PSL Quarterly Review

vol. 71 n. 285 (June 2018)

Original article

Manufacturing as driver of economic growth

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Abstract:

This study combines different theoretical strands on development regarding the importance of the manufacturing industry for economic growth. Through a confluence of the Keynesian-Kaldorian, structuralist and neo-Schumpeterian frameworks, the paper argues that the manufacturing industry presents some special properties, which are not found in other sectors. The first section describes Anglo-Saxon structuralism, focused on structural change dynamics, and the Latin American structuralist view of underdevelopment, according to which economic development results from technical progress induced or enabled by capital accumulation. The second section examines the Kaldorian approach to growth, understood as "laws", where Kaldor explains the differences in international growth rates recovering important elements in the contemporaneous debate. The third section investigates the neo-Schumpeterian route to development, exploring relations between innovation, economic dynamics and catching-up in a sectoral specific approach.

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How to cite this article:
Rocha I.L. (2018), "Manufacturing as driver of economic growth", *PSL Quarterly Review*, 71(285): 103-138.

DOI: http://dx.doi.org/10.13133/ 2037-3643_71.285_2

JEL codes:
B10, E12, O1, O14

Keywords:
Keynesian-Kaldorian, Structuralism, neo-Schumpeterian, development, manufacturing

Journal homepage:
http: //www.pslquarterlyreview.info

Theoretical, historical and empirical evidences have shown the importance of manufacturing to sustained economic growth. However, over the years, neoclassical economics has neglected such evidence, and advocated the idea that economic growth is sector-indifferent and, in some models, also activity-indifferent.[1] A remarkable example of models in which growth is activity and sector-indifferent are the early neoclassical growth models, i.e. Solow-Swan type models and the early endogenous growth models, namely "AK" models (Palma, 2005).[2] Solow-Swan type models are a result of the classical contributions by Solow (1956; 1957) and Swan (1956) and became the dominant approach for the analysis of economic

* I wish to thank Gabriel Palma, Ha-Joon Chang and Alfredo Saad-filho, and the two anonymous referees for their helpful comments on this paper. The usual disclaimer applies.

1 There is an important distinction between 'activity' and 'sector'. Examples of the former are research and development (R&D) and education; examples of the latter are manufacturing, agriculture and services (Palma, 2005).

2 See also Tregenna (2009).

growth from the mid-1950s until the 1970s. However, over the years, this model started to be considered by many economists an unrealistic description of the process leading to economic growth. In this approach, only continuous technological changes explain long-term economic growth since investments have diminishing returns to capital. Despite being a central explanatory factor, technological progress is not sector- or activity-specific.[3]

The dissatisfaction with the assumptions of the Solow-Swan model and its capacity to explain the non-convergence of living standards in the world economy stimulated further developments in the neoclassical growth theory. Frankel (1962), in an early version of the so-called "AK" growth model, endogenized the main factors, such as technological progress, that drive economic growth in the long run.[4] As pointed out by Palma (2005), recent endogenous growth theories are also included in this class of models, in which changes in the rate of growth are the result of the cumulative effect of market imperfections arising in the process of technological progress that operates in an obscure cumulative way, creating increasing returns.[5] Despite relevant developments in the neoclassical framework, sectoral and activity specificity were still absent in these theoretical approaches.

In the years that followed, important references regarding activity specificity arose in the neoclassical theory. The most recent wave of endogenous growth models, the so-called *New Growth Theory,* initiated by the research of Paul Romer (1986; 1990)[6] and Robert Lucas (1988), emerged in response to perceived theoretical and empirical deficiencies associated with the neoclassical growth model. In this approach, economic growth is explicitly attributed to some type of activity in the economy, particularly research and development (R&D) or education. Thus, the most important mechanisms concern the creation of new technical knowledge in R&D departments of firms (Romer, 1990) or the formation of human capital within education processes (Lucas, 1988).

In this type of growth model (and also in early neo-Schumpeterian models – such as in Aghion and Howitt, 1998, and Grossman and Helpman, 1991, which focus on technological spillovers) neoclassical economics approached activity specificity as the main source of endogenous growth. Although this approach incorporates endogenous characteristics of economic development (in contrast with Solow-Swan models, in which economic development is a result of exogenous shocks), the mechanisms employed continued to assume a self-regulating nature of the growth process, where technological change occurs automatically and is affected only by macroeconomic aggregates, that is, physical or human capital stocks.

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[3] Although economists have long recognised the crucial importance of technological change as a major source of dynamism in capitalist economies (especially Karl Marx and Joseph Schumpeter), it was Solow's work that brought technological progress to prominence within mainstream economics However, somewhat paradoxically, in Solow's theory, technological progress is exogenous, i.e., it is not explained by the model (Snowdon and Vane, 2005). This is because the model views improvements in total factor productivity (technological progress) to be the ultimate source of growth in output per worker, but does not provide an explanation as to where these improvements come from.

[4] Aghion and Howitt (1998) note that Frankel (1962) presented an early "AK" model that went largely unnoticed by the profession. In this model, 'endogenous' technological progress offsets the growth-cushioning effects of diminishing returns to capital accumulation that characterize the Solow model. However, it is important to highlight that in the heterodox strand, Robinson (1956) was the first to endogenize productivity growth.

[5] See Snowdon and Vane (2005), Barro and Sala-i-Martin (2004), and Blankenburg (2000; 2004) for overviews of New Growth theories.

[6] Romer (1986) explains technological progress as an unintentional by-product of capital accumulation by individual firms. However, a few years later, Romer (1990), dissatisfied with his initial approach, proceeded to develop a second strand of New Growth theory that embraces a neo-Schumpeterian framework of endogenous technological change (Snowdon and Vane, 2005).

Therefore, although recognizing endogenous elements of economic growth, the importance of sector specificity remains overlooked in the neoclassical approach. Moreover, neoclassical economics presumes that different types of economic sectors are structurally similar enough to be aggregated in a single representative sector. In this way, both the mechanisms which trigger the process of economic growth and the structural economic dynamics are overlooked. Additionally, inserted in a framework of general equilibrium and self-adjustment of economic variables, this strand of economic thought does not consider industrial policy as an effective way to promote economic development. In contrast to the structuralist approach (including the Latin American one and the Keynesian-Kaldorian one), in traditional neoclassical models, as well as in some of the later endogenous growth models, increasing returns, though generated by research-intensive activities, are explicitly not associated with the size, depth or strength of the manufacturing sector as such or with the process of capital accumulation within the manufacturing sector. Nor do they allow for a specific impact of the manufacturing sector on R&D activities (Palma, 2005).

In contrast to the traditional neoclassical view, the heterodox literature has emphasized sectoral specificity as a central feature of economic growth. This implies that, as opposed to the neoclassical view, a value-added unit is not necessarily equivalent across sectors, especially in terms of inducing and enhancing economic growth (Tregenna, 2009). It is commonly considered that the fundamental role of manufacturing in economic growth is only approached by the structuralist and the Keynesian-Kaldorian views. However, a careful analysis of the heterodox literature reveals that manufacturing is also the main engine of technological dynamism and specifically a locus of innovation in the Schumpeterian sense. The convergence of all these theories through a common channel, i.e. the special properties of the manufacturing sector, include a complex linking between theoretical approaches at different levels of economic theory, i.e. micro (firm), meso (sector and sub-sectors) and macro (economy). Therefore, as a corollary to this analysis, the heterodox triad composed by the structuralist, Keynesian-Kaldorian and neo-Schumpeterian views constitutes the mainspring of this study.

In this context, the aim of this paper is to systematize the literature on economic growth and industrialization in which the manufacturing sector plays an important role as the main engine of growth. Thus, the main contribution relies on the attempt to systematize the literature on sector specificity in a common channel that comprises the structuralist, Kaldorian and Neo-Schumpeterian contribution to the role of industrialization, specifically manufacturing, in economic growth. In this way, the first section reviews the main aspects related to the Anglo-Saxon and the Latin American approaches which, in turn, shed light on the industrialization process as a mechanism to overcome underdevelopment. The second section explores how manufacturing is the main engine of growth in the Kaldorian framework, understood as “laws” where Kaldor explains the differences in international growth rates and the approach developed for these “laws”, and the importance of manufacturing for the balance of payments. In the third section, another heterodox strand is considered, i.e. the Neo-Schumpeterian approach, exploring relationships between innovation and economic growth. Particularly, it analyses the idea that manufacturing is also the main engine of technological dynamism and specifically a locus of innovation. The catching-up hypothesis is emphasized, highlighting the connection between national systems of innovation and productive structure. Moreover, the sectoral specificity of the concept of systems of innovation is emphasized. The last section presents some concluding remarks.

1. The structuralist view: an alternative approach to the neoclassical analytical framework

Although structuralism is a popular term in economics, it is important to recognize that many concepts are derived from neighbouring sciences such as anthropology (Levi-Strauss, Godelier), psychology (Lacan, Piaget), philosophy (Althusser, Derrida, Foucault) (Palma, 1987; Gibson, 2003; Blankenburg et al., 2008). Therefore, it is possible to conceive structuralist economics as an outgrowth or extension of earlier work in these and other fields, a tendency that emerged in the 1940s. Within this multidisciplinary background, structuralist economics is fundamentally a theoretical approach that confronts the neoclassical methods of empiricism and positivism (Palma, 1987). Structuralism uses a method of inference analogous to that of abduction or retroduction. It begins with the observation of a determinate phenomenon, 'what is out there', and then works backward to a theory. Its focus is not on prediction but description and explanation (Baghirathan et al., 2004). Consequently, structuralism can be understood as an alternative way to theorizing in economics, since the mainstream theory represented mainly by the neoclassical approach is deductive and expressed in terms of 'uniformities' interpreted as (actual or hypothetical) correlations or event regularities.

Furthermore, as pointed out by Blankenburg et al. (2008, p. 69), structuralism assumes "an integrated system of distinguishable yet mutually constitutive elements". In other words, the relationships that constitute structures are more important than individual elements. This assertion is a central feature of the structuralist view and distinguishes it from the neoclassical approach.[7] According to the latter, the analysis of human action can be performed in a micro approach from the perspective of individual agents (methodological individualism). However, in the former, structural analysis emphasizes that interdependent elements of the economic system form a complex whole in a macro perspective which incorporates systemic properties that cannot be reduced to the analyses of individual elements. Thereby, the hallmark of the structuralist approach is its reliance on internal relations among parts making up a whole, which is closely related to methodological holism[8] (Jackson, 2003).

In economics, structuralism is principally associated with the so-called Anglo-Saxon, or 'early structuralism', and the Latin American strands.[9] Both strands base their analyses on the concept of complementarities and poverty traps, linkages, and dualism (Ancochea, 2007). The structuralist view usually stresses that economic development is strongly linked to a radical transformation in the structure of production to suppress obstacles, bottlenecks and other rigidities of underdevelopment. Based on the hypothesis that the industrial structure affects

[7] Moreover, as stressed by Street and James (1982), structuralism assumes two basic conceptions against the conventional neoclassical view. The first regards the economic system as an evolving process rather than an equilibrating mechanism of stable economic relations centring on market activities. The second conceives of human behaviour as characterized by habitual patterns resulting from cultural conditioning but capable of intelligent response to changing realities. It is thus distinguished from the neoclassical economic view that human behaviour is primarily devoted to utilitarian motivation and pecuniary calculation in a static system of markets. In a convergent analysis, Chenery exposes the origin of economic structuralism as a general view against the neoclassical approach based on the free market, emphasizing the importance of economic planning principally in late-development countries. In other words, economic interventionism is seen as a central variable to overcome various inhibiting factors in economic growth. Consequently, the structuralist approach is an attempt to "identify specific rigidities, lags, and other characteristics of the structure of developing economies that affect economic adjustments and the choice of development policy" (Chenery, 1975, p. 310).

[8] For a detailed explanation of methodological individualism versus methodological holism, see Kincaid (2008).

[9] It is important to emphasize that French structuralism, represented particularly by François Perroux, was very influential on the Latin American strand, which in turn is detailed in subsection 1.2.

both the rhythm and the direction of economic development, structuralist literature highlights the importance of industrialization as a process of structural change where the manufacturing sector plays a central role.

The structuralist strand states that without a dynamic industrialization, it is not feasible to increase employment, productivity and income per capita and, consequently, to reduce poverty. The main argument stresses that development involves a production reallocation from low productivity to high productivity sectors where increasing returns to scale prevail. Inserted in this theoretical background, economic structuralism has provided many reflections on how economic growth should be understood in a historical perspective of mutual causation in the economic system. While various historical, political and ideological factors contributed to the structuralist view, Keynesian criticism of neoclassical economics, and its argument in support of state interventionism were of principal importance.

Paul Rosenstein-Rodan, Ragnar Nurkse, Arthur Lewis, Albert Hirschman, Gunnar Myrdal, and Hollis Chenery belong to the handful of economic thinkers associated with early structuralism or pioneers of development.[10] Their seminal contributions challenged the neoclassical view of market efficiency in structural change, and recognized particularities through which the manufacturing industry has a central role in supporting and propelling economic development. A further theoretical contribution comes from Latin American structuralism, which is mainly related to the UN Economic Commission for Latin America and the Caribbean (ECLAC), whose works merged into a coherent school of thought in the late 1950s. Based on historical experience, the main thoughts presented in this Latin American version are encapsulated in the works of Raul Prebisch and Celso Furtado and focus on the specific challenges faced by developing countries in a global economy divided into two poles, the "centre" and the "periphery", and the distinctive structure of production present in them (Prebisch, 1949; Furtado, 1964). Problems relating to dualism in international trade, technology disparities, the balance of payments constraint, and state interventionism were all emphasized.

1.1. The early structuralist approach to manufacturing: first insights

In economic theory, many studies associate the emergence of early structuralism with the publication of Rosenstein-Rodan's "Problems of Industrialization of Eastern and South-Eastern Europe" (1943). In this study, Paul Rosenstein-Rodan assigned particular emphasis to the transformative power of industrialization in the economic system (Rosenstein-Rodan, 1943). In a similar line of thinking, Nurkse (1953), Lewis (1954), Hirschman (1958), Myrdal (1957) and Chenery (1960; 1979) pointed out that the study of long-term economic growth is a "sector-specific" process and consequently involves an increase of the industry share, which, in turn, provides the highest potential of productivity, spillover effects, forward and backward linkages, as well as technological and pecuniary externalities. Hence, their focus was essentially on the internal special properties of manufacturing and on the way in which these properties spread to the economy as a whole, stimulating the process of economic growth.

Although not always emphasized by the literature, the essence of these classical contributions relied especially on Allyn Young's ideas on the long-term determinants of economic growth, which were further extended in their seminal studies. These pioneers of economic development also focused on the identification of bottlenecks and rigidities that

[10] See for instance, Blankenburg et al. (2008) and Ancochea (2007).

block the industrialization process in underdeveloped economies. However, in spite of general agreement amongst these pioneering economists that industrialization was the most efficient means to support economic development, the emphasis on growth through industrialization engendered a debate over whether "balanced" or "unbalanced" growth was the best strategy to extract and propel economic development through the special properties of manufacturing.

1.1.1. Industrialization: balanced and unbalanced growth theories

The early structuralist approach to manufacturing is particularly associated with Rosenstein-Rodan's path-breaking research in economic development, which stresses the conditions for economic growth in line with Nurkse (1953). Paul Rosenstein-Rodan and Ragnar Nurkse supported the balanced growth theory based on 'classical' arguments concerning long-run determinants of economic growth, particularly dynamic externalities and increasing returns, as advanced by Allyn Young. This type of argument gave rise not only to reflections on the role of demand complementarities and increasing returns to scale in manufacturing industries, but also various arguments that justify industrial policy, especially of selective type, on the basis of the existence of interdependence between different activities (Chang et al., 2013).

Rosenstein-Rodan (1943) states that a remarkable feature of high-income economies, i.e. developed countries, is a structured and dynamic industrial sector. Unlike developed economies, underdeveloped countries were characterized by the absence of a structured and dynamic industrial sector. As a matter of fact, since industrialization tends to be concentrated in developed countries, massive and planned investments coordinated by the state are sine qua non conditions for the creation of a new institutional environment and, consequently, the successful carrying out of industrialization in underdeveloped countries. In this way, Rosenstein-Rodan (1943) describes what later became known as the "big push theory", i.e. a large-scale development programme geared towards jump-starting economic growth through the industrialization process of an underdeveloped economy. Rosenstein-Rodan states that free market mechanisms would only keep or even increase the distributive inequality between countries, highlighting the growing gap between developed and underdeveloped nations. In his words, "the market mechanism does not realize the 'optimum' either in one nation or between nations because it relies on such unrealistic assumptions", and it "obscures the nature of the development process" (Rosenstein-Rodan, 1984, p. 209).

Regarding planning, the author highlights two crucial points. The first is related to labour training policies coordinated by the state, to transform peasants into industrial workers. This assertion is based on the observation that the automatism of *laissez-faire* never worked properly in this field. In other words, from the perspective of an individual firm, investing in training labour is very risky since if workers move to another firm a considerable loss of capital may occur. Although not a good investment for a private firm, it is the best investment for the state when considering the economy as a whole (Rosenstein-Rodan, 1943). The second and most important argument in favour of such a large investment unit refers to the complementary influence between different industries that potentiates the dynamic effects of external economies and balances the process of economic growth. The expansion of the market through the creation of a planned complementary system of industries reduces the risk of

demand shortage and, since risk can be considered as a cost, it reduces costs and provides the most important set of arguments in favour of large-scale industrialization.[11]

In such a way, a big, comprehensive and balanced investment package between manufacturing sectors performed by the state, i.e. the "big push", – using Rosenstein-Rodan's terminology – is the key to economic development through positive linkages effects in the productive chain that enhance the dynamic effects of external economies. From this perspective, industrialization has a central role in economic development not only because of the terms of trade differential, as noted by Prebisch, but also due technological and pecuniary external economies which are the main source of increasing returns to scale – a central aspect in the development process – and which are much higher in manufacturing than in agriculture.[12]

In a similar view to Rosenstein-Rodan, Nurkse stressed that economic growth is "not a spontaneous and automatic affair" (Nurkse, 1953, p. 4). With this assertion in mind, Nurkse describes the forces that limit the development process in underdeveloped countries. The so-called "vicious circle of poverty" is illustrated as "a circular constellation of forces tending to act and react upon one another in such a way as to keep a poor country in a state of poverty" (ibid.). This dynamic, translated in a low level of investment and capital accumulation, operates both on the supply and demand side. From the supply side a low level of investment arises from the small amount of savings available in the economy as a result of its low-income level which, in turn, is a consequence of a low level of productivity. Moreover, low productivity is a direct result of small amounts of capital used in the production process and is related to the low domestic savings in the country. From the demand side, similar to Rosenstein-Rodan's analysis, the greatest obstacle to development was the atrophy of the domestic market caused by low demand for goods due to low income level which, in turn, discourages the formation of capital. When productivity per worker is low, real income is consequently low and the poverty vicious circle is complete. Additionally, it is important to emphasize that, when analysing the underlying causes of the scarcity of capital, Nurkse (1953) did not treat it just as an issue of resources availability.

The author recognizes that underdevelopment is linked to the kind of products produced by a specific country and how they are traded in the international market. In order to break this circle, a wave of capital investment in various industries should be carried out. This would enlarge the market size, increase productivity and provide incentives for the private sector to invest. As pointed out by Nurkse, the only way out of the dilemma is a

> more or less synchronized application of capital to a wide range of different industries. Here is an escape from the deadlock; here the result is an over-all enlargement of the market [...] most industries catering for mass consumption are complementary in the sense that they provide a market for, and thus support, each other (Nurkse, 1953, p. 11).

[11] As argued by Rosenstein-Rodan (1943) in his shoe factory example, the diversity of human wants creates a necessity for a planned effort to generate a sufficient and sustained expansion of the market.

[12] Although Rosenstein-Rodan (1943) clearly approaches the discussion of technological externalities, the discussion of pecuniary externalities is not as extensive. However, Rosenstein-Rodan (1961; 1984) explains it taking into consideration their horizontal and vertical dimensions on both demand and supply sides. According to him, any expansion of the market through the process of industrialization leads to external economies, both pecuniary and technological. Pecuniary externalities are market-transmitted or inter-industry interdependencies. Horizontal pecuniary external economies occur between firms producing consumer goods, while vertical pecuniary external economies occur between suppliers and final goods producers. In terms of technological externalities, manufacturing is recognised as a source of effective knowledge (contemporaneously also termed 'learning by doing').

In contrast to Nurkse and Rosenstein-Rodan, Hirschman did not support the balanced growth theory, arguing that imbalances generated between sectors could provide corrective reactions, supporting a theory of "unbalanced growth". According to Hirschman (1958), economic growth is essentially an unbalanced dynamic process, in which successive disequilibria produce the conditions for development in different sectors. In his unbalanced growth theory, the productive structure is linked through forward and backward linkages to downstream and upstream industries. These linkages represent physical relations of supply and demand among sectors of the economy. Thus, backward linkages are associated with the products that each sector demands from other sectors of the economy, while forward linkages are associated with the extension to which each sector's product is demanded by other sectors. In this dynamic, manufacturing industry is characterized by both strong backward and forward linkages, enabling this sector to generate higher economies of scale with positive effects in terms of productivity gains and cost savings in later stages of the production chain. From this perspective, as pointed out by Toner (1999), Hirschman focused particularly on the intermediate and capital goods sectors while Rosenstein-Rodan and Nurkse focused essentially on productivity growth in the consumer goods sector.

Furthermore, while also concentrating on the role of bottlenecks, external economies and complementarities, Albert Hirschman qualifies economic development "essentially as the record of how one thing leads to another" involving not only physical relations of supply and demand, but also technological linkages. This leads to the first insights on the concept of spillover effects, which stem from manufacturing to the rest of the economy, which is approached by the contemporary economic developmental literature, e.g. the Kaldorian and neo-Schumpeterian strands. Additionally, the author's opposition to Nurkse's and Rosenstein-Rodan's strategies relies on the idea that too many financial resources and planning efforts would be necessary to stimulate the economy, concluding that "if a country was ready to apply the doctrine of balanced growth, then it would not be underdeveloped in the first place" (Hirschman, 1958, pp. 53-54).

Hirschman's strategy rested on the idea that economic policy should focus on specific industries, i.e. key sectors with strong interdependence or linkages – both backward and forward – with other sectors of the economy.[13] The backward linkage refers to the potential of a sector to stimulate production and investment of sectors that provide its inputs, whilst forward linkage relates to the capacity of a sector to induce productive activities of sectors which demand its output. Key sectors, i.e. sectors with strong linkages, would be capable of generating higher economies of scale with positive effects in terms of productivity gains and cost savings in later stages of the production chain. As a matter of fact, unbalanced growth theory asserts that certain sectors, particularly inside the manufacturing industries, are the main engines of growth.[14]

Like Hirschman, Myrdal (1957) based his theory on the understanding that economic development is intrinsically a process in disequilibrium, breaking with the neoclassical

[13] Input-output models made possible the measuring of linkages. In fact, in the 1960s and 1970s, different indicators of forward and backward linkages based on the Leontief inverse matrix were developed in order to apply the theoretical approach.

[14] According to Ancochea (2007), the selectivity of some sectors as proposed by unbalanced growth economists received different names, such as the "propulsive industry" (Perroux, 1955), "leading sector" (Rostow, 1952; 1978), or the "development block" (Dahmén, 1987). For instance, see Hirschman (1987).

statement of stable equilibrium.[15] Myrdal's theory of unbalanced growth is centred on the concept of "cumulative causation" to analyse the problem of development inequality between nations. In this dynamic, trade and economic relations between developed and underdeveloped countries are discussed considering effects that arise from this interaction and may negatively ("backwash effect") or positively ("spread effect") impact the development of an economy. Furthermore, according to him, economic development involves not only economic relationships of supply and demand but also institutional and political structures, denominated non-economic factors, which, operating in a process of cumulative causation, reveals challenges to be faced by underdeveloped countries.[16]

In Myrdal's concept of circular cumulative causation, the main idea relies on the fact that free market forces would generally tend to increase regional disparities. The assertion was important because, while international economic inequality grew and became a common concern in many schools of thought, the neoclassical theory of international trade insisted on the idea that there was a gradual equalization tendency of factor prices and income across countries. Focusing on social aspects of this cumulative causation, Myrdal's theory provided the fundamental framework for later complementary heterodox theories, such as the Latin American structuralist approach – with a strong influence on Celso Furtado – and the Kaldorian theory, which focused on the demand-supply relationships of the manufacturing sector.

As a general link between all pioneers of economic development, although wrapped in a critical assessment of the level of state intervention in the economy, both approaches – balanced growth theory and unbalanced growth theory – directly or indirectly pay attention to the role of industrialization as a way to overcome underdevelopment. In the context of Latin American development problems, it is important to highlight that ECLAC participated actively in these discussions providing important contributions notably by Raúl Prebisch, Celso Furtado and Aníbal Pinto. From this background, the following section seeks to provide the main reflections on the obstacles encountered by developing countries in the face of the absence of a dynamic industrial structure.

1.2. Latin American structuralism: linking underdevelopment to the centre-periphery paradigm

In modern economics, Latin American structuralism should be placed in a methodological tradition, which has its origin in Raul Prebisch's (1949) study "El desarrollo económico de la América Latina y algunos de sus principales problemas". With Prebisch leading a group of outstanding economists, the ECLAC sparked remarkable insights and explanations regarding the causes of Latin American underdevelopment.[17] Latin American structuralist writers challenged the neoclassical theory through a critique of the prevailing international trade and proposed a theory of peripheral capitalism incorporating core elements presented in the

[15] To Myrdal, neoclassical trade theories were "never developed to comprehend the reality of great and growing economic inequalities and of the dynamic processes of under-development and development" (Myrdal, 1957, p. 51).
[16] See also Ho (2004).
[17] The French structuralism represented by the innovative contributions by François Perroux (1939) defined structural economics as a science that analyses the relations characteristic of an economic system situated in time and space. According to him, economic analysis should incorporate institutions and structures over time (see Blankenburg et al., 2008).

French[18] and Anglo-Saxon structuralist traditions, as well as in Keynesian thinking[19] (Furtado, 1967; Palma, 1987; Sunkel, 1989; Love, 1995; 1996; Blankenburg et al., 2008).

Based on this theoretical background, the basic analytical components of ECLAC and other Latin American structuralists were grounded in historical methodology, the study of domestic determinants of economic growth and technological progress, as well as an evaluation of arguments in favour and against state intervention (Bielschowsky, 1998). In this sense, many prominent works followed ECLAC thinking and provided important insights, critiques and complementarities for the understanding of Latin American underdevelopment. Through a sharp critique of neoclassical economics and its idea that specialization based on comparative advantage, whatever its nature, was a superior solution for economic growth, the Latin American structuralist school gave life to an important interpretation where the productive structure matters to the pace and scope of development. Comparing commodity-producer economies and industrialized countries, Prebisch (1949) noted that productivity was essentially higher in the manufacturing sector than in the primary activity. This dichotomy in levels of productivity between the productive structure of developed (centre) and underdeveloped (periphery) countries, the so-called structural heterogeneity, was also approached by Furtado (1959; 1961) and Pinto[20] (1965; 1970).

For Furtado (1961), the mainspring of capitalist development is technological progress through a process of incorporation and diffusion of new techniques with a consequent increase in production and productivity.[21] Therefore, underdevelopment is seen as a partial and blocked version of development, either because of the uneven spread of technical progress or the limited transmission of productivity gains into wages. According to him, while the centre countries internalize new technology by developing an industrial capital goods sector and by spreading the improved technology to all economic sectors, the periphery remains dependent on imported technology, which in turn is mainly confined to the primary export sector. Consequently, a sizeable low-productivity pre-capitalist sector continues to survive in the

[18] Perroux (1950) anticipated important elements of ECLAC's theory, particularly with regards to the centre-periphery model, which was an extension of the concept of economic systems where "the economic world is conceptualized in terms of hidden or explicit relationships of 'force', 'power' and 'constraints' between dominant and dominated entities" (Blankenburg et al., 2008, p. 2). Perroux's theory is based on different analytical levels, i.e., markets, firms and international economy and clarifies interactions between different entities with distinctive structures of power and the consequences in terms of trade and finance. According to Perroux, growth does not appear everywhere and all at once; "it appears in points or growth poles with variable intensities; it spreads along diverse channels and has varying terminal effects for the whole of the economy" (Perroux, 1955, p. 308). Thus, the intensity and magnitude of growth poles are determined by the fundamental role played by propulsive industries, which are in turn highly innovative and, according to Perroux, sources of technological progress. These industries constitute the pillar of economic development and generate positive effects (spread effects) in other regions, such as the increase in income and employment, and at the same time produce structural change through economic growth. Moreover, through the development pole, Perroux also exerted a fundamental influence on the ECLAC's division of the world between centre and periphery, and Furtado's early work including his doctoral dissertation at Sorbonne. See Furtado (1995).

[19] The Latin American structuralist school was also concerned, to a greater or lesser extent, with a coalition of the industrial bourgeoisie, the middle class and the urban working class under the coordination of the developmental state to propel economic development. According to the structuralist approach, it is the developmental state which is the main agent of change since it is the only institution capable of transcending sectional interests and thereby able to pursue the national interest (Kay, 1989).

[20] Although the concept of structural heterogeneity was a central element in the works of Raúl Prebisch or in those of Celso Furtado in the form of "dualism", it was with Anibal Pinto that the concept of structural heterogeneity solidifies during the 1970s. See, for instance, Pinto (1970; 1971; 1976).

[21] In a complementary approach, Tavares (1972, p. 50) highlights the problem of creating technical progress endogenously, and the consolidation of a diversified productive structure with increasing share of national content in domestic production.

periphery, producing a continuous surplus of labour and consequently keeping wages low. Without industrialization, the asymmetry between the centre and the periphery would not only perpetuate but also deepen.

In relation to this dynamic, Pinto (1965) highlighted the persistence of structural heterogeneity. According to Pinto, developed countries had a much more homogeneous level of productivity than the periphery. The heterogeneity in underdeveloped countries – expressed in sectors where productivity is high or 'normal' vis-à-vis others where productivity is lower or several times lower – would generate problems of underemployment in face of occupational mismatch. As the occupational structure is a mirror of the productive one, economies with high productivity tend to generate more employment, while structures with very low productivity tend to generate underemployment (Rodriguez, 2006).

Pinto (1970) identifies three levels of productivity in Latin America: i) the primary sector with low productivity and low earnings, keeping similarities with the prevailing forms of production since the colonial period; ii) the middle sector that is neither the upper end nor the lower end and thus is near the average of the economy as a whole; and iii) the modern sector with high productivity levels and gains, which are similar to the average of developed economies. Given these different levels of productivity, the rate of technical progress incorporation and productivity increase would be significantly higher in central economies vis-à-vis peripheral economies, which in turn are specialized in primary products. In this way, a shift from less productive sectors to those with higher productivity – notably the manufacturing industry – would promote an increase in aggregate productivity, a stimulus in the technological diffusion and an increase in real wages.[22]

While various writers contributed to the Latin American structuralist paradigm, Prebisch's original ideas were pivotal in launching a critical perspective on the neoclassical approach to the mutual profitability of free trade between developed and developing countries, whose influence was very remarkable in Latin America. In his thinking, a key structural economic characteristic of peripheral economies refers to the deterioration in their terms of trade over time due to different income-elasticity of demand – also known as "dynamic disparity of demand". Thus, contrary to what the comparative advantage theory suggests, prices of primary products produced and exported by peripheral countries, such as in Latin America, tend to present an antagonistic evolution when compared to prices of manufactured products exported by industrialized countries. This means that the centre's imports of primary

[22] During the 1980s, Fernando Fajnzylber provided important contributions to underdevelopment theory, emphasizing the Latin American bottlenecks, especially regarding technical progress and productivity. Fajnzylber (1983) explained the low technological dynamism that characterized Latin American industrialization through a convergence of structuralist thinking, the French regulation school and evolutionary economics. According to Fajnzylber, an economy which does not have an "endogenous nucleus of technological dynamism", cannot overcome underdevelopment. Moreover, since the sector of capital goods materially incorporates technological progress, policies to strengthen this sector should be carried out to establish an endogenous nucleus of technological dynamism and stimulate the diffusion of technology to other sectors as well as reverse the Latin American structural deficit in the current account. Without a strong developmental state to build this "endogenous nucleus of technological dynamism", as in developed countries and in late industrializing countries such as East Asia, including Japan, and in absence of an industrial vocation, i.e, business leadership capable of inducing transnational companies to build this "endogenous nucleus of technological dynamism", underdevelopment would be maintained. According to Fajnzylber, in Latin America, the problem with transnational companies was the establishment of productive structures based on technology transferred by headquarters which therefore did not contribute to the process of technological innovation. To clarify the understanding of how to overcome the inheritance of past mistakes, the author defends that Latin America should not only focus on macroeconomic stabilization and debt reduction, but also push the technological frontier inducing transnational companies to adopt innovative domestic behaviour.

products from the periphery rise at a lower rate than its national income, while the periphery's imports of manufactured goods from the centre grow at a faster rate than its income. Since demand for manufactured goods increases more rapidly than the demand for primary goods according to the well-known Engel's law, there is a tendency to deteriorate the terms of trade of those economies specialized in the production and export of primary goods in comparison to central industrialized economies.

In other words, prices of manufactured goods would be structurally higher in relation to primary products. This means that peripheral economies would have to export more to achieve the same value of industrial exports over time. In central economies, adjustments along the global economic cycle are made through export quantities, due to the high level of industrialization. On the other hand, in peripheral economies, adjustments occur through export prices due to the primary specialization.[23] In contrast to the free trade doctrine, these movements would be gradually accentuated in the absence of a dynamic industry. Thus, overcoming underdevelopment would not be possible through the international division of labour, in which peripheral countries would be doomed to a specialization in primary products. In this sense, industrialization was seen as a way to modify this process. Thus, through a productivity increase, the deterioration of the terms of trade could be reduced, the technological progress incorporated and a process of income distribution promoted.[24]

The limits of spontaneous industrialization in developing countries clearly revealed the need for active state intervention in the industrialization process. Although the state should have the capacity to promote particular sectors through the creation of public companies, it should especially focus on planning (Ancochea, 2007). For this purpose, many other Latin American structuralists sought to map different stages of industrialization in a similar manner, often distinguishing between the so-called stages of industrialization, i.e. internalizing the production of consumer goods, consumer durables, intermediary inputs and capital goods. It is not by chance that during the 1950s and 1960s this argument gave rise to the support of the import substitution industrialization (ISI) model, principally in Latin America. ISI was a trade and economic policy programme based on the premise that a country should attempt to reduce its foreign dependency through the local production of manufacturing goods. For this purpose, the developmental state would coordinate the process of industrialization from light to heavy industries through the import of intermediary and capital goods necessary to obtain a diversified and interdependent productive structure. In each stage of the industrialization process, a gradual replacement of imported goods for domestic production would spread technological and productivity gains over the economy.

Broadly speaking, the idea expressed by Latin American structuralism was that, despite the spread of modernity, backwardness and wide differences in labour productivity between economic sectors and subsectors and between regions and segments of the population tended to be maintained and sometimes expanded (Bielschowsky, 2009). According to these authors, developing countries could be characterized by a dual structure where a late agricultural sector and a modern industrial sector coexist. The importance of manufacturing vis-à-vis concentration in primary commodity exports was a central concern of the structuralist

[23] In a complementary way, see Prebisch (1950; 1959) and Singer (1950).

[24] These dynamics were also pointed out also by Furtado (1959). In this sense, Furtado's works are closely connected to Prebisch's, especially regarding endogenous dimensions of underdevelopment and its determinants. In general, the economic thinking of ECLAC and Celso Furtado addressed particularly the different stages of industrialization in a similar manner, often distinguishing between the so-called phases of industrialization.

approach associated with the ECLAC. In this way, industrialization is seen as the only way for developing countries to catch up. The Kaldorian theory, which concentrated on the demand-supply relationships in the manufacturing sector, complements this view giving further elements to explore the importance of industrialization, and more specifically of the manufacturing sector.

2. Kaldor's stylized facts and the contemporaneous debate

Kaldor showed the central role that the manufacturing sector plays in economic growth in two lectures: one in Cambridge in 1966 entitled *Causes of the Slow Rate of Growth of the United Kingdom* (Kaldor, 1966); the other at Cornell University in the same year, published as *Strategic Factors in Economic Development* (Kaldor, 1967). Inspired by studies of Allyn Young, Gunnar Myrdal and Adam Smith and recovering the empirical regularities pointed out by Kuznets, Rostow, Chenery and Syrquin, Nicholas Kaldor argued that it is not possible to understand development and growth rate differences between countries without taking a sectoral approach. In a complementary line of research to Furtado, Hirschman, Rosenstein-Rodan and Prebisch, Kaldor noted that the manufacturing sector is imbued with special growth-enhancing properties that trigger a process of cumulative causation that are not shared by other sectors.[25]

Kaldor's view offered support for the key role played by the manufacturing sector given some special characteristics, which forwarded itself to a special theoretical framework for understanding the causal relationships between industrial development and economic growth. Kaldor introduced the concept of dynamic economies of scale, such that the faster the growth of manufacturing output, the faster the growth of manufacturing productivity. He attributed these dynamic economies to Arrow's (1962) notion of learning by doing and argued that this occurred principally in manufacturing and not in services or agriculture. In this way, challenging the neoclassical statement of constant returns to scale across sectors, Kaldor noted that poor developing countries tend to specialize in land-based sectors – agriculture and mining – subject to diminishing returns, while richer developed countries specialize in (static and dynamics) increasing returns activities, such as manufacturing and sophisticated service activities associated with them, including banking, finance and insurance (Thirlwall, 2013).

Unlike neoclassical theories of growth, i.e. theories of exogenous and endogenous growth developed since Solow (1950), where the theoretical framework relies exclusively on the supply-side, Kaldor's argument considers the demand side,[26] particularly the role of aggregate demand, to explain the economic dynamic. On the basis of the interaction involving demand

[25] In this case, Kaldor's explanation is highly influenced by studies of Allyn Young, Gunnar Myrdal and Adam Smith. In his own words, "to explain why certain regions have become highly industrialized, while others have not we must introduce quite different kinds of considerations – what Myrdal (1957) called the principle of 'circular cumulative causation'. This is nothing but the existence of increasing returns to scale – using the term in the broadest sense – in processing activities. […] As Allyn Young (1928) pointed out in a famous paper, Adam Smith's principle of 'division of labour' operates through the constant sub-division of industries, the emergence of new kinds of specialized firms, of steadily increasing differentiation – more than through the expansion in the size of the individual plant or the individual firm" (Kaldor, 1970, p. 340). All these assumptions stimulated many studies which tried to provide a formalization of Kaldor's ideas of economic growth. In a well-known work, Dixon and Thirlwall (1975) provided a systematic formalization of the cumulative causation model.

[26] Differently from the neoclassical view, in the Kaldorian framework the output used in a modern capitalist economy is itself goods produced within the system given the effective demand.

and supply conditions in agriculture, manufacturing and services, Kaldor derived generalizations concerning the relationship between the growth of output, employment and productivity in different sectors of the economy. These theoretical formulations became known as "Kaldor's growth laws" or "stylized facts" and became an important turning point in the literature of economic growth.

Many empirical tests centred on Kaldor's laws to explain the differences in international growth rates were made and replicated for different groups of countries and periods of time since then, following the evolution of econometric methods for static- and dynamic-model data panels. Under this framework, many contemporaneous and prominent Kaldorian analyses emphasized a strong relationship between changes in the sectoral composition of an economy and economic growth. In a complementary way, the contemporary developmental literature has emphasized the bundle of interactions that connects manufacturing and economic growth, particularly considering distinct stages of development and the intersectoral relationship between services and manufacturing.

2.1. Manufacturing as engine of growth: from industrialization to de-industrialization

Over the years, the complex relationship between production structure and economic growth has been the subject of considerable debate among economists. The ever-increasing body of policy reports, academic papers and manufacturing national strategies covering economies with different income levels have showed the virtues of manufacturing. The so-called stylized facts are supported by important empirical regularities that recent research on patterns of economic growth has highlighted.[27] , The first law formulated by Kaldor states that "manufacturing is the engine of growth". It means that the faster the growth rate in manufacturing output is, the faster the growth rate of the economy as a whole will be.

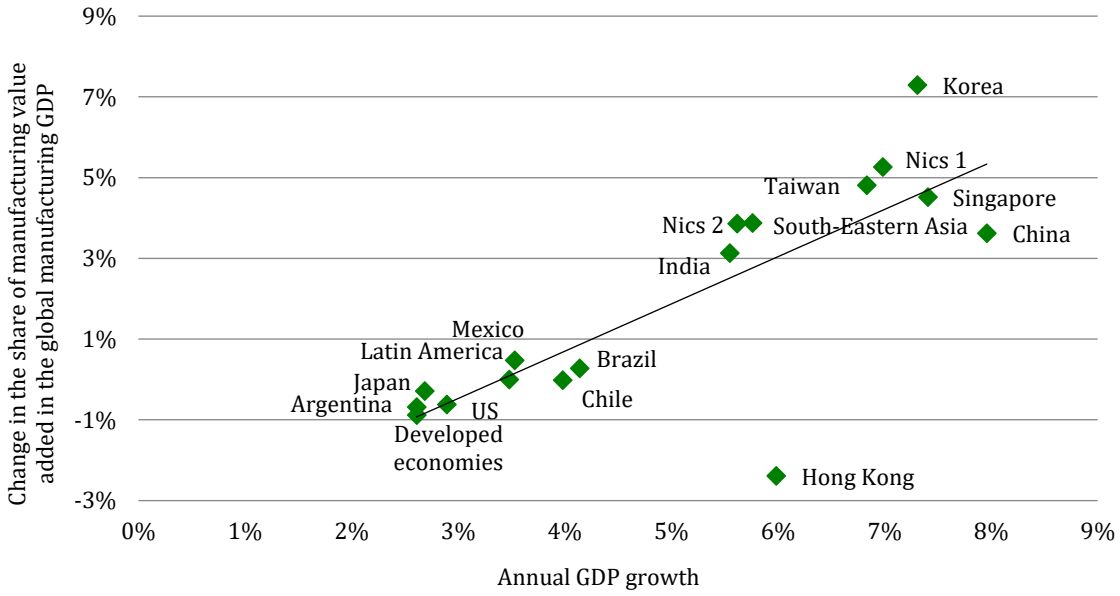
In dialogue with this hypothesis, using different econometric methods such as cross-section, panel and time-series data analysis, many empirical studies were strongly supportive of Kaldor's first law (Thirlwall, 2013). Kaldorian analyses showed that regression coefficients were statistically significant at the 95 per cent confidence level and above, and strong in the case of East Asian and Latin American economies (Hansen and Zhang, 1996; Mamgain, 1999; Wells and Thirlwall, 2003; Dasgupta and Singh, 2006; Libanio, 2006). Unlike manufacturing, in agriculture and services the relation between GDP growth and the growth of other sectors does not exist, at least not in the same magnitude. Studies did not find a correlation between the growth of agriculture and the growth of GDP in a causal sense. Furthermore, econometric tests have showed a strong negative correlation between GDP growth and the excess of agricultural growth over non-agricultural growth. Additionally, the coefficient for services was lower than those of manufacturing (Thirlwall, 2013).

Other empirical studies have been supportive of the Kaldorian literature. Rodrik (2006) found that since 1960 the economic growth of developing countries is strongly associated with the development of modern industrial sectors. Szirmai and Verspagen (2011) and Szirmai (2012), taking into account a sample of 21 advanced economies and 67 developing countries in the past fifty years, found that manufacturing has functioned as an important engine of growth in developing countries. These analyses have been in dialogue with Fagerberg and Verspagen's (1999) work, which noted that developing countries are those that benefit more

[27] Kaldor developed this stylized fact through a study of developed countries over the period 1952-54 to 1963-64 (Kaldor, 1966).

from expansions of the manufacturing sector. They test the importance of the most dynamic segments of manufacturing in economic growth and confirm the significance of the flexibility to shifts towards manufacturing.

Figure 1 – *Annual GDP growth and change in the share of manufacturing value added in the global manufacturing GDP, 1970-2010*



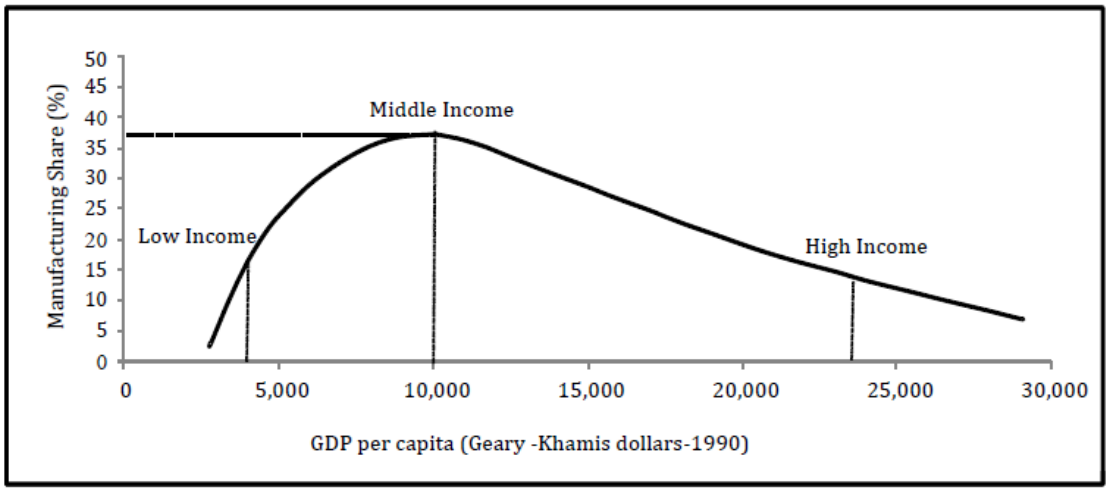
Note: according to the UNCTAD database, developed countries include Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Malta, the Netherlands, New Zealand, Norway, Portugal, San Marino, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Taiwan, the United Kingdom, and the United States of America. Nics 1: Korea, Taiwan, Hong Kong, and Singapore. Nics 2: Malaysia, Thailand, Indonesia, and the Philippines. South-Eastern Asia: Brunei Darussalan, Cambodia, Indonesia, Lao, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, and Vietnam.
R^2 = 74%; significance level of 5%.
Source: based on data from GGDC 10-Sector database and UNCTADSTAT.

Figure 1 illustrates a positive correlation between the rate of GDP growth and the increase in manufacturing's share in global manufacturing GDP. Those countries that achieved the fastest economic growth during the period are the countries where the increase shift towards manufacturing has been largest. The numbers in the figure illustrate the dichotomy between Asia and Latin America in terms of strategy of economic development. In Asia, the share of manufacturing in GDP grew at much higher rates, resulting in significant increases in GDP. With an opposite trend, Latin America and developed countries showed the reverse path, de-industrializing and achieving very modest rates of GDP per capita growth.

Nevertheless, Szirmai and Verspagen (2011), Fagerberg and Verspagen (1999) and Szirmai (2012) have noted that even though manufacturing plays a central role in the process of economic development, some countries have presented a decreasing share of manufacturing followed by an increasing share of services in their sectoral composition. As Rowthorn and

Wells (1987) noted in a seminal study, countries follow a broadly similar trajectory of economic development. As development gets under way in low-income countries, the share of agriculture in value added and in employment falls, and there is a rapid increase in the share of manufacturing. The transition from a reasonably diversified structure of production to a mature economy is known as industrialization and is mostly represented by the conditions of the so-called middle-income countries. When the economy reaches a certain level of income per capita, the share of manufacturing stabilizes and then starts to fall back with the whole process taking on the form of an 'inverted-U' (Rowthorn, 1995).[28] This trend is also followed by a corresponding increase in the share of services in national employment[29] and value-added, and is often described as a natural process of de-industrialization.[30]

Figure 2 – *The inverted-U relationship between manufacturing and income per capita*



Source: McKinsey (2012).

Many authors such as Robert Rowthorn have done seminal studies to understand this shift in terms of sectoral composition, contrasting the so-called natural de-industrialization, i.e. the consequence of industrial dynamism in an already developed economy, with the so-called

[28] Rowthorn and Wells (1987) defined de-industrialization as a decline in manufacturing employment first in relative terms and then, at least in some countries, also in absolute terms. Tregenna (2009) defined de-industrialization as the consistent reduction of both the share of employment and of value added of the manufacturing industry in total employment and GDP, respectively. In this section, de-industrialization will be analysed solely from the point of view of manufacturing value added.

[29] In terms of employment, the statistics also indicate that in most countries the growth rate of labour productivity in the manufacturing sector has been faster than in services and in the economy as a whole. Consequently, the relative decline of manufacturing employment has been mainly the result of rapid productivity growth in this sector (Rowthorn and Coutts, 2013a). See also Rowthorn and Coutts (2013b) and Coutts and Rowthorn (2013).

[30] The inverted-U curve also reflects the consumption pattern in each stage of the evolution of income per capita. During early stages of economic development, i.e. low-income countries, agriculture presents the biggest share in the economy because food represents most of households' consumption. Thus, as countries go through economic development, inputs such as steel and cement are needed for infrastructure as well as machinery and transportation equipment for the productive process of industries. When the country reaches the stage of middle-income economy, a higher income per capita triggers additional forms of consumption, particularly in services. An increase in spending on services such as education, health care, travel, banking and many others begins to take up gradually a higher share of income.

negative de-industrialization, which is defined as "a product of economic failure and occurs when industry is in severe difficulties and the general performance of the economy is poor" (Rowthorn and Wells, 1987, p. 9). Following this line of thinking, Rowthorn and Coutts (2004), Palma (2005), and Pieper (2003) stated that several developing countries are de-industrializing at a much lower level of per capita income than observed historically in today's developed countries. In order to consider if the rise of services is a symptom of economic failure and a harbinger of impending impoverishment or if the decline of manufacturing might be seen as something natural or even as a sign of development, some considerations must be taken into account.

2.2. Statistical illusions

A non-negligible part of the extent of de-industrialization in terms of decreasing relative importance of manufacturing, seems to be due to statistical illusions, in the sense that it reflects changes in statistical classification rather than changes in real activities. Therefore, the extent of de-industrialization has been overestimated due to the outsourcing of some services that used to be provided in-house by manufacturing firms and thus were counted as manufacturing output, e.g. catering and cleaning, research, design, IT, accounting, telecommunications, engineering activities, logistics, and legal services (Palma, 2005; Rowthorn and Coutts, 2004).[31]

Although these outsourced activities are still the same, now they are counted as part of the services sector output, rather than manufacturing output. Consequently, services become more important without a real change in the activities carried out. In this manner, experts agree the outsourcing effect has been a considerable source of de-industrialization in middle/high-income countries principally from the 1980s when neoliberal policies took momentum. This potential overestimation of manufacturing's decline in industrialized countries is also discussed by McCarthy and Anagnostou (2004) and Vittucci (2008). Another handful of theorists, such as Laplane and Sarti (1997), Carneiro (2008) and Rocha (2011), have highlighted that this statistical effect also affected Latin American countries. These studies noted that neoliberal policies, particularly regarding market deregulation and trade liberalization, led a wide range of manufacturing sectors to undertake defensive adjustments characterized by the process of outsourcing which shifted value added from manufacturing to services.[32]

2.3. Servicification

Although the explanation for the premature de-industrialization outlined above obscures the traditional distinction between services and manufacturing, empirical studies have shown that middle income countries – characterized by premature de-industrialization – and high-income countries tend to present strong correlation between GDP growth and the increasing share of services, particularly more sophisticated and high-value-added service activities,

[31] Rowthorn and Coutts (2004) named it a "statistical artefact".

[32] Additionally, as pointed out by Chang (2014, p. 261), "seeing the share of manufacturing in their output falling, some manufacturing firms have applied to be reclassified as service firms". In this sense, individual manufacturing firms have been reclassified as service firms, even though they still engage in some manufacturing production. According to the UK government's Department for Business, Enterprise and Regulatory Reform (BERR), up to 10% of the fall in manufacturing employment between 1998 and 2006 in the UK may have been due to this reclassification effect (Chang, 2012).

which in turn has shown a strong dependence on manufacturing. Although economists have also observed the difficulty of measuring interactions between services and manufacturing due to the process of outsourcing, input-output analyses revealed strong intersectoral interactions and interdependencies between these two sectors[33] (Lodefalk, 2010; Nordås and Kim, 2013).

Pilat and Wölfl (2005) showed that the character of European manufacturing seems to change over the years, interacting more with service industries than before, that is, manufacturing has been using more intermediate services and employs a rising number service-related workers. This trend has been not only a result of outsourcing that overestimates the use of services in manufacturing, but also of the increasing interdependence between some knowledge-intensive services and manufactured products. In the case of the latter, the most remarkable example is the service subsector of information and communications technology (ICT). However, although services now contribute more as providers of intermediate input and service-related workers to the performance of other industries, their role remains more limited than that of the manufacturing sector. Park and Chan (1989), Rocha et al. (2014), and Magacho et al. (2014) have confirmed Hirschman's intuition that manufacturing has larger multiplier indices than other sectors.

As suggested by Guerrieri and Meliciani (2005), the country's capacity to develop its services depends on the specific structural and technological composition of its manufacturing sector. Some knowledge-intensive services are spin-offs from manufacturing production, given that the manufacturing sector itself has been the key source of new productive knowledge to the rest of the economy. Moreover, the manufacturing sector creates demand for the growth of high-productivity services such as finance, engineering, design, accounting, consultancy, telecommunication and transport. Therefore, services growth is closely connected to the manufacturing sector and consequently a weakening manufacturing base would eventually lead to a decline in the quality of those services (Chang, 2014).

2.4. Productive fragmentation

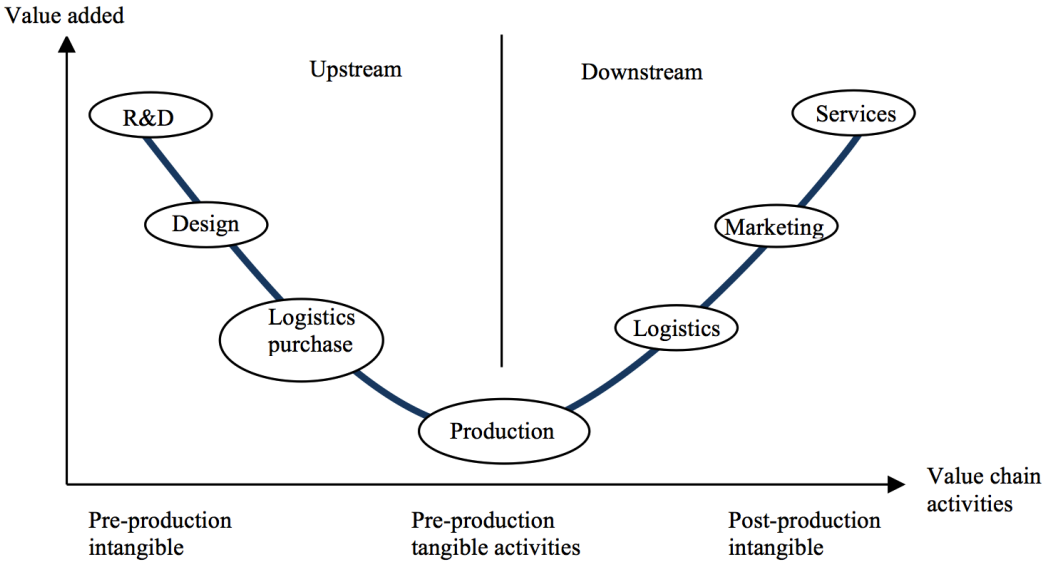
In recent decades, the geography of industrial production has gone through a revolution, with the breaking-down of the 'value chain' by multiproduct transnational corporations (TNCs), leading to de-industrialization in advanced economies. Since around the year 2000, the relocation of labour-intensive assembly-end part of the value chain to developing countries has significantly fragmented the international production in coordinated networks also known as global value chains (GVC) (Unctad, 2013). In this new productive environment countries not only specialize in terms of industries but also of activities carried out for the production of a particular product. Therefore, the value of a final product sold on the market embodies more and more value added from other countries due to an increasing process of international vertical specialization (Stehrer, 2013).

The dominant view stresses that international productive fragmentation is an important source of firm efficiency through improvements in competitiveness both in domestic and

[33] As shown by McKinsey (2012, p. 7), depending on the segment, 30 to 55% of manufacturing jobs in advanced economies are service-type functions, and service inputs make up 20 to 25% of manufacturing output. Moreover, for every dollar of output, US manufacturers use 19 cents of service inputs, creating $900 billion a year in demand for services, while services create $1.4 trillion in US manufacturing demand. In China, this interdependence is around $500 billion in services demand and $600 billion in manufacturing demand. Additionally, although manufacturing exports drive more than 80% of German exports, services and manufacturing contribute nearly equal shares of value added to the country's total exports.

international markets, and by cost savings. Through this productive fragmentation, companies could focus on the most dynamic levels of the global value chain such as R&D, product design, marketing and services. Companies responsible for tangible activities would also benefit from the learning flow with global buyers that would improve their production process and product upgrading. Countries specialized in production activities could also move to levels with higher value added in the global value chain. Therefore, the stage of economic development would be closely related to the process of acquiring new functions that generate higher incomes (and, conversely, ceasing to perform low-income activities). At the country level, the process of productive re-allocation to low and middle income nations would give companies more access to new consumer markets. In this process, low-income countries could also experience rapid economic growth stemming from the structural transformation of the large-scale migration of workers from the subsistence sector to manufacturing. Middle-income countries in turn could consolidate their productive structure and, in the course of economic development, move up in the global value chain.

Figure 3 –*Value added in the global value chain*



Source: based on OECD (2013).

However, many studies have stressed that the process of embracing the global value chain has generated dubious results. The decline of manufacturing in advanced countries like the USA and EU members, as well as in Latin American economies due to the process of productive fragmentation concerns policy-makers and scholars particularly with regards to the risk of losing the interdependence between production activities and technological innovation. The proponents of a manufacturing renaissance have been warning that a knowledge economy which loses interaction with its productive structure may lose the capacity to innovate next-generation technologies and products.

Therefore, prominent scholars have pointed out that the off-shoring of production is all too often followed by a deterioration of the so-called "industrial commons",[34] i.e. damages to other parts of the industrial system which include "reduced operations by local suppliers of materials, components and production technologies; a decline in process engineering skills, manufacturing know-how and leadership; a deterioration of prototyping, test-bed and pilot-manufacturing infrastructure" (O'Sullivan and Mitchell, 2013, p. 43). In this way, losing industrial commons may cause a decline in important technological capabilities that stem from the interconnection between product development, next-generation production technologies, and process engineering. Consequently, due to the fact that cutting-edge technologies often rely on elements of the industrial commons underpinned by dynamic manufacturing sectors, this process risks reducing the country's capacity to compete in some of the most important new industries.

Pisano and Shih (2009) illustrated this point by showing that US companies overestimated the advantages of outsourcing development and manufacturing work to specialists abroad and cutting their spending on basic research. Moreover, the outsourcing and off-shoring slogan comprised not only low-value tasks like simple assembly or circuit-board stuffing, but also sophisticated engineering and manufacturing capabilities that support innovation in a wide range of products and processes. Therefore, due to the process of losing knowledge, skilled people, and supplier infrastructure, the USA reduced its capacity to manufacture a vast range of cutting-edge products.

According to Ezell and Atkinson (2011), the current challenges faced by some industries in the USA illustrate this point well. In the case of the solar panel industry, they found that in order to lower costs, US companies re-allocated semiconductor foundries to Asian countries such as Japan, India, Taiwan, South Korea, and especially China. However, this not only deteriorated the silicon-processing and thin-film-deposition capabilities in the USA but also undermined the process of manufacturing solar panels. In the same way, US companies are falling behind in the software industry. Initially, companies outsourced only relatively mundane code-writing projects to Indian firms to lower software-development costs. However, over the years Indian companies developed their own software-engineering capabilities and started to attract more complex activities to India like developing architectural specifications and writing sophisticated firmware and device drivers (Pisano and Shih, 2009). The consequence of these trends is the slump of the US industrial base, "the hollowing out of advanced production supply chains, and the loss, for many US industries, of their industrial commons" (Ezell and Atkinson, 2011, p. 15).

Furthermore, the critics of productive fragmentation have widely documented that production and R&D cannot be disassociated because the proximity of research, development, and manufacturing is very important to leading-edge manufacturers. As stated by Berger (2011), there is a close connection between R&D and manufacturing. In this interdependence, for example, strategies for making processes more efficient stem from the close synergy involving R&D engineers and manufacturing. Off-shoring manufacturing is pulling high-end design and R&D capabilities out of the USA and consequently diminishing the country's capacity to create

[34] Pisano and Shih (2009) coined the term industrial commons based on Marshall's (1920) study. Moreover, based on Marshall's seminal study on industrial districts, Kaldor also pointed out that one of the most remarkable features of industrial districts is the special concentration of manufacturing activity that culminates in important advantages for industries as a whole due to the availability of specialized skills and ready communication of trade and managerial know-how (Kaldor, 1970; 1972).

new high-tech products. For this reason, Ezell and Atkinson (2011) highlight that nowadays, 90% of all electronics R&D takes place in Asia due to some extent to the scale of production needed to be able to afford general R&D. They also point out that from 1998 to 2007, US corporations invested more than 2.65 times in overseas R&D than domestically. Furthermore, almost "every US brand of notebook computer, except Apple, is now designed in Asia, and the same is true for most cell phones and many other handheld electronic devices" (Pisano and Shih, 2009, p. 1).

For this reason, especially after the outbreak of the global crisis in advanced countries, attention turned to the need of re-strengthening the manufacturing base together with the objective to 'bring manufacturing back home', which was lost during the productive fragmentation era that stimulated outsourcing and off-shoring. The European Commission has set an ambitious goal aiming for a manufacturing share of 20% of GDP by 2020 (it is now around 15%) and there is an active debate in the USA about the need of re-industrialization to guarantee further economic growth and high-quality job creation (Stehrer, 2013).[35]

3. Manufacturing as the main source of productivity growth

Through a sharp critique of the neoclassical theory, Kaldor postulated with regards to productivity growth in the manufacturing sector. The origin of Kaldor's second law is an observation made by Verdoorn in 1949, according to which there is a positive relationship between the rate of growth of output in manufacturing and the rate of growth of labour productivity in manufacturing. Influenced by Young (1928), Kaldor noted that increasing returns to scale are pervasive to manufacturing activities. According to Kaldor, the rate of productivity growth in the manufacturing sector depends on its rate of output growth due to the operation, within this sector, of static and, above all, dynamic returns to scale[36] are also a source of technological progress (Kaldor, 1981). Static returns are mainly related to economies of scale internal to the firm, where the large scale of production allows a reduction of the average cost. Dynamic returns refer to the induced effect that output growth has on capital accumulation through increased productivity derived from learning-by-doing, technological change, external economies in production, and so forth (Libanio, 2006).

Highlighting the relevance of the sectoral composition to economic growth, it is possible to verify that primary production and services do not possess the same properties as the manufacturing sector. The first one tends to present lower returns to scale, while in the second one, the scale of production tends to keep constant returns. There are several studies that tested the Kaldor-Verdoorn law over many different time periods and across a variety of countries and industries. The causal relation between the growth of manufacturing output and labour productivity growth in manufacturing has been tested for developed countries such as the United Kingdom (Hildreth, 1989; Harris and Lau, 1998), the USA (McCombie and De Ridder, 1983; Bernat, 1996), Japan (Knell, 2004), the European Community (Fingleton and McCombie, 1998; Angeriz et al., 2009), and developing economies, particularly in Asia (Timmer and Szirmai, 2000) and Latin America (Libanio, 2006). The results indicate substantial returns to

[35] See European Commission (2010).

[36] In his seminal study, Verdoorn (1949) demonstrated the existence of increasing returns both across industries within one country and in total industry across countries. Verdoorn was a member of the Research and Planning Division of the Economic Commission for Europe in Geneva, directed by Kaldor between 1947 and 1949, but did not receive widespread recognition until 1966, when Kaldor explicitly referred to him and coined the term Verdoorn's Law in his Cambridge Inaugural Lecture (Kaldor, 1966).

scale, especially dynamic increasing returns, in manufacturing industry. When the same tests are fitted to other activities, there is no evidence of increasing returns in agriculture and services, especially in developing economies.

Another important stylized fact is Kaldor's third law, which holds that the faster the growth of manufacturing output, the greater the rate of labour transfer from other sectors (where productivity is lower) to manufacturing industries (where productivity is higher). Thus, overall productivity growth is positively related to manufacturing output growth and negatively related to employment in non-manufacturing sectors. Moreover, the manufacturing sector increases the productivity of the system as a whole because it absorbs labour from the agricultural sector where there is a lower marginal product. Therefore, when the surplus of labour becomes exhausted in the agriculture sector, and levels of productivity tend to equalize across sectors, the degree of overall productivity growth induced by manufacturing output growth is likely to slow down.[37] In this sense, Kaldor stresses that this process is characteristic of economies in transition from "immaturity" to "maturity", where an "immature" economy is defined by a large amount of labour available to be transferred to industry (Thirlwall, 2013). This is why growth rates tend to be fastest in the initial stage of development, and decelerate as economies mature and become more service-oriented.

Over the years many empirical studies have tested Kaldor's third law. Even in the face of difficulties in measuring labour productivity growth in the non-manufacturing sectors, particularly service the type activities and public goods – such as education and health – results obtained by Hansen and Zhang (1996) for 28 regions of China, or Wells and Thirlwall (2003) for Africa shown that there is a strong negative relation between employment growth in non-manufacturing sectors and overall productivity growth. Moreover, emphasizing the crucial role of the manufacturing sector in economic growth, Kaldor states that industrialization endows special elements which trigger spillovers not only in the same sector, but also in primary production and services, i.e. intersectoral spillovers. As indicated by Szirmai (2012) and Tregenna (2007), the manufacturing sector is one of the primary sources of technological advance in the economy. It is inside manufacturing industries that most product and process technologies are developed. Important spillover effects in modern economies arise from manufacturing and spread to other sectors, such as the services sector. Therefore, for instance, advances in IC hardware technologies produced in the manufacturing sector (silicon chips, glass fibre cables) fuel technological change in the software producing and software using service sectors (Szirmai, 2012).

Complementary views on the role of productivity increases in the manufacturing sector for macroeconomic growth were further presented by Cornwall (1976; 1977), recovering Kaldor's ideas of manufacturing as a leading sector. In this sense, John Cornwall clearly refers to manufacturing as a driving force for productivity improvement in a whole range of sectors, through technological interdependence as well as input-output linkages between sectors (Verspagen, 2000). This link between manufacturing and technological change, as stressed by Cornwall, rests on neo-Schumpeterian literature which draws attention to the crucial role played by investment in technology for the catching-up of underdeveloped countries. In this way, Cornwall (1977), Fagerberg and Verspagen (1999) and Szirmai (2012) have emphasized

[37] However, as noted by Thirlwall (2013, p. 51), "manufacturing output growth is never likely to be constrained by a generalized shortage of labour, because labour is a very elastic factor of production in terms of hours worked, participation rates of males and females, and the possibility of international migration".

the limitations of a development strategy based on the production and trade of low value-added products.

4. Manufacturing really does matter for the equilibrium in the balance of payments

In contrast to the neoclassical model of international trade, free trade does not generate income increases and factor price equalization among countries. As noticed by Prebisch in the 1950s, the neoclassical literature regarding balance of payments did not recognize that an imbalance between the income elasticities of demand for imports and exports is a central explanation for the substantial constraint on economic growth for developing countries. In dialogue with the work of Prebisch, Kaldor attached great importance to export performance, thus reinforcing the link which would be developed in the literature on growth constraints imposed by the balance of payments (McCombie and Thirlwall, 1994).

Following the stylized facts proposed by Kaldor, the fourth law deduced from Harrod's foreign trade multiplier[38] shed light on economic growth led by demand and its limitations by the balance of payments equilibrium. Known also as Thirlwall's law, due to Thirlwall's (1979) pioneering work, it places emphasis on balance of payments constraints on growth, where the country's long-term growth rate is approximately given by the ratio between the rate of growth of exports and the income elasticity of demand for imports. In other words, the sustainability of growth depends on the country's ability to maintain the competitiveness of its exports, which in turn depends on the capacity of the manufacturing sector to increase productivity.

However, in spite of the recognition that manufacturing is the leading sector in economic growth, its relevance in the basic model of balance of payments was overshadowed due to all exports and imports being aggregated together in the standard model. Income elasticities of demand for exports and imports, which 'drive' the model, are aggregate elasticities. For this reason, Araujo and Lima (2007) integrating Pasinetti's structural economic dynamics (SED) to the balance of payments-constrained growth model created a multi-sectoral version of Thirlwall's law, in which changes in the productive structure affects the overall economic growth rate.[39] This model shows that each country's growth rate is directly proportional to the rate of exports growth in a sectoral perspective. Therefore, this proportionality is related inversely to the sector income-elasticity of demand for imports and directly to the sector income-elasticity. As stressed by the authors, even if the sectoral elasticities and the growth rate of world income are constant, it is still possible for a country to raise its long-term growth rate by favourably changing the sectoral composition of its trade.

Following the multi-sectoral approach, a number of recent studies have been exploring the connection between the sectoral composition of each country's trade and the differences in income elasticities of demand across sectors. Gouvêa and Lima (2010), dividing primary products from manufacturing products and taking into account the technological subdivisions of manufacturing, tested this multi-sectoral model for four Latin American countries (Argentina, Brazil, Colombia and Mexico) and four Asian countries (South Korea, Malaysia,

[38] According to Harrod (1933), the production of a country is determined by the external demand for its goods and tends to be a multiple of such demand, which is represented by the reciprocal proportion of domestic income spent on imports.

[39] Although Pasinetti's (1981; 1993) structural economic dynamics recognizes explicitly the role of demand-led structural change in economic growth, in his model there is no explicit balance of payments constraint on demand.

Philippines and Singapore) over the 1962-2006 period. The authors used the sectoral elasticities to estimate the year-by-year evolution of the aggregate income elasticities of exports and imports. The results showed that unlike Latin American countries (except Mexico), Asian countries have successfully changed their composition of exports and imports to technology-intensive manufacturing sectors in a way that led their weighted income elasticity of exports to grow faster than their weighted income elasticity of imports and consequently impacted positively on the balance of payments equilibrium.

Gouvêa and Lima (2013), in another disaggregated study, have estimated sectoral export and import functions in a panel of 90 countries over the period 1965-1999. Similarly to the previous study, their findings shown that technology-intensive manufacturing sectors have a higher income elasticity of demand for exports. Additionally, as noted by Cimoli et al. (2010) in a study involving 29 developed and developing countries, the inequality between nations was reduced in countries which sought to transform their economic structure towards sectors with a higher income elasticity of demand for exports relative to imports. These sectors would encompass both, as they call, "higher Schumpeterian and Keynesian efficiency", i.e. respectively products with a superior demand properties and technical characteristics. Based on these considerations, the next section draws attention to this dynamic, more specifically, to the role of technological progress in the economic development.

5. Technological dynamics, innovations and economic growth

According to Joseph Schumpeter and his intellectual heirs (sometimes called the neo-Schumpeterian school), the capitalist system is characterized by cyclical dynamics generated by successive waves of innovations penetrating markets. These ideas, particularly with regards to innovation, technical progress and structural change, became a contemporary subject in economic policy and scientific debate and influenced not only a vast amount of economic literature in mainstream economics, but also in the heterodox strands. A remarkable wave of Schumpeterian studies based on Nelson and Winter's (1982) ground-breaking research arose to qualify the crucial role of technology in economic growth. Building on the work of Schumpeter (1912; 1942), they argue for an evolutionary theory of production (and economic change), which delved inside the "black box" of the production function in order to understand how innovation occurs and affects competition and economic growth (Mazzucato, 2013). In this approach there is no vague production function as in the so-called new growth theory (including the early neo-Schumpeterian models – such as in Aghion and Howitt, 1998, and Grossman and Helpman, 1991), since the process of production and competition involves a complex process of differentiation among firms based on their different abilities to innovate.[40]

[40] This dynamic also reveals a central feature of Schumpeterian thinking, i.e. the so-called creative destruction. According to this concept, economic development is a dynamic phenomenon where new combinations – understood as a synonym of innovation – incessantly revolutionize the economic structure. The innovatory process involves the development of different products and processes, as well as a permanent search for new technologies, organizational capabilities and markets providing extraordinary gains to the innovative firm. Therefore, in the process of production and competition, the introduction of basic innovations leads to a process of creative destruction in which sectors associated with the 'old' technologies decline and new sectors emerge and grow (Schumpeter, 1912). This dynamic assumes an evolutionary character that endogenously recreates economic structures through an uninterrupted process of innovation. The capitalist dynamic involves competitive forces in constant search for gains, in which even leading companies with high market power may be aware that remaining in such a situation requires constant investment.

The evolutionary and Schumpeterian approach to study the complexity of innovation has led to a policy view where the so-called national innovation system (NIS) of a country, as firstly defined by Freeman (1982a; 1982b), is constituted by the institutional environment where firms of different types are embedded in a system at sectoral, regional and national levels (Mazzucato, 2013). Over the years, the NIS has been used as an analytical framework for policy analysis in both developed and underdeveloped countries. As a result, research and policy activities clearly focusing on systems of innovation can be observed in most countries and a rapidly growing number of studies of specific national systems of innovation, encompassing sectoral systems of innovation, have been produced (Cassiolato and Lastres, 2008).

Many studies have provided different explanations of the concept of NIS. However, the main definition states that NIS is shaped by collective and individual contributions of different agents to the development and spread of new technologies. This congregates a sequence of elements and relations that relate production, assimilation, use and diffusion of knowledge (Lundvall, 1992). The emphasis is not on the stock of R&D, but on the circulation of knowledge and its diffusion throughout the economy. In a micro and meso perspective, a structured NIS provides an institutional environment to promote technological progress and structural change.

5.1. The catching-up hypothesis: from imitation to innovation

Over the years, important contributions have been made, linking the Schumpeterian framework and policies for catching-up in an economic development perspective. Remarkable studies such as Abramovitz, (1986), Fagerberg (1988a; 1988b), Perez and Soete, (1988), Dosi et al. (1990), and Silverberg and Verspagen (1995) have highlighted that the innovatory dynamics sets the pace of economic growth where the ultimate goal is the catching-up. Thus, according to the catching-up hypothesis, a country's technological progress diffuses through the interface between innovative firms, responsible for introducing technological innovations in the economy, and imitative ones, responsible for the transmission of innovations throughout the economic system based on their activities of "technological imitation" (Abramovitz, 1986).

Innovative heterogeneity also divides countries according to the capacity to promote technological innovations. While "leading economies" are responsible for the frontier of the scientific knowledge, the "followers" – countries with a less developed scientific basis – can only improve their technological capabilities through the incorporation of technological progress developed in leading countries or based on improvements of the technological progress achieved by leading countries, which characterizes "opportunity windows" (Oliveira et al., 2003). In both cases, technological caching up involves relatively smaller costs than those costs related to innovation for leading countries.

Moreover, stressing the importance of productivity growth for economic development – as in the Kaldorian theory and the structuralist approach – Perez and Soete (1988) point out that an efficient rate of technology incorporation results in a growth rate of labour productivity in follower countries, i.e. developing economies.[41] The way in which these countries absorb and adapt technologies from leading countries will determine their productivity growth. In this process, cumulative causation is generated though the impact of knowledge accumulation on productivity growth (Nelson and Winter, 2002). This dynamic elucidates the essence of the

[41] This assertion elucidates the development path followed by South Korea as showed by Kim (1997).

catching-up hypothesis, where the gap between leading and follower countries determines the potential of technological progress for backward economies (Abramovitz, 1986; Fagerberg, 1988a). In this sense, the process of catching-up takes place when a backward country is able to maintain over time a technological progress higher than that of leading countries, due to significant efficiency in absorbing new technologies (Oliveira et al., 2003).

Although the technological gaps offer opportunities to catch up, they are not sufficient. Success depends on 'social capabilities' that allow developing countries to obtain advantages from the gap. In this way, as pointed out by Freeman (1995) and Nelson (1993), such characteristics are related to the institutional framework established in a determined structure by its NIS. In this case, emphasis is placed on the role of historical processes, reporting differences in socio-economic capabilities for distinct development paths and promoting systems of innovation with very particular local features and dynamics. The innovative performance depends not only on the scientific and educational infrastructure of a country, the magnitude of R&D, and labour force capabilities, among others, but also on the interaction between them and other variables, as well as all other forms by which industries in a country acquire, use, and diffuse knowledge.

The neo-Schumpeterian literature considers that NIS cannot be replaced by foreign technology since it has a local character. That is because the development of the NIS in a certain economy affects the degree of technological sophistication of its products and consequently its exports. Thus, despite the recent globalization process, NIS remains fundamental to the development of technical progress and its diffusion in a country (Dosi et al., 1994; Nelson, 1996; Freeman, 2004). Innovation capacity derives, thus, from the confluence of social, political, institutional, and cultural specific factors and from the environment in which economic agents operate in a specific country. Therefore, the chances of a country to catch up depend on its NIS capabilities in relation to 'mature countries' (Cassiolato and Lastres, 2008; Oliveira et al., 2003).[42] A movement of structural change in favour of an intensive economic growth requires investments to build an institutional structure that supports learning and innovation, which is essential to technological upgrading (Nelson and Winter, 1982; Fagerberg, 1994; Freeman, 1995; Albuquerque, 1999).

5.2. Manufacturing shaping a hierarchy of national innovation systems: the case of machinery industries

The analysis of historical and national trajectories, taking into account the productive, financial, social, institutional and political contexts, as well as micro, meso and macro spheres,

[42] Jayme Jr. and Resende (2009) also state that the institutional structure summarized in a developed NIS provides opportunities for productive diversification and spillovers towards the technological frontier, i.e. technological opportunities for other sectors in the economy. On the one hand, a developed NIS and a diversified industrial structure have the propensity to offer better conditions for gains in international trade through exports. An economy with this structure may generally present at least three features regarding its exports: *i*) the conquest of new markets will be as diversified as its exports; *ii*) more stability of the value exported since it involves distinct products and consequently reduce the risk of market fluctuations; and *iii*) an increase in the income elasticity of demand for exports since the demand for imports tends to grow in times of world economic growth, opening more opportunities for countries which have a diversified range of exports. On the other hand, a less developed NIS tends to present a more specialized productive structure. Consequently, the range of imports will be more diversified and the proportion of domestic market attended through the international supply higher. This dynamic tends also to affect the income elasticity of imports. Indeed, the country where the NIS is relatively less developed is exposed to structural external vulnerability because the income elasticity of export demand is lower than the income elasticity of import demand.

shows that an efficient NIS is a necessary condition to create the learning processes that allow structural change towards high-tech sectors, which are concentrated in the manufacturing industry (Nelson and Pack, 1999; Freeman, 2004; Lastres et al., 2003). Through a convergence of the neo-Schumpeterian literature and concepts presented in structuralist economics, Freeman and Soete (1997) and Lundvall et al. (2002) present a chronological overview of this dynamic, analysing, among other features, the role of "leading sectors" in the economy. They show how creative destruction has emerged from the manufacturing sectors and promoted a movement of structural change, i.e. changes measured ultimately by variations in the share of industrial sectors in production or employment, since the first industrial revolution.

Lundvall et al. (2002) showed that the convergence of the structuralist approach and Schumpeterian thinking was already present in Perroux and his French followers. French structuralism developed an analysis of the importance of the structure of national systems of production for economic dynamics, some of it rooted in the Marxian schemes of extended and intensive reproduction. Like Hirschman, they assumed that different sectors affect growth differently and that the most dynamic elements in the system (the growth poles) are located upstream, particularly in the manufacturing sector. This led them to ordering national systems in a hierarchy. It was assumed that countries such as the USA, Germany and the United Kingdom had a stronger economy than France because their economies were more industrialized and their production systems were particularly specialized in the production of machine tools. Machine tools were the catalyst for the industrial revolution, which emerged in Britain in the Eighteenth century. Since then, machine tools are the origin of almost every manufacturing process and for this reason are recognized as mother machines. Moreover, the historical experience of the great powers of the industrial era – the USA, the UK and Germany – gave rise to a perspective where well-functioning machinery sectors are the driving force of a strong manufacturing sector and a long-term innovative interaction between industrial sectors.

The relevance of the machine tools industry for economic growth is also documented by Rosenberg (1963), taking into account a historical perspective from 1840 to 1910. Rosenberg showed that the USA, the UK and Germany have been those nations that have controlled, within their territories, the global production, reproduction and destruction of machinery niches. As documented by Rynn (2010), by 1913, 82.4% of the global production of machine tools was centralized in these three countries, which had the most dynamic manufacturing development at that time.43 The USA produced 50% of the world's machinery, Germany 20.6% and the UK 11.6%. In 1925, the aggregated number rose to 84.3%, where the USA corresponded to 57.6%, the UK to 13.6% and Germany to 13.1%. The USA could be considered a super power in terms of machinery during this time period. During the period of World War II, the USSR overtook the UK as the third biggest producer of machine tools. Certainly, the technological global race evidenced in the years that followed, particularly during the Cold War, highlighted the importance of a leading capital goods sector as locus of technical change and economic hegemony.

Rosenberg (1963, p. 416) clarified the significant role played by the capital goods industry in promoting economic dynamism, particularly regarding the introduction and diffusion of technological change, through two key aspects.[44] Firstly, the aspect of "external adaptation" implies that "all innovations whether they include the introduction of a new product or provide

[43] In May 1927, the League of Nations held an International Economic Conference. As part of that conference, Dr. Karl Lange presented a memorandum that discussed the state of the machinery industries.

[44] Fajnzylber (1983) also emphasizes the central role played by the sector of capital goods for technological progress, and to create a nucleus of endogenous technological dynamism in the economy.

a cheaper way of producing an existing product – require that the capital goods sector shall in turn produce a new product (capital good) according to certain specifications". In other words, the industry of capital goods needs to maintain its production at the edge of the technological frontier in an adaptive and innovative way to develop dynamic systems of production that set the rhythm and path of economic growth.

Secondly, the "internal adaptation" aspect refers to the internal motivation that machinery producers improve their own techniques of production that affect the price of their machinery output – cost reduction – and therefore is an important determinant of investment activity throughout the economy and, consequently, it determines the rate at which technological innovations are introduced and diffused in other manufacturing industries. Furthermore, since cost reduction in the machinery industry is a form of capital saving for the economy, it also raises the marginal efficiency of capital of other industries.

Over the years, the sector of capital goods has undergone significant technical advancements enabling intra- and inter-sectoral spillover effects in the economy and pushing the technological frontier. The machine tools industry has also had a significant role in the industrialization process transferring production know-how and technology to other manufacturing sub-sectors, which enhances industry's capacity to develop and produce new products and increases the productivity and competitiveness of the country's manufacturing base. As a knowledge-intensive sub-sector of the manufacturing industry, machine tools also enable the transfer of the latest advancements in information and communication technologies or material sciences into production systems, which increases the efficiency of the productive process and develops new materials which are used later in new fields of application such as in railway vehicles, ship building, aerospace and automobile industries. Since the engineering know-how in production technologies accumulated in the machine tools industry is a competitive advantage, it also benefits first-mover firms in the development of many other new products and processes (Saxena and Sharma, 2014; CECIMO, 2011).

These unique characteristics found in the machine tools industry have a strategic place within the economic dynamic. Consequently, throughout the Twentieth century, countries that reduced the capacity to make manufactured goods became dependent on imported machinery for the domestic industries and consequently lost economic dynamism. Countries that faced a decline in their machine tools were also those who lost the higher shares in manufacturing. Due to the global shift of machine tool production towards Asian countries, the USA and Europe have clearly lost global market shares in the last four decades. Among developed countries, the USA underwent the most expressive decrease in machine tools production, losing around 77%. While the USA experienced a constant fall in the last four decades, Japan and Germany presented an increase until 1995 reaching respectively 23.5 and 16% of the global machine tools production. From 1995 onwards, all the most representative producers of machine tools in Europe, i.e. Germany, the United Kingdom and Italy, faced a constant fall in their market shares, dropping respectively from 22.6% to 16%, from 8.5% to 8% and from 2.7% to 1.7%. In an opposite trend, China followed an upward trajectory becoming the world's biggest producer of machine tools with 32% of the global production, i.e. one third of worldwide machine tools production is centralized in one country.[45]

[45] These data were taken from Rynn (2010) and Gildemeister *Annual Report 2010*.

6. Concluding remarks

This study combined different theoretical strands on development regarding the importance of the manufacturing industry to economic growth. Through a confluence of the Keynesian-Kaldorian, structuralist and neo-Schumpeterian frameworks, the paper argued that the manufacturing industry presents some special properties which are not found in other sectors. The theoretical discussion presented through this heterodox triad shows how these theories incorporate different levels of economic theory, i.e. micro (firm), meso (sector and sub-sectors) and macro (economy) that are mutually complementary about the special role of the manufacturing industry in economic development.

First we considered Anglo-Saxon structuralism, also known as early structuralism, and the Latin American strand. As a general characteristic among both structuralist strands, economic development is narrowly linked to a radical transformation in the structure of production to suppress obstacles, bottlenecks and other rigidities of underdevelopment. Based on the hypothesis that the industrial structure affects both the pace and the direction of economic development, the structuralist literature highlights the importance of industrialization as a process of structural change, where the manufacturing sector plays a central role. The structuralist strand states that without a dynamic industrialization, it is not feasible to increase employment, productivity and income per capita and, consequently, to reduce poverty. The main argument stresses that development involves a production reallocation from low productivity to high productivity sectors where increasing returns to scale prevail. Inserted in this theoretical background, economic structuralism has provided many reflections on how economic growth should be understood in a historical perspective of mutual causation in the economic system.

We then examined the Kaldorian approach to growth, understood as 'laws' whereby Kaldor argued that it is not possible to comprehend development and growth rate differences between countries without taking a sectoral approach. In a complementary line of research to Furtado, Hirschman, Rosenstein-Rodan, and Prebisch, Kaldor noted that the manufacturing sector is imbued with special growth-enhancing properties that trigger a process of cumulative causation that are not shared by other sectors. The so-called Kaldor's stylized facts were brought back in many contemporary studies that validated the Kaldorian approach to today's world economy. In reviewing the debate regarding the importance of the manufacturing industry for economic dynamism, it is important to highlight the debate on three sources of de-industrialization, i.e. the so-called statistical illusions, servicification and productive fragmentation. It emerges that a non-negligible part of the extent of de-industrialization reflects changes in statistical classification rather than a real decreasing relative importance of manufacturing. Despite the considerable rise of services in recent years, manufacturing is still the main engine of growth because many services essentially are spin-offs from manufacturing production. Furthermore, the increasing trend of productive fragmentation over the world has not only decreased the manufacturing share in many economies but also negatively affected these countries through a deterioration of the so-called industrial commons, which caused a loss of high-value added activities, such as R&D and design, as well as the capacity to generate technological innovation. The Kaldorian approach further explores the role of manufacturing for productivity growth stating that the rate of productivity growth in the manufacturing sector depends on its rate of output growth due to the operation, within this sector, of static and, above all, dynamic returns to scale. This discussion highlights the role of manufacturing for the equilibrium of balance of payments and highlighting the importance of manufacturing technology-intensive sectors in this dynamic.

We finally considered the neo-Schumpeterian route to development, exploring relations between innovation, economic dynamics and catching-up in a sectoral specific approach. Within this approach, it is emphasized that the way in which a developing country absorbs and adapts new technologies from leading countries will determine its economic dynamism. However, the technological catching-up depends on its national innovation system. The more developed the country's NIS is, the larger the range of goods produced in the global technological frontier will be. This process stimulates the performance of exports and mitigates the value of imports, generating a pattern of exports which can overcome structural external vulnerability and underdevelopment. Additionally, through the convergence of the neo-Schumpeterian literature and concepts presented in the structuralist economics, studies showed the role of the manufacturing sector as a locus of technological change since the first industrial revolution. From this perspective arose the role of the machine tools industry in economic growth, particularly regarding the introduction and diffusion of technological change in the economy.

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