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

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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. From the Kaldorian view, we anchor on the hypothesis that, by operating under static and dynamic economies of scale, the main sources of the growth of productivity of the economy as a whole come from the manufacturing sector. Yet, according to the so-called Thirlwall's Law, for a country to prevent from facing balance of payments contraints to growth in the long run and successfully catch up with the levels of income per capita and well-being of developed countries, it must maintain an income elasticity of demand for exports above the income elasticity of demand for imports. Based on these main hypotheses and some stylised facts observed and pioneered by Kaldor, we show some empirical evidence based on both descriptive statistics and econometric regressions for Brazil between 1970 and 2010. There are at least four clear indicators to suggest that Brazil has entered into a process of early de-industrialisation: i) the sharp drop in participation of the Brazilian manufacturing industry in total value added in the last decades; ii) its declining average yearly growth rate of labour productivity since the end of the 1990s; iii), the dramatic augmentation of the technological gap in all subsectors of the manufacturing industry, classified by technological intensity, since the end of the 1990s and; iv) the significant trade deficits in the manufacturing subsector of more technological intensity between 2006 and 2008. In addition, since our econometric estimates also show that there was a dramatic increase in the income elasticity of demand for imports (from 1.97 to 3.36) and a decrease in the income elasticity for exports between 1999 and 2010, compared with the 1980-1998 period (from 1.36 to 1.33), we can conclude that Brazil has already embarked on a trajectory of falling-behind and has been facing balance of payments constraints to growth in the long run. However, since our econometric estimation of the Kaldor-Verdoorn coefficient revealed that the Brazilian manufacturing industry operates under dynamic economies of scale, this result means that the Brazilian manufacturing industry has, in principle, potential to sustain economic growth in the long run. All these results have important economic policy implications. The most important is that there is still time to revert both the early de-industrialisation and falling behind path in favour of a catching up trajectory in the Brazilian economy, since there is a fine coordination between the long-term policies (industrial and technological policies, infrastructure and education policies, among others) and the short-term macroeconomic policies (monetary, fiscal and, especially, exchange rate policies) oriented to boost the technological content of both Brazilian manufacturing goods and exports.

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

RESUMO

O estudo apresenta uma abordagem baseada em Kaldor-Thirlwall em que se elucidam as forças motoras do comportamento da produtividade e do desenvolvimento econômico no longo prazo. Com base na abordagem de Kaldor, o estudo se ancora na hipótese principal segundo a qual, por operar sob condições de economias estáticas e dinâmicas de escala, a indústria de transformação é a principal fonte da qual provêm os ganhos de produtividade da economia como um todo. Já de acordo com a chamada Lei de Thirlwall, para que um país consiga completar o processo de convergência (*catching-up*) para níveis de renda per capita e bem-estar semelhantes aos de países desenvolvidos, sem enfrentar restrições externas ao crescimento no longo prazo, é necessário que a elasticidade-renda da demanda das exportações seja superior à das importações. Com base nessas hipóteses e em alguns fatos estilizados, apresentamos evidências empíricas para o Brasil relativas ao período 1970-2010. Pelo menos quatro indicadores sugerem que o Brasil se encontra em processo de desindustrialização precoce: i) uma significativa queda da participação da indústria de transformação no total do valor adicionado da economia nas últimas décadas; ii) o declínio das taxas médias anuais de crescimento da produtividade do trabalho desde fins da década de 1990; iii) um dramático aumento do *gap* tecnológico em todos os setores da indústria de transformação classificados segundo o grau de intensidade tecnológica; e iv) um expressivo aumento dos déficits comerciais dos setores da indústria de transformação de média-alta e alta intensidade tecnológica (em nosso estudo, denominados "setores baseados em ciência, engenharia e conhecimento") entre 2006 e 2008. Adicionalmente, as evidências econométricas apontam para um significativo aumento da elasticidade-renda das importações (de 1,97 para 3,36) e ligeira queda da elasticidade-renda das exportações (de 1,36 para 1,33) no período 1999-2010, comparado ao período 1980-1998, o que nos leva a concluir que o Brasil não apenas se encontra em processo de desindustrialização precoce e divergência em relação à economia mundial (*falling behind*), como também enfrenta restrições ao crescimento no longo prazo devido a problemas de balanço de pagamentos. Entretanto, ao estimar o chamado coeficiente Kaldor-Verdoorn, o estudo revela que a indústria de transformação brasileira está sujeita a economias dinâmicas de escala e, portanto, possui, em princípio, capacidade potencial para sustentar o crescimento no longo prazo. Esses resultados têm importantes implicações normativas. A principal é que, para que o processo em curso de desindustrialização precoce e *falling behind* seja revertido, é necessária fina coordenação entre as políticas de longo prazo (industrial, tecnológica, de infraestrutura, educacional, entre outras) e as políticas econômicas de curto prazo (monetária, fiscal e , sobretudo, cambial).

Palavras-chave: desindustrialização precoce; mudança estrutural; convergência; divergência; Brasil
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1. Introduction

There is practically a consensus nowadays that economic growth 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. 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.

The focus of this paper has basically two characteristics: first, it is structuralist, *par excellence*, in the sense that 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 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 sectors. 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 real income per capita, this phenomenon characterises an early de-industrialisation[1] and can strongly retard the process of catching up or even put the economy into a trajectory of falling behind. It is important to remark that the significant loss in participation of the manufacturing sector in total value added is considered 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).

According to Palma (2005), the real income per capita considered as the turning-point, among other aspects, for beginning to put a country in a long-term path of early de-industrialisation, characterised as a natural phenomenon of capitalist development, significantly changed from 1980 to 1998 (from US 20,645 to close to US 8,691 dollars, both amounts expressed by purchasing power parity – PPP). In 2011, according to the International Monetary Fund, the Brazilian real GDP per capita measured in PPP was around US 11,769 dollars. For this criterium, we could, in principle, immediately discard the hypothesis of early de-industrialisation in Brazil. However, nothing can be said about whether or not Brazil has embarked in early de-industrialisation or even entered into a process of falling behind, since both phenomena depend on other elements.

The theoretical framework of this paper is based on Kaldor (especially, 1966) and Thirlwall (1979) 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[2]. 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 the catching up process, the more will be its capacity to sustain

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

[2] 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 investiment 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.

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 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 large and diversified manufacturing sector, it is still not an industrialised country in the Kaldorian point of view. 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 1970-2008 period (in some cases, for the 1970-2010 period), shows a preliminary answer of whether or not Brazil has already entered into early de-industrialisation. 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 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 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 faced external constraints to long-term economic growth.

2. Structural change and economic development: the theoretical framework

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

Nowadays, there is practically full consensus on the importance of productivity growth as the main driving force of economic development[3]. Yet, the same cannot be said of the most relevant sources of change in productivity growth. Going directly to the point, 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.

[3] Neoclassical economists do prefer the total factor productivity (TFP) as the more appropriate indicator, instead of labour productivity, arguing that the former has the advantage of taking into consideration the contribution of both physical capital and labour in order to capture technical progress. However, TFP has two limitations: i) empirical issues in measuring the aggregate capital; and ii) even though labour productivity has the limitation of considering both physical capital and technical progress as given, in empirical implementations, TFP estimates technical progress as residual.

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 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 and 1970)

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[4]; 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 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). Only when a country has already reached a maturity stage (in other words, a developed country with an

[4] 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.

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[5]:

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 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.[6] In fact, as shown by Arrow (1962), once a large set of firms in different segments of the manufacturing sector accumulates technical knowledge and experience driven by research and development (R&D) as well as learning by doing, the more a country is able to show significant growth in its real GDP, the faster will be the increase of its aggregate productivity. For developing countries, the Kaldor-Verdoorn Law has an important economic policy implication: the more policy-makers are able to avoid that a significant and sustained growth in both productivity of the manufacturing industry and total output is constrained by business cycles, the faster a particular country will catch up.

In relation to that point, it is important to stress that in his seminal paper, Kaldor (1966) explicitly recognised the dangers for a country whose industrialisation process is constrained early on either by domestic or, mainly, (as will discussed ahead) external factors. By associating the different levels of income per capita 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 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 resource-based) to very diversified goods,

[5] McCombie and Thirlwall (1994) call these hypotheses Kaldor´s Laws.

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

especially engineering, science and knowledge-based goods which make up the majority of total exports.

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 the 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 supply of labour (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 deindustrialisation in matured economies tends to reduce the participation of both manufacturing (expressed by the value added) and employment in total 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. [7]

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 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

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

structure of the economy and the composition of net exports are mostly dominated by the presence of manufacturing segments that produce science, engineering and knowledge-based goods.

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

In countries that basically specialize in primary products and natural resource-based 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, 2011). 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 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.[8] 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 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:

[8] One could correctly argue that some natural resource-based manufacturing segments (e.g., oil refining, natural gas 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 significant dynamic economies of scale in the Kaldorian sense if it becomes highly dependent on a small group of natural resource-based industries.

$$\frac{\dot{Y}}{\dot{Y}*} = \frac{\varepsilon_X}{\pi_M} \quad (1)$$

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 issues in the long run.

By refining Thirlwall's Law, CEPAL (2007) rewrote equation (1) as:

$$\frac{\dot{Y}}{\dot{Y}*} = \frac{\varepsilon_X}{\pi_M}(\sigma, \delta, \vartheta) \quad (2)$$

Where σ is the technological gap; δ is a component that represents the structural change; and ϑ represents other factors, such as political conditions, institutional factors and so on. The interesting point in this representation is that the ratio $\frac{\varepsilon_X}{\pi_M}$ depends on all variables described between brackets in equation (2), but, at the same time, these latter variables can be dynamically changed by short-term and long-term consistent economic policies.

3. Structural change in the Brazilian economy: industrialisation (or early 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 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 the economies. 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. As seen in Table 1, as the Brazilian manufacturing industry was already structurally consolidated in the production matrix of the country at the end of the 1970s, the analysis in this subsection will be concentrated in the specificities of the actual structural changes in the manufacturing sector in Brazil. 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 in detail structural data from the manufacturing sector. [9]

[9] 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 carried out by the Brazilian Institute of Geography and Statistics (IBGE). Data for missing years from IBGE's

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

The dramatic fall in total value added of the manufacturing sector since the 1980s (from 31.3% to 14.6% in 2010) 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 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 (2006; 2010), following structuralist and Kaldorian traditions (1966), give special attention to changes in the relative position of a country's manufacturing industry in the world economy.

In principle, it is observed that 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 (see Nassif, 2008). However, since the Kaldorian tradition stresses the importance of the relative position of the domestic 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 (see Nassif, 2008). 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 sustaning 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 1 shows that, since the 1970s, the science, engineering and knowledge-based group is leading the growth of the Brazilian labour productivity.[10] 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 1 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.[11] However, around 1997 productivity gains began to slow down and a clear declining trend is observed in all three groups of industries.

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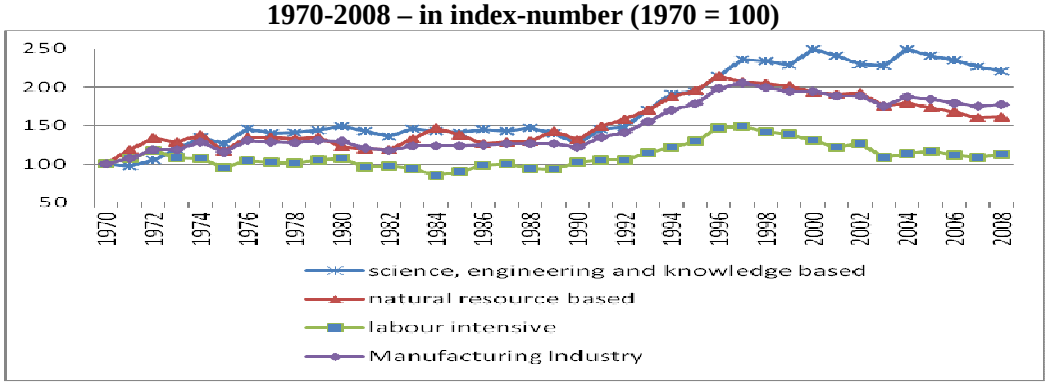
surveys have been estimated, following ECLAC's methodological procedures. Whenever applicable, all information provided in ECLAC-PADI has been converted to 1985 constant dollar prices.

[10] We based on the ECLAC-PADI taxonomy, which divides the manufacturing industry into three groups: science, engineering and knowledge-based; natural resource-based; and labour intensive.

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

Figure 1 - Labour productivity growth of the Brazilian manufacturing industry 1970-2008 – in index-number (1970 = 100)



Source: ECLAC-PADI

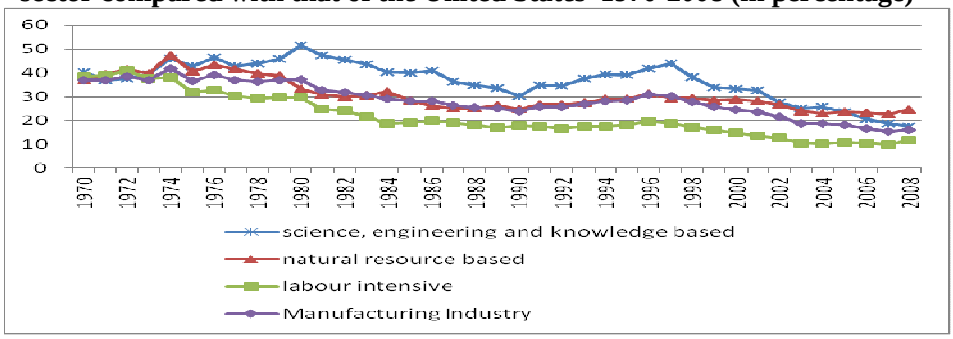
Although it can be realised that the rate of growth in the Brazilian manufacturing labour productivity has been higher in segments of major technological sophistication, it is important to check whether or not the speed of the productivity growth has been enough to keep the economy in a trajectory that reduces its technological handicap. In the Kaldorian perspective, this point is absolutely important. An estimate of how far productivity gains are from the technological frontier is shown in Figure 2, 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.[12] This indicator can be evaluated as a proxy for the technological gap.

According to Figure 2, 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%). 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.

Before doing some econometric exercises that could provide us with preliminary answers to the above question, we will investigate the evolution of the Brazilian exports and trade balance. 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 goods started to lose participation. This loss is being compensated by the increase in exports of basic goods.

[12] 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.

Figure 2 :The Brazilian technological gap: relative labour productivity in the Brazilian manufacturing sector compared with that of the United States 1970-2008 (in percentage)[13]



Source: ECLAC-PADI

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 mid-1990s, as already analysed. 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.[14] 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.

Table 1 summarizes the yearly average rate of growth of exports classified according to intensity of value added. After showing an extraordinary performance throughout the 1970s (a yearly average growth rate of 37.1 per cent), manufactured goods presented a relatively poorer performance in the 2000-2010 period (an average growth of 10.2 per cent p.y.) than the other groups. Basic goods, especially, showed an extraordinary yearly average growth rate in the same period (20.3 per cent). The 1990s presented the worst phase for Brazilian exports, insofar as all groups showed a negative yearly average growth rate of exports.

Table 1 - Brazilian yearly average growth rates of exports classified by intensity of value added

	Basic goods	Semi-manufactured goods	Manufactured goods
1970-79	13.8	24.5	37.1
1980-89	3.8	11.9	10.9
1990-99	-8.4	-12.0	-8.7
2000-10	20.3	12.2	10.2

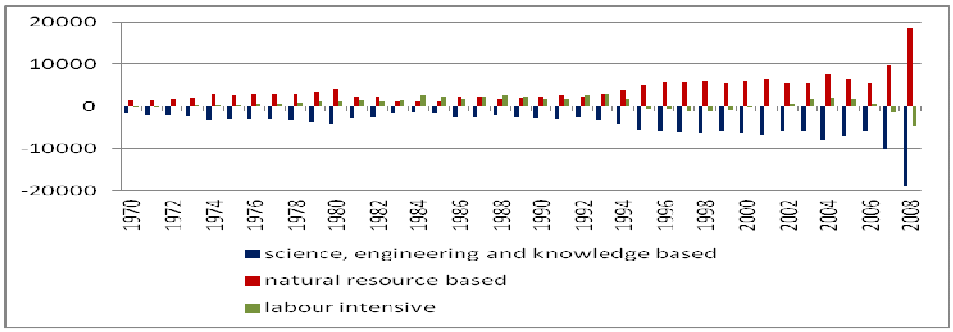
Source: SECEX/MDIC

[13] This Figure is the only one that follows the original classification of manufacturing sector according to the technological intensity available in PADI database, which, misleadindly 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 2 this was not possible, since 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.

[14] For details, see Nassif, Feijó and Araújo (2011).

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 3 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 3: 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 growth 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), as already discussed in Section 2[15]; the second one is related to the estimate of the income elasticity of demand for Brazilian exports and imports between

[15] 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.

1980 and 2010. This estimation is essential for drawing some conclusion on whether or not the Brazilian economic growth is subject to balance of payments constraints in the long run.

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):

$$p = a + bq \quad (3)$$

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.

The estimation covers the 1970-2010 period.[16] 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.[17] We estimated equation (3) by ordinary least squares (OLS). The results are shown in Table 2, whose footnotes also inform on the implemented variables and data sources.

Table 2:Estimate of the Kaldor-Verdoorn coefficient for the Brazilian economy (1970-2010)
Dependent variable: rate of growth of labour productivity - equation (3)

	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 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 added value of the Brazilian manufacturing industry, expressed in US million dollars (source: Brazilian 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 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

[16] For labour productivity in the manufacturing sector (defined as the value added to total employed workforce ratio) 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).

[17] 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.

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.

Obviously, the result presented in Table 2 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 on the Kaldor-Verdoorn coefficient, 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 according to the following specifications:

$$m_t = c + \psi(rer_t) + \pi(y_t) + e_t \quad (4)$$

$$x_t = c + \varphi(rer_t) + \varepsilon(y^*_t) + e_t \quad (5)$$

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.

Although equation (4) is the traditional way of estimating the demand function for imports, some authors suggest the inclusion of other variables besides the real GDP and the real exchange rate, such as an index that captures non-tariff barriers (Moreno-Brid, 2003), the level of capacity utilisation (Azevedo and Portugal, 1998) and the stock of international reserves (Resende, 2001), among others. In the estimates of the export function, in turn, Romeiro *et al.* (2011) suggest that the econometric exercise captures an export function using a variety of levels of disaggregation. However, for our purposes, we assume that the Cimoli, Porcile and Rovira (2008) models are appropriate for estimating the income elasticity of demand for imports and exports, for, in virtue of their simplicity, their econometric specifications can capture the main macroeconomic determinants of both import and export functions. For estimating the coefficients of equations (4) and (5), we had either to construct or take data from the several sources detailed in Appendix A.

After applying the conventional econometric tests, we realised that, since all the series are stationary, the regressions were estimated by ordinary least squares (OLS). Since we were also interested in comparing the more recent period with the period immediately following the 1980s, we broke down our series into two periods: from the third quarter of 1980 to the fourth quarter of 1998, and from the first quarter of 1999 to the second quarter of 2010, assuming that by 1999 the Brazilian economy had already undergone substantial institutional transformations that justifies the division of the period under analysis.

Tables 3 and 4 allows us to compare the estimated import and export functions for the subperiods before and post-1999.

Table 3 - Explanatory factors and income elasticity of demand for imports in Brazil : 1980-2010

	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	
$R^{2adjust}$	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.

Table 4 - Explanatory factors and income elasticity of demand for exports in Brazil:1980-2010

	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	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 3 -, 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).

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 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 import and export 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 5.

The last column of Table 5 is the empirical calculation of equation (1) for Brazil, 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.

Table 5 - 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 – 1998:4	1.358	1.967	0.690
1999:1 – 2010:2	1.329	3.361	0.395

Source: Authors'elaboration, based on the econometric estimates.

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 succeded 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 and exchange rate policies; see Nassif, 2011).

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

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, 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 2007. 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).[18] Fourth, by analysing total Brazilian exports, basic products overcame those of manufactured goods between 2009 and 2010. 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 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 and 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

[18] Due to lack of room in this study, the first, second and third conclusions were taken from ECLAC-PADI database and can be found with the authors under request.

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 to the scope of this study, we could, even so, briefly anticipate some priorities for an agenda that is oriented to sustaining economic development in Brazil:

i) to establish priorities is essential and, since the segments of more technological sophistication are those with greater capacity to explore dynamic economies of scale, the focus must be on medium and high tech goods. Needless to stress that the construction of dynamic comparative advantages is not incompatible with respect to some lessons on the theory of static comparative advantage. One of them is that the average protection of the domestic industry must be kept low and both tariff and non-tariff barriers of some industrial inputs of higher technological sophistication, such as machinery and equipment, some parts and components, among others, must be eliminated.
ii) it is common place to remember that the development of medium and high tech sectors must be accompanied by large investments in education and training of the workforce. So, the time has already past for Brazilian authorities to prioritise education in its current long-term agenda;
iii) by taking advantage of the existence of dynamic economies of scale in the Brazilian manufacturing sector, it is also important to stress that internal market and foreign trade are not mutually exclusive. As to the internal market, policy-makers must urgently replace the current priorities to augment the domestic consumption in favour of boosting public and private investments. This does not mean that the current stimulus to increase of the domestic aggregate consumption should be eliminated, but that priorities must focus on boosting the gross investment/GDP ratio in Brazil;
iv) although to reactivate an agenda of reforms that contemplates the supply side of the economy is important (e.g., a tax reform), it can also be a necessary, but not a sufficient condition to deep structural change and to put the Brazilian economy into a process of catching up. In fact, since the models we based ourselves on in this study are strongly demand-push, as already stressed, to boost both investment and innovation in Brazil are essential for achieving those goals. However, the coordination between the above mentioned long-term policies and the short-term macroeconomic policies must urgently be improved. As to these latter ones, Brazil has advanced in promoting the fiscal adjustment through the primary fiscal surplus targets. However, the same can not be said with respect to the recurrent insistence in adopting a strategy of economic growth highly dependent on external savings. With the aim at reverting this current strategy, it is essential that the cyclical tendency to overvaluate the Brazilian real must be eliminated. When we started the research for this paper (January 2012), depending on the methodology and the deflator used for evaluating the level of real exchange rate misalignment, the Brazilian real should be at between 2.40 per dollar and 2.90 per dollar (its actual nominal exchange rate was 1.79 per dollar, on average, in January 2012). Due to the high uncertainty that characterises the international scenario, when we finished our paper (end of May 2012), the Brazilian real was already depreciated to 1.98 per dollar. Since it is still largely overvalued, an important practical lesson Brazilian policy-makers could learn from the Asian countries is, by using apropriate exchange rate policies (including the adoption of more rigorous measures of capital controls, if necessary), to avoid the Brazilian domestic currency from entering into a trajectory of strong real appreciation again. Since entrepreneurs will judge high the opportunity costs associated with increasing physical investments and expenditures in research and development (R&D) when the real interest rates are too high compared with the world economy and the trend of the real exchange rate is persistently overvalued as it has been in Brazil in the last decade, most of the above mentioned measures suggested to revert the process of falling behind in Brazil might be badly performed. As Kaldor (1970:152) argued a long time ago, "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 - Data sources

-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)
-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);
-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).
-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);
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).