Department of Economics – FEA/USP

# Industrial Growth and Structural Change: Brazil in a Long-Run Perspective

**DANTE ALDRIGHI**

**RENATO P. COLISTETE**

WORKING PAPER SERIES Nº 2013-10

DEPARTMENT OF ECONOMICS, FEA-USP

WORKING PAPER Nº 2013-10

# Industrial Growth and Structural Change: Brazil in a Long-Run Perspective

Dante Aldrighi (aldrighi@usp.br)

Renato P. Colistete (rcolistete@usp.br)

**Abstract:**

This paper presents a long-run analysis of industrial growth and structural change in Brazil, from the coffee export economy in the nineteenth century to the present day. We focus on Brazil's high economic growth in most of the twentieth century and the disruption caused by the collapse of debt-led growth in the early 1980s. We then examine the recent trends in economic growth and structural change, with a sectoral analysis of output, employment and productivity growth. Employing new data and estimates, we identify a sharp break with the earlier period of high outuput and productivity growth in Brazil's manufacturing industry before the 1980s. From the 1990s, the relatively successful process of learning and technological advance by manufacturing firms that took place since the early industrialization has lost strength and Brazil's productivity growth has declined and stagnated.

**Keywords:** Industrial Growth, Structural Change, Brazil

**JEL Codes:** N66, O14, L60

# Industrial Growth and Structural Change: Brazil in a Long-Run Perspective

Dante Aldrighi (aldrighi@usp.br) and Renato P. Colistete (rcolistete@usp.br)*

This paper presents a long-run analysis of industrial growth and structural change in Brazil. From the late nineteenth century Brazil experienced fast economic growth in the wake of booming coffee exports, mass immigration, urbanization and expanding consumer markets. Developing as a natural extension of the burgeoning export economy, local industrial firms grew rapidly in importance and began to supply most of the domestic market for manufactures. By the 1950s the industrial sector surpassed agriculture in its contribution to national output, although Brazil's exports continued to be largely dominated by primary products. Shortage of foreign exchange was thus a constraint on macroeconomic policy for most of the postwar period, which was only temporarily circumvented by heavy reliance on inflows of foreign capital. The debt crisis of the 1980s would have a lasting effect on Brazil's macroeconomic performance. Rapid economic and industrial expansion was replaced by sluggish rates of economic growth even after the adoption of market reforms and the success of stabilization policies from the 1990s. Under the new economic conditions, industrial development has changed significantly and faced new challenges.

This story of boom, bust and low growth is the subject of this paper, with a focus on the long-run performance of the manufacturing sector. We begin with the first developments of Brazil's coffee export economy from the mid-nineteenth century and examine how this structure turned out to be one of the most dynamic economies until the 1970s. We highlight the disruption caused by the collapse of debt-led growth in Brazil in the early 1980s, when the historical record of fast economic and industrial growth was reversed. We then examine the recent trends in industrial growth and structural change.

Besides relying on historical and contemporary studies, we also provide new data and evidence on key aspects of the industrialization process in Brazil. The paper is organized in three sections. The first one addresses the origins of industrialization in the nineteenth century until the 1930s. The second section deals with the postwar years until the 1980s. The third section examines the new economic conditions during the last two decades and their effects on the Brazilian industrial sector.

* Paper presented in the BRICS conference held at UNIDO, Vienna, on 16-17 August 2012. We thank Eddy Szirmai and all the participants of the conference, as well as Irineu Carvalho Filho, Gustavo Barros and Svante Prado for their comments and suggestions. We are also indebted to Joaquim Guilhoto for his help with National Accounts data.

## I. Historical origins and development of industrialization

Modern research has portrayed industrial growth and diversification in Latin America as a long-run phenomenon which had its roots in the nineteenth century. Beginning with a few start-ups aimed at meeting the domestic needs of nondurable consumer goods, local manufacturing grew in the shadow of the export of primary products and gained ground in the largest Latin American economies during the early decades of the twentieth century. This is a story at variance with a long-held view of the beginning of local manufacturing as a by-product of the Great Depression and the collapse of Latin America's export sector during the 1930s.[1]

In the wake of rapidly increasing exports of coffee since the first half of the nineteenth century, Brazil turned out to be one of the most prominent cases of early industrialization and structural change in Latin America. Nonetheless, the impact of coffee exports on nineteenth century growth is blurred by a lack of accurate data. Estimates of GDP per capita growth diverge considerably in what they tell about both the first and second half of the nineteenth century, leading to different conclusions as to the role of exports in the Brazilian economic growth. According to Celso Furtado, for example, Brazil's GDP per capita contracted from 1800 to 1850 mainly as a result of the decline in gold mining activity. For the 1850-1900 period, however, he estimated an annual growth of GDP per capita of 1.5 percent, largely as a result of booming coffee exports in the southern states of the country. For the same period, Furtado calculated that the average growth of GDP per capita in the old sugar region of northern states was -0.6 percent, while southeast Brazil grew at 2.3 percent per annum (Furtado 1959, chapters 19 and 25).

While Furtado's figures suggest that exports of coffee and other primary products were the major drivers of economic growth in nineteenth century Brazil, other estimates show a different pattern. Richard Goldsmith, for example, found a significantly smaller (0.3 percent) annual growth rate of income per capita in Brazil during the second half of the nineteenth century (Goldsmith 1986, 20-4). A similar yearly rate of growth (0.4 percent) was calculated by Cláudio Contador and Cláudio Haddad for the period 1861-1900 (Contador and Haddad 1975, 411-2). Angus Maddison's estimates in purchase power parity (PPP) also diverge from Furtado's figures. As Maddison's GDP data are from Goldsmith (1986), their results are similar: according to the former, Brazil's average real income per capita in PPP international dollars of 1990 was $422 in 1800 and $686 in 1850, implying an annual compound rate of growth of 1.0 percent. His figures for the second half of

[1] The most compelling criticism of the view that the collapse of the export sector marked the beginning of industrialization in Latin America is Dean (1969). For recent analyses, see Haber 2006; Williamson 2011a; Bértola and Ocampo 2012.

nineteenth century show a negative growth in income per capita (-0.02 percent per annum), which means a low impact of exports on Brazil's income per capita during the coffee export boom.[2]

Direct estimates of the role of the export sector in Brazil's early development are not conclusive either. For example, Goldsmith's figures show that the average share of exports in GDP reached 16.8 percent between 1850 and 1870, fell to 15.3 percent from 1871 to 1900 and rose again to 17.6 percent between 1901 and 1913.[3] In turn, William Summerhill showed that one of the series estimated by Contador and Haddad implied that the share of exports in GDP declined from 44 percent in 1861 to 27 percent in 1900 and 17 percent in 1913 (Summerhill 2003, 144-8).

Even though the relative share of the export sector did decline so drastically, it does not mean that coffee exports were less important for Brazil's economic growth in the late nineteenth century. As Summerhill points out, the falling share of the export sector despite its high growth indicates that the expansion of the rest of the economy surpassed that of the export production (Summerhill 2003, 144-5). A successful growth process induced by exports depends on the strength of the linkages and externalities between the export base and other sectors of the economy. Neither a large nor a steadily growing share of exports in domestic production is a good measure of the role of exports in promoting sustained economic growth. Instead, a successful export-led growth should be expected to lead to a more than proportional increase in the domestic sector through its multiplier effects and induced investments (North 1955, 250-5; Watkins 1963, 149-52; Crafts 1973). As for Brazil, linkages and learning effects generated by the fast-growing coffee export sector seem to have been strong enough to stimulate investments in activities like immigration, railways, banking, public utilities, non-export agricultural goods and manufacturing industries, which led to an even more rapid growth of the domestic sector in the Brazilian economy.[4]

Table 1 summarizes basic macroeconomic indicators for the period 1850-1940. As noted before, the estimates of GDP and GDP per capita (from Goldsmith 1986) show that Brazil's economic growth only accelerated from the first decade of the twentieth century. As early as in the 1850s, coffee sales abroad represented nearly 50 percent of total exports, accounting for 64 percent of Brazilian exports by the 1890s. When other products like rubber, sugar and cotton are considered, agricultural goods represented more than 80 percent of total exports. As pointed out,

---

[2] Calculated from Maddison (2001) and his historical statistics database available on the Groningen Growth & Development Centre website: http://www.ggdc.net/maddison/Maddison.htm

[3] Calculated from Goldsmith (1986), 54-5, 110-1.

[4] Dean (1969) provided the most systematic study of the spread effects of the coffee economy in Brazil, but the notion that coffee sales abroad drove Brazilian economic growth and diversification from the 1850s was already well established among historians such as Caio Prado Jr. (1945) and Monbeig (1949).

however, the size of export sector in Brazil was relatively small when compared to national output.[5] Even before the collapse of commodity prices brought about by the Great Depression, the share of total exports in Brazil's GDP was on average 13.5 percent during the 1920s. Still, if we follow Lloyd Reynolds (1983, 958 and 968) in his analysis of relations between GDP, population and exports, Brazil had its turning point from extensive to intensive growth in 1850. Real exports (average of 3.8 percent per annum) grew faster than real GDP (2.7 percent) and population (2.1 percent) between 1855 and 1913.

*Table 1* - Macroeconomic indicators, Brazil, 1850-1940

| | Annual average growth (percent) | | | Average shares (percent) | | |
|---|---|---|---|---|---|---|
| Years | GDP | GDP per capita | Manufacturing investment | Coffee exports in total exports | Agricultural exports in total exports | Total exports in GDP |
| 1850-1860 | 3.0 | 1.4 | 23.5 | 48.7 | 83.8 | 17.0 |
| 1860-1870 | 2.5 | 1.0 | 6.8 | 45.8 | 84.1 | 16.4 |
| 1870-1880 | 1.7 | -0.2 | 4.7 | 56.4 | 89.6 | 14.8 |
| 1880-1890 | 2.3 | 0.4 | 10.9 | 61.6 | 89.4 | 13.7 |
| 1890-1900 | 0.6 | -1.7 | -2.9 | 64.3 | 93.1 | 17.7 |
| 1900-1910 | 4.8 | 2.7 | 11.2 | 51.5 | 90.8 | 18.0 |
| 1910-1920 | 4.8 | 1.9 | 7.4 | 52.8 | 79,8 | 14.8 |
| 1920-1930 | 4.6 | 2.5 | 4.2 | 68.6 | 83.4 | 13.5 |
| 1930-1940 | 4.5 | 2.4 | 7.6 | 53.2 | 74.5 | 11.3 |

Sources: GDP and GDP per capita: Goldsmith (1986), who uses figures from Haddad (1980) after 1910; manufacturing investment: basic data of exports of machinery to Brazil from Suzigan (2000) and population data from Mortara (1941) and IBGE (1939-1940); export data: IBGE (1939-1940).

Notes: Manufacturing investment = value of exports of machinery from Great Britain, United States, Germany and France to Brazil in sterlings, normalized by Brazil's population. GDP and GDP per capita growth in constant prices of 1910. Average shares were calculated in local currency and nominal values. Agricultural exports include coffee, cocoa, mate, tobacco, sugar, cotton and rubber.

Tentative as they are, the estimates of GDP and the role of export sector are useful but at the same time they are only limited approximations of the overall trends in production in the remote past, saying relatively little about structural change and the emergence of new activities such as manufacturing. Even though data on industrial activities in Brazil during the nineteenth century is lacking, a rough estimate of the investment rate in the manufacturing industry based on world exports of machinery to Brazil, normalized by population, suggests that industrial production to domestic markets grew at significant rates earlier in the nineteenth century – for example, the

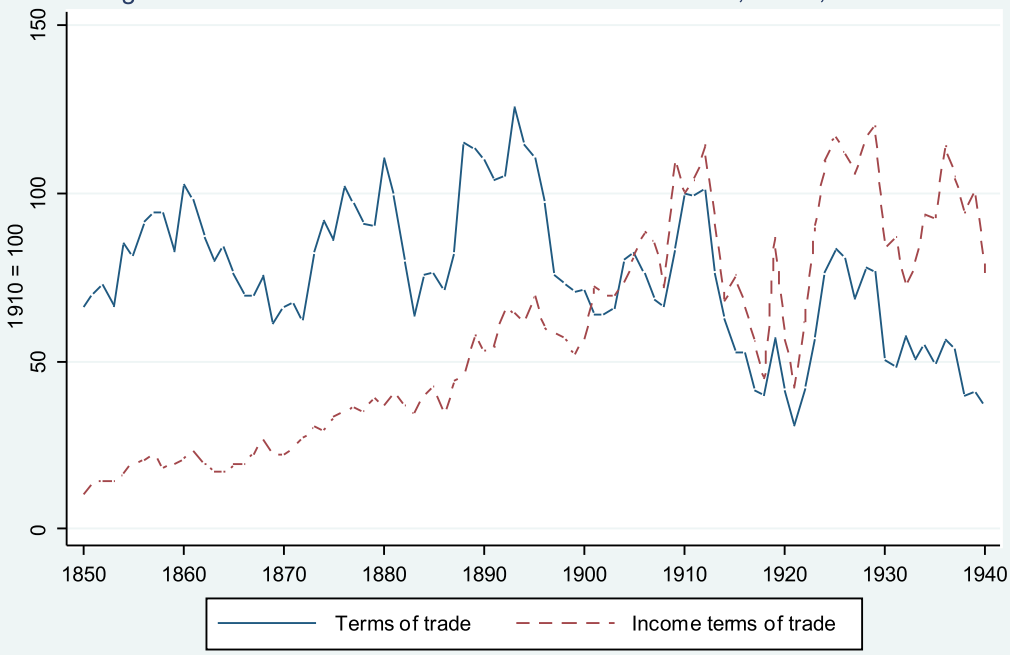
[5] See other countries' proportions in Kuznets (1967), 19-21.

annual average growth rate of manufacturing investment reached 10.9 percent during the 1880s (Table 1). This is an important evidence that the booming export sector generated important linkages and externalities that spurred local production and domestic markets, as we will see below.

Another way to assess the relation between exports and industrialization is to look at the behavior of world prices. Latin America has been described as an example of the role played by the relative price of exports in structural change, although for reasons opposite to those just summarized. Aurora Gómez-Galvarriato and Jeffrey Williamson have argued that Latin American countries suffered from powerful deindustrialization forces as a result of a long upswing of the terms of trade in most of the nineteenth century. It was only when this trend in the relative price of exports reversed from the 1870s that Latin America embarked on industrialization (Gómez-Galvarriato and Williamson 2009; Williamson 2011b).

How does this framework fit with Brazil's early industrialization until World War I? Figure 1 shows the behavior of terms of trade in Brazil between 1850 and 1940, a period which saw a remarkable growth of manufacturing in this country.

Figure 1 - Terms of Trade and Income Terms of Trade, Brazil, 1850-1940




Sources: 1850-1912: IBGE(1990), pp. 597-8; 1913-1940: IBGE (2006), Foreign Sector, Table 7.

It is clear from the figure that Brazil's terms of trade showed no trend until World War I. Instead, terms of trade were highly volatile until 1913, with ups and downs which followed the pattern of the main commodities exported, especially coffee. This evidence indicates that the terms of trade are not a good predictor of Brazilian early industrialization, differently from what Gómez-

Galvarriato and Williamson have argued. In fact, only Mexico experienced a sharp reversal in terms of trade among the largest economies in Latin America by the end of the nineteenth century.[6]

That terms of trade were highly volatile and do not appear to have been a decisive factor in Brazil's early industrialization do not imply, again, that the export sector was less significant for growth. The income terms of trade (or "capacity to import") show the purchasing power of a country's exports and help explain how the latter can contribute to the diversification of economic activities in a country which goes through a sustained export boom.[7] As done for the terms of trade, Figure 1 plots Brazil's income terms of trade index, which in this case displays a clear upward trend since 1850 to 1913. In the beginning, the fall of the international coffee prices was counteracted or mitigated by an increase of the volume of exports. As coffee production jumped to ever growing levels, stimulated by high prices in international markets, income terms of trade tended to fluctuate more widely, but the trend remained unchanged.[8]

The increase of the income terms of trade, despite the erratic behavior of the relative price of exports, indicates that the Brazilian economy showed a noticeable capacity to respond to foreign stimuli and mobilize large-scale resources. By 1909 Brazil accounted for 76 percent of the world coffee production – the share of the state of São Paulo alone being 61 percent of the world supply (Graham 1912, 10-1). Interestingly, the volume of coffee exported shows significant negative correlation with export prices between 1850 and 1913, even when we allow for a supply lag of 5-6 years corresponding to the time required for coffee trees to reach full production.[9] This result suggests, following Caves (1971, 426-7), that the growth of exports may have been primarily determined by changes in domestic supply rather than by short-run shifts in export demand.

As the largest coffee producer in Brazil, the state of São Paulo is a noteworthy example of how the income generated by primary exports provided the foundation for the growth of industry from the nineteenth century (Dean 1969). New railroads funded by coffee revenues crossed São Paulo's countryside from the 1860s, reducing costs of transport, integrating markets and adding huge areas of fertile land to the export economy. Besides export crops, the railways also gave a boost to the production of goods for the expanding domestic markets (Summerhill 2003). Coffee

---

[6] Gómez-Galvarriato and Williamson (2009), 682. For the variation in the trends of the terms of trade in Latin America, see Salvucci (2006).

[7] Income terms of trade can be formally defined as PxQx/Pm, where Px = price of exports, Qx = volume of exports and Pm = price of imports. For income terms of trade in Latin American countries, see Beatty (2000) and Salvucci (2006).

[8] The coefficient of variation of the income terms of trade rose from 0.195 between 1850 and 1870 to 0.409 between 1871 and 1913. For the impact of coffee cycles in Brazil, see Delfim Netto (1959).

[9] Estimates in first difference, as the series of export prices and quantities from 1850-1913 revealed to be non-stationary and integrated of order 1. Correlations of the differenced series with lags are significant at 10% level, at least.

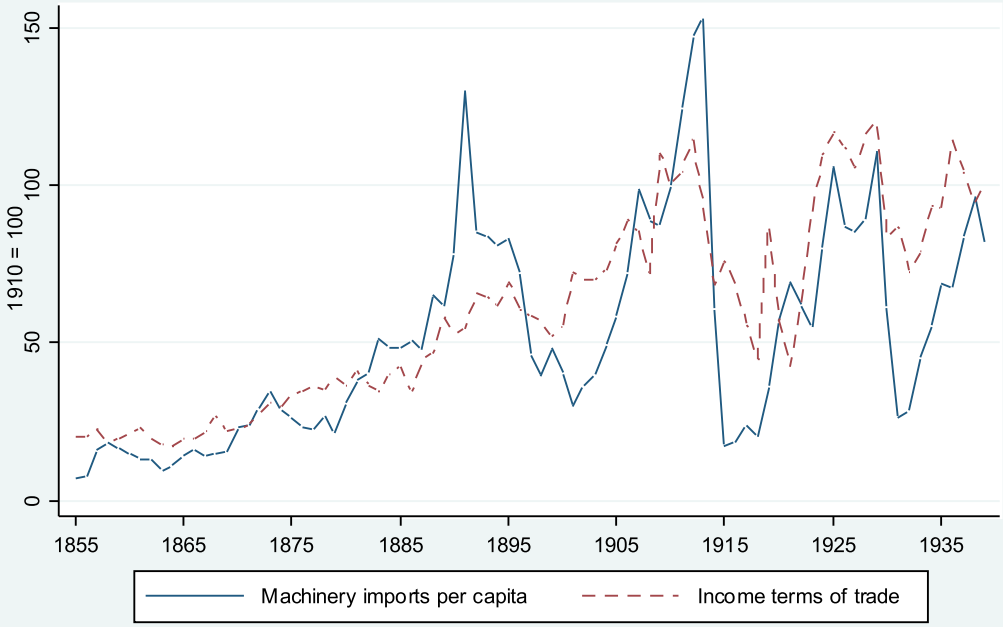
earnings were behind new investments in import firms, banking, public utilities and manufacturing companies (Cano 1977; Saes 1986a; 1986b; Hanley 2005). The arrival of European immigrants began timidly in the 1840s and, with the approval of a subsidized immigration program which took advantage of adverse social conditions in peripheral Europe, thousands of immigrant families began to flood São Paulo's rural and urban labor markets from the 1880s. The massive European immigration helped to dampen agricultural wages in a time of high growth and exceptionally strong demand for labor (Beiguelman 1968; Hall 1969; Leff 1972; Holloway 1974).

Mainly as a result of the rapidly expanding coffee economy, the last decades of the nineteenth century witnessed a substantial increase in industrial development in Brazil. The share of the industrial sector reached 14 percent of the country's GDP at factor prices in 1910, compared to 35.8 percent of agriculture and 50.2 percent of services (Abreu and Verner 1997, 26). By 1919 the share of local production was more than two-thirds of the value added in manufacturing. Import substitution became particularly widespread in industries such as textiles and food processing, with local firms accounting for more than 85 percent of these sectors' value added. Even in certain branches of more complex production there had been some advance in local manufacturing. One-third of the value added in transport equipment and metallurgy, for example, was supplied by local manufacturers in 1919. As expected, the lowest shares of local production were found in the capital goods industry – for example, only 3 percent in machinery production. In the following decades, local manufacturing production (both national and foreign) continued to grow and diversify. In 1939 the share of domestic supply in manufacturing reached 80 percent, with very high figures in metallurgical goods (more than 95 percent of value added) and substantial participation in intermediate and capital goods industries such as chemical products (60 percent), transport equipment (40 percent), electrical materials (20 percent) and machinery (34 percent) (Fishlow 1972).

Apart from the evidence unveiled by sectoral studies of the coffee economy, a look at long-run indicators can shed further light on the relations between the export economy and early industrialization in Brazil. Two variables are especially illustrative of the forces causing structural change in Brazil since the nineteenth century: machinery investment and inventive activity. Figure 2 plots the income terms of trade and the exports of machinery and equipment destined to industry in Brazil (normalized by population) by its four main international suppliers (Great Britain, US, Germany and France) between 1855 and 1939. The latter series is a good proxy for industrial investment as machinery was not produced locally in significant volume for most of this time span

– although the picture will be less precise with the rise of the domestic production of capital goods particularly in the 1920s and 1930s.[10] The figure shows a long-run relationship between income terms of trade and machinery imports per capita.[11] It seems that, as time progressed, machinery investment loosened its link to the revenues generated by primary exports and became more dependent on the demand shifts in the domestic economy (Fishlow 1972; Suzigan 2000).

Figure 2 - Machinery Imports Per Capita and Income Terms of Trade, Brazil, 1855-1939




Sources: machinery imports: Suzigan (2000); population: Mortara (1941), p. 43; IBGE (1939/1940), p. 1293.

Notes: machinery imports = machinery exports from Great Britain, US, Germany and France to Brasil; values in sterlings per 1.000 residents.

Another way to address the structural change in the export economy is to look at its capacity to innovate. Inventive activity is a major determinant of improvements in the technology embodied in products and processes, which are in turn a key factor to explain increases in productivity and income per capita in the long run. As patenting provides an approximate measure of inventive activity in a society, we use original data on patents as an important indicator of changes in a little-known aspect of early industrialization in Brazil.[12]

Figure 3 shows the number of patents per capita along with income terms of trade in Brazil between 1850 and 1913. The first conclusion that may be drawn from the figure is that, after years of stagnation, patenting activity began to grow rapidly in the 1870s and followed a steadily upward

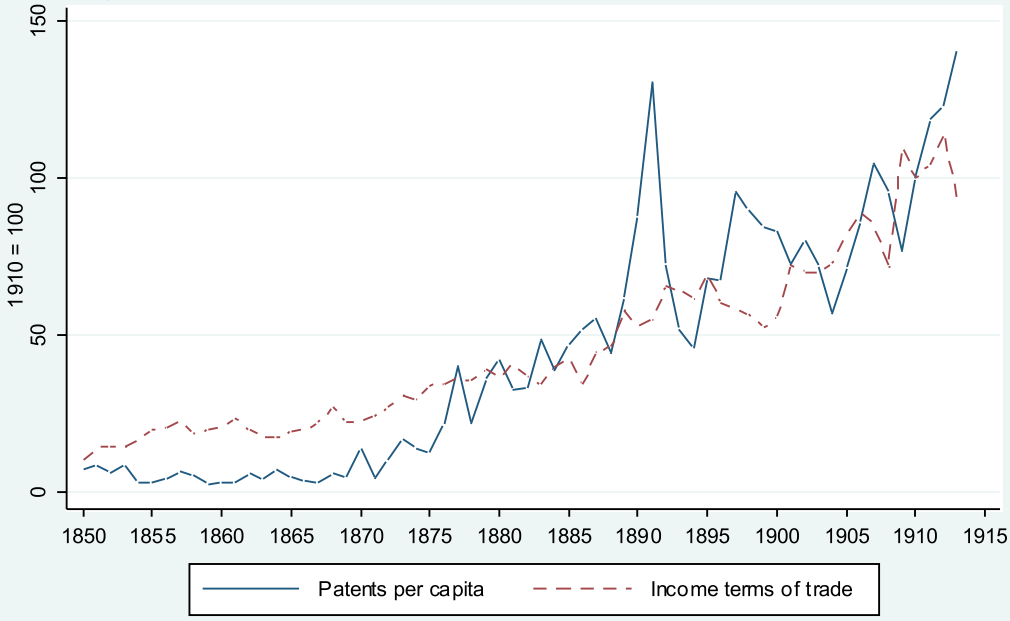
[10] Suzigan (2000), Appendix. See also Taffunel (2009). It should be noted that machinery for agriculture is not included in the series.

[11] Unit-root tests (Dickey-Fuller, Phillips-Perron, DF-GLS, KPSS and Clemente-Montanes-Reyes) indicate that both series are non-stationary. A residual-based test (Engle-Granger) shows that the series are cointegrated. The results are available upon request.

[12] Data for 8,925 patents registered in Brazil by local and foreign applicants. On patenting as a measure of inventive activity and its relation with industrial growth, see Schmookler (1966), Sokoloff (1988) and Macleod (1988).

trend until 1913. This leads to a second important conclusion: early industrialization in Brazil was marked by a sharp rise in inventive activity. Third, patents per capita shows a long-run relationship with income terms of trade.[13] Together, these results suggest that inventive activity was another major aspect of economic growth which may have been fueled by the burgeoning coffee exports in Brazil.

Figure 3 - Patents Per Capita and Income Terms of Trade, Brazil, 1850-1913




Sources: same as Table 2 and Brasil, Relatório do Ministério da Agricultura, various years.
Notes: annual number of patents per 1.000.000 residents. Total number of patents: 8,925.

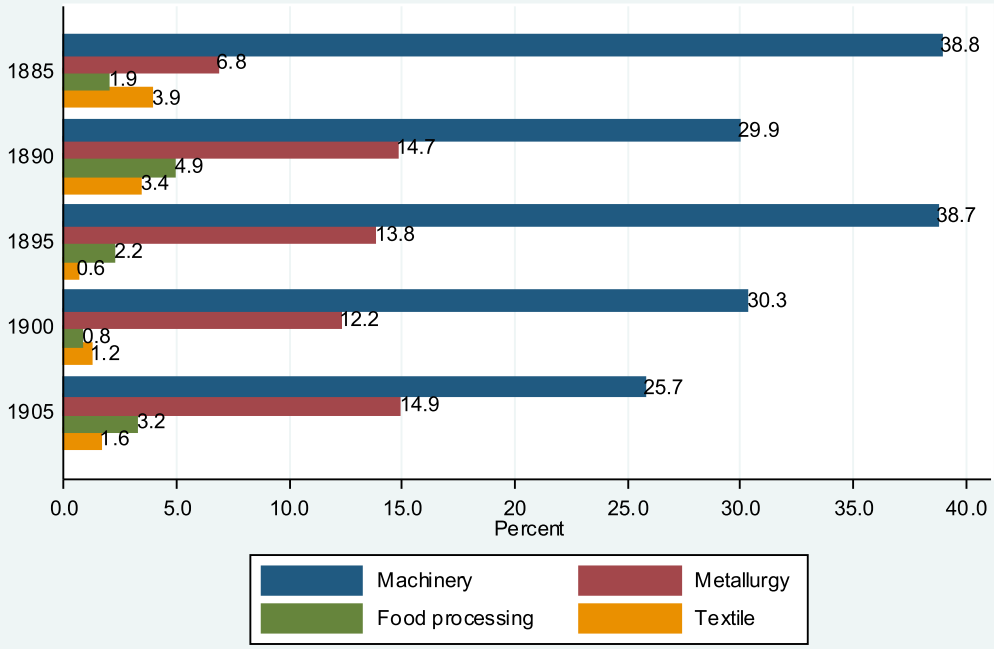
The sectoral distribution of patents reveals that inventive activity was highly concentrated in certain industries. For a sample period (1882-1908) on which we have detailed information about individual patents, more than half of the patent applications in Brazil were related to metalworking industries – that is, metal products, machinery, electrical materials and transport equipment. Perhaps contrary to what might be expected, the then largest industries that displayed the highest levels of import substitution – textile and food processing – showed much lower patenting rates than new industries.

As illustration, we chart in Figure 4 the patent shares of selected industries: two pertaining to the metal trades sector (machinery and metal products) and two relatively well-established industries (textile and food processing) at the turn of the twentieth century. Machinery was by far the industry with the highest propensity to patenting, with patent shares ranging from 39 percent to 26 percent between 1885 and 1905. It was followed by metallurgy, which increased its participation

[13] Both series are non-stationary, but cointegrated, according to the tests described in footnote 11.

in patenting from 7 percent in 1885 to 15 percent in 1905. Textile and food processing were well behind the performance of metal trades: the textile industry's shares never went above 3 percent and food processing only reached 5 percent in 1890 to decline in the following years.

Figure 4 - Patent Shares by Industry, Brazil, 1885-1905

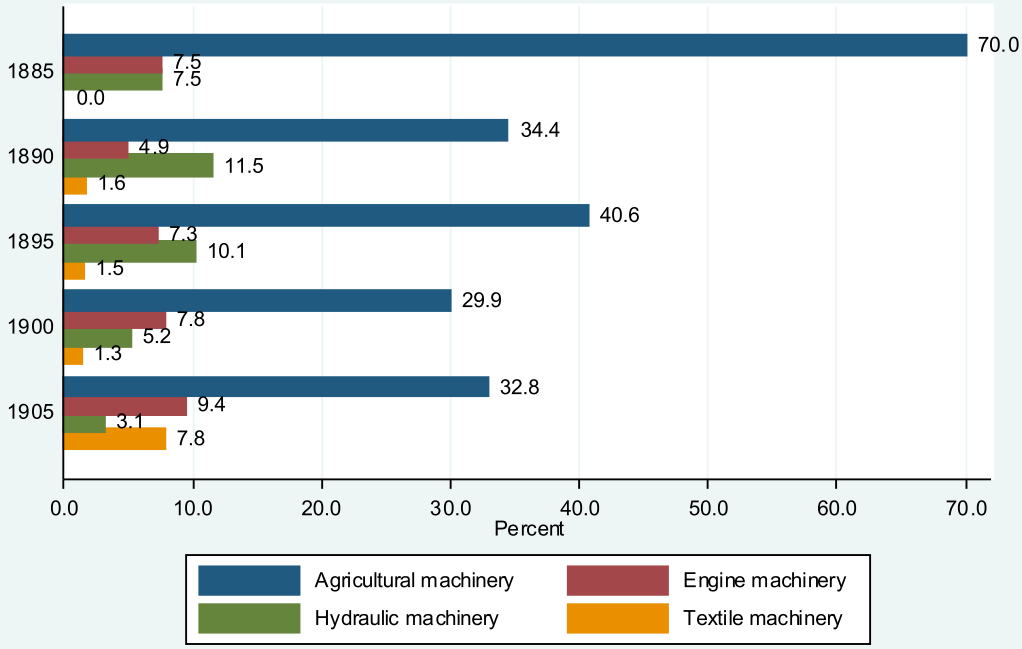



Source: Brasil, Relatório do Ministério da Agricultura, various years.

A further evidence that the export sector played a key role in Brazil's industrial diversification is the distribution of patents within the machinery industry, which stood out for its high rates of inventive activity. As can be gleaned from the selected industries in Figure 5, the shares of special-purpose machinery for traditional industries were relatively low, as in the case of the manufacture of machinery for textile production and food processing. Textile machinery, for example, represented only 1.6 percent of patent applications in 1905. On the other hand, an evidence that substancial productive diversification was taking place is the growth in patenting in general-purpose machinery, i.e. machinery used in a wide range of industries. Patents in manufacturing of engines, turbines and their parts represented 9.4 percent of all recorded inventions in the machinery industry in 1905. More important, however, is that agricultural machinery had the largest share in patent records, with a peak at 70 percent in 1885 then declining to an average of 34 percent in 1890-1905. Most of the inventions were related to the manufacture of special-purpose machinery for coffee processing (hulling and drying, for example), but there were also several patents for rice, cotton, manioc, sugar cane and other products which were mainly consumed in domestic markets (Figure 5). This evidence suggests that the agricultural demand for processing

and other types of machinery was an important spread effect of the export sector, apart from consumer good demand and fiscal linkages most commonly highlighted by historical studies of the Brazilian coffee economy.

Figure 5 - Patent Shares by Machinery Industry, Brazil, 1885-1905




Source: same as Table 4.

Overall the evidence summarized in this section suggests that there was a close connection between export growth and structural change in Brazil since the nineteenth century. Through linkages, externalities and learning effects, the growth of coffee exports boosted investments in an array of new activities, from rail transport, domestic agricultural products and banking to manufacturing production. Structural change and diversification towards new manufacturing activities were characterized not only by extensive growth, but also by an upsurge of inventive activity as measured by patent records. In the following section, we will examine how this emerging industrial sector fared through the World War II until the crisis of the 1980s.

## II. Structural change, high growth and crisis in the postwar years

With the outbreak of World War II, the economies of Latin America continued to be deeply disrupted by international events. For the largest economies in the region, the dislocation of international trade meant that import substitution in the manufacturing industry remained a natural path to be followed in the face of supply constraints imposed by the war. At the same time, local governments and elites became more convinced of the benefits of policies geared to promote

specific industrial sectors and protect the manufacturing industry as a whole. This strategy was reinforced by the fact that during the war – and contrary to what happened in the early 1930s – Latin American countries often benefited from the increased demand for agricultural, mineral and even manufactured products such as textiles by the Allies. Latin American economies gained strength and, as in other parts of the world, state intervention became a key instrument in the promotion of economic development. Accelerated industrialization was targeted as the major engine of growth, one that was capable of rescuing at least the largest economies of the region from their secular reliance upon primary exports and underdevelopment. Such was the institutional framework that shaped public and private decision making in the postwar years in Latin America (Thorp 1998; Haber 2006; Bértola and Ocampo 2012).

The performance of the Brazilian economy in the second half of the twentieth century is well-known and broadly similar to that of other large economies in Latin America. Brazil's economic growth was exceptionally rapid until it was caught by the crisis that engulfed the highly indebted countries from the early 1980s. During the golden age of developmentalism from 1945 to 1980, annual average GDP and industrial growth reached 7.3 and 8.8 percent respectively, which made Brazil one of the highlights among the high-speed, newly industrializing countries at the time. In the following decade, however, the annual average GDP growth dropped to 1.7 percent and industry collapsed to nearly zero-percent growth (0.04 percent) amidst escalating inflation (Baer 2001; Maddison et al. 1992). Table 2 presents Brazil's basic macroeconomic indicators between 1940 and 1990.

*Table 2* - Macroeconomic indicators, Brazil, 1940-1990

| | Annual average growth (percent) | | | | Average shares (percent) | |
|---|---|---|---|---|---|---|
| Years | GDP | GDP per capita | GDP deflator | Manufacturing | Gross domestic investment | Total Exports in GDP |
| 1940-1950 | 6.0 | 3.5 | 12.5 | 9.5 | 12.0 | 10.1 |
| 1950-1960 | 7.4 | 4.3 | 198.9 | 9.2 | 15.5 | 5.9 |
| 1960-1970 | 6.2 | 3.2 | 43.9 | 7.1 | 16.4 | 5.1 |
| 1970-1980 | 8.7 | 6.0 | 40.9 | 9.0 | 21.9 | 6.8 |
| 1980-1990 | 1.7 | -0.3 | 580.8 | 0.04 | 21.9 | 9.4 |

Sources: GDP and Gross Investment data: IBGE (2006); manufacturing: IBGE (2006) and Abreu, ed. (1990); export data: IBGE (1990) and IBGE, *Anuário Estatístico do Brasil*, various years.

Notes: GDP figures in constant prices of 1999. Average shares were calculated in local currency and nominal values.

Foreign direct investment in the 1950s and heavy external borrowing from the late 1960s were functional to the promotion of high levels of domestic investment. Nonetheless, the explosive growth of external debt placed a heavy burden on balance of payments and became a serious constraint on macroeconomic policy already in the mid-1970s (Cruz 1984). As a proportion of GDP, the stock of external debt jumped from 15 per cent in 1970 to 27 percent in 1980. With the rise of international interest rates at the time, the Brazilian economy plunged into a deep crisis which would last for years. By 1985, Brazil's external debt amounted to roughly 50 percent of its GDP and the long period of postwar growth was over. This sequence of boom, bust and growth deceleration continues to be a matter of controversy, even more so because economic growth rates in Brazil now remain well behind what was achieved before the debt crisis of the 1980s (Ocampo and Ros 2011; Palma 2011). A brief examination of the Brazilian economy in the postwar years will help to identify the main institutional and structural features of industrial growth in the period.

The shocks caused by the Great Depression and World War II had an enduring influence on Brazil's foreign trade and economic structure. The share of exports in the GDP decreased from 18 per cent on average in the first decade of the twentieth century to 6 per cent in the 1950s. It was only from the 1970s that there was a modest recovery of the participation of exports in the national product, reaching an average share of 9.4 per cent in the 1980s (Table 2). Indeed, there was a sustained expansion of exports that started early in the 1960s: the annual average growth rate of real exports was 5.0 percent in 1961-1970, 9.5 percent in 1971-1980, and 5.7 percent in 1981-1990, whereas the average growth of real imports was 5.7 percent, 8.7 percent and -0.8 percent in the same periods, respectively. Before these three decades, export growth had been sluggish, with a growth rate of -0.8 percent in 1941-1950 and 1.3 percent in 1951-1960 – compared to an average growth of real imports of 8.9 percent and 4.0 percent in these periods, respectively.[14]

The rapid growth of exports from the 1960s shows another significant change of Brazil's economic structure during the postwar years. Despite fast industrialization, Brazil continued exporting mainly primary products for several years yet (Goldsmith 1986, 280-2). The main agricultural products represented 74 percent of total exports in the 1950s, with coffee alone accounting for 56 percent of total exports. Only during the 1960s did Brazil witness the beginning of a change in the composition of exports, which was consolidated in the following two decades: the share of the main agricultural products fell to an average of 56 percent in the 1960s, then 43

[14] Export and import figures in US$ deflated by the implicit price indexes of exports and imports in US$. IBGE (2006), Foreign Sector, Tables 2 and 7.

percent in the 1970s, and 24 percent in the 1980s.[15] If we consider a classification of exports by their technological content, the average share of manufactures rose from 19 percent in the 1950s to 50 percent in the 1970s, although a substantial part of it was still made up of resource-based manufactures, that is, processed natural resources (31 percent in the 1970s) (Colistete 2010, 19).[16] Thus industrial exports lagged significantly behind the development of import-substituting industries, imposing severe constraints on the balance of payments and the management of macroeconomic policy in Brazil, as well as affecting growth during most of the postwar period (Teitel and Thoumi 1986; Chenery 1980).

The analysis of relative price of exports casts further light on the trends of the foreign sector. As happened before World War II, the behavior of terms of trade was in marked contrast to that of income terms of trade. Figure 6 shows that Brazil's terms of trade recovered in the 1940s and early 1950s from their historically lowest levels reached in the late 1930s, but this trend was reversed in the following years; besides, with the worldwide recession triggered by the oil shocks in the 1970s, they hit new low levels. In turn, Brazil's income terms of trade recovered during the war, remained relatively stagnant until the early 1960s and then experienced a sharp increase for more than two decades.

Figure 6 - Terms of Trade and Income Terms of Trade, Brazil, 1940-1990


Source: IBGE (2006), Foreign Sector, table 7.

[15] Data from IBGE (1939-1940); IBGE (1990); IBGE (1991). Figures calculated in current prices. The main agricultural products are: coffee, cocoa, mate, tobacco, sugar, cotton, rubber, orange juice and soya.

[16] Data for the 1970s refer to 1971-1979. Reliance on resource-based manufactures continue to be an important feature of Brazil's exports today, as shown by Haraguchi and Rezonja (2012).

Another relevant information can be obtained from export prices and quantities. Between 1940 and 1960, prices and quantities displayed a negative relationship, thus indicating that export growth in the latter period was not primarily induced by an autonomous expansion of foreign demand. In the following decades, however, exports grew rapidly even though export prices and quantities did not show significant correlation.[17] The distinctive fact now was that faster export growth from the 1960s was fueled by a gradual shift in the specialization of exports from primary products to manufactures that was largely determined by domestic forces. Two candidates stand out here: first, adoption of more competitive exchange rates and incentives increased the profitability of export sales and provided local manufacturers with a stimulus to look for external markets. Explicit exchange rate policies aimed at promoting export diversification (including manufactures) began to be implemented since the early 1950s, but they often faced the corrosive effect of inflation and a lack of coherence and continuity. During the 1960s, however, exchange rate policies and incentives became more effective, even though a relatively high anti-export bias persisted (Doellinger et al. 1973; Tyler 1976).

Second, fast industrial growth in the postwar years was accompanied by rapidly expanding markets, externalities, and learning effects that resulted in improving standards of Brazil's manufacturing industry. A core group of firms in traditional (textiles, for example) and modern industries (such as machine tools, auto parts and steel) began in the 1950s to adapt foreign technology and develop capabilities in engineering, designing, product quality, and distribution. From their home base, these firms were able to raise productivity and become competitive in external markets in the following decades with the help of favorable exchange rate policies. There were, nonetheless, significant institutional constraints that held back the diffusion of the best practices to the whole industry. As argued by contemporary studies, two major obstacles were the low wages and the high import protection that allowed obsolete methods of production and firms to survive. Those companies that supplied more demanding clients (such as those in the auto parts) or had relatively lower trade protection (such as the machine tools) suffered the pressure to modernize, develop higher skills and produce efficiently. Such were not the conditions, however, faced by the majority of firms – which specialized in supplying the low end of the market. The outcome of these variable conditions was less a lack of technological advance than a highly heterogeneous industrial structure as to technological development, quality production and productivity. Contrary to what is

[17] In both subperiods export prices and quantities series were non-stationary and integrated of order 1. The differenced series show negative correlation significant at 10% level between 1940 and 1960, and no correlation between 1960 and 1990.

argued by the dominant view of import-substituting industrialization, this structure did not prevent the emergence of incremental learning and innovation in Brazil's industry.[18]

A compelling evidence that industrial efficiency increased in Brazil during the postwar years despite major distortions is the performance of labor productivity growth. Table 3 shows the average annual compound growth rates of labor productivity in eighteen industries and in Brazil's manufacturing sector as a whole between 1945 and 1990.

*Table 3* - Growth of labor productivity by industrial sectors, Brazil, 1945-1990 (percent)

| Industries | 1945-1960 | 1960-1970 | 1970-1980 | 1980-1990 | 1945-1980 | 1945-1990 |
|---|---|---|---|---|---|---|
| Non-metallic mineral products | 9.3 | 4.1 | 6.9 | 3.1 | 6.7 | 5.2 |
| Basic metals and metal products | 7.8 | 2.4 | 8.2 | 2.7 | 6.0 | 4.7 |
| Machinery and equipment | 5.8 | 4.4 | 7.9 | 0.6 | 5.3 | 4.1 |
| Electrical materials and communication | 6.1 | 2.5 | 9.5 | 4.7 | 6.5 | 5.0 |
| Transport equipment | 6.4 | 0.5 | 10.0 | 0.3 | 4.8 | 3.7 |
| Wood | 7.5 | 2.4 | -0.2 | -2.3 | 2.0 | 1.6 |
| Furniture | 6.0 | 6.1 | 5.8 | -4.3 | 3.8 | 2.9 |
| Paper | 11.7 | 1.7 | 10.1 | 0.5 | 6.8 | 5.2 |
| Rubber | 12.4 | 0.3 | 4.3 | 5.4 | 6.3 | 4.9 |
| Leather | 4.8 | 4.5 | 1.5 | -2.8 | 2.2 | 1.7 |
| Chemical and pharmaceutical | 10.1 | 0.3 | 3.1 | 1.6 | 4.3 | 3.3 |
| Textiles | 9.2 | 5.8 | 16.7 | 6.6 | 10.9 | 8.4 |
| Clothing and footwear | 6.3 | 5.3 | 13.3 | -1.3 | 6.6 | 5.1 |
| Food products | 18.0 | 1.6 | 3.2 | 1.3 | 6.7 | 5.2 |
| Beverages | 6.0 | -0.9 | 6.0 | -2.4 | 2.4 | 1.9 |
| Tobacco | 11.5 | 7.5 | 3.5 | 2.3 | 7.0 | 5.4 |
| Printing and publishing | 7.8 | 5.4 | 5.6 | 3.5 | 6.4 | 4.9 |
| Miscellaneous | 6.9 | 7.3 | 7.7 | 1.1 | 6.6 | 5.1 |
| Total manufacturing industries | 8.7 | 2.7 | 6.9 | 2.1 | 5.8 | 4.5 |
| Standard deviation | 3,270 | 2,550 | 4,183 | 2,970 | 2,142 | 1,646 |
| Coefficient of variation | 0,383 | 0,750 | 0,611 | 2,609 | 0,380 | 0,378 |

Source: IBGE, Industrial Surveys and Censuses.

Notes: Figures in annual average compound growth rates. Labor productivity is defined as the ratio between industrial value added and the number of production workers. Nominal value added deflated by sectoral wholesale prices from the Getúlio Vargas Foundation, Conjuntura Econômica, various years. Missing sectoral wholesale prices before 1970 were proxied with those from roughly similar industries. Values for 1945-48, 1950, 1951, 1960, 1961, 1971, 1985-87 were estimated by linear interpolation. Details of the procedures and the original series are available upon request.

Labor productivity grew at 4.5 percent per annum between 1945 and 1990, although there were appreciable variations in growth rates throughout the postwar years. Two cycles of expansion of labor productivity occurred in 1945-1960, with a growth rate of 8.7 percent, and in 1970-1980, with 6.9 percent. These were years marked by high investment rates, output growth and by government policies aimed at accelerating industrial development – such as the Targets Plan (*Plano de Metas*) of 1956-1960, the "economic miracle" of 1968-1973 and the Second National Development Plan (*II PND*) of 1974-1979. The downturn in labor productivity growth took place in periods of acute macroeconomic instability, high inflation, and low economic growth, in all cases

[18] United Nations (1957); ECLA (1963); Colistete (2010). The dominant view is well represented by Bulmer-Thomas (2003) and Haber (2006).

associated with severe balance of payments imbalances: first, during the 1960s, when the acute shortage of foreign exchange led the government to pursue stabilization policies that stalled the economy and helped to create a political crisis that culminated with the collapse of representative democracy in 1964; second, during the 1980s, when the strategy of high reliance on foreign borrowing foundered with the combined shocks of interest rates, oil prices and international recession. The "lost decade" of the 1980s witnessed the worst record since World War II, with a productivity growth rate of 2.1 percent per annum. When only the period before de debt crisis is taken into account, manufacturing labor productivity shows an increase of 5.8 percent per annum between 1945 and 1980 (Table 3).

From an international perspective, the latter growth rate compares favorably with most industrializing countries in the postwar years. By using estimates from national industrial censuses and surveys as we do here, Bart van Ark and Marcel Timmer have presented evidence that there was a quite significant catch up of Brazil with the United States in their levels of labor productivity in the manufacturing industry until the early 1970s, when Brazil's labor productivity reached 56 percent of the United States's in 1973. Other industrializing countries at the time fared relatively worse than Brazil, such as Spain (43.4 percent), Mexico (41.7 percent), Korea (17.1 percent) and Taiwan (18.9 percent), for example. Brazil's convergence seems to have lost pace by the mid-1970s, but it was likely in the 1980s that manufacturing industry experienced the sharpest decline: in 1987 Brazil's labor productivity in manufacturing plunged to only 42.5 percent of the United States's. Mexico, another Latin American country that was harshly hit by the debt crisis, showed a similar performance, with a fall to 28 percent of the labor productivity levels of the United States. Korea in turn kept the upward trend and achieved 26.5 percent of the manufacturing productivity levels of the United States in 1987 (Ark and Timmer 2001, 48). The downward trend of Brazil's labor productivity in comparison with the U.S. levels has persisted into the 2000s (Naudé et al. 2012).

An important point to consider is that the performance of labor productivity tended to be affected by the sweeping changes in the structure of manufacturing industry. The share of manufacturing in Brazil's national output rose from 19 percent in 1950 to 32 percent in 1989, whereas the agriculture declined from 25 percent to 10 percent in the same period. Along with the expansion of manufacturing production, new and more technologically advanced industries grew in importance: the share of modern industries in the manufacturing output jumped from 26 percent in

1949 to 65 percent in 1990.[19] In such a context of rapid structural change, the shift of labor from lower to more productive activities may well become a major determinant of aggregate productivity growth – more important, for example, than gains in productivity accruing from new and more efficient methods of production within a specific industry (Fabricant 1942; Reynolds 1980; Fagerberg 2000; Timmer and Szirmai 2000).

We present in the following a shift-share analysis to assess the contribution to overall productivity growth made by the shift of labor between sectors (structural change) and the productivity gains obtained within individual industries. The analysis breaks down aggregate productivity growth in three components (Timmer and Szirmai 2000, 377):

$$\text{Growth} = \frac{LP_{T,t} - LP_{T,t-1}}{LP_{T,t-1}}$$

$$\frac{\overbrace{\sum_{i=1}^{n} S_{i,t-1}(LP_{i,t} - LP_{i,t-1})}^{\text{(I) within-industry effect}} + \overbrace{\sum_{i=1}^{n} LP_{i,t-1}(S_{i,t} - S_{i,t-1})}^{\text{(II) static shift effect}} + \overbrace{\sum_{i=1}^{n} (LP_{i,t} - LP_{i,t-1})(S_{i,t} - S_{i,t-1})}^{\text{(III) dynamic shift}}}{LP_{T,t-1}}$$

where $LP$ is the labour productivity, $i$ an individual industry, $Si$ the share of industry $i$ in total manufacturing, $T$ the sum over industries $i$, $t-1$ the initial year and $t$ the final year.

The first component (within-industry effect) measures the contribution of productivity growth within individual industries resulting from factors such as learning by doing, capital intensity and average hours of work. The other two terms of the equation reflect structural change. The second term (static effect) shows how much a shift of labour to industries with a higher or lower level of labour productivity affects aggregate labour productivity. The third term (dynamic effect) measures the combined effect of changes in labour productivity of individual industries and the shifts of their relative shares in total manufacturing.

Table 4 shows the shift-share estimates for Brazil's manufacturing industry between 1945 and 1990. Overall, productivity growth was mainly explained by gains of productivity within individual industries: 114.4 percent of productivity growth in 1945-1990 resulted from the within-

[19] Data from IBGE (1990), (2006). Modern industries roughly defined as comprising metal trades, machinery, electrical materials, transport equipment, non-metallic mineral products, chemical, pharmaceutical, paper and cellulose. Figures were calculated in current prices.

industry effect, whereas the net shift effect was negative. It means that, although there was a movement of labor between industries (static shift effect of 4.2 percent), a decreasing share of fast growing industries (dynamic-shift effect of -18.6 percent) contributed negatively to aggregate productivity growth. The shift of labor from lower to higher productivity industries had some importance in the early period, when accounted for nearly 12 percent of the productivity growth from 1945 to 1960 (static shift effect, 9 percent; dynamic shift effect, 2.8 percent) and roughly 16 percent in the 1960s (static shift effect, 17.7 percent; dynamic shift effect, -1.9 percent). During the 1970s, however, the shift component was negative (static shift effect of -0.03 percent and dynamic shift effect of -4.2 percent). The highest impact of the transference of labor to more productive industries occurred during the "lost decade" of the 1980s, with a shift effect of nearly 19 percent (static shift effect, 19.9 percent; dynamic shift effect, -1.1 percent). There is evidence, therefore, that the contribution to productivity growth by the shift of labor from lower to higher productivity industries was relatively more significant in those periods of slower industrial growth. In any case, productivity advances within individual industries were largely dominant as a source of aggregate productivity growth in Brazil's manufacturing industry in all periods examined.

*Table 4*. Decomposition of labor productivity growth in manufacturing, Brazil, 1945-1990

| Labor productivity growth | | Percentage of labor productivity growth explained by: | | | |
|---|---|---|---|---|---|
| Periods | Annual average compound growth (percent) | Within-industry effect | Static shift effect | Dynamic shift effect | Total effect |
| 1945-1960 | 8.7 | 88.2 | 9.0 | 2.8 | 100.0 |
| 1960-1970 | 2.7 | 84.3 | 17.7 | -1.9 | 100.0 |
| 1970-1980 | 6.9 | 104.2 | -0.03 | -4.2 | 100.0 |
| 1980-1990 | 2.1 | 81.2 | 19.9 | -1.1 | 100.0 |
| 1945-1980 | 5.8 | 120.3 | 3.2 | -23.5 | 100.0 |
| 1945-1990 | 4.5 | 114.4 | 4.2 | -18.6 | 100.0 |

Source: same as Table 3.

Another important issue that can be addressed with the shift-share analysis is about the role played by specific industries in the aggregate productivity growth (Reynolds 1970, ch. 3). The resulting estimates complement the average growth rates shown in Table 3 by taking into account the relative levels of productivity and the shares in industrial employment. Table 5 summarizes the weighted contribution by each industry to total productivity growth in Brazil's manufacturing industry. During 1945 to 1990, textiles, chemicals, metal products, electrical materials, and transport equipment had the greatest influence on total productivity in manufacturing. Textiles

apart, all these industries were relatively new sectors that developed mostly from the 1930s. It is worth noting that the exceptional performance of the textile industry's labor productivity growth occurred amidst a dramatic restructuring that reduced its participation in industrial employment from an estimated 30 percent in 1945 to 8 percent in 1990.[20] Other traditional industries (such as leather, beverages, and tobacco) made a marginal contribution to aggregate productivity, while clothing (8.1 percent) and food products (6.5 percent) showed significant figures.

*Table 5* - Contribution by individual industries to total productivity growth, Brazil, 1945-1990 (percent)

| Industries | 1945-1960 | 1960-1970 | 1970-1980 | 1980-1990 | 1945-1980 | 1945-1990 |
|---|---|---|---|---|---|---|
| Non-metallic mineral products | 5.3 | 6.1 | 4.6 | -4.3 | 5.5 | 2.6 |
| Basic metals and metal products | 13.1 | 8.1 | 14.4 | 12.8 | 13.8 | 13.1 |
| Machinery and equipment | 3.6 | 18.2 | 16.4 | -10.3 | 11.0 | 7.1 |
| Electrical materials and communication | 5.8 | 8.5 | 9.3 | 20.9 | 10.3 | 11.6 |
| Transport equipment | 10.9 | 7.6 | 11.6 | 12.0 | 8.7 | 11.2 |
| Wood | 2.0 | 2.1 | 0.01 | -2.4 | 0.4 | -0.02 |
| Furniture | 1.0 | 3.7 | 1.2 | -3.0 | 0.7 | 0.3 |
| Paper | 3.3 | 2.1 | 2.9 | 3.4 | 2.4 | 3.0 |
| Rubber | 3.1 | 0.8 | 0.8 | 4.8 | 1.9 | 2.3 |
| Leather | 0.3 | 0.4 | 0.02 | -0.1 | 0.0 | 0.1 |
| Chemical and pharmaceutical | 18.5 | 13.1 | 5.0 | 23.3 | 9.0 | 13.2 |
| Textiles | 6.7 | 6.8 | 15.1 | 28.5 | 19.0 | 16.2 |
| Clothing and footwear | 1.6 | 6.1 | 13.0 | 5.3 | 6.1 | 8.1 |
| Food products | 17.8 | 6.4 | 2.6 | 5.3 | 6.3 | 6.5 |
| Beverages | 2.4 | -1.5 | 0.04 | 0.7 | 0.1 | 0.5 |
| Tobacco | 0.8 | 1.8 | -0.03 | 1.0 | 0.5 | 0.6 |
| Printing and publishing | 2.0 | 6.5 | 1.1 | 0.5 | 2.5 | 1.7 |
| Miscellaneous | 1.8 | 3.3 | 1.9 | 1.6 | 1.8 | 2.0 |
| Total manufacturing industries | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Sources: same as Table 3.

Also worth noting is the performance of the machinery industry, given its importance for the rate of investment and the diffusion of technology. While accounting for the highest contribution to aggregate productivity growth during the 1960s (18.2 percent) and 1970s (16.4 percent), machinery suffered the deepest fall among all industries during the "lost decade", with a negative effect of -10.3 percent. When only the years before the debt crisis are considered (1945-1980), the machinery industry was amongst those with the greatest contribution (11 percent) to manufacturing productivity growth during the postwar years (Table 5).

A further dimension to be examined about manufacturing labor productivity growth is how it compared with industrial wages. The relation between productivity and wages is captured by the concept of unit labor cost (ULC), which can be expressed as the ratio of wage per worker and labor productivity (value added per worker) in an industry, sector or the economy. Adjusted by the market exchange rate with the currency of one or more countries, the ULC can be also useful to assess a

[20] Data not shown here but available upon request.

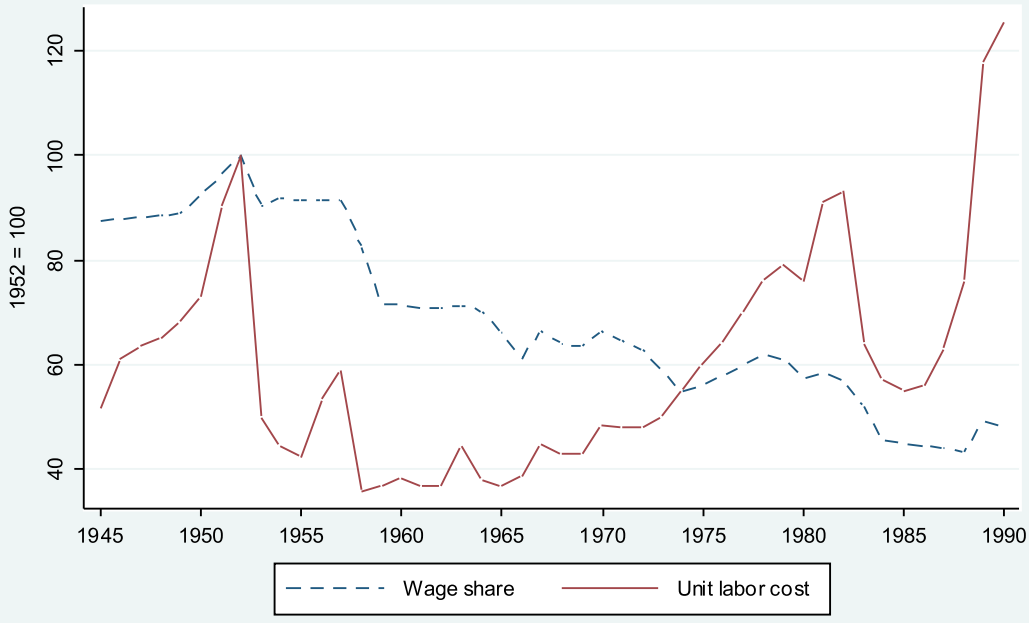
country's international cost competitiveness. Thus, a country's competitiveness can be affected by the combination of changes in the levels of the wage rate, the labor productivity, and the market exchange rate, as in the following:

$$ulc = \frac{\left(\frac{w}{\mathrm{E}}\right)}{\frac{\left(\frac{VA}{P}\right)}{L}} = \left(\frac{wL}{VA}\right)\left(\frac{P}{\mathrm{E}}\right)$$

where $w$ is the average wage rate, $E$ is the nominal exchange rate, $VA$ is the value added, $P$ is the output deflator and $L$ is the number of workers. The expression $(wL/VA)$ corresponds to the workers' share in the output, which highlights the distributive dimension associated with the analysis of unit labor cost (Ark et al. 2005; Felipe and Sipin 2004).

Figures 7 and 8 presents the indexes (1952 = 100) of ULC and its components using the data on Brazil's manufacturing industry. The exchange rate employed is the ratio between the Brazilian currency and the U.S. dollar, while $P$ is a proxy of the producer price index (*Índice de Preço por Atacado*, or IPA). In Figure 8 the wage rate was deflated by the IPA in order to be plotted against other variables without the effect of high inflation during the period under analysis.[21]

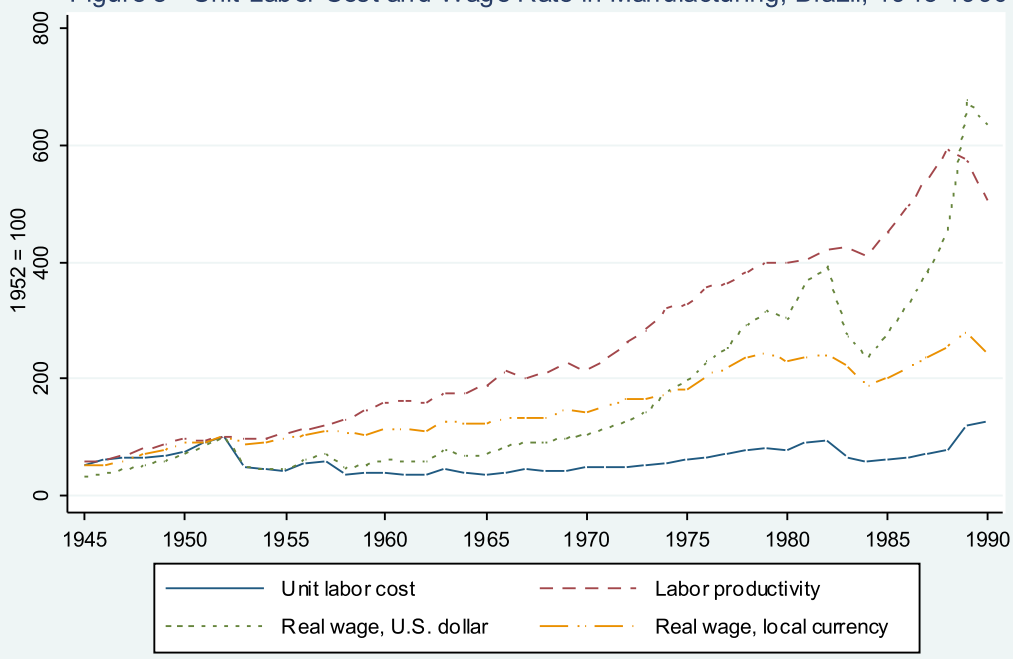
Figure 7 - Wage Share and Unit Labor Cost in Manufacturing, Brazil, 1945-1990




Source: same as Table 3.
Note: see definitions in the text.

[21] As we do not perform comparisons with other countries, we do not use PPP prices as deflators.

Figure 8 - Unit Labor Cost and Wage Rate in Manufacturing, Brazil, 1945-1990




Source: same as Table 3.

The wage share in Figure 7 shows the unit labor cost without the adjustment of the exchange rate, that is, it only considers the behavior of the average wages and labor productivity measured in Brazil's wholesale prices (IPA). The steep decline of the wage share throughout the period was a direct outcome of the rapid growth of labor productivity noted earlier. As shown in Figure 8, industrial workers's wages in local currency lagged behind labor productivity, even in situations when real wage growth was significant – for example, while real industrial wages increased at a remarkable annual average rate of 6 percent from 1971 to 1979, labor productivity expanded more rapidly, at 7 percent per annum.

The trend of unit labor cost was more sensitive to exchange rate fluctuations than to shifts in real wage rates. Thus, for example, the 7 percent average increase in the ULC from 1971 to 1982 was chiefly caused by an appreciation (7 percent per annum on average) of Brazil's currency against the U.S. dollar, as the real wage measured in dollars grew at an annual average rate of 12 percent compared to 4 percent and 5 percent by the real wage rate in local currency and labor productivity, respectively. In very few occasions real wages in local currency grew faster than labor productivity and contributed to an upward shift in the unit labor cost of manufacturing. One of these situations happened in the end of the 1980s, when the ULC rose by 24 percent on average between 1987 and 1990. Still, it was not so much that the real wage measured in local currency grew exceptionally fast (annual average rate of 3 percent) in these years, but rather that labor productivity stagnated (0.8 percent on average) amidst the debt crisis. Most of the impact on the ULC came from a sharp increase of 25 percent per annum in the real wage denominated in dollars, which was

largely determined by an appreciation of 16 percent in the local currency from 1987 to 1990. Finally, there was a sharp decline in the unit labor cost triggered by the economic crisis in the beginning of the 1980s, with the ULC falling on average 11 percent per annum between 1983 and 1986. Although the real wage rate in local currency declined 1.7 percent on a yearly average, it was the depreciation of the Brazilian currency (7.5 percent on average) and the increase in labor productivity (4 percent on average) that explain most of the adjustment in the unit labor cost at the time.

The slowdown in productivity growth and, in the end of the 1980s, overvalued exchange rates would be more than temporary effects of the macroeconomic instability and crisis that marked the "lost decade". As we will see in the next section, these were two of the most distinctive features of the ensuing decades of structural reforms.

## III. Structural change and productivity since the 1990s

In this section we examine how institutional reforms and economic transformations in the last two decades have shaped Brazil's industrial and structural change. At the beginning of the 1990s, Latin American economies continued to suffer from the severe macroeconomic imbalances that had made the 1980s a "lost decade." The external debt crisis remained unsolved and kept fueling the fiscal crisis that it had triggered. In Brazil, despite the dramatic measures adopted by the new administration that took office in 1990 (such as the arrest of financial assets), increasingly higher and volatile inflation rates persisted, against which the government reacted by escalating interest rates, putting the public debt into an unsustainable path and deepening investors' fear of default.

After five failed attempts of macroeconomic stabilization, the Real Plan, launched in 1994, tackled the runaway inflation, managing to reduce it from 2,708 percent in 1993 to less than 15 percent in 1995. Apart from creating a new currency, the Real, the stabilization program also adopted tight monetary policies, aiming at preventing demand pressures. Price stabilization was a turning point in the country's recent economic history, redefining incentives and payoffs to economic and political actors and imposing changes in deeply ingrained economic practices. Firms' inefficiencies became harder to be concealed than when they were under the inflationary veil. Banks in turn were hit by the fall in inflation tax revenues, leading the government to intervene in some of them owing to mismanagement or wrongdoing. Overall, the maintenance of low inflation improved the business environment by reducing uncertainties on input and output prices – such as those of labor and capital goods.

Also in 1994, under the auspices of the Brady Plan, the Brazilian government concluded the debt renegotiation with its main creditors to restructure and securitize the medium and long-term foreign loans. As happened to other countries in Latin America, debt renegotiation along with price stabilization favored a new wave of foreign capital inflows (Ffrench-Davis et al. 1998, 226-8; Bértola and Ocampo 2012, ch. 5). However, high interest rates combined with the near-fixed exchange rate regime, in a time when domestic inflation rate was higher than those of Brazil's main trade partners, ended up in the overvaluation of the real exchange rate. In a context of successive international currency and financial crises (Mexico in 1994-95, Asian countries in 1997-1998 and Russia in 1998), the increasingly overvalued exchange rate generated a currency crisis that culminated with the devaluation of the Real in 1999. The response to this critical situation led to a new macroeconomic regime whose foundation has been – or at least is supposed to be – the floating exchange rate, the inflation targeting and a commitment to primary fiscal surplus.

Low economic growth rates marked the first years after the launch of Real Plan. The compound growth rate of GDP per capita reached only 0.5 per annum between 1995 and 2000, which was not much higher than that of the "lost decade" of the 1980s. However, growth performance improved over the 2000s, particularly in the period 2005-2009 when the compound rate of GDP per capita grew at 2.6 percent per annum, compared to an average compound rate of 0.9 percent during the previous 10 years.[22] Another important development took place at the time: after hovering at 0.600 from the late 1980s, the Gini inequality coefficient of household income reversed the trend from 2001, dropping to 0.543 in 2009, which was still very high by international standards but well bellow the peak level of 0.636 in 1989. This significant fall of household income inequality was an outcome of a combination of factors ranging from faster economic growth and better distribution of education to a strong expansion of social security spending and conditional and non-conditional government transfers (Barros et al. 2010; Ferreira et al 2010).

How did these sweeping macroeconomic changes relate to Brazil's manufacturing performance? According to Brazil's official statistics, the share of manufacturing in GDP (current prices) witnessed a sharp fall to 14.6 percent in 2011 after peaking at 35.8 percent in 1985 (IBGE, National Accounts). These figures are marred, however, by methodological changes in Brazil's national accounts, which report that the share of manufacturing in GDP fell 5.8 and 8.2 percentage

[22] Calculated from figures in constant 2011 *Reais*. Estimates of GDP per capita in 1990s PPP dollars show that Brazil's GDP per capita growth has recently lagged behind that of other BRICs countries, such as China and Russia (Naudé et al. 2012).

points, respectively, in 1990 and 1995.[23] Bonelli and Pessôa (2010) recalculated the series in an attempt to make it consistent throughout the period and brought all values to 2008 basic prices. Although confirming that manufacturing indeed reduced its share in GDP, their results revealed that: i) the downward trend began in the middle of the 1970s; ii) the highest amplitude between the peak of manufacturing share in the middle of the 1970s, 21 percent, and the lowest share, 15.6 percent, in 2008 (the last year covered by their analysis) is of just 5.5 percentage points; iii) the bulk of the fall was concentrated from 1981 to 1992; iv) the share in the years from 1993 to 1997 was higher than or very similar to the 17.5 percent share prevailing in 1990 and 1991; and v) the declining trend was only interrupted in a few years of rapidly growth in manufacturing output, as in 1983-1986, 1992-1995, and 1999-2004.

Our own calculations, carried out in 2000 constant prices, show that the manufacturing share in GDP declined from 20.6 in 1995 to 16.6 percent in 2009.[24] Growing at an annual compound rate of 1.3 percent over the latter period (with no growth from 1995 to 2000), manufacturing fell behind all other sectors: for example, agriculture grew at 3.6 percent, extractive industries at 5.0 percent and services at 3.0 percent per annum between 1995 to 2009 (Table 6). The share of services in GDP, which was already high in 1995 (64.3 percent), increased throughout this period to reach 67.5 percent in 2009. At the more disaggregated level of activities (not shown here), variations in shares were small, being higher than 1 percentage point only for financial institutions and communications.

*Table 6* - Sectoral value added and growth performance, Brazil, 1995-2009

| Sectors | Share in GDP | | | Annual compound growth rate (percent) | | | |
|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2009 | 1995-2000 | 2000-2005 | 2005-2009 | 1995-2009 |
| Agriculture and livestock | 5.0 | 5.3 | 5.6 | 3.3 | 4.2 | 3.1 | 3.6 |
| Extractive | 1.4 | 1.7 | 1.8 | 6.0 | 6.3 | 2.1 | 5.0 |
| Manufacturing | 20.6 | 17.2 | 16.6 | 0.0 | 3.2 | 0.5 | 1.3 |
| Public utilities | 3.0 | 3.1 | 3.1 | 3.0 | 2.3 | 3.6 | 2.9 |
| Construction | 5.7 | 5.8 | 5.3 | 2.3 | 0.1 | 4.1 | 2.0 |
| Services | 64.3 | 65.2 | 67.5 | 2.2 | 2.9 | 4.2 | 3.0 |
| Total | 100.0 | 100.0 | 100.0 | 2.0 | 3.0 | 3.5 | 2.7 |

Source: IBGE, National Accounts (Revised).
Notes: value added deflated by sectoral deflators at 2000 prices. National accounts data comprise economic units from both formal and informal sectors.

[23] IBGE, National Accounts (Revised). Brazil's National Agency of Statistics, IBGE, has changed the base year of the national accounts to 2000 and revised back the series only to 1995. Therefore there is a lack of consistent official series covering the period since 1990, making difficult an accurate analysis of the events in the early 1990s.

[24] In this paper, we use the revised national accounts data available for the period 1995-2009 (http://www.ibge.gov.br/home/download/estatistica.shtm).

As shown in Table 7, the manufacturing sector saw an increase in its employment levels between 1995 and 2009 and maintained a share in total employment of around 12-13 percent. In turn, agriculture experienced a sharp decline in employment, with its relative share in total employment dropping from 26.0 percent in 1995 to 17.4 percent in 2009. Services, by contrast, gained ground and increased its participation in total employment from 54.3 to 62.1 percent in 1995-2009. Extractive and public utilities' shares in total employment were small and relatively stable, while construction showed an appreciable increase from 6.0 percent in 1995 to 7.1 percent in 2009. Thus, as regards employment growth, agriculture was the worst performer among all sectors, presenting an annual compound rate of -0.9 percent over the period 1995-2009. Employment in manufacturing grew at an annual compound rate of 1.8 percent from 1995 to 2009 (with a slight fall between 1995 and 2000), while employment in services expanded at the relatively high rate of 3.0 percent per annum in the same period – above the annual growth of 2.0 percent for the whole economy.

Table 7 - Employment by sector, Brazil, 1995-2009

| Sectors | Employment (1,000) | | | | Share in total employment (percent) | | | |
|---|---|---|---|---|---|---|---|---|
| | 1995 | 2000 | 2005 | 2009 | 1995 | 2000 | 2005 | 2009 |
| Agriculture and livestock | 19,101 | 17,611 | 18,981 | 16,778 | 26.0 | 22.3 | 20.9 | 17.4 |
| Extractive | 261 | 236 | 276 | 296 | 0.4 | 0.3 | 0.3 | 0.3 |
| Manufacturing | 9,535 | 9,494 | 11,674 | 12,256 | 13.0 | 12.0 | 12.8 | 12.7 |
| Public utilities | 362 | 342 | 372 | 412 | 0.5 | 0.4 | 0.4 | 0.4 |
| Construction | 4,380 | 5,330 | 5,873 | 6,885 | 6.0 | 6.7 | 6.5 | 7.1 |
| Services | 39,906 | 45,960 | 53,730 | 60,020 | 54.3 | 58.2 | 59.1 | 62.1 |
| Total | 73,545 | 78,972 | 90,906 | 96,647 | 100.0 | 100.0 | 100.0 | 100.0 |

Source: same as Table 6.

The manufacturing branches that suffered most with a decline in employment were oil refinery (reduction of 8.6 percent), steel (19.5 percent), chemical products (27.9 percent), coffee processing (56.9 percent) and vegetal oil (31.6 percent). In turn, chemical elements, pharmaceuticals, plastic material, meat processing, textiles, sugar refinery and dairy products created jobs at a higher rate than the average for the whole economy.[25] Overall these results are insufficient to characterize a clear process of deindustrialization, although the recently reported fall

[25] Data not shown here, available upon request.

in the share of manufacturing in GDP (from 16.2 in 2010 to 14.6 in 2011) does raise concern of structural weaknesses impairing this sector.[26]

One feature of the structural changes in the last two decades is that most of the new employment has been created in relatively low-productivity activities. Based on national accounts data for 42 sectors over the period 1995-2009, we found a negative and statistically significant relationship between industry employment growth and labor productivity, indicating that employment increased more in low labor productivity level sectors. Using only the 28 sub-sectors of the manufacturing industry, the results also show that employment-expanding industries were among the less productive during the period.[27] At the aggregate level, services was the sector that most contributed to employment growth, at the same time that, along with manufacturing and construction, exhibited the lowest rates of productivity growth over 1995-2009, as we will see later. Although higher than in agriculture and construction, services' productivity levels remained around 80 percent of manufacturing's and fell behind the growing figures recorded for the whole economy.

The trends in output and employment outlined so far were similar to what happened in labor markets. During the 1990s there was a sizable increase in the already high informal employment in the Brazilian economy, although this phenomenon was mostly restricted to jobs in the metropolitan areas. This rise in informality, however, was reversed in the early 2000s (Ramos 2009, 415-7). A look at sectoral data from the national accounts shows that formal employment in manufacturing increased from 52.1 percent in 2000 to 61.7 percent in 2009.[28] Services too experienced a substantial rise in formality (48 percent to 54.9 percent in the latter period), although with huge differences among their branches: for example, financial intermediation had already 77.2 percent of its labor force formally employed in 2000 (80 percent in 2009) while transport employed 41.9 percent in the formal sector in 2000 (53.6 percent in 2009). Even construction had its formal employment share increased from 18 percent in 2000 to 30.1 percent in 2009.

Given the nature of its activities, agriculture showed a high percentage of self-employed workers (70.3 percent in 2000 and 66.9 percent in 2009) and very low shares in formal employment (10.4 percent and 13.7 percent in 2000 and 2009, respectively). Overall the trend was clearly

---

[26] Shares in current prices, IBGE, National Accounts. Only aggregate data for 2010 and 2011 have been released so far (2012). Agriculture and services have stabilized their participation in total output in the latter years (agriculture: 5.3 percent in 2010 and 5.5 percent in 2011; services: 66.6 percent in 2010 and 67.0 in 2011).

[27] These results converge with those found by Macmillan and Rodrik (2011) for Latin American countries.

[28] Formal employment in Brazil's national accounts refers to persons who have a formal labor contract, are public sector employees or military, or owners of registered companies. Informal employment includes two groups: a) those without a registered labor contract and b) those with autonomous jobs: own-account workers, owners of informal companies and non-remunerated employees.

towards greater formalization – and presumably higher job quality – in labor markets: formal employment increased from 38.2 percent in 2000 to 47 percent in 2009 for the economy as a whole.[29] Nonetheless, there is also evidence that earnings differentials between formal employees, on the one hand, and informal employees and self-employed, on the other, increased significantly between 1996 and 2006, which suggests that growing formalization in labor markets may not have contributed to the fall in income inequality observed in this period in Brazil (Ferreira et al. 2010, 29-30).

Brazil's labor compensation (deflated by the national consumption price index, INPC) grew at an average compound rate of 2 percent between 1995 and 2009, as shown in Table 8. This outcome was strongly influenced by the relatively low growth of earnings in services (1.0 percent per annum) and construction (0.8 percent per annum), whose high shares in employment drove down the economy's average growth in labor compensation. Extractive industry (9.1 percent per annum), agriculture (4.5 percent) and manufacturing (4.4 percent) stood out with substantially higher growth rates than the economy's average. Our estimates with national accounts data confirm the existence of a negative and significant relationship between labor compensation and employment growth rates for 42 sectors between 1995 and 2009, although the correlation does not seem to be robust when the 28 sub-sectors of manufacturing industry are considered separately. The early 2000s was the worst period for labor earnings (annual growth of -0.5 percent): only agriculture (3.2 percent) and extractive industry (7.0 percent) exhibited positive figures, even though output and employment expanded in all sectors at the time. On the other hand, the higher growth rates of the period 2005-2009 were translated into increasing labor earnings for the whole economy (compound rate of 4.3 percent per annum) as well as for every sector (see Table 8).

Table 8 - Real compensation growth by sectors, Brazil, 1995-2009 (percent)

| Sectors | 1995-2000 | 2000-2005 | 2005-2009 | 1995-2009 |
|---|---|---|---|---|
| Agriculture and livestock | 5.1 | 3.2 | 4.2 | 4.5 |
| Extractive | 12.3 | 7.0 | 6.2 | 9.1 |
| Manufacturing | 10.0 | -0.8 | 3.4 | 4.4 |
| Public utilities | 2.2 | -3.9 | 1.9 | 0.0 |
| Construction | -2.2 | -0.3 | 5.1 | 0.8 |
| Services | 0.3 | -1.2 | 3.9 | 1.0 |
| Total | 1.8 | -0.5 | 4.3 | 2.0 |

Source: same as Table 6.

Notes: Annual compound growth rates. Labor compensation is the sum of wages, social contributions and earnings by the self-employed and owners of non-registered economic units, which are not classified as part of the formal business sector. Nominal values deflated by IBGE's national consumption price index (INPC).

[29] Data from IBGE, National Accounts (Revised), Summary Tables, Table 14.

To summarize, there was a sustained increase in employment levels in the labor-intensive industries (such as the construction sector and some branches of services), whose low productivity growth paradoxically helped to absorb and keep jobs growing. This was the opposite of what happened to the high-productivity agricultural sector, which reduced jobs in both relative and absolute terms – although the rising incomes partially made up for the negative effect of declining employment. Growth in manufacturing employment was high and thus contributed to the absorption of labor with relatively high compensation but, as this sector's share in total employment remained small, the impact on the overall economy was limited.

Let's turn now to productivity. In an in-depth analysis, Pagés et (2010) provide empirical evidence that Latin American countries fell behind East Asian countries' and even developed countries' productivity growth in recent decades. The study also highlights Latin America's heterogeneity in productivity levels across countries, across sectors within each country and across firms within the same sector or industry in the same country. Furthermore, the author associates the region's slow economic expansion in recent decades with the sluggish productivity growth, emphasizing that the productivity gap vis-à-vis the frontier is enlarging rather than closing, as the theory predicts and it does happen in East Asian countries. Since Brazil is the largest country in Latin America, this dismal picture for the region largely reflects the country's low productivity performance. Pagés et al. (2010) estimate that Brazil ranked below seven other Latin American countries in total factor productivity (TFP) – among which Argentina, Uruguay, Mexico and Chile – and its TFP level was 60 percent of the United States's (Chile's gap was of just 20 percent) in 2005. In contrast to the East Asian countries, TFP in Brazil increased less than in the USA from 1960 to 2005.

We calculate levels and growth rates of labor productivity in Brazil for sectors and industries between 1995 and 2009 employing various types of data. Differently from the previous section, we will now be able to provide estimates for other economic sectors (agriculture and livestock, extractive, public utilities, construction and services) besides manufacturing. For manufacturing, we use two different surveys conducted by Brazil's official statistical agency: the revised National Accounts, which provide data on output, number of employees and self-employed for both formal and informal sectors, and compensation between 1995 and 2009; and surveys that cover only formal sector firms and employees during the 2000s.[30] For other sectors, we use only data from the national accounts. As we did earlier for the period 1945-1990, we decompose the overall

[30] PIM-PF and PIMES or, respectively, *Pesquisa Industrial Mensal-Produção Física* and *Pesquisa Industrial Mensal de Emprego e Salário*.

productivity growth into three factors: one related to productivity growth within each sector and the other two capturing structural changes associated with inter-sectoral reallocation of labor. We also replicated the exercise of McMillan and Rodrik (2011), who estimate the relationship between variation in sectoral shares and their relative productivity levels.

Based on national accounts data, we estimate indicators of productivity levels and growth for the detailed panel of 42 sectors (not shown here) and for five aggregate sectors (Table 9 below) over the period 1995-2009. As for the detailed panel, discrepancies are huge and the leading sectors in productivity levels are those intensive in knowledge and physical and human capital – such as oil and gas extraction, real estate renting, steelmaking, financial institutions, automotive industry, oil refinery, pharmaceuticals, and public utilities. Apart from communications and vegetable processing, the ranking changed very little over the period under analysis. The fastest-growing sectors in productivity (more than 2 percent per annum) were agriculture and livestock, other processed foods, finance, automotive, real estate renting, cellulose and paper, and mineral extraction, some of which were among the less productive.

As shown in Table 9, Brazil's aggregate labor productivity grew at an annual compound rate of just 0.8 percent from 1995 to 2009. This poor performance is mostly explained by the stagnation of labor productivity in services (0.1 percent growth), whose share in the labor force increased in this period from 54 to 62 percent (64 to 67 percent in GDP), and by the negative annual growth of labor productivity in manufacturing (-0.5 percent) and civil construction (-1.2 percent). Agriculture and the extractive industry, in turn, grew at the high rates of 4.5 and 4.0 percent, respectively, between 1995 and 2009.

Table 9 - Labor productivity growth by sectors, Brazil, 1995-2009 (percent)

| Sectors | 1995-2000 | 2000-2005 | 2005-2009 | 1995-2009 |
|---|---|---|---|---|
| Agriculture and livestock | 5.0 | 2.6 | 5.1 | 4.5 |
| Extractive | 8.2 | 3.0 | 0.2 | 4.0 |
| Manufacturing | 0.1 | -1.0 | -0.6 | -0.5 |
| Public utilities | 4.2 | 0.6 | 0.8 | 1.9 |
| Construction | -1.6 | -1.8 | 0.1 | -1.2 |
| Services | -0.6 | -0.2 | 1.1 | 0.1 |
| Total | 0.5 | 0.1 | 1.5 | 0.8 |

Source: same as Table 6.

Note: Annual compound growth rates. Labor productivity is defined as the ratio between sectoral value added and number of employees. Nominal value added deflated by sectoral deflators at 2000 prices.

Agriculture productivity growth was particularly significant in 1995-2000 (5.0 percent) and 2005-2009 (5.1 percent), whereas the extractive industry enjoyed a noticeable expansion in 1995-2000 (8.2 percent) but declined consistently in the following years (0.2 percent growth in

2005-2009). Public utilities also had an unbalanced performance across the periods (4.2 percent in 1995-2000 and 0.8 percent in 2005-2009). Manufacturing, construction and services showed low or negative growth in nearly all periods, with the partial exception of the services sector, which reversed its downward drift and expanded at 1.1 percent per annum between 2005 and 2009. Nonetheless, a different picture emerges when we use data for manufacturing's formal sector during the 2001-2011 period: labor productivity presented an upward trend and increased at 2.2 percent per annum if measured as output per paid hour and at 2.1 percent if measured as output per worker.[31]

We now assess the contribution of structural change and sectoral productivity gains to aggregate labor productivity growth in Brazil since 1995. Table 10 shows that labor productivity within sectors explained 45.8 percent of the aggregate productivity growth in the Brazilian economy between 1995 and 2009. The impact of the transference of labor to higher productivity activities (static-shift effect, 70.3 percent) was partially offset by the negative dynamic-shift effect (-16.1 percent) resulting from the declining share of fast growing sectors in total employment. Even so, the structural change effect had a major contribution (54 percent) to the meagre aggregate productivity growth of 0.8 percent in Brazil during 1995 and 2009.

Table 10 - Decomposition of labor productivity growth for the Brazilian economy, 1995-2009

| Labor productivity growth | | Percentage of labor productivity growth explained by: | | | |
|---|---|---|---|---|---|
| Periods | Annual average compound growth (percent) | Within-sector effect | Static shift effect | Dynamic shift effect | Total effect |
| 1995-2000 | 0.5 | 17.8 | 105.0 | -22.8 | 100.0 |
| 2000-2005 | 0.1 | -191.9 | 312.7 | -20.8 | 100.0 |
| 2005-2009 | 1.5 | 64.8 | 36.3 | -1.0 | 100.0 |
| 1995-2009 | 0.8 | 45.8 | 70.3 | -16.1 | 100.0 |

Source: same as Table 6.

There was substantial variation in the outcomes of structural change and sectoral gains in the sub-periods. In 1995-2000, for example, the very modest productivity growth (0.5 percent per annum) came overwhelmingly (105 percent) from the transference of labor to higher productivity activities, although the dynamic effect was negative (-22.8 percent). In the following sub-period (2000-2005) the within-sector effect was strongly negative (-191.9 percent) and the static structural change component dominated (312.7 percent). However, between 2005 and 2009 the sectoral gains

[31] We calculated for every year the average of the seasonally adjusted monthly indexes and then the annual compound growth rates. For 2001-2009 labor productivity in manufacturing grew at 2.2 percent per annum using formal sector (PIM-PF/PIMES) data and -1.2 percent with National Accounts data.

in productivity recovered (64.8 percent) and contributed significantly more than the structural change effect to productivity growth in Brazil's economy. It seems, therefore, that the early 2000s was the worst period not only for productivity growth in general (annual growth of 0.1 percent), but also for improvements in efficiency within sectors.

We examine the issue in more detail by looking at the weighted contribution by individual sectors to total productivity growth in the Brazilian economy. Table 11 shows that services had by far the largest influence (93.6 percent) on national productivity growth between 1995 and 2009. Agriculture and livestock (11.4 percent) followed in importance, with a particularly significant role in sustaining overall productivity growth during the early 2000s. Strikingly, manufacturing's contribution to national productivity growth was negative (-15.3 percent) – only during the early 2000s did it play a positive role in Brazil's recent productivity growth.

*Table 11* - Contribution by individual sectors to total productivity growth, Brazil, 1995-2009 (percent)

| Sectors | 1995-2000 | 2000-2005 | 2005-2009 | 1995-2009 |
|---|---|---|---|---|
| Agriculture and livestock | 18.6 | 79.4 | 5.0 | 11.4 |
| Extractive | 12.3 | 60.3 | 0.5 | 5.9 |
| Manufacturing | -48.5 | 66.0 | -9.2 | -15.3 |
| Public utilities | 9.6 | -19.4 | 3.5 | 3.9 |
| Construction | 9.1 | -149.7 | 6.6 | 0.4 |
| Services | 98.9 | 64.4 | 93.6 | 93.6 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

Source: same as Table 6.

These results for Brazil contrast with those obtained by Pagés et al. (2010) and McMillan and Rodrik (2011) for a sample of Latin American countries – although our results converge in identifying a sharp decline in labor productivity growth from the 1990s, as shown earlier. McMillan and Rodrik (2011) found that the structural change effect on Latin America's productivity growth from 1990 to 2005 was negative or, when the decomposition of productivity growth for the region is calculated with weighted averages, positive but very small. They argue that labor productivity growth in Latin America from 1990 to 2005 was sluggish when compared to that of the period between 1950 and 1975 primarily because of the negative contribution of structural changes, as the within-sector productivity growth effects in these two periods are positive and of similar magnitude. As shown above, however, our shift-share analysis for the Brazilian economy in 1995-2009 indicates that structural change effects were far from negligible, although in a context of quite low rates of productivity growth.

Besides, to verify whether the 1990s economic liberalization did promote "productivity-enhancing structural change", McMillan and Rodrik (2011) regressed the relative productivities of

sectors on the change in their employment share between 1990 and 2005. Using data for nine sectors and several countries, they found a negative but small coefficient for Brazil, implying a negligible growth-reducing effect of structural change (contrary to Argentina, which showed a strong growth-reducing effect). We replicate their methodology for Brazil but using data on 42 economic sectors in Brazil for the period 1995-2009. Regressing the logarithm of the productivity of these sectors relative to that of the overall economy in 1995 on the variation in their share in total employment between 1995 and 2009, we find a positive and statistically significant (although only at the 10 percent level) coefficient, which may be a sign of productivity-enhancing structural change, in contrast with the results obtained by those two studies.

A further useful comparison is about the factors contributing to productivity growth in the manufacturing industry during recent decades. In Table 12, the shift-share estimates show that the decline of productivity within industries – rather than structural change – accounted for the bulk of the negative productivity growth (-0.5 percent per annum) in the manufacturing industry during 1995-2009.

*Table 12* – Decomposition of labor productivity growth in manufacturing, Brazil, 1995-2009

| Labor productivity growth | | Percentage of labor productivity growth explained by: | | | |
|---|---|---|---|---|---|
| Periods | Annual average compound growth (percent) | Within-industry effect | Static shift effect | Dynamic shift effect | Total effect |
| 1995-2000 | 0.1 | -1.1 | 83.7 | 17.4 | 100.0 |
| 2000-2005 | -1.0 | 3.7 | 70.0 | 26.3 | 100.0 |
| 2005-2009 | -0.6 | 205.1 | -122.3 | 17.3 | 100.0 |
| 1995-2009 | -0.5 | 127.3 | -47.8 | 20.5 | 100.0 |

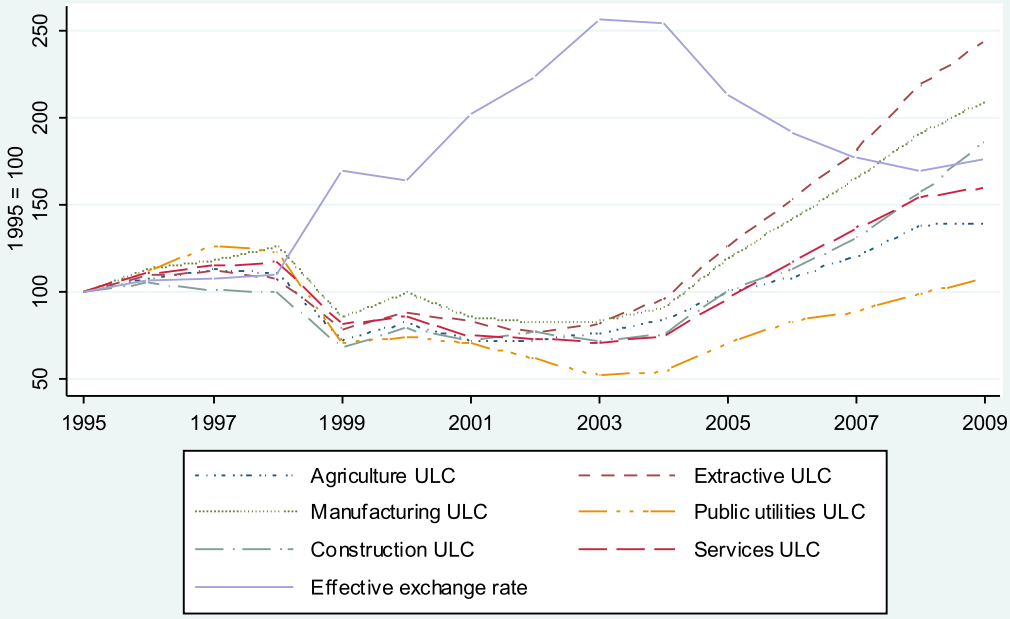
Source: same as Table 6.

In an attempt to grasp how labor cost competitiveness in Brazil's manufacturing has recently evolved, we estimate unit labor costs using data from national accounts. Figure 9 charts the unit labor cost for the main macro-sectors from 1995 to 2009.[32] After a sharp decline between 1999 and 2004 because of local currency devaluation, ULC in all sectors witnessed a rapid growth in the following years. The unit labor cost increased by more than 110 percent for the whole economy and more than 130 percent in manufacturing from 2004 to 2009.

[32] ULC deflates labor compensation by the effective exchange rate of Brazil's sixteen largest trade partners, as calculated by the Bank for International Settlements (BIS). Labor compensation is the sum of wages, social contributions and mixed earnings. Mixed earnings refer to earnings received by self-employed and owners of non-registered economic units, which are not classified as part of the formal business sector.

What lies behind this upsurge in Brazil's unit labor cost since the early 2000s? By construction, ULC adjusted by the effective exchange rate depends on the nominal average compensation rate, the effective exchange rate and the labor productivity. Figure 9 shows clearly that the upward drive of unit labor cost in all sectors was closely related to the appreciation of the Brazilian Real in the wake of the boom of commodities in international markets. The curves representing annual changes in ULC and effective exchange rate are nearly specular: when the Brazilian currency faced large depreciations, such as in 1999, the ULC fell sharply; conversely, the strong appreciation from 2004 was accompanied by a significant rise in ULC. Growth in average labor compensation for the whole economy, when deflated by the effective exchange rate, grew at nearly 17 percent per annum between 2004 and 2009, while labor productivity growth was stagnant, as seen earlier.

Figure 9 - Unit Labor Cost by Sector, Brazil, 1995-2009




Source: same as Table 6; exchange rate: Bank of International Settlements (BIS)
Note: effective exchange rate to currencies of Brazil´s sixteen largest trade partners.

It is worth showing the trends in each of the unit labor cost components for manufacturing (Figures 10 and 11). The rather divergent path of compensation share and unit labor cost displayed in Figure 10 shows the strong effect of exchange rate: while the unit labor cost jumped from 2004 (annual average growth of 17 percent until 2009), the compensation share grew only moderately at an average rate of 2.1 percent per annum in the same period.

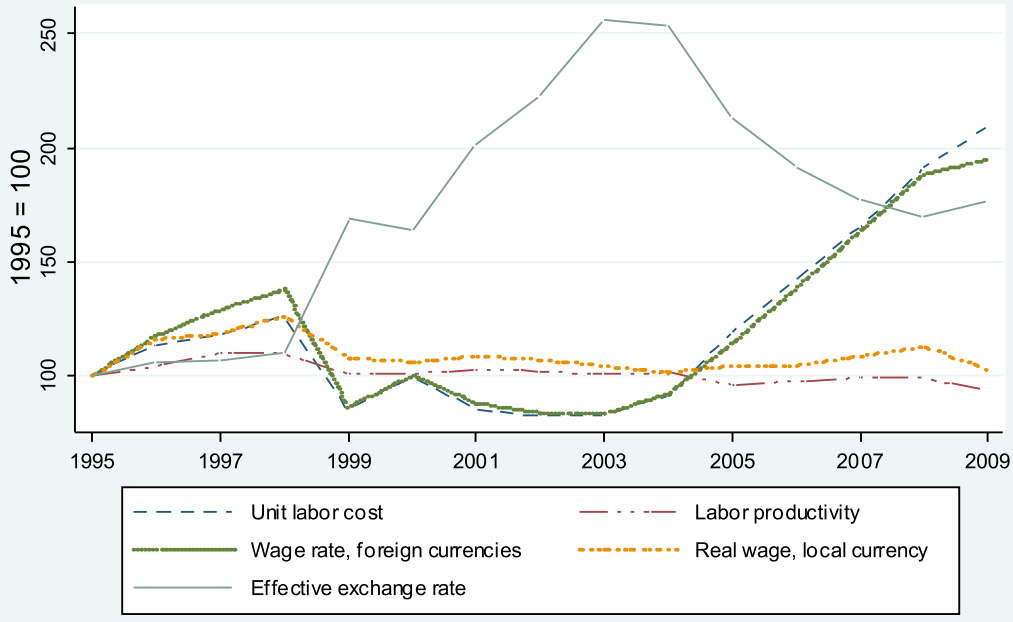
The decomposition of ULC growth in Figure 11 reveals, first, the close association between the average compensation rates deflated by the effective exchange rate and the unit labor cost in

manufacturing. Second, labor compensation deflated by domestic manufacturing prices grew slowly or even negatively: growth of labor compensation was on average 1.6 percent per annum between 2004 and 2008, and whether 2009 is included the average growth rate falls to -0.2 percent per annum. Third, labor productivity represented a drag on manufacturing since its annual average growth was negative (-1.2 percent) between 2004 and 2009. Therefore, the modest growth in the compensation share noted earlier was less an outcome of significant increases in labor compensation than a result of exceptional underperformance in manufacturing's labor productivity growth.

Figure 10 - Wage Share and Unit Labor Cost in Manufacturing, Brazil, 1995-2009


Source: same as Figure 9.

Figure 11 - ULC Components in Manufacturing, Brazil, 1995-2009




Source: same as Figure 9.
Note: see definitions in the text.

We have thus far presented evidence that in the last two decades the Brazilian economy experienced a significant increase in unit labor costs as well as in labor compensation adjusted by exchange rate, while labor compensation deflated by domestic production prices has grown quite modestly. Apart from currency appreciation, the other major determinant of increasing unit labor costs has been the stagnation or even negative growth of labor productivity since the 1990s. This outcome is in sharp contrast with the record of industrial performance during most of the postwar years which, as we have seen, was impressive for its gains in productivity growth amid rapid industrial expansion and diversification.

## IV. Conclusions

The expansion and diversification of Brazil's manufacturing industry from the nineteenth century until the late 1970s was a remarkable process. Despite distortions and inefficiencies, the experience of accelerated industrialization provided the country with a diversified and relatively complex industrial structure. In the 1980s and 1990s, the debt crisis and the ensuing macroeconomic imbalances undermined manufacturing performance, weakening incentives to invest and improve technological capabilities.

We have shown that productivity growth in Brazil's manufacturing industry in the last two decades was much below what was achieved during the earlier period of accelerated industrialization. Moreover, the shift-share analysis applied to both periods suggests that, historically, productivity gains within industries were relatively more important than the shifts of labor to higher productivity activities as the driving force for aggregate productivity growth. Only from the 1980s there was a reversal of industrial and sectoral performance and the role of structural change became relatively more important to explain productivity growth in Brazil's manufacturing. For the economy as a whole, structural change also revealed to be more important than sectoral productivity growth in the 1990s and 2000s. Thus there is evidence that the relatively successful process of learning and technological advance by manufacturing firms that took place since the early industrialization has lost strength as a major source of economic growth in Brazil during the recent decades. Most of productivity growth has now been coming from agricultural activities.

We also showed that, during most of the period of accelerated industrialization, industrial workers saw their wages measured in local currency lagging consistently behind labor productivity, which led to a declining share of wages in manufacturing income. Later, the unit labor costs adjusted by the exchange rate increased sharply, notably after 2003 and primarily as a result of currency appreciation and sluggish productivity growth. Labor compensation grew modestly in real

terms and had a minor role in increasing unit labor costs even when labor productivity slowed down persistently, as in the 2000s.

Our findings suggest that the performance of manufacturing in Brazil does raise concerns, but particularly because of its very low productivity growth and the tendency to currency appreciation that together affect unit labor costs and competitiveness. Manufacturing competitiveness might be significantly higher whether the costs of inputs and services other than labor (such as capital, taxes, infrastructure, bureaucracy and innovation) were lower or declining. Neither does this seem to be the case now, nor prospects appear to be bright. There are several factors that have conspired to reduce efficiency and productivity growth – such as the complex, burdensome tax system that tends to push firms to the informal, low-productivity sector; the high and unstable real interest rates and the relatively low-skilled workforce.

Furthermore, expenditures on R&D activities are below the levels attained in the most dynamic developing countries, limiting the technological spillovers that might benefit the whole economy. Innovative activities have also been negatively affected by low and volatile public investment and economic growth rates, which magnify uncertainty and inhibit long-horizon investment plans. Considering all these factors, no wonder that Brazil's investment rates remain much lower than those prevailing in most developing countries and, *a fortiori*, in China and Korea. As a consequence, it is unlikely that the poor performance of Brazil's manufacturing in productivity growth is being offset by appropriate incentives or reduction in the costs of key components that affect competitiveness in the long run.

## References


Abreu, Marcelo, ed. 1990. *A Ordem do Progresso. Cem Anos de Política Econômica Republicana, 1889-1990*. Rio de Janeiro: Campus.

Abreu, Marcelo, and Dorte Verner. 1997. *Long-Term Brazilian Economic Growth, 1930-1994*. Paris: OECD.

Ark, Bart van, and Timmer, Marcel. 2001. "The ICOP Manufacturing Database: International Comparisons of Productivity Levels." *International Productivity Monitor* 3: 44-51.

Ark, Bart van et al. 2005. *Unit Labour Costs, Productivity and International Competitiveness*. Groningen: Groningen Growth and Development Centre.

Baer, Werner. 2001. *Brazilian Economy: Growth and Development*. Westport: Greenwood.

Barros, Ricardo, Mirela de Carvalho, Samuel Franco and Rosane Mendonça. 2010. *Markets, the State and the Dynamics of Inequality: The Case of Brazil*. New York: United Nations Development Programme.

Beatty, Edward. 2000. "The Impact of Foreign Trade on the Mexican Economy: Terms of Trade and

the Rise of Industry, 1880-1923." *Journal of Latin American Studies* 32: 399-433.

Beiguelman, Paula. 1968. *A Formação do Povo no Complexo Cafeeiro: Aspectos Políticos*. São Paulo: Pioneira.

Bértola, Luis, and José Antonio Ocampo. 2012. *The Economic Development of Latin America since Independence*. Oxford: Oxford University Press.

BLS. Bureau of Labor Statistics. Division of International Labor Comparisons.

Bonelli, Regis, and Samuel de Abreu Pessôa. 2010. "Desindustrialização no Brasil: Um Resumo da Evidência." *Texto para Discussão* 7, IBRE-FGV.

Brasil, *Relatório do Ministério da Agricultura*, various years.

Bulmer-Thomas, Victor. 2003. *The Economic History of Latin America since Independence*. 2nd ed. Cambridge: Cambridge University Press.

Cano, Wilson. 1977. *Raízes da Concentração Industrial em São Paulo*. São Paulo: Difel.

Caves, Richard. 1971. "Export-led Growth and the New Economic History." In *Trade, Balance of Payments and Growth*, edited by J. Bhagwati, R. Jones, R. Mundell, and J. Vanek. Amsterdam: North Holland.

Chenery, Hollis. 1980. "Interactions between Industrialization and Exports." *American Economic Review* 70: 281-7.

Colistete, Renato P. 2010. "Revisiting Import-Substituting Industrialisation in Post-War Brazil." *MPRA Papers*. August, n. 24665.

Contador, Cláudio, and Cláudio Haddad. 1975. "Produto Real, Moeda e Preços: A Experiência Brasileira no Período 1861-1970." *Revista Brasileira de Estatística* 36: 407-440.

Crafts, Nicholas. 1973. "Trade as a Handmaiden of Growth: An Alternative View." *Economic Journal* 83: 875-84.

Cruz, Paulo Davidoff. 1984. *Dívida Externa e Política Econômica: A Experiência Brasileira nos Anos Setenta*. São Paulo: Brasiliense.

Dean, Warren. 1969. *The Industrialization of São Paulo, 1880-1945*. Austin: University of Texas Press.

Delfim Netto, Antônio. 1959. *O Problema do Café no Brasil*. São Paulo: IPE-USP.

Doellinger, Carlos von. 1973. *Transformação da Estrutura das Exportacoes Brasileiras: 1964-70*. Rio de Janeiro: IPEA.

ECLA. 1963. *The Textile Industry in Latin America. II – Brazil*. New York: United Nations.

Fabricant, Solomon. 1942. *Employment in Manufacturing, 1899-1939: An Analysis of Its Relation to the Volume of Production*. New York: NBER.

Fagerberg, Jan. 2000. "Technological Progress, Structural Change and Productivity Growth: A Comparative Study." *Structural Change and Economic Dynamics* 11: 393-411.

Felipe, Jesus, and Grace Sipin. 2004. "Competitiveness, Income Distribution, and Growth in the Philippines: What Does the Long-run Evidence Show?" *ERD Working Paper*, n. 53.

Ferreira, Francisco, Phillippe Leite, and Martin Ravallion. 2010. "Poverty Reduction Without Economic Growth? Explaining Brazil's Poverty Dynamics, 1985–2004." *Journal of Development*

*Economics*. 93: 20-36.

Fishlow, Albert. 1972. "Origens e Conseqüências do Processo de Substituição de Importações no Brasil." *Estudos Econômicos* 2: 7-75.

Ffrench-Davis, Ricardo, Oscar Muñoz, and José Gabriel Palma. 1998. "The Latin American Economies, 1950-1990." In *Latin America. Economy and Society Since 1930*, edited by Leslie Bethell. Cambridge: Cambridge University Press.

Furtado, Celso. 1959. *Formação Econômica do Brasil*. Rio de Janeiro: Fundo de Cultura.

Goldsmith, Richard W. *Brasil 1850-1984: Desenvolvimento Financeiro sob um Século de Inflação*. São Paulo: Harper & Row.

Gómez-Galvariatto, Aurora, and Jeffrey G. Williamson. 2009. "Was It Prices, Productivity or Policy? Latin American Industrialisation after 1870." *Journal of Latin American Studies* 41: 663-94.

Graham, Harry. 1912. *Coffee. Production, Trade, and Consumption By Countries*. Washington: Government Printing Office.

Haber, Stephen. 2006. "The Political Economy of Industrialization." In *The Cambridge Economic History of Latin America*, edited by Victor Bulmer-Thomas, John H. Coatsworth, and Roberto Cortés Conde, 537-584. Cambridge: Cambridge University Press, vol. II.

Haddad, Claudio. 1980 "Crescimento Econômico do Brasil, 1900-76." In *Economia Brasileira. Uma Visão Histórica*, edited by Paulo Neuhaus. Rio de Janeiro: Campus.

Hall, Michael. 1969. "The Origins of Mass Immigration in Brazil, 1871-1914." Phd diss., Columbia University.

Hanley, Anne G. 2005. *Native Capital: Financial Institutions and Economic Development in São Paulo, Brazil, 1850-1920*. Stanford: Stanford University Press.

Haraguchi, Nobuya, and Gorazd Rezonja. 2012. "Industrial Structural Change in the BRICS," in this volume.

Holloway, Thomas. 1974. *Migration and Mobility. Immigrants as Laborers and Landowners in the Coffee Zone of São Paulo, 1886-1934*. PhD diss., University of Wisconsin.

IBGE. 1939-1940. *Anuário Estatístico do Brasil*. Rio de Janeiro: IBGE.

IBGE. 1991. *Anuário Estatístico do Brasil*. Rio de Janeiro: IBGE.

IBGE. 1990. *Estatísticas Históricas do Brasil*. Rio de Janeiro: IBGE.

IBGE. 2006. *Estatísticas do Século XX*. Rio de Janeiro: IBGE.

IBGE. 1995-2009. National Accounts (Revised).

Kuznets, Simon. 1967. "Quantitative Aspects of the Economic Growth of Nations: X. Level and and Structure of Foreign Trade: Long-Term Trends." *Economic Development and Cultural Change* 15: 1-140.

Leff, Nathaniel. 1972. "Economic Retardation in Nineteenth-Century Brazil." *Economic History Review* 25: 489-507.

Macleod, Christine. 1988. *Inventing the Industrial Revolution. The English Patent System, 1660-1800*. Cambridge: Cambridge University Press.

Maddison, Angus et al. 1992. *The Political Economy of Poverty, Equity, and Growth. Brazil and*

*Mexico*. Oxford: Oxford University Press.

Maddison, Angus. 2001. *The World Economy: A Millenial Perspective*. Paris: OECD.

McMillan, Margaret, and Dani Rodrik. 2011. "Globalization, Structural Change, and Productivity Growth." *NBER Working* Papers. February, n. 17143.

Monbeig, Pierre. 1949. *Pioneiros e Fazendeiros de São Paulo*. Translated by Ary França and Raul de Andrade e Silva. 2a ed., São Paulo: Hucitec, 1998.

Mortara, Giorgio. 1941. "Estudos sobre a Utilização do Censo Demográfico para a Reconstituição das Estatísticas do Movimento da População do Brasil." *Revista Brasileira de Estatística* 5:39-89.

Naudé, Wim, Adam Szirmai, and Alejandro Lavopa. 2012. "Industrialization and Technological Change in BRICS: The Contribution of Multinational Enterprises and Domestic Investment," in this volume.

North, Douglass. 1955. "Location Theory and Regional Economic Growth." *Journal of Political Economy* 63: 243-58.

Ocampo, José Antonio, and Jaime Ros. 2011. "Shifting Paradigms in Latin America's Economic Development." In *The Oxford Handbook of Latin American Economics*, edited by José Antonio Ocampo and Jaime Ros, 3-25. Oxford: Oxford University Press.

Pagés, Carmen et al. 2010. *The Age of Productivity: Transforming Economies from the Bottom Up*. Washington, DC: Inter-American Development Bank.

Palma, José Gabriel. 2011. "Why Has Productivity Growth Stagnated In Most Latin American Countries Since The Neo-Liberal Reforms?" In *The Oxford Handbook of Latin American Economics*, edited by José Antonio Ocampo and Jaime Ros, 568-607. Oxford: Oxford University Press.

Prado Jr., Caio. 1945. *História Econômica do Brasil*. São Paulo: Brasiliense.

Ramos, Lauro. 2009. "Desempenho Recente do Mercado de Trabalho Brasileiro: 1992-2005." *Revista de Economia Política* 29: 406-20.

Reynolds, Clark. 1980. *A Shift-Share Analysis of Regional and Sectoral Productivity Growth in Contemporary Mexico*. Laxenburg: International Institute for Applied Systems Analysis.

Reynolds, Lloyd. 1983. "The Spread of Economic Growth to the Third World: 1850-1980." *Journal of Economic Literature* 21: 941-980.

Saes, Flávio A. M. 1986a. *Crédito e Bancos no Desenvolvimento da Economia Paulista, 1850-1930*. São Paulo: IPE-USP.

Saes, Flávio A. M. 1986b. A *Grande Empresa de Serviços Públicos na Economia cafeeira: 1850-1930*. São Paulo: Hucitec.

Salvucci, Richard. 2006. "Export-Led Industrialization." In *The Cambridge Economic History of Latin America*, edited by Victor Bulmer-Thomas, John H. Coatsworth, and Roberto Cortés Conde, 249-92. Cambridge: Cambridge University Press, vol. II.

Schmookler, Jacob. 1966. *Invention and Economic Growth*. Cambrige, Mass.: Harvard University Press.

Sokoloff, Kenneth. 1988. "Inventive Activity in Early Industrial America: Evidence from Patent Records, 1790-1846." *Journal of Economic History* 48, 813-50.

Stein, Stanley. 1957. *Brazilian Cotton Manufacture : Textile Enterprise in an Underdeveloped Area*.

Cambridge: Harvard University Press.

Summerhill, William R. 2003. *Order Against Progress. Government, Foreign Investment, and Railroads in Brazil, 1854-1913*. Stanford: Stanford University Press.

Suzigan, Wilson. 2000. *Indústria Brasileira. Origem e Desenvolvimento*. São Paulo: Hucitec.

Tafunell, Xavier. 2009. "Capital Formation in Machinery in Latin America, 1890-1930." *Journal of Economic History* 69: 928-50.

Teitel, Simon, and Thoumi, Francisco. 1986. "From Import Substitution to Exports: the Manufacturing Exports Experience of Argentina and Brazil," *Economic Development and Cultural Change*. 34: 455-490.

Thorp, Rosemary. 1998. *Progress, Poverty and Exclusion. An Economic History of Latin America in the 20th Century*. New York: IDB.

Timmer, Marcel, and Szirmai, Adam. 2000. "Productivity Growth in Asia Manufacturing: The Structural Bonus Hypothesis Examined." *Structural Change and Economic Dynamics* 11: 371-92

Tyler, William. 1976. *Manufacturing Export Expansion and Industrialization in Brazil*. Tübingen: J.C.B. Mohn (Paul Siebeck).

United Nations. 1951. *Labour Productivity of the Cotton Textile Industry in Five Latin American Countries*. New York: United Nations.

Watkins, Melville. 1963. "A Staple Theory of Economic Growth." *The Canadian Journal of Economics and Political Science/Revue Canadienne d'Economique et de Science Politique* 29: 141-58.

Williamson, Jeffrey G. 2008. "Globalization and the Great Divergence: Terms of Trade Booms, Volatility and the Poor Periphery, 1872-1913." *European Review of Economic History* 12: 355-91.

Williamson, Jeffrey G. 2011a. "Industrial Catching Up in the Poor Periphery 1870-1975." *NBER Working Papers*, February, n. 16809.

Williamson, Jeffrey. 2011b. *Trade and Poverty. When the Third World Fell Behind*. Camb., Mass.: MIT Press.