Faculdade de Economia,
Administração e Contabilidade
de Ribeirão Preto
Universidade de São Paulo

Texto para Discussão

Série Economia

TD-E 08 / 2013

Mudança estrutural e desenvolvimento econômico: o Brasil está 'catching up' ou 'falling behind'

Prof. Dr. Carmem Aparecida do Valle Costa Feijó

Av. Bandeirantes, 3900 - Monte Alegre - CEP: 14040-905 - Ribeirão Preto - SP
Fone (16) 3602-4331/Fax (16) 3602-3884 - e-mail: cebelima@usp.br site: www.fearp.usp.br

Universidade de São Paulo

Faculdade de Economia, Administração e Contabilidade de Ribeirão Preto

Faculdade de Economia, Administração e Contabilidade de Ribeirão Preto
Avenida dos Bandeirantes,3900
14040-905 Ribeirão Preto – SP

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STRUCTURAL CHANGE AND ECONOMIC DEVELOPMENT: IS BRAZIL CATCHING UP OR FALLING BEHIND?

André Nassif*
Fluminense Federal University (*Universidade Federal Fluminense*) and
The Brazilian Development Bank (BNDES), Rio de Janeiro, Brazil
andrenassif@bndes.gov.br
mailto:andrenassif27@gmail.com

Carmem Feijó*
Fluminense Federal University, Rio de Janeiro, Brazil
cfeijo@terra.com.br

Eliane Araújo*
State University of Maringá (*Universidade Estadual de Maringá*), Paraná, Brazil
elianedearaújo@gmail.com

March, 2013

The authors are very thankful to Gabriel Porcile, from the Economic Comission for Latin America and Caribbean (ECLAC), for having benevolently provided us organising data on the Brazilian manufacturing industry and patiently discussing it with us during the period we were preparing this study. When the first manuscript was presented at the Brazilian Development Bank (BNDES), in April, 2012, this study benefited from the comments and suggestions from David Kupfer, Erika Amorim Araujo, Fábio Giambiagi, Fernando Puga, Francisco Eduardo Pires de Souza and Jorge Arbache. It was also presented in a special session on Structural Change and Economic Development at the 9th International Conference on Developments in Economic Theory and Policies at the University of Bilbao (Spain), 28-29 June, 2012, and in the V Conference of the Brazilian Keynesian Association, at the School of Economics, Getulio Vargas Foundation, São Paulo, 22-24 August, 2012 . The opinions expressed in this study are those of the authors and do not reflect the views of the Brazilian government and the BNDES.

Abstract

We present a Kaldor-Thirlwall theoretical and empirical framework on the basic driving forces of the behaviour of productivity and economic development in the long-run. By calculating the so-called Thirlwall equation, the main contribution of our research is to respond on whether Brazil has been catching up or falling behind. We show some empirical evidence based on both descriptive statistics and econometric regressions for Brazil between 1970 and 2010. Some important indicators of descriptive statistics reveal that Brazil has entered into a process of early de-industrialisation. In addition, since our econometric estimates also show that there was a dramatic increase in the income elasticity of demand for imports between the 1980-1998 period and the 1999-2010 period (from 1.97 to 3.36) and a small decrease in the income elasticity for exports in the same periods (from 1.36 to 1.33), we can conclude that Brazil not only has already embarked on a trajectory of falling-behind related to the world economy and the international economic frontier, but also that it might show, in the absence of appropriate policies, lower growth rates in the long run. However, if the opposite occurs, it would face major long-term external constraints to growth.

Keywords: early de-industrialisation; structural change; catching up; falling behind; Brazil
*JEL classification*s: O11; 040; O47

1. Introduction

Since classical political economy, questions related to how to accelerate and sustain economic development in order to achieve both high real income per capita and social well-being levels have always been in the focus of economics. Notwithstanding, many economists are excessively pretentious to believe that economic development depends on mostly economic factors, since it is also actually influenced by a set of non-economic phenomena, such as those linked to history, geography, anthropology, sociology, culture, among others.[1] However, the isolation of any other non-economic or even economic factor - note that when theoretical economists do this, they use the common expression "considering all else equal" or what is known as the "*ceteris paribus*" hypothesis - is not a disadvantage *per se* when we are interested in capturing the main economic factors which influence most economic phenomena. For instance, in the case of economic development, nowadays there is practically a consensus that it is mostly determined by growth in productivity over time, which is, in turn, concretised by physical and human capital accumulation as well as technological progress.[2] In practical terms, these latter factors are responsible for sustaining high rates of growth in productivity in a particular country, and therefore, being the average growth in the world economy considered as a given, for accelerating the process of catching up.

Yet, the central point of divergence among economists is concerned with the most important sources for boosting growth rates in productivity both in absolute and relative terms in a developing country in order to reduce the technological gap with respect to developed countries and, therefore, to ease the process of catching up in the long run.[3] The focus of this paper has basically two characteristics: first, it is structuralist, *par excellence*, in the sense that

[1] See the provocative book by McCloskey (2010).

[2] Within the neoclassical literature, see Lucas, 1988; Romer, 1986, 1990; and Grossman and Helpman, 1991, among others. For a structuralist-evolutionary view, see Nelson and Winter, 1982; Fagerberg, 1988; and Dosi, Pavitt and Soete, 1990, among others.

[3] In economics, the long run refers to economic time, rather than calendar time. However, even in terms of calendar time, the period during which a country gets to be well succeeded in catching up depends on several factors, such as the size of the country, the quality of the industrial, technological and institutional policies implemented, and a fine coordination of these latter policies with macroeconomic policies. For instance, South Korea could catch up in a period of around 25 years, while China, if it will actually succeed in doing that, will take much more than 30 years. See Amsdem, 1989, for the South Korean case, and Amsdem, 2001, for comparing the hard efforts of several developing countries to search for adequate strategies to promote structural change and catching up.

the behaviour of productivity in the long run is basically determined by factors that affect aggregate demand, which, in turn, is strongly conditioned by both monetary, fiscal and exchange rate policies; second, that behaviour, when considered well succeeded, is manifested, firstly, by a strong shifting of resources from traditional sectors like the primary one to the manufacturing one, and then, after the country has achieved high levels of real income per capita, to service sector. Several authors have argued that, together with other facts, when the rapid and large loss of participation of the manufacturing sector in total value added and mainly in total employment occurs before the country has reached high levels of per capita income, this phenomenon characterises an early de-industrialisation[4] and can strongly retard the process of catching up or even put the economy into a trajectory of falling behind.[5] [6] It is important to remark that the significant loss in participation of the manufacturing sector in total value added is a natural phenomenon in developed countries, because in this stage of development, the domestic income elasticity of demand for services is a little higher than that for manufacturing goods (see Clark, 1940).

The theoretical framework of this paper is based on Kaldor and Thirlwall theories on the basic driving forces of the behaviour of productivity and economic growth in the long run. On the Kaldorian view, we will base our work on the hypothesis that the main sources of the behaviour of the aggregate productivity come from the manufacturing sector. The main empirical justification is that this sector, comparatively to primary and service sectors, operates under significant static and dynamic economies of scale, the reason for which it has the highest capacity to disseminate its gains from productivity to the economy as a whole.[7] By anchoring on this Kaldorian hypothesis, we also show that the more a country is able to construct a large and diversified manufacturing sector during the time through which it is in

[4] For other details on the recent literature about early de-industrialisation, see Rowthorn and Wells, 1987, Rowthorn e Ramaswany, 1999 and Palma (2005).

[5] In the definition of de-industrialisation, Rowthorn and Wells (1987) gives special importance to the loss of participation of the manufacturing sector in total employment, rather than in total value added.

[6] Then, the significant loss of participation of the manufacturing sector in total value added is a natural phenomenon in developed countries, because in this stage of development, the domestic income elasticity of demand for services is a little higher than that for manufacturing goods. For other details on de-industrialisation, see Rowthorn and Wells, 1987, and Rowthorn and Rowthorn e Ramaswany,1999.

[7] Static economies of scale occur when a firm doubles its total investment and the amount of the new production more than doubles. Therefore, considering that the factor prices used in that investment are kept constant, the long-term unit cost reduces. Dynamic economies of scale occur when a firm is able to reduce long-term unit costs by implementing well succeeded innovation over time and, therefore, tends to accumulate learning-by-doing, knowledge and major technological capacity.

the catching up process, the more will be its capacity to sustain high rates of economic growth in the long run. In the literature on economic development, this relationship between the real output of the manufacturing industry and its positive effects on the productivity of the economy as whole is known as the Kaldor-Verdoorn Law.

Yet, in addition, the previous theoretical framework will be complemented by the Thirlwall hypothesis on the importance of a country that intends to sustain economic growth without facing balance of payments constraints to have an elasticity of demand for exports above the elasticity of demand for imports (Thirlwall's Law). This hypothesis makes it clear why it is important for a developing country to have not only a large and diversified export composition, but also the majority of its net exports (exports minus imports) basket constituted by goods of high income-elasticity of demand in the long run.

The relevance of the paper for an emerging country like Brazil is that, despite the fact that this country has been well succeeded in building a relatively large and diversified manufacturing sector, it is still not an industrialised country in the Kaldorian point of view.[8] So, since responding to part of the title of this paper ("is Brazil catching up or falling behind?") has normative implications, the paper can assist policy-makers in evaluating whether or not the actual short and long-term economic policies *lato sensu* (industrial and technological policy, macroeconomic policy and so on) are in tune with each other to sustain the long-term economic growth of the Brazilian economy and promote the process of catching up with developed countries.

Besides this Introduction and the Conclusion, the paper is organised as follows. Section 2 presents with reasonable details the main hypothesis and stylised facts on structural change and economic development based on the Kaldor-Thirlwall theories. Section 3, by connecting the previous stylised facts and a basic hypothesis on the same theme with empirical evidence on the Brazilian economy based on descriptive statistics for the 1970-2010 period, shows a preliminary answer of whether or not Brazil has already entered into early de-industrialisation.[9] Section 4 presents two important pieces of econometric evidence: first, by estimating the so-called Kaldor-Verdoorn coefficient for the 1970-2010 period, we will show

[8] For a discussion about the stages of development of the Brazilian manufacturing industry, see Feijó and Lamonica, 2012.

[9] Due to unavailability of data, descriptive statistics on the Brazilian manufacturing sector will only cover the period between 1970 and 2008.

if the Brazilian manufacturing sector operates under dynamic economies of scale, a necessary (but not sufficient) condition for sustaining both high rates of productivity and growth in the long run; and second, we will estimate the long-term income-elasticities of demand for imports and exports for the Brazilian economy for the 1980-2010 period, which is essential evidence for showing if Brazil has either faced major external constraints to long-term economic growth or kept more distant from the international technological frontier.

2. Structural change and economic development: the theoretical framework

2.1 Towards a structuralist theory of economic development: a Kaldorian-Thirlwallian approach

Most economists today practically agree with the hypothesis that both innovation and technological spillovers are the main engine for explaining productivity growth. However, while neoclassical economists tend to give all sectors of the economy equal weight for explaining the productivity behaviour of the economy as a whole, structuralist ones, by identifying the manufacturing industry as the main creator and disseminator source of technical progress as well as the principle source of significant static and dynamic increasing returns to scale, argue that the manufacturing sector is the main force for explaining the aggregate productivity.[10]

The importance given to the maximisation of static and dynamic increasing returns to scale as the main explaining factor for boosting both aggregate productivity and (therefore) economic development is relatively old in economics. The general idea was presented not only in authors like Adam Smith (1776) and Allyin Young (1928), but also in that group of development economists whose contributions made economics reach what Krugman (1993) has called "high development theories": Paul Rosenstein-Rodan (1943), Albert Hirschman (1958), Gynnar Myrdal (1957) and others. However, it was not until the publication of a set of Kaldor's theoretical and empirical essays in the mid-1960s and the 1970s that the justification

[10] Karl Marx was, perhaps, the first author to emphasise the importance of the technical progress in the development process (see Marx, 1887, especially Vol. I, chapter XV, "Machinery and Large-Scale Industry"). Yet, the incorporation of this force as endogenous to economic development was only first emphasised by Schumpeter (1942).

of the manufacturing sector as the location for most industries subject to increasing returns to scale was so clearly and precisely demonstrated (see Kaldor 1966, 1967, 1968, 1970 and 1975).

Before summarising Kaldor's main hypothesis on the relationship between structural change and economic development, two points must be stressed: first, as Clark (1940) had already pointed out, Kaldor (1966) also recognized that as soon as economic development reaches maturity - that is to say, a stage in which countries, by having already caught up, are able to exhibit high levels of income per capita and well being -, a relatively significant loss of participation of the manufacturing industry in total real GDP is accompanied by a major participation of the service sector; second, one could argue that, since much (but not the majority) of the new ideas, knowledge and dynamic economies of scale are now being generated in the tradable service sector, the effects of microelectronic and telecommunication revolution (for most, the third industrial revolution) on the representative role of the manufacturing sector for economic development, as supported by Kaldor (1966), is becoming *passé*.

As to that latter point, the criticism is misleading for several reasons: first, as Kaldor presented his principal arguments when the service sector was composed basically of nontradables, he certainly would recognize the role of the tradable services today as additional forces to those coming from the manufacturing sector in accelerating and sustaining the development process; second, even if we take into account the increasing participation of several important tradable services (e.g. software) as being subject to static and dynamic increasing returns to scale in the entire service sector, the fact is that the majority of this latter phenomenon occurs and could continue to occur in the process of manufacturing production[11]; and third, and perhaps more important, following the insights pioneered by Young (1928), Kaldor (1966: 106) stresses that both static and dynamic "increasing returns (to scale) are a "macro-phenomenon" – just because so much of the economies of scale emerge as a result of increased differentiation, the emergence of new process and new subsidiary industries, they

[11] To give an example, various activities generated in the conception of goods produced by Apple, such as the creative ideas, knowledge and engineering of projects may be developed in the service sector. However, the majority of Apple family goods (i-pods, i-phones, i-pads and so on) are produced by segments of the manufacturing sector which operate under conditions of significant increasing returns to scale.

cannot be discerned adequately by observing the effects of variations in the size of an individual firm or a particular industry".

The interpretation of the static and dynamic economies of scale as a "macro-phenomenon" is essential for understanding Kaldor's hypothesis on the importance for developing countries to have a strong and diversified manufacturing industry, especially during the time when their manufacturing sector is in a trajectory departing from the immaturity to maturity stage. In addition, it is important to stress that, in a Kaldorian framework, the more a country has a manufacturing industry formed by segments which operate under static and dynamic increasing returns to scale, the more rapid is its catching up process. Then, for Kaldor (1966), economic development is a process through which structural change happens, that is to say, the productive resources are strongly reallocated from the traditional sector (especially agriculture) to the manufacturing sector (mainly those segments of more technological sophistication, namely those that are engineering, science and knowledge-based).[12] Only when a country has already reached a maturity stage (in other words, a developed country with an income per capita significantly above the world average), the loss of the participation of the manufacturing industry in total GDP could be accepted as natural.

In his seminal paper, Kaldor (1966) enumerated the following hypotheses on structural change and economic development as well as gave the econometric evidence which supports them[13]:

i) Long-term economic growth of a country is largely associated with the relative size and diversification of its manufacturing industry. Not only due to its high capacity for generating innovation and disseminating technological spillovers throughout the economy as a whole, but also in virtue of its above mentioned presence in static and dynamic increasing returns to scale, the manufacturing sector dictates the dynamism of the aggregate productivity growth;

ii) Insofar as static and dynamic economies of scale presented in the manufacturing sector are understood as a "macro-phenomenon", once economic development is sustained, the synergies

[12] In our empirical analysis ahead, we will break down the manufacturing sector into three groups: labour intensive; natural resource-based; and engineering, science and knowledge-based.
[13] McCombie and Thirlwall (1994) call these hypotheses Kaldor´s Laws.

between the increase of productivity in the manufacturing industry and positive changes in productivity of the economy as a whole make the aggregate productivity become largely associated with the increase in total output. This result, which is known as the Kaldor-Verdoorn Law, is largely explained by dynamic economies of scale.[14] [15] By associating the different levels of per capita income reached by a country with a minor or major propensity to consume manufacturing goods, Kaldor was perhaps the first author to call attention to the importance of preventing a country from early de-industrialisation, especially in the stage during which it has reached a level of income per capita close to the world average. In fact, since in this stage societies tend to have a high propensity to consume manufacturing goods – that is to say, their income elasticity of demand is significantly above one – a high and sustained growth of the manufacturing sector contributes for boosting economic growth in the long run.

iii) As if anticipating Thirlwall's (1979) model of the balance-of-payment constraint to growth, Kaldor (1966) suggested that, mainly in either intermediate or relatively advanced stages of development, net exports must increase at a faster rate in order to finance the high need of imported capital goods. The important question that could be raised as to this point is as follows: if it is a high demand increase in the manufacturing sector which governs the rhythm of growth in the economy as a whole, why should a weak foreign demand for exports constrain economic development even in large economies like the United States, China or Brazil? The answer is far from being associated with supporting an export-led growth strategy for these countries, insofar as the large size of their domestic market is perhaps more important than exports for boosting the advantages of economies of scale in the manufacturing sector. The main reason is that the more a country can augment and diversify its exports through a major composition of goods with high income elasticity of demand, the less will be

[14] P. J. Verdoorn (1949) was the first author to suggest this association.

[15] Kaldor (1966) showed econometric evidence on this relationship (see Table 2, p. 107). As McCombie and Thirlwall (1994, ch. 2) summarised, despite a variety of empirical works attempted to validate or not the Kaldor-Verdoorn Law for a group of countries in the long-run, the results, in principle, seemed not to be conclusive. However, since Kaldor (1970) later argued that it is more appropriate to estimate the "diffferences in "regional" growth rates (taking into account the) different areas within the same country (…), for there are few, if any, economic barriers to the interregional mobility of capital and to interstate migration", McCombie and Thirlwall (1994: 209) also summarised the estimates of the Kaldor-Verdoorn Law respecting Kaldor's suggestion and concluded that "the assumption of output growth is fundamentally demand, rather than supply, determined more plausible at both the international and the regional level".

the external constraint to economic growth in the long run. In fact, if one observes experiences of economic development in countries like Japan after World War II, South Korea in the 1960-1985 period and China from 1979 on, it could be concluded that all of them have well succeeded to shift the composition of their exports from small kinds of traditional goods (labour intensive and natural resource-based) to very diversified goods, especially science, engineering and knowledge-based goods which make up the majority of total exports.[16]

iv) The behaviour of economic growth is not supply-constrained neither in the short nor in the long run. As to this point, if, on the one hand, Kaldor supports Keynes's (1936) hypothesis that the behaviour of aggregate demand in the short-run explains the business cycles and the insufficiency of effective demand explains recessions and depressions, on the other hand, since the Kaldor-Verdoorn Law is in operation and under the assumption that there is no external constraints to growth, the supply of the economy can elastically respond to the increase of demand in the long-run. As a matter of fact, Kaldor does not completely discard the role of some supply constraint to the long-term growth. In fact, he observes at least two main forces from the supply side that could constrain long-term growth: first, the slow capacity of supply to respond to the increase in demand, especially of inputs and raw materials; and second, the shortage of labour supply. In the first case, Kaldor (1966: 115) argued that, unless there is a balance of payment constraint, there is no reason to believe in a supply constraint of this kind, because it would only arise if "a particular rate of growth generates a rate of growth of imports which exceeds the rate of growth of exports". In the second case, the answer is a little more complex. Kaldor (1966) accepts that as the country is in a trajectory of catching up and structural change, sooner or later, the unlimited labour supply (see Lewis, 1954) provided by the excess of manpower coming from agriculture will be over. While the manufacturing sector is not able to completely absorb the growing of the labour force as the economy shifts from immaturity to a developed stage, since the service sector is less sensitive to demand fluctuations, it could employ the excess of labour supply to demand. This explains why de-industrialisation in matured economies tends to reduce the participation of both manufacturing (expressed by the value added) and employment in total

[16] As will be shown ahead, in the empirical evidence, we will break down the manufacturing industry into three groups classified according to their technological sophistication: labour intensive; natural resource-based; and science, engineering and knowledge-based. The respective segments of each group are described in Appendix A.

real GDP. However, by adopting a Schumpeterian view, Kaldor (1966: 117-121) argues that technical progress is the dramatic engine that tends to "so radically reduce the labour requirements in industry as to make it possible to combine growth with *falling* industrial employment" in such a way that there is nothing but a "reservoir of surplus labour, or disguised unemployment, instead of a shortage of labour in the long-run". This conclusion reinforces Kaldor's main hypothesis that, by reducing external constraint, it is the dynamic economies of scale associated with the manufacturing sector, governed, in turn, by the demand side, which explains the long-term growth and the catching up process.

2.2 Stylised facts and a basic hypothesis on structural change and economic development

In this subsection, we will present some stylised facts and a basic hypothesis on structural change and economic development which, together with the above discussed theoretical framework, will serve as the analytical basis for the empirical evidence that will be shown in sections 3 and 4.[17]

Stylised fact 1: Economic development is a process of deep structural change of the economy

As Prebisch (1950) has emphasised a long time ago, although economic development is basically determined by the technical progress, the issue is that technology is neither generated nor equally distributed between developed and developing countries. Cimoli, Porcile and Rovira (2010), Cimoli and Porcile (2010a; 2010b) and Cimoli and Porcile (2011) have reactivated some of Prebisch's and Kaldor´s original ideas in order to support empirical evidence on how, by dominating the technical progress of the world, the productive structure of developed countries continues to be much more complex and diversified than that of developing countries. This means that economic development can be understood as a process through which a deep structural change occurs in the economy, in such a way that there is a reallocation of resources from the primary sector to the manufacturing sector, and, then, as soon as countries have achieved high levels of income per capita, from that latter sector to the service sector. So, economic development with deep structural change means that both the productive structure of the economy and the composition of net exports are mostly dominated

[17] Most of these stylised facts are based on Cimoli and Porcile (2011b).

by the presence of manufacturing segments that produce science, engineering and knowledge-based goods.

Stylised fact 2: Countries characterized by a productive structure and pattern of specialization concentrated in primary goods or natural resource-based manufactured commodities tend to direct most of the employment toward these sectors

In countries that basically specialize in primary products and natural resource-based manufactured commodities, the majority of the employment generated tends to be absorbed by these sectors. Then, even during the boom phases of the business cycle, the presence of a significant part of informal employment can be dissembled and masked by a "paradox of full employment" (see Cimoli and Porcile, 2011b). From a structuralist perspective, given the dramatic level of informality of manpower, however, the unemployment rate is used to being relatively high. Not by chance, these countries tend to weakly sustain the international competitiveness of these goods based on low wages. However, whenever either domestic currencies of these countries are overvalued in real terms or the terms of trade are temporarily favourable, wages tend to artificially increase and to destroy that "spurious" kind of competitiveness (see Fajnzylber, 1988). The main implication is that, by being basically determined by low relative wages, rather than by higher relative labour productivity, this pattern of static comparative advantage is not favourable to economic development (see Cimoli and Porcile, 2010a).

Stylised fact 3: The more rapidly a country is able to build and sustain a large and diversified manufacturing sector with a significant participation in total GDP and total net exports, the more rapidly it will catch up.

When several factors (lack of appropriate short-term and long-term economic policies, inadequate institutions, lack of political consensus on how to accelerate economic development, etc.) prevent countries from developing a large and diversified manufacturing industry, they tend to specialize in goods with static comparative advantages, especially in

labour intensive and natural resource-based goods.[18] Since these sectors have low capacity of generating and diffusing technical progress as well as of taking advantage of dynamic economies of scale, the technological gap increases to such a magnitude that the development process tends to become locked-in in a regressive technological path (see Arthur, 1989). So, the catching up process is more rapid when countries are well succeeded in producing structural change and redirecting most of their exports towards science, engineering and knowledge-based industries. Hausmann, Hwang and Rodrik (2007) showed sound empirical evidence that "what you export matters", that is to say, countries whose export basket has a significant part composed by products of high technological sophistication tend to show higher rates of economic growth in the long run. On the contrary, if their productive structure and pattern of specialization is dominated by labour intensive and natural resource-based goods, countries tend to engage in a falling behind path.

Basic hypothesis on structural change and economic development: *The more a country directs its productive structure and net export basket to very diversified goods, with a major presence of the science, engineering and knowledge-based sectors, the larger will be its degree of intensity of structural change.*

This above hypothesis depends on the so-called Thirlwall's Law (see Thirlwall, 1979), as follows:

$$\frac{\dot{Y}}{\dot{Y}*} = \frac{\varepsilon_X}{\pi_M} \tag{1}$$

[18] One could correctly argue that some natural resource-based manufacturing segments (e.g., oil refining, natural gas, paper and cellulose and others) have high capacity to generate technological spillovers and produce backward and forward linkages with industries of medium or high technology. For instance, investments and appropriate industrial policies in the oil industry (e.g. government purchasing policy and tax stimulus) could boost some industries of medium or high technological sophistication (through mainly backward linkages), such as the navy industry, oil and petrochemical equipment and some others. The issue is that a country will be hardly able to produce and sustain significant dynamic economies of scale in the Kaldorian sense in the long run if it becomes highly dependent on a small group of natural resource-based industries.

Where $\dot{Y}$ is the rate of economic growth in the domestic country; $\dot{Y}*$ is the rate of world economic growth; ε_X is the income elasticity of demand for exports; and π_M is the income elasticity of demand for imports.

Thirlwall's Law suggests that the convergence of the rate of economic growth in a particular country (say, a developing country) to the world economic growth depends on the ratio between the income elasticity of demand for exports and income elasticity of demand for imports. In other words, if the income elasticity of demand for exports increases above the income elasticity of demand for imports, economic development is sustained because economic growth will not be constrained by balance of payments constraints in the long run.

3. Structural change in the Brazilian economy: industrialisation (or de-industrialisation), cacthing up (or falling behind) since the 1970s?

The aim of this section is to show empirical evidence based on some indicators related to descriptive statistics on the evolution of the structural change and economic development in Brazil. With the exception of the statistics on foreign trade, which covers the 1970-2010 period, due to data unavailability, most of the indicators related to the Brazilian manufacturing performance covers the period between 1970 and 2008.

3.1. An overview of the Brazilian industrialization process

From 1947 to 1980, the Brazilian economy grew (6.4 per cent per year) above the average of both developed and underdeveloped economies, showing a strong vigour under the leadership of the manufacturing sector. This sector exhibited an average growth of 8.6 per cent per year in the same period.[19] During the 1970s, particularly, the industrial sector showed average yearly growth rates closed to 7.4 per cent. These results can be explained to a great extent by the strategy of import substitution to complete the industrialization process of the country. Indeed, between 1947 and 1980, the manufacturing sector increased its participation in the total GDP from 19.3 per cent to 31.3 per cent (Table 1). This increase can be, at least

[19] This expansion was not continuous over time, exposing the period 1963-67 as the least dynamic (average economic growth rates of 2.7 per cent p.y.).

partially, credited to the relative success of the implementation of three national development plans: Targets Plan (*Plano de Metas*, 1956-61), The First National Development Plan (*I PND*, 1968-73) and The Second National Development Plan (*II PND*, 1974-1979), which contributed to promoting significant changes in the productive structure of the country (Castro, 1985).

Although many criticisms received by the actual implementation of the strategy of the import substitution regime in Brazil are more than valid (e.g. very high rates of effective protection compared with those imposed by some successful Asian countries, inefficiency in policy implementation, negligence in carrying out policy evaluation, lack of high investments in education, among others), that strategy was, notwithstanding. responsible for the building of a large and diversified manufacturing sector in Brazil. Except over the short periods of normal business cycles, the extraordinary rhythm of economic growth was only interrupted, at the end of the 1970s, by the external debt crisis in 1980-1982, which revealed the unsustainability of the chosen model to finance development policies with external savings (basically through long-term foreign bank lendings subjected to flexible interest rates) adopted especially during the 1970s. As a result of the relative loss in dynamism of the manufacturing sector, its relative weight in total GDP fell. In addition, from 1980 to 2010, since the general priorities of the economic policy - particularly between 1980 and the mid-1990s - concentrated in stabilising high inflation and promoting the adjustment of severe problems of balance of payments and the external debt, the average growth rate of the real GDP was around only 2.7 per cent p.y.

Table 1

Brazilian main sectors of activity as share (in percentage) of total real value added

Selected years

	1947	***1960***	***1970***	***1980***	***1990***	***2000***	***2010***
Agriculture	20.7	17.8	11.6	10.1	6.3	5.6	5.5
Total industry (including mining, utilities and construction)	25.2	32.2	35.8	40.9	30.1	27.7	27.5
Manufacturing	19.3	25.6	27.4	31.3	20.7	17.2	14.6
Services	54.1	50.0	52.6	49.0	63.6	66.7	67.0

Source: System of National Accounts, Brazilian Institute of Geography and Statistics (IBGE)

Although a new growth cycle started in 2004, the 2008 financial global crisis suddenly interrupted this trend. The average growth rate of the real GDP between 2004 and 2008 increased to 4.7 per cent, though this performance has been much more worse than that of the set of all developing countries.[20] Table 1 breaks down the three sectors of the Brazilian economy and shows how Brazil's productive structure has been changing over the last 60 years.[21] In the recent debate about the reasons for the relatively slow growth of the Brazilian economy in comparison with similar economies, the dramatic loss of relative importance of manufacturing sector from the 1980's on has been pointed out as one of the main causes to be investigated.[22]

3.2 The connections between the stylised facts on structural change and economic development and the empirical evidence for the Brazilian economy

In order to deepen the discussion about structural change in Brazil, this section will focus on the Brazilian manufacturing industry following the Kaldorian view about its strategic role in the catching up process of an economy. We will connect the stylised facts already discussed in Section 2 with the indicators of descriptive statistics on the Brazilian economy in the period under study. Except for a few, most of the indicators which will be presented were based on the PADI (Analysis Program of Industrial Dynamics) database of the Economic Comission for Latin American and Caribbean (ECLAC) that exploits structural data from the manufacturing sector.[23]

[20] To refer to a larger period, the poor performance of the Brazilian economy between 1999 and 2012 can be revealed by comparing the annual average growth rates of real GDP in Brazil (3.2 per cent) with all developing and emerging countries (5.7 per cent). Data for Brazil is from the Brazilian Institute of Geography and Statistics and for developing and emerging countries from the World Bank database. For details, see Nassif, 2011.

[21] It should be observed that from 2000 onwards the Brazilian System of National Accounts changed the reference base for its estimates, using data from the annual surveys more extensively. If, on the one hand, this improvement implies more accuracy in the measure of the contribution of each sector to total value added and employment, on the other hand, it has also obviously become more difficult to make comparisons of data with those of previous years. See IBGE, 2007.

[22] For a long-term analysis of the Brazilian experience of growth and a review of the hot debate between opposing interpretations, see Bresser-Pereira (2006).

[23] ECLAC-PADI is an internationally harmonized database, which collects statistical information from national statistical offices. In the Brazilian case, the main source of information comes from the Industrial Censuses and the Annual Industrial Surveys (*Pesquisa Industrial Annual – PIA*) carried out by the Brazilian Institute of Geography and Statistics (IBGE). Data for missing years from IBGE's surveys have been estimated, following ECLAC's methodological procedures. Whenever applicable, all information provided in ECLAC-PADI has been converted from each countries´ currency to 1985 constant dollar prices.

As seen in Table 1, the augmented participation of the manufacturing industry in the total value added of the Brazilian economy until the 1980s was also accompanied by a broad diversification of its structure. The 1970s marked the establishment of a diversified productive structure of durable, non-durable, capital goods and intermediary goods, which represented the conclusion of the last stage of the process of import substitution (see Castro).[24] As it will be shown latter on, the diversification in the industrial production also led to the diversification of exports: in 1964 the share of manufactured and semi-manufactured goods reached 14.0 per cent and in 1980 this percentage increased to 57.0 per cent.[25] The consolidation of a diversified industrial structure occured in the mid-1980s with the maturation of investments implemented in the context of *II PND* (1974-1979). From the early-1990s on, a set of liberalizing reforms was implemented in the Brazilian economy (e.g. the trade liberalisation, external financial openess, privatisation of state enterprises, among others) within a context in which high inflation and serious problems in the external sector of the economy prevailed. The rapid loss of participation of the value added of the Brazilian manufacturing sector in total real GDP, which actually had began in the mid-1980s, as well as a growing international specialisation in exports of primary products and natural resource-based manufactured commodities, opened a intense debate in the 2000s on whether or not Brazil suffered from early de-industrilisation.[26]

Stylised facts 1 and 2: structural change in the Brazilian manufacturing industry: resource allocations and employment

According to Table 1 above, the dramatic drop of participation of the manufacturing industry in total value added since the 1980s could be, in principle, taken as a sign of early de-industrialisation in Brazil. However, according to the old and new literature on the theme, the diagnosis of early de-industrialisation must also take into account other indicators such as

[24] According to the Industrial Census of the Brazilian Institute of Geography and Statistics (IBGE), in 1980 more than 50 per cent of the value added of manufacturing and mining industries came from segments classified as scale-intensive (38.6 per cent), differentiated (11.7 per cent) and science-based (2.8 per cent).
[25] It is worth noting that even with the debt crisis in the 1980s, considering only manufactured exports, these amounted to more than 50 per cent of total exports in 1981, and this percentage remained at this level or above until 2008, when it fell to 47.0% (Brazilian Ministry of Development, Industry and Commerce -MDIC).
[26] On the debate about early de-industrialisation in Brazil, see Palma, 2005, IEDI, 2005, Jank, 2008, Nassif, 2008, Oreiro and Feijo, 2010, and Bacha and Fishlow (2011), among others.

relative growth rates of the manufacturing sector, the reallocations of resources in terms of value added, employment and exports within the manufacturing industry and throughout the economy as a whole, as well as the changes in both productivity and the technological gap over time. In fact, while Rowthorn and Wells (1987) and Rowthorn and Ramaswany (1999) prefer to diagnose early de-industrialisation looking at the evolution of economic indicators of a country in absolute terms (like participation of the manufacturing industry in total value added, employment, exports and so on), Palma (2005) and Bresser-Pereira (2008, 2010), following structuralist and Kaldor's traditions (1966), give special attention to **changes** in the relative position of a country's manufacturing industry in the world economy (boldface ours).

Initially, we will be interested in evaluating what happened only within the Brazilian manufactuing industry betweeen 1970 and 2008, and not in the economy as a whole. Figure 1 shows how the Brazilian industrial structure has been changing since the 1970s, considering a taxonomy of the manufacturing sector according to the technological intensity applied in its productive process. This classification helps to evaluate whether or not the structural change within the manufacturing sector was directed towards the set of segments with higher technological intensity. As this taxonomy breaks down the manufacturing sector into only three groups, a structural change that has been oriented towards the science, engineering and knowledge-based segments might signalise major potential for spillovering gains from productivity over the economy as whole, since those segments are more subject to static and dynamic economies of scale, as Kaldor stressed a long time ago.[27]

The distribution of the manufacturing value added among the three groups of industries has clearly moved towards an increase in the weight of the science, engineering and knowledge-based segment, which responded for 28.1 per cent of the total value added of the Brazilian manufacturing sector in 1970 and reached 45.8 per cent in 2008. This gain has dramatically been offset by the loss in importance of labour-intensive industries, which reduced their share from 32.0 per cent in 1970 to 16.7 per cent in 2008. The natural resource-based industries showed a small loss, although roughly maintained their participation at over 30 per cent. Looking closely inside each group, we realised that the strong increase in the

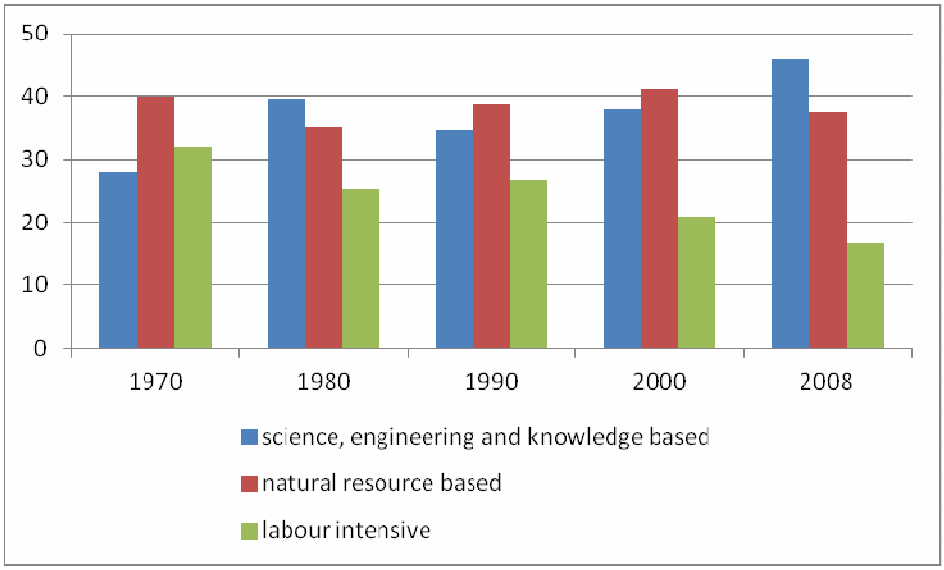
[27] As our taxonomy breaks down the Brazilian manufacturing industry into only three groups, one could correctly argue that the high level of aggregation might compromise the analysis. However, unfortunately, in virtue of not having sufficient data in the ECLAC-PADI database in the long period under investigation, we could not analyse the data of the Brazilian manufacturing industry in a more disaggregate level.

participation of the science, engineering and knowledge-based segments was due to a growing importance of machinery and equipment, electrical and transport industries. If, in the labour intensive group, all industries reduced their importance, in the natural resource-based one, while the food industry is still the most important, the oil refining industry gained weight in the period under consideration

Figure 1

Value added in the Brazilian manufacturing sector according to technological intensity

Selected years



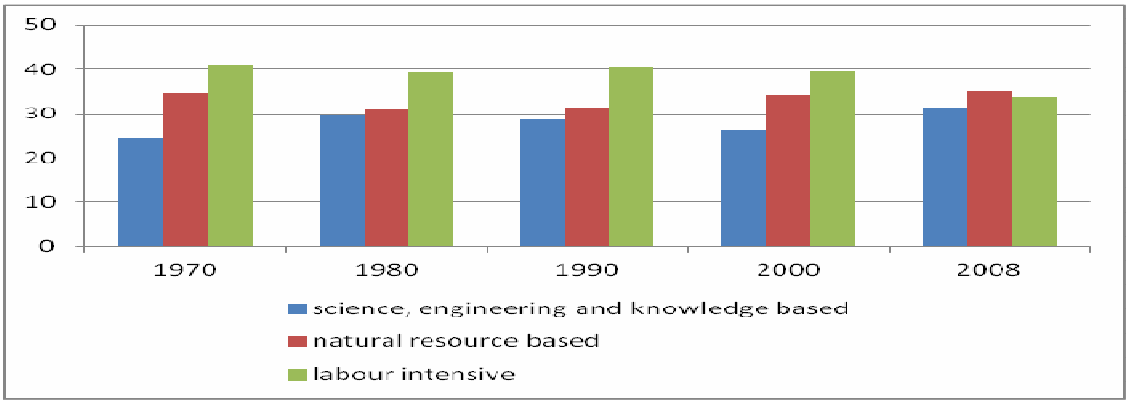
Source: ECLAC-PADI

Figure 2 shows the distribution of employment over each group of industries. The same movement is observed in the labour intensive industries which, differently from the other ones with higher employment participation, were the only ones to lose importance in job creation over the time period: their contribution falls from 41.0 per cent in 1970 to 33.8 per cent in 2008. The percentage of employment in the natural resource-based industries changed little from 1970 (34.6 per cent) to 2008 (35.0 per cent). The science, engineering and knowledge-based group is the one that shows the greatest increase in employment participation, moving from 24.4 per cent in 1970 to 31.2 per cent in 2008. In 2008 the distribution of jobs in the Brazilian manufacturing industry is rather equilibrated among the three groups of industries.

Figure 2

Percentage of total employment in the Brazilian manufacturing sector according to technological intensity

Selected years



Source: ECLAC-PADI

It is also important to analyse the evolution of the participation of employment in the Brazilian economy as a whole. Table 2 shows indicators on this subject in Brazil only between 2000 and 2009, the period in which data is available. Table 2 makes it clear that there was a shift in the workforce from agriculture, but not from total industry (including manufacturing), to the service sector in the period under consideration. In the case of the manufacturing industry, there was a small increase in the participation of employment in total employment from 12.0 per cent to 12.7 per cent between 2000 and 2009. Except for construction, which had a little increase from 6.7 per cent to 7.1 per cent between 2000 and 2009, the other subsectors of the Brazilian industry practically kept their relative participation.

Table 2

Participation of employment in Brazil by sector of economic activity
Selected years (in percentage)

Sectors	2000	2003	2005	2007	2009
Agriculture	22.3	21.0	20.9	18.6	17.4
Total Industry	19.5	19.1	20.0	20.1	20.5
Mining	0.3	0.3	0.3	0.3	0.3
Manufacturing	12.0	11.9	12.8	12.8	12.7
Utilities	0.4	0.4	0.4	0.4	0.4
Construction	6.7	6.4	6.5	6.6	7.1
Service	58.2	59.9	59.1	61.3	62.1
Total	**100**	**100**	**100**	**100**	**100**

Source: System of National Accounts, Brazilian Institute of Geography and Statistics (IBGE)

The interpretation of those combined above mentioned indicators is important for reactivating the debate of whether or not the Brazilian economy actually suffers from early de-industrialisation. Given the complexity of this process, it is not enough to look at only the loss in participation of the manufacturing sector in total value added, which, in the Brazilian case, was relatively rapid and strong from the early 1990s on, as already shown in Table 1.[28] Actually, as already discussed, if it is looked at from within its structure, the Brazilian manufacturing industry not only still keeps a relatively well diversified structure, with more than 40 per cent of the value added being generated in more sophisticated manufacturing segments, but also is able to absorb a significant part of the workforce (Figures 1 and 2, respectively). However, if we look at the economy as a whole, the service sector was already responsible for around 62 per cent of the Brazilian workforce in 2009 (Table 2). In addition, as will be shown ahead, the Brazilian manufacturing industry is getting more distant from the technological frontier. How to conciliate all this evidence?

In principle, the existence of a relatively diversified manufacturing sector and the keeping of a balanced distribution of employment in manufacturing between old and more technologically sophisticated industries - by not violating both stylised facts 1 and 2, as discussed in Section 2 - could not be signalising early de-industrialisation in Brazil. However, since the Kaldorian tradition stresses the importance of the relative position of the domestic

[28] Rigoursly speaking, the loss in participation of the manufacturing sector in the Brazilian real GDP began in the middle of the 1980s. So, as already argued by Nassif (2008), if we would take into account just this indicator, this phenomenon had began in Brazil before the introduction of its liberalising reforms in the early 1990s.

manufacturing industry comparatively to the world economy, if a strong augmentation of the technological gap and a poor performance of the evolution of both exports and trade balance is verified, these indicators would be signalising a tendency of both early de-industrialisation together with falling behind, insofar as these results would be violating stylised fact 3 and the basic hypothesis on structural change and economic development, according the Kaldor-Thirlwall theoretical analysis of Section 2.

So, thus far, a partial conclusion on the structural change in the Brazilian manufacturing sector is that there has been more diversification and it has moved towards segments of more technological sophistication. As discussed in Section 2, an economy with a more diversified manufacturing structure tends to show relatively higher aggregate productivity than countries strongly specialised in a few groups of traditional industries.

Stylised fact 3: the diversification of the Brazilian manufacturing industry and its sustainability- evolution of the labour productivity, technological gap and pattern of international specialisation

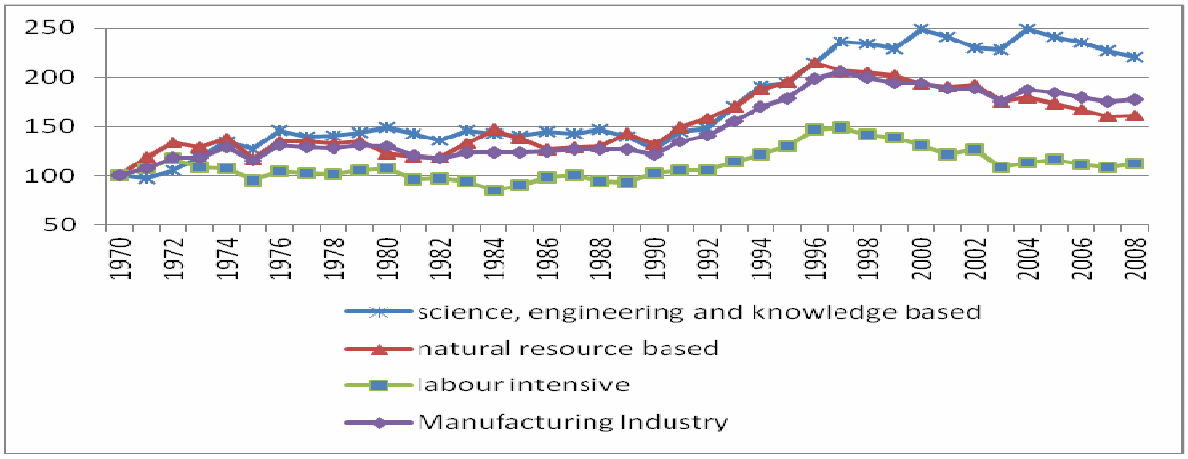
So far, the Brazilian manufacturing sector has shown a pattern of industrial change that could suggest that the economy is sustaining a process of catching up. Yet, from a structuralist perspective, another piece of information should be added to evaluate the profile of the competitiveness of the economy. This will be done through the analysis of the behaviour of the Brazilian labour productivity as well as its technological gap in relation to the international technological frontier of the three groups of industries. Figure 3 shows that, since the 1970s, the science, engineering and knowledge-based group has been leading the growth of the Brazilian labour productivity. While the labour-intensive manufacturing segment has been clearly behind the other ones, the natural resource-based group has followed close to the average of the manufacturing sector as a whole. Figure 3 also shows that the labour productivity improved significantly in the early-1990s, following Brazil's trade liberalisation, as had been documented in several studies on the theme.[29] However, around 1997 productivity gains began to slow down and a clear declining trend is observed in all three groups of industries.

[29] See Moreira and Correa (1998), Bonelli (2002), Feijó and Carvalho (2002) and Nassif (2003), among others.

Figure 3

Labour productivity growth of the Brazilian manufacturing industry

1970-2008 – in index-number (1970 = 100)



Source: ECLAC-PADI

Although it can be realised that the rate of growth in the Brazilian manufacturing labour productivity has been higher in segments of major technological sophistication, it is important to check whether or not the speed of the productivity growth has been enough to keep the economy in a trajectory that reduces its technological handicap. In the Kaldorian perspective, this point is absolutely important. In fact, as Kaldor (1966: 104)) strongly stressed, "rather than the *level*, the differences in growth rates (among countries) are largely accounted for by differences in the rates of growth of productivity (…) and also that the incidence of technical progress – as measured by the *rate of growth* of productivity – is higher in manufacturing activities than in other fields, so a great concentration of manufacturing increases the overall rate of advance" (italics from the original).

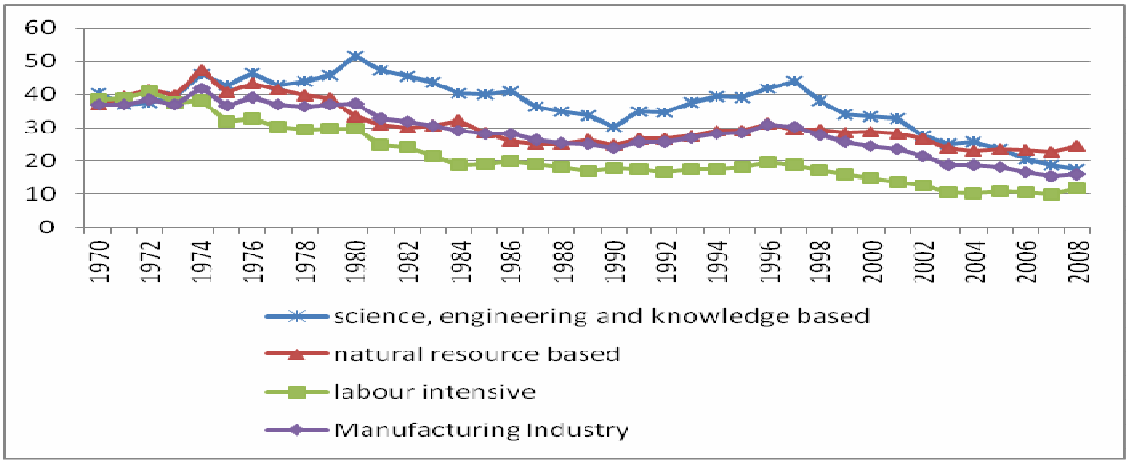
An estimate of how far productivity gains are from the technological frontier is shown in Figure 4, which measures the rate of growth in the Brazilian manufacturing labour productivity by technological intensity in comparison with that of the correspondent groups in the United States.[30] This indicator can be evaluated as a proxy for the technological gap.

[30] Even taking into account that the United States has been loosing importance in the global economy and is not in the avant-garde of all segments of the manufacturing sector, most studies consider that, on average, that country is still in the international technological frontier.

According to Figure 4, the productivity gap began to quickly and dramatically widen in all industrial groups near the end of the 1990s. The science, engineering and knowledge-based industries showed the lowest productivity gap, compared with the other groups, until 2006, when from then on the natural resource-based industries have shown better performance, even though they are still very far from the technological frontier. It should be remarked that, in 1980, the science, engineering and knowledge-based industries registered the lowest relative distance from the technological frontier (51 per cent). So, in spite of the movement of the industrial structure towards more diversified and technologically sophisticated sectors, the international comparison points out that the Brazilian manufacturing industry might be lagging behind. Rigourously speaking, independently from what happens with the other sectors of the Brazilian economy (primary and service sectors), in a Kaldorian perspective, the technological gap of the manufacturing sector as a whole has increased to so high a rhythm since the end of the 1990s that the level registered in 2008 is enough to draw the conclusion that the Brazilian economy has been characterised by signs of early de-industrialisation and a falling behind long-term path. The important issue to be answered is whether or not this falling behind path could be reverted in the medium-term.

Figure 4

The Brazilian technological gap: relative labour productivity in the Brazilian manufacturing sector compared with that of the United States 1970-2008 (in percentage)[31]



Source: ECLAC-PADI

Before doing some econometric exercises that could provide us with preliminary answers to the above question[32], we will investigate the evolution of the Brazilian exports and trade balance. Figure 5 shows the behavior of Brazilian exports since 1970. It is a remarkable fact that throughout the 1970s, a period during which the import substitution regime was most intense, manufactured goods increased their importance in Brazilian total exports. Starting from less than 20 per cent of total exports in 1970, this participation more than doubled by 1980. In 1984, manufacturing exports represented around 55 per cent of Brazilian total exports, and this participation kept around this mark until 2006, when exports of manufactured

[31] This Figure is the only one that follows the original classification of manufacturing sector according to the technological intensity available in ECLAC-PADI database, which, misleadingly considers the chemical industry as natural resource-based, instead of as science, engineering and knowledge-based. While in the construction of the other indicators, we could take out the chemical industry of the natural resource-based group, including it in the science, engineering and knowledge-based industries, for the indicator shown in Figure 4 this was not possible, since ECLAC-PADI database does not show the behaviour of the labour productivity of the chemical industry separately for the United States. Even so, particularly in the Brazilian case, by analysing the rate of growth of the labour productivity by groups, it does not make much difference if the chemical industry is included in either one or the other group.

[32] This will be carefully analysed in Section 4, related to some econometric estimates.

goods started to lose participation. This loss is being offset by the increase in exports of basic goods.

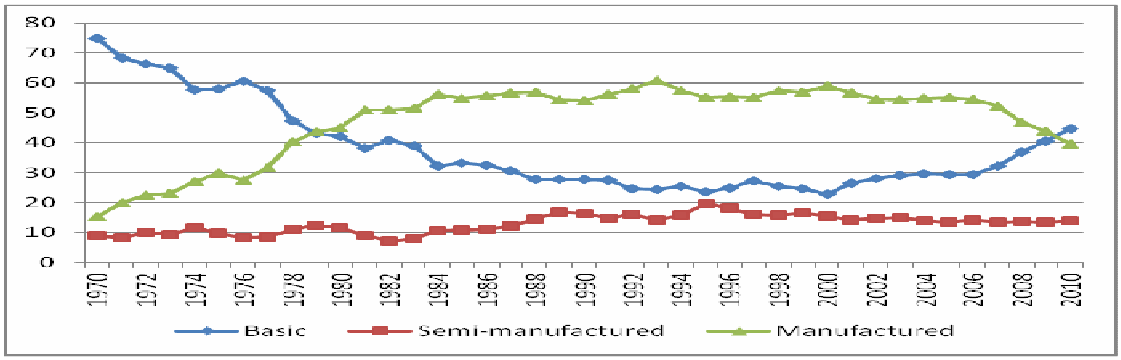
Two facts could explain the poor performance of the last few years. On the one hand, related to a more structural source, it could be associated with the enlargement of the technological gap in the manufacturing sector as a whole, a phenomenon that has been happening since the end-1990s, as already analysed.[33] On the other hand, the loss in participation of manufacturing goods in total exports could be associated with a persistent trend of overvaluation of the Brazilian currency since the 1990s.[34] This factor, combined with the significant growth in the world trade in the 2000s, could be responsible for putting the Brazilian economy in a dangerous path of specialising in goods in which it has static comparative advantage. By looking at the Brazilian total exports, we realised that this situation was so strongly accelerated between 2006 and 2010 that in this latter year Brazilian exports of basic products (especially primary products and commodities) surpassed those of manufactured goods (Figure 5). This set of poor indicators (high technological gap, sharp drop in manufacturing exports in recent years and a rapid increase in participation of primary and commodities goods in total exports) are clear preliminary signs that Brazil has actually not only entered into a process of early de-industrialisation, but also embarked on a trajectory of falling behind.

[33] As an illustration, the share of the Brazilian manufacturing industry in GDP (around 18%) is close to the value observed in developed countries, whose per capita income is on average 7 times the Brazilian's. This shows the premature character of the de-industrialization process of the Brazilian economy (IEDI, 2005).
[34] For details, see Nassif, Feijó and Araújo (2011).

Figure 5

Brazilian total exports classified by intensity of value added

1970-2010 (participation in percentage points)



Source: Brazilian Office of Foreign Trade/Ministry of Development, Industry and Commerce (SECEX/MDIC)

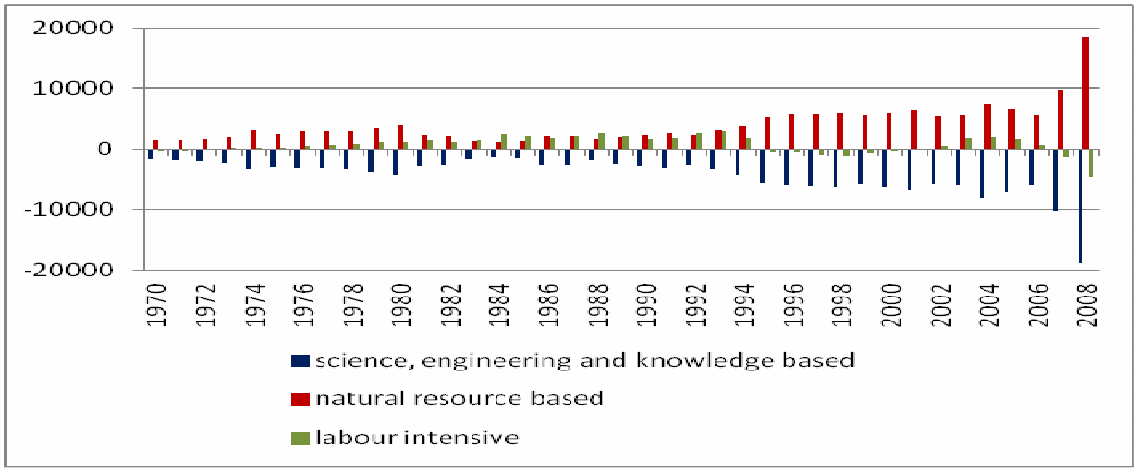
Another piece of evidence to support the argument of both early de-industrialisation and falling behind in the past few years could be analysed by the structural characteristics of the Brazilian trade balance. Figure 6 shows that, while the science, engineering and knowledge-based manufacturing industries showed persistent trade deficits, these negative trade balances not only continued to increase sharply over the 1990s, but also dramacatically accelerated between 2006 and 2008. Labour intensive manufacturing industries are those characterised by minor importance in Brazilian manufacturing exports and showed their worst trade performance in both the second half of 1990s and in the final years of the series. In turn, nature resource-based manufacturing industries are the only group that had trade surplus during the entire time. The positive trade balance of this latter group sharply accelerated in the last few years.

Figure 6

Trade balance of the Brazilian manufacturing industries classified by technological intensity

1970-2008

In US million dollars



Source: ECLAC-PADI

A preliminary conclusion could be drawn from this Section. If, on the one hand, the Brazilian manufacturing industry can still be characterized as a relatively large and diversified one, on the other, the enlargement of the technological gap, combined with a persistent real exchange rate overvaluation, has been responsible for the loss of international competitiveness in the manufacturing sector (except from the natural resource-based industries), as well as for putting the Brazilian economy in a dangerous path of falling behind. The science, engineering and knowledge-based manufaturing industries, particularly, have sharply enlarged both the technological gap and the trade deficits. From a Kaldorian perspective, the combination of this set of negative factors, by reducing the ability of the manufacturing sector to spillover its gains from productivity to the rest of the economy, might definitively deepen the Brazilian process of early de-industrialisation and accelerate the actual falling-behind path in the long run. In the next Section, we will carefully investigate not only if the Brazilian economy might be able to revert this negative trajectory in the medium term, but also if it is subjected to any external constraint to sustain economic growh in the long run.

4. Econometric evidence: the Kaldor-Verdoorn's and Thirlwall's Laws

Aiming at speculating on the potential capacity of the Brazilian economy to sustain its long-term growth, we need to implement at least two important econometric exercises: the first one consists in estimating the so-called Kaldor-Verdoorn coefficient in the 1970-2010 period. This indicator reveals whether or not the Brazilian manufacturing industry operates under static and (mainly) dynamic economies of scale, as interpreted by Kaldor (1966) and as already discussed in Section 2[35]; the second one is related to the estimate of the income elasticity of demand for Brazilian exports and imports between 1970 and 2010. This estimation is essential for drawing some conclusions on whether or not the Brazilian balance of payments constraints in the long-run have been increasing according to the so-called Thirlwall's Law.

4.1 Estimating the Kaldor-Verdoorn coefficient for the Brazilian economy (1970-2010)

The Kaldor-Verdoorn Law was originally specified by Verdoorn (1949) and used by Kaldor (1966) according the following equation (we will maintain the original notations):

$$p = a + bq \qquad (2)$$

where p is the exponential growth rate of the labour productivity in the manufacturing sector and q is the exponential growth rate in manufacturing output. The estimated coefficient, b, is the Kaldor-Verdoorn coefficient.

According to Kaldor's (1975: 693) interpretation, for having unequivocal evidence of existence of static and (mainly) dynamic economies of scale in manufacturing, there must be a "statistically significant relationship between p and q, with a regression coefficient which is significantly less than 1". At the same time, for the existence of constant returns to scale to be rejected, the above mentioned coefficient must statistically be significantly different from

[35] McCombie and Thirlwall (1994, ch.2, especially between pages 163 and 231) presented a detailed critical review on the Kaldor theory of growth in the long run, as well as a lot of econometric evidence (and the several issues related to its estimate) on the Kaldor-Verdoorn coefficient.

zero. Following McCombie and Thirlwall (1994), we also estimated the Kaldor-Verdoorn coefficient as specified in equation (2) by ordinary least squares (OLS).[36]

The estimation covers the 1970-2010 period.[37] However, in order to investigate if the post-trade liberalization period has produced any change in the Kaldor-Verdoorn coefficient in Brazil, we also implemented the econometric estimation for the subperiods between 1970-1989 and 1990-2010.[38] The results are shown in Table 3, whose footnotes also inform on the implemented variables and data sources.

Table 3

Estimate of the Kaldor-Verdoorn coefficient for the Brazilian economy (1970-2010)

Econometric estimate of equation (2)

Dependent variable: rate of growth of labour productivity

	1970-2010	**1970-1989**	**1990-2010**
Constant a	-0.002 (0.008)	-0.006 (0.014)	0.010 (0.011)
K-V coeff.b	0.392*** (0.129)	0.387** (0.178)	0.521** (0.210)
R^2	0.19	0.21	0.24
$R^{2\ adjusted}$	0.17	0.20	0.17
DW	1.99	2.07	2.01
n	40	20	21

Notes: i) *** Significant at 1 percent level; ** Significant at 5 percent level; * Significant at 10 percent level; ii) Values between brackets indicate standard deviation; iii) *DW* is the Durbin-Watson statistics; iv*) n* is the number of observations; v) *p*: the difference of the logarithm of the labour productivity in the Brazilian manufacturing sector (source: Brazilian System of National Accounts from the Brazilian Institute of Geography and Statistics; and Brazil's Ministry of Development, Industry and Commerce - MDIC); vi) *q*: the difference of the logarithm of the value added of the Brazilian manufacturing industry, expressed in US million dollars (source: Brazilian System of National Accounts from the Brazilian Institute of Geography and Statistics).

The results show that the Brazilian economy has, at least in principle, potential for growing in the long run. The estimated Kaldor-Verdoorn coefficients *b* not only were

[36] For a detailed discussion on problems related to the original Kaldor theoretical and empirical equation (but also other following proposed theoretical and econometric specifications), see McCombie and Thirlwall (1994: 175-231).

[37] For labour productivity in the manufacturing sector (defined as the ratio of value added to total employed workforce), we used the original source from ECLAC-PADI. However, as its available data go until 2008, we estimated the value added and total employment in the Brazilian manufacturing sector in 2009 and 2010 based on the yearly growth rates for both variables estimated by Brazil's Ministry of Development, Industry and Commerce (MDIC).

[38] If the period from 1970 to 2010 was divided into a larger number of subperiods, the regression methodology would have little information for estimating the coefficients and making the results reliable.

statistically highly significant and different from zero, but also were less than 1 in all estimated periods. This reveals that the Brazilian manufacturing industry operates under dynamic economies of scale, in the sense analysed by Kaldor (1966). The estimated coefficient *b* for all estimated periods (1970-2010) was the same as that related to the 1970-1989 period (0.39). Yet, between 1990 and 2010, the estimated Kaldor-Verdoorn coefficient significantly improved to 0.52, indicating that an increase in the growth of the Brazilian manufacturing output by one percentage point increases the growth of labour productivity by a bit more than one-half of a percentage point. This is proof that, even taking into account the severe micro and macroeconomic problems suffered by the Brazilian economy along a part of this latter subperiod (such as the necessary, but relatively rapid trade liberalization, high inflation, the persistent trend of overvaluation of the Brazilian currency in real terms, among others), the Brazilian manufacturing industry still operates under substantial dynamic economies of scale. In other words, in principle, it has potential for boosting both labour productivity and, therefore, economic growth in the long run. It is important to stress that, curiously, Kaldor considered, implicitly, a coefficient near 0.50 as idealistically good for a developing country sustaining a catching up process (see Kaldor,1966). In fact, countries like the United States and Germany, for instance, during the period in which they were close to catching up with the United Kingdom between the last quarter of the nineteenth century and theearly-twentieth century, showed Verdoorn coefficients (as originally calculated by Verdoorn and presented by McCombie and Thirlwall, 1994:170, Table 2.5) of 0.42 and 0.49, respectively.

Obviously, the result presented in Table 3 must be understood as a preliminary exercise that has some limitations, such as a linear technical progress function as originally specified by Kaldor (1966), simple econometric regression, omission of variables, among others. However, after summarizing several empirical studies from the most simple to highest econometric sophistication, McCombie and Thirlwall (1994:167) showed that almost all of them have econometric issues. Not by chance, these same authors concluded that “the debate over the Verdoorn Law would make a good textbook example of the problems that can beset statistical inference!”

4.2 Estimating the income elasticity of demand for Brazilian exports and imports (1980-2010)

This section aims at estimating the income elasticity of demand for Brazilian imports and exports. The estimated model uses quarterly data covering the 1980-2010 period. The econometric model closely follows Cimoli, Porcile and Rovira (2008), who implemented two regressions for estimating the demand functions for imports and exports, respectively, according to the following specifications:

$$m_t = c + \psi(rer_t) + \pi(y_t) + e_t \quad (3)$$

$$x_t = c + \varphi(rer_t) + \varepsilon(y^*_t) + e_t \quad (4)$$

where m is the growth rate of imports; c is the exogenous constant term; ψ is the price elasticity of demand for imports; *rer* is the growth rate of the real exchange rate (expressed as the domestic price of a foreign currency); π is the income elasticity of demand for imports; y is the growth rate of the domestic real GDP; e is a white noise error; x is the growth rate of exports; φ is the price elasticity of demand for exports; ε is the income elasticity of demand for exports; y^* is the growth rate of the world economy and t is the respective quarterly time. For estimating the coefficients of equations (3) and (4), we had either to construct or take data from the several sources detailed in Appendix B.

Before implementing the econometric exercise, we analyzed the potential non-stationarity of the time series through appropriate tests. First, by applying the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) unit root tests, we realised that all the series are stationary.[39] Then, since all time series revealed to be stationary, the estimated coefficients by ordinary least squares (OLS) are superconsistent, making the results of our estimations reliable.

Since we were also interested in comparing the more recent period with the period immediately following the 1980s, by avoiding an arbitrary year to divide the series in two subperiods, our first step was to implement several econometric structural break tests for both

[39] All results of these tests can be made available by the authors upon request.

import and export functions. For this purpose, we, implemented the CUSUM, the recursive residuals and the Chow tests.[40] We only identified one structural break in January 1999 for imports, but no structural break for exports. In spite of this, since by 1999 the Brazilian economy had already undergone substantial institutional changes, we think the division before and after that year is also economically justified to be the divisory line for analysing both import and export series.[41]

Table 4 and 5 present the results of our estimates of the elasticities of demand for Brazilian imports and exports between 1980 and 2010, respectively.

Table 4

Explanatory factors and income elasticity of demand for imports in Brazil

Third quarter of 1980 to the end of 1998 compared with the first quarter of 1999 to the second quarter of 2010

	1980:3 a 1998:4	1999:1 a 2010:2
C (Constant)	0.615 (0.164)	-0.757 (1.)798
ψ (Price-elasticity of demand for imports)	-0.612*** (0.245)	-0.279*** (0.172)
π (Income-elasticity of demand for imports	1.967** (0.732)	3.361*** (1.148)
R^2	0.327	0.228
$R^{2adjusted}$	0.316	0.192
DW	2.367	2.162
N	74	46

Note: i) *** Significant at 1 per cent level; ** Significant at 5 per cent level; * Significant at 10 per cent level. Values in parentheses indicate standard deviation. ii) *DW* is the Durbin-Watson statistics; iii*) n* is the number of observations; iv) The *rer* (real exchange rate) variable was used with a time lag.

[40] All applications of these tests as well as growth rates of the adopted used series implemented in the econometric exercise can be made available by the authors upon request.

[41] Among other institutional liberalizing reforms already adopted until 1999, we can mention the trade liberalization (1990-1994), the privatization of state enterprises (from 1990 on), the openness of short-term capital account (1992-1993), an adoption of a floating exchange rate regime (1999) as well as targets for both inflation rates and fiscal surplus (from 1999 on).

Table 5

Explanatory factors and income elasticity of demand for exports in Brazil

Third quarter of 1980 to the end of 1998 compared with the first quarter of 1999 to the second quarter of 2010

	1980:3 to 1998:4		1999:1 to 2010:2	
C (Constant)	0.670	(0.019)	1.782	(2.042)
φ (Price-elasticity of demand for exports)	0.371**	(0.181)	0.374*	(0.244)
ε (Income-elasticity of demand for exports	1.358**	(0.575)	1.329***	(0.476)
R^2	0.218		0.308	
$R^{2\ adjusted}$	0.201		0.276	
DW	2.09		2.30	
N	74		46	

Notes: i) *** Significant at 1 per cent level; ** Significant at 5 per cent level; * Significant at 10 per cent level. Values in parentheses indicate standard deviation; ii) *DW* is the Durbin-Watson statistics; iii*) n* is the number of observations; iv) The *y** (world real GDP) was used with a time lag

First of all, all estimated coefficients for both import and export functions revealed to be statistically significant for the two subperiods. By comparing the estimated coefficient of income-elasticity of demand for imports π for the 1980-1998 subperiod (1.97) - see Table 4 -, we notice that it sharply increased (to 3.36, or around 70 per cent). Yet, the estimated coefficient of the income-elasticity of demand for exports ε marginally decreased between the two analysed subperiods (from 1.36 to 1.33, see Table 5).

As pointed out by Thirlwall (1979) and McCombie and Thirlwall (1994), the income elasticities of demand for imports and exports reflect competitive factors associated with both price and productive structure of the economy as a whole. These elasticities are determined, in turn, by the content and other characteristics of both imported and exported goods, such as the degree of technological sophistication, the level of product differentiation and the domestic capacity to respond to changes in the global demand. Countries whose net import structure are characterised by higher technological content than the export one have higher income-elasticity of demand for imports than for exports. These characteristics of imports and exports

structure tend not only to augment the country's technological gap with respect to the international technological frontier, but also to put the country into a unsustainable economic development trajectory, insofar as it will face major external constraints to growth in the long run. This seems to be the case of Brazil in the last decade, which presented clear signs of falling behind, as can be seen in Table 6.

Table 6

Thirlwall's Law

Period	**Income-elasticity of demand for Brazilian exports(ε_x)**	**Income-elasticity of demand for Brazilian imports (π_M)**	**Thirlwall's Law** $\frac{\dot{Y}}{\dot{Y}*} = \frac{\varepsilon_X}{\pi_M}$
1980:3 – 2010:2	1.059	1.993	0.531
1980:3 – 1998:4	1.358	1.967	0.690
1999:1 – 2010:2	1.329	3.361	0.395

Note: Due to problems of space limitations, we decided not to show the econometric results for the whole period 1980-2010. For the interested reader, the econometric implementation can be made available by the authors upon request.
Source: Authors'elaboration, based on the econometric estimates.

The last column of Table 6 is the empirical calculation of equation (1) for Brazil – which is related to our basic hypothesis on structural change and economic development - , based on the estimated income elasticity of demand for exports and imports. Since the $\frac{\varepsilon_X}{\pi_M}$ ratio between 1999 and 2010 sharply decreased, compared with the 1980-1998 period, this results means that Brazil, by having augmented the technological gap and being notably far from the average world economic growth in the last decade, entered into a clear trajectory of falling behind.

However, taking into account that, according to the Kaldor-Verdoorn estimated coefficient, its manufacturing industry operates under dynamic economies of scale, there is still time to redirect the economy to a process of catching up. To achieve this goal, the Brazilian government needs to be well succeeded in adopting a fine coordination between the long-term policies (such as industrial and technological policies, infrastructure and education

policies, among others) and the short-term macroeconomic policies (especially the monetary, fiscal, financial, credit and, especially, exchange rate policies).[42]

One could argue that a high Kaldor-Verdoorn (*K-V*) coefficient that implies a manufacturing sector operating under conditions of dynamic economies of scales should be incompatible with a falling behind trajectory. In Brazil, however, this is not necessarily the case. In fact, it is possible that the high *K-V* coefficient is asymmetrically influenced by some segments of the manufactured industries like the natural resource-based ones that are characterised, at the same time, by a high capital/output ratio. This has positive economic policy implications because, with smart long-term technological policies, governments can use the state´s purchasing policy to boost and construct dynamic comparative advantages in industries such as naval, machines and equipment for extracting oil, machines and equipment associated with paper and cellulose, petrochemicals, pharmaceutical products, and so on.

5. Concluding remarks

This paper analysed a theoretical and empirical framework on the relationships between structural change and economic development based on Kaldorian and Thirlwallian theories. According to Kaldor (1966, 1970), when a country embarks on a sustainable path of catching up with both levels of income per capita and quality of life close to that of developed countries, this process is accompanied by structural change, in the sense that there is a strong reallocation of resources from traditional sectors to the manufacturing sector. At the same time, Kaldor's theories on long-term growth emphasise the role of the manufacturing industry to boost and spill over technical progress throughout the economy as whole. And since that industry, differently from the traditional ones (primary and nontradable service sectors), operates under static and dynamic economies of scale, it tends to augment the aggregate productivity. Kaldor was one of first authors to discuss the dangers to a country entering into a process of early de-industrialisation before it has achieved levels of income per capita comparable to those of developed countries. However, this is a complex phenomenon which is not only measured by the loss of participation of the manufacturing sector in total value added, employment and exports, but also by indicators that capture the country's international relative

[42] For detailed discussion, see Nassif (2011).

competitiveness, such as the technological gap, the participation of more technologically sophisticated sectors in the country's trade balance, among others.

Thirlwall, in turn, developing Kaldor's original ideas, showed the importance for a country to keep an income elasticity of demand for exports above that for imports in order to avoid persistently facing external constraints to long-term growth. Combining Kaldor's and Thirlwall's ideas, they suggest that the more a country is far from the international technological frontier, the more the income elasticity of demand for imports tends to overcome that for exports. If this is the case, economic development is recurrently constrained by balance of payments crisis.

By empirically analysing the Brazilian case between 1970 and 2010, we could draw some important conclusions. First, although there was a dramatic decrease in the participation of the manufacturing industry in total value added from 31.3 per cent in 1980 to 14.6 per cent in 2010, within the manufacturing industry *per se*, however, except for the labour intensive industries, there was a reallocation of resources from the traditional segments (labour intensive and natural resource-based) to the more technologically sophisticated ones (science, engineering and knowledge-based). Second, the level of employment, despite remaining relatively well balanced among all groups of manufacturing classified by technological intensity in the past few years, was not reallocated from the manufacturing industry to the service sector between 2000 and 2008. Third, within the manufacturing industry, the science, engineering and knowledge-based segments represented almost 50 per cent of total Brazilian manufacturing exports, followed by the natural resource-based segments (around 42 per cent) and labour intensive (less than 10 per cent). Fourth, by analysing **total** Brazilian exports, basic products overcame those of manufactured goods between 2009 and 2010 (boldface ours). Fifth, the sectoral trade deficits of the engineering, science and knowledge-based manufacturing sector significantly increased in recent years. Sixth, between the end of the 1990s and 2008, not only did the labour productivity of the Brazilian manufacturing sector decrease, but also its technological gap dramatically increased, revealing that it is getting farther from the international technological frontier. Seventh, our econometric estimates show that, since the income elasticity of demand for imports significantly augmented and kept above the income elasticity of demand for exports, these results not only reflect the above mentioned augmentation of the technological gap, but also that Brazil sharply increased its external

constraints to sustain economic growth in the long run. The conclusions from the fourth to seventh are sound evidence that Brazil has entered into a process of early de-industrialisation and falling behind since the end of the 1990s, comparatively with developed countries or even other emerging economies.

However, as the estimated Kaldor-Verdoorn coefficient surprisingly revealed that the Brazilian manufacturing industry operates under dynamic economies of scale, this suggests that it has, in principle, the potential for sustaining the growth in productivity of the economy as a whole and, therefore, Brazilian economic growth in the long run. It is important to stress that to still have a large and diversified manufacturing industry subject to dynamic increasing returns to scale is a necessary, but not a sufficient condition to assure economic development in the long run.

In fact, the findings in this paper bring about important long-term and short-term economic policy implications. The late Brazilian economist Antonio Barros de Castro used to repeat the word "breath" in his lectures to refer to the great capacity of the Brazilian manufaturing industry to face a diversity of internal and external shocks (high inflation, trade liberalisation, real exchange rate overvaluation and so on). Obviously, this capacity is not unlimited. Then, with apropriate and coordinated long-term (e.g. industrial and technological policies, infrastructure and educational policies, among others) and short-term economic policies (coordination among monetary, fiscal, financial, credit, and, especially, exchange rate policies pro-growth), there is still time to put the Brazilian economy into a process of catching up again. In 2008, the Brazilian government made important step in this direction with the adoption of the Policy for Productive Development (*Política de Desenvolvimento Produtivo – PDP*), which, among other instruments, introduced tax and credit stimulus to innovation, infrastructure and exports.

Although suggestions of economic policy instruments escape the scope of this study, we would like to finish this paper by stressing that any agenda that is oriented to sustaining economic development in Brazil should be fullfilled by two complementary conditions: i) policies of supply-side stimuli should be balanced by demand-side ones; ii) long-term policies such as industrial and technological policies, infrastructure, education, etc., will not have good performance if they are not well coordinated with other economic institutions, notably short-term macroeconomic policies (mainly monetary, fiscal and exchange rate policies).

As to the role of the real exchange rate as an important macroeconomic instrument (if not the most) to sanction the micro and meso economic policies introduced by governements in favour of economic development, Kaldor (1970:152) argued a long time ago that, “of these two instruments for counteracting adverse trends in “efficiency wages” – protection and devaluation – the latter is undoubtedly superior to the former. Devaluation, as has often been pointed out, is nothing else but a combination of a uniform *ad-valorem* duty on all imports an uniform *ad-valorem* subsidy on exports”.

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APPENDIX A

Manufacturing industry according to technological intensity

Science, engineering and knowledge-based

Metal products
Non electrical machinery
Electrical machinery
Motor vehicles
Scientific instruments
Chemicals

Natural resource-based

Food
Beverages
Tobacco
Wood products
Paper and cellulose
Petroleum refining
Oil and carbon products
Rubber products
Glass
Other non-metallic mineral products
Iron and steel
Non ferrous metals

Labour intensive

Textile
Clothing
Leather manufactures
Footwear
Furniture
Paper printing
Other chemicals
Plastic products
Pottery
Other manufactured products

Source: ECLAC-PADI

APPENDIX B

Data sources

1. Brazilian imports: imports expressed in US million dollar CIF (cost,insurance and freight) according to the International Monetary Fund, International Financial Statistics, browser on CD-ROM; current values were deflated by the US Wholesale Price Index (WPI); growth rates were based on the construction of index-numbers (average of 2005=100)
2. Brazilian real exchange rates: we tranform the monthly rates serie available at the Brazilian Institute of Applied Economic Research (IPEA) into quarterly real exchange rates– http://www.ipea.gov.br;); growth rates were based on the construction of index-numbers (average of 2005=100);
3. Brazilian real Gross Domestic Product (GDP) at maket prices: adjusted seasonally by the Brazilian Institute of Geography and Statistics (IBGE/SCN2000-Qtr) – http://www.ibge.gov.br; growth rates were calculated based on index-numbers (average of 2005 =100).
4. Brazilian exports: exports expressed in US million dollar FOB (free on board) according to Brazil's Central Bank Bulletin, Balance of Payments Section (BCB Bulletin/BP) - http://www.bcb.gov.br; current values were deflated by the US Wholesale Price Index (WPI); growth rates were based on the construction of index-numbers (average of 2005=100);
5. World quarterly real GDP: available at the International Monetary Fund (IMF) http://forums.imf.org/showthread.php?t=6124, calculed by IMF'st forum participants, based on official websites of country-members of the IMF, transformed into US million dollar and subtracting Brazil's quarterly real GDP; growth rates were based on index-numbers (average of 2005=100).