it to paid or unpaid work necessarily means devoting less of it to leisure and entertainment, which could heighten time poverty. Conversely, if an individual sacrifices consumption of certain basic goods in order to be able to afford other basic goods, the utility function remains unchanged; hence, this change would not be considered to impact negatively on an individual's well-being.

Conservation of resources theory defines resources as personal characteristics, conditions, or energies that are valued by the individual or that serve as a means for the attainment of other resources (Hobfoll, 1989, cited in Adkins and Premeaux, 2012). This definition treats time as an important resource for individuals who value it. This could generate an analytical gap between time and income, because income is generally assumed to be highly valued while this may not necessarily be the case for time. Accordingly, it is important to recall that individuals do not value all resources equally, and that

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[3]   Specifically, in time allocation, an individual interacts with the factors involved in the process of transforming individual capabilities into functionings.

[4]   An extensive body of literature exists on feminist economics' critiques of the "new economy of the family." This may be reviewed in Carrasco (1991).

personal preferences and sociocultural factors play a role in this appreciation.

Conservation of resources theory and its link with (deprivation of) time use implies that, as with income, the marginal benefit of each minute or hour depends on the level (or intensity) of use of the resource time. In other words, even if time per se represents a deprivation, the quality of the remaining or unused time that can potentially be distributed among different activities is a factor that a poverty indicator would have to consider. Burchardt (2010) notes that the yield of time use varies among the population, depending on individual income. For example, an hour in the time of a worker in the upper income deciles can be exchanged for one of many activities. However, the options are more limited for workers in the lower income deciles, since this segment of the population has fewer options for procuring services in the market to broaden their opportunities beyond domestic work.

However, whether or not time is treated as a resource does not prevent its conceptualization as a facilitator of or a barrier to "capabilities" and its potential effects on well-being.

3. Time as a facilitator of or a barrier to human capabilities

The concept of capabilities[5] refers to the set of vectors of functionings or "beings" and "doings" that encapsulates an individual's freedom to lead the type of life he or she considers worthwhile (Sen, 2000). Treating time as a factor that, given the freedom and opportunities,[6] facilitates the transformation of capabilities into effective functionings[7] for paid and unpaid work implies that an individual's capabilities should be assessed not by the resources and assets he or she possesses, but by

the effective exercise of freedom and opportunities to allocate his or her time among the activities he or she values. The allocation of time among the activities that an individual values is important because it is closely associated with his or her well-being (Stiglitz, Sen and Fitoussi, 2009) and is related to distributive justice.

The capabilities approach paves the way for a broader comprehension of inequality between the sexes than an approach based on the comparison of primary goods or resources (Sen, 2000). The distribution and allocation of time can be seen as the outcome of interrelating micro-inequalities, in the context of resource distribution and power use within a family unit. Brighouse and Robeyns (2010) thus argue that gender inequalities affect the access to opportunities to combat inequalities between caregivers and non-caregivers and the gender division within households. This argument adds further layers of complexity to the question of time poverty measurements or indicators, perhaps including the concepts of socioeconomic justice, freedom and individual agency.

According to Fraser and Honneth (2006) and Fraser (2009), claims for social justice divide into two types: distributive claims seeking a fairer distribution of resources and claims for recognition. Fraser (2009) integrates the two types in an approach that supports, from a normative and methodological perspective, the design of an indicator for public policy monitoring.[8] For the purpose of this research, it is important to consider the different theoretical approaches to socioeconomic justice grounded in recognition. This helps to answer the following questions: how can claims for socioeconomic justice in the (re)distribution of time between PW and UW be resolved? In what context or at what level —individual or collective— do the two approaches to socioeconomic justice (recognition and resource distribution) interact? How is justice served through recognition and how is it complemented by resource distribution?

One of the aims of analysing time as a facilitator or barrier to human capabilities individually and within the household is to help change patterns of time distribution that are based on inequality and the absence of freedom and distributive justice.

In keeping with this idea, time poverty represents a restriction on beings and doings and reflects a lack of access to capabilities. Sen (1992 and 2000) emphasizes the complementarities between an individual's different capabilities and his or her reliance on the characteristics of others and of the settings in which they live, including

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[5] Sen (1992 and 2000) and Nussbaum (2011) introduced the concept of capabilities in the study of social justice and freedoms, respectively. Sen's capability approach (1992 and 2000) is a "moral theoretical framework" which proposes that social structures must be appraised by the scope of freedom people have to pursue or attain the functionings they value. Another characteristic of the capabilities approach is the role of moral considerations and ethical principles, and the concern for justice, such that everyone can develop the capabilities they value in a context of equal opportunities for all within the "universe of capabilities" (Alkire, 2002).

[6] In the capabilities approach, opportunities refer to functionings, which are defined as what an individual is capable of being or doing.

[7] Robeyns (2003) establishes that the difference between functioning and capabilities is similar to the differences between achievements and the freedom to achieve, or the difference between results and opportunities. Capabilities together correspond to the freedom an individual has to achieve what he or she values (p. 63).

[8] Public policies aimed at achieving redistribution of resources and recognition in pursuit of greater social justice.

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justice. Although they have an intrinsic value, many of these capabilities are also a means to expand other capabilities that serve to increase well-being.

Conversion or transformation factors are also societal and, as argued by Brighouse and Robeyns (2010), this is the aspect of the capabilities approach that supports the argument for eliminating inequalities between men and women, because they affect women's capabilities to transform means or resources into functionings.

From the human capabilities and the gender approaches, time poverty must be conceptualized at the individual, the intra-household and, thus, the relational levels in terms of the preferences, restrictions, freedoms and opportunities that an individual has at the moment of time allocation. That allocation may or may not lead to time deprivation for an individual or other household members. For example, an individual may not lack time if another member of the household has transferred part of his or her time, sacrificing his or her own well-being (or not). Consequently, this transfer may be considered intra-household solidarity.

Recognition of time, as a resource that can be affected by conversion factors (internal in relation to the individual, social or within the household), is closely related to the recognition of unpaid caregiving, paid work and leisure as capabilities. Time is a resource and a means that, together with factors of conversion, throws into stark relief the influence of the sexual division of labour and the expectations and social norms associated with it and, hence, the "agency" that individuals have to make decisions that differ from social expectations. There is, of course, no such thing as a definitive list of human capabilities. Sen (1992) leaves the definition of capabilities open and insists that they should be defined among different voices, with sensitivity to gender differences, because it would be harmful not to consider these differences. Nussbaum (2003) proposes a list of basic capabilities for human development, among which a necessarily universal capability is receiving and giving care.

Level of individual agency (Sen, 2000) and lack of income autonomy are causes and effects, or both, of the interaction between time poverty and inequalities at the personal, family and social levels. An important assumption in the study of time poverty is that individuals with greater agency are less likely to be time-poor, either temporarily or permanently. Sen (2000) defines agency in terms of "someone who acts and brings about change, and whose achievements can be judged in terms of her own values and objectives." Consistently with the capabilities approach, Pick and Sirkin (2010)

propose the concept of agency as one that assumes more freedoms and responsibilities, increasing the sense of personal investment in development. These authors also describe agency as a concept that requires behaviours and decisions from individuals who do not perform according to external expectation and evaluation. Consequently, in a context of unequal time distribution, an individual with weaker agency is likely to be more time-poor than an individual who has stronger agency and is thus able to delink decisions from external expectations and assessments. It may be asked whether this act of delinking is a requirement or necessary condition for the use of capabilities —in Sen's terms— and for the exercise of agency.

Where external restrictions or structural barriers result in the absence of justice, an individual is not in a position to exercise economic autonomy. Lack of economic autonomy represents a deprivation of freedom when a person cannot, for example, devote time to PW, because UW restricts the distribution of time use. Consequently, UW becomes a barrier to entry to PW and the exercise of freedom. When an individual cannot exercise agency and freedom, the factors that limit his or her real possibilities of overcoming time poverty become more powerful. ECLAC views economic autonomy, freedom and socioeconomic justice as core components of individual and social well-being (ECLAC, 2014). Economic autonomy is a manifestation of the capability to exercise individual agency in the distribution of time among activities that contribute to well-being. The concept of freedom is one of the normative notions regarding the preconditions that have the potential to ensure that an individual may exercise agency.

4. Time poverty: remarks and assumptions regarding its definition

The concept of time poverty has been developed more empirically than theoretically. Rather than a comprehensive theory on time poverty, what exists is a set of assumptions that are still in the process of being defined. These are identified below.

In general terms, the poor population is identified on the basis of socioeconomic conditions that are considered to be unacceptable in a given society. Poverty has been conceptualized, on the one hand, as deprivations in terms of access to goods, services and income necessary to support a level of well-being accepted as a minimum in a society; and, on the other hand, as an unacceptable degree of inequity in social arrangements (Sen, 1992).

The conceptual development of time poverty integrates notions of equality, equity, distribution, freedom and recognition of injustices within the household. These are all notions that, together, are considered factors that explain part of the time allocation among activities that individuals value. The identification of deprivations —associated with inequity within the household and in the labour market— is one of the contributions of feminism, which emphasizes the effects of the sexual division of labour and women's excessive work burden on time poverty. Women —besides engaging in paid work— contribute most of the UW in households (ECLAC, 2013c).

The first assumption, the most common in the literature on time poverty, is the consideration of time as a resource, along with the negative influence that an individual's lack of freedom and agency exerts on time distribution. This distribution is markedly influenced by the unequal division of labour between women and men, and by the low social and economic value attributed to unpaid work compared with paid work (Jain, 2013, cited in ECLAC, 2013c).

A second assumption has to do with the trade-off between PW and UW at the individual and social levels. It may be asked whether this applies to men and women alike, or may be applied rather to those who value PW and UW equally. The existence of this trade-off is also called into doubt by the question of whether the trade-off is between time and income.

A third assumption is that an individual with less power within the household (Chiappori and others, 2011), weaker agency (Pick and Sirkin, 2010), and less influence over household spending decisions (Bonke and Browning, 2003) is the one who allocates a larger portion of his or her time to UW. Consequently, those factors restrict equitable allocation of UW time between the members of the household. Restrictions associated with lack of freedom in time allocation have effects for the population's living standards and income.

The allocation of time to PW potentially generates resources to meet the needs of individuals and their families and enables them to attain economic autonomy. Time poverty affects the well-being of the population in a different manner, depending on economic status. Thus, time poverty makes households that are not income-poor vulnerable, or more vulnerable. For example, individuals employed in lower-productivity and lower-income sectors are more likely to assign more time to PW, than their peers, in an attempt to make up for their low wages. As a result, employed individuals have fewer hours to devote to UW and leisure, to the detriment of family and household well-being.

The fourth assumption is that time poverty is a restriction on family well-being and on personal human development. Vickery (1977) and Goodin and others (2008) argue that a household needs enough time, as well as income, to maintain a minimum level of production to ensure its well-being. This is a basic premise among time poverty metrics, on the understanding that an individual and his or her household need more than income alone to function properly. Specifically, viewed in terms of the empirical development of well-being indicators, this assumption refers to a positive balance between family and work, among other quality-of-life criteria.

The fifth assumption concerns inequality in the free allocation of time among income groups in the population. The lower-income strata find it more difficult to substitute UW for market consumption of domestic labour and mercantilized care. Workers in these strata are highly likely to have an excessive total work burden (total time spent on PW and UW) and to become time-poor, as well as to belong to the income-vulnerable group. Lower-income individuals may, for example, receive time transfers to offset their lack of access to market care services, which can ease their time deprivation. For this reason, surveys and household survey modules on time use must include questions aimed at identifying the origin and destination of UW delivered outside the household of its providers.

The sixth assumption is linked to the very heterogeneous needs that household have in order to function. These needs arise from the cycles they experience in the production of unpaid domestic and care work, depending on their composition (number of dependants: children and older persons) and stages of life of their members (Douthitt, 1994). The study of UW focuses on the allocation of time to unpaid care and domestic work and its core questions in relation to time poverty and household life cycles include: what is the minimum amount of time that must be allocated to UW for a household to function at different stages of the family life cycle? What is the smallest relative contribution to UW that an individual can make in the household without impinging upon another household member's allocation of time to PW and leisure?

Unlike poverty measurements based on basic needs, time poverty is not only based on the notion of access to social minimums, but also emphasizes the lack of control over, or freedom to use, resources —in this case time and

income— or assets in pursuing the satisfaction of material needs (Goodin and others, 2008, and Gammage, 2009). Conversely, traditional poverty measurements offer an approach to material deprivations or shortfalls in living standards, represented by a shortage or the precariousness of resources, goods or access to public services (Feres and Mancero, 2001). This latter approach to poverty is part of the conceptual framework that treats income and material goods as the main proxies of well-being.

A key question for poverty measurement and analysis is: can an individual or household be considered poor if their time allocation decisions lead to a higher level of economic well-being contingent on a greater deprivation of time? There are probably different answers to this question, but they would be limited if the arguments were informed only by one-dimensional time poverty indicators. It may be methodologically challenging to answer this question by means of indicators that use other variables in addition to time, but it is also necessary in order to arrive at a better understanding of poverty and its manifestations.

Durán (2007) adds that individual time poverty is more temporary than structural, inasmuch as the life cycle of individuals and their households determines most of time poverty. This is to assume that, once dependent children who are in need of direct care move to a stage of indirect care, parents can free up, in an equitable manner, the time they previously devoted to direct caregiving. Understanding that this example is determined largely by gender roles, Durán (2007) shows the importance of shedding light on how these roles establish time distribution between women and men. How close or far individual decisions and behaviours are to these roles partly determines the freedom and flexibility to allocate time between PW, UW, personal activities and leisure time. A time poverty indicator could be said to represent the notion of distributive justice, insofar as it recognizes that the reinforcement in time allocation has to do with gender roles that affect choices among potential alternative functionings and adjust them to social expectations. The emphasis, as well as an advantage, of developing a definition of time poverty from the gender and the capability approaches is that if an individual is time-deprived, this may be understood as a restriction on the freedom to choose between different combinations of activities that impact on time allocation, which could undermine individual well-being.

The majority of time poverty indices have shown gaps, trends or changes in the phenomena they study and have specifically measured functionings or outcomes rather than capabilities. For example, absence of the capability for healthy living and good nutrition is treated the same, whether the individual lacks the capability for healthy living and good nutrition or fasts by his or her own free and informed decision and preference. This example applied to time poverty as a restriction on capabilities, indicates the complexity of identifying an individual as time-poor without knowing his or her preferences or at least intention in an imaginary scenario of time distribution change. This considers the challenge of including questions on preferences and expectations regarding the current and future redistribution of time use by the population.

Time poverty measurements can be grouped into one-dimensional and two-dimensional measurements. The main objective of one-dimensional studies is to identify an individual's time deficit after the chronological allocation of his or her PW and UW activities and how this relates to income poverty in the population deprived of discretionary time (Goodin and others, 2008). Conversely, two-dimensional time poverty studies aim to identify the population whose poverty status is conditional on their shortages of time and income (Zacharias, 2011). This study supports the idea that two-dimensional time-income poverty measurements suffer from a major limitation: the gender perspective is confined to the disaggregation of the indices by sex. For this reason, two-dimensional time-income poverty measurements are constrained in terms of enabling a deeper understanding of the inequalities and injustice regarding recognition and valuation of women's contribution to unpaid work in the household.

The following section develops a multidimensional index using the assumptions identified in the literature on time poverty. The dimensions of the index are treated as "spaces" in which individuals can exercise their freedom and agency in the distribution of time between PW and UW. Of the conceptual frameworks reviewed in this section, the capabilities approach helps to show how a multidimensional index can reveal barriers at the individual and the household levels that reduce the freedom and equity of its members, and determine the cases in which the distribution of time use is a matter of injustice. At the same time, using the concept of justice in the framework of the human capabilities approach implies that justice and its approach through the development of a multidimensional index must be sensitive to the ability of individuals to transform their capabilities into effective functionings.

III

Methodology of the well-being index

1.   Description of the data: time-use surveys

The data sources are time-use surveys conducted in four countries in the region: Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007). These surveys correspond to those available at the time of the research. Table 1 summarizes the methodological information relating to these surveys.

Women work more than men: on average in the four countries, total work time is 45.9 hours per week for men, and 52.5 hours per week for women (see figure

1). Analysing work by type reveals the sexual division: women carry an UW burden three times that of men. The level of UW (unpaid care and domestic work) is also uneven for women but even for men, after controlling for level of education, income, civil status, dependants in the household, activity status and age.

Life cycle is another important element in the analysis: men and women both work most during the 25 to 45 age range. This is also the age group in which the gaps between men and women are the largest (see figure 2).

TABLE 1

Description of time-use surveys

| Country/year	Purpose and universe	Classifier	Sample size and coverage	Methodological aspects
Colombia (2012)	To generate information regarding the time that the population aged 10 years and older devotes to work and personal activities.	CAUTAL ICATUS	46 310 households; national coverage.	List of activities during the 24 hours prior to the interview.
Ecuador (2012)	To generate information regarding the time that individuals aged 12 years and over distribute among paid activities, unpaid activities and free time.	CAUTAL	23 400 households; national coverage.	List of activities during the week.
Mexico (2009)	To measure the time individuals aged 12 years and over devote to daily activities and to provide statistical inputs necessary for measuring all forms of work, including paid and unpaid work.	CMAUT ICATUS	16 925 households; national coverage.	List of activities during the week.
Uruguay (2007)	To provide information regarding participation in unpaid activities and different types of unpaid work, and the time household members, both male and female, aged 14 years and over, spend on these activities.	ICATUS	4 200 households; national coverage.	List of activities during the week.

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

Note: CMAUT: Mexican Classification of Time-Use Activities; ICATUS: International Classification of Activities for Time Use Statistics; CAUTAL: Classification of Time-Use Activities for Latin America.
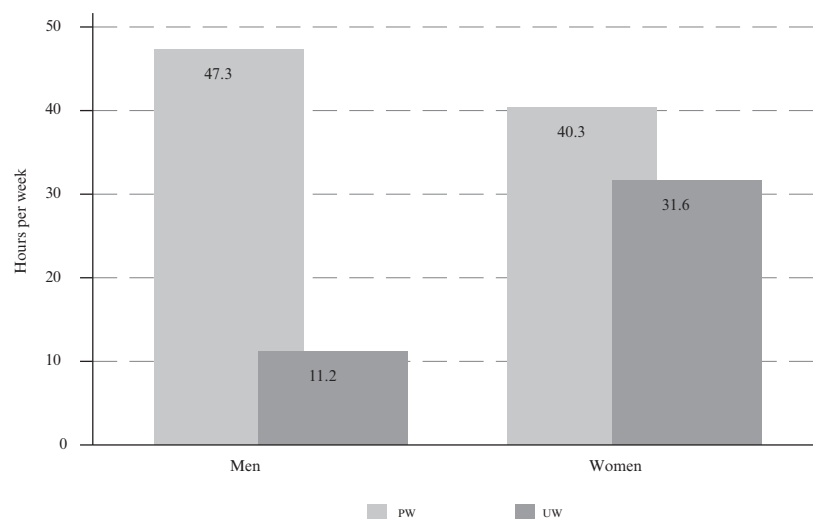
FIGURE 1

Colombia, Ecuador, Mexico and Uruguay: time spent on PW and UW, population aged 15 years and over and employed population
(Hours per week)

A. Population aged 15 years and over
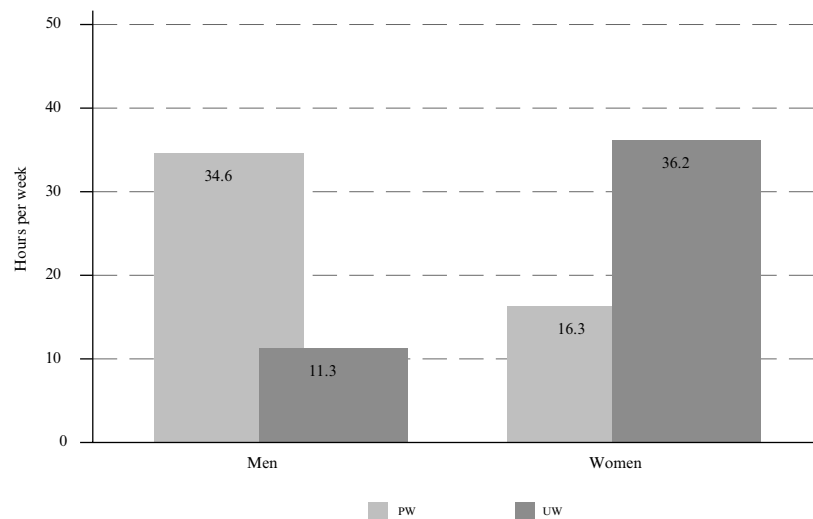
B. Employed population

Source: Prepared by the authors, on the basis of special tabulations of data from time-use surveys from Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007).

Note: Simple averages; PW: Paid work; UW: Unpaid work.

FIGURE 2

Colombia, Ecuador, Mexico and Uruguay: time devoted to PW and UW by age group, population aged 15 years and over
(Hours per week)
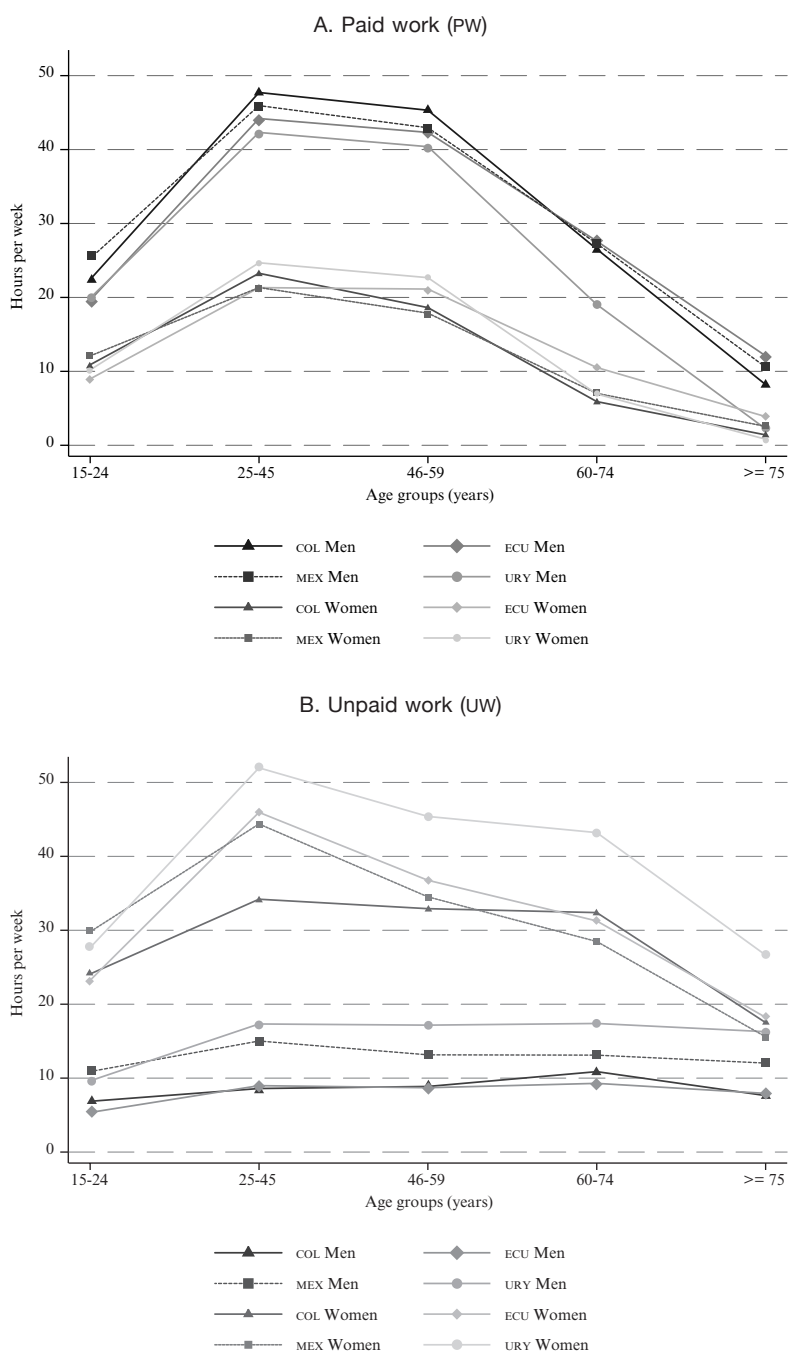
A. Paid work (PW)

B. Unpaid work (UW)

Source: Prepared by the authors, on the basis of special tabulations of data from time-use surveys from Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007).

Note: COL: Colombia; ECU: Ecuador; MEX: Mexico; URY: Uruguay.

These findings have been widely reported in different studies (see ECLAC, 2010a, 2010b and 2013c; Merino, 2010 and 2012). This article takes a step further in the analysis by looking within households and analysing how time devoted to UW is distributed among its members. Figure 3 shows the percentage of the contribution to UW made by men and women within the household. For the total population (left panel of figure 3.A), on average, the male figure in the household (male head of household or spouse) contributes 22% of the household's total UW, while the female figure (female head of household or spouse) contributes 57%. The remainder (22%) of the total UW time performed in the household is carried out by other members (children, other family members or other adults). These proportions indicate small variations by activity status (centre and right panels of figure 3.A).

In the percentage contribution by type of household, the widest gap between men and women occurs in the case of two-parent households: while women contribute on average 64% of the household's UW, men contribute just 18% (centre panel of figure 3.B). In the case of composite and extended households (left panel of figure 3.B), men and women both make a smaller contribution, reflecting the greater contribution of other household members. Lastly, single-parent households (right panel of figure 3.B) are notably the only case in which men contribute more UW than women.[9]

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[9] Only 11.3% of men are heads of single-parent households, compared with 31.4% of women.

FIGURE 3

Colombia, Ecuador, Mexico and Uruguay: contribution to household UW
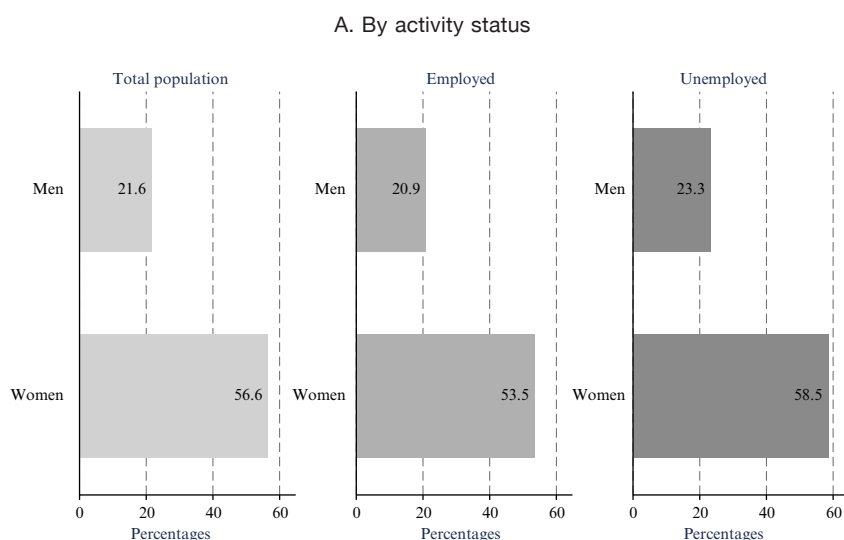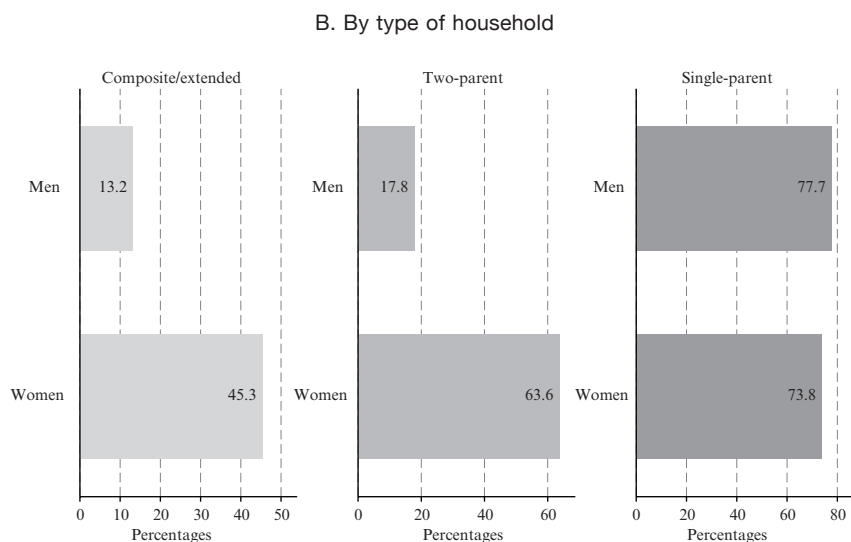*(Percentages)*

A. By activity status

Figure 3 (concluded)

B. By type of household

Source: Prepared by the authors, on the basis of special tabulations of data from time-use surveys from Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007).

Note: Unpaid work (UW) refers to average hours per week spent on domestic work, unpaid care work and voluntary work. In the four surveys used, the interviews were administered to all household members over the ages of 10, 12 or 14, depending on the country (see table 1).

2. Defining the unit of analysis: the household

Individuals share not only a roof and their income (regardless of how equally it is distributed), but also time and its distribution within the household. Individuals in multi-person households do not distribute their time independently of the other household members. A debate within contemporary feminism questions self-determination as a notion that establishes time distribution, insofar as self-determination is understood to be a relational and group-based notion. In other words, the idea of a man or a woman exercising self-determination after a process of reflection and prioritization of preferences is understood in the context of relations between individuals.

The inequalities between men and women regarding time distribution in PW and UW are considered not only from the gender perspective, but also in terms of the link to the composition and the structure of the household, and the individual and family life cycle. The overburden of PW and UW has a structural and time-bound component from the household perspective. Consequently, the analysis is conducted at the household level because the members have different capabilities that are interrelated with individual and relational decisions on time allocation and its distribution.

Defining the household as the unit of analysis means considering the interrelations among its members

as key aspects regarding: the allocation, distribution and valuation of paid and unpaid work. This implies treating the household as a space in which economic activities are performed, and hence as an extension of the labour market.

This study also proposes an analysis by household type (size and composition), in order to shed light on demographic patterns that may affect multidimensional poverty measurements. It should be noted that taking the household as the unit of analysis does not result in the underestimation of time poverty and poor living conditions, since, by construction, individual multidimensional deprivation always depicts less poverty than household deprivation multidimensional measures (Díaz, 2013).

The remainder of this section analyses different types of households: (i) two-parent nuclear; (ii) single-parent; (iii) one-person; (iv) composite and extended with two parents (spouses and heads of household), and (v) other composite and extended. In all cases, persons (including their dependants) performing domestic work for pay were excluded from the calculations. For this research, the household types defined are based on those established by the United Nations Statistics Division,[10] but slightly

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[10] See [online] http://unstats.un.org/unsd/demographic/sconcerns/fam/fammethods.htm.

modified: composite and extended households were grouped together, and separated into two subgroups by the presence or absence of a spouse in the household.

3.   Defining the dimensions and their indicators

The proposed index has five dimensions: time use, living conditions, economic autonomy, education and social exclusion. The indicators most used in multidimensional poverty measures are those that capture deprivations in housing (overcrowding and precarious materials), in basic services (water, sanitation and energy) and in education, owing to their significance and the availability of information from the household surveys. This work

follows the proposal by ECLAC (2013b) regarding these usual dimensions and adds others referring to time and economic autonomy. Table 2 set outs the dimensions, indicators and weightings that compose the multidimensional index.

The dimension "time use" is composed of two indicators: one for PW and the other for UW.

Indicator 1: time for UW, which includes unpaid domestic and care work. The household is deprived if at least one of its members shows an individual contribution (in percentages) to total household UW of less than 50% of the median (the median contribution per type of household) for the female population aged 15 years and over.

TABLE 2

Dimensions and indicators of deprivations and their weightings

Variables	Indicator of deprivation: the household is deprived in this dimension if for at least one household member…	Weighting
Dimension I: time		
Time for unpaid work	The individual percentage contribution to UW (unpaid care + domestic work) is less than 50% of the median contribution of women, by type of household.	1/10
Time for paid work	The number of hours is greater than the weekly ceiling according to national legislation.	1/10
Dimension II: living conditions		1/5
Lack of access to an improved water source	In urban areas: the water source is different from the public water system.	1/30
	In rural areas: the water source is unprotected well, bottled water, mobile water sources, stream, river, rainwater, other.	
Lack of a waste disposal system	The dwelling lacks a hygienic sewage disposal system or service connected to the public sewerage system or a septic tank.	1/30
Lack of electrical power	The dwelling is without electricity.	1/30
Cooking fuel harmful to health	The household uses fuelwood, coal or waste for cooking fuel.	1/30
Precarious housing materials	Most of the dwelling is made of precarious materials.	1/30
	Most of the roof of the dwelling is made of precarious materials.	
	The dwelling has dirt flooring.	
Overcrowding	There are three or more persons per room.	1/30
Dimension III: economic autonomy		1/5
Labour income	The daily wage is less than twice the minimum daily wage (53.19 Mexican pesos)	1/10
Population without independent income	At least one individual (except students aged 15 and over) in the household has no independent income.	1/10
Dimension IV: education		1/5
Non-attendance at school	At least one child of school age (6 to 17 years) in the household does not attend school	1/10
Adult educational lag	At least one adult aged 30 or more in the household does not have a minimum level of education. Individuals aged 30 to 59: have not completed primary education or have no schooling. Individuals aged 60 and over: have no education.	1/10
Dimension V: social exclusion or vulnerability		1/5
NEET (not in education, employment or training)	At least one adult aged 18 to 29 in the household is not working or in education or training (unemployed + inactive).	1/10
Access to health	At least one individual in the household is without access to the national health system.	1/10

Source: Prepared by the authors.

Including an indicator on time allocation for UW in a multidimensional well-being index is intended to shed light from a gender perspective on individual contributions to total household work related to unpaid caregiving and intrahousehold domestic work, because it identifies the sexual division of labour within the household. Consequently, the proposed indicator incorporates the gender perspective from its creation, and not through disaggregation by sex. Another argument in favour of this indicator is that it includes a component of social justice, because it distinguishes the individual contributions to unpaid care and domestic work made by the main adults in the household —spouses and heads of household— from those made by other household members. Statistical analysis of the components of this indicator shows that for each subthreshold —type of household— the cut-off point between deprived and non-deprived households should be 50% of the median time allocated to unpaid care and domestic work by women. It is, therefore, a relative threshold.

This indicator may contribute to identifying the population and the households that have fewer opportunities and gender inequality in the exercise of unpaid care work and UW capabilities.

Identifying a minimum allocation of time to UW is based on a real situation that represents one of the restrictions on women's development of capabilities and depends upon the disproportionate contribution of women to unpaid work (UN-Women, undated). In this context, identifying the sector of the population that is deprived in terms of UW is crucial for providing evidence of gender inequality within the household.

Subthresholds by type of UW (unpaid domestic and care work) and by household type are used to identify the differences between household types in terms of structure and potential distribution of UW among its members. Burchardt (2010) argues that in the case of domestic work, a minimum absolute time allocation can be established, based on the domestic needs of a household of a certain composition. However, this article does not use this type of indicator, because given the heterogeneity of household types —and even if thresholds could be identified for each type of household, depending on its composition— defining an absolute threshold would require an extensive discussion and agreement on the minimum amount of UW that households need in order to function.

For example, in the case of Mexico, for illustration purposes, in nuclear two-parent households, 51.7% have at least one individual with deprivations associated with unpaid care and domestic work (see table 3). A household is considered deprived if it meets at least one of the following conditions: (i) the head of household contributes less than 38.5% of the domestic work and less than 24.1% of care work, considering the total time allocated to these two components of unpaid work in the household, or (ii) the other members of the household[11] contribute less than 8.2% and 9.3% of the total time assigned in the household to domestic and care work, respectively.

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[11] That is, household members other than the head of household or spouse, excluding dependants over 80 years of age.

TABLE 3

**Mexico: value of subthresholds by household type and intrahousehold groups,
and count of deprived households by indicator 1**

Household type	Groups within the household	Cut-off point for individual percentage contribution to domestic work	Cut-off point for individual percentage contribution to care work	Households deprived in both components of the indicator
One-person	Head of household and/or spouse	50.0	…	3.3
Composite or extended	Head of household and/or spouse	24.6	11.4	67.5
	Other household members	10.7	10.0	
Two-parent	Head of household and/or spouse	38.5	24.1	51.7
	Other household members	8.2	9.3	
Single-parent	Head of household and/or spouse	40.5	25.0	25.1
	Other household members	14.1	16.1	
Composite or extended without spouse	Head of household and/or spouse	23.5	10.0	47.0
	Other household members	15.5	13.9	

Source: Prepared by the authors, on the basis of tabulations of data from the survey on time use (EUT) of Mexico, 2009.

Indicator 2: time deprivation in relation to excess or overburden of PW, in accordance with national legislation. A household is considered deprived if at least one of its members spends a total number of hours on PW greater than the maximum PW time established in national legislation.

Before defining this normative threshold, several relative cut-off points were tested based on the statistical distribution of the data of the relevant population. Accordingly, the median time of PW of employed persons aged 15 years and over was estimated, and 75% of this median was taken as the minimum threshold of time to be devoted to PW.

This indicator defines PW time deprivation in normative terms: a household is considered time-deprived owing to an excessive PW burden if at least one of its members allocates more than the weekly hours allowed in the national legislation to this purpose. An overburden of PW, according to Mexican legislation, means that an employed person works more than 57 hours per week (ILO, 2013). So, if at least one of the main adults or non-dependent adults in a household works more than 11.4 hours per day on average, that household will be time-deprived. Notably, 52% of the individuals who were PW time-deprived were also deprived in relation to UW.

A key question concerns the proportion of paid workers working more than the legal maximum hours and receiving labour income of two minimum wages or less (this being one of the indicators of the dimension "economic autonomy"). In the case of Mexico, 38% of the employed population works hours in excess of the legal maximum and earns two minimum wages or less. This shows the situation of the employed in terms of income and PW time as rather different from that portrayed in the literature, which focuses on the long work hours of high-income workers (Warren, 2003). On the contrary, this 38% of the employed wage-earning population works long hours for earnings that are insufficient to reach the middle of the income distribution of the employed population.

A possible alternative threshold is to consider the households in which at least one of the employed members (aged 15 years or over) works a total number of hours less than 75% of the median PW hours of the employed as deprived. Using a cut-off point of 100% of the median doubles the percentage of individuals with this deprivation. This alternative threshold was discarded, because in the process of presentation and

discussion of this indicator it was difficult to agree on the policy implications of a poverty indicator for PW based on a minimum.

The development of the rest of the components of the multidimensional index was based on chapter I of the *Social Panorama of Latin America 2013* (ECLAC, 2013b), in which multidimensional poverty was constructed on the basis of six dimensions (water and sanitation, energy, housing, education, income and exclusion). The proposal here follows this model with two exceptions. First, all aspects related to housing —water, sanitation, energy, materials and overcrowding— are grouped into a single dimension. Second, income is analysed as a function of the concept of economic autonomy, defined as "women's capacity to generate income and personal financial resources, based on access to paid work under conditions of equality with men. This parameter takes into account time use and women's contribution to the economy." This encompasses a more general concept of freedom, a fundamental factor in ensuring women's human rights in a context of full equality. It is crucial to identify households in which at least one member (excluding dependants) is deprived of economic autonomy, because this brings in a key dimension for the potential development of other capabilities. Part of the objective of this dimension is to show that, below a minimum level of economic autonomy, an individual is likely to find it difficult to develop other capabilities because of the limitations inherent in deprivation of economic independence.

The dimension "economic autonomy" includes two indicators:

Indicator 1: labour income. A household is considered deprived if at least one of its members has a daily wage of less than twice the legal minimum daily wage (in the case of Mexico: 53.19 Mexican pesos).[12]

Indicator 2: population without economic autonomy. A household is considered deprived if at least one mature individual (aged 30 years or more) —excluding students and dependants aged over 80 and the permanently disabled— has no independent income from paid work.

[12] The amount corresponds to the average minimum daily wage in the year 2009 (information from the Secretariat of Labour and Social Security).

IV

Results of the multidimensional index components: incidence, intensity and M_0

The results for the multidimensional time and living conditions index for Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007) are presented below.

Figure 4 shows the gross household count per indicator. In the dimension of time: between 45% (in Mexico) and 65% (in Colombia) of households are deprived in the indicator for UW. With respect to the PW

indicator, the count fluctuates between 19% (Colombia) and 34% (Uruguay) of households. In the four countries, the smallest percentage of deprived households occurs in the dimensions associated with housing conditions (except sanitation), and non-attendance at school. The high gross counts for economic autonomy in all the countries are notable.

FIGURE 4

Gross household count rate per deprivation indicator
(Percentages of households)
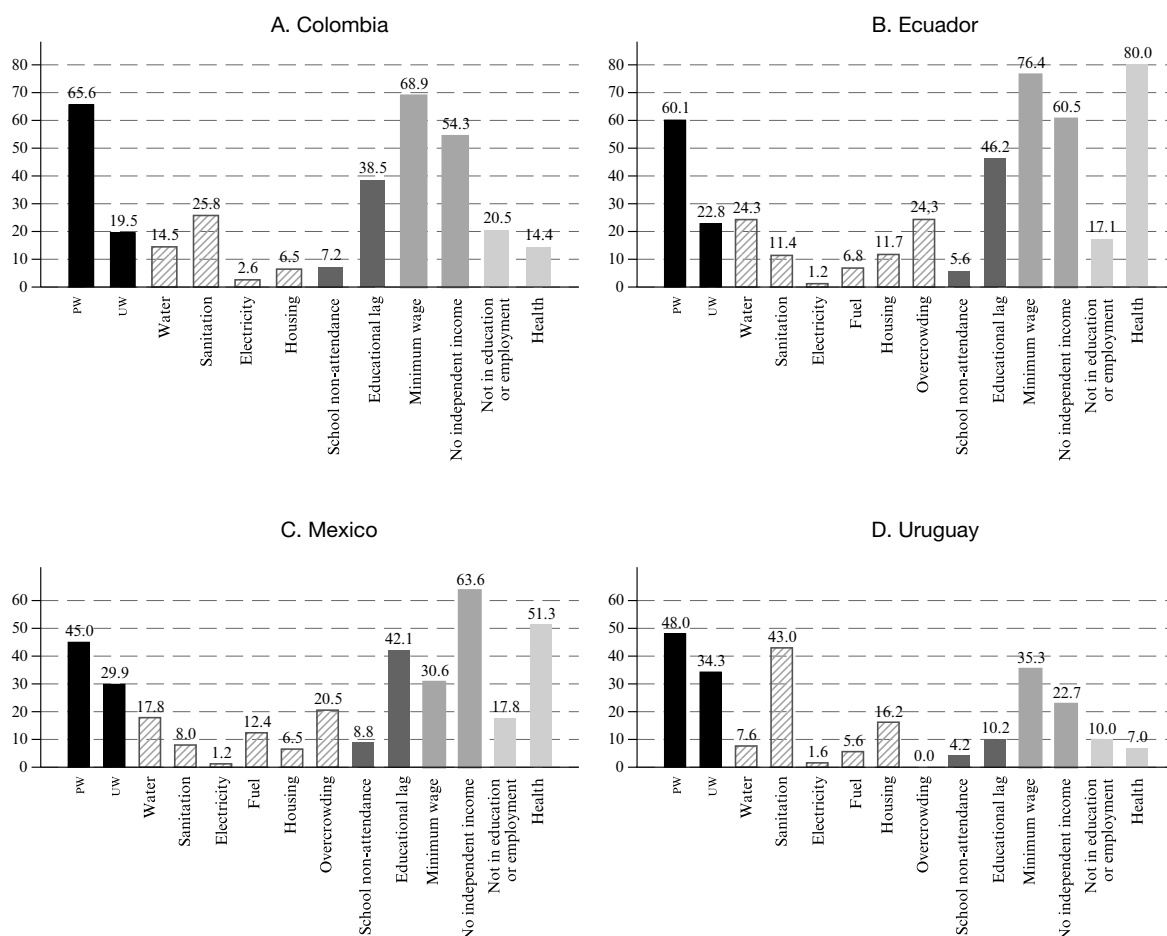
Source: Prepared by the authors, on the basis of tabulations of data from time-use surveys of Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007).

Note: PW: Paid work; UW: Unpaid work.

The household count rate (H or incidence) of poor households falls substantially as the number of deprivations included rises (estimated cut-off point or k considered a threshold of deprivation distinguishing between multidimensional poor and non-poor). Figure 5 shows that between 80% and 98% of households have deprivations of at least 10%. Lastly, with a multidimensional threshold (k) equivalent to 30% of deprivations, the multidimensional household count rate varies between 25% (in Uruguay) and 78% (in Ecuador) of households (see figure 5, left panel). For these households, the average deprivation varies between 35% and 45% (figure 6, right panel). Figure 6 shows the results for M_0,[13] according to the different k values. The rest of the article analyses the results for $k = 30\%$.

One of the most useful properties of the Alkire and Foster (2007) multidimensional poverty methodology, from the point of view of public policy, is its decomposability.[14] The largest contributions to the multidimensional index (M_0) at the national level are made by the following dimensions: economic autonomy, time, exclusion and education. Figure 7 shows the detail for each country.

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[13] The Alkire and Foster methodology (2007) defines multidimensional poverty of the adjusted headcount ratio as: $M_0 = H*A$.

[14] This is an extremely useful property for generating poverty profiles and targeting very poor groups.
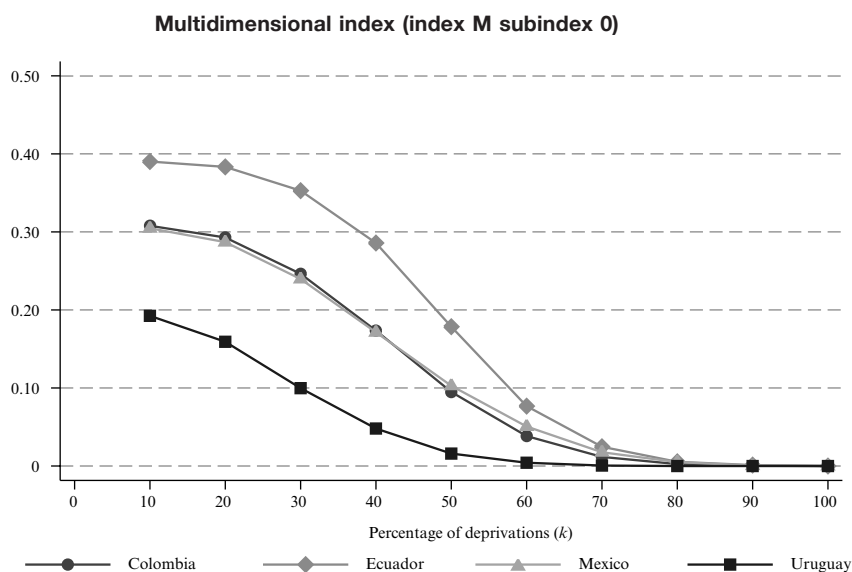
FIGURE 5

Household count (H) and average deprivations among poor households (A)
(Percentages of households and average percentage of deprivations)
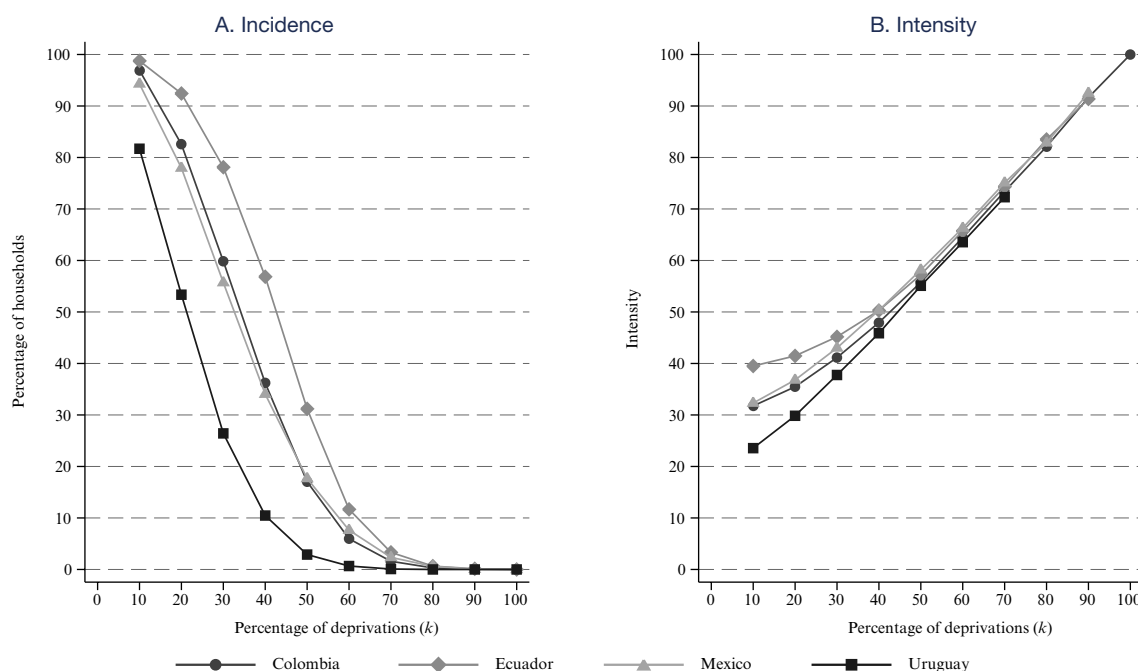
Source: Prepared by the authors, on the basis of tabulations of data from time-use surveys of Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007).

FIGURE 6

Multidimensional index (index M subindex 0)

Source: Prepared by the authors, on the basis of tabulations of data from time-use surveys of Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007).

FIGURE 7

Colombia, Ecuador, Mexico and Uruguay: contributions of the dimensions to the multidimensional index (M subindex 0)
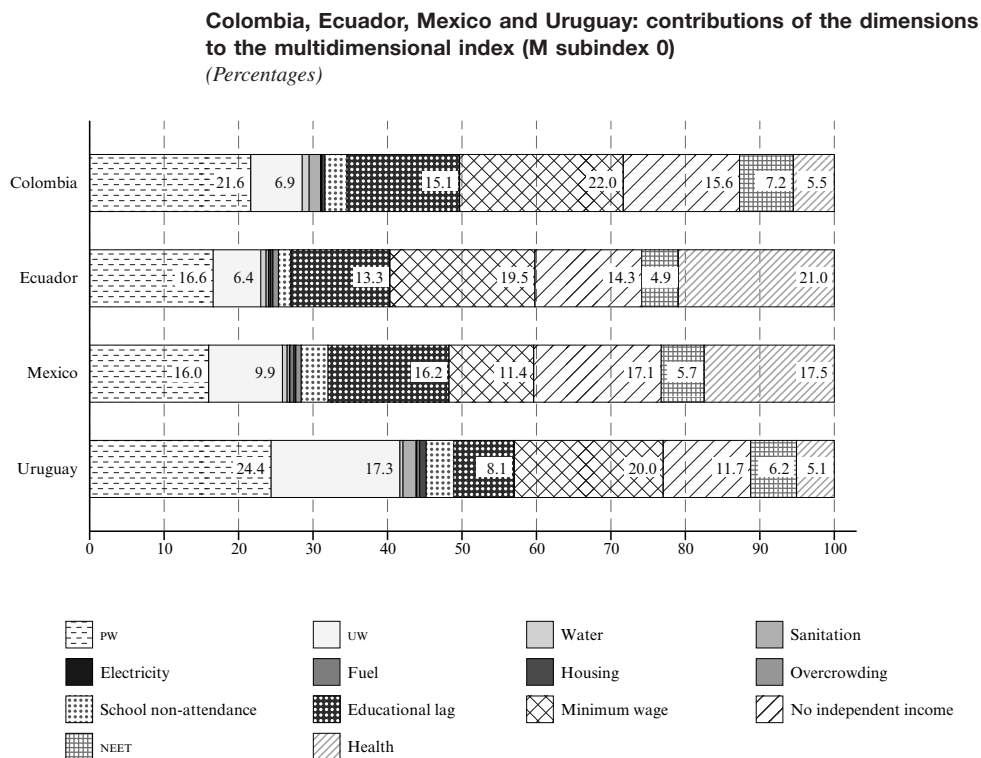*(Percentages)*

Source: Prepared by the authors, on the basis of tabulations of data from time-use surveys of Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007).

Note: PW: Paid work; UW: Unpaid work; NEET: Not in education, employment or training.

1. Decomposition of the multidimensional index: analysis by type of household

The multidimensional index captures different levels of deprivation by household type. Controlling by type of household, composite and extended households show a greater incidence of multidimensional poverty of time and social conditions. It is important to note that the variability in the incidence of poverty between household types moves within a range of 15% and 85% with $k = 30\%$. However, among poor households of all five types, the intensity of poverty is less variable than its incidence, with values ranging from 34% to 45%, the percentages that represent average deprivations experienced by each type of household (see figure 8).

FIGURE 8

Household count ratio (H) and intensity (A) of poverty, by type of household
(Percentages)
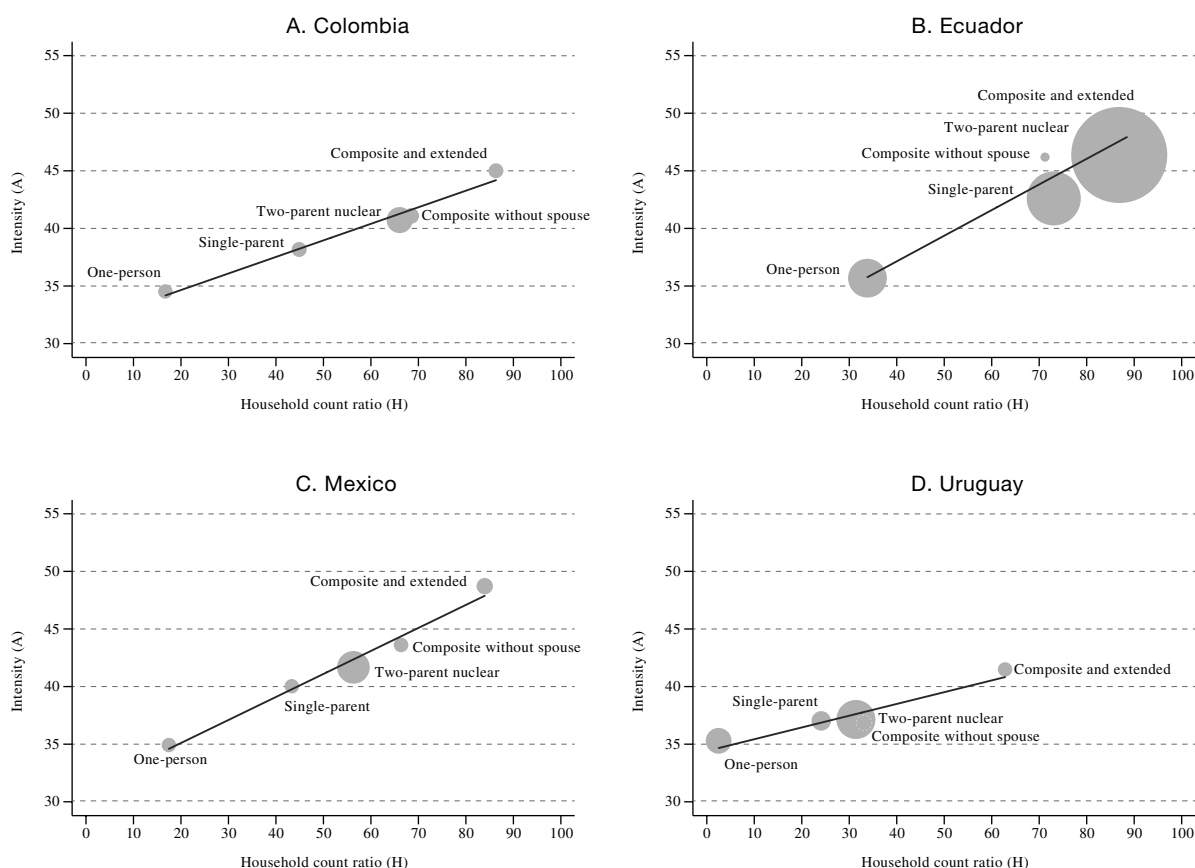
Source: Prepared by the authors, on the basis of tabulations of data from time-use surveys of Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007).

Identifying the percentage contribution by household types to the incidence and intensity of the multidimensional indexes with $k = 30\%$ shows that two-parent households contribute a greater proportion to both incidence and intensity and to M_0 than other types of household (figure 9 shows the relative contribution to M_0). This finding reveals two-parent households as those in which the sexual division of labour and its effects on deprivations in relation to time and other aspects of living conditions (housing, energy and access to water and sanitation in the household) are greater than in other types of household. One-person

households are those making the smallest contributions to these variables. One argument that could explain this smaller contribution is the type of indicators involved in the time dimension, since, for example, the time indicator for unpaid caregiving and domestic work is aimed at integrating the concept of justice and the gender component in the context of a household and the allocation of time to both types of uw. Accordingly, one-person households present no deprivations in this indicator because they have no structural counterpart to visualize excessive sexual division of labour between the members.

FIGURE 9

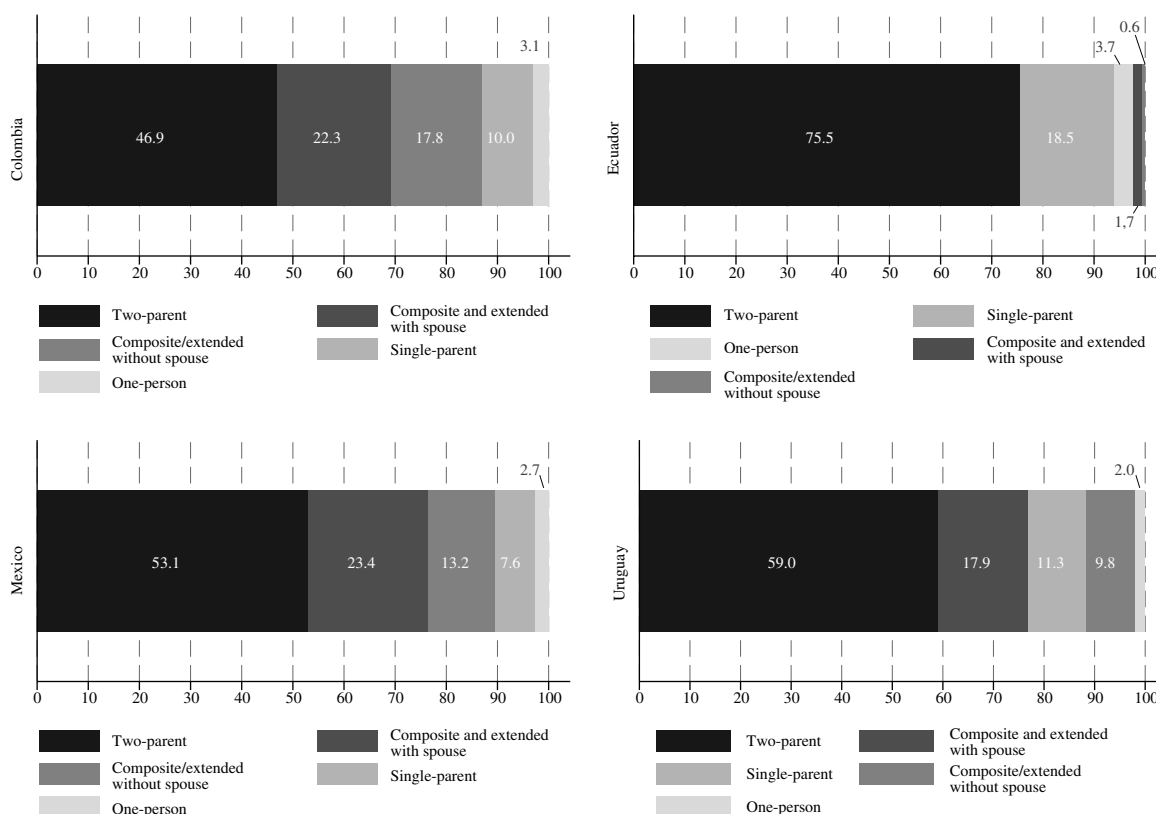**Relative contribution of household types**
(Percentages)

Source: Prepared by the authors, on the basis of tabulations of data from time-use surveys of Colombia (2012), Ecuador (2012), Mexico (2009) and Uruguay (2007).

V

Final remarks

There is concern over guaranteeing women's rights and building individual, family, community and institutional capabilities to generate the spaces and opportunities for the exercise of substantive freedoms in the context of socioeconomic inequality and lack of distributive justice. Today, this concern has different connotations from those of the mid-twentieth century. Modern policy and social efforts are focused on the development of mechanisms to promote the development of human capabilities and eliminate all forms of discrimination against women.

These shifts in vision should impact on rights and the development of capabilities in four spheres. First, the delegitimization of all forms of social, cultural and economic violence that limit women's freedom to make decisions regarding the use and development of the set or combination of capabilities that they value (including capability for leisure, PW and UW). This delegitimization must also be accompanied by public policies informed by an in-depth understanding of the contexts and sectors of the female population, where social exclusion and inequalities have built up and become entrenched throughout their life cycle.

Second, efforts to identify the barriers and facilitators of human development are already present among policy-makers' objectives. However, from the point of view of human development and capacities it is crucial to identify virtuous capabilities, i.e. those that generate spaces for the development of other capabilities (Wolff and De-Shalit, 2007).

Third, the effects of the sexual division of labour on the living conditions of households and their members can be better understood from a multidimensional perspective, in which deprivations, violation of rights and exclusion mechanisms not only integrate with political power, recognition, and opportunities for agency and social justice, but also impact on the distribution and exercise of human rights. In these circumstances, access to employment by household members can produce significant changes —for better or worse— in household socioeconomic status, which can generate shifts in power dynamics within the household.

Fourth, deprivations in tangible resources (income) and intangible resources (human and social capital) shape contexts in which barriers arise to the development of capabilities for paid work and economic autonomy.

These deprivations translate into barriers to human development, because they increase the likelihood of household insecurity regarding the provision and distribution of goods, resources and recognition among their members.

Difficulties in changing the vision of these social issues are determined in part by the four spheres mentioned and have major implications for social policy aimed at increasing women's participation in the labour market. From a multidimensional and dynamic perspective, lack of distributive justice within the household and the inequity this produces are not limited to the precarious material conditions in which lower-income groups live, effective opportunities for achieving functionings or developing the capabilities that they value. Consequently, the deprivations of individuals cannot be resolved by one-dimensional programmes, but require political strategies to increase their substantive freedom through intersectoral programmes, for example. It may thus be argued that in households in which at least one member lacks economic autonomy and is also time-poor, the effects of the determinants of poverty on individual well-being are more structural than temporary. This contrasts with the assumption that time poverty is limited to particular stages of an individual's life cycle. In this context, it is fundamental to develop strategies to attack the multidimensional phenomenon of the deprivations of a household and its individuals through social programmes capable of helping to overcome these deprivations, even if only one household member is deprived in one of the factors or determinants of a decent state of living. At the same time, it is important to motivate policies aimed at eliminating discriminatory practices in households, formal and informal social institutions and the labour market.

The quest for a multidimensional vision of social policy to complement targeted strategies for eradicating income poverty must include a discussion on well-being and living conditions, not only of the proportion of the population living in poverty, but also of the vulnerable sectors (those with difficulties in consolidating a secure economic situation). Although the determinants of poverty vary in relative importance between the two groups, in both cases, for women performing PW, an overburden of UW limits opportunities to develop other capabilities. This is evident in this article: the high

contribution women make to the total UW required for a household to function or to meet the caregiving needs and UW demands of their dependants and even non-dependants.

A set of actions emerge in this article that are important for policies aimed at promoting the exercise of substantive freedoms that people value. For this, the development model must change its standard vision of minimum skills, competences and guarantees for an approach based on the development of human capabilities in Latin America.

A first challenge is to advance towards a shift in vision with respect to the determinants of well-being that have traditionally been used as proxies for living conditions, and include the impact of cumulative inequalities and tangible and intangible deprivations in the measurement of well-being. The second challenge is to advance towards a national development model on the basis of gender equality. This vision should include identifying the contribution made by the determinants of deprivations in terms of time and living conditions. This analysis may then serve as a basis for identifying patterns of convergence and divergence between the different countries. Identifying patterns will then contribute to the development of a "typology" based on models of human development and capabilities, which will support the analysis of policies on unpaid care work, distributional social justice at the household level, and on incorporating women into the labour market from a multidimensional perspective.

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Intersectoral flows of technological knowledge in emerging countries: an input-output analysis

Eduardo Gonçalves and Amir Borges Ferreira Neto

ABSTRACT

In this paper, we aim to assess the production, use and diffusion of technology in the production structure in emerging countries, such as Brazil, China, the Russian Federation and South Africa, through the analysis of: (i) users and producers of technology; (ii) research and development (R&D) content in each group of sectors, and (iii) technical knowledge flows between these groups. We use input-output matrices combined with sectoral R&D statistics to achieve our objectives. Our major findings point to significant differences among the emerging countries and also between developing and developed countries, including differences in sectoral hierarchy in terms of production and use of technological knowledge, and differences in the direction of main technological flows among sectors.

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I

Introduction

According to Lundvall (2011), Brazil, China, India, the Russian Federation and South Africa play a major role on the international scene that goes beyond their territorial boundaries, population contingents and total outputs. Part of their importance is associated with changes in their national innovation systems in recent years, which have led them to become knowledge producers alongside Europe, Japan and the United States of America.

However, which of these countries are best characterized as knowledge producers? And which economic sectors are best qualified to generate and diffuse technological knowledge? Although these countries share features typical of emerging countries that have undergone late industrialization processes —including import substitution, varying degrees of economic opening and technological dependence in technology-intensive sectors— there might be differences among them in the process of sectoral technological accumulation.

In this paper we analyse the intensity of use and production of technological knowledge, and the intersectoral knowledge flow in Brazil, China, the Russian Federation and South Africa. More specifically, we try to answer the following questions: (i) what are the main sectoral differences in terms of production and use of technological knowledge? (ii) How do our findings relate to those of other studies on developed countries? (iii) Is there homogeneity in this particular group of emerging countries in terms of sectoral hierarchy and technological knowledge flows?

The productivity of a sector in a given economy depends on its own efforts in R&D, but also on the efforts of its trading partners, as such interrelations occur. For this reason Schmookler (1966), for example, associates technological performance improvements in one sector with innovative efforts coming from the other sectors in an economy. Hence, the technical knowledge produced in a given sector is not constrained by its own R&D expenses, since intersectoral purchases and sales allow sectors to incorporate knowledge embodied in inputs and capital goods.

Although trading of final goods, capital goods and intermediate inputs may be a channel through which

spillovers occur (Macdissi and Negassi, 2002), the mere acquisition of technology cannot enhance the innovative capacity of an importing country. That country will need a concomitant local R&D effort in order to benefit from the import of technology. Local effort develops absorption capacity and allows technological learning, which enables the catch-up process (Fu, Pietrobelli and Soete, 2011; Li, 2011; Viotti, 2002). In order to analyse emerging countries, we therefore needed a methodology that would weight the importance of the various sectors in an economy in terms of production of technological knowledge in relation to the use of technological knowledge from domestic and foreign sources.

Hence, in methodological terms, we follow the tradition introduced by Scherer (1982); Papaconstantinou, Sakurai and Wyckoff (1998); Wolff (1997); Van Meijl (1997); Sakurai, Papaconstantinou and Ioannidis (1997); Vuori (1997); Verspagen (1997), and, especially, Hauknes and Knell (2009), whose work combines input-output matrices and R&D data, allowing us to measure product-embodied R&D diffusion from domestic and foreign sources.

We use input-output matrices for Brazil, China, the Russian Federation and South Africa (data were from 2005 for Brazil and South Africa and from 2000 for China and the Russian Federation). For China, the Russian Federation and South Africa, we use input-output matrices from the Organization for Economic Cooperation and Development (OECD) and R&D data from the Analytical Business Enterprise Research and Development (ANBERD) database, while for Brazil we use data from the technological innovation survey (PINTEC), conducted by the Brazilian Institute of Geography and Statistics (IBGE).

In addition to the Introduction, this paper comprises five sections. Section II presents an empirical and theoretical review of the literature. Section III provides a brief discussion on the national innovation systems in the selected countries. In section IV we present information on the databases used, and in section V we describe all the methodologies used and their results. Section VI presents our conclusions.

II

Theoretical background

Mansfield (1971) emphasizes the importance of external sources of knowledge, ideas and innovations, affirming that their main external source is the flow of technology from one sector to another. Pavitt (1984) notes an empirical regularity that made it possible to construct a taxonomy confirming the existence of such intersectoral flows of technology and knowledge. Robson, Townsend and Pavitt (1988) also find sectoral differences deriving from the production and use of innovations. In view of the different patterns of sectoral innovation, Malerba (2004) proposes the existence of a sectoral system of innovation encompassing the variety of specific knowledge bases, technologies, production processes and many others aspects that characterize all economic sectors.

Pavitt's taxonomy (1984) points to similarities and differences among sectors with regard to the sources, nature and impacts of innovations. The taxonomy comprises three groups of sectors: (i) supplier-dominated sectors; (ii) production-intensive sectors (which in turn can be broken down into scale-intensive firms and specialized suppliers), and (iii) science-based sectors. These three sectors show different innovation patterns, depending on their technology sources (which include R&D laboratories, among others), user requirements (price, performance and reliability) and property rights (trade secrecy, patents, natural and lengthy technical lags, and other, non-technical means).

Firms belonging to supplier-dominated sectors (such as textiles, lumber, wood and paper products, printing and publishing, construction and services) provide small contributions to their product and process technologies, but most of their technological innovations come from equipment and materials suppliers. In scale-intensive sectors, such as automotive and steel industries, process innovation is important and its sources are both internal (R&D and learning by doing) and external (producers of equipment). Specialized-suppliers, such as equipment producers, also have both internal and external sources of technology. Tacit knowledge and knowledge gained from the experience of more skilled workers can be cited as examples of internal sources, while user-producer interaction is an example of an external source. Science-based sectors, such as pharmaceuticals and electronics, are characterized by high rates of product and process innovations, R&D expenditure

and scientific research carried out in universities and government institutions.

Innovation pattern differences and technological interdependence only become visible when we study input-output relationships in the economy. The advantages of using input-output matrices to study innovation benefits can be seen in the work of Rosenberg (1982), who emphasizes the need to consider inter-industry relationships in order to measure the benefits of technological innovation to society. According to this author, transferring technological change from one sector to another through sales of intermediate goods has significant implications for the understanding of productivity growth.

Bell and Pavitt (1993) state that, as far as developing countries are concerned, linkages between users and producers are sometimes weak or absent, which has negative repercussions on the possibilities for technological diffusion and capital stock efficiency.

In some developing countries, the expansion of capital goods industry and scale-intensive sectors was not accompanied by the development of sectors producing instrumentation and specialized and complex machinery or science-intensive sectors. Thus, these sectors are underrepresented in such economies, setting the stage for the historical process of technological dependence and the need to import technical processes. The industrialization process in emerging countries showed sectoral weakness, creating gaps in technological matrices, especially in technology diffusion sectors, such as the capital goods industry. This has historically weakened their national capacity to create new products and processes.

The technological activity of developing or late-industrializing countries is generally limited to adapting products and processes to the local conditions or improving them. More complex activities, such as developing new products and processes and conducting basic research, are less common in such countries (Fransman, 1985).

This difference in technological qualification is related to the historical routes taken in the industrialization processes of economies, which in turn create structural differences between economies considered to be developing and those considered to be developed. One reason can be traced to import substitution policies that, according to Ranis (1984), produced losses in terms of local

technological activities, owing to the focus on "getting things done" and obtaining technologies available on the world market, especially in combination with policies allowing the free entry of capital goods.

The consequences of an industrialization process that fails to internalize the capital goods segment can be evaluated based on Rosenberg (1976), who highlights the essential role played by the machine-tools sector as both producer and disseminator of new skills and techniques in the economy, in response to specific customer orders.

Some developing economies succeeded in the process of catching up with the technological frontier. Japan is considered the most successful example (Fransman, 1985). Other countries adopted industrialization models that emphasized building the absorption capacity of domestic firms. Using an active learning strategy to assimilate sources of technological information from foreign industries, such as capital goods imports, technological licensing and foreign direct investment (FDI), economies such as that of the Republic of Korea acquired the ability to copy and, later on, make incremental innovations in various consumer and capital goods (Viotti, 2002).

The examples from Asia, in particular the countries known as the "Asian tigers," showed that a successful industrialization and catch-up process involved more than absorbing embodied technology in capital goods, as it required the acquisition of complementary skills and the facilitation of linkages and spillovers between economic sectors (Van Dijk and Szirmai, 2006).

According to Bell and Pavitt (1993), developed countries differ from developing countries, and developing countries differ from each other, in terms of technological accumulation for three reasons: (i) depth and intensity of intra-firm technological accumulation; (ii) institutional infrastructure related to education and training institutions and to greater investment in human capital by some firms, and (iii) complementarities between the import of technology and local technology accumulation, where

the acquisition of foreign technology (through FDI, joint ventures, licensing) has been complemented by domestic R&D efforts to build technological absorption capacity.

The particularities of technological accumulation in emerging countries that did not follow the same trajectory as Asian economies such as Japan, the Republic of Korea and Taiwan Province of China, produced economies with the following characteristics:

(i)   A low proportion of R&D expenditure devoted to technological effort, not only in the economy as a whole, but also in the more technology-intensive sectors (medium-high and high technology).

(ii) High expenditure on technology embodied in inputs, machinery and equipment —largely imported from countries on the technological frontier and from other emerging countries— as a proportion of the total amount spent on innovation.

The modest weight of R&D expenditure in the economic structure of developing countries is related to low representation of the most intensive R&D sectors, such as science-based sectors. Thus, we wish to confirm the following hypotheses: first, Brazil, China, the Russian Federation and South Africa do not present a sectoral hierarchy similar to that found in developing countries in terms of their capacity for technological production. Based on differences in terms of sectoral weight in the input-output structure of each economy, we can formulate a second hypothesis to test: the direction of technological knowledge flows will be different between groups of sectors. For example, high-technology (science-based) sectors may emerge as net receivers of technological flows, whereas sectors considered as intermediate in terms of the use and diffusion of technological knowledge, such as specialized suppliers and scale-intensive sectors (Hauknes and Knell, 2009), may take on the role of net suppliers of technology. The direction of such flows within each group of sectors will also depend on the characteristics of each country, given the heterogeneity of their industrial and technological trajectories.

III

General features of production and innovation systems in emerging countries

National innovation systems should not be understood only as an innovative process stemming from R&D, but also as a manifestation of several different dimensions that encompass production structures, human capital, and financial and credit systems, among others (Cassiolato and Lastres, 2011). Hence, the relative position of each national innovation system reflects a different set of historical conditions in each country.[1]

Although there is some heterogeneity with regard to political systems, economic policies and structural features, some common characteristics and tendencies can be distinguished among the countries selected for study (Brazil, China, the Russian Federation and South Africa):

(i) All four countries implemented import substitution policies and had economic opening strategies, albeit to differing degrees (UNIDO, 2012).

(ii) Energy resources have accounted for a high proportion of the total production of all four countries. While China has been excelling in the renewable energy field (wind energy), Brazil has great potential in hydroelectric power. The contribution of natural resources to economic development has been of great importance in these countries, especially Brazil and South Africa. Thus, technological accumulation in emerging countries can be related to energy sectors, where such sectors account for a significant share

of the economic structure. We therefore need to examine whether all four countries exhibit the same pattern of technological opportunity (this is our third hypothesis). According to Cassiolato and Lastres (2011) and Cassiolato and Vitorino (2011), the greatest technological opportunities and constraints for Brazil and South Africa lie in sectors related to the environment.

(iii) With regard to technology, growth in R&D expenditure in some of the countries analysed, especially China, has exceeded the average increase in middle-income countries. On the other hand, the slow growth of R&D expenditure in Brazil, the Russian Federation and South Africa is an important difference among the selected countries and shows that the technology gap is still large when compared with the United States. Patent indicators grew in China, but have been falling since 2000 in Brazil, the Russian Federation and South Africa. Naudé, Szirmai and Lavopa (2013) conclude that, in general, technological progress has been more promising in China than in Brazil, the Russian Federation and South Africa, and highlight the fact that the economies of the Russian Federation and South Africa are dominated by natural resources extraction and traditional services.

Despite the similarities described above, some economic differences are apparent with regard to the availability of skilled labour, the weight of various economic sectors in the production structure and the role of each group of sectors, in terms of intensity of technological knowledge, in the industrial and technological dynamics in each country. These differences will be addressed in the sections that follow.

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[1] Details on the historical trajectories of each country's national innovation system can be found in Gokhberg and others (2011) for the Russian Federation, in Liu and Liu (2011) for China, in Kruss and Lorentzen (2011) for South Africa, and in Koeller and Cassiolato (2011) for Brazil.

IV

Databases

We used two different types of information in this study: (i) OECD input-output matrices containing data on 48 sectors[2] for Brazil, China, the Russian Federation[3] and South Africa, and (ii) R&D data from OECD contained in the ANBERD database.[4] Owing to features of the two databases, for Brazil and South Africa we used data from 2005, while for China and the Russian Federation[5] we used data from 2000, as input-output and R&D data were not available for 2005. Nevertheless, the comparison among the countries is still valid, especially as R&D spending in Brazil and South Africa in 2005 is similar to that in China and the Russian Federation in 2000 (see annex figure A.1).

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[2] See table A.1 in the annex.

[3] Owing to various constraints, data from the pharmaceutical industry in the Russia Federation were aggregated with data from the chemical industry. Hence, we disaggregated the data using as a proxy the mean of the share of the pharmaceutical industry in the chemical industry in Brazil (15%) and China (16%). For countries on the technological frontier in which the same constraint applied, we used value added to disaggregate the two industries.

[4] ANBERD is a databank developed to provide (information) analysts with understandable and internationally comparable data on industrial R&D expenditure, including a corresponding time series.

[5] Despite the availability of input-output data for India, this country could not be included in the analysis, as R&D data on sectoral expenditure comparable with data from ANBERD were not available.

To make up for the lack of information on R&D in Brazil in ANBERD, we used data from PINTEC, a triennial survey carried out by IBGE. PINTEC follows the same criteria as ANBERD, which makes it possible to use the two databases concomitantly. They were reconciled in accordance with the International Standard Industrial Classification of All Economic Activities, Rev. 3 (ISIC Rev. 3).

We aggregated the 48 sectors into the eight groups comprising the new classification by Hauknes and Knell (2009), based on Pavitt's taxonomy (1984). Pavitt's taxonomy divides industries into four groups: (i) science-based sectors that depend heavily on R&D activities and technological learning; (ii) specialized-suppliers that require specific skills and are able to adapt their products to their consumers' needs; (iii) scale-intensive sectors that rely heavily on cost reduction and product improvement through engineering practices, and (iv) supplier-dominated sectors that make incremental improvements and adaptations to new technologies from upstream suppliers.

Hauknes and Knell (2009) broke down the "supplier-dominated" group into two subgroups: energy-producing and traditional sectors. They also classified materials separately and identified two kinds of services: knowledge-intensive business services (KIBS) and other services. Thus, we have eight groups: (i) energy; (ii) traditional; (iii) materials; (iv) scale-intensive; (v) specialized supplier; (vi) science-based; (vii) services, and (viii) KIBS.

V

Methodological considerations and results

The input-output matrix describes the intersectoral flows in a national, regional or global economy. The main objective of such a matrix is to analyse the industrial interdependence in a specific economy (Miller and Blair, 2009). Applied in our context, this methodological approach allows us to make explicit some features of a national innovation system, as it stresses sectoral interdependence with regard to productive and technological knowledge flows.

By allowing us to analyse intersectoral flows, an input-output matrix becomes a way of measuring technical knowledge spillovers present in industrial sectors. Knowledge spillovers may be defined as externalities arising from an agent's investment in R&D that makes another agent's innovative effort easier (Breschi and Lissoni, 2001). Generally speaking, input-output matrices capture a kind of spillover called rent spillovers (Griliches, 1979). Following the literature, we therefore assume that

investments in R&D are embodied in purchased inputs, using sales of intermediate inputs as a weighting factor to measure the intersectoral spillover (Terleckyj, 1974; Wolff, 1997; Wolff and Nadiri, 1993).

1. Input-output matrix

An input-output matrix is an attempt to apply the neoclassic model of general equilibrium. Hence, we propose an input-output matrix describing the monetary flows of an economy:

$$Z + f = x \tag{1}$$

where Z is a matrix that represents intermediate consumption, f is the vector of final demand and x is the vector of gross output. Transforming vector x into a diagonal matrix, gives us x^D. Thus, matrix A of technical coefficients can be defined as:

$$A = Z\left(x^D\right)^{-1} \tag{2}$$

Each element of A is defined as $a_{ij} = z_{ij}/x_j$, which corresponds to the proportion of input that industry j needs from industry i to produce US\$ 1 of product.

Using (2) to solve (1), we get:

$$AX + f = x \tag{3}$$

and, after some algebraic manipulations, we get:

$$X = Bf \tag{4}$$

where B is the so-called Leontief inverse matrix, defined as $B = (I - A)^{-1}$. The elements b_{ij} of matrix B may be understood as the direct and indirect requirements of industry j for meeting one unit of output growth in industry i.

This approach is limited by the fact that technological changes are exogenous to the economic system, as technology is represented by technical coefficients of the input-output matrix. However, the analysis we present refers only to a single period of time and focuses on the production structure and input flows from different sectors in the economy. Therefore, the methodology used here is appropriate to this kind of analysis.

2. Embodied R&D and flows

As far as innovative activities are concerned, the stock of productive knowledge of industry j comprises direct R&D expenses and also those incorporated in purchased domestic inputs, goods and services resulting from domestic investment, imported intermediate inputs and goods and services resulting from imported investment.

Hauknes and Knell (2009) present calculations that allow us to measure product-embodied R&D diffusion. They divide the intensity of total R&D content in industry j $\left(s_j^x\right)$ into six components: own R&D $\left(r_j^d\right)$; intensity of R&D embodied in domestic inputs $\left(t_j^d\right)$; intensity of R&D embodied in foreign inputs $\left(t_j^m\right)$; R&D embodied in purchased domestic capital goods $\left(t_j^{dc}\right)$; and R&D embodied in purchased foreign capital goods $\left(t_j^{mc}\right)$. Mathematically, we get:[6]

$$s_j^x = r_j^d + t_j^d + t_j^m + t_j^{dc} + t_j^{mc} \tag{5}$$

where

$$r_j^d = tx_j^d \quad if \ i = j \tag{6}$$

$$t_j^d = \sum_{i, i \neq j} \left[r_i \left(b_{ij} / b_{jj} \right) \right] \tag{7}$$

$$s_j^d = r_j^d + t_j^d = \sum_i \left[r_i \left(b_{ij} / b_{jj} \right) \right] \tag{8}$$

$$t_j^m = \sum_i \left(R_i^F m_{ij} \right) \tag{9}$$

where $\left(t_j^m \right)$ is the expenditure of R&D embodied in imported inputs, R_i^F is the technological frontier, defined as the average R&D intensity of the United States and some countries of Europe,[7] and m_{ij} are the elements of matrix M of imported coefficients of all foreign sectors i for the domestic sector j.

$$t_j^{dc} = \sum_i \left\{ r_i \left[\sum_k \left(b_{ik} I_{kj}^d \right) \right] \right\} \tag{10}$$

$$t_j^{mc} = \sum_i \left(R_i^F I_{ij}^m \right) \tag{11}$$

where I_{kj}^d and I_{ij}^m are constructed by dividing the vector of gross fixed capital formation (FBCF) by the vector of gross output. For the former we used data from the

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[6] $Tx = r^D O = [tx_{ij}]$, where $O = B(B^D)^{-1}$, B^D is a matrix with the diagonal elements of B, and r^D is the matrix of vector r diagonalized, where $r_i = R_i/x_i$, and R_i is R&D expenditure of industry i. Tx will thus measure total embodied R&D, or the technology intensity of industry j relative to total output of this industry. For more details, see Hauknes and Knell (2009).

[7] Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Spain, Sweden and the United Kingdom of Great Britain and Northern Ireland.

domestic matrix and for the latter, data from the foreign inputs matrix.

Regarding flows, let Z^t be the total intermediate consumption matrix, now also taking imports into account. A^t will be considered the technical coefficient matrix and B^t Leontief's inverse matrix, defined as $B^t = \left(I - A^t\right)^{-1} = \left[b_{ij}^t\right]$. Matrix L of elements l_{ij} is to measure the amplitude of the aggregate linkage between industries i and j, so that:

$$l_{ij} = b_{ij}^t \big/ \left(b_{ii}^t b_{jj}^t - b_{ij}^t b_{ji}^t\right) \qquad (12)$$

It is worth noting that, at this point, matrix B^t does not change into matrix O since, though making sense from a mathematical viewpoint, matrix O does not make economic sense, as pointed out by Hauknes and Knell (2009). From equation (12) it is possible to calculate the technological flow from i to j as:

$$f_i^j = \left(r_i l_{ij} x_j\right) \big/ \left(r_j x_j\right) \qquad (13)$$

Following the methodology described above, it is possible to break down the technological intensity into five components, as described in equation (5). The result can be seen in figure 1 below, which shows the total technological intensity for each country and also the technology multiplier, defined as the ratio between total technological intensity and R&D intensity:

$$MTEC = \sum_j s_j^x \Big/ \sum_j r_j \qquad (14)$$

This equation should be interpreted as follows: if the technology multiplier is equal to one, the industry is a pure technology producer. However, if the technology multiplier approaches infinity, the industry is a pure technology user. As for magnitude, the technology multipliers can be interpreted as follows: knowledge-producing countries exhibit a low multiplier, while knowledge-using countries exhibit a high multiplier.

FIGURE 1

Selected countries: technology multiplier components
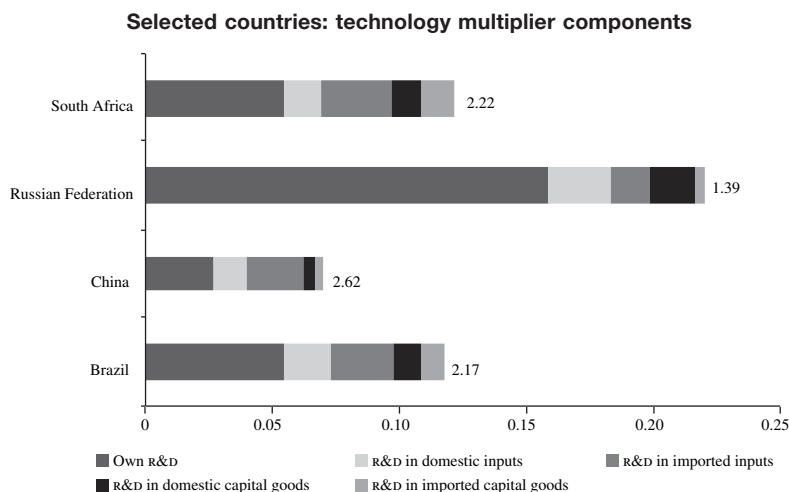
Source: Prepared by the authors.

Note: For Brazil and South Africa data are for 2005, while for China and the Russian Federation data are for 2000.

Generally speaking, the absolute values of the multipliers are higher than those presented by Hauknes and Knell (2009) for OECD countries, which is consistent with the role played by each set of countries in terms of their proximity to the technology frontier. Using that criterion, China would be the highest user of foreign

technical knowledge. However, as our data for China are for the year 2000, its technology multiplier can be expected to have decreased in recent years, as the ratio of R&D expenditure to gross domestic product (GDP) between 2000 and 2009 almost doubled, rising from 0.90% to 1.70%. At the same time, Brazil, the Russian

Federation and South Africa showed a more modest evolution in terms of R&D expenditure during the 2000s (see annex figure A.1(a)), which could prolong their status as technology users.

The Russian Federation shows the lowest absolute value for the technology multiplier, reflecting the country's historical conditions, in which large investments were made in constructing science and technology systems and developing high-technology sectors, such as electronics, for military use. Several authors, such as UNIDO (2012) and Gokhberg and others (2011), have highlighted the importance of the former Soviet Union to current Russian innovation capacity, despite the country's low investment in R&D in relation to other emerging countries in the 2000s.

For all of the countries, except China, own R&D exceeds 40% of total technology intensity. R&D in foreign capital goods represents 8% of technology intensity in Brazil and 11% in South Africa, but only 5% in China and 2% in the Russian Federation. Conversely, the percentage participation of domestic components is, strikingly, over 60% for all countries. South Africa and China recorded the highest multipliers, although their domestic components proportion is the lowest: 66% and 63% respectively. The Russian Federation, on the other hand, shows the highest proportion (91%) and the lowest multiplier.

Hauknes and Knell (2009) developed the methodology used in this paper but studied only developed countries (France, Germany, Norway, Sweden and the United States) in 2000. For that purpose, the authors used OECD input-output tables and the ANBERD R&D data.

When comparing the composition of these countries' technology multipliers with that of the developed countries studied by Hauknes and Knell (2009), we can see that, in both cases, own R&D is the most important multiplier component. On the other hand, technology dependence is evident, particularly for Brazil, China, and South Africa, when the share of R&D embodied in imported capital goods is, on average, much smaller in developed countries than in emerging countries. Although the R&D embodied in inputs and capital goods is a way to assess the R&D produced at the technological frontier, the low level of internal R&D can jeopardize effective technological learning, as discussed in section II.

Table 1 disaggregates the information contained in figure 1 by sector. The results are also derived from equation (5). In line with figure 1, table 1 confirms that own R&D is the most important component in most sectors, except when the multiplier shows a high magnitude. Own R&D is less expressive in cases such as services in Brazil and China or in traditional sectors in China, the Russian Federation and South Africa. A similar pattern among the emerging countries is that traditional and service sectors show lower own R&D intensity in general. In Brazil and the Russian Federation, KIBS sectors are among those with the highest own R&D intensity.

Based on the hypotheses put forward in sections II and III, we would expect that in some sectors, even those that are science-based, the absolute value of the technology multiplier would be higher than in other economic sectors of emerging countries, owing to external absorption of knowledge resulting from R&D.

In China and the Russian Federation, the science-based and KIBS sectors show, in general, the lowest values relative to other sectors, indicating that they are producers of technological knowledge, based on the value of the technology multiplier by sector (see table 1). In Brazil, however, the science-based sectors are more users than producers of knowledge and are in a worse situation than most other sectors. This reveals weaknesses in the pharmaceuticals and electronics sectors, in line with the weight of imports in those fields, as can be seen in the third and fifth columns of table 1, where the figures for foreign R&D in inputs and capital goods are higher for the science-based sector, and in annex table A.3, where imports account for 32% of the gross output of the sector in 2005.

In sectors with lower total technology intensity, we found the same pattern as for the OECD countries studied by Hauknes and Knell (2009). However, a striking difference between OECD and emerging countries is the great relative distance between leading sectors in own R&D (which are always science-based) and the other sectors in the taxonomy. Furthermore, the R&D intensity of specialized suppliers, scale-intensive industries and KIBS is in-between that of science-based sectors and of traditional and service sectors in the developed countries.

In general, these differences between emerging and developed countries are evidence of the scant presence of science-based sectors in the industrial structure of emerging countries. These sectors in emerging countries are ill-equipped to carry out their own R&D, and the absolute value of the multipliers reflects this.

In contrast to developed countries, in some cases, science-based sectors in emerging countries have higher multipliers compared with energy, traditional and materials sectors, except in China and the Russian Federation. Thus, in terms of technological knowledge production, taking into consideration the absolute value

of the technology multiplier, we can affirm that there is no sectoral hierarchy similar to that observed in developing countries. In the emerging countries, science-based sectors show higher R&D dependence on input and capital goods suppliers, both domestic and foreign, than science-based sectors in developed countries, as is evident when table 1

is compared with the results from Hauknes and Knell (2009). This holds true especially in Brazil and South Africa, while in China and the Russian Federation the status of the science-based sector is similar to that of its counterparts in developed countries, with a lower absolute value for the technology multiplier.

TABLE 1

Selected emerging countries: total R&D content and technology multiplier by sector

		Own R&D	R&D in domestic inputs	R&D in imported inputs	R&D in domestic capital goods	R&D in imported capital goods	Total embodied R&D	Technology multiplier
Brazil	1. Energy	0.0030	0.0015	0.0007	0.0003	0.0000	0.0056	1.88
	2. Traditional	0.0008	0.0020	0.0001	0.0003	0.0000	0.0032	3.86
	3. Materials	0.0023	0.0031	0.0020	0.0004	0.0000	0.0079	3.41
	4. Scale-intensive	0.0095	0.0019	0.0040	0.0025	0.0011	0.0190	2.01
	5. Specialized-supplier	0.0076	0.0039	0.0014	0.0026	0.0038	0.0194	2.55
	6. Science-based	0.0106	0.0034	0.0157	0.0034	0.0042	0.0373	3.52
	7. Services	0.0003	0.0017	0.0006	0.0001	0.0000	0.0026	10.11
	8. KIBS	0.0202	0.0007	0.0006	0.0011	0.0001	0.0227	1.12
China	1. Energy	0.0011	0.0011	0.0002	0.0001	0.0000	0.0026	2.29
	2. Traditional	0.0005	0.0015	0.0003	0.0002	0.0000	0.0026	4.85
	3. Materials	0.0021	0.0014	0.0014	0.0004	0.0000	0.0054	2.52
	4. Scale-intensive	0.0038	0.0015	0.0021	0.0008	0.0004	0.0085	2.27
	5. Specialized-supplier	0.0042	0.0020	0.0132	0.0011	0.0009	0.0214	5.14
	6. Science-based	0.0125	0.0023	0.0049	0.0012	0.0020	0.0228	1.83
	7. Services	0.0003	0.0017	0.0002	0.0000	0.0000	0.0022	7.88
	8. KIBS	0.0021	0.0021	0.0000	0.0001	0.0000	0.0043	2.02
Russian Federation	1. Energy	0.0002	0.0032	0.0007	0.0000	0.0000	0.0040	20.67
	2. Traditional	0.0003	0.0019	0.0015	0.0001	0.0000	0.0037	14.47
	3. Materials	0.0008	0.0019	0.0018	0.0001	0.0000	0.0045	5.70
	4. Scale-intensive	0.0395	0.0025	0.0064	0.0007	0.0002	0.0493	1.25
	5. Specialized-supplier	0.0061	0.0040	0.0031	0.0017	0.0021	0.0169	2.75
	6. Science-based	0.0289	0.0072	0.0007	0.0001	0.0000	0.0371	1.28
	7. Services	0.0015	0.0023	0.0013	0.0002	0.0000	0.0053	3.47
	8. KIBS	0.0811	0.0016	0.0001	0.0149	0.0021	0.0997	1.23
South Africa	1. Energy	0.0053	0.0013	0.0013	0.0007	0.0001	0.0086	1.64
	2. Traditional	0.0006	0.0019	0.0009	0.0002	0.0000	0.0036	5.94
	3. Materials	0.0027	0.0015	0.0037	0.0008	0.0005	0.0092	3.35
	4. Scale-intensive	0.0049	0.0018	0.0035	0.0011	0.0010	0.0124	2.51
	5. Specialized-supplier	0.0056	0.0027	0.0040	0.0012	0.0011	0.0146	2.61
	6. Science-based	0.0316	0.0022	0.0137	0.0067	0.0103	0.0645	2.04
	7. Services	0.0023	0.0007	0.0006	0.0007	0.0000	0.0044	1.89
	8. KIBS	0.0017	0.0019	0.0003	0.0001	0.0000	0.0041	2.43

Source: Prepared by the authors.

The structure of the Russian Federation is more similar to that of more developed countries, as science-based sectors, KIBS and scale-intensive sectors are considered technology producers and technology multipliers have the lowest values. The legacy of the

former Soviet Union explains these indicators. However, the ratio of R&D expenditure to GDP has been declining since 2003, which could jeopardize the country's status as a knowledge producer in these sectors (see annex figure A.1).

Table 2 shows intersectoral knowledge flows. Hauknes and Knell (2009) created their matrix of flows using the variational principle in disaggregated intermediate input-output flows. However, as our matrix was already disaggregated into eight technological groups, we used the net flow as a reference. Hence, if the value is equal to zero, there is a bidirectional flow. If the value is negative, the flow is strictly from the sector in the column to the sector in the row; whereas, if the value is positive the inverse is true: the flow is strictly from the sector in the row to the sector in the column. Some patterns emerge from these findings, such as the flow from the energy sector to the traditional sector, except in the case of the Russian Federation, where it is bidirectional.

TABLE 2

Selected emerging countries: intersectoral net flows, weighted by R&D

		1. Energy	2. Traditional	3. Materials	4. Scale-intensive	5. Specialized-supplier	6. Science-based	7. Services
Brazil	1. Energy							
	2. Traditional	-0.2						
	3. Materials	-0.1	0.2					
	4. Scale-intensive	0.1	0.8	0.5				
	5. Specialized-supplier	0.0	0.1	0.0	-0.2			
	6. Science-based	0.0	0.1	0.0	-0.1	0.0		
	7. Services	-0.5	-0.1	-0.1	-0.8	-0.2	-0.2	
	8. KIBS	0.3	0.6	0.3	0.1	0.1	0.1	3.7
China	1. Energy							
	2. Traditional	-0.2						
	3. Materials	0.1	0.4					
	4. Scale-intensive	0.1	0.6	0.1				
	5. Specialized-supplier	0.2	0.4	0.0	0.0			
	6. Science-based	0.1	0.3	0.0	0.0	0.0		
	7. Services	-0.3	-0.2	-0.5	-0.8	-0.9	-1.7	
	8. KIBS	0.0	0.1	-0.1	-0.1	-0.1	-0.3	0.3
Russian Federation	1. Energy							
	2. Traditional	0.0						
	3. Materials	0.0	0.2					
	4. Scale-intensive	1.8	2.3	0.5				
	5. Specialized-supplier	0.5	0.7	0.1	-0.1			
	6. Science-based	0.3	0.4	0.1	-0.1	0.0		
	7. Services	1.3	0.7	0.2	-0.3	-0.1	0.0	
	8. KIBS	9.6	2.0	0.9	0.0	0.3	0.0	0.8
South Africa	1. Energy							
	2. Traditional	-0.8						
	3. Materials	-0.1	0.4					
	4. Scale-intensive	-0.1	0.1	0.0				
	5. Specialized-supplier	-0.1	0.1	-0.1	0.0			
	6. Science-based	0.0	0.1	0.0	0.0	0.0		
	7. Services	0.0	0.8	0.1	0.0	0.1	0.0	
	8. KIBS	-0.1	0.1	0.0	0.0	0.0	-0.1	-0.5

Source: Prepared by the authors.

The KIBS group comprises services that are science- and technology-intensive, such as informatics, R&D and other business services. In Brazil and the Russian Federation, there is a flow from this sector to the others. In China and South Africa, such flows are, in general, inverted, which indicates lower technological capacity than other sectors in the production structure.

While the science-based sectors flows are predominantly in the expected direction (positive), there are also numerous bidirectional flows, indicating that other sectors are also suppliers of technological knowledge to the science-based sectors. This finding differs from the situation in developed countries, where positive flows prevail, as science-based sectors are primarily suppliers of technological knowledge (Hauknes and Knell, 2009).

Specialized supplier's flows go towards more basic sectors (energy, traditional and materials) in China and the Russian Federation. In Brazil and South Africa the flow is from specialized suppliers to traditional sectors, while the flow to energy and materials is bidirectional in Brazil and inversed in South Africa.

On the other hand, in Brazil, China and the Russian Federation, the direction of technological flows between specialized suppliers and scale-intensive sectors appears to be inverted, as those sectors provide the technology used by the suppliers. This flow direction is the same as in Germany and the United States, as observed by Hauknes and Knell (2009).

The scale-intensive sectors are the chemical, metallurgy, shipbuilding, and car, aircraft and railway rolling-stock manufacturing industries. With regard to gross output, these sectors have a 9.8%, a 3% and an 11% share, in Brazil, the Russian Federation and China, respectively, while specialized suppliers have a share of 3% in Brazil, 9% in the Russian Federation and 10% in China. This indicates that these sectors do not account for a large proportion of production in these emerging countries compared with other sectors (annex table A.3).

However, the same cannot be said when the share of R&D in each sector relative to total R&D expenditure is analysed. For this ratio, the scale-intensive sectors are very important in terms of innovation and investment, accounting for 31% of R&D in Brazil, 23% in the Russian Federation and 20% in China. On the other hand, specialized suppliers account for 7% of R&D in Brazil, 11% in the Russian Federation and 19% in China. Added together, the two groups make up more than one third of R&D in each country.

Although there is, in general, some heterogeneity in the direction of technological knowledge flows among the emerging countries, the following similarities can be identified:

(i) Sectors considered intermediate in the use and diffusion of technological knowledge (specialized suppliers and scale-intensive sectors) play a very important role in the production of this knowledge in developed countries. In developing countries, these sectors sometimes overtake those considered to be high-technology sectors, when the technology multipliers are considered. This situation reflects the history of industrialization and technological dependence in developing countries.

(ii) The energy sector in Brazil, China and South Africa is more a producer than a user of knowledge, based on the technology multiplier and the direction of flows. In the Russian Federation, while the sector accounts for a higher share of production, it is more a user than a producer of technological knowledge (12% of gross output and 0.7% of R&D expenditure). This finding confirms that Brazil, China and South Africa have a technological opportunity with regard to the energy sector.

(iii) The science-based sector has high multipliers and does not follow the sectoral hierarchy of developed countries, particularly in Brazil and South Africa. With regard to the direction of technology flows, according to Pavitt (1984) the expected direction is observed in some cases, but the most common pattern is bidirectional flows. This finding contrasts with what Hauknes and Knell (2009) observed in developed countries, where the science-based sector is primarily a technology supplier. This reflects the technological dependence of emerging countries.

(iv) KIBS behave as expected in Brazil and the Russian Federation, that is, as technology suppliers, but behave differently in China and South Africa. Despite the significant growth in the tertiary sector in South Africa since 1994, the country's level of education is still low, which negatively affects the performance of sectors such as KIBS (UNIDO, 2012). In China, on the other hand, industrial development deepened in the 2000s, favouring the growth of the capital goods sector. Both cases differ from Brazil, where, although the industrialization process did not culminate in the full development of the capital goods sector, there was some development of modern and knowledge-intensive services to support industries.

VI

Conclusions

Given the increasing relative importance of some emerging countries, including Brazil, China, the Russian Federation and South Africa, in technology production and diffusion, we sought to contribute empirically to the discussion on this matter, as the comparative literature on these countries' national innovation systems is scarce. Therefore, we calculated different indicators, such as technology multipliers, total R&D content and technological knowledge flows. For that purpose, we used input-output matrices for Brazil, China, the Russian Federation and South Africa, and aggregated the sectors based on the taxonomy of Pavitt (1984) extended by Hauknes and Knell (2009).

Overall, our main findings pointed to disparities among the so-called BRICS countries (Brazil, the Russian Federation, India, China and South Africa).[8] In terms of total R&D content, technology multiplier and technological flows, the Russian Federation is closest to the results of developed countries, based on indicators from the year 2000. However, these indicators may worsen as a result of weak R&D expenditure during the 2000s.

Although net technological flows reveal some heterogeneity among developing countries, some common ground can be found. Our methodology allowed us to compare the direction of flows of these countries with those of developed countries, which revealed few similarities.

We were able to test all of our hypotheses, and had to reject the hypothesis that the sectoral hierarchy would be similar to that in developed countries. The hypothesis that technological flows in the emerging countries analysed would behave differently in the science-based, scale-intensive and specialized-supplier sectors was partially refuted, as the science-based sector is not a diffuser of technology to the economy. Moreover, in some cases, scale-intensive and specialized-supplier sectors assume a more important position in the sectoral hierarchy or in the direction of technological flows. Lastly, with regard to the hypothesis of technological opportunity, we can affirm that the emerging countries do not all show the same pattern, although there are some similarities, for example in the energy sectors in Brazil, China and South Africa.

Flows in sectors that are net receivers of technology, such as the traditional, materials and service sectors, behave similarly to those in developed countries. In sectors such as KIBS, the flow moves in the expected direction, but these sectors are heterogeneous across the four countries analysed. In Brazil and the Russian Federation, these sectors are net suppliers of technology, but this is not the case in China and South Africa, a finding that is explained by differences in the industrialization trajectories of each economy. The energy sector in emerging countries is very different from that in developed countries, as it is a supplier of technology in Brazil, China and South Africa.

The differences among the set of countries analysed support the view that the BRICS countries do not exhibit the homogeneity normally expected of a bloc of countries, particularly with regard to indicators of technology flow and sectoral capacity for production and use of technology.

Lastly, Hauknes and Knell (2009) point out that specialized-supplier and scale-intensive (medium-high and medium-low tech) industries are the most important industries for economic growth, and that high-tech services are important as they interconnect industry groups. On the basis of total embodied R&D and net flows, we can affirm that medium-tech sectors are relatively less important in Brazil and South Africa than in China and the Russian Federation. At the same time, KIBS appear to be more important in Brazil and the Russian Federation than in China and South Africa. Thus, we conclude that the Russian Federation is best positioned to achieve greater economic growth as a result of technological development, followed by China, Brazil and South Africa, in that order.

A future extension of this paper might evaluate the temporal dimension of the indicators of production and use of technological knowledge and of intersectoral flows, in order to take into account structural changes in the technology dynamics of emerging countries. Such an undertaking would depend on the availability and comparability of input-output and R&D data for all four countries (Brazil, China, the Russian Federation and South Africa). Another possible extension arises from the limitations of this paper, which only evaluates local technological efforts and diffusion of embodied technology by means of R&D expenditure. Other kinds of innovative expenditures (such as the purchase of machinery, training of workers, industrial projects, licensing and know-how acquisition) might be used, if such data were available.

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[8] Some studies, such as that of Armijo (2007), argue that this acronym is not a good way to group these countries as an analytical category. Our findings corroborate that study from a technological perspective.

ANNEX

TABLE A.1

Reconciliation of input-output matrix and suggested classification

Input-output according to OECD	Classification
1. Agriculture, hunting, forestry and fishing	2
2. Mining and quarrying (energy)	1
3. Mining and quarrying (non-energy)	3
4. Food products, beverages and tobacco	2
5. Textiles, textile products, leather and footwear	2
6. Wood and products of wood and cork	2
7. Pulp, paper, paper products, printing and publishing	2
8. Coke, refined petroleum products and nuclear fuel	1
9. Chemicals, excluding pharmaceuticals	4
10. Pharmaceuticals	6
11. Rubber and plastics products	3
12. Other non-metallic mineral products	3
13. Iron and steel	3
14. Non-ferrous metals	3
15. Fabricated metal products, except machinery and equipment	4
16. Machinery and equipment, NEC	5
17. Office, accounting and computing machinery	6
18. Electrical machinery and apparatus, NEC	5
19. Radio, television and communication equipment	6
20. Precision and optical medical instruments	6
21. Motor vehicles, trailers and semi-trailers	4
22. Building and repairing of ships and boats	2
23. Aircraft and spacecraft	2
24. Railroad and transport equipment, NEC	2
25. Manufacturing, NEC, recycling (including furniture)	2
26. Production, collection and distribution of electricity	1
27. Manufacture of gas, distribution of gaseous fuels through mains	1
28. Steam and hot water supply	1
29. Collection, purification and distribution of water	3
30. Construction	2
31. Wholesale and retail trade, repairs	7
32. Hotels and restaurants	7
33. Land transport, transport via pipelines	7
34. Water transport	7
35. Air transport	7
36. Supporting and auxiliary transport activities, activities of travel agencies	7
37. Post and telecommunications	7
38. Finance and insurance	7
39. Real estate activities	7
40. Renting of machinery and equipment	7
41. Computer and related activities	8
42. Research and development (R&D)	8
43. Other business activities	8
44. Public administration and defence, compulsory social security	7
45. Education	7
46. Health and social services	7
47. Other community, social and personal services	7
48. Private households with employed persons, extra-territorial organizations and bodies	7

Source: Adapted from J. Hauknes and M. Knell, "Embodied knowledge and sectoral linkages: an input–output approach to the interaction of high- and low-tech industries", *Research Policy*, vol. 38, No. 3, Amsterdam, Elsevier, 2009.

Note: OECD: Organization for Economic Cooperation and Development.

NEC: Not elsewhere classified.

TABLE A.2

Harmonization between the Analytical Business Enterprise Research and Development database (ANBERD) and the Technology Innovation Survey (PINTEC), suggested classification
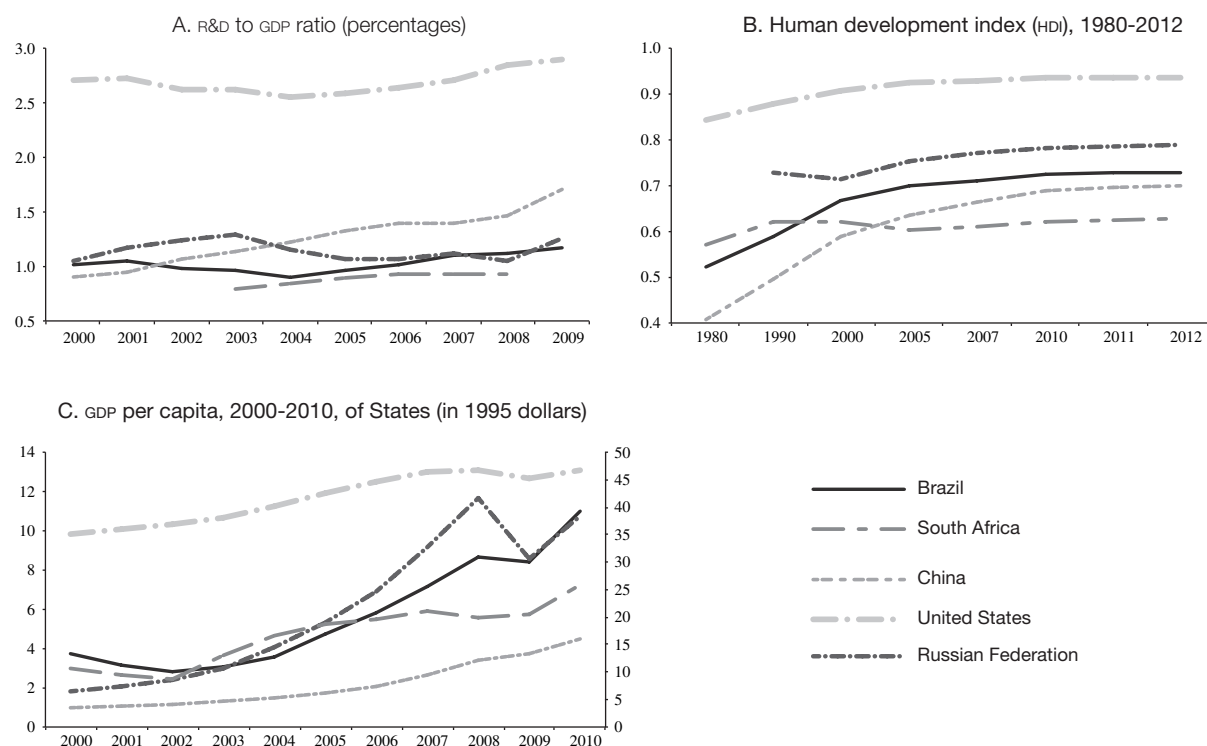
Classification (by sectors)	ANBERD	PINTEC (NACE 1.0)
1. Energy	23, 40	23
2. Traditional	15-22, 36-37, 45	15-22, 36-37
3. Materials	25-27, 41	25-27
4. Scale-intensive	24 (except 24, 23), 28, 34-35	24 (except 24.5), 28, 34, 35
5. Specialized-supplier	29, 31	29, 31
6. Science-based	24, 23, 30, 33	24.5, 30, 32, 33
7. Services	50-52, 55, 60-67, 70-71, 75-99	61
8. Knowledge-intensive business services (KIBS)	72-74	72-74

Source: Prepared by the authors.

Note: NACE: National Classification of Economic Activities (version 1.0). The numbers in the ANBERD and PINTEC columns correspond to their numbers in that database and survey.

FIGURE A.1

Selected countries: descriptive data

A. R&D to GDP ratio (percentages)

B. Human development index (HDI), 1980-2012

C. GDP per capita, 2000-2010, of States (in 1995 dollars)

Brazil
South Africa
China
United States
Russian Federation

Source: Prepared by the authors.

Note: In figure (c), the values for the United States are on the right-hand scale and all values are expressed in thousands of dollars, at constant prices, deflated by the implicit price deflator of United States GDP.
R&D: Research and development; GDP: Gross domestic product.

TABLE A.3

Selected countries: share of gross output of each sector, imports as a percentage of total gross output and imports as a percentage of gross output by sector
(Percentages)

	Brazil			Russian Federation		
	Share of gross output	Imports/total gross output	Imports/sector gross output	Share of gross output	Imports/total gross output	Imports/sector gross output
1. Energy	9.4	1.0	10.2	12.0	0.5	4.1
2. Traditional	21.2	0.5	2.3	25.0	4.2	16.9
3. Materials	5.8	0.5	8.3	8.8	1.0	11.7
4. Scale-intensive	9.8	1.4	13.8	3.0	0.8	26.7
5. Specialized-supplier	3.1	0.7	20.8	9.4	3.1	32.9
6. Science-based	3.2	1.0	32.1	0.3	0.1	26.7
7. Services	43.8	0.9	2.1	39.7	1.0	2.6
8. KIBS	3.7	0.3	7.5	1.8	0.1	5.4

	China			South Africa		
	Share of gross output	Imports/total gross output	Imports/sector gross output	Share of gross output	Imports/total gross output	Imports/sector gross output
1. Energy	8.3	0.6	7.5	10.8	1.5	14.2
2. Traditional	33.0	1.2	3.6	17.7	1.5	8.5
3. Materials	11.2	0.9	7.9	14.5	3.6	25.2
4. Scale-intensive	11.1	1.3	11.8	6.4	2.3	36.2
5. Specialized-supplier	10.2	1.9	18.4	1.1	0.3	26.7
6. Science-based	5.0	0.9	17.2	1.3	1.0	74.3
7. Services	17.5	0.2	1.3	44.3	1.1	2.5
8. KIBS	3.7	0.0	0.0	3.9	0.3	7.4

Source: Prepared by the authors.

Note: Calculations based on input-output matrices. The share of gross output represents the gross output of each sector divided by the sum of gross output of all sectors. The imports to total gross output ratio is imports from the sector divided by the sum of gross output of all sectors. The imports to sector gross output ratio is imports from the sector divided by the gross output of the sector.

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The business cycle and copper mining in Chile

Fernando Fuentes and Carlos J. García

ABSTRACT

This article "endogenizes" the copper supply, incorporating demand for mining-sector inputs represented by other goods in the economy (specifically, intermediate goods) and also energy into a dynamic stochastic general equilibrium (DSGE) model for a sample of the 2003-2013 period. The model estimation reveals that a rise of 1% in the copper price leads to a 0.16% increase in gross domestic product (GDP) over five years. The main contribution of the study is to show that, if the mining sector is treated as integrated into the rest of the economy rather than being assumed to be an enclave, as it usually is, the effects of the copper price on the Chilean economy at least double.

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I

Introduction

The main purpose of this study is to measure the contribution of the mining sector to the Chilean business cycle by constructing and estimating a dynamic stochastic general equilibrium (DSGE) model[1] that explicitly includes the sector's connections with other production sectors.

In the first place, it should be noted that there is a huge literature of DSGE models for small open economies that analyse the effects on the economy of the price of a mining commodity on the assumption that the production (supply) of the commodity is exogenous. Examples of such studies include Dib (2008); Bems and De Carvalho Filho (2011); Bodenstein, Erceg and Guerrieri (2011); García, Restrepo and Tanner (2011); Lama and Medina (2012); Natal (2012), and García and González (2014). A similar perspective is also common in the DSGE models developed by a number of central banks, including those of Australia (Jääskelä and Nimark, 2008), Canada (Murchison and Rennison, 2006), New Zealand (Lees, 2009), Chile (Medina and Soto, 2007) and Spain (Andrés, Burriel and Estrada, 2006).

In models where production of the commodity is incorporated exogenously, its influence on the DSGE model is wholly confined to fluctuations in its price. There are two ways of modelling this price, as an exogenous shock (see, for example, García and González, 2014) or as a value endogenously determined by the structures representing the rest of the world in the model (Laxton and Pesenti, 2003). In the latter case, the whole international economy must be modelled, not just the country concerned, and as a result the first alternative has been more popular than the second in the literature of recent years.

As an alternative to what has been described, there has been little literature endogenizing the production of a mining commodity in a DSGE model. Two seminal articles are those of Gross and Hansen (2013) and Veroude (2012), who introduce elements of the vast literature on optimal extraction into a simple DSGE model that is calibrated but has no frictions and no external sector.[2] Both articles start by assuming a production function for ore extraction that depends on labour, capital K and ore reserves R. Thus, mining firms are subject to two constraints, capital formation and the depletion of ore reserves, which can be expanded by new finds of ore. However, the most salient point in these articles is that endogenizing production opens up the possibility of the mining sector drawing in resources from the wider economy. In other words, the mining sector ceases to be an "enclave" and is "integrated" with the other sectors of the economy, so that the effects of mining on the economy are multiplied.

This article synthesizes the two approaches. First, it takes a full DSGE model where the external sector and short-term nominal and real frictions are modelled. Second, it endogenizes supply in the production of copper, incorporating demand for mining-sector inputs in the rest of the economy. In addition, the model is estimated using Bayesian econometrics with a view to obtaining an empirical measure of the contribution of the mining sector to the Chilean economy over the last 10 years (quarterly information for 2003-2013), focusing the analysis on two key variables: gross domestic product (GDP) growth and the real exchange rate.

The present article is organized as follows: section II summarizes the correlation between mining and the business cycle, section III presents the DSGE model, section IV gives the results and section V presents the conclusions of the study.

[1] Studies produced recently but with a different methodology from this article's include Aroca (2000), De Gregorio (2009) and Álvarez and Fuentes (2004), who analyse growth in the mining sector, linking it to Chile's comparative advantage in ore extraction. Other research has concentrated on the sectoral economic repercussions of mining. This is the case with Aroca (2000), Acevedo and others (2006) and COCHILCO (2013), where the elasticities of the mining sector relative to other economic sectors are calculated using an input-output matrix. Meller (2013) presents an econometric model that uses a reduced form equation to relate growth in the Chilean economy to mining activity. The results indicate that the more copper exports expand, the more the economy grows, a rebuttal, according to the study, of the hypothesis that the boom in the copper sector over the last decade might have caused Dutch disease.

[2] This literature sets out to identify the point up to which extraction of a non-renewable resource is optimal (see, for example, Bohn and Deacon, 2000).

II

The copper mining sector and the Chilean business cycle

This section presents evidence for the dynamic correlations between the mining sector and the business cycle in the Chilean economy. The sample used depended on the availability of data. Ideally, though, it was quarterly, covering the period from 2000 to 2013.

The correlation-type analysis indicated was chosen because: it can be used to examine the interaction between the mining sector and the business cycle in Chile over the last decade; it provides information additional to that yielded by the studies cited earlier about the impact of the mining sector on the economy; and, most importantly, it provides a way into the analysis to be carried out in estimating the DSGE model, with mining-sector output being incorporated endogenously.

The cross-correlations between the economic series representing the mining sector m (copper price, mining GDP or both) and the macroeconomic series y (GDP, consumption, real exchange rate, investment, etc.) are measured as follows:

$$r_{m,y}(l) = \frac{C_{m,y}(l)}{\sqrt{C_{m,m}(0)}\sqrt{C_{y,y}(0)}} \qquad l = 0, +1, +2, \dots \quad (1)$$

where:

$$C_{m,y}(l) = \sum_{t=1}^{T-l}\left(\left(m_i - \bar{m}\right)\left(y_{i+l} - \bar{y}\right)\right)/T \qquad l = 0, 1, 2, \dots$$

$C_{m,y}(l)$ covariance between m and y.
$C_{m,m}(0)$ variance of m.
$C_{y,y}(0)$ variance of y.

What equation (1) can estimate is whether the variables representing the mining sector "anticipate" movements in the macroeconomic series, coincide with them or are simply unrelated. Thus, it is established that the mining variable m precedes the cycle of a macroeconomic variable by $T–l$ periods (quarters or years) if this correlation is significant (positive or negative) for $T–l > 0$ (García, Jaramillo and Selaive, 2007). The statistical significance of a specific correlation, i.e., whether this correlation is different from zero, is measured by analysing whether the

value of the correlation is or is not outside a confidence band of two standard deviations, represented by: $\pm 2/\sqrt{N}$, where N is the number of observations.

Table 1 measures the dynamic correlations between the copper price and macroeconomic aggregates: private consumption, private investment, exports and imports, all measured in real terms. All the variables were expressed in quarterly growth rates.[3] These correlations indicate that future consumption growth, GDP, investment and imports covary positively with present changes in the copper price. Nonetheless, it is important to stress that the analysis in this area only deals with comovement between variables and not causality. Thus, it is illustrative to confirm that the copper price weakly but positively "anticipates"[4] variables such as aggregate investment.

Conversely, total exports do not evince any kind of future comovement with the copper price. This is an important fact because not only is there no positive dynamic correlation, but there is no negative one, which would be indicative for example of symptoms of Dutch disease, i.e., a situation in which a very high copper price could be causing real exchange-rate appreciation and thereby undermining the competitiveness of the industrial sector.

Table 2 shows the results of dynamic correlations between the copper price and levels of GDP by branch of economic activity. This price covaries positively with the commerce sector in the first place, and then with the industrial sector, although it is important to note that the correlation with the industrial and commerce sectors does not necessarily indicate a positive causal influence from the mining sector, as there could also be a third variable or economic force (such as the international business cycle) that is affecting all the variables in the same direction. Lastly, there is no evidence of the copper price covarying either with construction or with agriculture.

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[3] One alternative is to use the cyclical component of the decomposition carried out with the Hodrick-Prescott filter (García, Jaramillo and Selaive, 2007; Restrepo and Soto, 2006).

[4] Hereinafter, "weak" is to be understood as meaning that a correlation is statistically significant but very close to the confidence band.

TABLE 1

Dynamic correlations between the copper price and macroeconomic aggregates

Quarters	Gross domestic product (GDP)	Investment	Consumption	Imports	Exports
0	0.2937	0.1904	0.3835[a]	0.4512[a]	0.1554
1	0.3206[a]	0.4203[a]	0.3614[a]	0.5708[a]	0.1168
2	0.2073	0.3018	0.344[a]	0.375[a]	0.0982
3	0.0892	0.024	0.2043	-0.0009	0.1235
4	0.1085	0.067	0.1617	-0.116	-0.0797
5	0.1622	0.0108	0.0893	0.0291	0.1754
6	-0.1683	-0.0088	-0.1586	-0.0656	-0.1762
7	-0.116	0.1954	-0.0876	0.0458	-0.0793
8	0.0827	0.1532	-0.0661	0.0885	0.0465
9	0.0704	-0.0134	0.0109	-0.0995	0.0425
10	-0.0493	-0.0072	-0.1058	-0.135	-0.0886
11	-0.2165	-0.2155	-0.1847	-0.2669	-0.2138
12	-0.1457	-0.1611	-0.0875	-0.0769	-0.0872
13	-0.11	-0.079	-0.0837	-0.0323	0.0885
14	-0.1072	-0.0961	-0.011	-0.0107	0.0442
15	-0.0836	-0.2022	-0.0872	-0.0378	0.0141
16	-0.0427	0.0193	-0.0162	-0.0462	-0.1344

Source: Prepared by the authors, on the basis of the sources given in annex 2.

[a] Significant and greater than two standard errors.

TABLE 2

Dynamic correlations between the copper price and gross domestic product (GDP) by branch of economic activity

Quarters	Agriculture	Commerce	Industry	Construction	Transport
0	0.0541	0.4254[a]	0.3835[a]	0.2145	0.1253
1	0.2793	0.3213[a]	0.3614[a]	0.2398	0.2316
2	0.0023	0.2837[a]	0.344[a]	0.1318	0.3091[a]
3	-0.1391	0.2115	0.2043	0.0443	0.0914
4	0.0821	0.1765	0.1617	-0.0559	0.1263
5	0.2889	0.016	0.0893	0.1723	0.045
6	0.0356	-0.3144[a]	-0.1586	-0.0085	-0.3754[a]
7	-0.1641	0.01	-0.0876	0.2086	-0.2536
8	-0.0475	0.0411	-0.0661	0.1244	0.0651
9	-0.0109	0.0358	0.0109	0.0414	0.1082
10	0.0533	-0.1916	-0.1058	0.0219	0.0007
11	-0.1664	-0.1448	-0.1847	-0.1833	-0.2772[a]
12	-0.0656	-0.1104	-0.0875	-0.0954	-0.101
13	0.132	-0.1883	-0.0837	-0.1429	-0.1712
14	-0.097	-0.159	-0.011	-0.0557	-0.1168
15	-0.0181	-0.0456	-0.0872	-0.0481	-0.0861
16	-0.0533	0.0603	-0.0162	0.0004	0.0053

Source: Prepared by the authors.

[a] Significant and greater than two standard errors.

Table 3 uses annual data to show the dynamic correlations between the copper price and fiscal spending and revenue, expressed as percentages of GDP. As was to be expected, there is a contemporary correlation between the copper price and fiscal revenue from copper. One finding that stands out, though, is that changes in the copper price anticipate increases in the different fiscal expenditure items as shares of GDP. This outcome is consistent with a fiscal rule whereby copper revenues are to be spent over time (García, Jaramillo and Selaive, 2007) and not immediately.

Table 4 uses quarterly data to show dynamic correlations between the copper price and external-sector variables, measured as percentages of GDP (current account and foreign investment), together with dollar-denominated export growth rates. All the variables were

measured in each year's dollars, including the current account and foreign investment, and then divided by GDP in dollars. The results indicate that the copper price anticipates foreign investment as a share of GDP by many periods. Furthermore, this price coincides in time with a current account surplus. Both findings are consistent with the fact that the higher copper prices of recent years have attracted foreign investment, and with the evidence that a good price enables a current account surplus to be achieved because of its effect on the trade balance.

TABLE 3

Dynamic correlations between the copper price and fiscal spending and revenue

Quarters	Personal spending	Transfers	Total spending	Tax revenue	Copper revenue
0	-0.2766	0.4325	-0.3055	0.5138	0.5714[a]
1	0.0615	0.5707[a]	0.0303	0.4515	0.2084
2	0.3703	0.681[a]	0.3645	0.1567	-0.0858
3	0.5482[a]	0.6368[a]	0.5444	-0.0019	-0.3263
4	0.5762[a]	0.5032	0.5389	0.1354	-0.4802
5	0.4447	0.2405	0.4037	0.0663	-0.4854
6	0.258	-0.0438	0.2174	0.0221	-0.3859

Source: Prepared by the authors.

[a] Significant and greater than two standard errors.

TABLE 4

Dynamic correlations between the copper price and external-sector variables

Quarters	Current account	Foreign investment	Industrial exports	Agricultural exports	Mining exports
0	0.5107[a]	0.5518[a]	0.677[a]	0.4815[a]	0.6292[a]
1	0.3196[a]	0.5276[a]	0.3476[a]	0.0394	0.0052
2	0.0751	0.5064[a]	0.0146	0.0709	-0.1842
3	-0.1319	0.4571[a]	-0.1035	-0.0123	-0.0632
4	-0.2508	0.4869[a]	0.078	0.1017	-0.1164
5	-0.2913	0.5075[a]	0.2427	-0.1207	0.161
6	-0.3237[a]	0.4959[a]	-0.0977	-0.2111	-0.0245
7	-0.3583[a]	0.5136[a]	0.0575	0.2176	0.0813
8	-0.3626[a]	0.468[a]	0.1426	0.1343	-0.0081
9	-0.3392[a]	0.4197[a]	-0.0059	0.0318	-0.0931
10	-0.2236	0.448[a]	-0.411	-0.3212	-0.2498
11	-0.0595	0.4058[a]	-0.2698	-0.0558	-0.1683
12	0.1303	0.353[a]	0.0791	-0.0697	0.037
13	0.2782	0.2565	0.0412	0.1024	0.1962
14	0.3507[a]	0.1469	-0.0011	0.1173	0.1062
15	0.3526[a]	0.0988	-0.0018	-0.0484	-0.1463
16	0.3228[a]	0.0646	-0.0298	0.0678	-0.0459

Source: Prepared by the authors.

Note: The current account and foreign investment are expressed as percentages of GDP and exports as quarterly growth rates. The copper price was expressed in different ways. The trend of the Hodrick-Prescott (HP) filter was used for the correlation with foreign investment, the cyclical part of the HP filter for the current account, and the quarterly growth rate for exports.

[a] Significant and greater than two standard errors.

As already mentioned, the positive dynamic correlation between the copper price and dollar-denominated agricultural and industrial export growth may be signalling that a third variable or economic force has pushed up (or down) not only the copper price, but exports of all kinds. In this context, it seems reasonable to assume that fluctuations in the international economy might be this third variable or economic force, represented first by the long growth cycle up until 2007, and then by the sharp contraction resulting from the international financial crisis that began in 2008 (and the subsequent recovery).

Table 5 shows the dynamic correlations between the copper price and labour-market and real exchange-rate (RER) variables. The results clearly indicate that the correlations between labour market variables and the copper

price are statistically equal to zero or counterintuitive (the correlation with real wages is zero or negative). This evidence is in line with the weight of mining-sector employment in total employment. The mining sector is marginal, accounting for about 3%, a very small share by comparison with the major non-mining sectors of the economy (industry, commerce and construction), which between them account for almost 55% of total employment in the Chilean economy. Consequently, it is very likely that the mining sector does not have direct effects on employment, the unemployment rate and the evolution of real wages nationally.

Furthermore, as was to be expected, table 5 shows that there is a negative correlation between the copper price and the real exchange rate, although this comovement is very weak and strictly contemporary. This finding is consistent with systematic evidence in Chile and internationally that commodity prices do not predict exchange-rate fluctuations (Meese and Rogoff, 1983; Chen, Rogoff and Rossi, 2010; García, González and Moncado, 2013).

TABLE 5

Dynamic correlations between the copper price, labour market variables and the real exchange rate (RER)

Quarters	Unemployment rate	Employment	Real labour costs	Real pay	RER
0	0.1684	0.0221	0.0399	0.0685	-0.408
1	0.2077	0.1766	-0.3467[a]	-0.3344[a]	0.2214
2	0.1408	0.1346	-0.0801	-0.0833	0.1231
3	-0.0604	0.1187	0.0587	0.0758	0.0125
4	-0.1576	0.1195	0.0411	0.0647	0.0676
5	-0.1301	0.019	-0.1298	-0.1106	0.0051
6	-0.1019	-0.3123[a]	-0.0136	0.0188	-0.1419
7	-0.1259	-0.1416	0.0925	0.1247	-0.2438
8	-0.0846	0.213	-0.0766	-0.0586	0.0775
9	-0.0851	0.0155	-0.1327	-0.1324	0.1643
10	-0.077	-0.2929	-0.0592	-0.023	0.1641
11	-0.1502	-0.0561	0.074	0.099	-0.1046
12	-0.1709	0.2484	0.1139	0.1089	-0.0615
13	-0.0767	-0.054	-0.0062	0.0084	0.0022
14	-0.0058	-0.4331[a]	-0.0286	0.0174	-0.0297
15	-0.0102	0.0365	-0.0569	-0.0409	0.1145
16	0.0101	0.5146[a]	0.008	-0.0157	0.0151

Source: Prepared by the authors.

[a] Significant and greater than two standard errors.

In conclusion, the stylized facts in this section indicate a number of elements that need to be considered when the mining sector is modelled in a DSGE macro model:
- The copper price seems to be the key variable encapsulating the effects of the mining sector on the rest of the economy.
- The copper price anticipates changes in GDP, private investment, consumption and imports.
- This price also anticipates increases in fiscal spending, although this occurs three years after the increase in the copper price.
- The copper price also anticipates foreign investment.

- The mining sector does not greatly affect the labour market nationally. In this respect, the sector can be seen as an enclave with its own workforce concentrated in regions I, II, III and IV.
- The effects on the real exchange rate are negative, but there is no evidence that copper price variations anticipate changes in the real exchange rate.
- Although real exchange-rate appreciation could reduce the competitiveness of the non-mining export sector, the evidence found in this study does not indicate that mining activity is the explanation for major episodes of exchange-rate appreciation.

III

The macroeconomic model

This section presents the key modifications to the standard DSGE model (see, for example, García and González, 2014) that had to be made for the mining sector to be included appropriately.[5] The modifications were of two kinds. First, mining-sector output was modelled endogenously. Then, as a result of this change, a new channel of integration between this sector and the rest of the economy was added: demand for intermediate inputs. In this way, it can be demonstrated that, given the assumptions of the model used in the study, imported inputs turn into intermediate goods that meet the demand for consumption, investment by the intermediate sector itself and the government, and mining-sector investment. Conversely, the standard model only emphasizes the direct fiscal contribution of the mining sector, discounting profit remittances by mining firms of foreign origin.

Accordingly, the standard DSGE model was modified in two ways as set out below.

1. The mining sector

Unlike the standard DSGE model, this one assumed that copper production was not exogenous. On the contrary, it assumed that the production of copper QCU_t depended on labour L_t^{CU}, capital K_t^{CU} and energy E_t.

$$QCU_t = A_t^{CU} L_t^{CU\bar{\alpha}} K_t^{CU\bar{\beta}} E_t^{1-\bar{\alpha}-\bar{\beta}} \qquad (2)$$

where A_t^{cu} represents the availability of ore; for example, longer haulage distances and lower ore grades. Thus, a drop in this variable also leads to a reduction in mining GDP unless production inputs are increased. In logarithmic terms, this variable is assumed to take the following form:

$$a_t = \left(rho\_A\_COPPER\right)a_{t-1} + \varepsilon_t^{EE} \qquad (3)$$

The incorporation of these three inputs (L_t^{CU}, K_t^{CU} and E_t^{CU}) makes modelling the DSGE more difficult in a number of respects. A number of assumptions thus had to be made to simplify the modelling.

First, it was assumed that the mining sector used a mix of energy comprising fuel (oil) and electricity. The mining sector was assumed to be a price taker for both inputs.

$$E_t = OIL_t^{\delta} EE_t^{1-\delta} \qquad (4)$$

where OIL is the fuel and EE_t is electricity. Thus, given a certain level of production and thence total energy (E_t), the demand for fuel and for electricity can be obtained separately from their prices. The electricity-sector model is simplified, and it is assumed that the mining sector cannot affect the electricity price. It is acknowledged that a more realistic (but also more complex) model would consider the possibility that the mining sector could affect the electricity price, and thence the cost of all production activities in the country, because of its relative size within the Chilean economy. It has been left for future research to spell out this additional channel from mining to the rest of the economy. In logarithmic terms, the electricity price is assumed to have the following form:

$$p_t^{EE} = \left(rho\_PEE\right)p_{t-1}^{EE} + \varepsilon_t^{EE} \qquad (5)$$

Notwithstanding, to improve the fit of the DSGE model there were also assumed to be lags in the response of demand for both energy and all other inputs to their respective prices.[6]

Thus, demand for a generic input J, termed $input_{J,t}$, measured in log-linearized terms, depends positively on the level of output as defined by $output_t$, negatively on the real-terms price of the input as defined by $P_{J,t}$, and on a lag defined by $input_{J,t-1}$:

$$input_{J,t} = MP\_input_J\_COPPER\left(output_t - p_{J,t}\right)$$
$$+ \left(1 - MP\_input_J\_COPPER\right)input_{J,t-1} \qquad (6)$$

---

[5] Annex 1 details the equations of the model employed.

[6] Berger, Caballero and Engel (2014) show that this functional form is equivalent to the assumption of a firm taking input procurement decisions in a lumpy fashion.

Secondly, copper-producing firms purchase capital from other firms in each period t. Although in point of fact some firms may also produce some of their own capital goods, this study assumes, purely for simplicity's sake, that these are separate firms.

For the same reason, it is also assumed that at the end of each period t copper-producing firms can resell the capital purchased from capital goods-producing firms.

Thus, the copper-producing firm's target function is:

$$
\begin{aligned}
\max_{\left\{K^{CU}_{t+k}, L^{CU}_{t+k}, E_{t+k}\right\}^\infty_{k=0}} \sum^\infty_{k=0} E_t &\left\{ \Lambda_{t,t+k} \underbrace{\left(P^{CU}_{t+k} A^{CU}_{t+k} L^{CU\bar{\alpha}}_{t+k} K^{CU\bar{\beta}}_{t+k} E^{1-\bar{\alpha}-\bar{\beta}}_{t+k} + \left(1-\delta^{CU}\right) K^{CU}_{t+k} Q^{CU}_{t+k}\right)\left(1-t^u_t\right)}_{REVENUE} \right\} \\
&- \sum^\infty_{k=0} E_0 \left\{ \Lambda_{t,t+k} \underbrace{\left(R_{F,t+k} Q^{CU}_{t+k-1} K^{CU}_{t+k} + W^{CU}_{t+k} L^{CU}_{t+k} + P^E_{t+k} E_{t+k}\right)\left(1-t^u_t\right)}_{COSTS} \right\}
\end{aligned}
\tag{7}
$$

where $\Lambda_{t,t+k}$ is the stochastic discount factor, δ^{CU} the depreciation rate, P^{CU}_{t+k} the copper price, W^{CU}_{t+k} wages in the sector, P^E_{t+k} the energy price (an index composed of the oil and electricity prices), Q^{CU}_{t+k} the price of capital, $R_{F,t+k}$ the return on capital and t^u_t taxes on profits. Equation (7) yields the demand for capital, labour and total energy.

Again, capital-producing firms buy used capital from intermediate goods-producing firms, repair depreciated capital and construct new capital, where I^{cu}_t is the new capital created. Then, the maximization problem of capital-producing firms is:

$$
\max_{\left\{I^{CU}_{t+k}\right\}^\infty_{k=0}} \sum^\infty_{k=0} E_t \left\{ \Lambda_{t,t+k}\left(\left(Q^{CU}_{t+k}-1\right)I^{CU}_{t+k} - t^u_t Q^{CU}_{t+k} I^{CU}_{t+k} - f\left(\frac{I^{CU}_{t+k}}{I^{CU}_{t+k-1}}\right)I^{CU}_{t+k}\right) \right\}
\tag{8}
$$

where f is an increasing function that represents investment adjustment costs and $K^{CU}_{t+k+1} = \left(1-\delta^{CU}\right)K^{CU}_{t+k} + I^{CU}_{t+k}$. Equation (8) yields the supply of capital, which together with the demand for capital (equation (7)) can be used to determine the price of capital and the amount of capital available for the next period.

Third, as in the rest of the economy, there is assumed to be partial wage rigidity (in accordance with Calvo; see also by way of example the details in García and González, 2014). In other words, wages change exogenously over time as a result of two factors: the portion of wages adjusted directly because of changes in contracts (defined by *xi_w_COPPER*) and the portion of wages (defined by *index_w_COPPER*) that remain current but are adjusted for past inflation.

A labour supply can be derived from the modelling of wages. Thus, taking this assumption about wages and adding in the labour demand equation derived from

equation (8) yields mining-sector employment and wages. Purely for simplicity's sake, it is assumed that the marginal utility of consumption by families working in the mining sector is equal to the marginal utility of all other families in the economy. This assumption is innocuous if it is considered that the mining labour market has only marginal effects on the aggregate labour market in the Chilean economy (see section II).

2. The mining sector and the general equilibrium of the economy

In standard DSGE models that take mining output as exogenous (see, for example, García and González, 2014), the only connection between the mining sector and the rest of the economy is expressed through the fiscal sector: a portion of copper GDP is set down directly as fiscal revenue, the rest as remittances abroad.

In the present study, conversely, a wider connection is allowed, as it is further assumed that the mining sector draws in goods from the rest of the economy, in addition to electricity. To illustrate this point, equation (9) represents the goods market equilibrium when mining output is assumed to be exogenous:

$$P_{m,t} Y_t = P_t C_t + P_t I_t + P_t G_t + P_t X_t \qquad (9)$$

where I_t is investment in domestic or (non-commodity) intermediate goods, Y_t is output of these goods, C_t is household consumption, X_t is exports (external demand) and G_t is government spending on these goods.

By contrast, the present article assumes that mining-sector investment I_t^{cu} takes place in the domestic goods market:

$$P_{m,t} Y_t = \underbrace{P_t C_t + P_t I_t + P_t G_t}_{REST\ OF\ THE\ ECONOMY} + \underbrace{P_t X_t}_{EXTERNAL\ SECTOR} + \underbrace{P_t I_t^{cu}}_{MINING} \quad (10)$$

Although integration of the mining sector into the rest of the economy is an assumption of the model, this is based on the production structure of the Chilean economy. Table 6 shows the percentage of inputs that the copper mining sector draws from the wider economy; this was about 70% in 2008-2011, a figure obtained from the input-output matrix (Central Bank of Chile, 2013). While serving to simplify the analysis, though, this assumption produces limitations in the study, since assuming that the only connection between the mining sector and the rest of the economy is through investment-related purchases underestimates the ultimate impact of mining on the rest of the economy. It will be for future research to explore the wider connections between the copper sector and other sectors of the economy.

TABLE 6

Inputs produced by other sectors of the economy that are used for copper mining

Year	Percentage
2008	0.66
2009	0.69
2010	0.68
2011	0.73

Source: Prepared by the authors, on the basis of information from the Central Bank of Chile.

Lastly, once all the family and firm constraints have been aggregated, discounting the production of electricity for mining and considering that mining GDP (QCU_t) is wholly exported, the total constraint in the economy is obtained:

$$\underbrace{P_t C_t + P_t I_t + P_t G_t + P_t I_t^{CU}}_{SPENDING} + \underbrace{P_t CAJ_t}_{\substack{INVESTMENT \\ ADJUSTMENT \\ COSTS}} \leq \underbrace{P_{m,t} Y_t}_{\substack{INTERMEDIATE \\ GOODS \\ PRODUCTION}}$$

$$\underbrace{- SX_t M_t - SX_t P_t^{OIL} OIL_t - SX_t P_t^{OIL} OIL_t^{CU}}_{INPUT\ AND\ FUEL\ IMPORTS} \qquad (11)$$

$$\underbrace{+ SX_t \frac{B_{t+1}^*}{\tilde{R}_t^*} - SX_t B_t^*}_{CHANGE\ IN\ EXTERNAL\ DEBT} + \underbrace{\Gamma\left(SX_t P_t^{cu} QCU_t\right)}_{COPPER\ REVENUES}$$

where SX_t is the nominal exchange rate, P_t^{OIL} the oil price, M_t imports of inputs for the production of intermediate goods, B_t^* the external debt, $\tilde{R}_t^*$ the external interest rate adjusted for the risk premium and CAJ_t the total (i.e., both mining and non-mining) investment adjustment costs.

In sum, spending in the economy, including investment adjustment costs, must be financed from the output of intermediate goods, net of imports of both intermediate goods inputs and fuel (including the portion for copper), plus the change in external financing (changes in external debt) and copper revenue (copper's contribution to GDP minus remittances abroad).

IV

Model estimation and main results

This section will show the details of the results of the estimations and simulations serving to measure not only the impact of copper mining on the rest of the economy but also the way this sector in particular is affected by key variables such as the copper price, the electricity price and wages.

The exercises carried out are of three kinds. First, we analyse how a shock of 1% in the copper price affects the macroeconomic variables of the Chilean economy (mining-sector elasticity). Second, we measure the contribution of different economic shocks to variance in GDP growth, including the copper price and the availability of ore. Lastly, we examine what impact the copper price would have on the rest of the economy if mining were an enclave, i.e., if this sector were not integrated into the rest of the economy and thus did not draw in intermediate goods from it.

1. Results of the estimation using the DSGE model[7]

The DSGE macro model is estimated using Bayesian econometrics, meaning that the distribution of the parameter needs to be established using prior values, after which standard econometric techniques (maximum likelihood) and repetitions (simulation) are used to obtain the distributions of the final or posterior estimates. The prior values of the parameters estimated were taken from the traditional macro model literature (see García and González, 2014; and García, González and Moncado, 2013).[8] Two independent estimations were carried out with a large number of repetitions to ensure quality, and the distribution of the parameters was found to converge on similar values in both (see figure A.3.1 of annex 3).

There were two parts to the macro model estimation strategy, one where the parameters relating to the stationary state were calibrated, and one where only the parameters relating to the model dynamic were estimated (i.e., the

way the model converges on the stationary state after a shock).

The calibration replicated the long-term equilibrium or stationary state of the Chilean economy, measured by ratios such as consumption to GDP, investment to GDP or government spending to GDP. In the calibration process, it is crucial to obtain values for the parameters of the mining-sector output function (equation (2)).[9] These parameters represent the share of each of the inputs in copper production. To calibrate these parameters, use was made of information from the Chilean Copper Commission (COCHILCO), the National Energy Commission (CNE) and the Central Bank of Chile. The results of the calibration are shown in table 7, with the shares of capital (51%) and labour (39%) being predominant in copper output. Of the total energy used by the sector (10%), electricity makes up the bulk with 70% (see the bottom of table 7).[10]

In summary, calibrating the DSGE model produces the following stationary state or long-term equilibrium for the Chilean economy, which is consistent with the information available from the Central Bank of Chile (see table 8).

TABLE 7

Share of inputs and energy types employed in copper production

Parameter	Share
Labour	0.39
Capital	0.51
Energy	0.1
Parameter	Share
Fuel	0.3
Electricity	0.7

Source: Prepared by the authors, on the basis of information from the Chilean Copper Commission (COCHILCO), the National Energy Commission (CNE) and the Central Bank of Chile.

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[7] Annex 2 presents the data employed.

[8] The subsequent posterior values were obtained using the Metropolis-Hastings algorithm based on a Markov chain of 20,000 repetitions to construct the estimated distribution of the (subsequent) parameters. Estimations with 100,000 repetitions yielded similar results.

[9] Annex 3 presents the parameters for the rest of the economy.

[10] Annex 4 presents the details of the calibration of the Cobb-Douglas functions for the mining sector.

TABLE 8

Stationary state of the DSGE model

Stationary state	Ratio to gross domestic product (GDP)
Consumption	0.64
Intermediate investment	0.19
Copper investment	0.06
Government spending	0.10
Intermediate exports	0.27
Imported inputs	0.41
Imported fuel	0.03
Copper GDP	0.17
Tax burden	0.18

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

The parameters associated with the impact of copper mining[11] on the economy will now be evaluated (see table 9). First, the standard deviations of the shocks affecting the sector will be observed. Here, the greatest volatility derives from the prices of copper itself and oil, both at around 16% (oil is a major input in copper production). It transpires that these two variables represent the most volatile shocks facing the Chilean economy in absolute terms, according to the DSGE model estimation (see annex 3). Next comes the effect of the electricity

price and of the shock represented by the availability of the material (copper); these are more moderate, being comparable to other shocks affecting the economy, at around 6% (see annex 3).

Next, as explained with equation (6), the parameters (MP) measure the short-term sensitivity of demand for each input to activity and prices in the mining sector. As can be seen in table 9, all the MP parameters are well below 0.5, which indicates a high degree of inertia in the copper mining sector where procurement of new inputs is concerned. Within a quarter, in other words, the decision to acquire an input is heavily influenced by the decision taken in the previous period, and the adjustment process (meaning the time taken to fully change an input demand decision because of a change in prices and output) lasts an average of five quarters.[12]

Where wages in the mining sector are concerned, the model shows these remaining rigid for about three quarters,[13] and they present a level of indexation to past inflation of about 1.[14] This finding is in line with those obtained in estimating the dynamic of wages in the rest of the economy (see annex 3).

---

[11] With regard to the estimates of the parameters determining the dynamic of the macro model, many of the values estimated are found to be in line with the values found by other studies (García and González, 2014; and García, González and Moncado, 2013). Annex 3 presents detailed estimates of all the parameters in the macro model.

---

[12] 3.9 quarters = 1/(1-0.74), where 0.74 is the average lag of the parameters (1 - MP).

[13] 2.65 quarters = 1/(1-xi_w_COPPER) = 1/(1-0.62), where xi_w_COPPER measures the average likelihood of nominal wages remaining rigid in the copper sector.

[14] index_w_COPPER = 0.9, where index_w_COPPER is the inflationary inertia of nominal wages.

TABLE 9

Parameters relating to the impact of copper mining on the economy

Parameter	Prior (mean)	Posterior (mean)	Confidence interval 90%		Prior distribution	Prior standard deviation
MP_EE_EN_COPPER	0.5	0.2564	0.1317	0.3676	beta	0.1
MP_EN_COPPER	0.5	0.1423	0.0555	0.2258	beta	0.1
MP_L_COPPER	0.5	0.0848	0.051	0.1188	beta	0.1
MP_K_COPPER	0.5	0.5461	0.4031	0.6778	beta	0.1
index_w_COPPER	0.9	0.9046	0.8335	0.9712	beta	0.05
xi_w_COPPER	0.67	0.6216	0.5705	0.6813	beta	0.05
rho_Oil	0.9	0.8655	0.7959	0.9337	beta	0.05
rho_Pcu	0.9	0.8623	0.8377	0.8915	beta	0.05
rho_A_COPPER	0.9	0.9045	0.8917	0.9168	beta	0.01
rho_PEE	0.5	0.8518	0.8016	0.9022	beta	0.1
Standard deviation:						
Copper price	16.53	16.627	15.8637	17.4668	invg2	0.5
Oil price	16.07	16.2808	15.608	17.0067	invg2	0.5
Mining wage price	0.9	0.5559	0.4213	0.6845	invg2	0.5
Electricity price	6.84	6.9106	6.2696	7.6251	invg2	0.5
A^{cu}	3.59	7.2804	5.834	8.6681	invg2	0.5

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

Lastly, all the shocks affecting this sector have a high level of persistence (rho parameters), exceeding 0.8.

2. The elasticity of the copper mining sector

To measure the impact of the mining sector on the Chilean economy, the decision was taken to analyse the effect over time (quarters) of a 1% copper price shock on all the variables in that economy, assuming that no other shock was affecting it. This way of quantifying impact is known as an impulse-response function (IRF).

The information will be presented using a (quarterly) chart to set out the way the copper price affects the rest of the economy, i.e., the history behind a change in the copper price. The chart comprises subcharts showing the evolution of the different macroeconomic variables after a 1% copper price shock over the quarters. For the variables to be compared, all the subcharts have the same dimensions on the vertical axis.

Then, a table will give a precise summary of the impact of the copper price on the main macroeconomic variables over the years. Given that the DSGE model is linear and was estimated using percentage change data (log differences multiplied by 100), the numbers in the table can be interpreted as elasticities. Thus, they have to be multiplied by 10 to find out what effect a 10% increase in the copper price would have. With this method, it is easy to quantify any impact on the Chilean economy of a change in the copper price.

Figure 1 shows the impulse responses in the economy to a 1% shock in the copper price. This shock is clearly expansionary, i.e., it leads to increased growth in GDP, investment, electricity use, employment and wages in the mining sector. The way this spreads through the Chilean economy is as follows, confirming the correlations analysis presented at the beginning of this paper.

There is a direct expansionary effect on GDP, since mining GDP is part of this, averaging a share of 17% in recent years. There is a lesser increase in consumption and a rise in mining-sector demand for intermediate goods, driving an increase in imported inputs and employment in non-copper sectors (these sectors' wages remain practically unchanged). All this contributes to an expansion in overall GDP beyond the increase in mining GDP alone.

Government spending rises moderately, as the fiscal rule is assumed to be operating in the DSGE model.

Inflation rises marginally because of the increased activity level, causing the central bank to raise interest rates slightly, which has two effects: (i) the real exchange rate appreciates, so that non-copper exports fall, and (ii) non-copper investment falls, although total investment (i.e., including that in the mining sector) rises.

It can be seen that a marginal rise in the interest rate has significant effects on the real exchange rate and investment in other production activities, since these variables in the DSGE model do not depend on the current level of the interest rate alone but on the whole path of this

FIGURE 1

Effect of the copper price on the Chilean economy
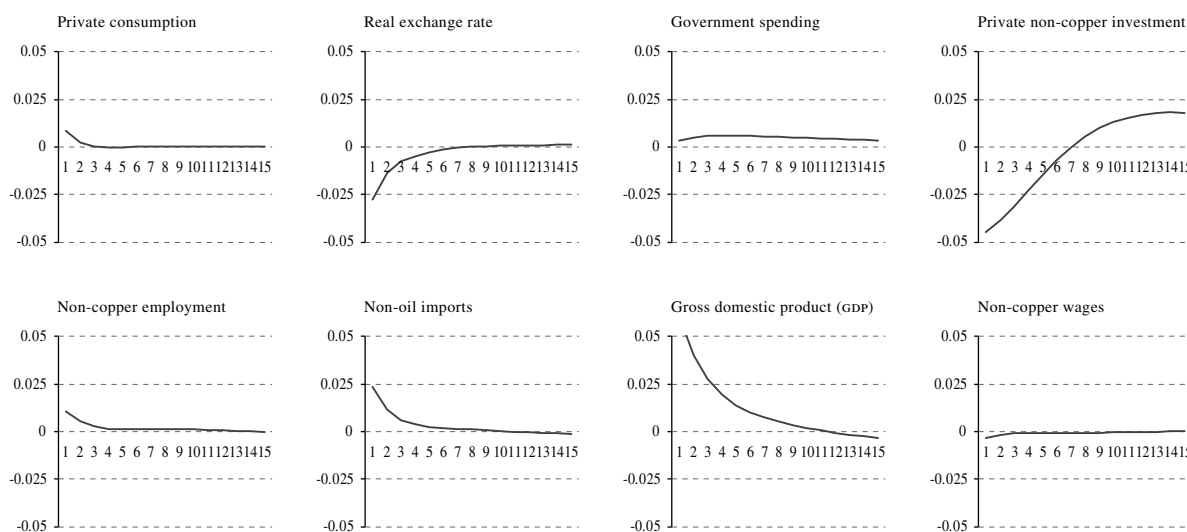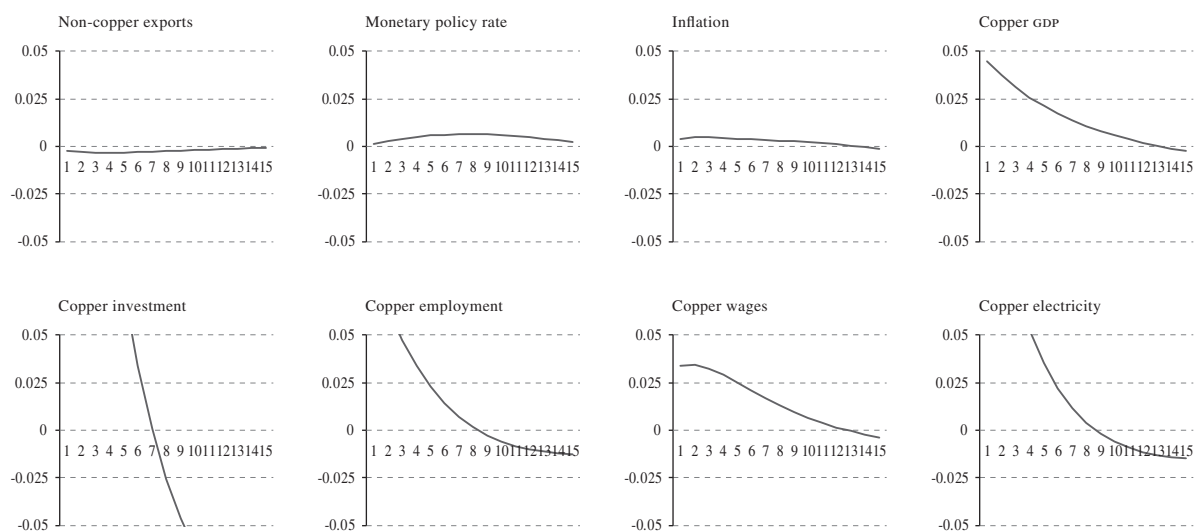*(All variables measured as growth rates)*

Figure 1 (concluded)

| Non-copper exports | Monetary policy rate | Inflation | Copper GDP |
| Copper investment | Copper employment | Copper wages | Copper electricity |

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

variable (long-term interest rate). The accumulation of higher marginal rates over a prolonged period ultimately reduces these two variables in the early periods.

To provide a clearer picture of all this, table 10 shows the growth values for the different macroeconomic variables resulting from a 1% copper price shock. Table 10

is constructed from the same information as figure 1, but summarizes the information in annual terms. It details the evolution of the economy until five years after the shock, while also giving cumulative results for 1, 5 and 10 years. The main changes observed are as follows.

TABLE 10

Impact of a 1% copper price increase

Year	C	E	G	NCI	NCE	NOM	GDP	W	X	R	PI	CGDP	CI	CE	CW	EE
1	0.011	-0.054	0.020	-0.137	0.020	0.045	0.147	-0.007	-0.012	0.013	0.019	0.140	0.911	0.229	0.130	0.381
2	0.000	-0.004	0.023	-0.016	0.004	0.007	0.036	-0.002	-0.012	0.025	0.014	0.063	0.083	0.046	0.076	0.073
3	0.001	0.003	0.019	0.055	0.004	0.001	0.006	-0.002	-0.007	0.023	0.008	0.020	-0.267	-0.027	0.022	-0.028
4	0.001	0.005	0.015	0.072	0.000	-0.004	-0.011	0.001	-0.004	0.011	-0.003	-0.007	-0.364	-0.048	-0.011	-0.057
5	0.001	0.006	0.011	0.062	-0.003	-0.006	-0.019	0.004	-0.001	-0.007	-0.017	-0.023	-0.331	-0.048	-0.027	-0.060

Cumulative

	C	E	G	NCI	NCE	NOM	GDP	W	X	R	PI	CGDP	CI	CE	CW	EE
1	0.011	-0.054	0.020	-0.137	0.020	0.045	0.147	-0.007	-0.012	0.013	0.019	0.140	0.911	0.229	0.130	0.381
5	0.015	-0.044	0.088	0.035	0.026	0.042	0.159	-0.006	-0.036	0.064	0.021	0.192	0.027	0.151	0.191	0.307
10	0.020	-0.022	0.112	0.093	-0.002	0.023	0.043	0.024	-0.023	-0.176	-0.209	0.016	-0.452	0.005	0.050	0.068

C	Private consumption	X	Non-copper exports
E	Real exchange rate	R	Monetary policy rate
G	Government spending	PI	Inflation
NCI	Private non-copper investment	CGDP	Copper GDP
NCE	Non-copper employment	CI	Copper investment
NOM	Non-oil imports	CE	Copper employment
GDP	Gross domestic product	CW	Copper real wages
W	Non-copper real wages	EE	Copper electricity

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

A 1% rise in the copper price causes GDP to grow by up to 0.16% five years on from the shock. Thus, mining elasticity in the event of a rise in the copper price is 0.16 = (0.16%/1%) in five years.

The past experience of the Chilean economy has been of persistent quarterly increases in the copper price over time. The calculations carried out in this study using the DSGE model indicate that the impact of this on GDP has been quantitatively large: if this quarterly growth in the copper price continued for 4, 8, 12 and 16 quarters, cumulative GDP would grow by 0.67%, 1.41%, 2.18% and 2.89%, respectively.[15]

Given that the copper price shows large standard deviations (up to 16%), a positive fluctuation of this size would equate to almost two points of growth in five years (2.54% = 16*0,16).

Growth in copper investment easily offsets the drop in non-copper investment the first year. Because inflation falls, though, the central bank also cuts the interest rate, so that investment partially recovers in other sectors.

Although consumption rises by 0.015% in five years, the main macro aggregate that rises is government spending (0.088%).

The rising copper price is undoubtedly associated with real exchange-rate appreciation. This amounts to 0.044%, which reduces non-copper exports by 0.036% in five years. During this period, however, employment in other sectors rises by up to 0.026% in five years.

3. The contribution of the copper mining sector to growth volatility

The variance of the growth observed in 2003-2013 is broken down into the macroeconomic shocks of the DSGE model with a view to measuring the contribution of the copper mining sector to growth volatility. The strength of this analysis, then, is that it consider all shocks together, allowing a clearer picture to be formed of the importance of mining, and the copper price in particular, in comparison with other elements that are also drivers of the business cycle in the Chilean economy.

By construction, these shocks must add up to 100% of growth variance in the Chilean economy in the period defined. Consequently, a great variety of shocks studied by the literature on economic fluctuations in open economies (monetary, fiscal, production, terms of trade, risk premium, etc.) were included in the DSGE model so that the fluctuations observed in the Chilean economy were not left to be explained by just a few kinds of shock. Due to the great persistence of the shocks affecting the economy, furthermore, the growth variance decomposition was analysed from 1 quarter to 20 quarters.

The approach described puts into perspective the effect of the copper price not only on GDP growth but also on one of the key variables in the Chilean economy, the real exchange rate. Indeed, the previous section clearly showed that a rise in the copper price causes the real exchange rate to strengthen, and thus non-copper exports to fall. An important question arises for the 2003-2013 period, though: was the copper price a fundamental determinant of the evolution of the real exchange rate, or did other shocks drive this variable?

Table 11 shows a key element in the country's economy: external factors are almost as important in explaining the business cycle as productivity. Among these factors, the copper price by itself accounted for about 5.8% of GDP variance in 2003-2013 and was the largest factor, ahead of the risk premium and far ahead of external activity (the weighted growth of the United States, Europe and Japan), external interest rates and the oil price.

Furthermore, table 12 indicates that the copper price has a very marginal influence on fluctuations in the real exchange rate. Conversely, the risk premium for the exchange rate itself and productivity shocks account for almost 60% of the fluctuation in this variable. Consequently, it can be said that although a higher copper price leads to real-term appreciation of the Chilean peso, exchange-rate fluctuations in the 2003-2013 period were associated with other shocks more connected with financial and production factors.[16]

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[15] Annex 5 presents the details of this calculation.

[16] García and González (2014) find that this also holds true for other economies with a large mining sector, such as Australia.

TABLE 11

Decomposition of variance in GDP growth
(Percentages)

GDP growth	Quarters				
Shock	1	4	8	16	20
Consumption	15.4	25.1	21.0	20.8	20.7
Monetary policy interest rate	13.5	8.7	8.5	8.4	8.3
Government spending	4.5	3.5	2.8	2.8	2.7
Risk premium	2.8	2.4	2.0	2.0	2.0
Wage	46.8	33.3	32.9	32.7	32.7
External interest rate	0.3	0.5	0.5	0.6	0.6
External gross domestic product (GDP)	0.5	0.4	0.5	0.6	0.6
Copper price	6.0	5.8	5.0	4.9	5.0
Oil price	0.4	0.5	0.6	0.7	0.7
Productivity	0.8	14.8	22.0	22.5	22.6
Copper availability	0.6	0.5	0.4	0.4	0.4
Other	8.4	4.6	3.7	3.6	3.6
Mining (copper price + availability)	6.7	6.3	5.4	5.4	5.4
External factors	10.0	9.6	8.7	8.9	8.9

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

TABLE 12

Percentage decomposition of variance in the bilateral real exchange rate with the United States

Changes in the real exchange rate	Quarters				
Shock	1	4	8	16	20
Consumption	10.5	14.6	14.1	14.1	14.1
Monetary policy interest rate	4.0	3.5	3.6	3.6	3.6
Government spending	0.0	0.0	0.0	0.0	0.0
Risk premium	23.2	26.6	25.6	25.5	25.5
Wage	15.2	13.3	13.6	13.6	13.6
External interest rate	9.5	8.6	8.7	8.7	8.7
External gross domestic product (GDP)	1.9	1.6	1.6	1.6	1.6
Copper price	0.4	0.0	0.0	0.0	0.0
Oil price	0.1	0.2	0.2	0.2	0.2
Productivity	35.2	31.1	32.3	32.2	32.2
Copper availability	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.4	0.4	0.4	0.4
Mining (copper price + availability)	0.4	0.0	0.0	0.0	0.0
External factors	23.2	26.6	25.6	25.5	25.5

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

4. Integration versus enclave

It is important to quantify just how important to all the results presented hitherto is the key assumption that the copper mining industry is integrated with or connected to the rest of the Chilean economy via demand for intermediate inputs.

In order for the effect of this assumption on the model results to be quantified, these are compared with the results obtained using the alternative assumption that mining behaves like an "enclave", i.e., that its contribution to the economy is confined to contributing

to fiscal revenues, whether directly via the Chilean National Copper Corporation (CODELCO), the country's State copper producer, or through profit taxes.
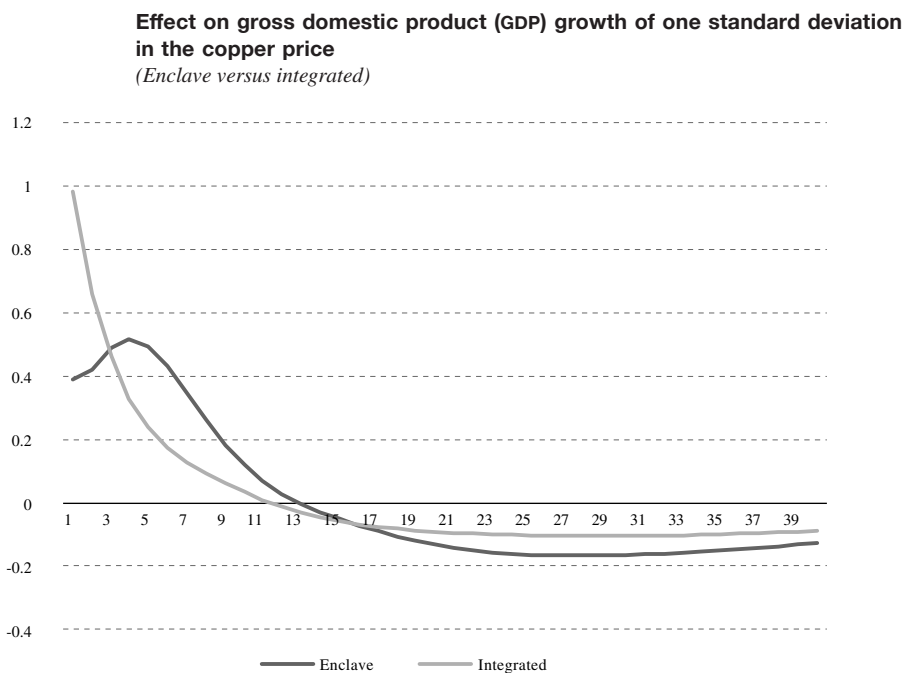
Figure 2 illustrates the importance of properly modelling the integration of mining into the rest of the economy and not just considering the sector's fiscal effects. If the DSGE model had treated the mining sector as an enclave unintegrated into the rest of the economy, the effects on GDP growth would have had to be divided by almost 2.5 (0.98/0.39).

It is worth clarifying that the distinction between integration and enclave was of basic importance in

identifying the impacts of the copper price on the economy. From the point of view of the model as a whole, the improvements yielded by this distinction proved marginal. In other words, the fit (as measured by the Bayesian factors) is very much the same in both models. Nonetheless, it is important to stress that this is a common problem in the estimation of DSGE models, i.e., the sample properties are not sufficient to discriminate between different models. Del Negro and Schorfheide (2008) argue that the solution to this identification problem is to look for microeconomic evidence that enables the value of the parameters concerned to be fixed. In the present case in particular, there is a fairly obvious connection between the copper sector and the rest of the economy. Going by the information in the input-output matrices since 2008 (see table 6), the copper sector systematically draws a substantial proportion of its inputs from the rest of the economy.

FIGURE 2

Effect on gross domestic product (GDP) growth of one standard deviation in the copper price
(Enclave versus integrated)

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

V

Conclusions

When modelling the importance of copper mining in the Chilean economy, it is vital to recognize the connections this sector has with the rest of the economy as well as the resources it generates for the Government of Chile.

Thus, while the sector's chief contribution is via the copper price, it is important to realize that its output depends on inputs largely supplied by the rest of the economy. Thus, copper price increases will activate a range of demand that will positively affect many other sectors in the economy.

In quantitative terms, a 1% rise in the copper price leads to a cumulative GDP increase of 0.16% in five years. When continuous increases in the copper price as seen in the past decade were modelled, the results were quantitatively important in explaining the upsurge of growth in the economy over those years.

Lastly, although copper price increases are associated with real exchange-rate appreciation, there is no evidence that the copper price accounted for the variance in the exchange rate in 2003-2013. In fact, this variable is driven mainly by risk premium and productivity shocks.

ANNEXES

ANNEX 1

The DSGE model

The DSGE model used generally accords with what is proposed by Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2003 and 2007). In addition to oil and copper, however, it also incorporates electricity as a production input.

Households

There is a continuum of families of unitary size, indexed by $i \in [0,1]$. There are two types of families in the model: one portion $(1 - \lambda_c)$ are "Ricardian"

families with access to the capital market, while another portion λ_c are restricted families whose income comes entirely from earnings. The preferences of Ricardian families are given by (A1.1), where C_t^o is consumption and L_t^o is the family's supply of labour.

The coefficient $\sigma > 0$ measures risk aversion and ρ_L the disutility of working; the inverse of this parameter is also the inverse of the elasticity of hours worked to the real wage; h measures the formation of habits to capture the dynamic of consumption.

$$\max_{\left\{C_{t+k}^o(i), L_{t+k}^o(i), B_{t+k}^o(i), B_{t+k}^{o^*}(i)\right\}_{k=0}^{\infty}} E_t \sum_{k=0}^{\infty} \beta^k \left(\frac{\left(C_{t+k}^o(i) - h C_{t+k-1}^o(i)\right)^{1-\sigma}}{1-\sigma} - \frac{L_{t+k}^o(i)^{1+\rho_L}}{1+\rho_L} \right) \tag{A1.1}$$

The budgetary constraint on unrestricted families (explained in detail in section III) is given by:

$$\left(1 + t_{t+k}^c\right) P_{t+k} C_{t+k}^o(i) \leq \left(1 - t_{t+k}^W\right) W_{t+k}(i) L_{t+k}^o(i)$$
$$+ B_{t+k}^o(i) - SX_{t+k} B_{t+k}^{o^*}(i) + D_{t+k}^o - R_{t+k}^{-1} B_{t+k+1}^o(i)$$
$$+ \left(\Phi\left(\frac{B_{t+k+1}^{o^*}}{PIB_{t+k}}\right) R_{t+k}^*\right)^{-1} B_{t+k+1}^{o^*}(i) \tag{A1.2}$$

where t_t^W is income tax, t_t^C the consumption tax, W_t wages, SX_t the nominal exchange rate, B_t^o domestic debt stocks, $B_t^{o^*}$ the external debt stock, D_t^o dividends, R_t the domestic interest rate and R_t^* the external interest rate. Restricted families are subject to the following budgetary constraint (free of income taxes):

$$\left(1 + t_c\right) P_t C_t^R(i) = W_t(i) L_t^R(i) \tag{A1.3}$$

Financial intermediaries

Financial intermediaries lend funds S_{jt} obtained from families to non-financial firms. These funds come from their own wealth N_{jt} and funds obtained from families B_{jt}.

$$Q_t S_{jt} = N_{jt} + B_{jt} \tag{A1.4}$$

Financial wealth evolves via the spread between the market rate R_{Ft+1}, for producers of capital, and the monetary policy rate R_{t+1}, which is also the effective interest rate for families.

$$N_{jt+1} = \left(R_{Ft+1} - R_{t+1}\right) Q_t S_{jt} + R_{t+1} N_{jt} \tag{A1.5}$$

Financial intermediaries' goal is to maximize their expected wealth, given by:

$$V_{jt} = \max_{\left\{N_{jt+k+1}\right\}_{k=0}^{\infty}} E_0 \sum_{k=0}^{\infty} (1-\theta)\theta^k \Lambda_{t,t+k+1} \left[\left(R_{Ft+1+k} - R_{t+1+k}\right) Q_{t+k} S_{jt+k} + R_{t+1+k} N_{jt+k}\right] \tag{A1.6}$$

Gertler and Karadi (2011) introduce moral hazard into problem (A1.6), showing that in the aggregate:

$$Q_t S_t = \phi_t N_t \qquad (A1.7)$$

Equation (A1.7) indicates that the total availability of private credit is intermediaries' wealth multiplied by a factor ø, which indicates their degree of leverage.

Intermediate goods firms

Intermediate goods firms use capital K_t, labour L_t and imported goods M_t to produce intermediate goods Y_t. At the end of period t, intermediate goods-producing firms purchase capital K_{t+1} for use in production in the following period. Once the production process is over, firms have the option of selling the capital. To acquire the resources needed to fund capital purchases, firms

hand over S_t entitlements equal to the number of units of capital acquired K_{t+1} and the price of each entitlement is Q_t. In other words, $Q_t K_{t+1}$ is the value of the capital acquired and $Q_t S_t$ the value of the entitlements against capital. Then the following must be satisfied:

$$Q_t K_{t+1} = Q_t S_t \qquad (A1.8)$$

In each period or at each time t, the firm produces Y_t using capital, labour and imported goods. Let A_t be total factor productivity. Then, output is given by:

$$Y_t = A_t K_t^\beta L_t^\alpha M_t^{1-\alpha-\beta} \qquad (A1.9)$$

Let $P_{m,t+k}$ be the price of the intermediate good. Given that the firm's decision is taken at the end of period t, the maximization problem for the firm producing intermediate goods is:

$$\max_{\{K_{t+k}(j),L_{t+k}(j),M_{t+k}(j)\}_{k=0}^\infty} \sum_{k=0}^\infty \Lambda_{t,t+k} E_t \left\{ \left(P_{m,t+k} Y_{t+k}(j) + (1-\delta) K_{t+k}(j) Q_{t+k} \right)(1-t_{t+k}^u) \right\}$$
$$- \sum_{k=0}^\infty \Lambda_{t,t+k} E_t \left\{ \left(R_{F,t+k} Q_{t+k-1} K_{t+k}(j) + W_{t+k} L_{t+k}(j) + SX_{t+k} M_{t+k}(j) \right)(1-t_{t+k}^u) \right\} \qquad (A1.10)$$

Taxes on these firms' profits t_t^u do not affect the demand for inputs and nor do they have fiscal effects, given the assumption of perfect competition in the production of these goods, which means zero profits.

The coefficient $\sigma > 0$ measures risk aversion and ρ_L measures the disutility of working; the inverse of this parameter is also the inverse of the elasticity of hours worked to the real wage, while h measures the formation of habit to capture the dynamic of consumption. To better model the dynamic of consumption, expected

earnings were aggregated ad hoc in the Euler equation for optimizers.

Capital-producing firms

Capital-producing firms purchase capital from intermediate goods-producing firms, repair depreciated capital and construct new capital with the repaired capital. If we define I_t as investment, the maximization problem for capital-producing firms is:

$$\max_{\{I_{t+k}\}_{k=0}^\infty} \sum_{k=0}^\infty \Lambda_{t,t+k} E_t \left\{ \left((Q_{t+k}-1) I_{t+k} - t_{t+k}^u Q_{t+k} I_{t+k} - f\left(\frac{I_{t+k}}{I_{t+k-1}} \right) I_{t+k} \right) \right\} \qquad (A1.11)$$

In other words, the capital goods-producing firm obtains a profit for investing in each period of $(Q_t - 1) I_t$, minus adjustment costs $f(I_t/I_{t-1})$. Lastly, *tu* are taxes on undistributed profits. The law of capital movement is given by:

$$K_{t+1+k} = (1-\delta) K_{t+k} + I_{t+k} \qquad (A1.12)$$

Retail firms

The final product Y_t is obtained using a constant elasticity of substitution (CES) function to aggregate the output of intermediate firms. This is assumed to be done by other firms, called retailers, which simply package the output of intermediate goods:

$$Y_t = \left(\int_0^1 Y_{ft}^{\frac{\varepsilon-1}{\varepsilon}} df \right)^{\frac{\varepsilon}{\varepsilon-1}} \qquad \text{(A1.13)}$$

As in Christiano, Eichenbaum and Evans (2005), retail firms operate in conditions of Calvo pricing and partial indexation. Then, the maximization problem for a retailer j is given by:

$$\max_{\{P_t^*(j)\}_{k=0}^\infty} \sum_{k=0}^\infty \theta^k E_t \left\{ \Lambda_{t,t+k} Y_{t+k}(j) \left(P_t^*(j) \prod_{l=1}^k \left(\pi_{t+l-1}^k \right)^{\delta_D} - MC_{t+k} \right) \right\}$$

$$\text{s.a.} \quad Y_{t+k}(j) \leq \left(\frac{P_t^*(j)}{P_{t+k}} \right)^{-\varepsilon_D} Y_{t+k} \qquad \text{(A1.14)}$$

where MC_{t+k} are the marginal costs of the retail firm. In particular, a firm is willing to adjust its prices with probability $(1 - \theta)$ in each period. Between these periods, the firm is willing to partially index its price (i.e., $\delta_D \in [0, 1]$) to the past inflation rate. With these assumptions, the price level evolves in accordance with:

$$P_t = \left((1-\theta) \left(P_t^* \right)^{\frac{1}{1-\varepsilon}} + \theta \left(\pi_{t-1}^{\delta_D} P_{t-1} \right)^{\frac{1}{1-\varepsilon}} \right)^{1-\varepsilon} \quad \text{(A1.15)}$$

The final product used by consumers and firms is assumed to be a combination between Y_t and imports of oil for transport $TOIL_t$.

Monetary policy

Monetary policy follows a Taylor rule that responds to changes in output, inflation and the exchange rate.

$$R_t^* = \overline{R} \left(\left(\frac{\Pi_{t+1}}{\overline{\Pi}} \right)^{\phi_\pi} \left(\frac{GDP_t}{\overline{GDP}} \right)^{\phi_y} \left(\frac{E_t}{\overline{E}} \right)^{\zeta_e^1} \left(\frac{E_t}{E_{t-1}} \right)^{\zeta_e^2} \right) e^{u_t^R} \text{(A1.16)}$$

$$R_t = \left(R_{t-1} \right)^{\Omega_R} \left(R_t^* \right)^{1-\Omega_R} \qquad \text{(A1.17)}$$

where $\overline{R}$ is the natural rate, Π_t is total inflation, $\overline{\Pi}$ is the inflation target, $\overline{GDP}$ is potential GDP, E_t is the real exchange rate, $\overline{E}$ is the equilibrium real exchange rate and u_t^R is a monetary shock. In estimating equations (A1.16) and (A1.17), GDP excluding natural resources (i.e., the copper sector) was used.

Non-mining exports

In the model, exports X_t are assumed to depend on the real exchange rate E_t and international economic activity GDP^*_t and to present a degree of inertia Ω. Then,

$$X_t = \left(E_t \right)^{-\eta^*} GDP_t^* \qquad \text{(A1.18)}$$

$$X_t = \left(X_{t-1} \right)^{\Omega} \left(X_t \right)^{1-\Omega} \qquad \text{(A1.19)}$$

Country risk

To close the model, the further assumption is made, as in Schmitt-Grohé and Uribe (2003), that country risk depends on external debt as follows:

$$SX_t \left(\Phi \left(\frac{B_{t+1}^*}{GDP_t} \right) R_t^* \right)^{-1} \qquad \text{(A1.20)}$$

The resource constraint, copper output and government spending

The fiscal rule establishes that spending depends on structural revenue IT, plus an adjustment for excess of public debt. In other words, if this debt is consistent with its long-run value B^{G^*}, then the value of fiscal spending is equal to structural revenue IT.

$$P_t G_t = \left(\frac{B_t^{G^*}}{B^{G^*}} \right)^{-\phi^G} IT \qquad \text{(A1.21)}$$

The government budgetary constraint, which includes all tax revenues plus copper transfers $\gamma^{cu} SX_t P_t^{cu} QCU_t$, is:

$$
\begin{aligned}
& t_t^c P_t C_t + t_t^u P_t I_t + t_t^u P_t I_t^{cu} + t_t^W W_t N_t + \left(R_t\right)^{-1} B_{t+1}^G \\
& + \gamma^{cu} SX_t P_t^{cu} QCU_t = B_t^G + P_t G_t
\end{aligned}
\tag{A1.22}
$$

where B_t^G is government debt and γ^{cu} is the percentage of total copper exports by value made by the government (CODELCO).

Data used

The study sample is quarterly, from January 2003 to April 2013.

(i) *Macroeconomic data*
     Macroeconomic information was taken from the website of the Central Bank of Chile:
     http://si3.bcentral.cl/Siete/secure/cuadros/home.aspx.

(ii) *Mining-sector data*
     Copper GDP:
     Central Bank of Chile (quarterly figures for 2003-2013, spliced with reference series from 2008). (Data available online):
     http://si3.bcentral.cl/Siete/secure/cuadros/home.aspx.

Mining investment

Obtained from COCHILCO, Inversión de la Gran Minería del Cobre, *Anuario*, using annual figures from 2003 to 2013 measured in each year's dollars multiplied by the exchange rate and divided by an investment deflator to give a value in real terms. (Data available online):
     http://www.cochilco.cl/estadisticas/anuario.asp.

Obtained from the Central Bank of Chile: gross fixed capital formation (GFCF), using annual figures from 2003 to 2013 measured in each year's dollars multiplied by the exchange rate and divided by an investment deflator to give a value in real terms. (Data available online):
     http://si3.bcentral.cl/Siete/secure/cuadros/home.aspx.
     This information was used to calculate mining investment as a share of total investment each year.
     In any year, the mining investment share is assumed to rise in a linear fashion to its annual share.

Central Bank of Chile: gross fixed capital formation (GFCF), taking quarterly figures from 2003 to 2013 spliced with reference series from 2008. (Data available online):
     http://si3.bcentral.cl/Siete/secure/cuadros/home.aspx.

Mining employment

National Institute of Statistics (INE), employment by category, mining and quarrying, 2010-2013. (Data available online):
     http://www.ine.cl/canales/chile_estadistico/mercado_del_trabajo/empleo/series_estadisticas/nuevas_empalmadas/series_fecha.php.

INE, employment by catgory, mining and quarrying, 2010-2013. (Data available online):
     http://www.ine.cl/canales/chile_estadistico/mercado_del_trabajo/nene/series_trimestrales_2011.php.
     The series were then spliced and converted into quarterly figures (Microsoft Excel ©) and seasonally adjusted using the EViews 8 Census X-13 © software.

Mining pay

Nominal pay index, mining and quarrying, ine, with the series obtained from two series: (i) spliced historical series from 1993 to 2007 (base January 2006 = 100), and (ii) reference series with annual base 2009 = 100. (Data available online):
     http://www.ine.cl/canales/chile_estadistico/mercado_del_trabajo/remuneraciones/series_estadisticas/nuevo_series_estadisticas.php.
     The series is monthly and was converted to quarterly figures (Microsoft Excel ©) and seasonally adjusted using the EViews 8 Census X-13 © software.

Electricity

COCHILCO, Consumo Nacional de la Energía en la Minería del Cobre, *Anuario*, taking the 2003-2013 annual average in terajoules (TJ). (Data available online):
     http://www.cochilco.cl/estadisticas/energia.asp.

The series was converted into GWh (1 GWh»0.28 TJ). (Data available online):
     http://www.lngplants.com/conversiontables.html.

National Energy Commission (CNE), gross generation in the Central Interconnected System (SIC)-Interconnected System of the Norte Grande (SING) (annual average in GWh). (Data available online):

http://www.cne.cl/estadisticas/energia/electricidad.

This information was used to calculate mining electricity consumption as a share of total national consumption each year.

CNE, gross generation SIC-SING (monthly average in GWh). This was converted into quarterly figures (Microsoft Excel ©) and seasonally adjusted using the EViews 8 Census X-13 © software. (Data available online):

http://www.cne.cl/estadisticas/energia/electricidad.

Within any year, the mining share of electricity consumption is assumed to rise in a linear fashion to its annual share.

The energy price

The energy price relevant to mining is constructed by taking a weighted average of the price in the SIC and the SING.

The weights used are the percentage of mining GDP in regions I and II for SING (0.6) and the percentage of mining GDP in regions III, IV, V and VI for SIC (0.4). Regional information is only available for 2010-2012, however.

The pricing details are as follows:
- From the third quarter of 2006 to the fourth quarter of 2013, use is made of the average market price in pesos/kwh for customers not subject to price regulation, as published by the National Energy Commission. Since published prices are four-month averages, the figure used for any quarter was the simple average of the two four-month periods that included the three months of the quarter concerned (for the third quarter of 2006, for example, a simple average of the two four-month periods June 2006-September 2006 and July 2006-October 2006 was taken).
- For the period from the first quarter of 2000 to the second quarter of 2006, use was made of the data calculated by Synex, as employed in the study "Impacto macroeconómico del retraso en las inversiones de generación eléctrica en Chile" (Agurto and others, 2013).

ANNEX 3

Convergence and parameters estimated for the DSGE model

FIGURE A.3.1

Convergence and stability of parameters
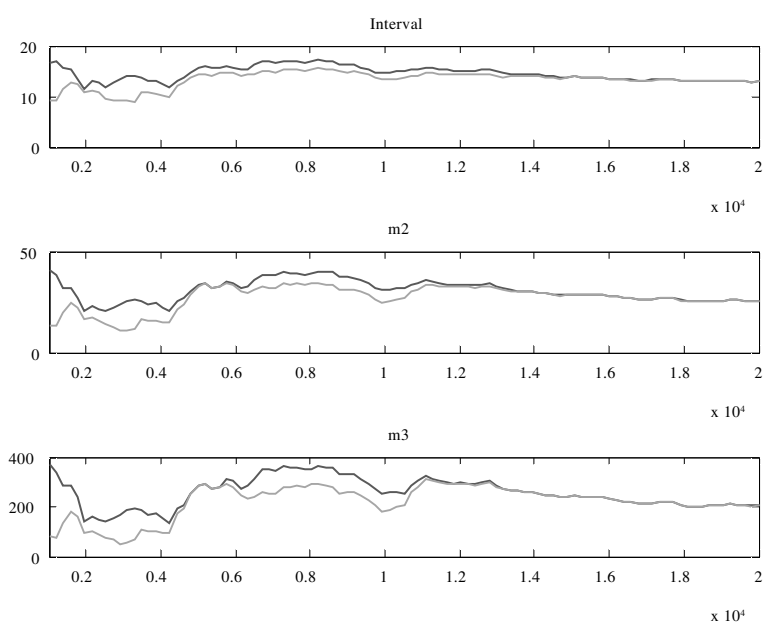
Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

TABLE A.3.1

Parameters estimated for the DSGE model

Parameter	Prior	Posterior	90% confidence interval		Prior distribution	Standard deviation
sigma	2	1.7726	1.6361	1.8897	gamma	0.1
h	0.3	0.2638	0.2018	0.3359	beta	0.05
rho_L	1	1.1488	1.0025	1.2985	gamma	0.1
rho_G	0.9	0.9119	0.8497	0.9793	beta	0.05
rho_A	0.9	0.931	0.9051	0.9535	beta	0.05
rho_Rstart	0.9	0.6335	0.5437	0.7146	beta	0.05
rho_Ystart	0.9	0.974	0.9651	0.9827	beta	0.05
rho_Oil	0.9	0.8655	0.7959	0.9337	beta	0.05
rho_Pcu	0.9	0.8623	0.8377	0.8915	beta	0.05
rho_GD	0.1	0.0098	0.0083	0.0111	beta	0.05
index	0.906	0.8815	0.8013	0.9641	beta	0.05
xi	0.804	0.8173	0.8024	0.8298	beta	0.01
index_w	0.9	0.6731	0.5775	0.785	beta	0.05
xi_w	0.67	0.8961	0.8802	0.9136	beta	0.05
beta1	0.8	0.7961	0.7821	0.8106	gamma	0.01
beta2	0.1	0.0999	0.0987	0.1013	beta	0.001
rho_R	0.92	0.9201	0.906	0.9325	beta	0.01
rho_inf	2	1.9894	1.8261	2.1729	beta	0.1
rho_y	0.5	0.5758	0.456	0.7018	beta	0.1
rho_e1	0.3	0.2655	0.1338	0.3943	beta	0.2
rho_e2	0.3	0.0811	0.0001	0.1715	beta	0.2
rho_E	0.3	0.3015	0.2848	0.3198	beta	0.01
MP_M	0.5	0.3838	0.281	0.4713	beta	0.1
MP_L	0.5	0.1662	0.1344	0.193	beta	0.1
MP_K	0.5	0.5271	0.3736	0.6914	beta	0.1
theta_TOIL	0.5	0.4599	0.2992	0.6423	beta	0.1
theta_L	0.5	0.8001	0.7209	0.8725	beta	0.1
theta_K	0.5	0.5046	0.3333	0.6619	beta	0.1
theta_M	0.5	0.5602	0.419	0.688	beta	0.1
MP_TOIL	0.1	0.0694	0.0103	0.1306	beta	0.05
MP_G	0.5	0.5863	0.5159	0.6519	beta	0.05
trend_GDP	1.1	1.2909	1.2053	1.3755	gamma	0.1
trend_Oil	2.42	2.4448	2.3135	2.5874	gamma	0.1
trend_Pcu	3.28	3.2443	3.0929	3.3895	gamma	0.1
trend_GDPstar	1.22	1.2056	1.0516	1.3425	gamma	0.1
trend_L	0.71	0.5789	0.4701	0.6934	gamma	0.1
trend_E	0.5	0.112	0.0006	0.228	unif	0.2887
constant_R	0.99	0.9837	0.828	1.1513	gamma	0.1
constant_PI	0.75	0.7538	0.6067	0.8976	gamma	0.1
constant_Rstar	0.5	0.3869	0.0004	0.728	unif	0.2887
rho_PEE	0.5	0.8518	0.8016	0.9022	beta	0.1
MP_EE_EN_COPPER	0.5	0.2564	0.1317	0.3676	beta	0.1
index_w_COPPER	0.9	0.9046	0.8335	0.9712	beta	0.05
xi_w_COPPER	0.67	0.6216	0.5705	0.6813	beta	0.05
MP_EN_COPPER	0.5	0.1423	0.0555	0.2258	beta	0.1
MP_L_COPPER	0.5	0.0848	0.051	0.1188	beta	0.1
MP_K_COPPER	0.5	0.5461	0.4031	0.6778	beta	0.1
rho_A_COPPER	0.9	0.9045	0.8917	0.9168	beta	0.01
trend_GDP_COPPER	0.1	0.1039	0.09	0.1187	gamma	0.01
trend_PEE	0.64	0.6381	0.4976	0.7886	gamma	0.1

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

TABLE A.3.2

Standard deviations of the shocks estimated in the DSGE model

Standard deviation of shocks	Prior	Posterior	90% confidence interval		Prior distribution	Standard deviation
Err_C	1.08	0.4898	0.3557	0.6311	invg2	0.5
Err_E	3.56	5.1476	4.5078	5.7673	invg2	0.5
Err_G	1.72	1.1	0.9047	1.2844	invg2	0.5
Err_M	4.78	4.5151	3.9697	5.1656	invg2	0.5
Err_Oil	16.07	16.2808	15.608	17.0067	invg2	0.5
Err_Pcu	16.53	16.627	15.8637	17.4668	invg2	0.5
Err_GDP	1.16	1.8313	1.3863	2.2744	invg2	0.5
Err_Q	9.76	9.7315	8.9636	10.7295	invg2	0.5
Err_W	0.87	0.4109	0.3251	0.4877	invg2	0.5
Err_X	5.03	5.1674	4.5989	5.7607	invg2	0.5
Err_Ystart	2.81	3.31	2.662	3.9391	invg2	0.5
Err_R	0.48	0.2178	0.1732	0.2618	invg2	0.5
Err_PI	0.96	0.7168	0.5913	0.8459	invg2	0.5
Err_Rstart	0.89	0.9244	0.7517	1.0735	invg2	0.5
Err_QCU	3.59	3.7614	3.2334	4.2889	invg2	0.5
Err_COPPER_I	6.46	6.4473	5.8375	7.0691	invg2	0.5
Err_I	4.6	4.4445	3.9205	4.93	invg2	0.5
Err_L_COPPER	1.4	4.4021	3.7446	5.0181	invg2	0.5
Err_L	0.81	1.5259	1.2768	1.753	invg2	0.5
Err_COPPER_W	0.9	0.5559	0.4213	0.6845	invg2	0.5
Err_EE_COPPER	4.34	5.1935	4.3792	5.8902	invg2	0.5
Err_PEE	6.84	6.9106	6.2696	7.6251	invg2	0.5
Err_A	1.16	0.7197	0.5738	0.8635	invg2	0.5
Err_A_COPPER	3.59	7.2804	5.834	8.6681	invg2	0.5

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

ANNEX 4

Calibration of Cobb-Douglas functions in the mining sector

The functions represented by copper production are as follows:

$$QCU_t = A_t^{CU} L_t^{CU\tilde{\alpha}} K_t^{CU\tilde{\beta}} E_t^{1-\tilde{\alpha}-\tilde{\beta}}$$

$$E_t = OIL_t^{\delta} EE_t^{1-\delta}$$

$\tilde{\beta}$ is estimated as follows: first the average ratio between copper mining investment and mining GDP is taken, then the share of $\tilde{\beta}$ is calculated by:

$$\tilde{\beta} = share = \left(r + \delta^{cu}\right)\frac{K^{cu}}{QCU}$$

$$= \left(0.02368 + 0.02\right) * 0.23 = 0.51$$

The interest rate is calculated by assuming a subjective discount rate of 0.9865, plus a differential of 1%. The depreciation rate γ^{cu} is assumed to be 2% a quarter, the same as the depreciation rate for the rest of the economy, which in turn was set at that level to give

reasonable values for the stationary state (consumption over GDP, investment over GDP and others).

In the case of energy, use is made of the average annual electricity and fuel consumption figures in terajoules (TJ) published by COCHILCO. Then, annual consumption is transformed into barrels of oil equivalent (dividing by 5.75/1,000) and GWh (multiplying by 0.28), since peso prices exist for these units (the price of a barrel of oil is multiplied by the observed exchange rate to give the peso price).

The total values for each energy type are calculated by multiplying prices by the number of barrels and GWh, respectively. Then the respective shares are obtained by dividing the annual values by copper GDP in each year's pesos. Thus, the average of the shares for 2003-2013 is calculated. In summary, total energy represents 10% of copper GDP, with fuel accounting for 3% and electricity for 7%, so that 30% of the total energy bill is for fuel and 70% for electricity.

The labour share is obtained as a residual, once the capital and energy share has been calculated (1 - 0.51 - 0.1 = 0.39).

ANNEX 5

One characteristic of the copper price is that it has had long periods of growth, rising at an average quarterly rate of 12% from 2003 to 2006, for example. Accordingly, table A.5.1 shows cumulative GDP growth if the copper price increases continuously by 1% a quarter over different time horizons.

TABLE A.5.1

Cumulative GDP growth with continuous increases of 1% in the copper price

Years	Quarters in which the copper price rises by 1%															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.12	0.21	0.29	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
2	0.15	0.29	0.42	0.55	0.67	0.77	0.85	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
3	0.15	0.30	0.45	0.60	0.75	0.89	1.03	1.15	1.27	1.37	1.45	1.50	1.50	1.50	1.50	1.50
4	0.14	0.28	0.42	0.57	0.72	0.87	1.02	1.17	1.32	1.46	1.60	1.73	1.85	1.95	2.03	2.08
5	0.12	0.24	0.37	0.51	0.65	0.79	0.93	1.08	1.23	1.38	1.53	1.69	1.83	1.98	2.12	2.25

Source: Prepared by the authors, on the basis of the dynamic stochastic general equilibrium (DSGE) model.

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Beyond capital controls: regulation of foreign currency derivatives markets in the Republic of Korea and Brazil after the global financial crisis

Daniela Magalhães Prates and Barbara Fritz

ABSTRACT

Within the management of capital flows, some emerging economies have been facing economic policy dilemmas after the global financial crisis, related to financial instrument operations, in a context of abundant liquidity in the advanced economies. However, neither the academic literature nor the financial institutions have paid sufficient attention to foreign currency (FX) derivatives regulation in emerging economies. This paper analyses the measures adopted by Brazil and the Republic of Korea. We find, first, that the breadth of regulation concerning FX derivatives operations depends on the actors involved and the type of contract used. Second, effective domestic institutions are needed to formulate and implement regulations. Third, countries should not limit their policy space through multilateral or bilateral agreements, and leave space for domestic financial regulation.

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I

Introduction

Emerging economies have been coping with the problems of success.[1] Not only have they boasted higher employment and growth rates than member countries of the Organisation for Economic Cooperation and Development (OECD), but they also have recovered rapidly from the financial crisis sparked by the 2008 Lehman Brothers default. Consequently, since mid-2009, emerging economies have seen a new boom in capital inflows, albeit a highly unstable one. Many governments have become increasingly concerned about the downsides of such inflows. They perceive dependence on highly volatile capital flows as a threat to short-term financial stability and, more generally, to their domestic economic policy space.

At the same time, the debate on capital controls, long discarded as anachronistic, has returned to the political and academic agenda with a vengeance (Gallagher, Griffith-Jones and Ocampo, 2012; Jeanne, Subramanian and Williamson, 2012; Fritz and Magalhães Prates, 2014). Even the International Monetary Fund (IMF), which was long hostile to any kind of capital control regime, is engaging in a new debate on capital flow management (IMF, 2012b). However, this debate has caught international financial institutions, and much of academia, ill prepared. As Rodrik (2010, p. 2) states, "we currently do not know much about designing capital control regimes. The taboo that has [been] attached to capital controls has discouraged practical, policy-oriented work that would help to manage capital flows directly."

Besides the management of capital flows (spot settlement), some emerging economies have also faced economic policy dilemmas related to foreign (non-resident) and domestic (resident) FX derivatives operations (forward settlement). In an environment of abundant liquidity and historically low interest rates in advanced economies, foreign investors searching for short-term yield, as well as domestic agents, often obtain huge profits from the interest rate differentials between advanced and emerging economies. Yet the regulation of FX derivatives in emerging economies has not received due attention, whether in the academic

literature or within international financial institutions, though it might prove crucial for emerging economies with a high degree of financial openness and liquidity as well as for deep FX derivatives markets, such as Brazil and the Republic of Korea.

As Mihaljek and Packer (2010, p. 51) point out, Brazil and the Republic of Korea have the largest FX derivatives markets among emerging economies. This feature, combined with a hands-off approach to capital inflows, seemed to reinforce the contagion effect of the global financial crisis on the currencies and financial markets of both countries, despite their current account surpluses until 2007 and their huge international reserves (Prates and Cintra, 2010).

Brazil and the Republic of Korea (like other emerging economies) have learned hard lessons from the global crisis, which showed that reserve accumulation could not cushion them against the adverse effects of volatile capital flows and speculative operations in the FX derivatives markets. Since 2009, both countries have resorted to capital controls and prudential financial regulation to deal with the new boom of capital flows to emerging economies.[2] These and other regulatory tools are also being used to curb the FX derivatives transactions of non-residents and/or resident agents.

This paper analyses the approaches adopted by Brazil and the Republic of Korea to FX derivatives regulation in the wake of the global financial crisis. Regulation of operations in domestic FX derivatives markets is difficult to assess by econometric methods, as the analysis has to deal with the overlap and interdependency of factors in very short time periods, including the following: (i) frequent external shocks, given the unstable global environment and the high volatility of international capital flows; (ii) very short time periods; (iii) macroeconomic policy shifts, especially in terms of monetary and foreign exchange policies, and (iv) frequent regulatory changes at the domestic level. Our analysis therefore incorporates qualitative methods and descriptive statistical analysis.

In contrast to empirical assessments, we focus here on the specificity of FX derivatives regulation in Brazil

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[1] "Emerging economies" are defined herein as developing countries that have engaged in financial globalization. We are thus not employing the International Monetary Fund (IMF) definition, which classifies the Republic of Korea as a newly advanced economy.

[2] Besides Brazil and the Republic of Korea, the main recipients of capital inflows in the post-crisis boom of capital flows have been South Africa, Peru, Thailand, Indonesia and Turkey. For more details, see IMF (2011a).

and the Republic of Korea. Our hypothesis is that this kind of regulation is distinct from capital controls and prudential financial regulation, which have to be adjusted in keeping with the country-specific institutional framework in order to cover this class of financial transaction and to encompass both non-resident and resident agents.

The paper seeks to contribute to the debate on financial regulation in response to the global crisis. While there is a growing consensus on the need for a more systemic approach to macroeconomic, monetary and financial policies (Blanchard, Dell'Ariccia and Mauro, 2010; Eichengreen and others, 2011), as opposed to one that prioritizes price-level stabilization alone, the debate on the regulation of international capital flows —in particular FX derivatives in emerging economies— is far from consolidated, both in theoretical terms and with regard to economic policy recommendations.

In section II, based on a review of typologies of capital flow regulation, we establish a broad approach to financial regulation. This enables us to take in country-specific regulatory approaches. In emerging economies characterized by a high degree of financial openness and sophisticated domestic financial markets, such as our cases, these markets and cross-border flows are deeply intertwined. We thus argue that the analytical division, generally adopted in the literature, between domestic and external financial regulation, is no longer useful or even possible. In this setting, prudential financial regulation, capital controls and other regulatory measures (such as the regulation of FX derivatives markets) should be seen as an essential part of the financial regulatory toolkit. In section III, we analyse the experiences of the Republic of Korea and Brazil. Some general conclusions from these case studies are set out in section IV.

II

A broad approach to financial regulation

The academic literature on the regulation of capital flows by emerging economies —that is, external financial regulation— has flourished since the 1990s and gained further momentum after the global financial crisis, resulting in different typologies.

Given the volume and volatility of these flows and their potentially damaging consequences for emerging economies, IMF has effected a clear shift in its official position on the evaluation of capital controls (IMF, 2010, 2011a and 2012b; Ostry and others, 2010 and 2011a), which resulted in a new institutional view endorsed by the Fund (IMF, 2011a and 2012b). In these recent papers, the set of tools designed to influence capital inflows is called "capital flows management measures", defined as the sum of the measures established to slow exchange rate appreciation or divert these flows to other countries. It comprises measures that distinguish between residency statuses and between currency denominations, as well as other regulations such as minimum holding periods and taxes on specific investments that are typically applied in the non-financial sector (IMF, 2011a).

In academia, the discussion started earlier. In chronological order, Epstein, Grabel and Jomo (2004) use the term "capital management techniques" for two complementary types of financial regulations that affect capital flows and that often overlap. These are the policies that govern international private capital flows, called "capital controls", and enforce the prudential management of domestic financial institutions. Their definition takes into account the fact that some prudential financial regulation instruments function in practice as capital controls, while others contribute to reducing systemic financial risks. Ocampo (2012) and Gallagher, Griffith-Jones and Ocampo (2012) prefer the term "capital account regulations" (CARS) to underscore the fact that these regulations on capital flows belong to the broader family of financial regulations and should encompass not only inflows, but also outflows and price-based and quantity-based instruments. Priewe (2011) puts forward the concept of "capital account management," which encompasses all the forms by which authorities could have (in)direct influence on capital flows and capital accounts, to wit: sovereign monetary and fiscal policy, exchange rate management, domestic financial sector regulations, regulations related to foreign direct investment (FDI), direct capital controls and international rules, and coordination intervention to stabilize exchange rates.

Despite conceptual differences, especially between IMF and other approaches, all theorists acknowledge four key precepts.[3] First, the regulation of capital flows needs to encompass multi-faceted policies —capital controls and prudential regulations— since no single measure can achieve diverse objectives. Second, a strict bifurcation between these policies often cannot be maintained in practice (Epstein, Grabel and Jomo, 2004; Ocampo, 2012). Third, there is often a great deal of synergy and overlap between these measures. In particular, Epstein, Grabel and Jomo (2004, p. 6) point out that "the effectiveness of any single management technique magnifies the effectiveness of other techniques and enhances the efficacy of the entire regime of capital management. For example, certain prudential financial regulations magnify the effectiveness of capital controls (and vice versa). In this case, the stabilizing aspect of prudential regulation reduces the need for the most stringent form of capital control. Thus, a programme of complementary capital management techniques reduces the necessary severity of any one technique and magnifies the effectiveness of the regime of financial control." Finally, there are also feedback loops between these two regulations (prudential financial regulations and capital controls) and macroeconomic policy.

Moreover, in emerging economies with a high degree of financial openness and sophisticated domestic financial markets, these markets and cross-border flows are deeply intertwined. Consequently, the traditional analytical division (generally adopted in the literature) between

domestic and external financial regulation is no longer useful or even possible. Therefore, financial regulation in emerging economies with these features should be considered in a broader sense, without separating its internal and external dimensions. Prudential financial regulations, capital controls and other regulatory measures (such as the regulation of derivatives markets) should be seen as an essential part of the financial regulatory toolkit governing residents and non-residents, as well as financial and non-financial agents, with respect to their portfolio decisions in foreign and domestic currency, and in both spot and derivatives markets.

This toolkit should be country-specific, shaped by local context in terms of the degree of financial openness, the financial system's institutional framework and the country's policy goals for regulation. In the case of emerging economies, the most important goals are to reduce risks and increase policy space in the effort to control key macroeconomic prices, such as the exchange rate and the interest rate, particularly to enable the pursuit of countercyclical policies that mitigate booms and busts of capital flows and the risk appetite of global investors. There are important feedbacks between these two goals. For instance, currency appreciation stimulates speculative positions in FX derivatives, threatening financial stability. Therefore, the ability to maintain the exchange rate at a competitive level (secondary goal) contributes to this stability (primary goal).

As each regulatory tool is also specific in terms of the range of agents and markets that it can reach (see table 1), each country's regulatory toolkit may encompass a number of regulations, depending on its institutional specificities and policy goals. It is therefore important to define each type of regulatory tool clearly.

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[3] For a critical analysis of the new IMF approach, see Fritz and Magalhães Prates (2014), and Gallagher (2012).

TABLE 1

Financial regulation toolkit

Regulation	Agents		Market
	Financial or non-financial	Resident or non-resident	*(spot or derivatives)*
Prudential regulation	Financial institutions	Resident	Both
FX derivatives regulation	Both	Both	Derivatives
Capital controls			
Portfolio investments and FDI	Both	Non-resident	Spot
Foreign loans	Both	Resident	Spot

Source: Prepared by the authors.

Note: FDI: Foreign direct investment.

Prudential financial regulations refer to policies such as capital-adequacy standards, reporting requirements or restrictions on the ability and terms under which domestic financial institutions can provide capital to certain types of project. They may also include prudential rules on currency mismatching of balance sheets, or restrictions on issuing certain types of derivative or forward contract (Epstein, Grabel and Jomo, 2004). These regulations only affect the asset and liability positions of resident financial institutions.

As for capital controls, there is no unique, generally accepted legal definition. We thus adhere to the broadest functional definition as proposed by Neely (1999), according to which these controls refer to measures that manage the volume, composition or allocation of international private capital flows.[4] Capital controls can target inflows or outflows, and they generally concern particular flows (such as portfolio investment, based on their perceived risks and opportunities). Moreover, capital controls can be tax-based or quantitative. Financial taxes or reserve requirements against certain types of investment are examples of tax-based controls. Quantitative capital controls involve outright bans on certain investments (for example, the purchase of equities by foreign investors), restrictions or quotas, or license requirements (Epstein, Grabel and Jomo, 2004). In other words, capital controls are a range of financial regulation tools that manage cross-border flows (both inflows

and outflows) associated with both foreign investors and resident companies and banks. Unlike prudential financial regulations, they can influence portfolio decisions taken by resident non-financial institutions and non-resident agents.

In addition to prudential financial measures and capital controls, a third kind of regulation may be needed to curb financial risks and increase policy space in emerging economies with open and sophisticated FX derivatives markets, depending on the institutional features of these markets. On the one hand, prudential financial regulation may not be sufficient to reach FX derivatives operations, as it only affects financial institutions' balance sheets; FX derivatives operations carried out by non-resident investors and non-financial resident agents are thus outside the scope of this class of regulation. On the other hand, capital controls influence cross-border transactions alone and, hence, do not cover FX derivatives operations in the domestic market. Even for an operation carried out by foreign investors, capital controls are not the most suitable and effective type of regulation, since they would have only a small impact in the case of, say, a capital inflow related to paying for the cost of a derivative operation, like margin requirements on futures contracts. One important characteristic of financial derivatives as a whole is their high degree of leverage, to the extent that they require only a margin requirement or the payment of a premium to be carried out. This specific feature, in turn, makes FX derivatives a privileged instrument for currency speculation and profiting from interest rate differentials. Furthermore, these inflows may not even take place: in emerging economies with open financial markets, foreign investors typically have investments in other assets that they could settle and transfer to meet this cost. This third class of regulation will herein be referred to as foreign exchange derivatives regulations, focusing on regulating resident and non-resident operations with this forward settlement instrument in the domestic market (see table 1).

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[4] Ostry and others (2011a, p. 11) admit that there is no unique definition of capital controls, but stick to a juridical definition presented by the Organisation for Economic Cooperation and Development (OECD) in its OECD Code for Liberalization of Capital Movements (2009), which considers capital controls to be subject to liberalization obligations only if they discriminate between residents and non-residents. Later IMF papers on this subject also adopt this definition. Herein lies one of the problems with the new IMF approach. For the sake of non-discrimination, capital controls defined in this manner should be applied only as a means of last resort. IMF has introduced a hierarchy of measures instead of focusing on the adequacy and efficiency of the regulations at hand.

III

Case studies

Since 2008, most advanced economies have been marked by financial turmoil and sharp recessions or low growth, while most emerging economies and some developing countries have been faring much better in financial and

economic terms (Ocampo, 2012; Canuto and Giugale, 2010; Canuto and Leipziger, 2012).

In response to these conditions, the advanced economies implemented quantitative easing (QE) policies,

generating abundant liquidity and low interest rates and triggering a new boom in capital flows to emerging economies since the second quarter of 2009. This new boom —the fourth in the post–Bretton Woods era— has thus been driven by post-crisis circumstances. These flows lost some momentum after May 2013, when the Federal Reserve of the United States of America indicated that it might begin tapering its QE policy towards the end of the calendar year. Nevertheless, we assume that emerging markets will experience an extended period of high capital inflows (Akyüz, 2011; BIS, 2010; Canuto and Leipziger, 2012).

As before the crisis, the currencies and assets of several emerging countries have once again become the target of carry trade activities —due to interest rate differentials— and other capital flows. The resulting combination of high growth rates, accelerating inflation (also associated with a renewed commodity price boom), excessive currency appreciation and/or asset-price overshooting has presented emerging economies with policy dilemmas (Akyüz, 2011; BIS, 2010). In this scenario, the adoption of restrictive monetary policy would help to contain growth and inflationary pressures, but it would encourage further capital inflows, which, in turn, would foster an asset price boom and exchange rate misalignment, thereby aggravating the risk of future sudden stops and subsequent financial crises. To deal with these dilemmas, many emerging economies have turned to capital controls and prudential financial regulations. In a departure from the pre-crisis context, many of these countries are now unwilling to adopt a hands-off approach to capital inflows.

However, country experiences both prior to the global financial crisis (Ariyoshi and others, 2000; Herr and Priewe, 2006; Magud, Reinhart and Rogoff, 2011) and after it (Klein, 2012; IMF, 2011a; Fritz and Magalhães Prates, 2014; Baumann and Gallagher, 2012 and 2013) indicate that designing the financial regulatory toolkit is a highly complex process, as it is shaped by a set of macroeconomic, institutional and structural factors, such as the degree of financial openness, the composition of capital flows, the features of financial and currency markets, and the policy goals at hand.

The experiences of Brazil and the Republic of Korea, the two case studies presented in this paper, exemplify this complexity. These countries pursued very similar strategies in managing capital flows in 2003-2007, with an overinvestment in costly reserve accumulation and underinvestment in capital account management policies (Rodrik, 2006, p. 12). Like other emerging economies, however, policymakers in Brazil and the Republic of Korea

learned lessons from the global financial crisis, seeing that this strategy was not able to cushion them against the harmful effects of excessive risk-taking by domestic financial institutions or of currency overappreciation, caused by capital flows and FX derivatives operations.

In the face of the renewed risk appetite of global investors for emerging economies' assets and currencies since 2009, these two countries have adopted a number of regulatory measures to address policy dilemmas and avoid the reemergence of these imbalances. Both were forced to adopt specific regulations targeting FX derivatives operations, in addition to regulations aimed at curbing capital flows, given how they influence the exchange rate trend and the financial situation of banks and corporations in both economies. The following two subsections detail the regulations implemented by Brazil and the Republic of Korea to curb risk-taking strategies through FX derivatives operations, with variants in each country due to the different institutional features of their FX derivatives markets.[5]

1. Republic of Korea

After the crisis of 1997, the Government of the Republic of Korea decided to increase the country's financial openness. As Kim and Yong Yang (2010) point out, most capital flow restrictions were dismantled, and, as also occurred in Brazil, capital inflows and outflows became market determined. During the capital flow boom between 2003 and 2007, the Republic of Korea initiated a process of reserve accumulation and steadily relaxed outward investment controls to stem appreciation pressures; this resulted in the elimination of most controls by 2007 (Baba and Kokenyne, 2011).

The resumption of inflows following the global financial crisis was led by portfolio flows into debt and equity markets, and driven by factors both external (the post-crisis circumstances) and internal (the country's quick economic recovery and sound macroeconomic situation). Short-term bank debt, however, remained lower than in the pre-crisis period, thanks to the financial regulation strategy launched by Republic of Korea authorities after November 2009 to deal with the new boom in capital flows (see table 2). This strategy, in turn, had been shaped by the huge contagion effect exerted

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[5] Since the focus of our analysis is FX derivatives operations, the regulation of capital flows is portrayed in broad strokes in this paper. For a detailed analysis of this regulation in Brazil and the Republic of Korea after the global financial crisis, see IMF (2011a) and Fritz and Magalhães Prates (2014).

by the global financial crisis in the Republic of Korea banking system.[6]

As in the case of Brazil, the sharp devaluation of the currency of the Republic of Korea (the won) was associated with companies' FX derivatives operations. The overshooting of the won-dollar exchange rate (see figure 1) between August 2007 and October 2008 was the result of the relationship between FX derivatives operations carried out in the onshore over-the-counter (OTC) derivative markets and the large short-term debt contracted by the country's banks. This link was related to two institutional features of the FX derivatives market in the Republic of Korea. First, in OTC derivatives markets, banks perform the role of the counterparty

of their clients. Second, gains or losses are settled in United States dollars (that is, they are deliverable), as is the case in most countries, though not in Brazil. Before the crisis, the banks sold "knock-in knock-out" (KIKO) foreign exchange options, an exotic OTC derivative for hedging against the appreciation of the local currency in relation to the dollar, to exporter companies (mainly shipbuilders). As Dodd (2009) explains, this option allowed firms to sell dollars at a fixed won-dollar exchange rate (which is the price of United States dollars) in the event that the exchange rate fluctuated within a range stipulated in the contract, providing a long position in the local currency. Companies' potential gains on the transactions (in case the won appreciated, as they were long in this currency) were capped or limited, while losses (in case the won depreciated) were not limited, but rather geared to occur at a faster rate (usually twice the rate) for a given change in the underlying exchange rate.

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[6] In 2009, the Government initiated a US$ 130 billion rescue plan to stabilize the domestic financial market, especially the foreign exchange market, because of banks' huge foreign currency liabilities (Prates and Cintra, 2010).

TABLE 2

Republic of Korea: financial regulation toolkit

| Date	Number and kind	Measure
Nov. 2009	1st PR	• Higher foreign currency liquidity standards to reduce the maturity mismatch of banks' foreign currency assets and liabilities and to improve the quality of their liquid assets. • A 125% cap (relative to underlying export revenues) on forward foreign exchange contracts between banks and exporters.
June 2010	2nd PR	• A ceiling on resident banks' FX derivatives contracts of no more than 50% and —in the case of branches of foreign banks— of no more than 250% of their capital in the previous month. • A limit on banks, allowing them to provide only 100% of underlying transactions for forward contracts with exporters (previously 125%). • A stipulation that resident banks' FX loans and held-to-maturity securities (equal to or more than one-year maturity) must be covered by at least 100% of FX borrowing with maturity of more than one year.
June 2010	1st CC	Limit on FX financing for overseas use only, with some exceptions for small and medium-sized manufacturers.
Jan. 2010	2nd CC	Reintroduction of a 14% withholding tax on non-residents' purchases of treasury and monetary stabilization bonds, bringing the tax back in line with the tax on residents' bond purchases. Foreign corporations and non-residents are subject to the withholding tax, but those based in countries that have double taxation treaties with the Republic of Korea and official investors are exempt.
June 2011	3rd PR	Limits on banks' FX derivatives tightened.
Aug. 2011	3rd CC	Levy on FX liabilities.
Nov. 2012[a]	4th PR	Limits on banks' FX derivatives tightened.

Source: International Monetary Fund (IMF), "Recent Experiences in Managing Capital Inflows. Cross-Cutting Themes and Possible Policy Framework", 2011 [online] http://bit.ly/QSqrVQ; M. Pradhan and others, "Policy responses to capital flows in emerging markets", *IMF Staff Discussion Notes*, No. 11/10, Washington, D.C., International Monetary Fund, 2011; Bank of Korea [online] http://www.bok.or.kr/eng/engMain.action; and Reuters.

Note: CC: Capital control; PR: Prudential regulation.
[a] Announcement date: measure effective since January 2013.

FIGURE 1

Republic of Korea: nominal exchange rate and financial regulation measures
(Won per dollar)
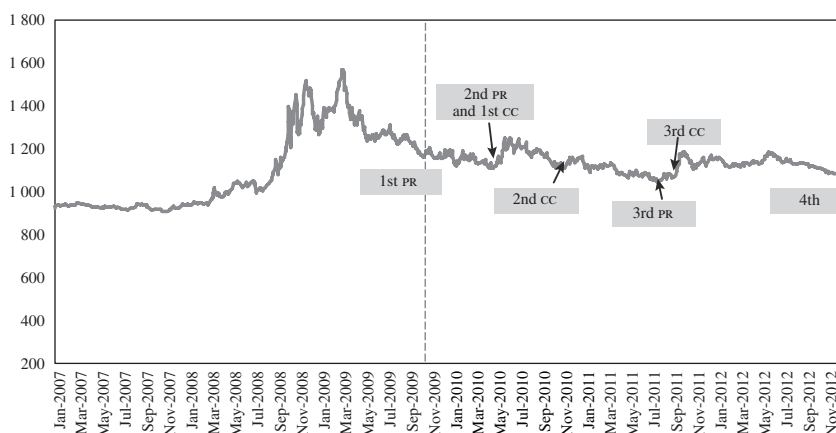
Source: Prepared by the authors, on the basis of information from Bloomberg.

Note: PR: Prudential regulation; CC: Capital control.

These companies began to hedge their foreign exchange exposure in 2004 and increased their hedging ratio in anticipation of continued won appreciation. Moreover, banks (mainly the local branches of foreign banks, which were only subject to risk management standards, not to liquidity ratios or other direct regulations applicable to Korean banks) engaged in interest rate arbitrage, borrowing dollars on a short-term basis, selling those dollars for won on the spot market, then buying certificates of deposit or other domestic bonds and selling the won forward for dollars. It was against this backdrop of strong capital inflows that authorities progressively liberalized capital outflows (Baba and Kokenyne, 2011; IMF, 2011a).

To make operations in the OTC derivatives market possible and profitable, national and foreign banks with local branches borrowed in United States dollars to sustain their positions in this market. With the outbreak of the crisis and the credit crunch in international financial markets, these banks were unable to roll over their maturing short-term external liabilities as global banks cut credit lines to shore up liquidity. National banks then started buying dollars to liquidate their external liabilities, thus exerting devaluating pressure on the won. This depreciation led to losses for companies that relied on the currency's appreciation and forced them to hand over the corresponding dollars, some of which had to be obtained on the spot foreign exchange market, to the banks. This put further depreciation pressure on the won. Around 520 small and medium-sized export

companies that had purchased KIKO options lost an estimated US$ 2 billion, landing them on the verge of insolvency. Several national banks suffered when their customers sued or became bankrupt (IMF, 2011a; Kim and Yong Yang, 2010; Dodd, 2009).

The contagion effect of the global financial crisis thus revealed the significant vulnerability of the banking system of the Republic of Korea to changes in global funding conditions, due to its high levels of short-term external debt and related FX derivatives, as well as the impact of these spot and derivatives operations on the exchange rate. The financial regulation toolkit adopted by the Government of the Republic of Korea since 2009 has therefore sought to reduce the financial risks and the exchange rate changes linked to capital flows and FX derivatives operations (see table 2).

Given that the main targets of the financial regulation were banks' spot and forward foreign exchange exposures, national authorities introduced a set of prudential financial regulatory measures after November 2009 (see table 2), with the goal of strengthening banks' foreign exchange liquidity management and limiting their short-term debt and forward contracts to sustainable levels. The measures for reaching these FX forward positions indirectly aimed at reducing external borrowing by the banking sector, as had been the case before the crisis. National and foreign banks with local branches borrowed in United States dollars to sustain their positions in the OTC derivatives market.

Therefore, prudential financial regulation measures, which only addressed banks' asset and liability positions in both the spot and forward markets (see table 2), helped to prevent external debt from returning to pre-crisis levels and contributed to limiting onshore FX derivatives operations. Both issues were closely linked with the banks' portfolio decisions. Hence, these measures aided in protecting the exchange rate from appreciation pressures deriving from banks' short-term external debt.

Since the adoption of these first prudential financial regulation measures, the won-dollar nominal exchange rate has been nominally stable, with the won appreciating only 0.9% (see figure 1).[7] In the face of renewed appreciation pressures in the last quarter of 2012 due to Japan's ultra-expansionary monetary policy, Republic of Korea authorities tightened the limits on banks' FX derivatives in November 2012 (Jun and Nam, 2012; see table 2).

Some empirical studies point to the effectiveness of the regulatory toolkit of the Republic of Korea. According to Bruno and Shin (2013), the sensitivity of capital flows into the Republic of Korea to global conditions decreased in the period following the introduction of macroprudential policies in 2010. Baumann and Gallagher (2013) find that national controls had a statistically significant negative impact on exchange rate volatility. Similarly, Huh, An and Yang (2013) find that the Republic of Korea's macroprudential measures in the 2000s affected the maturity structure of the banks' foreign liability.

While prudential financial measures have been the main regulatory tool of choice for national policymakers, the Republic of Korea has also adopted capital controls to counter the undesirable effects of capital flows. In that regard, the main capital control measure was the withholding tax on foreign holdings of government bonds and central bank securities, bringing the tax back in line with the tax on residents' bond purchases. This price-based capital control was re-imposed in January 2011 due to the strong increase in debt portfolio inflows, which reached record levels (IMF, 2011a). The impact of this measure on portfolio inflows is likely to be marginal, however, for two reasons. First, foreign corporations and non-resident investors based in countries that have double taxation treaties with the Republic of Korea are exempt, and the Republic of Korea has this kind of treaty with more than 70 countries. Second, this tax does not affect equity portfolio flows, which have also increased significantly since 2009 (Pradhan and others, 2011).

2. Brazil

The Brazilian Government responded to the 1999 currency crisis with the adoption of a new set of economic policies based on an inflation target and a managed (or dirty) floating exchange rate. This change in the macroeconomic regime was accompanied by a process of financial opening that began in 1990 and gained momentum in January 2000, when Resolution no. 2689 from the National Monetary Council (*Conselho Monetário Nacional*, or CMN) allowed the unrestricted access of non-resident (that is, foreign) investors to all segments of the domestic financial market, including the derivatives market. Moreover, in 2005, residents' capital exports were fully liberalized. The Brazilian economy thus became fully open to capital inflows and outflows.
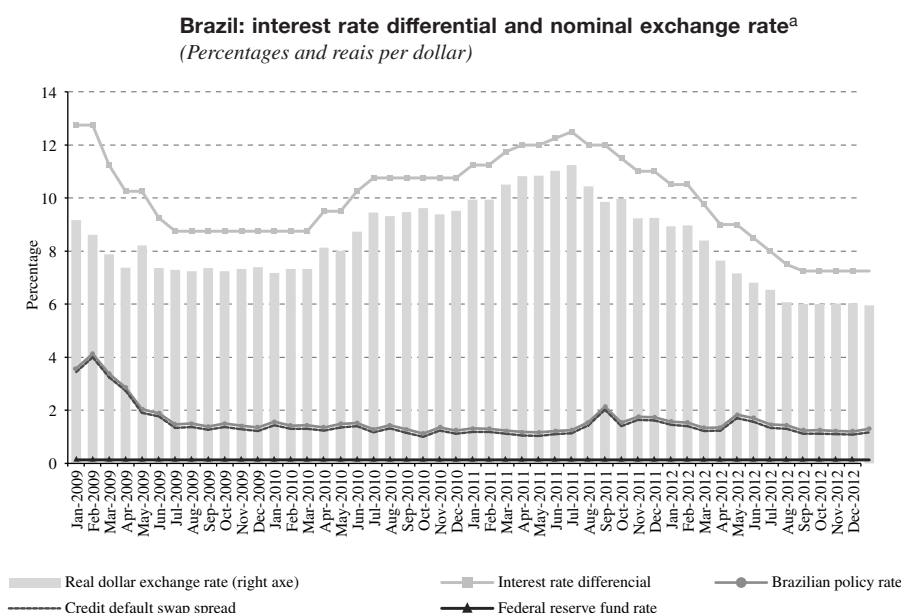
In this context of high capital mobility, the post-global-crisis scenario —combined with domestic factors (primarily the resumption of economic growth and very high interest rates, by international standards, until recently)— resulted in large capital inflows and strong appreciation pressures between 2009 and mid-2011 (see figure 2 and table 3).[8] Two specific features of the Brazilian economy (related to macroeconomic and institutional factors) reinforced the economic policy dilemmas faced by Brazilian monetary authorities in terms of macroeconomic management and financial regulation in the post-crisis context.

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[7] According to Pradhan and others (2011), the decline in demand for currency forwards (especially from shipbuilders, due to a smaller order book in the post-crisis period) has also contributed to stemming the won-dollar nominal exchange rate appreciation.

[8] Brazil became the main destination for capital flows in Latin America in this period (IMF, 2011a).

FIGURE 2

Brazil: interest rate differential and nominal exchange rate[a]
(Percentages and reais per dollar)

Real dollar exchange rate (right axe)	Interest rate differential	Brazilian policy rate
Credit default swap spread	Federal reserve fund rate	

Source: Prepared by the authors, on the basis of information from the Central Bank of Brazil.

[a] Brazilian policy rate plus Brazil risk minus the federal funds rate.

TABLE 3

Brazil and Republic of Korea: selected macroeconomic data

Year	Policy rate *(percentages)*		FX reserves *(billions of dollars)*		Inflation *(percentages)*		Fiscal result *(nominal and percentages of GNP)*	
	Brazil	Republic of Korea	Brazil	Republic of Korea	Brazil	Republic of Korea	Brazil	Republic of Korea
2003	23.55	3.96	48 844	154 509	17.05	3.5	−5.23	0.47
2004	16.38	3.6	52 458	198 175	6.29	3.6	−2.9	2.72
2005	19.14	3.33	53 216	209 968	5.77	2.8	−3.58	3.38
2006	15.32	4.23	85 148	238 388	3.27	2.2	−3.63	3.92
2007	12.05	4.73	179 431	261 771	4.08	2.5	−2.80	4.65
2008	12.44	4.73	192 842	200 479	6.57	4.7	−2.0	2.96
2009	10.16	2.04	231 888	265 202	5.06	2.8	−3.3	−1.14
2010	9.89	2.17	280 570	286 926	5.11	2.9	−2.5	−0.04
2011	11.76	3.1	343 384	298 233	6.6	4.0	n.a.	n.a.

Source: Prepared by the authors, on the basis of Oxford Economics [online] http://www.oxfordeconomics.com/; International Monetary Fund (IMF), International Financial Statistics; and statistical information from the respective countries.

As for the macroeconomic factor, Brazil's reserve accumulation strategy faces two important constraints: a significant amount of public debt concentrated in short-term maturities and a very large differential between internal and external interest rates (stemming from the high domestic policy rate).[9] These constraints made the cost of sterilization operations excessively high, reducing the central bank's

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[9] This factor is not the focus of the paper and is therefore not described in detail here.

policy space for exchange rate management (Prates, Cunha and Lélis, 2009a).

With regard to the institutional factor, which is the focus of this paper, both before and after the global financial crisis, the FX derivatives market has played a central role in the path of the Brazilian currency, the real, which has predominantly followed an appreciation trend.[10] This has undermined the monetary authority's capacity to influence the exchange rate (based on conventional exchange rate interventions, such as intervention in the spot currency market) and the efficacy of capital controls and prudential financial regulations in stemming currency appreciation.

This central role of the FX derivatives market derives from the much higher number of trades and turnover of the FX futures market in comparison with the FX spot market, which, in turn, makes the FX futures market deeper and more liquid than the spot market. In this setting, FX futures operations have a key influence in the real-dollar exchange rate trend, as many studies point out (Farhi, 2010; Ventura and García, 2009; Prates, Cunha and Lélis 2009a; Kaltenbrunner, 2010; Chamon and Garcia, 2013). The most important determinant of the higher liquidity and depth of the FX futures market relative to the spot market is the prohibition of foreign currency accounts (bank deposits), with only a few exceptions.[11] In other words, if we follow the concept of financial openness proposed by Akyüz (1993), the internal convertibility of the real is very limited, as almost all transactions have to be settled in the domestic currency. On the other hand, the Brazilian currency has a fully external convertibility, as capital inflows and outflows have been totally liberalized since 2005.

This distinctive feature of the Brazilian currency is associated with the high inflation in the 1980s and the first half of the 1990s, which was marked by widespread indexation, especially in the financial sector. Indexation prevented the dollarization of domestic financial operations and the disintermediation of the banking process. Consequently, the financial sector engaged in sophisticated trading operations. Financial sophistication was further facilitated by the dominance of large domestic and foreign banks. Another institutional trait of the Brazilian financial system, also linked with the particular nature of the country's inflationary process, is the existence of a developed derivatives exchange since the 1980s (namely, the BM&F), where FX futures contracts are traded.[12]

The limited internal convertibility of the real is the main determinant of the features that set the FX spot and derivatives markets apart from those of the Republic of Korea, as well as other Latin American emerging economies, such as Mexico, Chile and Colombia. In terms of the FX spot market, residents and non-residents are not allowed to have FX accounts; they cannot hold spot FX positions. Therefore, most spot FX transactions are settled by transfers of funds between FX accounts abroad.[13] Therefore, they do not result in currency flows, but have an impact on non-residents' and residents' asset and liability positions held abroad. Furthermore, all FX transactions must be recorded under an FX contract. Only a few banks authorized by the Central Bank of Brazil to have FX portfolios can hold FX spot positions, as they have access to short-term external credit lines in the international interbank market (called "clean lines"). However, changes in these credit lines are not recorded under an FX contract since they only affect banks' overseas assets and liabilities.

In terms of the FX derivatives market (futures and OTC), the limited internal convertibility of the real also underlies its non-deliverable nature. That is, gains or losses in this market are settled in domestic rather than the foreign currency, which is normally the case in other countries. Precisely because these operations are settled in real, any agent can hold positions in the FX futures market as long as they fulfil minimum standards required by the Brazilian exchange (Ventura and García, 2009; Kaltenbrunner, 2010). In the case of FX futures contracts, the main agents are resident banks (whether Brazilian or foreign-owned), resident institutional investors, non-financial resident companies and non-resident investors (who have had unrestricted access to the derivatives market since January 2000). During periods of low risk aversion both before the global financial crisis (2003 to mid-2008) and after it (mainly from mid-2009 to mid-2011), these investors (primarily hedge funds) have been the most important non-bank investor group in the Brazilian FX

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[10] The Brazilian real was the second most traded currency worldwide in organized derivatives markets in 2010, while the financial volume of FX derivatives traded in onshore OTC markets was low (US$ 18 billion in April 2010) relative to other emerging markets, such as the Republic of Korea (Avdjiev, Upper and Vause, 2010).

[11] According to chapter 14 of the "International Capital and Foreign Exchange Market Regulation" (BCB, 2013), FX bank accounts are allowed only for embassies, multilateral institutions and insurance companies that deal with foreign trade. However, their use is very limited.

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[12] On 25 March 2008, the BM&F merged with BOVESPA, the main Brazilian stock exchange.

[13] The exception is the buying and selling of foreign currencies related to international travels. In this case, physical flows are allowed (BCB, 2013).

futures market, fostering a real appreciation trend through the derivatives carry trade. This is a different kind of currency speculation strategy from the canonical mode of carry trade through spot market operations —that is, borrowing low-interest-rate currencies and lending high-interest-rate currencies (Burnside and others, 2006; Gagnon and Chaboud, 2007; Kaltenbrunner, 2010). In derivatives markets, the carry trade expresses itself as a bet that results in a short position in the funding currency and a long position in the target currency (Gagnon and Chaboud, 2007).

As mentioned, the Brazilian macroeconomic environment is characterized by a dirty floating regime adopted in January 1999 and one of the largest interest rate differentials of the emerging economies (Prates, Cunha and Lélis, 2009a, see figure 2). This has led foreign investors to make one-way bets on the appreciation of the Brazilian currency through short positions in the FX futures market, selling United States dollars and buying reais.[14] The result is downward pressure on the dollar price and thus upward pressure on the real price in the futures market (Farhi, 2010). Furthermore, the income tax on the yields of government bonds owned by foreign investors, which was in place through February 2006, also increased the advantages of the derivatives carry trade relative to the traditional carry trade.

The derivatives carry trade turns out to be even more attractive in Brazil due to the non-deliverable characteristic of the FX derivatives market. Foreign and domestic agents can engage in the derivatives carry trade without disbursing even a single United States dollar. Until October 2010, this carry trade strategy could also be executed without the expenditure of a single real because investors could meet their margin requirements in reais via domestic borrowed securities or guarantees from the resident banks. Despite the predominance of foreign investors in the derivatives carry trade, profit-seeking domestic agents such as institutional investors and companies have also participated in this segment of the financial market.

Moreover, the outstanding performance of the reais futures market has contributed to increased trading of the Brazilian currency on offshore OTC markets through non-deliverable forward contracts (NDFS). The existence of a deep futures market has made it possible

for foreign banks with branches in Brazil to sell reais offshore and simultaneously hedge their real exposure in the onshore futures market (Kaltenbrunner, 2010). The growth of the NDF market for the Brazilian real has, in turn, enhanced the liquidity and depth of the Brazilian futures market even further. Consequently, some international investors began to use reais futures contracts as a proxy for other emerging currencies' derivatives, which have been highly correlated with the Brazilian real but do not have deep and liquid derivatives markets, such as the Turkish lira and the South African rand. This practice further increased the trading of reais futures contracts.

The wide range of participants ensures greater trade volume and turnover in the FX futures market relative to the FX spot market. As Ventura and García (2009) point out, given the higher liquidity of the FX futures market, banks with FX portfolios have chosen to transfer operations typical of the spot FX market to the FX futures market, increasing their trades with FX futures. As these authors argue, the first dollar futures contract (30 days for next settlement) has become the locus of formation for the real-dollar exchange rate, based on its high liquidity. The spot exchange rate results from arbitrage between the futures and spot exchange rates carried out by banks with FX portfolios. In general, these agents are in a position opposite that of non-bank investors (among which foreign investors were prominent between 2009 and mid-2011) in the FX futures market: they hold a long position in dollars and short in reais, which means they buy dollars in this market and sell them in the spot market. With this strategy, banks have earned arbitrage profits and, at the same time, generated pressure on the dollar spot price, which has meant a drop in the real-dollar spot exchange rate and an appreciation of the Brazilian currency. Because only banks can hold FX positions in the FX spot market in Brazil, they have played a central role in conveying appreciation pressure through the carry trade in the futures market to the real-dollar spot exchange rate.[15] At the same time, this key role of FX futures in the real-dollar exchange rate dynamics does not mean that spot FX transactions do not also have an influence. Arbitrage between the futures and spot rates only works if there is liquidity in the spot market, which depends on actual FX inflows and outflows.

[14] It is possible to profit from the appreciation of the Brazilian real and the positive interest rate differential via onshore derivatives traded at BM&FBOVESPA. The most common trades are shorting the United States dollar futures contract, shorting contracts on the onshore dollar rate or shorting the onshore dollar rate, combined with the ongoing long on the domestic interest rate futures (DI x Pre) (Ventura and García, 2011).

[15] The role of FX derivatives in the current exchange rate dynamics of advanced economies' currencies has been pointed out by Burnside and others (2006) and Klitgaard (2004). However, the theoretical analysis of the key influence of these instruments in exchange rate dynamics is far from consolidated.

The main goal of the capital controls, prudential financial regulations and FX derivatives regulations implemented in Brazil since October 2009 is to curb the appreciation of the real. The day after the first control was announced, the Finance Minister, Guido Mantega, stated that "We want to prevent an excessive appreciation of the real. When the real appreciates, it makes our exports more expensive and our imports cheaper, and we already have an expressive increase in imports while the exports are not growing as they should" (cited in Chamon and Garcia, 2013, p. 7). Each measure was publicly announced by Guido Mantega and throughout the course of his speeches on their use, he repeatedly referred to the capital flows as a "tsunami" caused by lax monetary policy in the United States of America and beyond. He said the financial transactions tax (IOF) and related measures were Brazil's only defence against this tsunami and the "currency war" thrust upon them by the United States and China (Gallagher, 2014).

Thus, specific features of the Brazilian currency market presented Brazilian policymakers with greater challenges than those faced by their counterparts in the Republic of Korea. On the one hand, because FX derivatives are non-deliverable, they could simulate the impact of capital flows on the exchange rate without any actual foreign currency flows, thereby lowering the efficacy of capital controls. On the other hand, given the predominance of FX futures, prudential financial regulation has also proved insufficient to reach FX derivatives operations, as it does not encompass non-resident investors and non-bank resident agents. Nevertheless, this regulation does reach banks' short dollar positions in the FX spot

market, which are outside the scope of capital controls that apply only to FX flows recorded in FX contracts.

The Brazilian regulatory authorities recognize these constraints. Since October 2010, they have implemented, along with capital controls and prudential financial regulations, FX derivatives regulations that apply to the FX derivatives operations of all agents, be they residents or non-residents, financial or non-financial actors.

In October 2010, along with strengthening a price-based capital control on portfolio investment (a tax on capital inflows called a financial transactions tax (IOF)), the Brazilian Government launched the first FX derivatives regulation: IOF on margin requirements for FX derivatives transactions was increased from 0.38% to 6.0%, and some loopholes for IOF on margin requirements were closed (see table 4). However, the first rounds of capital controls and FX derivatives regulation have clearly not halted the currency appreciation. Private agents found loopholes to circumvent these controls, and the FX derivatives regulations were not sufficient to stem the derivatives carry trade, given the latter's high degree of leverage (see figure 3). In fact, IOF on portfolio inflows only encouraged the build-up of long real/short dollar positions on the onshore derivatives market; that is, it fostered the derivatives carry trade supported by resident banks with FX portfolios that assumed the position opposite that of non-resident investors in the derivatives market (short real/long dollar positions). Since these banks have to comply with prudential rules regarding their FX positions, they increased their short dollar positions in the spot currency market with the aim of reducing or eliminating the currency risk (IMF, 2011a).

TABLE 4

Brazil: financial regulation toolkit

Date	Number and kind	Tighten or loosen	Measure
Oct. 2009	1st CC	Tighten	• The Ministry of Finance implemented a 2% financial transaction tax (IOF) on non-resident equity and fixed-income portfolio inflows.
Oct. 2010	2nd CC	Tighten	• IOF increased from 2% to 4% for fixed-income portfolio investments and equity funds. • IOF increased to 6% for fixed-income investments. • Limitations were also introduced on the ability of foreign investors to shift investment from equity to fixed-income investment.
Oct. 2010	1st FXDR	Tighten	• IOF on margin requirements on FX derivatives transactions increased from 0.38% to 6%. • Loopholes for IOF on margin requirements were closed: foreign investors in the futures markets were no longer allowed to meet their margin requirements via locally borrowed securities or guarantees from local banks, which allowed them to avoid payment of the tax.
Jan. 2011	1st PR	Tighten	• Non-interest reserve requirement equivalent to 60% of banks' short dollar positions in the FX spot market that exceed US$ 3 billion or their capital base, whichever is smaller (to be implemented over 90 days).

Table 4 (concluded)

Mar. 2011	3rd CC	Tighten	• IOF on new foreign loans (banking loans and securities issued abroad) with maturities of up to 1 year increased to 6%. Companies and banks previously only paid a 5.38% IOF on loans up to 90 days.
Apr. 2011	4th CC	Tighten	• 6% IOF extended for the renewal of foreign loans with maturities of up to 1 year. • 6% IOF extended for both new and renewed foreign loans with maturities of up to 2 years.
July 2011	2nd PR	Tighten	• The non-interest reserve requirement became mandatory for amounts over US$ 1 billion or their capital base (whichever is smaller).
July 2011	2nd FXDR	Tighten	• Excessive long positions on Brazilian real off all agents pay a financial tax of 1%. This tax can be increased up to 25%.
Dec. 2011	5th CC	Loosen	• IOF on equity and fixed-income (linked with infrastructure projects) portfolio inflows reduced to 0%.
Mar. 2012	6th CC	Tighten	• 6% IOF extended for both new and renewed foreign loans with maturities of up to 3 years; some days, extended again for both new and renewed foreign loans with maturities of up to 5 years. • Export advanced payment transactions with maturities of more than a year prohibited.
Mar. 2012	3rd FXDR	Loosen	• Exporters hedge operations (up to 1.2 times the exports of the previous year) exempted from IOF.
June 2012	7th CC	Loosen	• 6% IOF only for new and renewed foreign loans with maturities of up to 2 years (namely, the changes adopted in March were reversed).
Dec. 2012	8th CC	Loosen	• 6% IOF only for new and renewed foreign loans with maturities of up to 1 year. • Export advanced payment transactions maturity extended from 1 to 5 years.

Source: Prepared by the authors, on the basis of information from the Central Bank of Brazil [online] http://www.bcb.gov.br/pt-br/paginas/default.aspx; and the Ministry of Finance [online] http://www.fazenda.gov.br/.

Note: CC: Capital control; PR: Prudential regulation; FXDR: Foreign exchange derivatives regulation; IOF: Financial transactions tax.

FIGURE 3

Brazil: nominal exchange rate and the application of tighter regulations

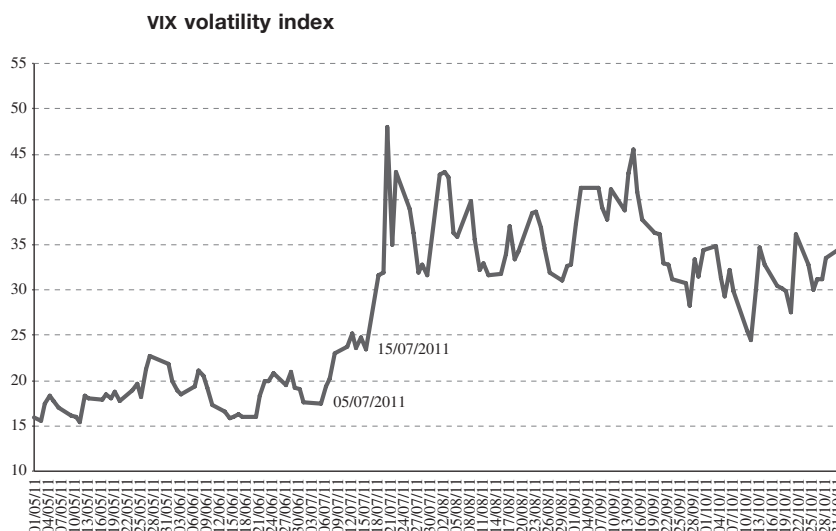**Source:** Prepared by the authors, on the basis of information from the Central Bank of Brazil.

To close this loophole, the Central Bank of Brazil imposed a non-interest reserve requirement (a prudential financial regulation) on these positions in January 2010. Nevertheless, by switching to short-term foreign borrowing, banks and companies were able to find another channel to circumvent regulations. In response, the Government imposed IOF on short-term foreign borrowing in March 2011, but private agents were able to make longer-term loans, given excess liquidity and the search for yield on the international financial market. In April 2011, the Government subsequently extended IOF to these loans.

The currency continued to appreciate (see figure 3). In July 2011, the Government tightened the prudential financial regulation adopted in January and launched a broader set of FX derivatives regulations, including a financial tax of 1.0% on excessively long net positions on the real in the FX derivatives market. Because this tax is calculated on the notional value of the FX derivatives operations, it had a major impact on the derivatives carry trade and was comparable to IOF on the margin requirement already in force. The adoption of this tax was

possible because at the same time, the National Monetary Council (CMN) was made responsible for regulating the derivatives market, and new rules regarding the recording of FX derivatives were adopted. CMN comprises the Central Bank Governor, the Minister of Finance, and the Minister of Planning, Budget and Management (see [online] www.bcb.gov.br/?cmn). These institutions could then easily coordinate their efforts to contain appreciation pressures stemming from this market segment.

These measures had some effects, at least in the short term. Before long, however, important changes took place both in the external environment and in domestic monetary policy that also influenced the exchange rate path. First, foreign agents' risk aversion, as measured by the VIX volatility index, increased amidst the worsening of the euro crisis (see figure 4). Second, the regulatory shift was embedded in a major policy rate cut from August 2011 onward (see figure 2). Still, although VIX had begun to rise in the first week of July, the Brazilian currency only began depreciating after the launch of the new FX regulations, but before the policy rate reductions in August (see figures 2, 3, and 4).

FIGURE 4

VIX volatility index

Source: Prepared by the authors, on the basis of information from the Chicago Board Options Exchange.

Some empirical studies suggest that the Brazilian regulatory toolkit was successful in curbing the currency appreciation trend. For instance, Chamon and Garcia (2013) stress that the measures adopted to stem the currency appreciation may have amplified the effects of

the policy rate drop between August 2011 and October 2012 on the real-dollar exchange rate. Baumann and Gallagher (2012) find that the regulation adopted by the Brazilian policymakers between October 2009 and December 2012 was associated with a shift from short-

term to longer-term inflows, had a lasting impact on the level and volatility of the exchange rate and modestly increased the autonomy of Brazilian monetary policy. On the other hand, Klein (2012) concludes that the Brazilian IOF was an episodic control on capital inflows that did not temper the appreciation of the Brazilian currency; however, the period covered in his study ends in 2010, before the adoption of broader FX derivatives regulation.

FIGURE 5

Selected emerging countries: credit default swap premium (five years)

Brazil ——— Chile ——— - - - Mexico - - - ——— Turkey ——— Russian Federation - - - - - ▪▪▪▪▪▪Peru——— South Africa
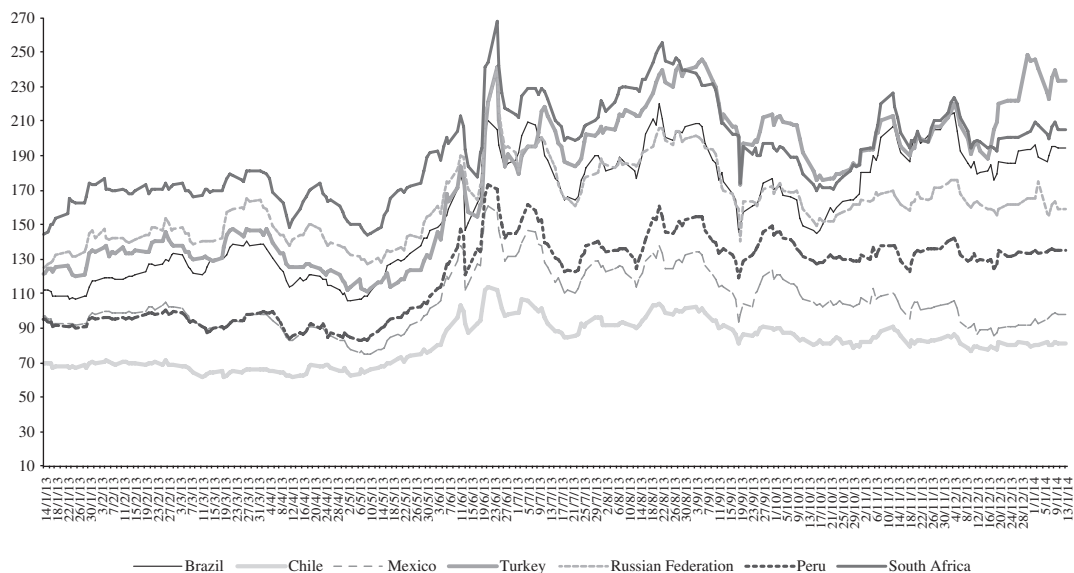
Source: Prepared by the authors, on the basis of information from Bloomberg.

IV

Conclusions

As emerging markets with open financial accounts and sophisticated FX derivatives markets, the case studies of Brazil and the Republic of Korea exemplify that country-specific factors have to be considered when designing the financial regulatory toolkit aimed at curbing foreign and domestic agents' speculative strategies in the search for yield. Three insights emerge from our comparative analysis.

First, the necessary breadth of financial regulation depends on the financial actors involved and the type of financial contract. In Brazil, it was necessary to implement a third type of regulation, which we call FX derivatives regulation, because the main locus of FX operations is the organized derivatives market, where resident and non-resident banks and non-bank financial agents are

involved. Consequently, prudential financial regulation is not sufficient. The Brazilian case also serves as an example in which capital controls are insufficient to curb FX derivatives, because both resident and non-resident operations are denominated in foreign currency, but liquidated in domestic currency, and the effect of foreign investors' portfolio decisions on the exchange rate may be uncoupled from the volume of international capital flows. Similarly, in the Republic of Korea, prudential financial regulation has been able to reach FX derivatives operations, because they are mostly carried out on OTC markets —where banks perform the role of counterparty in all transactions— and the operations are settled in United States dollars. Thus, prudential regulation is able to cover all operations.

Second, institutional specifications in a strict sense are relevant. It is important to have effective domestic institutions and jurisdictions able to formulate and implement regulations. Unlike many emerging economies, Brazil has an institutional framework that allows financial authorities to act quickly and at their discretion to impose regulations on capital flows and FX derivatives. The framework is based on three institutional tools: (i) domestic norms on FX transactions allow for the implementation of capital controls and FX derivatives regulations at any time; (ii) Brazil's finance ministry has jurisdiction over all tax policy, including any taxes on cross-border finance; and (iii) all monetary, credit and exchange rate policies in Brazil must be agreed on by consensus by CMN, a body that includes representatives of the Central Bank and the Finance Ministry. Thus, monetary and exchange rate policies and financial regulation can be properly coordinated, which seems to be highly relevant in determining their potential effectiveness (see Prates and Fritz, 2014).

Third, countries should not limit their own policy space through multilateral or bilateral agreements; rather these agreements should leave manoeuvring room for domestic policies. Brazil has been able to launch broad capital controls and FX derivatives regulations because, since the 1990s, the Government has been careful to avoid any commitments under the General Agreement on Trade in Services (GATS), or to sign any bilateral investment treaties or free trade agreements that could reduce the country's policy space to implement these regulations at any moment (Paula and Prates, 2013). While most treaties that liberalize trade in services employ a "positive list" approach with respect to trade in financial services, capital controls and FX regulations could become inconsistent with treaty obligations if they intervene in cross-border movements of capital related to such services. The Republic of Korea, as an OECD member State, is much more restricted in regulating transnational financial transactions, and it also has double taxation treaties with most of its economic partner countries, so taxes on capital flows do not apply. Hence, it was mainly the dominant presence of resident banks in international capital flow transactions that enabled the Republic of Korea authorities to regulate the relevant operations.

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Agricultural productivity: closing the gap between Brazil and the United States

José Eustáquio Ribeiro Vieira Filho and Armando Fornazier

ABSTRACT

Since the 1970s, Brazilian agriculture has undergone far-reaching changes and has played a major role in agricultural production worldwide. This article assesses the structural heterogeneity prevailing in Brazilian and United States agriculture by studying total factor productivity (TFP), which has increased in both economies, mainly through technologies allowing for economies in the use of land and labour. Although higher growth rates have enabled Brazil to narrow the productivity gap with the United States, this does not mean its productivity is superior. Each country's production structure has specific features; and productivity differences can be seen not only between but also within countries, owing to a variety of factors, including climate, technology and learning in the production process. Resource use has become more efficient in both countries, enabling them to produce more with fewer inputs.

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I

Introduction

In recent decades, Brazilian agriculture has undergone major transformations that have resulted in the sector's modernization, with the incorporation of technology and productivity growth. Brazil has become a major world producer of food and biofuels, alongside other countries such as the United States. Nonetheless, some farm units operate with little technology and low productivity levels, remaining a long way from modern development models.[1] Some producers are often excluded from markets and sometimes exist in a situation of rural poverty, owing to their low level of production. This reflects the heterogeneous nature of Brazilian agriculture.

Labour productivity, calculated as the ratio between value added and the population employed on each farm, is the variable generally used to measure structural heterogeneity in studies by the Economic Commission for Latin America and the Caribbean (ECLAC) (Pinto, 1970; Nohlen and Sturm, 1982; Sunkel and Infante, 2009; ECLAC, 2010; Vieira Filho, Santos and Fornazier, 2013). Structural heterogeneity can be measured through differences in labour productivity, either between countries (referred to here as the international productivity gap), or between sectors (industry, services and agriculture) or within agriculture itself (comparing specific farmers and crops).

The comparison aims to display the external competitiveness models followed by Brazilian agriculture, based on narrowing the international productivity gap, and to demonstrate the dual form of development that persists in the economy and prevents segments ignored by the technological modernization process from gaining productive inclusion.

According to Fornazier and Vieira Filho (2012), Vieira Filho, Santos and Fornazier (2013), and Vieira Filho (2013), the productivity of farming activity varies greatly, particularly in Brazil. While some producers use modern techniques to increase productivity, others can only adopt less technology-intensive techniques owing

to difficulties in accessing more modern technologies, or even obstacles related to the adaptation process.

The process of combining factors of production expands as agriculture modernizes, since farmers have the chance to adopt technologies that enable them to economize on certain resources (such as land and labour) and replace them with others (such as a larger amount of capital). To modify the production process, agricultural policies themselves —including policies in relation to credit (which is often subsidized)— have increased the capitalization of agriculture by fostering relations with other sectors, such as input industries and agribusiness, commerce and supermarkets, among other segments linked to production; and by defining models and promoting credit.

Development does not occur homogeneously across countries and regions, or even within a given sector or activity. During the process, differences are created in the economic, social, political, technological and cultural environments. The theoretical discussion on developmental differences between countries began in ECLAC in the 1950s, when the dissimilarities between the developed centres and the developing peripheries were studied (Nohlen and Sturm, 1982).

Pinto (1970) had already defined structural heterogeneity as a visible phenomenon in developing countries, particularly in Latin America. It was claimed that the productivity of modern agriculture was as much as 14 times higher than that of the traditional sector. Not all producers have succeeded in modernizing; and there are significant regional differences which can explain the co-existence of modern and backward sectors.

Differences between sectors, or even within the same economic activity, reflect problems of access to financial resources for modernization, and a lack of stakeholder knowledge (social capital), which impair capacity to promote changes. Cultural, climatic and regional factors also can disrupt local production and increase disparities between regions.

Differences between and within sectors form part of Brazil's history. According to Fornazier and Vieira Filho (2012) and Vieira Filho (2013), heterogeneity can be seen both in production and across the region. The coexistence of a modern agricultural sector targeting the external market, with another that is almost exclusively devoted to the subsistence of rural families and supplying

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[1] For an extended analysis of the results of the 2006 agricultural census, see Gasques and others (2010). The study provides a general overview of the most recent transformation in Brazilian agriculture. Buainain and others (2014) provides a wide-ranging discussion on technological transformations in Brazilian agriculture in 1960-2015, when Brazil shifted from being a net food importer to an exporter and a major global producer (as from the 1980s).

small local markets has a long history. Irrespective of size, the most productive agriculture is comparable with agriculture at the global technological frontier.

In the economic sphere, a number of indicators can be used to examine structural heterogeneity. For example, Nohlen and Sturm (1982) argue that productivity can be used as an indicator to define the scope of research and measurements in the economy. Creating indices makes it possible to identify the disparities that exist and the path of the development models of specific activities. According to ECLAC (2010, p. 24): "Achieving productive convergence requires closing productivity gaps with more competitive countries, while also reducing internal structural heterogeneity. These social and productivity gaps can literally be "mapped out," as they are reflected in —and partially caused by— territorial segmentation."

When comparing agricultural activity between countries, it is important to study the history of their development by analysing the factors that caused them to diverge through time. Disparities with respect to more modern sectors or countries decrease or increase over the years, as factor combinations improve in the more advanced sectors or countries, where there is a high level of accumulated knowledge. It is therefore important to evaluate productivity to determine technological and productive differences.

The aim of this study is to judge whether the development of the Brazilian economy is approaching the productivity gains achieved at the technological frontier of agricultural production, and to analyse the structural heterogeneity present in that sector. The Brazilian agricultural sector is compared with its counterpart in the United States, which in this study is taken as a benchmark representing the technological frontier. The study analyses how the productivity gaps between Brazil and the United States have behaved through time, specifically in terms of differences in total factor productivity (TFP); and a framework is provided to compare the two countries.

The results show that, although agricultural productivity in Brazil has converged with that of the United States over the last four decades, there is still considerable productive heterogeneity in Brazilian agriculture. While TFP is converging in the two countries, there is still a very high level of intra-regional heterogeneity in Brazil's farming sector.

This article is organized as follows: section II discusses agricultural development in both countries and section III presents the method of analysis, which consists of measuring total factor productivity (TFP). Section IV then compares TFP between Brazil and the United States, and section V sets forth final thoughts.

II

Agricultural development in Brazil and the United States

As a dynamic sector of the Brazilian economy, agriculture makes a major contribution to gross domestic product (GDP) and to the country's exports; and it also generates employment and produces food and energy (Vieira Filho, 2014).

Nonetheless, it is heterogeneous in terms of modernization, according to the description made by Paiva (1971), who outlined the agricultural modernization process and its technological dualism or multiplicity. In some more economically developed regions, the percentage of modern farmers is always very high compared with the other categories. In contrast, in regions referred to as "backward", the proportion of traditional farmers predominates or is even total. Between these two extremes, however, there are developing regions that

display varying degrees of modernization. Apart from the differences between regions, Paiva (1971) also draws attention to disparities in the degree of modernization between the products of a given region.

Modernization changes production relations by increasing capital and forging links between agriculture and other sectors, such as manufacturing industry or agribusiness.[2] It is defined as the technical transformation of farming in the post-war period, based on imports of tractors and fertilizers in an effort to raise productivity (Graziano da Silva, 1996, p. 19).

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[2] On the green revolution, see Chianca (2004) and Fuck and Bonacelli (2007).

Public policies, particularly towards rural credit, also gave many producers the opportunity to use more modern resources in agriculture; but not all farmers had access to them. The change in the technical basis of agriculture increases the need for investment, so credit becomes essential for gaining access to more modern technologies. Ciprandi and Fert Neto (1996) show that, in Brazil, public policies giving incentives to modernization mainly benefited large and medium-scale owners.

Other factors, such as the opening of markets to trade, forced many producers to improve their production and management techniques to be able to compete with the imported products. Coura, Figueiredo and Santos (2006) noted that the technical efficiency of certain crops (such as cotton, rice, beans, maize and soya) increased following the liberalization of the Brazilian economy, particularly after the introduction of the real in 1994. These authors highlight the fact that São Paulo agriculture reacted to the greater external competition caused by liberalization, combined with the appreciation of the national currency and increasing productivity. The benefits were not distributed uniformly between the different regions, however, with the largest gains clearly concentrated in the regions that receive more support from technical assistance and rural extension services.

In addition to trade liberalization, burgeoning demand driven by the growth of many developing countries elicited greater production of food and raw materials, and provided an opportunity for producers to improve efficiency and make profits in those "emerging" markets. According to Wilkinson (2010), demand from emerging countries has given a second wind to the life cycle of the key commodities. In recent years, the financial sector has also become more involved in agribusiness. In the case of grains and oilseeds, new financial instruments have been designed to support the futures market and provide advance financing. Large traders have also become more involved in harvest financing.

Some Brazilian crops display productivity patterns that are similar to those of global benchmark countries. Gasques, Bastos and Bacchi (2008) describe how the TFP of Brazilian agriculture (which is the ratio of the sum of all outputs to the sum of all inputs) has grown at high and rising rates over the last 30 years. These authors estimate average annual growth in that period at 2.51%, which is higher than the rate reported for the United States by Ball (2006).

Agriculture in the United States is characterized by high productivity, the adoption of technologies and extensive farmed areas, which make that country one of the world's largest crop producers. In 2010, for example,

it was the largest producer of maize, ahead of China and Brazil, and the largest soya producer, followed by Brazil.[3]

The high productivity indices achieved by the United States agriculture sector have become benchmarks for many countries. Nonetheless, the adoption of technologies and modernization occurred in earlier periods than in Brazil. This is particularly true of labour-saving technologies, as noted by Hayami and Ruttan (1988) when comparing the United States, where such technologies were adopted owing to labour scarcity in the countryside, with Japan, which introduced technologies that economized on land, since this was the scarcest resource in that country.[4]

According to Fuglie, MacDonald and Ball (2007), the amount of labour employed in the agriculture sector declined rapidly in the 1950s, 1960s and 1970s in the United States, owing to the increase in inputs (new agricultural machinery and improved chemical inputs) and, mainly, the reduction in farm labour, since the increase in labour costs encouraged farmers to adopt technologies. The change began with an improvement in the quality of inputs (including machines) and chemical products, with new modes of application, which in many cases reduced the chemical load per hectare without compromising crop yield. Moreover, larger scale and integration between rural producers, input suppliers, and processors have improved practices in animal husbandry, among other areas.

Innovations, particularly in the agricultural machinery industry, were decisive for the expansion of the sector in the west of the United States during the nineteenth century, mainly through labour-saving technologies. In addition to production innovations, new production arrangements were already changing the country's farming in the 1950s, such as the integration of the agriculture sector with input manufacturers and agribusiness (Sunding and Zilberman, 2000). As noted by Alves (2010), chemical-biological technologies, such as inputs that increase land yields, also have potential to enhance labour productivity, or output per worker, which thus depends on both biochemical and mechanical technology.

The greater interaction between agriculture and other sectors in the United States in the 1950s was already displaying the decline in agricultural production (*dentro*

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[3] For further details, see FAO (2012).

[4] For a critical review of the literature and the role of learning economies see Vieira Filho and Silveira (2012). The authors work with the technological diffusion model, productive dualism and induced innovation, incorporating elements of technological competition (Vieira Filho, Campos and Ferreira, 2005), and agents' learning (Vieira Filho and Silveira, 2011) into the debate.

da porteira)[5] relative to GDP. According to Davis and Goldberg (1957), the term "agribusiness" was defined as the sum of operations involved in input purchase and the production and distribution of agricultural products, because in that period, there was a closer relation between agricultural activity and the production chain *antes da porteira* and *depois da porteira* (industry and trade that supply inputs for rural production and the purchase, transport, processing and sale of agricultural products, to the final consumer, respectively).

For Dimitri, Effland and Conklin (2005), technological evolution in United States agriculture began in the post-World War II period; and low-cost chemical fertilizers and pesticides have been used since 1945. Simultaneously, progress was made in terms of the genetic improvement of plants and animals and in mechanization, which made

agricultural activity more profitable. In the late 1960s, mechanized harvesting was adopted in crops such as sugar beet, cotton and tomatoes; and in 1970, tractors replaced animal power. Since 1900, new technologies and rural infrastructure development have strengthened and increased the links between farmers and labour and capital markets, and with many services.[6]

When analysing the evolution of agricultural productivity in Brazil and the United States, differences can be observed through time; and it is important to remember that the initial phase of comparison is different, because the modernization process in each country did not occur at the same time. In this case, following the ECLAC tradition, Rodríguez (1977) shows that many technologies were developed and adopted in the more developed countries (centre), and some of them later spread to the less developed countries (periphery).

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[5] The term "*dentro da porteira*" encompasses everything relating to agricultural production: planting, management, office, yields, machine maintenance, input storage, disposal of containers, and labour. "*Antes da porteira*" refers to everything necessary for agricultural production but is not present on the farm, which the farmer has to purchase to be able to produce: all inputs (machines, chemical agents, fertilizers, seeds and others). "*Depois da porteira*" refers to storage and distribution, including logistics.

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[6] It is worth noting transport costs which directly affect factor use (labour, land and type of technology) in the two countries. See, for example, Chomitz and Gray (1996) and Cropper, Puri and Griffiths (2001). To some extent this is an important aspect that is not fully captured by the adopted methodologies.

III

Method of analysis: measurement of TFP

The growth of TFP is the difference between the effective growth rate of production and the growth rate of the factors of production, assuming no technological change or improvement in producer efficiency. Output growth can indicate two different situations: one reflecting an increase in the physical quantity of inputs used in the production process, and another resulting from a more efficient use made of the factors of production in the process. The latter is TFP growth.

According to Sadoulet and De Janvry (1995), TFP is the most common measurement of technical progress, defined as a ratio between output and an index of all inputs. For Pires and Garcia (2004), changes in allocative efficiency play a fundamental role, even more important than the technological gap, in explaining productivity differences between developed and developing countries. Jorgenson (1996) and Christensen (1975) seek to provide details of the concepts and construction of the index that evaluates this productivity measure. Gasques and others (2010) have calculated this indicator with respect to Brazil.

According to those authors, the Tornqvist index, which is used to calculate TFP, is a discrete approximation to the Divisia Index (Chambers, 1998) and the most appropriate tool for analysing economic variables, since the data are available in discreet form, thus:

$$ln\left(\frac{PTF_t}{PTF_{(t-1)}}\right) = \frac{1}{2}\sum_{i=1}^{n}\left(S_{it} + S_{i(t-1)}\right)ln\left(\frac{Y_{it}}{Y_{i(t-1)}}\right)$$
$$-\frac{1}{2}\sum_{j=1}^{m}\left(C_{jt} + C_{j(t-1)}\right)ln\left(\frac{X_{jt}}{X_{j(t-1)}}\right) \quad (1)$$

Where Y_i and X_j are the amount produced and the volume of inputs used, respectively; whereas S_i and C_j refer to the proportion of product i in the total value of production and the portion of input j in total input cost.

The left-hand side of the equation defines the variation of TFP over two successive time periods; while the right-hand side contains two terms. The first is the logarithm of the ratio of quantities in two periods of time,

weighted by the average proportion of each product in total output value. The second is the logarithm of the ratio of input quantities in the same period, also weighted by the average proportion of each input in total cost.

Consequently, calculation of the Tornqvist index requires the prices and quantities of all products and inputs used. The variation in TFP is calculated by an exponential function. To attain the TFP index for each year, a base year is chosen for which the index value is set at 100, and it is then chained with subsequent years. This chaining process can be studied in Hoffmann (1980).

According to MAPA/AGE (2011) and Gasques and others (2014), two types of indices must be measured to calculate TFP: (i) aggregate output, and (ii) aggregate input. The first used data on permanent and seasonal crops, and on animal production and slaughter. The index encompassed 66 crop products (31 seasonal and 35 permanent) and 11 livestock activities (eight products from animal breeding and three types of meat —beef, pork, and chicken—). Data from the Brazilian Geographical and Statistical Institute (IBGE), on the values and quantities are based on the Municipal Agricultural Output Surveys (PAM) and Municipal Livestock Production Surveys (PPM). The figures for the weight of carcasses were taken from the IBGE Quarterly Survey of Animal Slaughter. The prices were obtained from the survey conducted by the Getulio Vargas Foundation.

The aggregate input index is formed by three components: land (crops and pastures), labour (personnel employed) and capital (machines, pesticides and fertilizers). In the case of land, the data on areas cultivated were taken from the PAM survey, and those on grazing area from the IBGE agricultural censuses. Statistics for the inter-census years were calculated by interpolation using growth rates. Land prices and rents are obtained from the Getulio Vargas Foundation. Labour market data (persons

aged 15 years or older employed in agricultural activities) and wages were taken from the IBGE National Household Survey (PNAD). In the case of capital, the quantities of motorized agricultural machinery used were obtained from the yearbook of the National Association of Motor Vehicle Manufacturers (ANFAVEA), and the values of sales by firms with units and spare parts sold domestically.

The depreciation period considered was 16 years. Thus, every 16 years, the number of units existing up to that year is subtracted from the number of units sold, so that the result gives the stock of machines during the year. Data on fertilizer and pesticide consumption were obtained by requests. In the case of fertilizers, information was requested from Potafos and the National Association for Fertilizer Diffusion (ANDA), whereas in the case of pesticides, the National Union of the Industry of Agricultural Defence Products (SINDIVEG) was contacted.

To calculate the indices, it is not necessary to deflate the values of outputs and inputs, because the calculation uses annual shares. The period studied spans 1975 to 2010. In the case of the United States, the statistics were obtained from the Economic Research Service (ERS) of the United States Department of Agriculture (USDA). The Brazilian statistics were calculated using the same formula and methodology as applied by USDA, specifically to provide a good basis for comparison. It should be noted that the period studied is quite long and both the Brazilian and United States economic structures changed significantly in that time. Nonetheless, this does not invalidate the comparative study. Among studies that make various international comparisons of TFP, the reader can consult the volume produced by Fuglie, Wang and Ball (2012). Brazilian TFP growth was one of the fastest among the various countries analysed, as can also be seen in the following comparative analysis with the trend in the United States.

IV

Comparison of TFP between Brazil and the United States

1. Evolution and overview

Although the initial phase of TFP analysis in a sector such as agriculture or in the production of a crop can vary from one country to another, the aim of this article

is to determine whether the gaps or differences between Brazil and the United States have widened or narrowed through time. As the historical series analysed runs from 1975 to 2013, the production structures in both countries are very different between the start and end of

that period, and the two economies must be compared in that context.

The productivity of the Brazilian agriculture sector has been evaluated in many studies, including Gasques and Conceição (2000); Gasques, Villa Verde and Oliveira (2004); Gasques, Bastos and Bacchi (2008), and Gasques and others (2010). The main specific analyses of the evolution of United States agricultural activity based on TFP calculations are those made by ERS/USDA. Nonetheless, there are no comparative studies of the evolution of the two countries to determine whether the gaps are increasing or decreasing through time. The current study chose to make the comparison with the United States because this country displays high productivity indices, maintains a considerable volume of agricultural production, and is considered a world leader in the production of many crops.

The TFP indices measure aggregate output per unit of aggregate input, and thus provide a guide to the efficiency of agricultural production (Thirtle and Bottomley, 1992). Few studies have calculated TFP by crop, owing to the difficulty of controlling for specific levels of input and output. The fact that inputs are often shared in a given production unit makes it difficult to assign inputs to a specific crop. For example, the methodology of the Brazilian agricultural census itself collects data on inputs, labour and output by establishment, and not by crop. For this reason, the comparison approach is by agricultural sector.

Before comparing the trend of TFP in Brazilian and United States agriculture, it is worth reviewing the trend of that indicator in other regions of the world. Figure 1 shows the TFP of countries of Latin America and the Caribbean, including Brazil, compared with that of other regions and country groupings, including high-income countries such as the United States. The high-income group registered the highest average TFP growth from 1961 to 2007; and this was followed by Latin America and the Caribbean, where growth was actually above the world average. Ludena (2010) highlights the strong economic performance of the region with respect to other developing regions: after 1980, efficiency increased and the gap with respect to high-income countries such as the United States narrowed.

FIGURE 1

Annual TFP growth in agriculture, weighted average, 1961-2007
(Percentages)
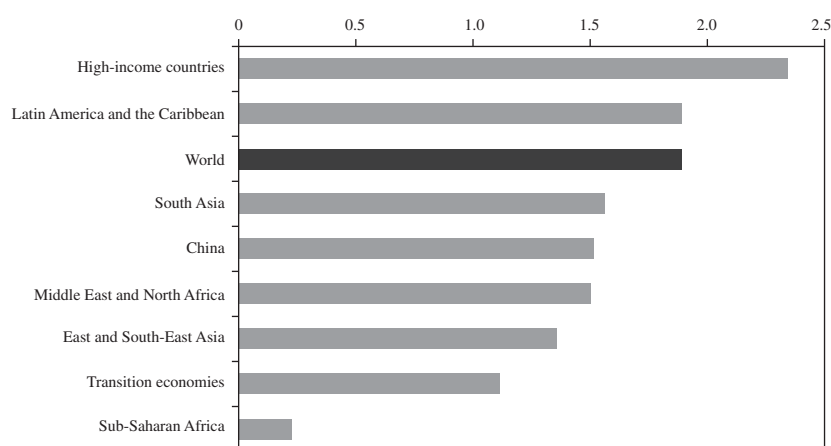
Source: C.E. Ludena, "Agricultural productivity growth, efficiency change and technical progress in Latin America and the Caribbean", *IDB Working Paper Series*, No. 186, Washington, D.C., Inter-American Development Bank, 2010.

Table 1 reports data on agricultural output growth and agricultural TFP between 1961 and 2007, with a breakdown by decade and for the whole period studied. For that purpose, all developing countries were taken as the reference. Although data are available for Latin America and the Caribbean, for a closer analysis of Brazil, the study focused on the group of countries referred to as the north-east of South America, namely Brazil followed by French Guyana, Guyana and Suriname. The figure shows the evolution of all developed countries, particularly the United States and Canada.

The group that includes Brazil recorded major growth in both agricultural production and TFP, except for a few periods such as 1961 to 1979, in which TFP did not increase. In the other periods, productive growth surpassed that of other developed countries and that of the group consisting of the United States and Canada. The strongest TFP growth in the north-east of South America —which includes Brazil— occurred in the 1980s, when average growth rates outpaced those of the rest of Latin America and the Caribbean.

The analysis of TFP in Brazil alone reveals a larger increase in later years compared with the longer series covering the 1970s and 1980s. In table 2, Gasques, Bastos and Bacchi (2008) list the main studies of TFP in Brazil and the United States.

The stronger growth of TFP in more recent periods confirms studies that describe how Brazilian agriculture has moved towards new agricultural frontiers. Grain production in the centre-west, benefiting from the use of modern inputs and mechanization, is an example. According to Yokoyama and Igreja (1992), the share of soya from that region in Brazilian agriculture increased from just 4% of the cultivated area in 1975 to 28% in 1985.

TABLE 1

Regions of the world: agricultural output and productivity growth by decade, 1961-2007
(Percentages, annual average throughout the period)

Periods	Growth of agricultural output						Growth of agricultural TFP					
	1961-1969	1970-1979	1980-1989	1990-1999	2000-2007	1961-2007	1961-1969	1970-1979	1980-1989	1990-1999	2000-2007	1961-2007
All developing countries	3.16	2.82	3.47	3.65	2.99	3.23	0.18	0.54	1.66	2.3	1.98	1.35
Latin America and the Caribbean	3.11	3.07	2.39	2.92	3.23	2.92	0.29	0.7	1.2	2.54	2.6	1.47
North-East of South America (mainly Brazil)	3.56	3.82	3.7	3.31	4.05	3.68	-0.52	-0.76	3.08	3.81	3.63	1.87
All developed countries	2.08	1.86	0.88	1.16	0.17	1.24	1.21	1.52	1.47	2.13	0.86	1.48
United States and Canada	2.05	2.17	0.73	2.04	1.04	1.61	0.86	1.37	1.35	2.26	0.33	1.29

Source: K.O. Fuglie, "Total factor productivity in the global agricultural economy: evidence from FAO data", *The Shifting Patterns of Agricultural Production and Productivity Worldwide*, J.M. Alston, B.A. Babcock and P.G. Pardey (eds.), Iowa, Iowa State University, 2010.
Note: TFP: Total factor productivity.

TABLE 2

Brazil and the United States: annual productivity growth in agriculture
(Percentages)

Regions	Total factor productivity (TFP)	Studies
São Paulo (1995-2002)	2.48	(Vicente, 2003)
United States (1999-2002)	1.38	(Ball, 2006)
Brazil (1975-2005)	2.51	(Gasques, Bastos and Bacchi, 2007)
Brazil (2000-2005)	3.87	(Gasques, Bastos and Bacchi, 2007)

Source: J.G. Gasques, E.T. Bastos and M.R.P. Bacchi, "Produtividade e fontes de crescimento da agricultura brasileira", *Políticas de incentivo à inovação tecnológica*, J.A. de Negri and L.C. Kubota (eds.), Brasilia, Institute of Applied Economic Research (IPEA), 2008.

Table 3 reports growth indices in selected periods to compare the trends of other factors, such as land and labour productivity. The latter, or output per worker, depends on both biochemical and mechanical technology. Vieira Filho and Silveira (2011) stress the importance of knowledge, which can be used to improve production techniques. That knowledge may be either tacit or based on research conducted by institutions such as the Brazilian Agricultural Research Enterprise (EMBRAPA).

TABLE 3

Brazil: annual growth rates, 1970-2006 and 1995-2006
(Percentages)

Indicators	1970-2006	1995-2006
Output index	3.483	3.138
Input index	1.189	0.991
TFP	2.267	2.126
Productivity of land	3.316	3.158
Productivity of labour	3.528	3.409

Source: J.G. Gasques, "Produtividade total dos fatores e transformações da agricultura brasileira: análise dos dados dos censos agropecuários", *A agricultura brasileira: desempenho, desafios e perspectivas*, J.G. Gasques, J.E.R. Vieira Filho and Z. Navarro (orgs.), Brasilia, Institute of Applied Economic Research Aplicada (IPEA), 2010.

Note: TFP: Total factor productivity.

When a section is taken of the trend of the indices between 1970-2006 and 1995-2006, it can be seen that output growth is mainly due to the increase in TFP and that labour productivity growth outpaced that of land in both periods. Nonetheless, as noted by Gasques and others (2010), labour productivity is measured on a gross basis, and its main component is the productivity of the land. Thus, the use of a land-economizing technology, such as fertilizer, can help improve labour productivity, since operations such as harvesting can be done with fewer people and machines.

As shown by Sunding and Zilberman (2000), the modernization process in the United States, involving the adoption of land- and labour-saving technologies, began in the 1950s, much earlier than in Brazil, where this occurred in the ensuing decades.

Figure 2 shows the trend of the indices of inputs, output and TFP in the United States from 1948 to 2009. The agricultural inputs index varies little, so TFP growth reflects a higher level of output. According to Gasques and others (2010), a variety of factors, including agricultural research, play a major role in productivity growth. Better allocation of resources —including more modern technologies that reduce losses in the use of inputs, such as fertilizers with less leaching, biological nutrient fixing, improved varieties, cumulative knowledge and learning— makes it possible to increase output with fewer inputs.

There are many factors that enhance efficiency in resource management in agricultural activity and help optimize their use. Agricultural research by public and private enterprises is important for creating technological innovations, generally through new production processes. As noted by Vieira Filho (2009), the practice of direct seeding into stubble, which is widely used in Brazil for cereal cropping, is the fruit of that interaction in which learning plays a major role. Technological change, such as direct seeding or fertilizer with a higher level of absorption by the plants, makes it possible to produce more (higher productivity) using fewer inputs. Coelli and Prasada Rao (2005) state that the differences in access to certain factors (fertilizers, tractors, animals and irrigation, among others) can generate productivity differences between countries. Moreover, Ruttan (2002) draws attention to a number of problems faced by farmers around the world that alter agricultural productivity, such as soil degradation and loss; flooding and salinity; the joint evolution of pests, pathogens and hosts; and climate change.

FIGURE 2
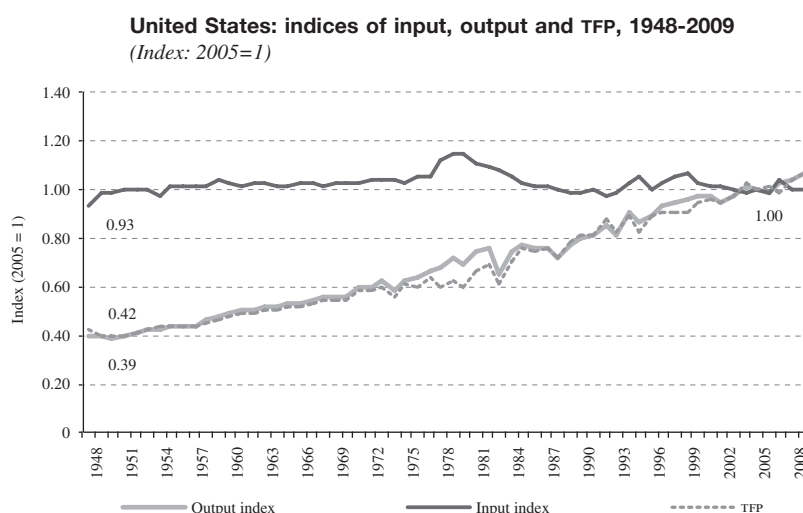
United States: indices of input, output and TFP, 1948-2009
(Index: 2005=1)

Source: United States Department of Agriculture, "Agricultural Productivity in the U.S.", Economic Research Service, 2012 [online] http://www.ers.usda.gov/Data/AgProductivity.

Note: TFP: Total factor productivity.

Table 4 displays the main sources of agricultural growth in the United States from 1948 to 2009. The fact that the labour indicator was negative in all periods, means less labour was used.

The output index was positive throughout the series; and in some periods —such as 1966-1979— was the fastest growing. In the case of land, there were no major variations through time. Capital grew most between 1948 and 1953, when, according to Sunding and Zilberman

(2000), United States farmers started to use technology more intensively (agricultural machines and fertilizers), and this meant a larger need for capital. Except between 1979 and 1990 and in the most recent period (2007-2009), the source referred to as materials, or entry of materials, which encompasses energy, fertilizer and chemical use, displays rising values. This shows that United States agriculture increasingly uses products from other sectors, such as industry.

TABLE 4

United States: sources of growth in the agriculture sector and average annual growth rates, 1948-2009
(Percentages)

	1948-2009	1948-1953	1953-1957	1957-1960	1960-1966	1966-1969	1969-1973	1973-1979	1979-1981	1981-1990	1990-2000	2000-2007	2007-2009
Output	1.63	1.18	0.96	4.03	1.21	2.24	2.65	2.26	1.54	0.96	1.84	0.77	1.88
Input	0.11	1.34	0.28	0.50	0.05	-0.08	0.46	1.64	-1.85	-1.22	0.31	0.14	-1.80
Sources													
Labour	-0.52	-0.81	-1.08	-0.83	-0.81	-0.61	-0.38	-0.19	-0.22	-0.43	-0.34	-0.35	-0.64
Capital	0.02	0.54	0.15	0.03	0.08	0.32	0.14	0.32	0.23	-0.61	-0.21	0.05	0.35
Land	-0.08	0.02	-0.17	-0.16	-0.07	-0.22	-0.29	0.00	-0.12	-0.09	0.00	-0.08	-0.12
Materials	0.69	1.58	1.38	1.45	0.85	0.43	0.99	1.50	-1.74	-0.09	0.87	0.52	-1.39
TFP	1.52	-0.16	0.68	3.53	1.16	2.32	2.19	0.62	3.39	2.19	1.53	0.63	3.68

Source: United States Department of Agriculture, "Agricultural Productivity in the U.S.", Economic Research Service, 2012 [online] http://www.ers.usda.gov/Data/AgProductivity.

Note: TFP: Total factor productivity.

Brazilian agriculture has grown at rates similar to, or even faster than, those in the United States, so the gap between the two countries has narrowed. Nonetheless, the factor composition is not the same, because they are in different stages of agricultural evolution. Ludena (2010) advises cautious interpretation, because the development levels of the countries are different. For example, the study by Alauddin, Headey and Prasada Rao (2005) shows that TFP in Brazil in 1970 was half that of the United States. Climate factors can cause reduce output, which in turn causes a fall in TFP. Changes in price expectations on markets can encourage or discourage an activity, and can even lead to its replacement by others that are productively less efficient.

2. Comparison framework: reducing the productivity gap

Measuring the international productivity gap entails comparing national productivity against the international benchmark, which in this case is United States agriculture because of the technology applied and for its high productivity indices. Figure 3 compares the Brazilian TFP with that of the United States. Brazilian TFP growth outpaced that of the United States after 1975, so the productivity gap between the two countries narrowed.

At the end of the period studied the indices stood at 3.67 in Brazil (2010) and 1.75 in the United States (2008), so the former grew by 267% and the latter by 75%. The changes that led to a sharp increase in productivity in United States agriculture occurred between 1950 and 1970. In Brazil, the modernization process started with the importation of agricultural machinery in the 1950s, but it was only in the 1970s that productivity started to grow significantly, particularly with the planning of agricultural research. In addition, the expansion of the agricultural frontier in Brazil occurred as from 1970, which probably differs from what happened in the United States.

FIGURE 3

Brazil and the United States: TFP indices, 1975-2010
(Index: 1975=1)
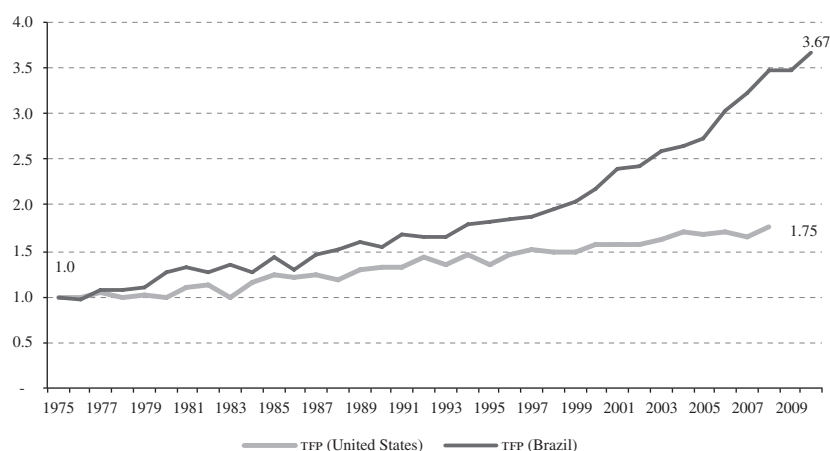
Source: United States Department of Agriculture, *Total Factor Productivity*, Washington, D.C., Economic Research Service, 2008; and Ministry of Agriculture, Livestock and Food Supply, *Produtividade total dos fatores*, Brasilia, 2011.

Note: TFP: Total factor productivity.

The study conducted by the Organization for Economic Cooperation and Development (OECD, 2011) reports statistics on TFP growth rates in various regions of the world. While the rate tends to decline in the developed economies, dropping from 1.48% per year in 1961-2007 to 0.86% per year in 2000-2007, it has trended up in developing countries, from 1.35% per year in 1961-2007 to 1.98% per year in 2000-2007.

Figure 4 compares Brazil's TFP and input and output indices with those of the United States. This

makes it possible to determine whether output growth reflects more intensive input use or the incorporation of efficiency-enhancing technology.

In the period studied, the input index for agricultural production remained broadly stable (rising by just 5%) whereas the output index rose by 284%. Most of the increase in output was due to technological changes, which means that more is being produced with fewer resources. According to the data reported, the annual average growth rate of TFP in Brazil between 1975 and 2010 was 3.6%, compared with 1.9% in the United States.[7] The input index in that country declined by 7%, dropping from 1.00 in 1975 to 0.93 in 2008. Nonetheless, output and TFP grew by 62% and 75%, respectively, so again more was produced with less.

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[7] See comparisons in Ball (2006) and Gasques and others (2012).

FIGURE 4

Brazil and the United States: indices of input, output and TFP, 1975-2010
(Index: 1975=1)
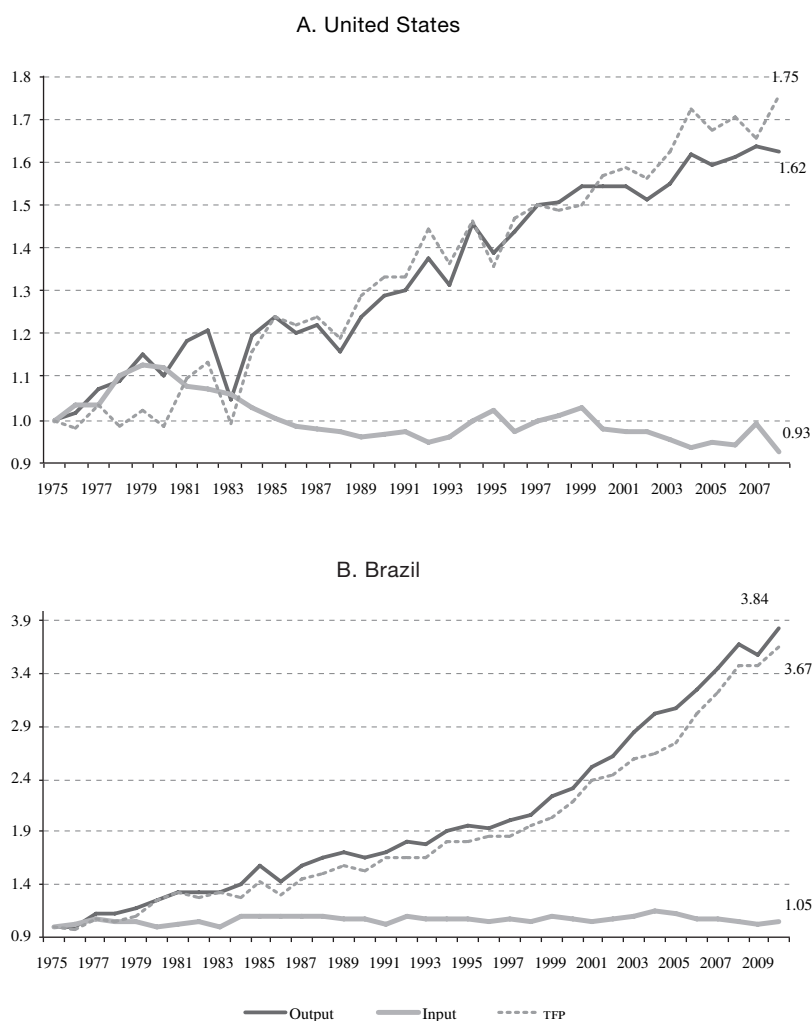
A. United States

B. Brazil

— Output   — Input   ---- TFP

Source: United States Department of Agriculture, *Total Factor Productivity*, Washington, D.C., Economic Research Service, 2008; and Ministry of Agriculture, Livestock and Food Supply, *Produtividade total dos fatores*, Brasilia, 2011.

Note: TFP: Total factor productivity.

Figure 5 compares the use of labour, land and capital in the production of the United States and Brazil. Although capital use grew in the United States economy between 1975 and 1981, the longer period 1975-2010 reveals a decrease in the use of all three factors. In the case of capital, the reduction occurs as from 1981. Ball and others (2001) note that capital use was important in United States agriculture between 1973 and 1981, but its importance declined between 1982 and 1993 since net fixed capital investment was negative in that latter period. This suggests that the obsolescence of the capital stock, perhaps owing to the high price of energy, could hold back productivity growth.

FIGURE 5

Brazil and the United States: indices of production factors (labour, land and capital), 1975-2010
(Index: 1975=1)
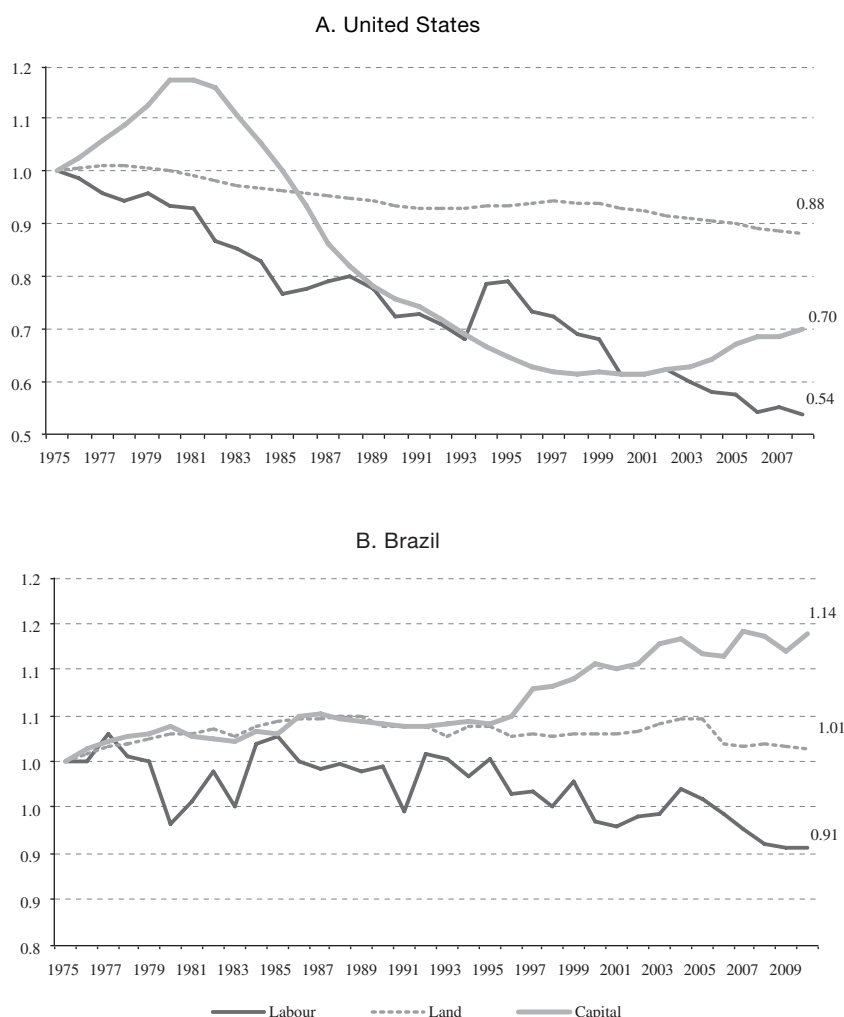
A. United States

B. Brazil

Labour ---- Land ----- Capital

Source: United States Department of Agriculture, *Total Factor Productivity*, Washington, D.C., Economic Research Service, 2008; and Ministry of Agriculture, Livestock and Food Supply, *Produtividade total dos fatores*, Brasilia, 2011.

The reduction of capital intensity in the United States economy is another sign of technological progress, since, as noted above, the output index trended upwards in the same period. In Brazil, there was strong capital growth throughout the period. The incorporation of new agricultural frontiers in the latter part of the 1980s, relative stabilization in land use as from the 1990s, and a considerable reduction in the labour factor as from 1990. Capital grew and labour declined particularly in those years, coinciding with trade liberalization and greater private investment in agriculture.

The rise in the capital index is associated with the creation of programmes of financing and investment in Brazilian agriculture as from the second half of the 1990s. These included the National Programme for Strengthening Family Farming (PRONAF), followed by the Programme to Modernize the Agricultural Tractor Fleet and Harvester Tools (MODERFROTA). These programmes were fundamental for the modernization and technological progress of capital in Brazilian agriculture, and led to a 14% increase in the period studied.

According to Gasques and others (2010, p. 35), the higher productivity of land in Brazil was a result of increased research expenditure, particularly by EMBRAPA, and the incorporation of new areas with higher productivity in part of the reference period spanning more than 30 years. The authors state that the higher productivity of land also reflects innovations made in production processes, including agricultural research, the direct seeding system, inoculation with bacteria, integrated pest management and the creation of varieties and species with sufficient flexibility to adapt to the different climatic and environmental conditions. Gasques and others (2013) show that the migration of crop production and livestock activity to new regions of the north, centre west and centre north-east, along with the quality of inputs used in agricultural activity, among other factors, also contributed to productivity growth.

University participation in agricultural research is also very important for Brazil. Teixeira, Clemente and Braga (2013) highlight the relevance of postgraduate research programmes in areas such as the improvement of plants and animals, soils and fertility, mechanization, plant and animal management, and in the creation of products that allow for the development of agribusiness in the country.

With regard to the convergence of agricultural productivity in Brazil with that of the United States, the gap between the two countries has narrowed. Brazilian agriculture has grown very strongly, becoming more productive and less labour-intensive, while the amount of land used has remained stable.

3. Productive inequality of Brazilian agriculture[8]

A comparison of the Brazilian agriculture sector with that of the United States reveals TFP convergence, thereby narrowing the productivity gaps between the two countries. Nonetheless, that convergence does not encompass all Brazilian farming, owing to the high degree of structural heterogeneity that exists in the production segment.

Although the TFP figures are convergent, Brazil's regional heterogeneity and complexity mean that not all of the agriculture sector is technologically up-to-date, so only part of the production sector benefits from the effects of modernization (Vieira Filho, 2012). As noted by Poudel, Paudel and Zilberman (2011), there may be convergence between regions within a country, but not throughout the national territory as a whole. This means that, despite convergence between certain regions, the growth indices within a given country can vary greatly, maintaining regional heterogeneities, which can also relate to crops and activities.

Fornazier and Vieira Filho (2012) and Vieira Filho, Santos and Fornazier (2013) find very pronounced productive heterogeneity in Brazilian agriculture in terms of income inequality; and Vieira Filho (2013) reaches a similar conclusion in an analysis of results for family farming.

Table 5 shows that farms can be subdivided into four income levels: extreme poverty and low, middle and high income. The results show that the middle- and high-income groups, which account for less than 10% of farms, produced 85% of gross production value (GPV), while the 63% of farms that exist in conditions of extreme poverty produced less than 4% of total GPV. The Gini coefficient of production reported an indicator of high inequality, with a value close to 1.

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[8] The aim of this subsection is to briefly show that the productivity gains mentioned are incorporated in a different way in Brazil, particularly owing to the high productive concentration that exists there, which is reflected in regional and sectoral terms. An exhaustive investigation of these issues is beyond the scope of this article. For deeper and more detailed studies of the topic, see Fornazier and Vieira Filho (2012); Vieira Filho, Santos and Fornazier (2013).

TABLE 5

Brazil: stratification of farm incomes by production, 2006

Groups	Minimum monthly wage equivalent[a]	Number of farms *(thousands)*	Percentage	Annual gross production value (GPV) *(billions)*	Percentage	Gini coefficient
Extreme poverty	(0 - 2)	3 242	69.6	6.5	3.9	
Low income	(2 - 10)	960	20.9	18.5	11.1	
Middle income	(10 - 200)	416	9	59.9	35.9	0.89
High income	>200	23	0.5	81.7	49	
	Total	4 641	100	166.7	100	

Source: Brazilian Geographical and Statistical Institute (IBGE), *Agricultural Census 2006*, Rio de Janeiro.

[a] Minimum wage equivalent = monthly gross production value (VBP)/monthly minimum wage.

The group that exists in conditions of extreme poverty, which consists of roughly 3.2 million farms, is at the margin of agricultural production and is excluded from all sectors of economic activity because it lacks basic productive organization structures (both micro- and macroeconomic).

The low-income group (960,000 farms) needs government assistance in the form of development policies and the invigoration of small-scale normally family-based production. These are farms of low technological content and little capacity to absorb external knowledge, compounded by shortcomings in the managerial and macroeconomic spheres. It is necessary to improve credit access for these producers and to encourage the use of new technologies. The government needs to improve access to technical assistance and develop public-domain research when the market does not provide this.

Lastly, agricultural wealth is concentrated in the middle- and high-income groups. For those groups, technological absorption capacity is a secondary problem, but a macroeconomic environment favourable to sales growth is fundamental. Public policies need to be oriented towards topics that go beyond macroeconomic aspects, focusing on stimulating competitiveness, promoting exports, agricultural insurance and improving the logistical distribution of the products.

The productivity difference of a crop in a given state or region also reflects TFP differences: in some regions, producers concentrate on crops that are better suited to the prevailing climate and soil conditions, and they achieve a better allocation of resources, such as inputs, which implies a variation in TFP. Gasques and others (2010) show that TFP in Brazilian agriculture posted annual average growth of 2.27% in 1970-2006, whereas growth was negative in some states, such as Amazonas (-0.902% per year). In other cases, including Mato Grosso, growth was positive (4.67% per year), in the same period. These results show that, while the gaps between countries may narrow, intra-regional differences within Brazil can persist. In the United States, there are also productivity differences between the states, as revealed in the statistics (USDA, 2012).

Public policies, together with investment in agricultural research, technical assistance, and rural outreach, can help farmers make better use of resources —in other words, obtain higher productivity using fewer resources—. In addition to increasing output, reduced input use in the agriculture sector can have effects that are desirable from the environmental, labour and public health standpoint, by improving optimization and reducing pressure on natural resources (Blandford, 2012).

This makes it possible to design public policies for specific regions and identify places where higher productivity can be obtained, for example through agro-climatic zoning. Nonetheless, policies to that end must take account of the different aspects environmental conservation and social integration in the labour market.

V

Final thoughts

According to ECLAC (2010), there are many differences in development levels between countries and even within a given country or sector, which constitute structural heterogeneity. Nonetheless, the gaps can narrow with time and thus reduce that heterogeneity.

To measure the difference between countries or sectors, this study compared the trends of TFP in the Brazilian and United States agriculture sectors and found that the productivity gap is tending to narrow. Nonetheless, the modernization of agricultural activity and its linkage with other sectors of the economy (such as inputs) is taking place in different periods in the two countries. Consequently, the reduction does not necessarily mean that productivity indices in the two countries are converging, because other factors come into play —such as the level of cumulative knowledge in an activity— which can not only promote growth differences, but also ratify the existing distance.

The countries analysed here recorded an increase in TFP in a longer series, so that greater production was obtained with fewer inputs. To achieve this, land economizing technologies were used, such as fertilizers and other agrochemicals, alongside labour-saving technologies in the form of machinery and agricultural tools.

With the more intensive use of certain inputs and the substitution of technologies in favour of one or other resource in particular, the activities-productivity gap between countries can decline. Nonetheless, climate differences, or differences in the capacity to adopt certain technologies, among other factors, make it difficult for all to benefit from the productivity gains. Although the productivity gap between Brazil and the United States has narrowed, there are many differences within these countries. In other words, structural heterogeneity exists not only between developed countries and developing ones, but also within a given country or activity.

Public policies (such as investment in research and development (R&D), technical assistance and rural extension) can help farmers improve their efficiency in food production and animal breeding, to obtain a return with fewer inputs and resources. In addition to increasing TFP, they also help to optimize these factors and reduce environmental problems.

Given the degree of regional heterogeneity and complexity, not all of the Brazilian agricultural sector is technologically up-to-date, so only a part of that sector benefits from the effects of modernization. A comparison of Brazilian agriculture with that of the United States shows convergence in TFP (or a reduction in the productivity gap), which reduces the productivity gaps between the two countries. Nonetheless, that convergence does not encompass all of Brazilian production, owing to the high degree of structural heterogeneity that exists and productive concentration between agents. Over the last few decades, Brazilian agriculture has grown rapidly, becoming more productive and less labour-intensive, while using a stable quantity of land. Nonetheless, there are still huge challenges in promoting stakeholder-inclusive development.

Structural heterogeneity prevents the most backward segments from participating productively in the fastest growing markets. From the standpoint of public policymaking, the study shows that the failure of inclusive development will persist until the structural disparities in Brazilian agriculture are overcome. There are micro- and macroeconomic problems that are differentiated according to the specifics of each production group; and these must also be taken into account when designing government policies to correct the failings and minimize the structural problems.

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Community, connectivity and the regional movement in Patagonia: the evolution of social capital in the Aysén Region of Chile

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ABSTRACT

Small rural communities in the Aysén Region of Chile evince a variety of forms and types of social capital. The predominant form of social capital has evolved in accordance with changes in the national context and the gradual integration through communications. Having been an example of community cooperation, rural communities were faced with the challenge of relating to more powerful social actors on the broader stage of the region's civil society. This change often resulted in autonomy declining and community factions being caught up in chains of clientelism. In 2012, however, the "Your problem is my problem" movement emerged to address the marginalization perceived in the region's asymmetrical relations with central government. The mass civil disobedience this involved was grounded in three types of social capital and marked the emergence of a citizenship that spanned the region, thus meeting one of the conditions for fully democratic decentralization.

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I

Introduction

Social capital is an intangible resource developed by individuals and collective actors to bring their projects to fruition, not just in traditional communities but in modern societies as well. Its basic attributes of trust, diffuse reciprocity and cooperation go against the principles of the market, but they are actively involved in this, as well as in civil society.

For more than two decades, the concept of social capital has attracted the attention of academics and policy designers because of its implications for economic development and governance. Research and proposals have centred on two aspects: the importance of networks in people's strategies, and the potential for small communities to apply this intangible asset in their strategies as actors in the market and in civil society. The present case study concentrates on the interaction between these two forms (personal and collective) of social capital in the field of civil society, combining information from the academic literature on social capital, civil society and social movements with empirical information on the Aysén Region.

Two main questions are addressed in this article: which forms of social capital have predominated at different times in the Aysén Region, and what implications the forms of social capital involved in the recent regional movement have for decentralization. The ultimate goal of the methodology applied is to capture the role of social capital in an emerging civil society at the regional level.

A selection was made of seven rural communities that exemplified a variety of degrees of isolation (see table 1) and geographical and population characteristics. In them, a survey was applied[1] to 493 Internet users, with an estimated omission rate of less than 5%. Each household was visited up to three times on successive days and all users who had accessed the Internet in the previous week were interviewed.

A cluster analysis methodology was applied to Internet users aged over 25. The technique employed to develop this classification is a two-stage cluster analysis that works by dividing a given number of cases into a set of groups where: (i) one case corresponds to one group only, and (ii) the set of groups contains all the cases covered by the classification. For these conditions to be met, the distance/difference within groups must be smaller than the distance/difference between groups, which means obtaining a silhouette coefficient of 0.6 or higher in the case of the two-stage classification.

The qualitative instruments and strategies of grounded theory (an inductive sociological method) were applied. With this method, instead of independent and dependent variables being defined (excluding the rest of the information from the environment), open interviews based on very general research questions are used. Hypotheses emerge as information is accumulated, without any pretension of "proving" them. The process of repeated comparison, hypothesizing and fieldwork also involves critical scrutiny of the theoretical literature. The last stage of the research project concentrates the efforts to generate new interpretations of theoretical value or potential use in public policies, always keeping a very close eye on the empirical data.

The practices, relationships and processes detected through these qualitative techniques exemplify phenomena that can provide a basis for interpretative models, but do not represent the quantitative scale a phenomenon may have in the total population. Accordingly, the qualitative information was collated with the numerical data, from which new hypotheses about the relationship between connectivity and social capital emerged.

The article is structured as follows. After this Introduction, section II deals with the debates, definitions and diversity surrounding social capital. Section III examines connectivity and community social capital in isolated areas of Aysén. Section IV focuses on the regional movement and the role played by social capital and the Internet in this context. Lastly, section V contains the main conclusions drawn from the study.

II

Social capital: debates, definitions and diversity

Interpersonal relationships and sociocultural organizations embody social capital when they turn norms of reciprocity, identity and solidarity into practices of cooperation and mutual assistance. By dint of repetition, these practices reinforce such norms, while increasing trust among the people involved. Taken together, these facets of social capital open the way to endeavours in all kinds of fields, making it more likely that goals beyond the reach of individuals acting alone can be attained.

During the last decade of the twentieth century and the first five years of the present one, the debate on the concept of social capital spread throughout the world of social policy. It even took hold among a wider public, with the success of the book *Making Democracy Work* (Putnam, 1993). It also took on a probably excessive importance in discussions about participatory development and poverty reduction, with heights of hyperbole being reached in cases such as the World Bank publication arguing that social capital might be the "missing link" in development (Grootaert, 1998). For most analysts, the fact that grass-roots social actors possessed these collective capabilities was a reason to reinforce this intangible resource by allocating more public resources to self-managed group endeavours.

Until then, even the relevance to development of the topics of associativity and cooperation had been in doubt, partly because of the axiomatic assumption in economic models that actors sought to maximize their individual gains. Hardin reinforced the argument against the possibility of cooperation and collective action in a modern market system: in his 1968 work *The Tragedy of the Commons*, he argued that the individual interest of each actor ensured the depletion of common economic resources, such as communal grazing areas. The publication of *Governing the Commons* (Ostrom, 1990) changed many minds.

Elinor Ostrom, the only woman to have been awarded the Nobel Prize in Economics, analysed thousands of cases of community management of common goods and ultimately cast doubt over Hardin's theoretical arguments. As Uphoff (2003) puts it, Ostrom's work serves "to explain the great many collective actions that do in fact occur and endure." Ostrom's studies take full account of individuals' rational choice, and thus emphasize the role of rules in sustainable collective management to

avoid this being betrayed when individuals are tempted by the prospect of personal gain. However, they also take account of people's feeling that they are shaping their own destiny and of the cultural norms that bestow prestige on behaviours that serve the group.

1. Two types of social capital

One of the main ways in which social capital manifests itself is the creation of civil society organizations (Putnam, 1993; Molenaars, 2006). Another is the formation of extensive networks of personal ties, which also influence civic life (Portes, 1998). These are two different ways in which people participate in the civil society of their community and country. Their interaction largely determines the role of different forms of social capital in the direction taken by civil society in a given territory.

The distinction is important, since personal social capital consists in a reciprocal or dyadic link between two people and the networks these links create, while the collective takes on more organized forms, with division of labour, legitimation of leaders and social oversight of members. In each concrete case, interpersonal ties and loyalties can mean that a grass-roots organization works better when the resources to which these provide access are placed at the disposal of the collectivity by the individual. However, these personal links can also mean that these organizations' resources are diverted to pettier goals, damaging trust in the collectivity. The separation of the two concepts is an advance, since definitions of social capital in the early 1990s (Putnam, 1993, for example) mixed different levels of analysis (values, practices, outcomes) and did not distinguish between different forms of social capital.

2. Organizations

The earliest formulations of social capital as an analytical category, dating back about a century, focused on its collective communitarian form. The great educational theorist John Dewey also inaugurated the theoretical and academic use of the term in the late nineteenth century (see Farr, 2004). In his writings and those of one of his followers, Lyda Hanifan, a clearly collective definition is expounded:

"[social capital is] good will, fellowship, sympathy, and social intercourse among the individuals and families who make up a social unit, the rural community… this social capital may easily be directed towards the general improvement of the community well-being" (Hanifan, 1920).

Not every formal organization has a high level of social capital, which is an intangible and informal asset. In many "paper" organizations, the partners' practices do not follow informal standards of solidarity and honesty. Nor are informal groups lacking clear formal rules stable over time. Ostrom teaches that formal organization is needed in order for social capital to cope with greater management goals, as well as to exclude free-riders through rules setting out who the members are and what rights they have and laying down progressive sanctions against rule-breakers, depending on the seriousness of the transgression (Ostrom, 1990).

The ramifications and limits of collective social capital have become clearer as empirical studies pile up and analyses are made (Atria, 2003), so that it has become established as one of the key concepts in a new analytical framework of "grass-roots development." Nonetheless, social capital is just one asset among many that individuals and collectivities possess and employ in strategies to improve their social position.

Social capital has other important aspects: it is always an asset for its possessors, but is not always good for society at large. It is now clear that power is a key link in this conceptual framework that was "missing" for many scholars of the subject in the 1990s. Elites' use of their personal networks to exclude large sections of the population from decision-making on matters of public interest was studied in France, in great empirical and theoretical detail, by Pierre Bourdieu. That author developed his concept of "social capital" in the 1970s (Bourdieu and De Saint Martin, 1978). His view of the subject encompassed aspects not considered by Hanifan, or by Putnam afterwards. Bourdieu and his followers relate social capital to the struggle between different networks of business or bank owners and high-level public officials to control fields of power. The relevant terms of his wide-ranging and dispersed model of social capital also include, for example, shared patterns of behaviour based on experience (*habitus*) which reinforce class identities, inherited relationships, cultural and educational capital (classmates) and modes of domination

(Bourdieu, 2001). Its importance at this point is that it requires the notion of social capital as a "resource for the poor" to make way to one of social capital as a resource in the competition between all actors. In this model, civil society and the State are shot through with ties between allies and struggles between rival groups to control the field of public policy.

This conception, which incorporates the inequality of power, draws a distinction between actors occupying similarly powerful social positions, with "symmetrical" or "horizontal" ties,[2] and asymmetrical social capital, such as political clientelism, linking people who are unequally placed.

Simply put, political clientelism is the trading of "favours for votes," but it has other important facets that make it a form of social capital: (i) linkage between individuals, and (ii) its function as an "upward" extension of traditional microlocal mutual assistance networks among the grass roots. In summary, clientelism is a "personalized" (Auyero, 2001), "asymmetrical" and "inter-class" form of social inclusion for individuals and communities whose position is that of subalterns (literally "the others below"). Like all other ties of interpersonal social capital, clientelism is symbolically reinforced by gestures of (real or simulated) friendship (Wolf, 1966). It also helps unprivileged strata gain access to (mainly public) resources controlled by privileged ones. There is a great variety of roles and relationships associated with different situations of political clientelism, ranging from the role of "boss" to that of "semi-clientelist reformist" (Fox, 1996).

Lastly, a distinction is drawn between "active" grass-roots social capital and "submerged" social capital, which survives in latent form as a social memory when the conditions in the environment are inhospitable to it (Salazar, 2001).

The present study uses a number of these dichotomous concepts of social capital: personal and collective, active and submerged, symmetrical and asymmetrical. The study in the Aysén Region sheds light on some aspects of this conceptual and empirical complexity in contexts of growing integration and connectivity.

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[2] Also known as bridging social capital, because it links pairs of different groups or localities (Woolcock and Narayan, 2000).

III

Connectivity and community social capital in isolated areas of Aysén

The Aysén Region, in Chilean Patagonia, is one of the country's 15 administrative and electoral regions. Aysén is characterized by low population density, a cold, rainy climate, extensive forests and rugged terrain. Taken together, these conditions configure a geographical space that is difficult to traverse and inhabit, and also to connect up.

The purpose of this section is to better understand how the progressive reduction in isolation has contributed to changes in the forms of social capital predominating in rural communities of the Aysén Region (see table 1).

TABLE 1

Degrees of isolation of the communities studied in the Aysén Region

Quintile	Communities
1 (most isolated 20%)	Villa O'Higgins
2	Lago Verde, Puerto Tranquilo
3	Villa Amengual, Caleta Tortel
4	Puerto Ibáñez, Cerro Castillo
5 (least isolated 20%)	-------
	Universe = 52 inhabited localities

Source: Prepared by the authors, on the basis of Office of the Undersecretary for Regional and Administrative Development (SUBDERE), "Metodología para la identificación de localidades en condición de aislamiento", Santiago, 2013 [online] http://www.subdere.gov.cl/sites/default/files/documentos/metodologia_03072013.pdf.

The seven communities range in size from about 300 to 800 inhabitants each. They also exemplify a variety of geographical and economic variables.

The term "connectivity" is often used to refer to the rapid exchange of information via computers and other new media such as mobile phones. These are the so-called "modern" information and communications technologies (ICTs). Here, though, the term is used in a broad sense to include not just the Internet but also "traditional" ICTs (radio, telephone, television) and all forms of territorial integration (carriage of messages, people and goods by land, water and air); in short, all techniques that reduce isolation.

It will now be contended, first, that the increase in broadly defined connectivity has affected community (i.e., collective and local) social capital in rural areas in varying ways, and has reduced the historical isolation of the region; second, that rural communities in Aysén have been experiencing this process continuously for at least half a century; third, that personalized and asymmetrical forms of social capital have replaced many of its community forms in the field of civil society; and lastly, that the development on the region's territory of a critical mass of grass-roots organizations, together with the interaction of traditional and modern ICTs, made it possible for a successful regionwide social movement to arise.

The first contention sets out from theoretical arguments and empirical evidence from other countries. Wellman (2001) argues, first, that the spread of the telegraph and other inventions in the nineteenth century freed communication from the constraints of transport; second, that most people in Canada and the United States relate more now through extra-community networks than with other local residents; and third, that these changes are causing people to feel less engaged with their communities, leaving these with less control over their behaviour, while feelings of belonging, membership and identity with the local group have been weakening. The Internet, in particular, has increased the opportunity, contingency and uncertainty of interpersonal relationships relative to the old context of local groups.

The first formulations of community social capital were produced in the United States almost a century ago. Hanifan (1920) noted with concern that the railway, the telegraph, the telephone and the automobile had hastened the rural exodus in the period after the First World War, weakening the social fabric of rural communities. In the face of the challenge posed by the progressive disappearance of rural community activities, Hanifan proposed the development of a complete strategy of community centres to reconstruct communities' impaired social capital. Although there is a huge gap between the situation in Aysén and that in the United States formerly, the near-universal tendency towards the disappearance of many rural communities due to the expansion of connectivity is well known. This evolution differs between communities in Aysén, but it should be noted that these have experienced the impact of ICTs from a century ago (telephone, radio) and the ICTs of the twenty-first century almost simultaneously, in a swift, intense transformation.

IV

Social capital and connectivity: periods and transitions

During the last 50 years, the development of connectivity and the transformation of social capital in Aysén can be divided into three periods corresponding to improvements in connectivity and changes in the relationship between the region's rural communities and central government.

(a)   *The period from 1964 to 1973*

By about 1964 (the start of the reformist administration of the Christian Democracy party), the State had already established basic connectivity for the region in the form of road, river, sea and air transport and postal and telephony services (Martinic, 2005). Radio spread as soon as electricity became available (initially from car batteries or miniature water turbines). The radio quickly became the main channel for information, personal messages and real-time conversation.[3] In the 1960s, horse trails were gradually widened into cart tracks, which were used by the first motor vehicles (Universidad de Los Lagos/ Centre for Social Network Analysis, n/d).

Even accounting for the near-universal sentiment that "the past was always better," the in-depth interviews clearly revealed how many solidary ventures were undertaken a generation ago within each community studied. The practice of free, collective school-building for example, is historically documented. When money was needed for some community venture, fund-raising dances used to be held and attended by people from other communities as much as two days' travel away. Young people from the different communities in each microregion met at such dances and formed couples. Now such events only involve local people and are held when a resident needs help with medical expenses or after a fire, but the old ways left a network of kinship in the region's communities (Universidad de Los Lagos/ Centre for Social Network Analysis, n/d). In the five communities studied, according to the Survey of Rural Users, 34% of users were born in a different commune in the Aysén Region. Each community, then, has ties of kinship across the region.

In Aysén, like everywhere else in the country, this was a period of major changes in rural communities: the agrarian reform under the governments of Eduardo Frei Montalva and Salvador Allende, unionization and ideological polarization in civil society. Catholic and left-wing organization proposals competed to set up neighbourhood associations and committees of small farmers (through the National Institute for Agricultural Development (INDAP)) and to register voters. Many inhabitants of rural communities in Aysén benefited from agrarian reform and the extension services for rural cooperatives fostered by these two administrations.

The connectivity of the 1960s improved the ability of the State to empower rural communities by formalizing their rights and providing advisory services to them as organizations. The committees of small farmers set up by the idealistic early extensionists of INDAP took on a variety of social action roles, as local residents and not just as farmers. The collective social capital of small communities was supplemented and also complicated by the growing presence of asymmetrical forms not just of political clientelism, but also of more solidary manifestations of social capital.

(b)   *Asymmetrical ties of solidarity*

The idealistic extensionists and officials of the agrarian reform programme of 1964-1973 allied themselves with the inhabitants of rural communities in Aysén, acting from higher social positions in the field of State-rural relationships. The wool commercialization cooperatives supported by INDAP at that time are still part of social memory in the communities studied by the aforementioned National Fund for Scientific and Technological Development (FONDECYT) project. The personal relationships between local leaders and professional extensionists connected these leaders with the directors of the regional offices and with the parties in government at the regional and central levels. The sense of mission driving many of these extensionists led them to place their contacts at the service of local leaders, who gained in prestige as they were able to help improve the quality of life of their entire community (Astorga, 2007; Universidad de Los Lagos/Centre for Social Network Analysis, n/d).

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[3] Short-wave radio, an "old" technology compared to mobile telephony or the Internet, created the conditions for subjectivity in dialogue in Aysén more than half a century ago.

(c) *The period from 1973 to 1989*

Agrarian reform was cut short after the military coup of 1973, while the rest of that decade and the whole of the next were marked by the military presence throughout the region at different levels of the State and civil society. In Aysén, telecommunications were a key factor in "internal security" and in the defence against a possible Argentine invasion. They also ensured the virtual absence of opponents of the de facto government in the region's civil society organizations. In addition to physically eliminating many activists, the State promoted the creation of residents' associations whose leaders were adherents of the regime. These helped decide on the distribution of goods, this being also a new and important role for the mayors appointed by the head of State.

Chile's Route 7, also known as the Carretera Longitudinal or Carretera Austral (it was originally named after President Augusto Pinochet), was an emblematic contribution by the army to the region's connectivity and served as an emigration route for many impoverished settlers and a way in for forestry, fisheries, transport and tourism companies. As of around 1970, there were some 1,000 kilometres of public highway. The expansion work was begun by the Military Labour Corps in 1976. Including the network of side roads, 1,283 kilometres were built between 1976 and 1989, taking the total to 2,300 kilometres. The road network is now about 3,500 kilometres long.

The military government divided up the region into a larger number of communes and appointed mayors in these as it sought to increase support for its geopolitical strategy in Chilean Patagonia,[4] but at the same time the initiative for collective action in the communities of Aysén was lost and a welfarist relationship began in which social capital was asymmetrical and people held positions of power because of their relationship with the central State:

> "… a lot of subsidies were given during the dictatorship, and there were all sorts of handouts, especially family food baskets. So people gradually got used to going to meetings just to ask for or collect subsidies…" (Resident of a rural Aysén community, in Astorga, 2007).

The second half of the 1970s was a time of discouragement in the rural communities of Aysén,[5] since the policy of severely reining in the economy and employment as a shock treatment for inflation coincided with a collapse in the world price for wool, a crisis from which sheep farmers in Aysén never recovered. As a result, an exodus began in the early 1980s as people left the region in search of employment and education.

As new firms came in, trade unionism re-emerged, clandestinely at first, as a grass-roots actor with collective social capital, particularly in the fishing sector. In general, though, the period of the dictatorship resulted in the destruction of social capital, both personal (with the loss of trust) and collective (because of the repression of organizations). For the rural world in Aysén, then, this was eminently a period of "submerged" social capital (Salazar, 2001).

(d) *The period from 1990 to 2013*

The ending of the military dictatorship following the 1988 plebiscite opened the way to free elections and grass-roots associativity. Conditions improved for unions and local organizations and more resources were made available by the central State for community organizations, partly through the elected mayors. However, this expansion of civil society was guided by the parties in the two main electoral coalitions, which have alternated in power in recent years.

There was further expansion of the road network, air transport and television and radio broadcasters, and modern ICTs such as mobile phones began to spread. Thanks to low handset prices (subsidized by the telecommunications firms), use of these expanded quickly, especially from 2010, as new transmission masts were built.

As for the Internet, a number of communities had had at least an Internet café or community centre with a satellite or fixed modem service for several years. With the advent of mobile telephony, though, computer owners could use a 3G signal to connect to the Internet from their homes or workplaces.

In the years following the dictatorship, the personalized asymmetrical relationship of solidarity between the community and vocation-driven officials was developed by the young professionals of Servicio País (Universidad de Los Lagos/Centre for Social Network

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[4] The army remains an important actor in the region, owing to the geopolitical concept of effective sovereignty: "The army's role in cooperating with the development of isolated and outlying areas… has been an issue of constant concern… We need to improve our ability to control empty spaces, since otherwise some other actor or threat will tend to occupy them or capitalize on this" (Commander-in-Chief of the Army, in Ejército de Chile, 2013).

[5] One exception was Father Antonio Ronchi, considered by respondents to be another driving force in community organization, as he encouraged the formation of local organizations to create communications infrastructure using local resources. Among many other projects, his was the predominant advisory role in the construction of satellite television antennae by the community.

Analysis, n/d), a programme of support for mostly rural municipalities. The sense of mission of many of these functionaries led them to place their contacts at the service of local leaders. The personal relationships between these leaders and the professionals connected the former with the people responsible for running a number of public services in the region. Local leaders gained in prestige insofar as they were instrumental in improving quality of life for all residents.

(e) *Clientelistic links*

The presence of State agencies has not always meant more social capital and greater power for rural communities in Aysén. Electoral clientelism is neither a new phenomenon nor peculiar to Aysén, but universal in representative democracies. Leaders with contacts and allies in the political parties and State bureaucracy were viewed by their neighbours as friends who could solve the problems they encountered with different public services (Auyero, 2001). Leaders of a "managing" type are brokers (Valenzuela, 1977) who deal with requests through these vertical links. The negotiations they enter into to solve local problems engage communities' voting intentions. Unlike vocation-driven extensionists, political brokers do not usually empower grass-roots organizations so much as enhance their own political careers.

Although lack of connectivity limited the penetration of clientelism in the early period of isolated communities, by 2012-2013 mayors were the brokers most often mentioned (Universidad de Los Lagos/Centre for Social Network Analysis, n/d). They could give public-sector jobs to their followers or, more subtly, appoint their officials as advisors who would help to draft good applications to development funds for communities whose leaders could assure them of their votes (Universidad de Los Lagos/Centre for Social Network Analysis, n/d). In Puerto Tranquilo and Puerto Bertrand, both small inland communities, Astorga (2007) found that:

> "People group together and make their needs known to the leader, who is responsible for speaking to the authorities and conveying the community's concerns. This gives the leader a new role and power within the community, as the person able to put the community in touch with 'higher' circles" (Astorga, 2007).

In 2013, the qualitative research detected more clientelist leaders than participatory leaders accountable to the grass roots. The survival of certain traditional forms of participation clashed with the increase in clientelistic relationships. These two opposing forms of social capital in the rural communities of Aysén translated into growing divergences between those living there.

(f) *The impact of the Internet on rural communities*

Although most of the rural Aysén communities studied only received large-scale access to the Internet in 2011 or 2012, by the latter year there were already indications of at least four changes in social capital that can be related to this ICT.

First, according to the respondents, people tend to spend more time at home communicating with each other via Facebook, so that there is less face-to-face contact:

> "… the tradition of going to each other's houses, drinking *mate* and talking about everyday things started to be lost because of this opportunity to communicate digitally" (Universidad de Los Lagos/ Centre for Social Network Analysis, n/d).

Second, mobile phones and the Internet offer a way to create autonomous and independent economic connections with the outside.

Third, this technology can make residents less dependent on the leaders who were formerly the brokers between them and the wider world, as they can directly access information that was once the preserve of well-connected leaders. Many people can now establish their own social capital links, both horizontally with distant peers (bridging capital) and vertically with public officials and other more powerful people. This broad empowerment is beginning to reduce the asymmetry in relationships of political clientelism.

It is not that there is less social capital in the region now than formerly, but that the social capital produced by modern ICTs is not usually community-based but personal (for the same phenomenon in other countries, see Foth, 2003, and Ferlander and Timms, 2007). It is not surprising, then, that in 2013 just 48% of all Internet users participated in local organizations. Within this general trend, however, respondents fall into three clusters differing clearly in behaviour and attitudes:

(i) participants only (they do not use the Internet, but tend to participate in local organizations);

(ii) Internet users (they are frequent users of the Internet but participate less in local organizations. They tend to be younger and better educated than people in the other two clusters).

(iii) participatory Internet users (they are frequent users of the Internet and also participate in local organizations).

Thus, for example, 93.3% of participatory Internet users (who are about a third of all users) agree with the proposition "I feel part of the community," which is a higher share than for the other two clusters (see table 2).

TABLE 2

Indicate agreement or disagreement

Disagree		I feel part of the community			Total
		Disagree	Neither agree nor disagree	Agree	
Participants	Number	4	2	51	57
	% row	7.0	3.5	89.5	100.0
	% column	11.8	6.9	18.8	17.0
	Corrected standardized residuals	-0.9	-1.5	1.8	
Internet users	Number	29	20	110	159
	% row	18.2	12.6	69.2	100.0
	% column	85.3	69.0	40.4	47.5
	Corrected standardized residuals	4.7	2.4	-5.3	
Participatory Internet users	Number	1	7	111	119
	% row	0.8	5.9	93.3	100.0
	% column	2.9	24.1	40.8	35.5
	Corrected standardized residuals	-4.2	-1.3	4.2	
Total	Number	34	29	272	335
	% row	10.1	8.7	81.2	100.0
	% column	100.0	100.0	100.0	100.0

Source: Universidad de Los Lagos/Centre for Social Network Analysis (n/d), "Documentos de trabajo internos", FONDECYT Project (No. 1120866), "El impacto de Internet en el capital social de las comunidades aisladas", Santiago.

(g)   *From clientelism to the social movement*

To summarize, social capital in the rural communities of Aysén has undergone major changes over the last half-century. Although the different specific forms of social capital have been present at all times, some have weakened while the presence of others has increased. These tendencies seem to be connected to the progressive integration of isolated communities into national society and to changes in central government orientation. In civil society, there has been an increase in clientelistic relationships with political leaders. The most common effect where collective social capital is concerned has been for communities to become increasingly divided into factions (Universidad de Los Lagos/Centre for Social Network Analysis, n/d; Astorga, 2007). At the personal level, though, the net effect seems to have been an increase in networked social capital spanning greater geographical and social distances. Nonetheless, horizontal networks and collective forms of social capital continued to exist in a "submerged" (latent) form. This persistence was crucial to the success of the regional movement of 2012.

V

The "Your problem is my problem" regional movement: the role of social capital

In early February 2012, an organization of artisanal fishermen invited other organizations to a meeting in Puerto Aysén to suggest they present a united front in their demands (Miranda and Morales, 2012). That meeting led on to a series of marches, barricades and demonstrations by thousands of people in the streets of towns and villages that paralysed the whole region for over a month. The speed with which the "Your problem is my problem" social movement emerged took the central government by surprise, and its reaction was to use the police to suppress it. Eventually the government was obliged to negotiate and to accept many of the movement's demands.

The regional approach has been virtually forgotten in the debate about social capital, despite being the cornerstone of the book that unleashed the avalanche of studies and debates. In *Making Democracy Work* (1993), Robert Putnam argued that the Emilia-Romagna Region of

Italy was a successful case of decentralization, with regional democratic management of public resources, because it had a society endowed with plentiful social capital.

The few studies on social capital and regionalist movements in Latin America include, first and foremost, the study by Fox (1996) of various regions of Mexico. Fox traces the route by which a grass-roots regional movement is forged from community social capital. More recently, Cortés and Sinisterra (2009) have explored the relationship between social capital, social movements and good governance in the Cauca region of Colombia, while Burbano de Lara (2012) has compared the movements for autonomy in Santa Cruz in the Plurinational State of Bolivia and Guayaquil in Ecuador, focusing on the social capital of regional oligarchies.

Aysén's is a "contentious" movement (Tarrow, 1998), i.e., one intended to create a contention with the State, an impasse that will force the latter to meet its demands and listen to its proposals. This contention developed as a joint evolution of these two actors' strategies to the point where doubt was cast over the State's ability to fulfil its role as guarantor of the conditions (such as transport routes, basic services and public order) for economic life in this territory. By mounting an illegal general strike and using barricades to close public highways, the movement broke the established rules and started a "game of the rules."[6] The government employed a strategy of violent repression, and the movement implemented a communications strategy of displaying this violence, thus eliciting a great deal of support from Chilean and international public opinion.

The specialist literature helps to establish and separate the analytical categories of social capital and social movement. Cortés and Sinisterra (2009) argue that a social movement is a very different phenomenon to social capital: a movement is a collective action that may have a great deal of social capital or little. Again, the Aysén movement differs from those of Santa Cruz and Guayaquil in that these were largely initiated by regional "oligarchies" (Burbano de Lara, 2012) with populist discourses. The "Your problem is my problem" movement in Aysén, by contrast, grew out of and was mobilized in the region's grass roots. The emerging hypothesis is that, with the consolidation and success of this movement, a regional social actor emerged that drew in all subaltern sectors.

The field study identified three aspects of this movement in which social capital played a role: existing regional organizations (collective social capital), networks among leaders (interpersonal bridging social capital) and Patagonian social memory ("submerged" social capital).

(i) Organizations. The 2012 regional movement was able to mobilize a great many people quickly in part because it was initiated by a number of organizations with informal collective social capital, i.e., informal rules and effective accountability practices at the grass roots. The unions of artisanal fishermen and workers in fisheries firms, the organization combating the hydroelectric macroproject, hauliers and public-sector employees, having each mounted major mobilizations on their own account, also committed heavily to the strike and demonstrations in this common cause.[7]

The project this study forms part of was implemented in a sample of seven communities chosen with a view to exemplifying the diversity of the kinds of isolation found in the region, whose organizations, each acting by itself, had successfully held strikes, demonstrations and negotiations in earlier years. Their goals also differed radically from one another's, something that has also been characteristic of other social movements in Latin America (De Sousa Santos, 2001). In January 2012, though, the leaders of a number of organizations began to meet to explore areas of convergence regarding the region's situation (Universidad de Los Lagos/Centre for Social Network Analysis, n/d). In sum, the fact that there were already organizations with collective social capital was a determinant in the success of the regional movement.

(ii) Personal horizontal networks between leaders. Data on Aysén from 2006 indicated that over 70% of people claimed to have personal support networks in case of need (ILPES/GORE, 2012). And, as has been seen, residents of rural communities usually have ties of kinship across the region.

At the regional level, this same horizontal type of bridging social capital among the main leaders of "Your problem is my problem," who were personally known to one another, constituted an interpersonal network even before the regional movement arose (see figure 1). The interviews conducted with various regional leaders indicated that networked social capital, with closed or overlapping mutual recognition among these leaders, can

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[6] The main leader, however, successfully stood for a seat in the national Chamber of Deputies in 2013. This departure from and return to the "rules" meant an advance in the democratization of political life in Aysén.

[7] These organizations exist to negotiate with the State. This is obvious in the case of the public-sector employees' association, but it is also true of the artisanal fishermen's unions (the original kernel of the movement), created as a result of incentives in the Fisheries Act to negotiate fishing quotas with the National Fisheries Service (SERNAPESCA).

largely explain why the mobilization spread so quickly.

(iii) Submerged social capital. This concept refers to social capital that was developed in the past and remains latent. The "social memory" of earlier generations' experiences is kept alive and organizational capabilities once employed in the old communities are transmitted (Astorga, 2007):

> "The community goes through long periods of lethargy and inactivity [but] when faced with an external threat it temporarily resumes a proactive role" (Universidad de Los Lagos/Centre for Social Network Analysis, n/d).

Another form of submerged social capital is the always latent ability to mobilize around a socio-territorial goal. There is still a clear Aysén and, more broadly, Patagonian identity, associated with the fact of having been born in Patagonia and sharing an array of norms and values. This is a collective identity process that rests on the distinction between *us* and the *others* (Barth, 1969). People born in the region exclude "incomers" who are not Patagonian and also those who do not practise the pioneer *habitus* of generosity, reciprocity and solidarity, i.e., "the rich." The alterity is clear:

> "[Outsiders] come with a good standard of living… they come here and start to live in the centre, they form a circle where everyone is a professional… they cut themselves off totally and completely from the local people… so it's like two worlds existing side by side" (Universidad de Los Lagos/Centre for Social Network Analysis, n/d).

The contention, then, is that these three forms of submerged social capital, namely the social memory of collective action, inter-community and inter-organization interpersonal networks and the collective Patagonian identity, all contributed to the strength of the "Your problem is my problem" movement.

FIGURE 1

Network of contacts between leaders before January 2012
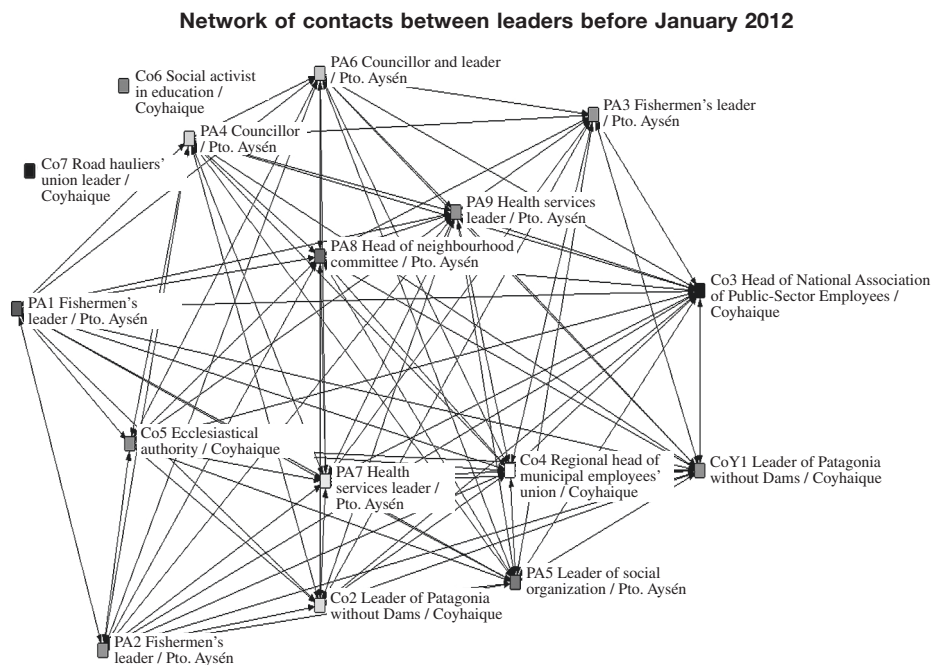
Source: Prepared by the authors, on the basis of interviews and the social network analysis method processed using the UCINET software.

1. The role of the Internet in the movement

The Internet is unquestionably the technology with the greatest potential for the advancement of social movements based on networking. Even in the 2009-2011 period, the Internet was crucial in the effort to coordinate and finance "Patagonia without Dams," a major anti-hydroelectric movement regionally, nationally and internationally (Astorga, 2013). Partly because Internet coverage in the countryside was still incipient, however, in 2012 rural residents learned of "Your problem is my problem" mainly from the radio, which played the central role in creating broad support:

> "Here there are a lot of people living in the countryside who have to get their news from a battery radio… the radio has always been very important for ordinary

people and for social leaders" (Universidad de Los Lagos/Centre for Social Network Analysis, n/d).

Nonetheless, the Internet did play a twofold role in the success of the movement. First, 41% of participatory Internet users in rural communities participated in or supported social movements via the Internet, which was almost double the rate for "pure" Internet users (see table 3). Furthermore, 100% of this subset of residents participate in local organizations. In sum, participatory Internet users provided a link between two levels of collective social capital: that of the local community and that of regional organizations.

TABLE 3

How often do you use the Internet and participate in or support social action?

		Never	At least sometimes	Total
Participants	Number	51	6	57
	% row	89.5	10.5	100.0
	Corrected standardized residuals	3.1	-3.1	
Internet users	Number	119	35	154
	% row	77.3	22.7	100.0
	Corrected standardized residuals	1.7	-1.7	
Participatory Internet users	Number	69	48	117
	% row	59.0	41.0	100.0
	Corrected standardized residuals	-4.2	4.2	
Total	Number	239	89	328
	% row	72.9	27.1	100.0

Source: Universidad de Los Lagos/Centre for Social Network Analysis (n/d), "Documentos de trabajo internos", FONDECYT Project (No. 1120866), "El impacto de Internet en el capital social de las comunidades aisladas", Santiago.

Second, young professionals with Internet experience gained with "Patagonia without Dams" played a key role in developing media capacity for the "Your problem is my problem" regional movement. Artisanal fishermen's leaders are low-income workers and knew little about the Internet. The movement's early communications initiatives consisted in going to the local radio stations and sticking up posters on walls in Puerto Aysén calling on people to join in the first march. Within a few days, though, the support of "Patagonia without Dams" for the new movement meant there could be a qualitative leap in impact on national public opinion.

"… [T]hat was a tremendous contribution to the movement by 'Patagonia without Dams'… They know the media, so they would take what we said and send it [over the Internet] to different newspapers..." (Universidad de Los Lagos/Centre for Social Network Analysis, n/d).

The main national media tended to reprint government press releases and gave little space to the movement's complaints about police violence, for example. However, use of all the resources of the Internet, from e-mail to blogs and Facebook, led to the movement's messages going viral among users of these virtual social networks. Facebook in particular proved a good channel for influencing public opinion with videos of police repression and interviews with leaders.

But the Internet was not the only communications tool vital to the movement's success: there was a complex dynamic of interaction between traditional ICTs (radio, television, newspapers) and modern ones, while the use of Twitter (the microblogging Internet application used to send short messages that can go viral among huge numbers of users) on mobile phones made it possible (i) to coordinate a rapid mobilization of the movement in response to repressive tactics, and (ii) to communicate the movement's demands, support for the strike and police repression to the country and the world:

"… the police were throwing bombs and all that, and that came out through Facebook [from people] who were in there online or with iPhones and stuff, and we [on the radio] were picking up on a lot of that information… there was nothing on the telly, so what a lot of pressure was applied by this humble medium!" (Universidad de Los Lagos/Centre for Social Network Analysis, n/d).[8]

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[8] The live webcast by Radio Santa María in Coyhaique was followed by regional, national and international journalists and activists.

In summary, despite the incompleteness of Internet coverage in rural communities of Aysén and the digital exclusion of low-income strata, it was thanks to this interaction between media and technologies that the

Internet played a key role in the ultimate success of the regional movement, enhancing communication both with local actors and with national public opinion by supplementing traditional ICTs.

VI

Conclusions

By distinguishing between different types of social capital, this study has been able to develop new hypotheses about its evolution in the Aysén Region and its role in changes within civil society. This article has presented a historically and socially grounded review of the different forms of social capital that flourished in four stages of the development of the region's civil society. Different types of social capital have come to the fore successively as transport and communications connectivity has grown, during different periods of central government public policy.

More than 50 years ago, at a time when communities were very isolated and the presence of the State was limited, the composition of social capital was dominated by horizontal networks that reinforced collective community actions. These networks were subsequently weakened as all forms of collective capital were co-opted or repressed. With the return to electoral democracy, there was an upsurge in clientelism; finally, from 2012, the different forms of submerged social capital were reactivated by a regional movement.

The 2012 movement does not seem to have been a one-off, but marks a watershed in Aysén civil society and in the forms of social capital sustaining it. Although its effect on public policy was limited the first year (Pérez, 2014) and the movement returned to a relatively "submerged" state, regional grass-roots organizations continued to press their demands and the central State, together with the national Congress, laid the foundations for a State policy for this and other "outlying areas". Within the framework of a new law for these regions, the public budget for Aysén was increased by 67% from the 2012-2015 period (Universidad de Los Lagos/Centre for Social Network Analysis, n/d).

The contentious movement in Aysén is a case deserving of consideration and comparison, firstly because it is a case of bottom-up participation not dominated by "regional oligarchies," and secondly because it marked a transition from actors with social capital "in" the regional territory to a grass-roots actor "of" the territory at the regional level. Although there were already local and regionwide organizations with collective social capital, the 2012 movement led to the emergence of a broad-based subaltern social actor with a regional presence, capable of counterbalancing actors in more powerful social positions.

The relevance of an analysis of the different forms of social capital to the implementation of electoral and administrative decentralization is now beyond doubt:

"… the more social capital there is to buttress their legitimacy, grounded in relations of loyalty and/or trust in them on the part of social organizations, the better chance these actors will have of playing a proactive role in any decentralized process" (De la Maza, Cunhill and Joignant, 2012).

Putnam (1993) showed, in the case of Italian regional decentralization, that social capital matters to the outcome of this process, as the general welfare is enhanced when it is present while inequality is exacerbated when it is absent. In the light of the Aysén experience, the authors of the present study suggest that this approach can be applied to other regions that benefit, potentially at least, from decentralization. The lessons of Aysén, whose civil society has been successfully democratized, provide clues to the way the social capital of potential subaltern collective actors can be enhanced as an integral part of decentralization.

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ISBN 978-92-1-121915-9