PRODUCTIVE DIVERSIFICATION, STRUCTURAL TRANSITION AND DENSITY OF INDUSTRIAL CHAINS: ARE BRAZIL AND SOUTH KOREA DIFFERENT?

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Abstract

This paper aims to analyse the structural transition undertaken by Brazil and South Korea from the 1950s to 2000s in terms of sectoral diversification in a inter and intra-sectoral perspective. Additionally, through the so-called structural decomposition analysis (SDA) was investigated factors which contributed to the movement of specialisation observed in these economies. Moreover, the paper consolidated the understanding of the structural economic dynamics via movements related to the density of industrial chains. The main findings of this study showed that, (i) Brazil was affected by a process o premature specialisation in inter and intra-sectoral levels; (ii) South Korea increased sharply the share of medium/high-sectors in the economy while Brazil although more diversified, remained dependent of less dynamic sectors; (iii) The SDA methodology revealed the output growth of manufacturing was much more intense than in Brazil, particularly from 1995 to 2003. Furthermore, from 1995 to 2008, South Korea output growth in South Korea was pulled mainly by Exports, while in Brazil from 2003 to 2008 the domestic demand composed the main source of economic dynamism; (iv) During 2003 to 2008 both countries registered a significant rise of imported coefficients in the domestic production, but with distinct impacts over the share of manufacturing in the total value added.

Key Words: Industrial Diversification, Brazil, South Korea, Structural decomposition, Density of industrial chains.

Resumo

Este artigo tem como objetivo analisar a transição estrutural empreendida pelo Brasil e Coréia do Sul da década de 1950 aos anos 2000 em termos de diversificação setorial em uma perspectiva inter e intra-setorial. Adicionalmente, através da chamada análise de decomposição estrutural (ADS) foram investigados os fatores que contribuíram para o movimento de especialização observado nessas economias. Ademais, o artigo consolidou o entendimento da dinâmica estrutural da economia via movimentos relacionados à densidade de suas cadeias produtivas. As principais conclusões do estudo mostraram que, (i) O Brasil foi afetado por um processo de especialização precoce em nível inter e intra-setorial; (ii) A Coreia do Sul aumentou nitidamente a participação de setores de media/alta tecnologia na economia enquanto o Brasil, embora mais diversificado, permaneceu dependente de setores menos dinâmicos; (iii) A metodologia de (ADS) revelou que o crescimento da produção da manufatura na Coreia do Sul foi muito mais intenso que no Brasil, particularmente de 1995 até 2003. Ademais, de 1995 até 2008, o crescimento da produção na Coreia do Sul foi especialmente puxado pelas exportações, enquanto no Brasil de 2003 até 2008 foi a demanda domestica que compôs a principal fonte de dinamismo econômico; (iv) Durante 2003 até 2008 ambos os países registraram um significante aumento dos coeficientes de insumos importados para produção domestica, mas com distintos impactos sobre a participação da manufatura no valor adicionado total.

Palavras-Chave: Diversificação industrial, Brasil, Coréia do Sul, Decomposição Estrutural, Densidade das cadeias industriais.

Código Jel: C67, L16, O11

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Introduction[2]

Despite of the Brazilian economic boom from 2002 until the global financial crisis of 2008, the neoliberal shock of the 1990s produced deleterious economic changes. The country faced a productive disarticulation and the absence of sustained economic growth. In a "stop and go" performance, the manufacturing sector has gradually decreased. In this process the domestic industrial chains has shrunken and been affected by 'predatory' imports. In other words, imported inputs played a substitutive role in the productive chain. Moreover, the economy has exposed a specialisation in less dynamic sectors such as services and commodities. Furthermore, in terms of trade, the economy has increased its dependence on exports of primary products, i.e., commodities which in turn affected negatively the Brazilian trade pattern.

In South Korea, along the same period, were also adopted reforms regarding trade and financial liberalisation. However, the economic reforms were totally different to the messianic endeavour seen in Brazil. In fact, economic reforms in South Korea were much more pragmatic in order to continue and strength the existing ambitious strategy of industrialisation. Even during de Asian crisis in 1997, despite of the re-articulation between State and private sector, the whole of the State remained fundamental. To overcome the crisis there was a reorganization of the corporate structure with processes of mergers and acquisitions gaining momentum. However, it is important to note that at no time the manufacturing sector was neglected. Therefore, the South Korean State remained active promoting the consolidation and expansion of the industrial structure and exports. In this process imports of inputs had fundamentally a complementary role in the productive process. Moreover, in a strategy of productive and trade upgrading, South Korea took advantage of the special properties of manufacturing as engine of growth. Not by coincidence, the South Korean economic growth has been higher and much more sustainable when compared to the Brazilian economy.

Therefore, inserted in this short background, this paper seeks to analyse the structural transition of Brazil and South Korea. Through the input-output framework, in a comparative perspective, the paper makes an effort to investigate these economies regarding their pattern of productive diversification, structural transition and density of industrial chains. Therefore, the contributions of this paper to the existing literature are threefold. First, the paper adopt the methodology proposed by Imbs and Wacziargs (2003) in an inter and intra-sectoral perspective to indentify the path of economic diversification undertook by Brazil and South Korea over the decades. Second, in a complementary analysis, the input-output framework is used to identify and quantify factors that contributed to this pattern of specialisation. The method used was based on the Structural Decomposition Analysis (SDA) inspired particularly by Chenery's studies. Third, the paper advances in the input-output methodology employed by Rocha (2011) to estimate imported input coefficients for Brazil and South Korea through the World Input-Output Database (WIOD).

Therefore, the paper is organised as follows. First section discuss the long-lasting debate about specialisation or diversification and apply the method proposed by Imbs and Wacziarg (2003) to investigate the stages of sectoral diversification presented by Brazil and South Korea over the decades. In this part is also described the methodology, including database and level of sectoral aggregation. Second section focuses on the sectoral composition of manufacturing in these economies and their economic dynamism in a global perspective. Third section through the so-called structural decomposition analysis (SDA) investigates distinct factors, i.e. demand, trade and technological change, which contributed to the movement of structural change observed in these economies. In the fourth section, the paper consolidates the understanding of the structural economic dynamics via movements related to the density of industrial chains. Fifth section concludes the paper.

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1. Structural change and economic dynamic: Specialization vs. Diversification

The neoclassical view stresses that specialisation based on comparative advantages, whatever its nature, was a superior solution for economic growth. In this thinking, through the process of specialisation, resources become more efficiently allocated and consequently countries are mutually benefited in terms of welfare (Krugman and Obstfeld, 2006). Influential neoclassical visions such as Schultz, (1964), Lipton (1968) and Chayanov (1966) grounded their analyses on the neoclassical theory of comparative advantage and recommended that late development countries (LDC) should specialise in the production and exports of primary commodities and import manufactured products from industrialised economies. Although the idea of comparative advantage has received further developments in the current mainstream approach, particularly in the New Structural Economics (NSE) framework, specialisation according to the country's factor endowment structure continues to be an integral part of policy advice (Lin, 2012). As pointed out by Rodrik (2004, p. 6) many economists that "associate underdevelopment with inadequate exposure to international markets generally imply – although this is often left unstated – that specialization according to comparative advantage is an essential ingredient of development". Currently this understanding is also supported by the World Trade Organization (WTO) which advocates in favour of market friendly policies. The WTO (2009) states that "countries prosper first by taking advantage of their assets in order to concentrate on what they can produce best, and then by trading these products for products that other countries produce best. Moreover, specialization on comparative advantages through liberal policies would sharp competition, motivate innovation and breed success.

In a critical perspective, the Structuralist-Kaldorian view points out the limitations of a strategy of economic development based in comparative advantages. Therefore, based in the argument that diversification in manufactured products is the main engine of growth, authors such as Rosenstein-Rodan (1943), Prebisch (1949), Lewis (1954), Rostow (1952), Furtado (1961), Hirschman (1958), Kaldor (1966; 1967) and Chenery (1960; 1979) belong to the handful of economic thinkers that emphasised the importance of diversification to economic development. According to them, development is essentially a process of structural change. In other words, sustained economic growth is associated with the capacity to diversify the structure of domestic production, i.e. generate new activities to expand possibilities of production, linkages and higher value-added goods by providing incentives to manufacturing. According to Kaldor (1966), economic growth is brought about by shifting productive sectors with decreasing returns to those with increasing returns. This shift creates dynamic economies of scale and triggers a process of cumulative causation in the economy. The author states that manufactured goods is the one with the greatest capacity to do so and therefore its expansion plays a key role in promoting sustainable growth in the long term and consequent modernization and diversification of the production structure.

1.1. The U-shaped curve for Brazil and South Korea

Recently this long-lasting debate about economic specialisation or diversification was approached by empirical studies that tried to modelling the trajectory of economic diversification undertook by a vast range of economies. In an important paper, Imbs and Wacziarg (2003) investigated the stages of sectoral diversification in a large cross-section of countries. Using OECD, ILO and UNIDO databases, this study employed a non-parametric methodology based on locally robust weighted scatter plot smoothing (Lowess) to identify regularities about the process of productive diversification. Thus, the authors detected a non-linear relationship between specialization and GDP per capita, described as U-curve.

In this U-shaped curve, low-income countries present a very specialised productive structure. As countries move from low to medium levels of income, diversification takes place in the economy. This process goes on until relatively late in the process of economic development. On average, the diversification

takes place until the country reaches a turning point around $ 9,000 GDP per capita. Thereafter, the sectoral distribution exhibits re-specialisation with the curve presenting an ascendant trajectory. From this perspective, as pointed out by Rodrik (2004), Imbs and Wacziargs' findings suggest that specialisation according to comparative advantage conventionally understood cannot be the driving force of economic development. In other words, countries growth and reach a high level of income per capita during the phase of diversification and not specialisation.

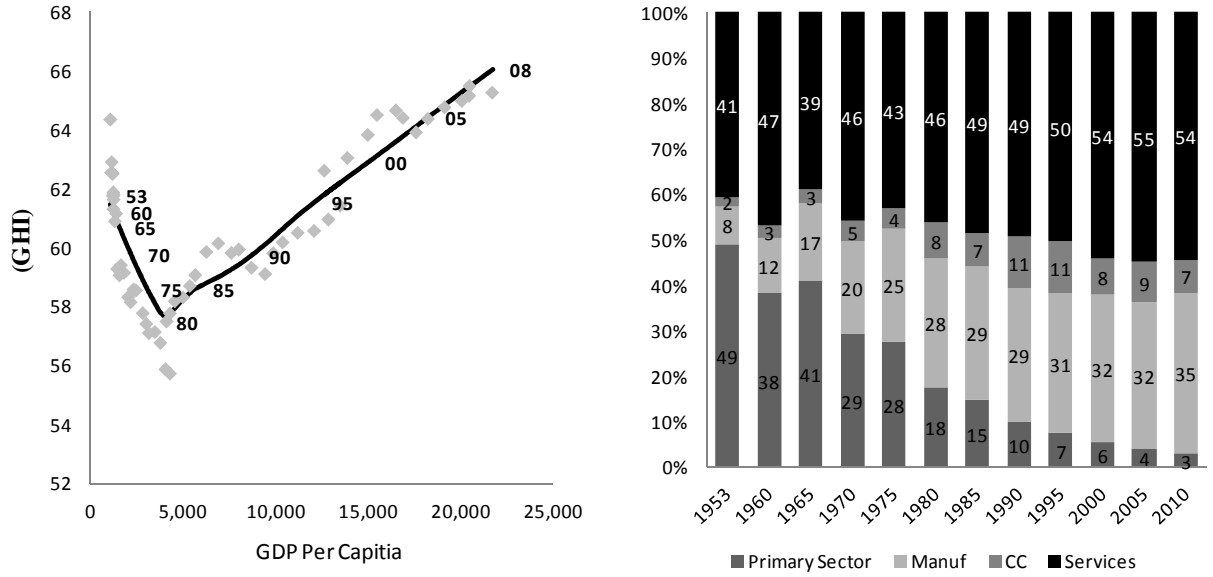
Therefore, seeking to evaluate the movement of structural change undergone by Brazil and South Korea, in a comparative perspective, this section employed the Imbs and Wacziargs methodology to investigate these economies both intersectoral, i.e., between primary sector, manufacturing, civil construction and services, as well as, intra-sectoral (among manufacturing subsectors)[3]. In order to calculate the economy inter-sectoral curve of specialization, the GGDC 10-Sector Database and the IBGE database were used to South Korea and Brazil respectively. For the intra-sectoral analysis to South Korea, the manufacturing value added of 23 subsectors from the UNIDO database was used. In the case of Brazil, due to lack of long-term data, this study used the ECLAC-PADI database with 28 manufacturing subsectors. Since this paper seeks to compare Brazil and South Korea, both databases were aggregated in a common level involving 14 manufacturing subsectors. Additionally to the same aggregation level, figures 3.3 and 3.4 presents two distinct graphics. The first graph plots the Gini-Hirschman index (GHI) against GDP per capita, along with a non-parametric Lowess. The second shows the sectoral share between primary sector, manufacturing, civil construction and services. The graphs are presented together to investigate particularities regarding the process of economic diversification and structural change undergone by these economies.

In an inter-sectoral view, based in a developmental premise that industrialisation in general and manufacturing specifically is a central condition to economic development, South Korea raised constantly its share of manufacturing followed by a substantial decrease of the primary sector. From 1953 to 2010 the former rose 320.7% while the latter fell 93.7%. Moreover, a joint analysis between data from the curve of diversification and sectoral share of the economy revealed that the movement of intersectoral structural change pursued by South Korea followed two stages of manufacturing expansion. In the first stage, from 1953 to 1980, South Korea moved to a strategy of economic diversification expanding remarkably not only the manufacturing sector but also civil construction (and strongly services during the 1950s). During this period manufacturing rose 236.6%, while civil construction increased 337.9% and services 13.3%. Thus, in the end of the 1980s the South Korean economy achieved a considerable degree of diversification.

In the second stage, from 1980 to 2010, although the pace of structural change decreased, with manufacturing and services growing respectively 25.1% and 17.6%, the economy engendered a process of economic specialisation. The share of services and manufacturing from the begging to the end of this stage clarifies the magnitude of this trajectory. While in 1980 manufacturing and services together accounted for approximately 74% of the economy value added, in 2010 this number jumped sharply to 90%. It was only possible because the expansion of both sectors took place mainly by the reduction of the primary sector. Even during the decades of 1990s and 2000s, the clear rise of services was not followed by a loss in manufacturing. Therefore, the figure 3.2 illustrates clearly that despite of the large share of services in the economy, South Korea has perused a pattern of specialisation based in the expansion of the manufacturing sector.

[3] Technical details about methodology are summarised in Appendix 3.1.

Figure 3.1 - The inter-sectoral U-shaped curve and sectoral share for South Korea

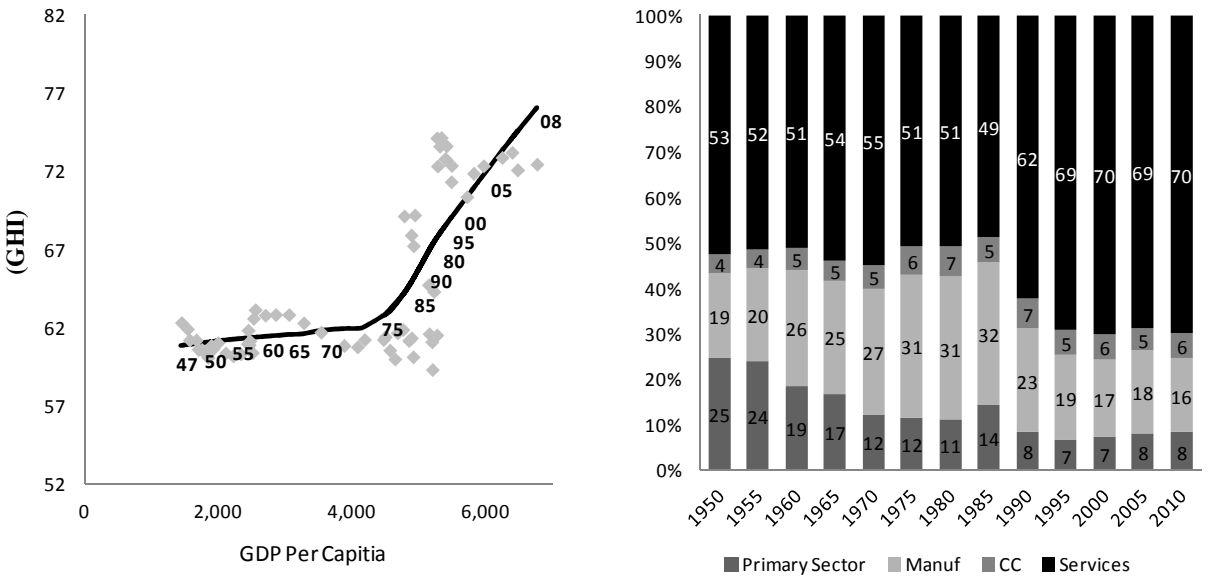


Source: Own calculations based on data from GGDC 10-Sector Database.
Note: Data calculated in current US dollars.

In a distinct trend to South Korea, Brazil did not present the same process of structural change and productive diversification for the period analysed. As a matter of fact, the country smoothed data did not fit well to the U-shaped curve. However, two import issues must be considered. Firstly, an important period of economic diversification not captured by the data was engendered by the Brazilian economy during the 1930s and 1940s. In other words, as widely documented in the Brazilian economic literature, the process of economic diversification was initiated in the 1930s after the great world economic crisis in 1929. At that time, Brazil moved from a primary export model to a strategy of Import Substitution Industrialisation (ISI). Secondly, despite an upward sloping, the country maintained a diversified inter-sectoral productive structure until the first half of the 1970s. As a matter of fact, from 1950 to practically 1980, the share of manufacturing and civil construction grew respectively 67.6%, 66.6%, while the primary sector and services dropped 54.7% and 3.5%. Moreover the GDP per capita expanded continually.

However, with the outbreak of the debt crisis (in 1982) and rise of neoliberal policies, Brazil embarked in a regressive trajectory. From 1980 to 2010, not only manufacturing and civil construction declined sharply in terms of GDP share (around 48.1% and 18.6% respectively) but also income per capita regressed in many periods like 1981-1983, 1988-1992, and 1998-1999. In this sense, Brazil different to South Korea did not expose the same long-term dynamism in manufacturing and GDP per capita growth. Additionally, one of the most impressive effects of marked friendly policies, intensified during the second half of the 1990s, were the collapse of manufacturing share in the total GDP. The economy gradually lost the manufacturing sector to the point of present a lower share than in 1950. The figure 3.2 illustrates these processes.

Figure 3.2 - The inter-sectoral U-shaped curve and sectoral share for Brazil

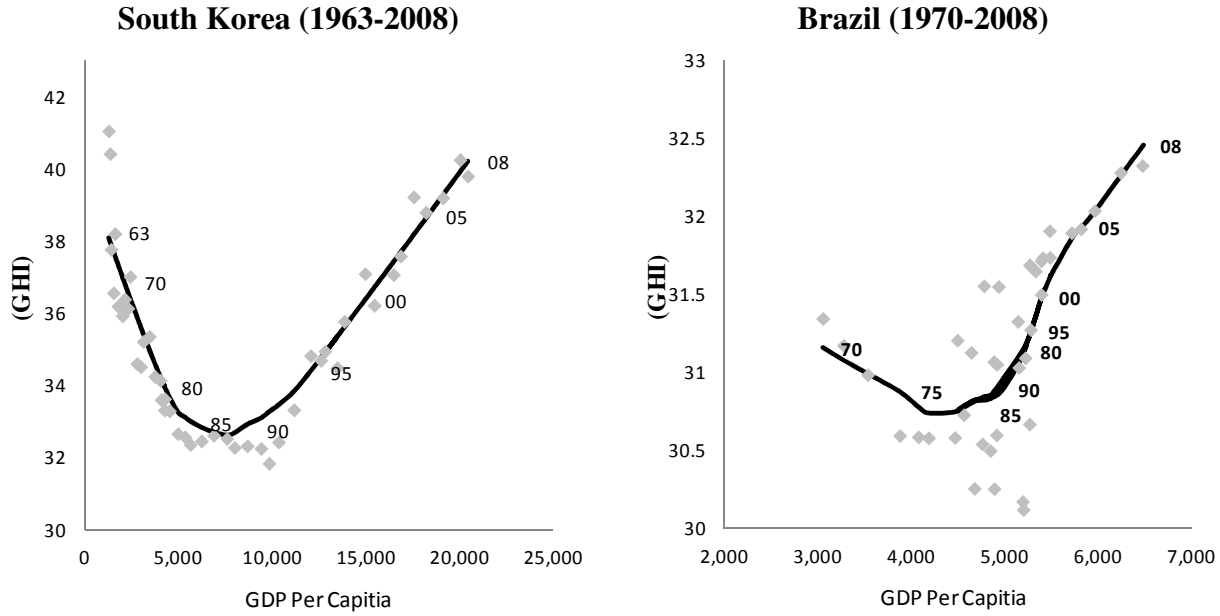


Source: Own calculations based on data IBGE.
Note: Data calculated in current US dollars.

As aforementioned the intra-sectoral movement inside manufacturing was also analysed. As it is possible to see in the Figure 3.3, both Brazil and South Korea exposed a U-Shaped trajectory. However, in a comparative perspective, the U-Shaped pattern also presented three important differences. First, the phase of economic diversification was more intense in South Korea. Second, in terms of value added, the South Korean economy showed the point of maximum diversification in 1988 with $7,621 GDP per capita[4], while in Brazil it occurred in 1975 with $4,187 GDP per capita. After these stages both economies engendered an ascendant and constant trend of re-specialisation. Nevertheless, as showed by the Figure 3.3, South Korea after 1988 specialised its manufacturing in subsectors that enabled a substantial increase in terms of GDP per capita. Thus, from 1988 to 2008 the GDP per capita increased 168.8%, reaching $ 20,482 in 2008. In the case of Brazil, the premature trajectory of re-specialisation culminated in a less dynamic productive structure that trapped the economy into a 'low-growth landscape'. From 1975 to 2008 the GDP per capita increased only 54.7% and the economy exposed a chronic dynamic of ‘stop and go’. The following section analyses manufacturing subsectors and their evolution over time.

[4] It is important to note that the turning point to a trajectory of re-specialisation is significantly lower than those observed in advanced countries. For more details see Imbs and Wacziarg (2003).

Figure 3.3 - The intra-sectoral U-shaped curve for South Korea



Source: Own calculations based on data from UNIDO and ECLAC-PADI.
Note: Data calculated in constant US dollars for Brazil and in current prices for Korea due the lack of data.

1.2. Sectoral composition and economic dynamism

Another dimension that deserves a close analysis to understand the path of specialisation undertaken by the Brazilian and South Korean manufacturing industries in relation to the GDP per capita is the evolution of this process over time. In this context, simply taking into account the share of each manufacturing subsector in the total value added and specialisation indexes over decades is possible to trace the pattern of specialisation underway in this economies. Moreover, through this analysis is also possible to investigate the pattern of specialisation in terms of technology intensity. Therefore, starting in 1990, table 3.1 shows the evolution of sectoral composition of the manufacturing value added in Brazil and South Korea, at an interval of five years in each decade.

The trajectory of intra-sectoral specialisation in South Korea was marked by a significant drop of low-tech sectors into the economy compensated by a strong expansion in high sectors. From 1990 to 2008, the former slumped from 33.2% to 13.9% while the latter increased sharply from 43.4% to 59.3%. In this trend, the sharp increase of 'Machinery, Nec' draws attention particularly due its expressive rise in the total value added of the economy, i.e., 10.1% of share gain. Recognised as knowledge intensive subsector of manufacturing, the Structuralist-Schumpeterian literature has stressed the growth-inducing effects of the machinery subsector particularly regarding introduction and diffusion of technological change. Other sector that composed expressively to expand the high-tech group was 'Transport Equipment' that rose from 10.5% to 16.8%. Additionally, the increase of medium-tech subsectors, although in a lesser extent, also contributed for the productive specialisation (and economic dynamism) varying positively in 3.4%. In short, the South Korea's pattern of intra-sectoral specialisation was marked by a gradual share concentration in medium and high-tech sectors that together reached 86.1% of the total value added in 2008.

In Brazil, the pattern of productive specialization was also marked by the expansion of high-tech subsectors such as 'Machinery, Nec', 'Electrical and Optical Equipment' and 'Transport Equipment'.

However, despite of the substantial increase of 9.6% in this group the pace and proportion of this expansion was clearly lower than in South Korea. Moreover, although the low-tech sector exposed a clear drop of 7.7%, the Brazilian economy remained dependent of less dynamic sectors such as 'Food, Beverages and Tobacco' in which represents 15.1% of the total value added in the economy. Furthermore, the medium-tech group presented a slight descendent trajectory varying from 26.5% in 1990 to 24.7% in 2008. In this group the most expressive loss was in 'Rubber and Plastics' that dropped 2%. In brief, Brazil presents a manufacturing sector more diversified than South Korea but in less dynamic sectors. In a comparative perspective of economic development this dichotomy stimulates differently processes of cumulative causation and, consequently, divergence in countries' growth rates.

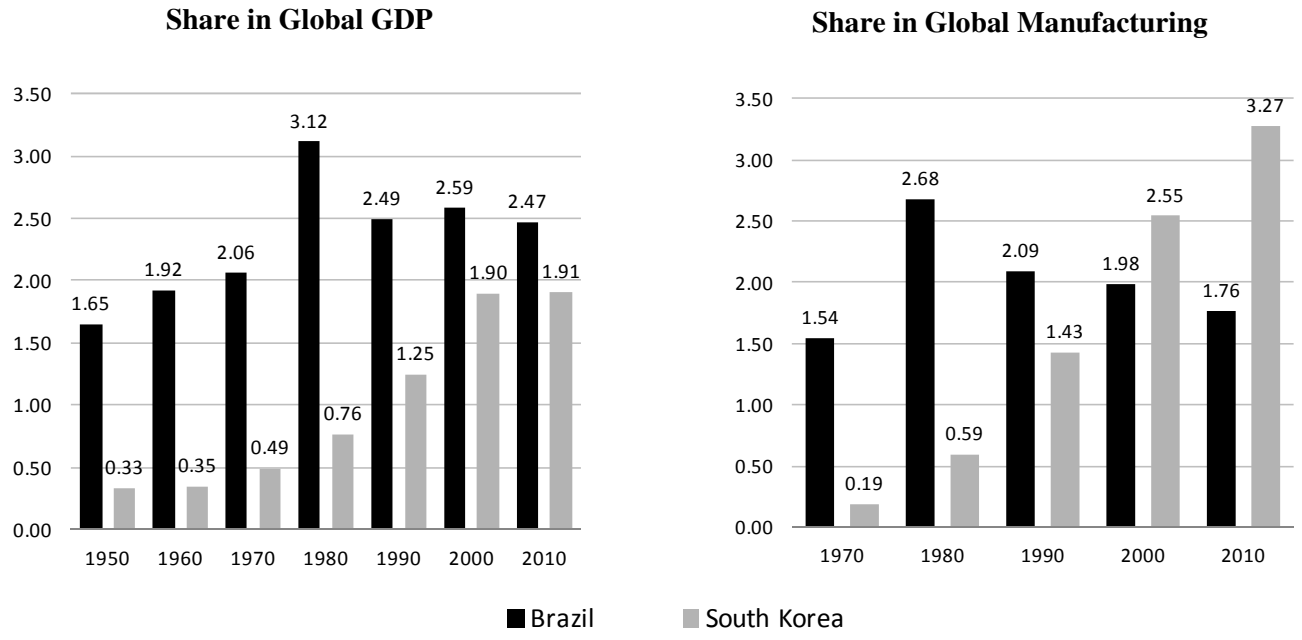
Table 3.1 – Sectoral composition of the manufacturing sector (%), 1990-2008

	South Korea					Brazil				
Subsectors	**90**	**95**	**00**	**05**	**08**	**90**	**95**	**00**	**05**	**08**
Food, Beverages and Tobacco	10.7	8.4	8.3	6.6	6.1	15.1	13.4	14.5	13.6	15.1
Textiles and Textile Products	10.3	8.8	7.1	4.8	3.6	9.7	7.9	7.0	5.5	4.9
Leather, Leather and Footwear	3.6	1.4	0.9	0.5	0.4	2.3	1.4	1.0	0.8	0.7
Wood and Products of Wood and Cork	0.9	0.8	0.6	0.5	0.4	1.5	1.1	1.2	1.1	0.9
Pulp, Paper, Paper , Printing and Publishing	4.9	4.9	4.8	4.0	2.1	6.5	7.8	7.7	7.8	7.1
Coke, Refined Petroleum and Nuclear Fuel	3.0	3.4	2.6	3.5	4.6	6.1	7.6	8.6	7.8	6.9
Chemicals and Chemical Products	9.2	9.3	9.5	8.6	8.7	12.7	11.1	11.3	10.0	9.0
Rubber and Plastics	3.9	3.9	4.0	4.7	4.3	4.6	3.3	3.4	2.9	2.6
Other Non-Metallic Mineral	5.1	4.8	3.8	3.4	3.3	2.6	2.3	2.4	2.1	2.1
Basic Metals and Fabricated Metal	11.4	11.5	10.4	13.2	14.6	13.3	13.9	13.4	13.6	13.0
Machinery, Nec	19.7	24.8	28.2	30.2	29.8	8.1	10.4	9.8	12.0	12.8
Electrical and Optical Equipment	4.0	4.3	4.8	4.5	4.0	8.2	10.5	10.9	11.8	11.4
Transport Equipment	10.5	11.3	13.1	13.8	16.8	7.1	7.8	7.6	10.0	12.4
Manufacturing, Nec; Recycling	2.9	2.3	1.8	1.6	1.3	2.2	1.6	1.3	1.1	0.9
Total manufacturing	100	100	100	100	100	100	100	100	100	100
Low-Tech	33.2	26.6	23.4	18.0	13.9	37.4	33.2	32.7	30.0	29.7
Medium-Tech	23.4	23.7	20.9	24.9	26.8	26.5	27.0	27.7	26.2	24.7
High-Tech	43.4	49.7	55.7	57.2	59.3	36.1	39.8	39.6	43.7	45.7
GHI	32.3	34.8	37.1	38.8	39.8	31.0	31.3	31.5	31.9	32.3

Source: Own calculations based on data from UNIDO and ECLAC-PADI.
Note: Data calculated in constant US dollars for Brazil and in current prices for Korea due the lack of data.

The inter and intra-sectoral composition of Brazil and South Korea culminated in distinct economic performances. In a comparative perspective it can also be illustrated with the global economy. Thus, figure 3.4 shows the evolution of their shares in both global manufacturing and GDP elucidating the South Korean thriving economic dynamism vis-à-vis the Brazilian poor performance. Therefore, over the decades South Korea exposed a sustained economic growth taking advantage of dynamic economies of scale, increasing returns and spill-over effects that set in motion processes of cumulative causation. From 1950 to 1980, the share of South Korea in global GDP expanded 133.1% and manufacturing rose 210.7% (from 1970 to 1980). Even after the turbulent 1980s and the rise of neoliberal policies in the development world particularly in the 1990s, the economy kept the impetus of growth increasing its share in the global GDP and manufacturing. Brazil by contrast, although with a considerable increase of these variables from 1950 until 1980, collapsed with the outbreak of the debt crisis. During the 1980s, Brazil was trapped in an economic dynamics that sentenced the country to a poor economic performance in subsequent decades. From the 1990s with the advent of neoliberal reforms the economy not only remained stagnated in the evolution of the global GDP share and but also lost a significant share in the global manufacturing.

Figure 3.4 - Shares in global manufacturing and GDP



Source: Elaborated by the author, using data from The Groningen Growth and Development Centre and UNCTAD.
Note: Sectoral shares calculated at constant 2005 national prices.

2. The structural decomposition analysis

Seeking to understand the results found in the previous section, this section tries to find factors that led the path of structural change observed in Brazil and South Korea in light of liberalising policies implemented in these economies during the second half of 1990s. Therefore, based on the pioneer analysis developed by Leontief (1936 and 1941), the theoretical approach is based on the input-output method. Over the years this methodology has been widely used in structural analyses to study effects of distinct economic policies over the structure of production. Thus, from an analytical input-output framework, the so-called structural decomposition analysis (SDA) inspired by Chenery (1960), Chenery *et al.* (1962), Chenery & Syrquin (1980) and Chenery *et al.* (1986), has been applied for many countries in vast range of contexts and periods to identify and quantify factors that contribute to a given change in the sectoral structure. This method is usually adopted to investigate distinct factors, i.e. demand, trade and technological change, which contributed to a certain change in the industrial structure.

Differently to the framework of neoclassical models, which consider economic growth as a process limited by the supply side, the SDA is a method of growth account by the demand side. Furthermore, it takes account inter-relationships between various sectors (and subsectors) of the economy, rather than sectoral trends in isolation from one another. Using this methodology, it is possible to empirically investigate the economic role of a productive sector without restricting the analysis to its "direct effects" on the economy regarding generating production, employment, value-added products, tax revenue, and exports. With this method, it is possible to also investigate the "indirect effects", i.e., the effects that a sector can exert on other sectors through channels established by input/output transactions between different economic sectors.

Over the years the SDA methodology was improved as analytical tool and different methods were developed. In this sense, Feldman et al. (1987), Skolka (1989), Rose & Casler (1996) and Dietzenbacher &

Los (1998) were particularly relevant. Contemporaneously, many studies analysed the economic structure though this line of methods. Kupfer el al. (2003) decomposed the output and employment variation of the Brazilian economy between 1990 and 2001. Tregenna (2012) applied this method to South Africa from 2000 to 2007. And Zakariah & Ahmad (1999) used the factor decomposition approach to Malaysia from 1978 to 1987. However, none employed the SDA methodology in a comparative perspective between Brazil and South Korea through a common database. Therefore, the data available at the World Input-Output Database (WIOD) were used to analyse the output decomposition between two periods: 1995-2003 and 2003-2008. These breakdowns were applied more due data availability than to distinct economic policies. In addition, input-output tables were estimated in constant prices using the database available in both current and previous years' prices. Therefore, analogously to Chenery, Robinson and Syrquin (1986) this paper decomposed output growth (ΔX) in manufacturing into the following four components[5]:

- Domestic demand (ΔD): Refers to the direct and indirect effect of variations in the domestic final demand throughout the economy on the sector (or subsector) output. Domestic demand includes household consumption expenditure, government consumption expenditure and gross capital formation.
- Export (ΔE): Indicates the direct and indirect variation of exports on each sectoral (or subsector) output. It is important to note that this component is affected by intersectoral relationships. In other words, it is affected not only by exports of the sector under analysis, but also by exports of other sectors with which this sector is linked.
- Import substitution (ΔM): Refers to the direct and indirect variation of sectoral output associated to the substitution of imports (intermediates and final goods) for by domestic production. Analogously to export expansion, this component is affected by intersectoral relationships and consequently reflects not only import substitution in a specific sector, but also import substitution in other sectors with which a sector is linked.
- Technological change (ΔT): Indicates the variation on sector (or subsector) output associated with changes in the production processes which affect the economy coefficients (input-output coefficients). Thus, this component is obtained through changes in the table of technical coefficients, which shows the flow of intermediate inputs (domestically and imported) into the production of all goods and services of the economy.

Tables 3.2 and 3.3 show the results for both countries from 1995 to 2003 and 2003 to 2008. For each sector (or subsector) the contributions of the four components (domestic demand, export, import substitution and technological change) to economic growth are presented. Inter and intra-sectoral results are presented to provide subsidies to understand the process of specialisation in Brazil and South Korea. In order to maintain a robust intra-sectoral analysis, results of the SDA were presented as close as possible to the aggregation of the last section. Thus, manufacturing was aggregated in 15 subsectors. Additionally, manufacturing was divided by technology intensity (low, medium and high tech) according to UNIDO classification.

3. Interpreting results in light of distinct economic policies

During the 1990s Brazil and Korea faced distinct economics polices. In Brazil, after a turbulent and critical passage through the 1980s marked by economic stagnation and high inflationary rates, the Real Plan (*Plano Real*) was adopted in 1994 aiming to stabilise the economy. The economic policy of the period was essentially based on liberalising reforms that south through high interest rates, currency overvaluation and wage squeeze stabilise the economy. Measures such as trade liberalisation (reduction of tariff and non-tariff barriers), privatisation of state-owned enterprises and capital account openness culminated in a disastrous

[5] Technical details about methodology are summarised in Appendix 3.1.

economic environment for the national industry. Moreover, from 1998 to 2003 the Brazilian economy experienced a period of balance-of-payment crisis and currency depreciation that associated to a restrictive macroeconomic policy based on the inflation target regime undermined any attempt of significant recovery in the manufacturing sector.

Therefore, as showed in Table 3.2, from 1995 to 2003 manufacturing output increased only 9.1% and exports pushed only 15.9% of this component. Additionally, it is important to note that during this period all components of the Brazilian manufacturing sector registered negative variations. In an intra-sectoral perspective results of the structural decomposition analysis revels that many manufacturing subsectors affected were those inserted in the medium and high-tech group. Remarkable examples are the subsectors of 'rubber and plastics', 'non-metallic mineral' as well as 'electrical and optical equipment'. By contrast the primary sector output based on the Brazilian comparative advantage grew 43.0% mostly driven by exports that represented 26.0% of this expansion. Furthermore, during this period services output expanded 18.0% probably as a result of the privatisation process of the decade particularly in subsectors of infrastructure such as energy and telecommunications.

In a distinct economic dynamism South Korea did not embarked in the same type of 'fundamentalist' economic reforms. As a matter of fact, although financial and trade liberalisation marked South Korea during the 1990s, it was much more pragmatic in order to continue and strength the existing ambitious strategy of industrialisation. Over de decades the South Korean history of economic development has been marked the special properties of manufacturing as a key sector to economic growth. Therefore economic reforms were implemented as pragmatic mechanism to help lift specific pressing economic and financial constraints in order to expand the manufacturing sector. Even during de Asian crisis in 1997, despite of the re-articulation between State and private sector, the whole of the State was central to keep the industrial dynamism. To overcome the crisis there was a reorganization of the corporate structure with processes of mergers and acquisitions gaining momentum. Additionally, the South Korean State remained active either through long-term programmes for the development of high-tech sectors, either ensuring important long-term funding sources through public banks.

Therefore, in an inter-sectoral and intra-sectoral perspective Table 3.2 highlights the dichotomy between Brazil and South Korea. From 1995 to 2003 manufacturing production in South Korea increased 58.3% wherein 50.7% was explained by exports. Moreover the booming expansion of medium/high-tech industries composed one of the main sources of economic dynamism. During the 1980s and 1990s, the South Korean government engendered a massive effort to constitute a solid strategy based in technology development enhancing the industrial structure toward dynamic manufacturing industries. For example, the output in 'chemicals and chemical products', 'rubber and plastics', 'basic metals and fabricated metal', 'machinery, nec', 'electrical and optical equipment', and 'transport equipment' expanded significantly mainly pulled by exports. In numbers, electrical and optical equipment, and transport equipment increased the output production in 317.2% and 86.4% respectively where exports corresponded to 222.1% and 69.7%. Not by coincidence, the South Korean economic growth has been higher and much more sustainable when compared to the Brazilian economy.

Table 3.2 - Inter and Intra-sectoral decomposition of output growth (%), 1995-2003

	Korea					**Brazil**				
Sectors	(ΔT)	(ΔM)	(ΔD)	(ΔE)	(ΔX)	(ΔT)	(ΔM)	(ΔD)	(ΔE)	(ΔX)
Primary Sector	21.0	-16.8	-8.7	4.5	0.0	9.6	1.0	6.3	26.0	43.0
Manufacturing	-9.7	6.3	11.0	50.7	58.3	-2.7	-0.8	-3.3	15.9	9.1
Food, Beverages and Tobacco	14.7	3.7	-4.9	4.8	18.3	-3.3	1.0	5.4	16.3	19.3
Textiles and Textile Products	-2.1	9.2	5.6	8.1	20.8	-4.5	1.9	-17.9	6.3	-14.1
Leather, Leather and Footwear	-14.3	2.4	-1.4	-15.7	-29.0	-5.4	0.6	-19.1	17.2	-6.7

Wood and Products of Wood and Cork	-28.6	18.7	11.3	12.4	13.8	-27.4	-0.1	-2.2	32.7	3.0
Pulp, Paper, Paper , Printing and Publishing	-14.6	11.9	21.9	30.3	49.5	-1.9	3.3	6.7	12.5	20.6
Coke, Refined Petroleum and Nuclear Fuel	-38.6	4.9	13.9	47.8	28.1	7.2	-0.5	-2.9	13.7	17.5
Chemicals and Chemical Products	-2.9	14.0	6.3	57.8	75.1	7.9	-2.5	-1.8	11.1	14.7
Rubber and Plastics	-10.9	1.5	10.4	50.7	51.7	-8.5	-0.6	-4.8	14.8	0.9
Other Non-Metallic Mineral	-23.5	-1.8	18.5	29.3	22.7	-1.3	0.0	-4.6	10.0	4.0
Basic Metals and Fabricated Metal	-22.2	5.2	9.2	45.7	37.9	-8.7	-1.4	-1.4	19.4	7.9
Machinery, Nec	-9.3	8.3	18.0	50.6	67.7	-4.1	-1.6	3.7	16.6	14.5
Electrical and Optical Equipment	24.5	7.5	63.1	222.1	317.2	-1.2	-5.7	-21.0	14.6	-13.4
Transport Equipment	8.9	4.2	3.5	69.7	86.4	-8.7	-2.4	-6.8	28.7	10.7
Manufacturing, Nec; Recycling	-4.0	3.2	-1.2	16.6	14.6	-5.0	-0.1	-4.0	7.9	-1.2
Services	-4.0	0.4	36.8	11.7	44.9	3.3	0.0	10.5	4.2	18.0

Source: Own calculations based on data from WIOD.
Note: Data calculated in 2008 US constant dollars.

From 2003 until the outbreak of the global financial crisis in 2008, the pattern of economic development for these two economies exposed interesting movements. According to Table 3.3, in South Korea exports of the manufacturing sector was maintained as engine of economic growth. However, the 'flying geese' movement of regional productive fragmentation associated to the economic policy based on paradigm of global value chains affected negatively the component of import substitution. Although the country presented a higher output expansion when compared to the Brazilian economy, the productive reallocation of components and labour-intensive assembly-end part to other countries of the Asian block such as the 'third-tier' NICs (particularly China) slowed the pace of output growth during the period. As showed by Table 3.3, although the output growth rose 39.1% mainly pushed by exports, the component of import substitution affected negatively the manufacturing sector in 8.6%. In an intra-sectoral view, despite the consolidation of medium/high tech manufacturing subsectors as engine of economic dynamism, the same industries were badly affected with a negative variation of import substitution. In this aspect, notable examples were 'Coke, Refined Petroleum and Nuclear Fuel', 'Chemicals and Chemical Products', 'Rubber and Plastics', 'Other Non-Metallic Mineral', 'Basic Metals and Fabricated Metal', 'Machinery, Nec', and 'Transport Equipment'. In short, the economic dynamism of the South Korean economy was not higher because of deleterious effects of imports in the domestic production.

In Brazil, inter and intra-sectoral results indicates a different pattern of economic growth but also some common trends. While South Korea the pattern of economic development was in both periods (before and after 2003) driven by exports of manufacturing products, in Brazil the domestic demand from 2003 to 2008 composed the key variable of economic growth. In this period, the so-called commodity prices boom and the credit-led consumption-boom boosted the economy. The former affected the economy promoting the exports of primary products while the latter pushed the domestic demand as a whole. However, even in this context once again manufacturing performed worse when compared to services that exposed the most dynamic output growth. Not even the Brazilian National Development Bank (BNDES) providing many benefits for national producers, such as funding with very low interest rates and certain benefits to stimulate exports (especially for producers that use domestic inputs) was capable to reverse this trend. In an extreme adverse macroeconomic policy marked by high and volatile interest and exchange rates the industrial policy became innocuous.

Moreover, a comparative intra-sectoral analysis between Brazil and South Korea revels that low-tech manufacturing subsectors such as 'leather, leather and footwear' and 'wood and products of wood and cork' (in the case of Brazil) exposed a negative output variation while 'machinery, mec', 'electrical and optical equipment' and 'transport equipment' expanded significantly in both economies. Finally another common

trend between Brazil and South Korea was the clear negative variation of import substitution in the total output. In both economies the demand has been attended by imports either means of production either inputs. Therefore seeking to evaluate this common trend in detail next the section turns to this issue.

Table 3.3 - Inter and Intra-sectoral decomposition of output growth (%), 2003-2008

	Korea					Brazil				
Sectors	(ΔT)	(ΔM)	(ΔD)	(ΔE)	(ΔX)	(ΔT)	(ΔM)	(ΔD)	(ΔE)	(ΔX)
Primary Sector	117.5	-118.5	11.7	4.3	15.0	9.2	-11.8	13.7	10.2	21.3
Manufacturing	4.8	-8.6	3.9	39.0	39.1	3.1	-8.2	26.8	0.5	22.2
Food, Beverages and Tobacco	3.9	-3.3	3.0	3.9	7.4	1.6	-1.6	13.7	1.2	14.9
Textiles and Textile Products	2.7	0.9	13.5	-13.8	3.3	-6.9	-5.0	29.5	-3.3	14.3
Leather, Leather and Footwear	-1.3	0.7	-19.0	-10.3	-29.9	-1.3	-0.5	14.3	-18.0	-5.6
Wood and Products of Wood and Cork	2.3	-1.9	8.1	9.3	17.7	-2.8	-2.1	16.1	-24.1	-12.9
Pulp, Paper, Paper , Printing and Publishing	-9.8	-4.0	3.9	15.2	5.4	-1.0	-5.1	25.4	0.4	19.7
Coke, Refined Petroleum and Nuclear Fuel	27.3	-20.8	1.3	28.1	35.9	2.9	-11.6	15.4	6.6	13.4
Chemicals and Chemical Products	-11.2	-9.6	4.9	32.8	16.9	6.0	-16.6	21.5	-0.4	10.5
Rubber and Plastics	3.7	-6.6	5.0	37.2	39.4	-0.6	-9.8	27.4	2.4	19.5
Other Non-Metallic Mineral	5.7	-7.2	6.5	19.4	24.4	3.4	-4.9	30.1	-0.8	27.8
Basic Metals and Fabricated Metal	8.1	-18.3	4.7	33.5	28.1	0.5	-11.3	26.8	-1.3	14.6
Machinery, Nec	17.5	-7.7	5.6	49.2	64.5	3.4	-6.6	49.6	3.2	49.5
Electrical and Optical Equipment	-0.6	3.9	5.5	88.3	97.1	13.2	-16.5	44.4	-0.3	40.8
Transport Equipment	0.2	-4.9	-2.1	59.3	52.4	11.4	-6.9	56.5	6.0	67.0
Manufacturing, Nec; Recycling	19.6	-2.3	14.8	2.4	34.4	-1.9	-1.8	27.2	-3.4	20.1
Services	4.8	-5.2	12.4	8.3	20.2	4.8	-2.8	24.1	1.0	27.1

Source: Own calculations based on data from WIOD.
Note: Data calculated in 2008 US constant dollars.

4. The density of industrial chains

Data regarding import input coefficients for Brazil and South constitutes an important indicator to analyse the density of domestic industrial chains. Thus, through data available at the World Input-Output Database (WIOD) and some input-output techniques is possible to measure the evolution of such confidents over time. In this way, tables 3.4 and 3.5 elucidate that in each economy this coefficients followed a distinct trend marked by contrasting economic policies and strategies of development[6]. In South Korea, over the years the process of industrialisation was characterised by a constant expansion of manufacturing and gradual density increase of the domestic industrial chains. However, as showed by table 3.4, from 1995 to 2002 this process sketched movements related to an increasing share of imported inputs in the domestic manufacturing sector that were consolidated in the subsequent period. As a matter of fact, from 2003 to 2008 the South Korean economy significantly increased the share of imported inputs not only in the manufacturing sector but also in the economy as a whole. The reasons for that are twofold. The first relates to the new productive environment marked by the global value chains (GVC) where the productive structure has been gradually fragmented over the years. In this view productive fragmentation is seen as an important source of firm efficiency through improvements in competitiveness both in domestic and international markets and by cost

[6] Rocha (2011) analysed the participation of imported input coefficients only in the Brazilian industrial chains. Additionally, in this study the analysis adopted the IBGE database.

savings. The second reason relates to the 'flying geese' process of industrialisation, where the productivity capacity at a certain stage of the economic development is transferred to the less developed country (particularly Nics-2 and China) in a process of regional fragmentation of the productive chain. Although both reasons are associated to the concept of productive fragmentation they might be seen as different sides of the same coin. It is because the fist reason is related to cost savings *per se* and a premature process of de-industrialisation, while the second one relates to a regional strategy of development and expansion of manufacturing in the economy. Since South Korea expanded not only the presence of imported inputs in its productive structure but also the share of manufacturing, the second reason becomes more likely.

Table 3.4 - Import input coefficients for Korea, 1995-2008

	Korea													
Sectors	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**
Primary Sector	14.6	14.4	13.6	11.5	11.8	13.1	12.0	11.5	12.0	12.9	14.7	16.1	16.7	19.5
Manufacturing	31.2	32.5	31.8	27.0	27.9	30.9	27.8	26.9	29.1	32.7	35.7	38.5	39.4	44.2
Food, Beverages and Tobacco	25.4	25.7	23.2	19.2	19.8	20.3	18.8	18.3	19.0	20.6	22.3	23.5	24.6	29.1
Textiles and Textile Products	40.2	39.7	38.4	35.2	33.8	35.0	31.6	28.3	29.3	30.2	31.2	31.4	31.0	30.4
Leather, Leather and Footwear	30.3	28.7	29.4	24.9	23.8	26.7	27.2	24.9	23.9	25.9	26.9	28.3	29.2	29.0
Wood and Products of Wood and Cork	45.9	44.8	43.1	30.4	33.2	34.3	31.1	32.0	31.2	33.6	34.9	36.3	38.4	39.2
Pulp, Paper, Paper , Printing and Publishing	22.7	22.6	21.7	20.9	19.8	23.5	19.7	18.3	19.1	21.4	22.8	23.5	24.5	28.0
Coke, Refined Petroleum and Nuclear Fuel	28.1	31.9	31.0	22.9	25.7	37.6	32.9	30.8	36.3	40.7	51.0	61.2	63.8	82.0
Chemicals and Chemical Products	29.7	28.8	27.7	23.3	23.5	28.0	25.4	23.1	26.3	31.8	35.8	39.5	41.4	48.1
Rubber and Plastics	28.7	29.3	28.0	22.9	23.7	25.5	23.7	23.4	25.3	28.5	32.3	34.3	34.9	37.4
Other Non-Metallic Mineral	31.0	31.5	29.9	25.0	24.7	25.4	24.1	24.2	25.5	26.7	29.3	30.7	29.8	32.5
Basic Metals and Fabricated Metal	26.4	27.9	27.8	24.4	23.8	23.9	21.7	22.0	25.0	31.5	33.5	38.0	40.8	48.8
Machinery, Nec	34.4	36.3	35.5	29.7	30.9	29.5	27.5	27.8	29.5	32.1	35.1	36.8	37.2	36.8
Electrical and Optical Equipment	83.2	87.4	86.7	67.7	62.1	60.6	52.7	48.1	47.0	46.3	46.5	43.8	41.7	41.1
Transport Equipment	25.3	26.4	27.3	24.4	25.3	25.6	23.9	24.5	25.0	27.0	29.2	31.3	32.6	34.4
Manufacturing, Nec; Recycling	31.7	32.6	30.4	24.9	26.6	28.3	26.0	26.2	26.9	29.8	32.0	34.2	34.5	32.2
Services	11.5	12.1	12.2	9.6	10.2	12.6	11.3	10.8	11.8	13.4	15.3	16.8	17.5	19.2

Source: Own calculations based on data from WIOD.
Note: Data calculated in 2008 US constant dollars.

In the Brazilian economy, unlike South Korea, the manufacturing sector fell apart during the so-called lost decade in the 1980s. Moreover, the restrictive neoliberal economic policy grounded in market friendly mechanisms led to a process of premature de-industrialisation without an end in sight. In this dynamic, industrial restructuring involved mainly defensive adjustments in a context where investments were kept to a minimum level. Thus, the productive fragmentation seeking cost savings was widely adopted without any long-term economic planning. Additionally, under a high and volatile interest and exchange rates, in periods of demand expansion (as during the 2000s) substitution of national inputs for imported ones constituted the easiest way to attend the demand. Analysing the import input coefficients is possible to realise the dependence of the Brazilian domestic industry in relation to the international supply and the progressive loss of density in its industrial chains. It associated to a gradual shift to free market policies intensified the presence of imported inputs the domestic industry.

From 1995 to 1999 the ascendant trend of import input coefficients appeared blurred. However from this period onwards these coefficients raised almost constantly. Furthermore, particularly after 2002 this process gained speed essentially due the economic recovery (pushed by the commodity boom) and the

structural mismatch between the structures of supply and demand. The most representative examples of subsectors that exposed a substantial ascendant trajectory of imported inputs were 'coke, refined petroleum and nuclear fuel', 'chemicals and chemical products', 'rubber and plastics', 'electrical and optical equipment' and 'transport equipment'. Additionally, it is important to note that the most affected manufacturing subsectors were those inserted in the medium/high-tech group. In this sense, it is not by chance that the Brazilian economy has not structured the bases for a long-term economic growth. In fact, contemporaneously the only achievement of the Brazilian economic policy has been the establishment of successive short cycles of 'stop and go' arising from a decreasing share of manufacturing in the value added and the disarticulation of domestic industrial chains especially in medium/high-tech subsectors.

Table 3.5 - Import input coefficients for Brazil, 1995-2008

	Brazil													
Sectors	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**
Primary Sector	3.7	4.0	4.1	4.1	3.9	4.5	4.6	4.4	4.6	5.3	5.6	5.9	7.1	9.4
Manufacturing	6.9	7.4	7.6	7.4	6.9	8.5	8.5	7.5	7.8	9.0	9.9	11.1	12.7	16.1
Food, Beverages and Tobacco	4.7	5.7	5.9	5.5	4.9	5.6	5.1	4.6	5.0	5.0	5.5	6.0	7.2	9.6
Textiles and Textile Products	6.5	5.7	6.2	6.2	5.6	6.4	6.2	5.7	5.5	6.0	6.3	7.6	9.1	10.5
Leather, Leather and Footwear	7.1	6.8	7.3	7.1	6.5	7.7	7.5	6.3	6.1	7.2	6.8	7.6	9.2	10.9
Wood and Products of Wood and Cork	2.7	2.9	3.1	3.1	2.9	3.5	3.5	3.5	3.7	4.7	4.9	5.2	6.3	8.2
Pulp, Paper, Paper , Printing and Publishing	7.6	7.6	8.1	8.3	7.4	8.8	8.2	7.1	6.5	7.0	7.5	7.8	9.3	10.8
Coke, Refined Petroleum and Nuclear Fuel	10.0	11.7	10.5	8.2	8.3	11.5	11.2	9.8	10.3	14.1	15.9	18.9	21.6	26.5
Chemicals and Chemical Products	6.1	7.0	7.2	6.9	6.8	9.4	9.3	8.5	9.4	11.3	10.9	11.4	13.9	18.9
Rubber and Plastics	8.4	8.7	9.1	9.2	9.1	11.1	10.6	9.2	10.3	11.6	12.3	13.1	15.3	18.5
Other Non-Metallic Mineral	6.9	6.6	6.9	7.2	6.3	6.9	7.8	6.0	6.5	6.5	6.8	8.0	9.5	12.7
Basic Metals and Fabricated Metal	6.6	6.1	6.5	6.7	6.1	6.5	6.7	6.5	6.3	7.2	8.8	10.6	12.2	15.6
Machinery, Nec	7.2	7.1	7.8	8.2	7.4	8.7	9.4	8.2	8.3	8.8	10.1	11.5	12.8	15.2
Electrical and Optical Equipment	8.7	9.2	9.8	10.0	9.9	12.9	12.7	12.1	11.4	13.3	15.3	17.2	16.2	21.8
Transport Equipment	8.7	8.9	9.9	10.5	10.0	11.8	13.2	11.5	11.5	12.5	14.0	15.2	16.6	19.8
Manufacturing, Nec; Recycling	5.9	5.9	6.3	6.6	6.1	7.0	6.7	5.7	5.9	6.5	6.7	7.3	8.3	10.6
Services	3.0	3.2	3.4	3.5	3.1	3.8	3.8	3.3	2.9	3.1	3.6	4.0	4.5	5.4

Source: Own calculations based on data from WIOD.
Note: Data calculated in 2008 US constant dollars.

5. Concluding remarks

This empirical paper sought to provide a comprehension of the structural transition undertaken by Brazil and South Korea in a comparative perspective. Therefore, the first section, through the Imbs and Wacziargs' methodology, analysed the pattern of inter and intra-sectoral diversification exposed by these economies before and after the 1980s. Firstly the data showed that Brazil was affected by a process o premature specialisation in inter and intra-sectoral levels. Secondly the intra-sectoral data of manufacturing revealed that during the specialisation stage South Korea increased sharply the share of medium/high-sectors in the economy while Brazil although more diversified, remained dependent of less dynamic sectors. In a comparative perspective of economic development this dichotomy propelled different processes of cumulative causation and, consequently, impacted the countries' growth rates distinctly. Therefore, it is not by coincidence that the constant drop of the Brazilian share in the global manufacturing was followed by a

regressive evolution in the global GDP. Consequently, Brazil remained trapped in a middle-income landscape translated in an unsustainable economic performance.

In the second and third section, the analysis turned to the understanding of factors (demand, trade and technological change) that contributed to the formation of these productive structures in light of liberalising policies implemented during the second half of 1990s. Thus, from 1995 to 2003 during the height of neoliberal reforms Brazil increased its manufacturing output in only 9.1%. In this period, with the exception of exports, all components registered negative variations. In a distinct economic dynamism, the South Korean manufacturing production increased 58.3% wherein 50.7% was explained by exports. Furthermore, this expansion was composed mainly by medium/high-tech industries. In the subsequent period, from 2003 to 2008, South Korea maintained manufacturing as engine of economic growth but with an expressive increase of imports mainly due the 'flying geese' movement of regional productive fragmentation marked specially by the rise of China as the world's factory. While the South Korean pattern of economic development was in both periods (before and after 2003) driven by exports of manufacturing products, in Brazil the domestic demand from 2003 to 2008 composed the key variable of economic growth pushed mainly by the credit-led consumption of the period. In this dynamic, the so-called commodity prices boom also played a central whole to boost the economy. However, even in this context once again manufacturing performed worse when compared to services that exposed the most dynamic output growth.

In the fourth section was measured the density of domestic industrial chains through import input coefficients. In South Korea, from 1995 to 2002 this process sketched movements related to an increasing share of imported inputs in the domestic manufacturing sector that were consolidated in the subsequent period. From 2003 to 2008 the South Korean economy significantly increased the share of imported inputs not only in the manufacturing sector but also in the economy as a whole. This finding is consistent to the aforementioned 'flying geese' process of industrialisation where the productivity capacity at a certain stage of the economic development is transferred to the less developed country (in this case particularly China) in a process of regional fragmentation of the productive chain. By contrast, Brazil did not follow this pattern of economic development. As a matter of fact, the manufacturing sector fell apart during the 1980s and 1990s in a process of premature de-industrialisation without an end in sight. In this productive disarticulation, many manufacturing industries kept investments to a minimum level. Furthermore, the productive fragmentation seeking cost savings *per se* was widely adopted without any long-term economic planning. Additionally, under a high and volatile interest and exchange rates, in periods of demand expansion (as during the 2000s) substitution of national inputs for imported ones constituted the easiest way to attend the demand. This fact not only revealed the dependence of the Brazilian domestic industry in relation to the international supply but also the absence of important intra-sectoral linkages.

6. References

Chayanov, A.V. (1966) The theory of peasant economy, in D. Thorner, B. Kerblay and R.E.F. Smith, eds. Homewood, IL: Richard D. Irwin, Inc.

Chenery, H. B. (1960) 'Patterns of Industriai Growth', *American Economie Review*, 50(4), 624-654.

Chenery, H. B. (1979), *Structural Change and Development Policy*, New York: Oxford University Press.

Chenery, H. B.; Robinson, S. & Syrquin, M. (1986), *Industrialization and growth: a comparative study*. Oxford: Oxford University Press.

Chenery, H. & Syrquin, M. (1980) A comparative analysis of industrial growth, in R. C. O. Matthews (Ed.) *Economic Growth and Resources*: Volume 2—Trends and Factors (London: Macmillan).

Chenery, H., Shishido, S. & Watanabe, T. (1962) 'The pattern of Japanese growth, 1914-1954', *Econometrica*, 30(1), pp. 98–139.

Dietzenbacher, E. and B. Los (1998) 'Structural Decomposition Techniques: Sense and Sensibility', *Economics Systems Research*, 10(4)l, 307-323.

Feldman, S.J., D. McClain and K. Palmer (1987) 'Sources of Structural Changes in the United States: an Input-Output Perspective', *The Review of Economics and Statistics*, 69(3), 503-510.

Furtado, C. (1961) *Desenvolvimento e Subdesenvolvimento*, Rio de Janeiro, RJ: Fundo de Cultura, 1965.

Hirschman, A. O. (1958), *The Strategy of Economic development*, New Haven, Conn: Yale University Press.

Kaldor, N. (1966) 'Causes of the Slow Rate of Economic Growth of the United Kingdom: on Inaugural Lecture', Cambridge: Cambridge University Press.

Kaldor, N. (1967) *Strategic Factors in Economic Development*, New York: Ithaca.

Krugman, P. & Obstfeld, M. (2006) *International Economics: Theory and Policy*, 7. ed., Boston, Massachusetts: Pearson, Addison-Wesley.

Kupfer, D.; Freitas, F. & Young, C. E. F. (2003) 'Decomposição estrutural da variação do produto e do emprego entre 1990 e 2001 - uma estimativa a partir das matrizes insumo-produto', *Relatório de pesquisa para a CEPAL/Divisão de Indústria*, IE/UFRJ.

Leontief, W. (1936) 'Quantitative Input and Output Relations in the Economic Systems of the United States', *Review of Economics and Statistics*, 18(3),105-25.

Leontief, W. (1941) *The Structure of American Economy*, Cambridge: Harvard University Press.

Lewis, W.A. (1954) 'Economic development with unlimited supplies of labour', in A.N. Agarwala & S.P. Singh, (eds), *The economics of underdevelopment*, Oxford: Oxford University Press.

Lin, J. Y. (2012) *New Structural Economics: A Framework for Rethinking Development and Policy*, Washington DC: The World Bank.

Lipton, M. (1968) 'Strategy for agriculture: urban bias and rural planning', in: P. Streeten and M. Lipton, eds. *The crisis of Indian planning*. London: Oxford University Press.

Miller, R. & Blair, P. (2009) *Input-Output Analysis: Foundations and Extensions*, Cambridge: Cambridge University Press.

Prebisch, R. (1949) 'Estudo econômico da América Latina', in R. Bielschowsky, eds, Cinqüenta anos de pensamento na Cepal. São Paulo: Cepal/Cofecon/ Record.

Ricardo, D. (1817) *On the principles of political economy and taxation*, London: Murray, 3rd edition, 1821.

Rocha, I. L. (2011) 'Reestruturação industrial no Brasil: uma análise da dinâmica comercial e produtiva da economia'. MA thesis in Economics. Campinas: IE/Unicamp.

Rodrik, D. (2004) 'Industrial policy for the twenty-first century', John H. Kennedy School of Government, Harvard University.

Rose, A. and S. Casler (1996) 'Input-Output Structural Analysis Decomposition: a critical appraisal', *Economic Systems Research*, 8(1), 33-62.

Rosenstein-Rodan, P. (1943) 'Problems of Industrialisation of Eastern and South-Eastern Europe', *Economic Journal*, 53(210/1) 202-11.

Rostow, W. W. (1952) *The Process of Economic Growth*, New York: W. W. Norton & Co.

Schultz, T.W. (1964) *Transforming traditional agriculture*, New Haven, CT: Yale University Press.

Skolka, J. (1989) 'Input-Output Structural Decomposition for Austria', *Journal of Policy Modelling*, 11(1), 45-66.

Tregenna, F. (2012) 'Sources of Subsectoral Growth in South Africa', *Oxford Development Studies*, vol. 40(2), 162-189.

UNIDO (2013) *Sustaining Employment Growth: The role of manufacturing and structural change*, Industrial development report 2013, Vienna, Austria.

Zakariah, A. R & Ahmad, E. E. (1999)' Sources of industrial growth using factor decomposition approach: Malaysia, 1979-87', *The developing economies*, XXXVII-2, 162-196.

Appendix 3.1 – Technical Details

Lowess Methodology and the U-shaped curve

Analogously to the procedure adopted in Imbs and Wacziarg (2003), the study employs a non-parametric methodology based on locally robust weighted scatter plot smoothing (LOWESS)7. In this procedure, each estimate x is a function of the xi's in the neighbourhood to be estimated, with the closest observations receiving more weight than the more distant observations. The LOWESS smoother requires specification of a span, which is the percentage or total number of observations to be included in the estimated regression at observation i. In this study the span adopted is 0.60 which means that 40 of total observations are used in each local regression. Moreover, the LOWESS uses a tricubic weighting function with the following formula:

$$w_i = \left(1 - \left|\frac{x - x_i}{d(x)}\right|^3\right)^3 \qquad (3.1)$$

Where x is the smoothed response, xi are the nearest neighbours of x as defined by the span, and d(x) is the distance along the abscissa from x to the most distant predictor value within the span. In the present study, as well as in Imbs and Wacziarg (2003), the response variable y corresponds to a measure of sectoral specialisation, while the independent variable x is the GDP per capita of each country (in 2005 dollars). The observations of x and y are the annual values of each indicator for the country under consideration. In this sense, the x values estimated by the nonparametric local regression will give form to a smoothed curve (U-curved) that connects x to y and represents the relationship between specialization and GDP per capita. The measure of sectoral specialization employed is the Gini-Hirschman index (GHI) which is obtained by taking the square root of the Hirschman-Herfindahl Index (HHI) and multiplying it by a 100. These indexes are defined as follows:

$$HHI = \sum_{i=1}^{n} \left(\frac{x_{ij}}{xj}\right)^2 \qquad (3.2)$$

$$GHI = 100.\sqrt{\sum_{i=1}^{n} \left(\frac{x_{ij}}{xj}\right)^2} \qquad (3.3)$$

[7] This method was first proposed by Cleveland (1979) and further developed by Cleveland and Devlin (1988).

In these equations, x_{ij} is the value added of sector i and x is the total value added of the country j and n is the number of sectors. Therefore, the higher is the GHI, the more specialised is the economy. The GHI is within a certain limit value. The maximum value of the index is 100 and in this case there is only one sector in the economy.

Decomposition of output growth

Analogously to the method used in Chenery (1960, 1962), the so-called Structural Decomposition Analysis (SDA) is applied following Miller and Blair's (2009) approach. The total output is defined as:

$$X = (I - A_d)^{-1}(D + E) \tag{3.4}$$

Where, A_d is the matrix of domestic inputs, D is the domestic demand of national goods and E is the exports. Considering the basic Leontief model for two periods t and $+h$, the vector of gross output (x) can be written as follows:

$$\mathrm{x^{t+h}} = \mathrm{L^{t+h}(D^{t+h} + E^{t+h})} \text{ and } \mathrm{x^{t}} = \mathrm{L^{t}(D^{t} + E^{t})} \tag{3.5}$$

Where the matrix $L(nxn)$ represents the Leontief matrix of direct and indirect production coefficients defined as $L = (I - A_d)^{-1}$. Thus, the change in gross output between two periods t and $+h$, can be rewritten as:

$$\Delta \mathrm{x} = \mathrm{x^{t+h}} - \mathrm{x^{t}} = \mathrm{L^{t+h}(D^{t+h} + E^{t+h})} - \mathrm{L^{t}(D^{t} + E^{t})} \tag{3.6}$$

Then through basic matrix algebraic manipulation, changes in L and $\mathrm{D} + \mathrm{E}$, and consequently effects on Δx are represented as:

$$\Delta \mathrm{x} = \mathrm{L^{t+h}(D^{t} + E^{t} + \Delta D + \Delta E)} - \left(\mathrm{L^{t+h}} - \Delta \mathrm{L}\right)\mathrm{(D^{t} + E^{t})} \tag{3.7}$$

$$\Delta \mathrm{x} = \mathrm{(L^{t} + \Delta L)(D^{t+h} + E^{t+h})} - \mathrm{L^{t+h}}\left(\mathrm{D^{t+h} + E^{t+h}} - \Delta \mathrm{D} - \Delta \mathrm{E}\right) \tag{3.8}$$

Additionally the equations are summarised according to the average approach. As argued by Dietzenbacher and Los (1998) this method enhances the SDA methodology. Thus, summing equations (3.7) and (3.8), and applying the average approach the following equation is obtained:

$$\Delta \mathrm{x} = \frac{1}{2}(\Delta \mathrm{L})\mathrm{(D^{t} + D^{t+h} + E^{t} + E^{t+h})} + \frac{1}{2}\mathrm{(L^{t} + L^{t+h})}(\Delta \mathrm{D}) + \frac{1}{2}\mathrm{(L^{t} + L^{t+h})}(\Delta \mathrm{E}) \tag{3.9}$$

Where the first term indicates the effects of the change in the Leontief coefficients over the change in gross output, the second term refers to the effects of the change in domestic demand, and the third, exports.

Assuming $A_d = A - A_m$, where A is the matrix of total inputs and A_m is the matrix of imported inputs, equation 3.9 can be re-written as:

$$\Delta x = \frac{1}{2}\left(L^t + L^{t+h}\right)(\Delta D) + \frac{1}{2}\left(L^t + L^{t+h}\right)(\Delta E) + \frac{1}{2}[L^{t+h}(-\Delta A_m)L^t](D^t + D^{t+h} + E^t + E^{t+h}) + \frac{1}{2}[L^1(\Delta A)L^t]\left(D^t + D^{t+h} + E^t + E^{t+h}\right) \quad (3.10)$$

The four components of total output change for any sector or subsector over the period h are thus calculated as follows:

Domestic demand $(\Delta D) = \frac{1}{2}\left(L^t + L^{t+h}\right)(\Delta D + \Delta E)$

Export $(\Delta E) = \frac{1}{2}\left(L^t + L^{t+h}\right)(\Delta E)$

Import substitution $(\Delta M) = \frac{1}{2}[L^{t+h}(-\Delta A_m)L^t](D^t + D^{t+h} + E^t + E^{t+h})$

Technological change $(\Delta T) = \frac{1}{2}[L^{t+h}(\Delta A)L^0]\left(D^t + D^{t+h} + E^t + E^{t+h}\right)$

The density of industrial chains

Rocha (2011) through the input-output framework decomposed import coefficients between inputs and final goods. In this analysis, import input coefficients by sector are defined as IIC and the total import input coefficient for the economy as TIIC.

Firstly define $A_{m\,(nxn)}$ as the matrix of direct import input coefficients:

$$A_m = \frac{Z^I}{x} \quad (3.11)$$

where $x_{nx1}$is the vector of gross is output and $Z^I_{nxn}$is the matrix of intermediate consumption.

Considering the Leontief matrix of direct and indirect production coefficients defined as $L = (I - A_d)^{-1}$ and multiplying it by $C^I$the following equation is obtained:

$$IIC^I = A_m(I - A_d)^{-1} \quad (3.12)$$

$$IIC^I_j = \sum_{j=1}^{n} CII^I_{ij} \quad (3.12)$$

$$IIC^I_{total} = \sum_{j=1}^{n}\left(CII^I_j . \frac{x_j}{x}\right) \quad (3.12)$$

where i and j indicate each economic sector (seller and buyer, respectively) and n is the total of these sectors.