Productive structure and the functional distribution of income: an application of the input-output model

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ABSTRACT

The ECLAC tradition views structural heterogeneity as one of the main causes of Latin America's unequal income distribution. Accordingly, industrial policy should aim to change the productive structure, while incorporating technical progress and raising productivity levels. Simulations performed using Brazilian input-output tables make it possible to discover and evaluate the effects of changes in the productive structure on the functional distribution of income and employment levels over the most recent business cycle. These simulations are an important tool for formulating industrial policies that simultaneously promote higher growth rates and a reduction in inequalities. The estimations made revealed that increasing the proportion of engineering-intensive sectors could help to improve distributive results, expand the share of wages in output, and create more jobs.

KEYWORDS ECLAC, economic conditions, industrial policy, income distribution, input-output analysis, Brazil

JEL CLASSIFICATION C67, O21, N16

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I
Introduction

Traditionally, the Economic Commission for Latin America and the Caribbean (ECLAC) has considered structural heterogeneity to be the cause of the region's unequal income distribution. Since its founding, ECLAC has provided independent theoretical thinking on the specifics of the economic development process in Latin America, and has recommended the adoption of industrial policies to foster changes in the productive structure and stimulate domestic and external convergence in terms of productivity levels.

In the 1980s, the external debt crisis and the intensification of the inflationary process interrupted the import substitution industrialization process in the region. At the same time, liberal thinking gained ground in developed countries, and its recommendations for trade and financial liberalization attracted increasing support in Latin America. This point of view increasingly criticized State intervention — particularly in terms of industrial policy — for interfering in market self-regulation and causing distortions in relative prices and inefficient allocation. This period also saw wide dissemination of the belief that the best industrial policy for a country would be no industrial policy at all.

Nonetheless, just as the economic growth of the "golden years" did not generate positive distributional effects, the liberal reforms also failed to fill the "empty box" — described by Fajnzylber — of Latin American countries that have simultaneously raised their economic growth rates and improved the income distribution. Thus, issues relating to State action in the economy reappeared in the economic debate in the decade of 2000. Recent cases, such as exchange-rate policy management in Argentina and the new Brazilian industrial policy, are examples of the use of heterodox tools to bring about changes in the productive structure, through government action.

Since 2003, the Brazilian economy has striven to fill the aforementioned "empty box"; and the country has been achieving positive results in terms of growth and income distribution — the latter particularly when the measurements are made in functional terms, in other words considering how income is shared between wages and profits.

According to the ECLAC viewpoint, in which balance of payments constraints can impede growth, the large trade surpluses and the accumulation of reserves resulting from a sharp improvement in the terms of trade can be seen as fundamental factors for renewing Brazil's growth cycle. Nonetheless, despite the external boost, speeding up growth is overwhelmingly the task of domestic demand, particularly family consumption and investment driven by high levels of employment and income. Moreover, on the supply side, there has been a slight change in the productive structure, with the shares of agriculture and manufacturing industry sectors declining and that of services expanding.

What potential links could exist between changes in the productive structure and the income distribution? How can the effects of changes in the productive structure on employment and remuneration levels be measured? How can manufacturing industry, especially highly technology-intensive sectors, help to generate higher levels employment and wages? What is the role of industrial policy in overcoming the inequalities prevailing in the Latin American region? These are the key issues this article aims to investigate.

The analysis in this study considers inequality from the standpoint of the functional distribution of income, which is consistent with the classical notion that the productive process is where output shares are determined. The way the productive structure affects the functional distribution of income is evaluated using the input-output tables model, which was created by Leontief in 1941 and served as a major tool of economic analysis, planning and industrial policy-making throughout the twentieth century. The advantage of input-output tables is that they make it possible to combine the three facets of output: production, expenditure and income. The matrices also make it possible to perform simulations of employment, remuneration and production levels, by capturing the direct and indirect effects of observed (or hypothetical) changes in the productive structure on income shares, from a standpoint that takes account of inter-sectoral relations and their linkages.

At a time when the status quo of the last few decades is being called into question and the importance of State action in the economy is again being recognized, there is a chance to discuss public-policy alternatives for overcoming the region's historical inequalities. Reflection on the specifics of Latin American development has always been at the heart of the historical-structuralist debate, particularly the importance of fostering changes in the productive structure. In that context, the analysis of this article aims to contribute to the formulation of industrial policies that promote technical progress, to improve the sustainability of the region's exit from the notorious "empty box", while at the same time promoting high growth rates and improvement in the income distribution, increasing the share of wages in output and boosting job creation.

Section II, which follows this introduction, addresses the issue of structural heterogeneity and reviews ECLAC thinking and recommendations on Latin America's industrial development process. Section III assesses how the productive structure affects the functional distribution of income; and lastly, section IV offers final thoughts. The annex contains the Brazilian economy's input-output table for 2005.

II

Structural heterogeneity and the ECLAC tradition

1. The ECLAC tradition

Throughout the twentieth century, Latin America experienced far-reaching transformations in its productive structure, particularly after the World War II. As shown in table 1, the region progressed from a predominantly agricultural economy at the start of the century, to a period of intense industrialization with active State participation, in which the historical-structuralist theoretical tradition and policy recommended by ECLAC played a key role.

The perception that the economic development process in Latin America should be viewed differently than that of the central countries dates back to the founding of ECLAC. According to Bielschowsky (2000), for the supporters of industrialization, there was sort of "theoretical vacuum"; and scepticism of existing economic theory caused perplexity given the lack of theories that could be adapted to the economic and social realities they were striving to understand and change. Thus, ECLAC thinking since the 1950s fulfilled the function of formulating a regional development theory consistent with the Keynesian heterodox hegemony, while taking account of economic reality in its specific details. While embracing different concepts and ways of formulating the issue, authors associated with ECLAC at that time propounded the same key message: the need to implement industrial policies to overcome underdevelopment and poverty.

The ECLAC inaugural text, written by Raúl Prebisch in 1949, was fundamental in that regard, asserting that "One of the most conspicuous deficiencies of general economic theory, from the point of view of the periphery, is its false sense of universality [...] An intelligent knowledge of the ideas of others must not be confused with that mental subjection to them from which we are slowly learning to free ourselves" (Prebisch, 1963).

TABLE 1

Latin America: productive structure, 1950, 1960, 1970,1980 and 1990
(Percentages)

Sector	1950	1960	1970	1980	1990
Agriculture	22.1	18.7	13.0	9.7	10.4
Mining and oil	3.2	3.6	3.0	3.2	3.7
Manufacturing industry	21.7	25.7	24.9	27.0	23.4
Public utility services	1.3	1.6	1.9	1.7	2.4
Civil construction	7.0	6.9	5.2	7.0	4.9
Commerce	20.1	20.2	18.5	14.6	13.1
Transport, storage and postal services	6.1	5.9	5.4	5.5	7.0
Financial services	4.1	4.1	11.0	14.0	15.3
Other services	14.5	13.4	17.2	17.4	19.9

Source: Economic Commission for Latin America and the Caribbean (ECLAC), 2010.

By pointing out the need for a Latin American theoretical formulation, Prebisch reveals one of the key ideas of his economic thinking: the relation between the centre and the periphery. In his pioneering formulation, the economic growth process, international trade and technical progress would not occur in the same way in both regions. In brief, based on the economic theory of comparative advantage, it can be seen that the international division of labour does not favour the industrialization of peripheral countries. Accordingly, these countries have no way to absorb technical progress, which is fundamental for raising productivity and improving the population's living standards, as can be inferred from the following statement: "Hence, the fundamental significance of the industrialization of the new countries. Industrialization is not an end in itself, but the principal means at the disposal of those countries of obtaining a share of the benefits of technical progress and of progressively raising the standard of living of the masses" (Prebisch, 1963).

Like Prebisch, Furtado also explains the Latin American economic reality from a historical perspective, arguing that underdevelopment is an autonomous process and not a development stage. He also stresses the need for technical progress to be generated domestically, since technology defines the set of goods to be produced and influences the choice of productive processes; and the fact that technological decisions are made in the central countries detracts from autonomous domestic decision-making in the periphery and accentuates technological dependency (Furtado, 1975).

This author also differentiates the paths of the central and peripheral countries, particularly in his analysis of the industrialization process; and he blames those differences for the periphery's bad income distribution. Unlike what happened in the central countries, labour supply in developing countries remained infinitely elastic, and the persistently small volume of labour employed allowed a hybrid and dual structure to emerge, in which capitalist sectors coexist with pre-capitalist sectors, thereby preventing wages from rising above subsistence levels and discouraging the redistribution of income towards wage earners.

The notion of the coexistence of productive structures that vary in terms of productivity and technical progress dates back to the theoretical formulation of Aníbal Pinto, who, in the 1960s proposed the concept of structural heterogeneity. According to Pinto (1970), "dualism" originally predominated in the region, with highly productive export enclaves contrasting with the rest of the economy characterized by low productivity. For this author, the industrialization process experienced by Latin America in the post-war years would tend to reproduce the old heterogeneity prevailing in the agricultural-export period, by consolidating the creation of a non-exporting sector of well above-average productivity. Moreover, the inter-sectoral productivity differences between the countries of the region would be significantly greater than those seen in developed countries, thereby encouraging a more pronounced concentration of income, owing to the inverse relation between the size of employed population and the productive level of each sector.

In the 1990s, Fajnzylber participated in the debate on the causes of the unequal income distribution, identifying its origins in the productive process. In his article "Industrialization in Latin America: from black box to empty box", the author points out that no Latin American country had succeeded in combining positive indicators of economic dynamism (per capita income growth of above 2.4%) and equity (ratio between the incomes of the poorest 40% and richest 10% of around 0.4) in the period between 1970 and 1984. As the group of countries analysed included some with incomes similar to those in Latin America, such as Spain, the Former Yugoslav Republic of Macedonia, Hungary, Israel, Portugal and the Republic of Korea, Fajnzylber identifies insufficient incorporation of technical progress (black box) as a possible cause of those varying results, because:

> *The empty box would be directly related to what might be called an inability to open the "black box" of technical progress; this is partly due to the origin of Latin American societies, their institutional structure and a set of economic and structural factors which have a complex but indisputable bearing on the social and political environment.* (Fajnzylber, 1990).

A more recent study (ECLAC, 2007), entitled "Technical progress and structural change in Latin America", reconsidered the importance of the productive structure and technology as decisive factors for the convergence of per capita income growth rates, finding that performance in Latin America was clearly falling behind, particularly compared to Asia, not only in terms of per capita income, but also in the growth of gross domestic product (GDP), productivity and external competitiveness with the creation of good-quality jobs. On that point, Ferraz (2008) reiterates the importance of continuing to study the productive structure and technical progress in Latin America: the traditional interpretation sees human capital and macroeconomic stability as the main reasons for the better Asian performance. Nonetheless, in general, no progress is made in discussing issues that have always been important for the Latin American economies, particularly those most in line with ECLAC thinking, namely productive structure and technical progress.

ECLAC (2007) also performed an econometric exercise to compare the paths of per capita income for groups of countries, considering the diversification of their productive structures and indicators of investment in technical progress. The research showed that the countries which made most economic progress had a diversified industrial structure, focused on technology-intensive economic activities; and this led it to conclude that long-term development depends not only on the "traditional" variables, but also, and particularly, on the productive structure. At a time when industrial policies are undergoing a revival in Latin America, the study helped to refocus government action on the change in productive structure, particularly the importance of engineering-intensive sectors. Investment in those sectors fulfils a positive function in terms of the incorporation of technical progress and concentration of the productive chain, with repercussions for productivity and, consequently, for expanding income and employment and reducing inequality levels.

In relation to the importance of productivity, the document entitled "Time for equality: closing gaps, opening trails" (ECLAC, 2010) argues that two features distinguish the Latin American economies, namely the external gap and the domestic gap. In terms of the external gap, the region continues to lag behind in technological capacities: "Developed economies innovate in technology and disseminate it throughout their productive system more quickly than the countries of Latin America and the Caribbean are able to absorb, imitate, adapt and innovate in technology following international best practices" (ECLAC, 2010).

The domestic gap, in contrast, is defined by the glaring productivity differences that exist within and between sectors, and also between the firms of Latin American countries, which are much greater than those seen in developed countries. Large productivity differentials, compounded by the concentration of employment in sectors of very low relative productivity, can be seen as indicating the persistence of structural heterogeneity in the region. Table 2 shows the distribution of the occupational structure in Latin America, from 1990 to 2008. In the period analysed, the high-productivity sectors (mining, electricity and finance) represent a very small and essentially constant share of formal employment; and the share of medium-productivity sectors (manufacturing industry and transport) declines, while that of low-productivity sectors (agriculture, construction, trade and municipal and personal services) expands slightly.

TABLE 2

Latin America: occupational structure 1990,1998, 2003 and 2008
(Percentages)

Sector	1990	1998	2003	2008
High-productivity sectors	7.9	7.0	7.3	8.1
Medium-productivity sectors	23.1	20.7	19.7	20.0
Low-productivity sectors	69.0	72.3	73.0	71.9

Source: Economic Commission for Latin America and the Caribbean (ECLAC), 2010

Based on the document entitled "Structural heterogeneity largely explains acute social inequality in Latin America and the Caribbean" (ECLAC, 2010), ECLAC recommended countries to adopt industrial policies that promote convergence between sector productivity levels, with a view to improving the income distribution and combating social exclusion. In that regard: "a pivotal item on the agenda is the identification of key sectors, which will have to be selected on the basis of the specific features of each country's production structure and in accordance with the sector's capacity to generate and disseminate knowledge and innovation and to encourage linkages with other manufacturing and services activities. It will be the task of industrial policy to focus efforts on these sectors" (ECLAC, 2010).

Infante and Sunkel (2009) help to evaluate the relations that exist between structural heterogeneity and the income distribution, proposing a review based on input-output tables for the Chilean economy. According to these authors, despite a doubling of per capita income over the last few decades and a notable reduction in poverty indices, high levels of inequality and social exclusion have persisted in the country. Despite the positive results achieved, social policies are considered compensatory, so the authors argue that only a new, production-oriented, development strategy can achieve sustainable results in the fight against inequality: "although something can be achieved in that way, this paper argues that a different development strategy needs to be designed. The underlying problem is both the pace of growth and its composition, in other words, the profound differences in productivity and quality of the productive structure, in both goods-producing and service sectors" (Infante and Sunkel, 2009).

Thus, following Pinto's classification, the authors define structural heterogeneity by dividing the economy into three sectors: traditional, modern and intermediate, according to productivity levels. Using input-output tables, they note that the heterogeneity observed in the production sphere (domestic consumption and final demand) is also visible in employment (jobs and wages). In short, the Chilean economy is divided into high-productivity sectors which drive the economy and pay higher wages, and low- and medium- productivity sectors that contribute less to growth but absorb most employment. Lastly, a high proportion of the value added by low-productivity sectors corresponds to labour income (72.5%), despite the fact that pay in these sectors accounts for just 20.7% of total remuneration in the economy. In contrast, in the high-productivity sectors, pay accounts for 37.9% of value-added and 64.1% of total remuneration.

The aforementioned authors choose to use input-output tables, given the possibility of performing simulations based on different hypotheses, particularly in relation to the productive structure. The coefficients of the matrices make it possible to identify the contribution made by each of the productive factors (inputs, capital and labour) to each sector's output, and thus simulate the effect on total production of different hypothetical changes in aggregate demand, through the differentiated effects in the various productive sectors.

Infante (2007) provides additional tools for viewing the relations between structural heterogeneity and income distribution. According to this author, the persistence of productive heterogeneity is what gives rise to differential wages and unequal access to good-quality jobs. Furthermore, job quality (level of pay, formalization and social protection) is what best illustrates the link between the productive structure and the labour market. Nonetheless, as job quality is still not a sufficient condition to determine the wage, it is necessary to focus particularly on the prevailing types of labour relations and the bargaining power of labour unions, as fundamental factors.

2. Choice of the functional distribution of income

Classical political economy (Smith, Ricardo, Marx) viewed labour as the only wealth creator; so the generation and appropriation of income could only take place in the production process. This approach leads to the concept of the functional distribution of income.

Throughout the development of economic theory, new perspectives have been used to understand the distribution process. Various theoretical concepts aimed to explain how income is shared between wages and profits, ranging from those that argue the labour productivity is what determines wage levels, to Marxist value-added theories which argue that the wage only covers part of the value produced by labour in production, as a result of the distributive conflict between the classes (labour and the capitalist); so the wage level depends on workers' bargaining power to appropriate the surplus and productivity increases. According to the neoclassical tradition, the wage level is equal to the respective marginal productivity, with no space for distributive conflicts, since the wage seen as determined through a "natural" process that is perfectly balanced or tends to equilibrium. Under the liberal approach, differences in the distribution of income are now measured using inequality coefficients (Gini or others) or the income gap between the upper and lower extremes. Consequently, inequality is measured from a personal standpoint. Although those indicators measure important issues, such as education and training of the labour force, the key feature of this approach is that it makes no mention of the productive fabric in determining inequality. Correcting distortions is the task of social policies, which therefore calls for government fiscal action to formulate compensatory policies, outside the domain of the productive process.

Thus, the decision to analyse the functional distribution of income is consistent with the research objectives, namely to evaluate the productive linkages in determining the income distribution. In this regard, recognizing that action to overcome inequalities needs to be taken in the sphere of production, industrial policy could play a major role in increasing the share of wages in output. This will be the purpose of the simulations using input-output tables, because, as shown in the next section, it is possible to evaluate how changes in the productive structure can affect the functional distribution of income and the employment level, thereby becoming a tool industrial policy-making.

III

Evaluation of how the productive structure affects the functional distribution of income

1. The recent cycle of the Brazilian economy, growth with income distribution

From 2003 until the most recent international financial crisis, Brazil experienced the most significant expansionary cycle of recent decades. As shown in figure 1, growth was initially driven by the external sector, thanks to an improvement in the terms of trade and increased exports of commodities to China. Nonetheless, since 2004, domestic demand, particularly family consumption and gross capital formation, has been the main engine of growth, while a better income distribution has played a key role in expanding the domestic market.

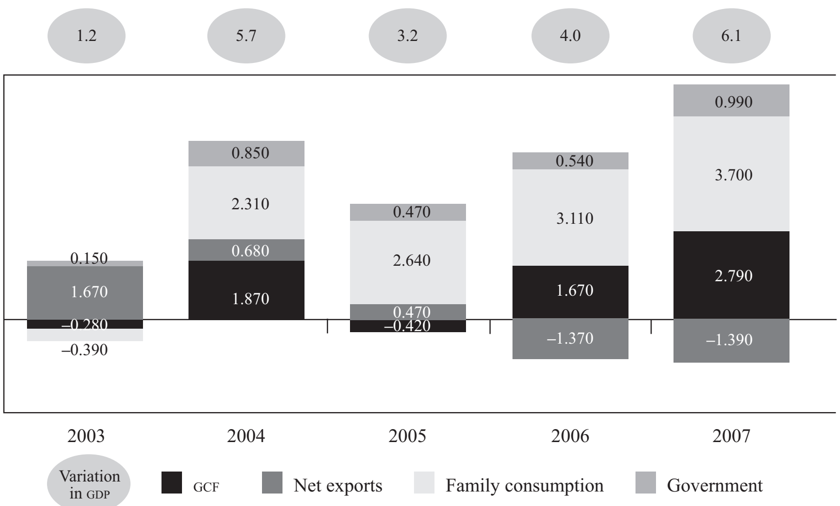
In terms of the income distribution, there were improvements during the period both in personal terms (Gini coefficients), and in the functional distribution (between wages and profits). After fluctuating between 0.58 and 0.61 in the 1990s, the Gini coefficient embarked on a steady downward trend in 2001, to reach 0.56 by 2007. Since 2003, the Gini coefficient has posted the best inequality indicators in its historical series (see figure 2).

In functional terms (see figure 3), following the sharp contraction in the share of labour income in output in the early 1990s, there was a recovery in this indicator in the initial years of the Real Plan, which was only interrupted by the financial crises that occurred towards the end of that decade. Since 2003, however, in keeping with the revival of the business cycle, the labour share grew systematically, to reach a level of 48.1% in 2007.

The larger share of wages in output could be reflecting both the larger number of jobs created and the rise in average pay (increase in real wages or a larger proportion of higher-paying sectors). Table 3 shows data for GDP, remuneration and employment from 2003 to 2007. While the volume of remuneration grew at an average rate of 5.3% during the period, employment grew by 3.0%. It is therefore possible to state that wages were more decisive than new job creation for the progress made in the functional distribution of income, so sector-level research is needed to identify the main determinants of this improvement in pay.

FIGURE 1

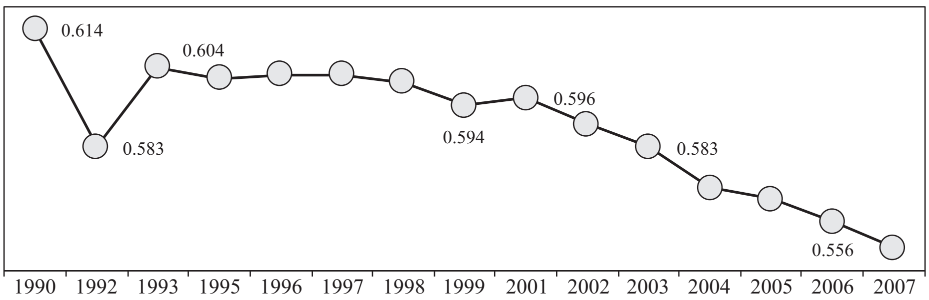
Brazil: contribution to growth, 2003, 2004, 2005, 2006 and 2007
(Percentage points)



Source: Prepared by the author on the basis of the economic and financial database (Ipeadata) of the Institute of Applied Economic Research ((IPEA).
GDP: Gross domestic product.

FIGURE 2

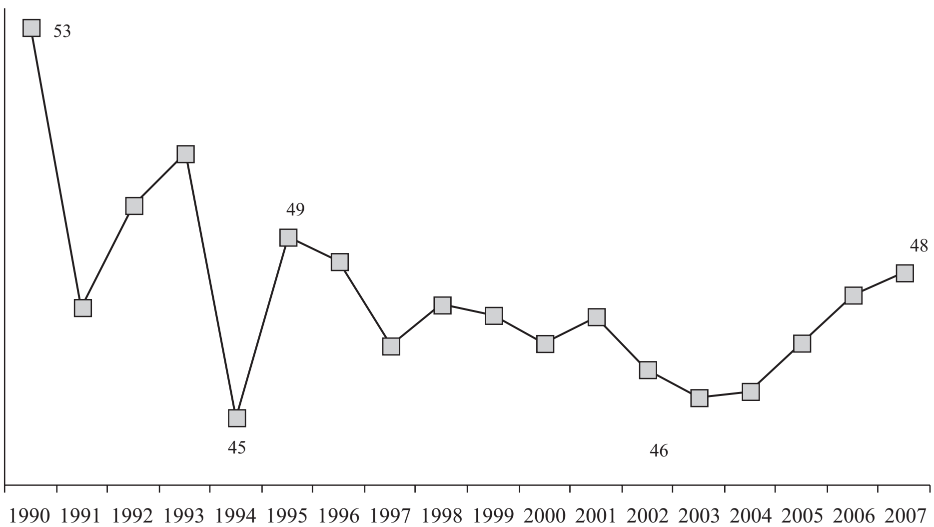
Brazil: Gini coefficient, 1990-2007



Source: Prepared by the author on the basis of the economic and financial database (Ipeadata) of the Institute of Applied Economic Research (IPEA).

FIGURE 3

Brazil: share of remuneration in output, 1990-2007
(Percentages)



Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

TABLE 3

Brazil: GDP, remuneration and jobs, 2003 and 2007

	2003	2007	Annual growth (%)
GDP (R$ million, at 2007 prices)	1 894 452	2 287 858	4.8
Remuneration (R$ million, at 2007 prices)	895 962	1 099 903	5.3
Jobs	84 034 981	94 713 909	3.0
Average remuneration (R$ million, at 2007 prices)	10 662	11 613	2.2

Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

Firstly, the sector productive structures are compared between 2003 and 2007 (see table 4). In this period, there were increases in the GDP shares of trade, financial services, mining, oil and public services, while agriculture, manufacturing industry and real estate and rental services all declined relatively. The trend of sector shares in terms of pay and jobs can also be analysed (see tables 5 and 6): trade and manufacturing industry increased their shares of total remuneration, while manufacturing industry, trade, public services and other services accounted for a larger share of jobs.

Other indicators are also available to evaluate the performance of remuneration and their relation to the productive structure, such as the share of remuneration in the output of each sector. As shown in table 7, manufacturing industry, in addition to displaying a large share of remuneration in value added, also records the largest increase in the share of remuneration in sector output over the cycle analysed, rising from 45.5% in 2003 to 51.8% in 2007.

Accordingly, as a result of the growth of jobs and the larger share of remuneration in sector output, manufacturing industry is a key contributor to the total variation in remuneration. As can be seen in table 8, it accounts for 20.2% of the growth in total remuneration, although this is less than the contribution made by the public administration sector.

TABLE 4

Brazil: productive structure, 2003 and 2007
(Percentages)

Sector	2003	2007
Agriculture	7.4	5.6
Mining and oil	1.7	2.3
Manufacturing industry	18.0	17.0
Public utility services	3.4	3.6
Civil construction	4.7	4.9
Commerce	10.6	12.1
Transport, storage and postal services	4.7	4.8
Information services	3.6	3.8
Financial services	7.1	7.7
Real estate and rental services	9.6	8.5
Other services	14.0	14.2
Administration, public health and education, and social security	15.1	15.5

Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

TABLE 5

Brazil: remuneration structure, 2003 and 2007
(Percentages)

Sector	2003	2007
Agriculture	5.3	4.2
Mining and oil	1.0	1.2
Manufacturing industry	17.9	18.4
Public utility services	1.8	1.5
Civil construction	3.2	3.3
Commerce	10.2	11.3
Transport, storage and postal services	4.5	4.5
Information services	2.5	2.7
Financial services	6.3	5.8
Real estate and rental services	0.5	0.6
Other services	18.0	17.7
Administration, public health and education, and social security	28.9	28.7

Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

TABLE 6

Brazil: occupational structure, 2003 and 2007
(Percentages)

Sector	2003	2007
Agriculture	21.0	18.6
Mining and oil	0.3	0.3
Manufacturing industry	11.9	12.8
Public utility services	0.4	0.4
Civil construction	6.4	6.6
Commerce	16.6	16.7
Transport, storage and postal services	4.2	4.3
Information services	1.7	1.9
Financial services	1.1	1.0
Real estate and rental services	0.6	0.7
Other services	25.2	25.9
Administration, public health and education, and social security	10.5	10.9

Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

TABLE 7

Brazil: Share of remuneration in sector output
(Percentages)

Sector	2003	2007
Agriculture	32.6	36.7
Extractive industry	27.6	25.1
Manufacturing industry	45.5	51.8
Public utility services	23.4	20.6
Civil construction	31.4	32.2
Commerce	43.8	44.7
Transport, storage and postal services	44.0	45.2
Information services	31.0	34.3
Financial services	40.4	36.5
Real estate and rental services	2.4	3.4
Other services	58.5	59.9
Administration, public health and education, and social security	87.4	89.2
Total	*45.7*	*48.1*

Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

Lastly, comparing the sector-level variations in productivity and average pay, it can be seen that manufacturing industry was one of the main sectors passing productivity increases on to pay throughout the cyclical upswing. Whereas for the average of sectors during the period analysed, remuneration outpaced productivity growth by 1.3 percentage points, in the case of manufacturing industry, the difference was 3.3 points (see table 9).

The combination of those results focuses attention on the performance of manufacturing industry, which, despite losing share in the productive structure in terms of value added, recorded increases in terms of the number of jobs and the volume of remuneration. This is probably attributable to the far-reaching changes that occurred in the composition of Brazilian industrial output during the period. Table 10 shows the composition of industrial output by technological intensity, using the ECLAC classification, revealing the increased share of engineering-intensive sectors — although Brazil still displays an industrial structure that is very different than that of the United States, for example, which is considered the global technology frontier.

TABLE 8

Brazil: remuneration by sector
(R$ million)

Remuneration	2003	2007	Variation	Contribution to the variation (%)
Agriculture	47 151	46 680	(471)	-0.2
Extractive industry	9 296	13 497	4 201	2.1
Manufacturing industry	160 746	201 926	41 180	20.2
Production and distribution of electricity and gas, water, sewerage, and urban cleaning	15 692	16 845	1 153	0.6
Civil construction	28 838	35 799	6 961	3.4
Commerce	91 025	124 060	33 035	16.2
Transport, storage and postal services	40 351	49 618	9 267	4.5
Information services	22 057	30 110	8 053	3.9
Financial intermediation, insurance, and complimentary pension and related services	56 144	64 114	7 970	3.9
Real estate and rental services	4 567	6 628	2 061	1.0
Other services	160 924	194 997	34 073	16.7
Administration, public health and education, and social security	259 170	315 629	56 459	27.7
TOTAL	*895 962*	*1 099 903*	*203 941*	

Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

TABLE 9

Brazil: productivity and remuneration

Sector	Productivity (Valor value added by occupation, R$)			Average remuneration (R$)			Variation of average remuneration/ Variation of productivity (B)/(A)
	2003	2007	Variation in productivity (A)	2003	2007	Variation in average remuneration (B)	
Agriculture	6 150	7 228	4.1%	2 002	2 651	7.3%	3.0%
Extractive industry	99 963	182 263	16.2%	27 599	45 837	13.5%	-2.3%
Manufacturing industry	26 536	32 213	5.0%	12 073	16 695	8.4%	3.3%
Production and distribution of electricity and gas, water, sewerage, and urban cleaning	141 614	210 307	10.4%	33 086	43 313	7.0%	-3.1%
Civil construction	12 744	17 884	8.8%	3 998	5 757	9.5%	0.6%
Commerce	11 170	17 509	11.9%	4 895	7 831	12.5%	0.5%
Transport, storage and postal services	19 254	27 079	8.9%	8 474	12 239	9.6%	0.7%
Information services	38 119	50 039	7.0%	11 818	17 174	9.8%	2.6%
Financial intermediation, insurance, and complimentary pension and related services	113 357	181 041	12.4%	45 792	66 098	9.6%	-2.5%
Real estate and rental services	259 904	286 431	2.5%	6 279	9 763	11.7%	9.0%
Other services	9 736	13 274	8.1%	5 693	7 949	8.7%	0.6%
Administration, public health and education, and social security	25 267	34 412	8.0%	22 092	30 706	8.6%	0.5%
TOTAL	*17 500*	*24 155*	*8.4%*	*7 995*	*11 613*	*9.8%*	*1.3%*

Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

In addition to their larger share in industrial output, in the period analysed engineering-intensive sectors made a major contribution to remuneration growth and to a lesser extent to job creation (see table 11). This suggests that the shift in the productive structure towards more intensive technology use could have benefited aggregate wage growth in industry as a whole, given the higher wages paid in those sectors.

TABLE 10

Brazil (2003 and 2007) and the United States (2007): industrial output by category of technology-use intensity
(Percentages of GDP)

Intensity of technology use	Brazil 2003	Brazil 2007	United States 2007
Natural resources	10.3	8.2	2.8
Labour	3.3	3.8	2.0
Engineering	4.3	5.0	6.5
Manufacturing industry	18.0	17.0	11.3

Source: Prepared by the author on the basis of data from Economic Commission for Latin America and the Caribbean (ECLAC).

TABLE 11

Brazil: manufacturing industry, contribution to the variation (2007/2003) by category of technology-use intensity
(Percentages)

Intensity of technology use	Value-added	Wages	Jobs
Natural resources	22.5	18.9	35.1
Labour	36.9	42.3	36.2
Engineering	40.6	38.8	28.7

Source: Prepared by the author on the basis of data from Economic Commission for Latin America and the Caribbean (ECLAC).

2. The input-output model and the methodology used for the simulations

(a) *Historical review of the input-output model*

The input-output tables model was created by Leontief in 1941, largely inspired in the economic frameworks developed by Quesnay in the eighteenth century. Thanks to the pioneering work of organization, formalization, and improvement of studies on inter-industrial relations, the input-output table became a major tool of economic planning and industrial policy-making throughout the twentieth century, mainly in the planned socialist economies, but also in market economies.

As commonly defined, an input-output table is a matrix of direct technical coefficients indicating how many units of the goods produced by other sectors in a given activity are required by a sector to produce a monetary unit of its own good. Nonetheless, according to the Brazilian Geographical and Statistical Institute (IBGE, 2008), construction of the matrix involves a series of studies and decisions that start with the definition of the concepts adopted for the variables in its database through to the hypotheses made on the technology to be used to calculate the technical coefficients effectively.

Input-output tables are constructed by combining the indicators contained in the system of national accounts under the three approaches for measuring output: production, expenditure and income. This makes it possible to perform sector analyses, evaluating, among other issues, the importance of a given industry in terms of generating jobs, income and taxes, as well as sector-level capital and import needs.

Another important application of input-output tables are impact analyses, as noted earlier in Infante and Sunkel (2009). According to United Nations (2000) in “Handbook of input/output table compilation and analysis”, these impact analyses can be conducted from two standpoints: (i) the impact of other activities on the industry being studied; and (ii) the impact of that industry on other activities.

In that handbook, the basic impact equation with input-output models consists of evaluating the effects of the growth path of the complete vector of final demand (by sectors) on sector outputs; in other words evaluation of the direct and indirect effects of variations in demand on the productive structure. The United Nations study stresses that the input-output analysis is done on an integrated basis, considering all sectors together, to be able to fully capture the inter-industry linkages prevailing in each productive structure.

Other techniques used to analyse impact are multipliers and backward and forward linkages. The multipliers basically serve to measure the total effect on production, employment or value-added caused by a unit increase in the output of a given sector. They can be used to calculate forward or backward linkages in the productive chain, in other words output and input multipliers, through the sum of the lines relating to the column of a given sector in matrices of inter-sectoral repercussions and national coefficients. It is worth noting that there is a risk of mistaken interpretations when analysing multipliers, particularly when concluding that a sector with a larger multiplier is the one that should be exclusively promoted — hence the importance of inter-sectoral impact analyses being made of final demand as a whole. Lastly, multipliers can also be used to measure the employment and income effects of a variation in final demand; in other words they are analytical instruments that belong to a typically Keynesian approach.

The backward and forward linkages are obtained, respectively, from the sum of the columns or rows relating to a given sector in a matrix of direct coefficients. Backward linkages are simply the product's own multipliers.

Input-output tables to some extent summarize the objectives of this study, as they represent the most appropriate tool for jointly evaluating variations in the productive structure and in the functional distribution of income. Apart from the work of Infante and Sunkel (2009), other authors have used that methodology to evaluate the effects on the income distribution, including Muñoz and Riaño (1992), who use input-output tables to analyse changes in the national income distribution between the fundamental groups of society: workers and employers. In that case, the study aimed to calculate the distribution frontiers for Colombia, in other words analyse the effects of variations in profit rates on the functional distribution of income in that country.

(b) *Simulation methodology*

The exercise proposed in this study consists of using the input-output tables model to evaluate the level of employment and volume of remuneration generated different productive structures, consistently with the impact analyses based on employment and remuneration multipliers.

In the case of employment, the direct requirements vector (L) is calculated, by dividing jobs created (E) by total production (VBP) in each of the sectors analysed.

$$L = E / VBP \quad (1)$$

The direct employment requirements vector is then diagonalized, to obtain a diagonal matrix L^d. The next step consists of multiplying this diagonal matrix L^d by the Leontief direct and indirect requirements matrix ($(I\text{-}A)_{nxn}^{-1}$), thereby making it possible to include the indirect effects of one sector's production on the other sectors. This gives the direct and indirect requirements matrix (L_{nxn}):

$$L_{nxn} = L^d{}_{nxn} \text{ X } (I\text{-}A)_{nxn}^{-1} \quad (2)$$

From L_{nxn} it is possible to estimate the level of sector employment that corresponds to a given exogenous final demand, also expressed at the sector level (equation 3). Then the sector employments can be added together to obtain the level of employment that corresponds to a given productive structure (equation 4).

$$E_{nx1} = L_{nxn} \text{ X } Y_{nx1\,;} \quad (3)$$

$$E = \Sigma E_i \quad (4)$$

The model for remuneration is exactly the same as for employment, with jobs (E) being replaced by remuneration (R). Equations (1) to (4) can then be rewritten as (1') to (4'), considering W as the vector of direct requirements for remuneration:

$$W = R/VBP \quad (1')$$
$$W_{nxn} = W^d{}_{nxn} \text{ X } (I\text{-}A)_{nxn}^{-1} \quad (2')$$
$$R_{nx1} = W_{nxn} \text{ X } Y_{nx1\,;} \quad (3')$$
$$R = \Sigma R_i \quad (4')$$

The use of input-output tables to perform simulations is subject to a number of constraints. Firstly, the matrices are formulated on the basis of the economy's performance in a given year, so they need to reflect prevailing conditions in terms of income-elasticity, productive process, technology, productivity and distribution of income between wages and profits, among other things. The simulations that can be performed should therefore be seen from a comparative-statics perspective, to provide a general overview of job-creation and remuneration trends.

To perform a dynamic analysis it would be best to compare the results using matrices from different years. This is even more necessary when considering the existence of increasing returns to scale (the Kaldor-Verdoorn effect), which would require taking account of productivity increases arising from the output expansion cycle. The input-output tables assume constant returns to scale, which means that the same relative combinations of productive factors will be used for any amount produced.

Lastly, it should be noted that these simulations do not consider the possibility of intra-sectoral functional redistribution over the business cycle. It is possible that factors such as wage negotiations, an increase in workers' bargaining power, taxation and productivity, among others, could cause changes in the share of labour income in each sector.

3. Results of the simulations

As it is known how to calculate the level of employment and remuneration associated with a given structure of value-added, it is possible to simulate the effects of a structural change on the functional distribution of income and level of employment. The simulations shown below used the input-output tables published by the, IBGE, for 2005 at the 55-subsector level

The use of input-output tables from a different year than that used to construct the productive structure vector could cause inaccuracies in the simulation results obtained, owing to changes in technology, production processes and productivity levels. Nonetheless, the period of analysis in question is too short for major changes, and the most recent input-output table published in official Brazilian statistics is for 2005, since Brazil publishes these indicators much more frequently than other countries. Thus, using a 2005 matrix would be unlikely to induce errors that are important enough to make its use unviable, duly adjusted to the purposes of this study.[1]

(a) *Evaluation of the effect of structural change*

The first simulation basically consisted of breaking down the observed variation in remuneration and employment to evaluate the extent to which this was due to the change in productive structure that occurred between 2003 and 2007. For that purpose, the remuneration and employment results were calculated as if there had been no change in the productive structure — in other words, as if the sector shares of value-added had been the same in 2007 as in 2003. Equation (5) shows the variation actually observed from 2003 to 2007.

$$\Delta E = (E_{2007}^{estruc\ 2007} - E_{2003}^{estruc\ 2003}) \qquad (5)$$

As an algebraic device, equation (5) includes the 2007 employment level, assuming that the 2003 structure of value added ($E_{2007}^{estruc\ 2003}$). Equation (6) separates the total change into two effects. The first summation refers to the effect of structural change, in other words, the extent to which the total variation of employment can be attributed to a change in the productive structure. The second summation refers to the effect of demand, because both employment levels (observed and estimated) are associated with the 2003 productive structure:

$$\Delta E = (E_{2007}^{estruc\ 2007} - E_{2007}^{estruc\ 2003}) + (E_{2007}^{estruc\ 2003} - E_{2003}^{estruc\ 2003}) \qquad (6)$$

Table 12 shows the results of applying this exercise to the Brazilian economy in relation to employment levels, remuneration and the functional distribution of income.[2] This shows that the changes in productive structure that occurred between 2003 and 2007 had contrasting effects in terms of employment and pay. The level of employment actually observed in 2007 was lower than it would have been if there had been no changes in the productive structure. In contrast, remuneration and, hence, the functional distribution of income, benefited from the growth of total remuneration, because 0.7 percentage points of the 2.3 percentage point increase can be attributed to the change in the productive structure. Thus, the calculations show that the effect of the structural change was negative for employment (24.4%) and positive for pay (8.8%). Thus, in keeping with the observed growth cycle, it can be seen that the effect of demand is positive for both the level of jobs and remuneration.

[1] The sum of the estimations of values added, employment and remunerations had to be adjusted by a common factor calculated in each of those categories, since a 2005 matrix was used to evaluate 2007 structures.

[2] In all of the results of the simulations performed in this research, the first and third columns referred to actually observed levels, while the second column reports the result of the estimation.

The concept of structural heterogeneity helps to explain the divergent effects of the productive structure on employment and remuneration. By way of illustration, figure 4 relates the sector distribution of the employed population to average sector remuneration. The dotted line represents average total remuneration of R$11,600; and it can be seen that roughly 70% of the employed population works in sectors with below-average pay. This is not the case of the manufacturing industry, however, which, as the figure shows, accounts the largest population group employed in sectors with above-average pay. Moreover, just three sectors (financial services, mining and public utility services) absorb just 2.2% of employment, but their pay levels are almost triple the level of aggregate average remuneration.

In that context, understanding the divergent behaviour of remuneration in relation to jobs requires calculating the sector breakdown of the difference between the results observed in 2007 and the hypothetical estimate assuming no structural change. Table 13 sets out the results, ranked in ascending order of average sector remuneration in 2007. In the lowest-paid sectors, particularly agriculture, which has the lowest sector-average remuneration, there was an aggregate loss of jobs owing to the changes are productive structure. In contrast, sectors with above average pay levels, in addition to having generated positive job creation, accounted for nearly 80% of the total change in remuneration, thereby making a large contribution to the improvement in the functional distribution of income.

TABLE 12

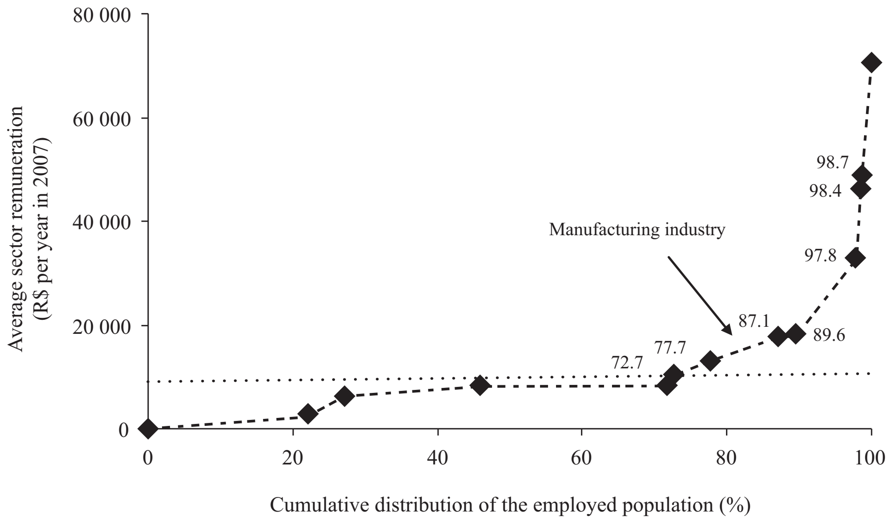
Simulation: productive structure of 2003

	2003	2007 simulated	2007
Jobs	84 034 981	97 324 264	94 713 909
Remuneration (R$ thousand)	895 961 738	1 082 019 140	1 099 903 000
Labour income (% of value-added)	45.7	47.3	48.1

Source: Prepared by the author.

FIGURE 4

Brazil: cumulative distribution of the employed population by average sector remuneration
(Percentages)



Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

TABLE 13

Breakdown of the effect of structural change by sectors

Sector	Variation in remuneration (R$ million)	Variation of jobs (thousands)	Jobs (Percentages en 2007)	Average remuneration (R$ per year)
Agriculture	(13 344)	(6 231)	22	2 833
Construction	898	1 431	5.0	6 152
Commerce	14 886	(720)	18.8	8 368
Other services	1 593	378	25.9	8 494
Real estate services	(1 087)	(270)	0.9	10 432
Below-average remuneration	2 945	(5 411)	72.7	
Transport services	1 288	(657)	5.0	13 078
Manufacturing industry	(1 732)	2 537	9.4	17 840
Information technology services	2 089	(720)	2.5	18 352
Public service	6 260	2 048	8.2	32 811
Public utilities	667	(180)	0.6	46 283
Mining industry	29	(30)	0.3	48 980
Financial services	5 209	(197)	1.3	70 630
Above-average remuneration	13 810	2 801	27.3	16 611
TOTAL	*16 755*	*(2 610)*	*100.0*	*11 613*

Source: Prepared by the author on the basis of data from the Brazilian Geographical and Statistical Institute (IBGE).

(b) *Simulations with an increased industry share*

The notion that better economic results depend on industrialization is a familiar one. Accordingly, two simulations are now performed in which manufacturing industry would have a 19.2% share of the structure of Brazilian GDP, this figure being chosen because it is the highest level achieved by this indicator since economic stabilization in 1994.

— *Share of Brazilian industry in value-added equal to 19.2%; the share of the other sectors is proportional to the current structure*

The first simulation considered an increase in the industry share, with the rest of the sectors being distributed proportionately to their value-added shares in 2007.

The results shown in table 14 confirm that increasing the manufacturing industry share of value-added does not necessarily improve employment and pay levels. The productivity differences arising from structural heterogeneity are such that progress in industry without changes in the intra-sectoral structure, in terms of intensive technology use, combined with a reduction in the share of sectors with higher job creation potential, fail to produce positive results in terms of either employment or remuneration.

— *Share of Brazilian industry in value added equal to 19.2%, with technology-use intensity similar to that of the United States*

The second simulation considered an increase in the industry share, with the rest of the sectors distributed proportionately according to the technology-use intensity of industrial output in the United States. Basically, an intra-sectoral restructuring was performed with shares measured by United States technology-use intensity. This means that the share of engineering-intensive sectors had to increase, from 5.0% to 9.8% of total value-added, while the natural resource and labour-intensive sectors were adjusted respectively from 8.2% to 4.2% and from 3.8% to 3.1%[3].

The results shown in table 15 confirm the importance of technological progress for increasing the share of remuneration in output. Unlike the previous simulation, when the structure of industrial output is changed the share of remuneration in output exceeds the 2007 level. Employment, however, continues to report a result inferior to that actually observed.

[3] An adjustment was also made to ensure that the subsectors comprising each of the technological-intensity groups proportionally matched their share in the Brazilian industrial structure of 2007.

TABLE 14

Simulation: percentage of manufacturing industry = 19.2%

	2003	2007 simulated	2007
Jobs	84 034 981	91 349 316	94 713 909
Remuneration (R$ thousand)	895 961 738	1 098 549 498	1 099 903 000
Labour income (% of value added)	45.7	48.0	48.1

Source: Prepared by the author.

TABLE 15

Simulation: percentage of manufacturing industry = 19.2%, with United States technology-use intensity

	2003	2007 simulated	2007
Jobs	84 034 981	92 406 926	94 713 909
Remuneration (R$ thousand)	895 961 738	1 104 357 094	1 099 903 000
Labour income (% of value added)	45.7	48.3	48.1

Source: Prepared by the author.

(c) *Simulations with the productive structure of the United States*

Lastly, simulations were performed based on comparisons with the structure of the United States economy, which is viewed as the global technology frontier. In fact, according to the publications reviewed, those exercises aimed to evaluate the effects of productive convergence in the Brazilian economy on employment and remuneration. Two types of convergence were considered: industrial value-added and GDP.

— Industrial structure equal to that of United States, considering the intensity of technology use and share of industry in value added of 17.0%

The first simulation aimed to evaluate the effects of a change in the industrial productive structure, by technology-use intensity, while holding the manufacturing industry share at 17.0%. The results are presented below for employment, remuneration and the income distribution, compared to the figures actually observed in 2003-2007 (see table 16).

As can be seen, the simulated structure produced progress in terms of the functional distribution of income, but with a lower level of employment than actually recorded in 2007. This confirms the tendency for a structure with a larger proportion of engineering-intensive sectors to boost remuneration levels, albeit with less job creation.

— United States GDP structure

The second simulation provides a more in-depth view of change in the productive structure, by considering how job creation and remuneration in the Brazilian economy would behave if its GDP were distributed similarly to that of the United States. For ease of reading, a comparison of the productive structure of GDP in Brazil and the United States is provided below in table 17.

TABLE 16

Simulation: percentage of manufacturing industry = 17.0%, with United States technology-use intensity

	2003	2007 simulated	2007
Jobs	84 034 981	92 943 457	94 713 909
Remuneration (R$ thousand)	895 961 738	1 104 913 772	1 099 903 000
Labour income (% of value added)	45.7	48.3	48.1

Source: Prepared by the author.

TABLE 17

Productive structure of Brazil and the United States, 2007
(Percentages)

Sector	Brazil	United States
Agriculture	5.6	0.9
Mining and oil	2.3	1.6
Manufacturing industry	17.0	11.3
Public utility services	3.6	1.6
Civil construction	4.9	5.5
Commerce	12.1	13.4
Transport, storage and postal services	4.8	2.9
Information services	3.8	3.6
Financial services	7.7	8.2
Real estate and rental services	8.5	8.7
Other services	14.2	30.3
Administration, public health and education, and social security	15.5	11.7

Source: Brazilian Geographical and Statistical Institute (IBGE) and Bureau of Economic Analysis (BEA).

The main differences between the GDP structures are the smaller share of the agriculture and manufacturing industry sectors in the United States, and a larger share of other services (basically owing to business services, health and commercial education). When that productive structure is simulated for the Brazilian economy, the results reported in table 18 are obtained:

TABLE 18

Simulation - productive structure of the United States

	2003	2007 simulated	2007
Jobs	84 034 981	96 916 468	94 713 909
Remuneration (R$ thousand)	895 961 738	1 180 901 144	1 099 903 000
Labour income (% of value added)	45.7	51.6	48.1

Source: Prepared by the author.

The results of this latter simulation are highly significant in terms of improvements in the functional distribution of income and a higher level of employment. With the United States GDP structure, wages represent more than 50% of output, which reinforces the idea that the productive structure is a decisive factor for the functional distribution of income. Another interesting point is that this result was obtained despite a reduction in the industry share of GDP. This shows that the importance of industrialization is not measured in terms of its share in value-added, because many of the jobs and much of remuneration paid in the industrial sector depends on articulation with other sectors in terms of the productive chain, as noted above.

4. Summary of the simulations performed

Lastly, table 19 provides a summary of the simulations performed throughout the study. In functional-distribution terms, the best result was obtained from the simulation in which the GDP structure mirrored that of the United States — as would be expected, given the major change involved in that hypothetical case. In terms of jobs, the largest volume was obtained by maintaining a productive structure equal to that of 2003. This result is based on the positive relation between technology and the generation of high wages, as seen in simulations in which the industrial structure reproduces the technology-use intensity of the United States economy. Nonetheless, that case produces a lower figure for the number of jobs, thereby indicating a trade-off between job creation and remuneration in the hypothetical cases where engineering-intensive sectors account for a larger share of manufacturing industry.

TABLE 19

Summary of simulations performed

	Functional distribution (Share of remuneration in output)	Jobs
Results obtained		
2003	45.7	84 034 981
2007	48.1	94 713 909
Simulations		
Simulation GDP of 2007 with 2003 structure	47.3	97 324 264
Simulation of manufacturing industry = 19.2%	48.0	91 349 316
Simulation manufacturing industry = 19.2%, United States technology-use intensity	48.3	92 406 926
Simulation manufacturing industry = 17.0%, United States technology-use intensity	48.3	92 943 457
Simulation GDP distribution of United States	51.6	96 916 468

Source: Prepared by the author.

GDP: Gross domestic product.

IV

Final thoughts

From the standpoint of structuralist theory, which sees heterogeneity in the productive structure as one of the key factors explaining the historical inequalities that characterize the Latin American economic development process, it can be stated that, in the recent cycle, the Brazilian economy showed some signs of having filled Fajnzylber's infamous "empty box", combining a revival of growth with improvements in the functional distribution of income. The change in the industrial productive structure, with a larger proportion of engineering-intensive sectors, played a fundamental role in promoting a larger share of labour income in output, despite a reduction in the share of manufacturing industry in GDP throughout the 2003-2007 cycle. Moreover, the structural change observed produced side-effects that mainly benefited remuneration, because employment would have been even greater if the productive structure had not suffered changes in the period.

This article has also sought to highlight the importance of input-output tables as a tool of economic planning and industrial policy. As this is an instrument in which the three approaches to the breakdown of output can be combined, the matrices make it possible to relate the effects of the productive structure on the functional distribution of income, and to confirm the classical and structuralist principles that output shares are determined in productive process. The use of the matrices also revealed the importance of inter-sectoral articulations for analysing aggregate results in terms of jobs and remuneration. The results of one sector often depend on what happens in the other sectors, so only an integrated analysis of the economy produces satisfactory results in terms of economic planning

It is therefore timely to stress another relevant point of this research: the fact that a larger industry share does not necessarily produce better results in terms of employment and income distribution. More important is the function fulfilled by technical progress leading to increase in the share of engineering-intensive sectors. Nonetheless, the tendency for those sectors to create fewer jobs raises the issue of the trade-off between job creation and wages.

The methodology proposed in this study is considered useful as a tool of industrial policy-making in Latin American countries. Consequently, a more in-depth analysis is needed of the recent sector performance of the other Latin American economies. For that purpose, it would be very important for research institutes to update their input-output tables more frequently. Other relevant research would consist of comparing the economic paths of countries in different periods, thereby making it possible to dynamically evaluate changes in the productive structure and income distribution, considering the technological changes and those that occurred in the production process.

Lastly, further progress could have been made in this research if the productivity dimension had been analysed in greater depth. According to the ECLAC tradition, overcoming structural heterogeneity and inequalities depends on bringing domestic and external productivities into line. In that regard, exercises that combine structural and productivity adjustment hypotheses in explicitly overcoming those gaps would contribute greatly to the structuralist analysis. Special attention could also be paid to the import effects of changes in the productive structure, consistently with balance-of-payments-constraint models — an application that could be used with the input-output model.

As can be seen, the productive structure plays an important role in job creation and remuneration, particularly in heterogeneous economies such as those of Brazil and other Latin American countries. To analyse those effects, it was proposed to revive the input-output models of economic planning, the results of which can guide industrial policy formulation in the region. In fact, the main objective of this article has been to provide an empirical basis for analysing the roots of inequality and the formulation of public policies to overcome it. At a time when the economic status quo is being challenged, industrial policy could play a role in overcoming Latin America' historical challenges and collaborate in defining a new sustained socioeconomic development path that combines economic growth with reductions in inequality.

ANNEX

Brazil: input-output table for 2005

The Brazilian Geographical and Statistical Institute (IBGE) presents the input-output table for 2005, based on tables of resources and uses. The process of producing the input-output table can be viewed in two stages. The first consists of the task of compiling various data sources and preparing basic production and consumption tables. The second stage involves applying a mathematical model which, based on those tables and on hypotheses regarding technology, are used to calculate a matrix of technical coefficients according to the model developed by Leontief. The Brazilian matrices used models for calculating the technical coefficients that had small changes in their formulation

The IBGE publishes the results of the matrices at two levels of economic-activity aggregation: level 12 and level 55. As an illustration of the sectoral inter-relations prevailing in the Brazilian economy in 2005, the Leontief matrix of inter-sectoral impacts and the table of uses of goods and services at consumer prices are presented for the 12-economic-activities level.

ANNEX 1

TABLE A1

Brazil: Leontief matrix

Sector	Agriculture	Mining and oil	Manufacturing industry	Public utility services	Civil construction	Commerce	Transport storage and postal services	Information services	Financial services	Real estate and rental activities	Other services	Public services
Agriculture	1.136053	0.031459	0.144723	0.015871	0.041238	0.01312	0.039742	0.015427	0.009803	0.002449	0.030883	0.013768
Mining and oil	0.030290	1.079399	0.084589	0.050569	0.033204	0.007916	0.022308	0.009133	0.005626	0.001621	0.015621	0.008092
Manufacturing industry	0.430881	0.312399	1.583156	0.156302	0.413684	0.129652	0.396527	0.150019	0.094689	0.024123	0.265715	0.127596
Public utility services	0.028241	0.073559	0.069264	1.296158	0.023515	0.030838	0.040689	0.033250	0.015892	0.002837	0.042569	0.029696
Civil construction	0.001621	0.016647	0.004414	0.002153	1.022438	0.002486	0.002304	0.007581	0.008303	0.023718	0.008198	0.026701
Commerce	0.067389	0.048929	0.088996	0.027464	0.078135	1.035860	0.063871	0.029376	0.020773	0.004657	0.052319	0.025984
Transport, storage and postal services	0.050472	0.139542	0.080737	0.039839	0.040493	0.059455	1.117527	0.041226	0.022356	0.003691	0.043073	0.021846
Information services	0.015969	0.062771	0.034608	0.031176	0.015124	0.027148	0.031280	1.210599	0.062448	0.003978	0.080727	0.066850
Financial services	0.028747	0.039324	0.045616	0.028522	0.024293	0.029488	0.039913	0.040030	1.137310	0.005249	0.022736	0.086142
Real estate and rental services	0.005917	0.013326	0.012105	0.007170	0.005696	0.024794	0.009633	0.031508	0.009722	1.003632	0.014693	0.019984
Other services	0.026390	0.094315	0.062310	0.075690	0.040136	0.074733	0.091721	0.128319	0.096790	0.013274	1.085023	0.094432
Public services	0.002456	0.005582	0.004597	0.007805	0.002481	0.003171	0.004777	0.004413	0.002914	0.000434	0.003688	1.003175

Source: Brazilian Geographical and Statistical Institute (IBGE).

TABLE A2

Brazil: table of uses of goods and services – basic prices
(R$ million)

Sector	Intermediate consumption	Exports	Government consumption	Family consumption	Gross fixed capital formation	Variation in inventories	Final demand	Total demand
Agriculture	122 709	18 043	0	28 195	11 193	(-) 848	56 583	179 292
Mining	78 738	27 728	0	235	0	2 028	29 991	108 729
Manufacturing industry	682 178	224 412	0	320 604	97 073	4 356	646 445	1 328 623
Public utility services	100 163	0	0	34 537	0	0	34 537	134 700
Civil construction	25 482	946	0	0	140 613	0	141 559	167 041
Commerce	116 185	13 217	0	139 835	25 363	0	178 415	294 600
Transport, storage and postal services	112 836	10 059	0	56 344	4 086	0	70 489	183 325
Information services	102 623	953	0	37 861	0	0	38 814	141 437
Financial services	103 341	1 653	1 541	92 360	0	0	95 554	198 895
Real estate and rental services	33 956	2 506	0	158 344	3 895	0	164 745	198 701
Other services	152 147	24 550	10 069	218 393	1 102	0	283 250	435 397
Administration, public health and education, and social security	0	0	415 943	0	0	0	415 943	415 943
Total	*1 630 358*	*324 067*	*427 553*	*1 086 708*	*283 325*	*5 536*	*2 156 325*	*3 786 683*

Source: Brazilian Geographical and Statistical Institute (IBGE).

Bibliography

Bielschowsky, R. (2000), "Cinquenta anos de pensamento na CEPAL. Uma resenha", *Cinqüenta anos de pensamento na CEPAL*, R. Bielschowsky (org.), Rio de Janeiro, Record.

Chatterji, M. and M. Wickens (1983), "Verdoorn's Law and Kaldor's Law: a revisionist interpretation?", *Journal of Post Keynesian Economics*, vol. 5, No. 3, M.E. Sharpe, Inc.

ECLAC (Economic Commission for Latin America and the Caribbean) (2010), *Time for equality: closing gaps, opening trails* (LC/G.2432(SES.33.3)), Santiago, Chile.

_____ (2007), "Progreso técnico y cambio estructural en América Latina", *Project Document*, No. 136 (LC/W.136), Santiago, Chile.

Fajnzylber, F. (1990), "Industrialization in Latin America: from the 'black box' to the 'empty box': a comparison of contemporary industrialization patterns", *Cuadernos de la CEPAL*, No. 60 (LC/G.1534/Rev.1-P), Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC). United Nations publication, Sales No. E.89.II.G.5.

Ferraz, J.C. (2008), "Crescimento econômico: a importância da estrutura produtiva e da tecnologia", *Visão do desenvolvimento*, No. 45, Rio de Janeiro, Brazilian Development Bank (BNDES).

Furtado, C. (2000), "Desenvolvimento e subdesenvolvimento", *Cinqüenta anos de pensamento na CEPAL*, R. Bielschowsky (orgs.), Rio de Janeiro, Record.

_____ (1975), *Análise do modelo brasileiro*, Rio de Janeiro, Editora Civilização Brasileira.

IBGE (Brazilian Geographical and Statistic Institute) (2008), "Matriz de insumo produto Brasil 2000/2005", *Contas nacionais*, No. 23, Rio de Janeiro.

Infante, R. (2009a), "Heterogeneidad productiva y del mercado laboral", *Hacia un desarrollo inclusivo: El caso de Chile* (LC/L.3126), R. Infante and O. Sunkel, Santiago, Chile, Economic Commission for Latin America and the Caribbean (CEPAL).

_____ (2009b), "Distribución del ingreso y heterogeneidad estructural", *Hacia un desarrollo inclusivo: El caso de Chile* (LC/L.3126), R. Infante and O. Sunkel, Santiago, Chile, Economic Commission for Latin America and the Caribbean (CEPAL).

_____ (2007), "Una política de distribución de ingresos desde la perspectiva de la heterogeneidad estructural", *Perspectivas económicas para el Chile del Bicentenario: Desafíos y oportunidades*, M. Jelvez (org.), Santiago, Chile, Centre for Development Research (CED)/United Nations Development Programme (UNDP).

Infante, R. and O. Sunkel (2009), "Hacia un crecimiento inclusivo", *Hacia un desarrollo inclusivo: El caso de Chile* (LC/L.3126), R. Infante and O. Sunkel, Santiago, Chile, Economic Commission for Latin America and the Caribbean (CEPAL).

IPEA (Institute of Applied Economic Research) (2008), "Distribuição funcional da renda no Brasil: situação recente", *Comunicado da presidência*, No. 14, Brasilia.

IPEADATA [online] www.ipeadata.gov.br.

Knell, M. (2004), "Structure change and the Kaldor-Verdoorn law in the 1990s", *Revue d'économie industrielle*, vol. 105, No. 1, Programme National Persée.

Lindeboim, J. (2008), "Distribución funcional del ingreso: Un tema olvidado que reclama atención", *Problemas del Desarrollo: Revista Latinoamericana de Economía*, vol. 39, No. 153, Mexico City, National Autonomous University of Mexico, April/June.

Muñoz, A. and C. Riaño (1992), "La matriz insumo-producto y la distribución del ingreso en Colombia", *Cuadernos de Economía*, vol. 12, No. 17, Bogotá, National University of Colombia.

Pinto, A. (1970), "Naturaleza e implicaciones de la heterogeneidad estructural en América Latina", *El Trimestre Económico*, México City, Fondo de Cultura Económica.

Prebisch, R. (1963), *Hacia una dinámica del desarrollo latinoamericano*, México City, Fondo de Cultura Económica.

_____ (1950), *The economic development of Latin América and its principal problems* (E/CN/12/89/Rev.1), New York. United Nations publication, Sales No. 50.II.G.2.

Sant'Anna, A. (2003), *Distribuição funcional da renda e crescimento econômico na década de noventa: uma aplicação do modelo departamental de Kalecki,* Rio de Janeiro, Federal University of Rio de Janeiro.

Sant'Anna, A. and C.E.F. Young (2007), "The use of input-output analysis to simulate effects of income redistribution on economic growth" [online] http://www.anpec.org.br/encontro2007/artigos/A07A110.pdf.

Schuschny, A.R. (2005), "Tópicos sobre el modelo de insumo-producto: Teoría y aplicaciones", *Estudios Estadísticos y Prospectivos series*, No. 37 (LC/L.2444-P), Santiago, Chile, Economic Commission for Latin America and the Caribbean (CEPAL). United Nations publication, Sales No. S.05.II.G.191.

United Nations (2000), *Handbook of National Accounting: Input/Output Tables – Compilation and Analysis*, New York.