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# Trade patterns in a globalized world: the case of Brazil*

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## Abstract

Globalization can be defined as the extent and intensity with which a country's production, trade and capital flows are integrated in the world economy. Our focus is on the globalization through international trade flows. After analyzing the main theoretical predictions about the effects of global trade integration on trade patterns between countries of different levels of income and technology, this paper investigates the case of Brazil, focusing on its trade integration over the last 26 years (1990-2016). Particularly, we are interested in investigating whether or not (and if so, to what extent) Brazil's recent trajectory has been directed to a regressive pattern of specialization. By regressive specialization we refer to that in which both production and export structures are strongly oriented to goods of low technological sophistication and low income-elasticity of demand. The recent theoretical literature on technological gaps and long-term growth suggests that, when a country enters into a quick and sustained regressive pattern of specialization, its capacity of showing growth rates aligned with its balance-of--payment equilibrium is reduced and, therefore, a falling behind trajectory is observed. Our main empirical findings are: (i) the technological gap significantly widened for all groups of manufactured goods classified by factor content and technological sophistication; (ii) the income elasticity of demand for Brazilian exports is greater than for Brazilian imports, suggesting a regressive specialization concentrated in low-tech goods and implying that growth has been constrained by long-term balance-of-payments equilibrium (Thirlwall's Law); and (iii) a very marked trend of high concentration of Brazilian exports in primary goods, but a more diversified basket of imports composed of high technologically sophisticated manufactured goods, reinforcing the regressive specialization of Brazil's trade pattern in the last decades.

**Keywords**: patterns of specialization; regressive specialization; diversification; Brazil.

## Contents

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# 1. Introduction

Globalization can be defined as the extent and intensity with which a country is integrated in the world economy. Although such integration can and does reach production, trade and capital flows, our focus is on the globalization through international trade flows. Even though other earlier waves of economic internationalization have happened—from the Industrial Revolution until the beginning of World War I —, the speed and intensity with which the present wave of trade globalization has spread over the entire world economy since the early 1980s has no precedent in modern occidental economic history. In fact, from the 1980s onwards, the rise and diffusion of the microelectronic revolution as well as the significant reduction of trade barriers also put pressure on most developing countries to accelerate trade integration into the world economy.

In the case of Brazil, for instance, between 1990 and 1994, after several decades of protectionist policies adopted under the import substitution development strategy, the Brazilian government decided to adopt a unilateral and ambitious trade liberalization programme, which eliminated most nontrade barriers and reduced average nominal tariffs for all goods from 30.5% to 11.2%.[1] Since several studies were released in the 1990s and 2000s with the goal of evaluating the impacts of the Brazilian trade liberalization experience on productivity, trade pattern, employment etc.,[2] this paper does not aim at replicating such studies. However, there is extensive literature documenting that two marked phenomena have characterized the Brazilian economy in the last 25 years: the first one is the significant and continuous reduction of the share of value-added industrial activities in the GDP;[3] and the second one is a recurrent long-term trend of overvaluation of the Brazilian currency in relation to the currencies of Brazil's main trading partners.[4] Although the second phenomenon may have contributed to deepening the first one, both may have influenced the observed changes in the pattern of trade integration of the Brazilian economy in terms of sectoral specialization, geographical composition of trade flows and the competitiveness of Brazilian goods.

This paper has two main goals: first, it reviews and analyzes the main theoretical predictions about the effects of global trade integration on trade patterns between countries of different income and technological levels; and second, it investigates the case of Brazilian trade integration over the last 26 years (1990-2016). Particularly, we are interested in investigating whether or not (and if so,

1 See Kume, Piani and Souza (2000, p. 11).

2 See Feijó and Carvalho (1994), Moreira and Correa (1998), Bonelli and Fonseca (1998) and Nassif (2003).

3 See Nassif (2008), Oreiro and Feijó (2010) and Nassif, Feijó and Araújo (2015), among others.

4 See Bresser-Pereira (2010), Nassif, Feijó and Araújo (2017) and Nassif, Bresser-Pereira and Feijó (2017).

to what extent) Brazil's recent trajectory has been directed to a regressive pattern of specialization. By regressive specialization we refer to that in which both production and export structures are strongly oriented to activities or segments of low technological sophistication and low income elasticity of demand.[5] As we will further discuss, the recent theoretical literature on technological gaps and long-term growth suggests that, when a country enters into a quick and sustained regressive pattern of specialization, its capacity of showing growth rates aligned with their balance-of-payment equilibrium is reduced and, therefore, it enters a "falling behind" trajectory, the term coined by Abramovitz (1986) to contrast with a "catching up" path.

For analyzing Brazil's recent change in trade patterns, we will estimate the following indicators:

i) income elasticity of demand for exports and imports;

ii) the composition and dynamics of both exports and imports classified by factor content and degree of technological sophistication;

iii) the degree of export diversification and the importance of the extensive and intensive margins of trade for Brazilian exports, whose indicators permit us to measure the extent to which Brazil's export expansion resulted from the increase of "old" goods that it traditionally exports (intensive margin) or from the raise of either "old" or "new" products highly demanded by global markets (extensive margin);

iv) the degree of concentration versus diversification of the export basket;

v) the index of intraindustrial trade; and

vi) the geographical distribution of exports and imports. Most indicators will be calculated through descriptive statistics, using a methodology compiled by Reis and Farole (2012).

This paper is divided into four sections, including the Introduction. Section 2 presents a theoretical analysis of the determination of trade patterns in a globalized economy, emphasizing recent theories of international trade and focusing on trade flows between countries with different per capita income and technological levels. Section 3 presents a general view of the Brazilian economy during the period under study and shows empirical evidence of Brazil's recent experience, based on the abovementioned indicators. Section 4 draws the main conclusions of the study as well as suggesting some policy implications.

5 Coutinho (1997) first coined the term "regressive specialization" when analyzing the Brazilian economy throughout the 1990s. In our paper, rather than production, we will emphasize the trade (export and import) structures.

# 2. Trade patterns in a globalized world: a survey of the theoretical literature

## 2.1 Trade patterns in traditional trade models of comparative advantage

The investigation of the determinants of trade patterns and the advantages of a country to engage in global trade has been a long tradition in economics. In the classical political economy, technological capacity was the main source for explaining different sectoral productivity levels between countries and, therefore, the existence of global trade. Adam Smith (1776/1937), however, was more concerned about the effects of global trade on a country's economic growth, while David Ricardo (1817/1951) and John Stuart Mill (1848/1970) deviated completely from the theoretical analysis to the effects of international trade on the allocative efficiency of productive resources and its capacity to increase social well-being by augmenting the trade volume between countries engaged in free trade. Indeed, in Smith's theoretical analysis, trade was driven by differences in sectoral absolute costs between countries (which, in turn, reflect differences of absolute technology and productivity), whereas in Ricardo's and Mill's analysis, trade was driven by differences in sectoral relative costs (which, in turn, reflect differences of comparative productivity). Since in Ricardo's and Mill's theoretical framework technology was exogenously determined and evaluated in comparative terms, they started a long-lasting tradition in which trade patterns were basically determined by supply-side forces.

In the modern neoclassical theoretical treatment of Ricardian analysis, the determination of trade pattern by comparative advantage depends on several unrealistic assumptions, such as perfect competition in goods and labor markets, total domestic labor mobility, technologies subject to constant returns to scale and full employment. Under such conditions, by extending the analysis to many goods (a *continuum* of goods), Dornbusch, Fischer and Samuelson's (1977) seminal paper showed that comparative advantage and trade pattern are jointly determined by different relative productivities at the sectoral level and different relative wages between countries. In fact, since differences in sectoral relative productivities are determined first and ranked for each country, and given a country's relative wage compared with another trade partner, it is possible to determine the range of goods in which each one of them has comparative advantage. As the expenditure shares are the same in both trade partners (homothetic demand), the demand side has no role in determining trade pattern. In such circumstances, international trade leads to complete interindustrial specialization, even considering that a subset of goods cannot eventually be traded, be it because relative unit labor costs (that is, the ratio of wage rates to labor productivity) are the same in both countries, or because transport costs can be high enough to work as a trade constraint.

Although the Ricardian hypothesis for determining a country's trade pattern (different sectoral relative productivities reflecting distinct relative technologies) has been supported by several empirical tests,[6] it was the Heckscher-Ohlin (H-O) version of comparative advantage that became the standard neoclassical trade model for explaining trade pattern, gains from trade and advantages of free trade policies. In fact, in an original paper written when Sweden was still a net export of agricultural goods, Eli Heckscher (1919/1991) argued that, in a world characterized by different relative factor endowments, each country tends to specialize in the production of goods intensively using the abundant factor, importing goods that intensively use the scarce factor. A doctoral thesis supervised by Heckscher, Bertil Ohlin (1924/1991) transformed those original views into an elegant mathematical framework that not only permitted the determination of a unique solution for the trade pattern, but also the establishment of a theoretical basis for developing a set of important theorems about global trade by neoclassical economists.

The original model proposed by Ohlin (1924/1991) is based on the following set of assumptions:

i) the technology of each industry *i*, subject to constant returns to scale, is the same for all countries in the world;

ii) there is no possibility of factor-reversal (that is, the technology cannot be reversed by changes in factor prices);

iii) each country ("region", in Ohlin's word) is defined by its relative factor endowment;

iv) each factor of production has perfect domestic mobility;

v) relative abundance or scarcity of each factor of production defines its relative price in autarky; and

vi) given production functions and preferences, each country has its relative goods and factor prices, output and resources allocation determined by the Walrasian general equilibrium mechanisms.

The main proposition of the H-O model is that each country exports goods that intensively use the abundant factor in their production, and imports those that intensively use the scarce factor.

In his book *Interregional and international trade*, Ohlin (1933/1968) showed that, if the world economy was characterized by industries that operate under perfect competition and factor immobility, free trade—by changing relative factor prices in each country—would be the main channel explaining geographical location of

[6] See McDougall (1951) and Eaton and Kortum (2002).

productive activities and pattern of specialization. It is worth noting that, in the H-O model, the unrealistic assumption of identical and unchanged sectoral technologies between countries is kept even when relative factor prices are changed by free global trade. In a word, trade is the main channel through which each country can surpass the scarcity of some factors of production.

The original presentation of the H-O model in a Walrasian general equilibrium framework eased the development of important theorems related to free trade. The first one, shown by Samuelson (1948; 1949), is the factor price equalization theorem, which predicts that, under a set of restricted conditions, such as perfect competition in goods and factors markets (in a model of two sectors and two factors), homothetic demand and trade completely determined by the H-O proposition, free trade integration tends to generate a total equalization of goods and factor relative prices since both goods will be produced by both countries. The intuition of this theorem is simple: since a country can use more than one factor (say, capital and labor, and not only one factor, as in the Ricardian model), trade in goods generates a full equalization of factor relative prices through full equalization of goods relative prices.[7] As Feenstra (2004, p. 13) points out, the factor equalization theorem suggests that "trade in goods is a perfect substitute for trade in factors". In the face of large inequality in wages between countries in the global economy, the theorem has a very unrealistic conclusion. However, it demonstrates that free global trade at least generates changes in relative goods and factor prices compared with those observed in autarkic conditions.

The second theorem, demonstrated by Stolper and Samuelson (1941), shows that, if comparative advantage is the main force to govern trade patterns in the global economy, free trade can predict net gains for society as a whole in each country, but its impacts on income distribution is unequal among the factors' owners. The intuition of this theorem is also quite simple: it says that, if two goods are produced under constant returns to scale and perfect competitive conditions in a country, the engagement in free trade relations tends to increase the relative price of the exported good and, therefore, to also increase the relative price of the factor intensively used in its production; but it tends to decrease the relative price of the imported good as well as the relative price of the factor intensively used in its production. In a word, the Stolper-Samuelson theorem shows that free trade redistributes the national income to the owners of the abundant factor in such a way that the main losers are the owners of the scarce factor.

It is curious that most studies based on the H-O model do not worry about the eventual effects of technological change on a country's trade pattern. If technical progress occurs, it is always an exogenous phenomenon. The same cannot be

7 For an original mathematical demonstration, see Samuelson (1949), and for a rigorous recent demonstration, see Feenstra (2004, p. 13-15).

said about changes in a country's endowment. In this case, as the third theorem derived from the H-O model stresses (the Rybczynski theorem), a change in factor endowment of a country will change the relative output of the economy. Rybczynski (1955) supposes two factors (say, natural resources and labor) and two industries (one natural resource-based, and the other, labor-intensive) subject to constant returns to scale and perfectly competitive. If new large sources of natural resources are discovered in a country, there will be a disproportional rise in the output of the natural resource-based sector and a contraction of the labor-intensive. This result depends on the relative factor prices remaining unchanged, a requirement that is easily satisfied because the relative demand of the factors is going in opposite directions (while demand of natural resources is increased, the demand of labor is contracted proportionally).

It is important to remember that the normative implications of the H-O model and the factor price equalization theorem were severely criticized by Latin American economists in the early 1950s. The most severe attack came from Raúl Prebisch, the second executive secretary of the United Nations Economic Commission for Latin America and the Caribbean (Eclac). In an influential paper, Prebisch (1950) criticized the main hypothesis that supports the factor price equalization theorem: first, while the theorem predicts that the engagement of primary products exporting countries in global free trade would favor relative prices and industrialization by importing capital goods with falling relative prices, Prebisch (1950) argued that such a result depends on the income elasticity of demand of both goods being equal to one, a hypothesis not held in practice;[8] and second, as empirical evidence shows that manufactured goods (the main imported good of Latin-American countries) have much higher income elasticity of demand in the long run, periphery countries specialized in primary and commodity goods have their long-term economic growth recurrently constrained by balance of payments crisis.[9,10]

Indeed, the soundness of the H-O model as a general theoretical approach to explain trade patterns and gains from trade has long lived up to theoretical and empirical proofs. The theoretical model was originally developed for two sectors, two factors and two countries (2x2x2 model). However, if we consider an extended H-O model including many goods, many factors and many countries,

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8 In Prebisch's (1950, p. 1, italics ours) words, "it is true that the reasoning on the economic advantages of the international division of labor is theoretically sound, but it is usually forgotten that *it is based upon an assumption which has been conclusively proved false by facts*. According to this assumption, the benefits of technical progress tend to be distributed alike over the whole community, either by the lowering of prices or the corresponding raising of incomes".

9 As Thirlwall (2011, p. 13) recognized, Prebisch's (1950) equation expressing his centre-periphery model was "the true forerunner of my [that is, Thirlwall's] balance of payments constrained growth model developed much later".

10 Needless to say, Prebisch's (1950) criticism was related to the long-term trend (or secular trend) of the income elasticity of demand of manufactured goods *vis-à-vis* primary and commodity goods. In other words, rather than static gains from trade, Prebisch was worried about the dynamic effects on economic development for countries unconditionally engaged in free global trade and specialized in primary goods.

the determination of the trade pattern becomes quite complicated. Several studies have shown that the trade pattern, the factor price equalization and the Stolper-Samuelson theorem are only rigorously determined if the number of goods, factors and countries is equal. In the more realistic case in which the number of goods is higher than the number of factors (maintaining two trade countries), the trade pattern is indeterminate (FEENSTRA, 2004, p. 65).

At the empirical level, the most controversial result was the famous Leontief's (1953) test which, by calculating the capital/labor ratio for US exports and imports for 1947, showed that the share of US exports was mostly labor-intensive. Since the US was then considered a capital abundant country, the Leontief paradox revealed the theoretical inability of the H-O model to explain the country's trade pattern. Since Leontief's (1953) test was published, the H-O model has been subjected to a continuing debate between Neoclassical and Structuralist economists. Within the Neoclassical framework, the first discussions concentrated on possible explanations for the Leontief test to not validate the H-O predictions, such as having ignored other factors of production (e.g., land) rather than capital and labor as well as not having considered skilled and unskilled labor. At the empirical level, since the original H-O model did not take into consideration all these hypotheses, this kind of criticism is misleading (FEENSTRA, 2004, p. 37).

Since then, empirical tests on the main predictions of the H-0 model have used the procedure suggested by Vanek (1968), according to which, instead of the capital-labor ratio of exports and imports, as in Leontief's test, the test should estimate the factor content of exports as well as the factor content of imports. Through input-output matrices, he suggests computing the factor service content in each exported and imported good. For instance, an estimate of Brazil's net exports (calculated as the difference between the domestic output and domestic consumption) results in the difference between the factor content of its exports and the factor content of its imports. If the difference is positive, it means that Brazil exports (on net) the services of this input; if the difference is negative, it means that Brazil imports (on net) the services of this input. The Heckscher-Ohlin-Vanek (H-O-V) model is appealing for permitting friendlier empirical tests on trade pattern based on the factor proportion model. However, the Vanek (1968) model requires several restricted assumptions, such as identical constant-returns-to-scale technologies for all countries in the world and total factor price equalization. Despite this, the modern acceptance of factor proportion theory is considered within the H-O-V framework.[11]

As to Structuralist criticisms on the H-O model, the Leontief paradox gave rise to several academic studies in the 1960s aiming at investigating new hypotheses

[11] See, for instance, Helpman and Krugman (1985, ch.1) and Feenstra (2004, p. 37-56) for mathematical demonstrations. See Helpman (2011, p. 38-45) for textual presentation.

for explaining trade patterns in the manufacturing sector as well as the dynamic effects of global free trade on long-term growth. This will be discussed in the following subsections.

## 2.2 From the heterodox models of the 1960s to the "new trade theories" of the late 1970s and onwards

### *2.2.1 Linder's demand-push trade model and the "new trade theories" of the late 1970s and onwards*

The so-called "new trade theory", a modern theoretical current of international trade captained by Paul Krugman, Elhanam Helpman, Anthony Venables, James Brander, Barbara Spencer and others, justifies the adjective "new" because most models incorporate imperfect competition, increasing returns to scale and the dichotomy of homogeneous versus differentiated goods as basic assumptions. However, such assumptions had been considered by heterodox authors in the 1960s, like Staffan Linder (1961), Michael Posner (1961) and Raymond Vernon (1966). Indeed, differently from the former group of authors, this latter group, as they did not construct formal trade models, treated forces such as oligopolistic or monopolistic competition, product differentiation and economies of scale more as possibilities than precise hypotheses. Even so, the major innovation of some of these models pioneered a demand basis trade theory for explaining a country's international competitiveness for exporting manufactured goods. In this subsection, we will only present the Linder (1961) model.

Linder (1961) accepts the theoretical hypothesis of factor endowment for explaining international trade of natural resource-based goods (especially agricultural goods). However, he rejected the H-O model in the explanation of international trade in manufactured goods. His model is one of the first to emphasize the central role of domestic market size in providing demand high enough for creating potential international competitiveness for a country to export manufactured goods. Like under free trade, the initial costs are high enough for firms of the manufacturing sector to export. As a matter of fact, Linder (1961) stresses that a "representative demand" must exist in the domestic market before the global markets can be reached. In other words, as most industrial firms of the manufacturing sector must choose technologies subject to increasing returns to scale, they will not be able to have international competitiveness for exporting such goods if the size of the domestic market is not large enough to provide them minimum efficient scales. For Linder, then by taking advantage of their proximity to their respective domestic markets, firms seek to explore economies of scale to reach foreign markets in the future. In Linder's (1961) theoretical model, the higher a country's per capita income, the higher will be the size of its domestic demand and the more sophisticated will be the demand pattern. Thus, its potential for exporting manufactured goods will be higher. His main conclusion is that countries with the highest and closest levels of per capita income have a significant share of their manufacturing trade characterized by intraindustrial trade of differentiated goods. The importance of Linder's theoretical model is that he was the first to explain the predominance of manufactured goods in the trade among countries of similar per capita income. His main contribution is that he was the first to not only indicate economies of scale and product differentiation as the main sources of intraindustrial global trade, but also to suggest that such sources are primarily realized in the domestic marketplace, before firms are able to compete in the global markets.[12]

Yet, from the late 1970s on, a set of neoclassical models labelled by Krugman (1990a) as "new trade theory" began to appear. Rather than for having incorporated imperfect competition, the adjective "new" can be justified by three main reasons:

i) First, because these models demonstrated that, in certain oligopolistic cases, as trade pattern depends on a combination of complex factors existing in each country, such as market size, number of competing firms, factor prices, barriers to entry etc., its theoretical determination is much harder to predict; in some cases, the trade pattern is either undetermined (see HELPMAN; KRUGMAN, 1985, p. 86-88) or presents multiple equilibria (see HELPMAN; KRUGMAN, 1985, p. 53-55);

ii) Second, because these authors mathematically demonstrated the original Graham's (1923) conjecture according to which, in the presence of economies of scale and market power, trade globalization can, under certain conditions, lead to an unequal distribution of gains among countries. If, for example, trade reallocates productive resources from sectors subject to increasing returns to scale to sectors subject to constant returns to scale in a country, all gains from trade may be appropriated by the countries whose reallocation of resources happened in the opposite way (see HELPMAN; KRUGMAN, 1985, p. 50-55);

iii) And third, because, by using Vanek's (1968) suggestion of estimating the trade pattern based on the factor content services presented in both exports and imports, these models also seek to show how the basic H-O-V model can interact with new models incorporating economies of scale, product differentiation and monopolistic competition.

In this section, as we are interested in cases in which the trade pattern can be determined and the gains from trade are assured for all countries, the new trade

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[12] It is unacceptable that Linder's (1961) contribution, despite being recognized by Krugman's (1979) seminal paper, has been omitted from the bibliographic references in Krugman, Obstfeld and Melitz (2012), Helpman and Krugman (1985) and Feenstra (2004), the three leading textbooks in undergraduate and graduate courses.

theory shows that such cases are only guaranteed if imperfect competition assumes the monopolistic competition form.[13] In the basic model presented by Krugman (1979, 1980), an industry from two countries is composed of several firms producing a large number of differentiated goods and competing in monopolistic competition. Despite all firms using only one factor of production (labor), as technology is identical for all firms, but subject to economies of scale, and all differentiated products enter symmetrically into demand, each firm produces only one differentiated and close substitute good. As competition is driven by product differentiation, each firm chooses its price and maximizes profits by equalizing marginal revenue to marginal cost, but ignoring the prices fixed by their competitors in the market.

To demonstrate that the economies of scale are the main cause for trading, Krugman (1980) also supposes that both countries have the same factor endowments and technological level. Considering zero transport costs, if these countries decide to engage in free trade, rather than being driven by any difference between relative costs or factor endowments (as in traditional models of comparative advantage), trade pattern will be determined by economies of scale and product differentiation, in such a way that each differentiated good is produced by only one firm and in only one country.[14] Differently from comparative advantage, in which trade pattern is of the interindustrial type, trade pattern driven by economies of scale and product differentiation is of the intraindustrial type. As Krugman (1980, p. 952) concludes, "gains from trade will occur because the world economy will produce a greater variety of goods than would either country alone, offering each individual a wider range of choice". Even though the **direction** of trade is undetermined, since all range of goods are differentiated, it does not matter who produces what, but rather that trade integration provides a greater **volume** of varied goods. In an extended model, Krugman (1980) also considers the case in which one of the two countries has a larger domestic market than the other. The result is as intuitively expected: since a larger domestic market has a major potential for exploring economies of scale, the bigger country will be a net exporter of all range of goods whose technology is subject to increasing returns to scale, as had already been suggested by Linder (1961).

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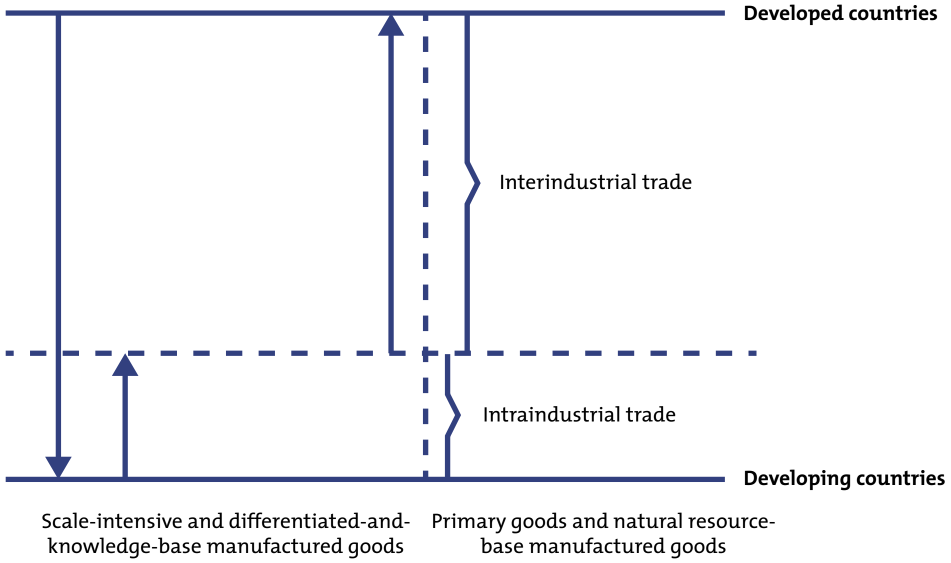
[13] We leave the cases in which the presence of increasing returns to scale makes a country reduce its social well-being and long-term growth after engaging in free trade for the next section.

[14] The introduction of transport costs does not modify the general results. See Krugman (1980, section II, p. 953-955).

**Figure 1.** Global trade between developed and developing countries




Source: Elaborated by the authors, based on Krugman (1990b, p. 77).

In another paper, Krugman (1981) integrated the traditional Heckscher-Ohlin trade model with the main features of the new trade theory, whose results are illustrated in Figure 1. With this paper, Krugman completed the trilogy that might have justified his Nobel Prize laureate in 2008.[15] Krugman (1981) proposed a model in which the global economy is composed of several countries defined by either their similarity or differences in their factor endowments.[16] In practical terms, if we divide this world into two groups of countries, the first would be formed by all capital-abundant developed countries, while the second would be composed of all natural-resources-abundant developing countries. The global output is composed of two sectors: a capital-intensive, which produces scale-intensive and differentiated-and-knowledge-based manufactured goods subject to increasing returns to scale and monopolistic competition; and a natural resource-based, which produces primary and natural-resource-based manufactured goods subject to constant returns to scale and perfect competition.

As Figure 1 illustrates, given the different factor endowments of the two groups of countries, a free integration of their markets implies that the resulting net trade pattern will be mainly driven by the traditional H-O model and predominantly of interindustry type. In other words, while the developed countries will be net

15 The trilogy is composed of the 1979, 1980 and 1981 Krugman papers (the 1990's paper summarizes the 1981's). According to the Nobel Prize Committee, Krugman was honoured with the prize in economics in 2008 "for his analysis of trade patterns and location of economic activity". See <https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2008/press.html>.

16 This is a free adaptation of Krugman's (1981) seminal model, which was summarized by Krugman (1990b). In this model, instead of capital and labor factors of production, the author uses only labor, differentiated by labor type 1 and labor type 2. Two countries will have identical factor endowments, if, by indexing their respective labor force as $L_1 = 2 - z$ and $L_2 = z$; and $L_1^* = z$ and $L_2^* = 2 - z$ (asterisks refer to the second country), the result for $z$ is equal to 1.

exporters of technologically sophisticated manufactured goods, which intensively use the services of the abundant factor (capital) available in this group, the developing countries will be net exporters of primary goods and industrial commodities, which intensively use the abundant factor (natural resources) available in this group. However, there may be a range of intraindustrial trade in scale-intensive and differentiated-and-knowledge-based manufactured goods between both groups, but the more different their respective factor endowments, the smaller the volume of such flows, which are, as already shown, driven by economies of scale and product differentiation. Summing up, Krugman's (1981) model demonstrates why most of the global flows of technologically sophisticated manufactured goods are concentrated in rich countries whose factor endowments are similar to each other.

### 2.2.2 The "new new trade theories" of intrafirm global trade and theoretical models explaining the genesis of global value chains

More recently, a new generation of neoclassical trade models (the "new new trade theory") has predicted intrafirm global trade in which a significant share of manufactured goods is produced and traded by heterogeneous firms ranked among the highest level of productivity (HELPMAN, 2011, ch. 5; MELITZ; TREFLER, 2012). Melitz (2003) developed the seminal intrafirm trade model. By departing from similar assumptions on intraindustrial trade with monopolistic competition, Melitz (2003) assumes that a firm's entry into a segment of differentiated manufactured goods depends on its expectation of profits to cover, at least, the research and development (R&D) costs of its differentiated good as well as the costs of manufacturing it. In Melitz's model, there is free entry and exit of firms in an industry for developing and manufacturing each specific good, but profitability is highly uncertain because it depends on the unknown firm's total factor productivity (TFP). In a strategy to decide whether or not to develop and manufacture a new good, a firm estimates different levels of productivity, which are decomposed into expected productivities if all goods are for selling in the domestic market, in foreign markets or both. The decision to distribute part of the total production to foreign markets involves additional costs because the firm must face variable trade costs, such as transport costs, tariffs imposed by importing countries and other trade costs.

Despite not emphasizing it, Melitz (2003) implicitly assumes Linder's hypothesis that larger domestic markets tend to generate higher levels of productivity than smaller ones. Thus, in his model, firm size matters for determining their corresponding level of productivity, in such a way that the largest firms, by being more able to draw gains from static economies of scale, have higher levels of productivity and major potential to export. In these circumstances, by integrating into the global markets, these firms tend to maximize their gains from productivity resulting from higher economies of scale and the expanded market. The impact of global trade integration is similar to that of Krugman's model: it puts each surviving firm's demand up, making it more elastic due to the joint effect of more competition and bigger market size. Although the markup of the largest surviving firms is reduced, they can increase their operating profits due to the effect of higher market shares.[17] However, as Melitz and Trefler (2012, p. 101) point out,

> economic integration through market expansion does not directly affect firm productivity. Nevertheless, it generates an overall increase in aggregate productivity as market shares are reallocated from the low-productivity firms with high marginal costs to the high-productivity ones with low marginal costs.

In other words, the increase in aggregate productivity results in a reallocation of resources within the industry.

As exports are not the only way of reaching global markets and since the majority of world trade in goods and services are driven by multinational firms, trade economists have also been modelling the possibility of firms to establish affiliates abroad. The three main cases are the vertical multinational FDI (foreign direct investment), which occurs when a multinational firm chooses to keep its headquarters in one country and production in another with the goal of taking advantages of factor price differences across countries in the world economy (HELPMAN, 1984); the horizontal multinational FDI, which occurs when a multinational firm decides to operate plants with specific fixed costs in multiple countries, which are chosen considering the different transport costs between them (MARKUSEN, 1984; 2002); and complex integration, which occurs when multinational FDI combines both vertical and horizontal strategies in the world economy in such a way that, as summarized by Helpman (2011, p. 146-147), subsidiaries of multinational companies sell their products in host countries and import intermediate inputs from parent firms. But they also export products to their parent countries as well as to third markets, to affiliated parties and nonaffiliated parties alike.

Since complex integration has been not only the most registered form of multinational FDI, but also the mechanism through which the global value chains are interconnected, it is worth analyzing its main determinants. Helpman (2011, p. 148) suggests "thinking about horizontal FDI, vertical FDI, and platform FDI as interrelated

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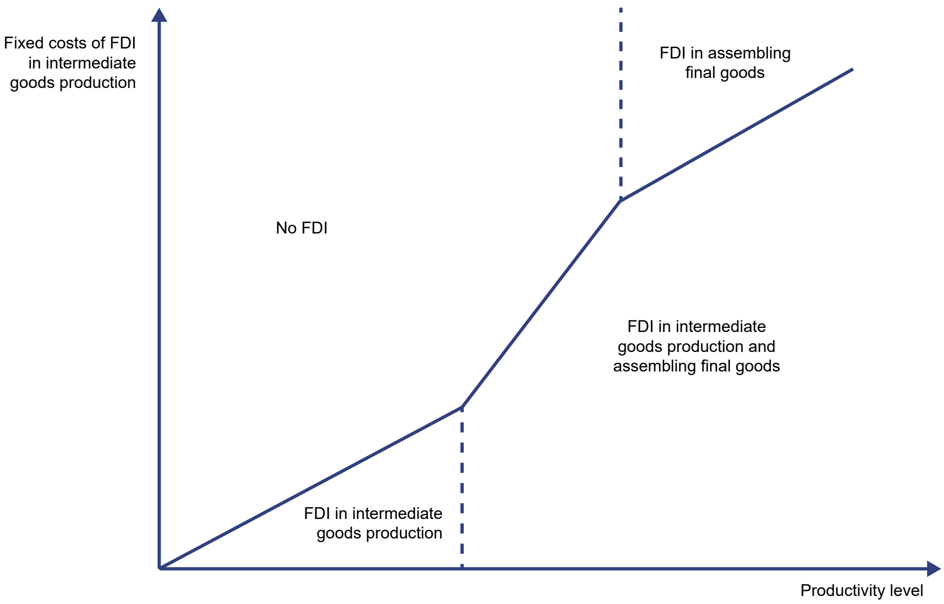
17 By comparing a situation that occurred pre-and-post a trade liberalization reform, this only happens for firms that choose to produce and sell for both domestic and foreign markets after trade liberalization reform. For firms that choose only to produce and sell in domestic markets, the operating profits are reduced due to the fall in prices resulting from foreign competition. For details, see Melitz and Trefler (2012, p.103-109).

strategies".[18,19] A theoretical model is summarized as follows.[20] The world economy is represented by a set of big countries from the North (the United States, France and Germany) and small countries from the South (the Philippines, Vietnam and Indonesia). There are several intermediate inputs for production of a final differentiated good, and their location in each of the countries depends on different fixed costs of FDI in intermediate goods as well as the productivity levels of heterogeneous firms.

**Figure 2.** FDI strategies and the genesis of global value chains in the world economy




Source: Helpman (2012, p. 151).

Figure 2 illustrates four different strategies of FDI that generate and spread global value chains in the world economy. In the absence of transport costs and for a given fixed cost in assembling final goods, the first strategy occurs when higher fixed costs of FDI in intermediate goods production imply that neither FDI in assembly nor in production of intermediate goods in the South countries can be utilized by very low-productivity firms from the North. This is because they are unable to cover the fixed costs. The second strategy occurs when firms from the North have high productivity levels that can offset high fixed costs of FDI. In this case, they can invest in both intermediates and assembly goods in the South countries. In the third strategy, the above-average-productivity firms from

18 For "platform FDI", Helpman (2011) refers to "the acquisition of subsidiaries whose purpose is to export their products to third countries (that is, not to the country in which the parent firm is located)".

19 This suggestion is based on 2003 data on different strategies of US companies across the global economy. Helpman (2011, p.148) documents that "while American companies operating in Greece were primarily driven by horizontal FDI considerations, since they exported back to the United States only 1 percent and to third countries only 8 percent of their total sales, in Ireland and Belgium investment was driven primarily by platform FDI. And in Malaysia and the Philippines, both vertical FDI and platform FDI played in important role".

20 This theoretical model is a slightly modified model summarized by Helpman (2011, ch.6).

the North can engage only in assembling final goods in the South countries. They are unable to produce intermediate goods due to their extremely high fixed costs. In the fourth strategy, low-productivity firms can engage in FDI in intermediate goods in the South if, and only if, the fixed costs of their inputs are low enough to offset their low productivity levels. Although these models were designed to understand different strategies of multinational FDI pursued by the largest firms from North developed countries, they also clearly suggest that most firms from South developing countries—being characterized by smaller sizes—are hardly able to engage in FDI and create multinational enterprises.[21]

## 2.3 A Structuralist-Neoschumpeterian technological gap model: trade patterns and growth dynamics

As all the conventional models previously analyzed assume that either factor endowment or technology is exogenous, both trade patterns and the gains or losses from trade are evaluated in static terms. Although few theoretical trade models are worried about the dynamic impacts of free trade on countries' long-term growth, Grossman and Helpman (1991), on the Neoclassical front, and Dosi, Pavitt and Soete (1990), on the Structuralist-Neoshumpeterian approach, show consistent predictions about the countries' engagement in the global economy. In practical terms, the great challenge for developing countries characterized by large technological and productivity gaps in relation to developed countries is to evaluate the extent to which unconditional adoption of free trade policies could significantly reduce their long-term growth. This issue is clearly analyzed by both Neoclassical (GROSSMAN; HELPMAN, 1991) and Neoschumpeterian (DOSI; PAVITT; SOETE, 1990) approaches. Despite their quite different methodological frameworks, they reach similar conclusions.[22] The most important cases are as follows. The first one is to consider the global economy composed of two countries that produce manufactured (the capital-intensive sector, subject to increasing returns to scale and product differentiation) and traditional goods (the labor-intensive sector that operates under conditions of constant returns to scale) and are completely similar in terms of endowments or technologies and accumulated knowledge. If these two countries decide to integrate their markets through free trade practices, both could sustain the same long-term growth rates only and only if the same rate of innovation is observed in both countries. Free trade benefits both countries by enlarging the variety of traded goods, but the net dynamic effect of global trade to long-term growth would be zero.

[21] The obvious exception is (or tends to be) Chinese firms that operate in several industries, especially in manufacturing and service sectors.

[22] Among other aspects, while the Neoclassical Grossman and Helpman's (1991) model assumes several unrealistic hypotheses such as free entry in the research and development (R&D) sector (notwithstanding that it is subject to large increasing returns to scale) as well as treating technology as a service easily absorbed by firms through the knowledge transmission channels, Dosi, Pavitt and Soete's model (1990) gives up on the method of general equilibrium, refuses the idea that technology can be freely traded in domestic and global markets and accepts the assumption that the pattern of specialization can have long-term cumulative (positive or negative) effects.

The second case is to consider the global economy formed by two groups of countries that produce the above-mentioned kinds of goods: the first group is composed of the developed innovator countries characterized by high per capita income, high levels of aggregated productivity and technological capabilities close or equal to the technological frontier; the second group gathers all developing imitator countries characterized by per capita incomes close to the average of the world economy as well as significant technological and productivity gaps in relation to developed countries. Since these assumptions are closer to the reality of periphery countries like Brazil, we will briefly present a Structuralist-Neoschumpeterian model proposed by Cimoli and Porcile (2010),[23] who replicate more realistically long-term growth dynamics and implications of their engagement in free international trade.[24]

Cimoli and Porcile (2010) depart from Dornbusch, Fischer and Samuelson's (1977) Ricardian model of comparative advantage of a *continuum* of goods. We will adapt this model to a world composed of two groups of countries: the North innovator countries (N), specialized in the production of manufactured goods and services of high technological sophistication; and the periphery-South imitator countries (S), specialized in the production of primary and low-tech goods. Assuming that labor is the only factor of production, the static pattern of comparative advantage of the South imitator countries is ranked in a decreasing order:

$$\frac{a_1^*}{a_1} > \frac{a_2^*}{a_2} > \ldots > \ldots > \frac{a_n^*}{a_n} \tag{1}$$

where $a_n$ is the labor requirement for producing a unit of good $n$ and the symbol "*" refers to North innovator countries. Relative labor requirements are a function of the technological gap. In other words, relative productivity of South countries is greater in the first $a_n$ goods (because they require lower labor inputs), in our case, in primary and low-tech goods. Since the model is a *continuum* of goods, we can also rank them in a [0,1] interval according to a decreasing order of comparative advantage of South imitator countries, in such a way that:

$$A(z) = \frac{a^*(z)}{a(z)} \tag{2}$$

is a function in which good $z$ is associated with each point in the [0,1] interval, with $A(z)$ continuous and decreasing in $z$; that is, the comparative advantage of

[23] The basic model was firstly presented by Cimoli, Dosi and Soete (1986), Cimoli (1988) and Dosi, Pavitt and Soete (1990). In this paper, we will strictly follow Cimoli and Porcile's (2010) model.

[24] Even considering their quite different methodological approach, Grossman and Helpman's model (1991, ch. 9, p. 246-250) has similar results to the Cimoli and Porcile one presented afterwards. Yet, it is interesting that in his book entitled *Understanding the global trade*, written without formalism with the goal of reaching a large audience, Helpman (2011) put aside the dynamic implications of an unconditional engagement in free trade for developing countries, especially lower long-term growth rates when their technological gap is large in relation to developed countries.

periphery-South imitator countries to North innovator countries in industry $z$ has a decreasing ranking, or $A'(z) < 0$.

With many goods, comparative advantage in each country depends not only on relative labor productivity, but also on relative wages between the two groups of countries $w/w^*$. Thus, the good $z$ will be produced in the South countries if:

$$a(z)w \leq a^*(z)\, w^* \tag{3}$$

Rearranging (3), we obtain:

$$\frac{w}{w^*} \leq \frac{a^*(z)}{a(z)} \tag{4}$$

By defining:

$$\omega \equiv \frac{w}{w^*} \tag{5}$$

we obtain:

$$\omega \leq A(z) \qquad (6)^{25}$$

Given ω, South countries will produce (and so will have comparative advantage)[26] in the following interval of goods:

$$0 \leq z \leq \tilde{z}(\omega) \tag{7}$$

Taking (6) as an equality, we can define the border for good $z$ as:

$$\tilde{z} = A^{-1}(\omega) \tag{8}$$

As $A^{-1}$ is an inverse function of $A(\omega)$, the pattern of specialization of North innovator countries will be concentrated in the interval:

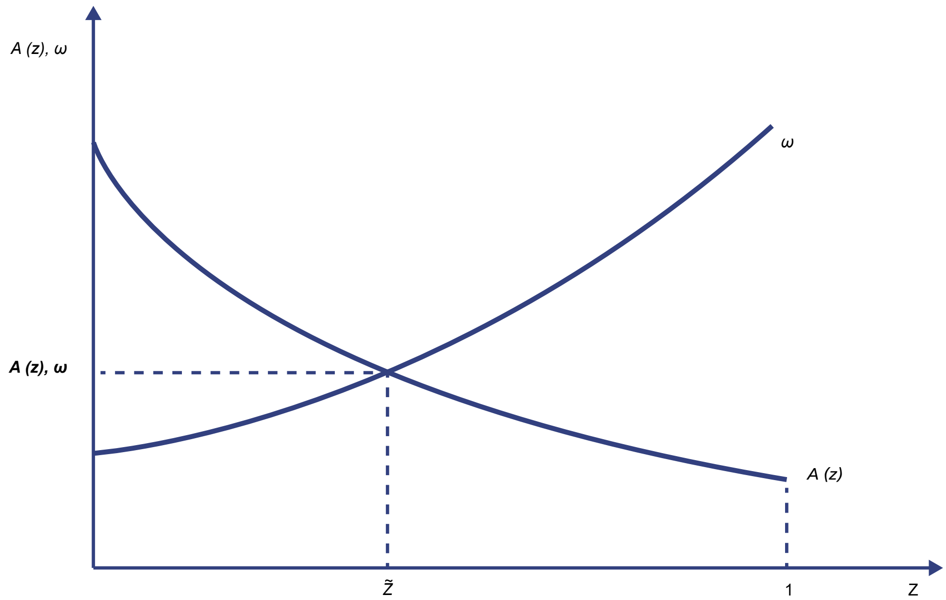
[25] Since Cimoli and Porcile (2010) assumed that wages are measured in nominal terms in both countries (according to their respective currencies), they had to consider the nominal exchange rate to put both wages in a common currency unit. However, for simplicity, we follow the original Dornbusch, Fischer and Samuelson's (1977) assumption according to which wages are measured in real terms (as units of required labor) in both countries.

[26] As is well known, the Ricardian model of comparative advantage predicts complete specialization in such a way that all goods in which a country has comparative disadvantage will be produced by its trade partner. For details, see Krugman, Obstfeld and Melitz (2012, ch.3).

$$\tilde{z}\,(\omega) \leq z \leq 1 \qquad (9)$$

Figure 3 shows the structure of production and pattern of specialization as a decreasing function of $\omega$, the relative wage between South and North countries. A($z$) is a decreasing curve because South countries lose comparative advantage as the economy moves towards goods of higher technological sophistication. Yet, $\omega$ is an increasing curve in $z$ because, as the South countries tend to diversify their economies, the rise in demand for labor implies an increasing of $\omega$. Figure 3 suggests that an increase in wages in South countries relative to those in North countries will shift the $\omega$ to the left, reducing the set of goods produced and exported by the former group of countries.[27] Under conditions of perfect competition, comparative advantage depends simultaneously on relative productivities and relative wages between the two groups of countries. In such circumstances, South imitator countries will have comparative advantages in all goods for which A($z$) > $\omega$. In the world trade equilibrium, their production and export structures cover all goods from 0 to $\tilde{z}$, while those of the North innovator countries cover the goods from $\tilde{z}$ to 1.[28]

**Figure 3.** Static pattern of specialization in the Ricardian model with a *continuum* of goods




Source: Dornbusch, Fisher and Samuelson (1977, p. 825).

From this point on, differently from Dornbusch, Fischer and Samuelson's (1977) static model, which assumes labor market-clear conditions as well as homothetic

[27] In a comment on this result, Dosi, Pavitt and Soete (1990, p. 202) remind us that "it also applies in those cases where there are capital inputs and positive profits, provided that there is no 'reswitching of commodities'".

[28] Note that at the borderline $\tilde{z}$, as comparative advantage is the same for all groups, there is no international trade for this good.

preferences of the demand functions, we will consider Cimoli and Porcile's (2010) dynamic model through which both trade pattern and the effects on long-term growth are simultaneously determined. The following assumptions are implicitly introduced in the model:

i) Based on Engels's microeconomic laws, the *n* goods can show a wide range of price and income elasticities.

ii) Although there is only one factor of production (labor), the economic system is formed by workers and capitalists, who make the initial financial funds required for contracting workers.

iii) All goods are produced under conditions of imperfect competition, in such a way that the entrepreneurs fix prices according to a mark-up *m* on average labor costs. Thus, the set of goods *z* will be produced in South imitator countries if $mwa_z < m^*w^* a^*_z$.

iv) Since perfect competition is also removed from labor markets, the nominal wage is the result of bargaining between labor unions and entrepreneurs.

v) Rather than labor constrained, capitalist economies are balance-of-payments constrained in the long run.

vi) Given the state of technology, capitalist economies are generally below full employment; in the short run, economic activity depends on effective demand in the spirit of Keynes (1936).

vii) In the long run, changes in technology are endogenously determined and affected by expected demand.[29]

By allying with the Structuralist view pioneeringly exposed by Raúl Prebisch (1950), Nicholas Kaldor (1966) and A. P. Thirwall (1979), Cimoli and Porcile (2010) present a model in which not only the pattern of specialization, but also the pace of long-term growth are affected by the technological gap (*TG*), defined as the relative technological levels in North innovator ($T_N$) and South imitator ($T_S$) countries, or:[30,31]

$$TG = \frac{T_N}{T_S} \geq 1 \tag{9a}$$

[29] Dosi, Pavitt and Soete (1990, p. 203), for instance, discard the possibility that technical progress can result from properties related to the steady-state equilibrium with "representative agents" and expectations according to "rational expectations".

[30] Most empirical studies used to take the relative average labor productivity between South and North countries as a proxy measure of the technological gap. In such cases, the technological gap *TG* varies in the interval $0 \leq G \leq 1$, as we will consider in the empirical section ahead.

[31] The remainder of this section rigorously follows Cimoli and Porcile (2010).

The dynamics of the technological gap is expressed by the following differential equation (the symbol "^" means change over time):

$$\widehat{TG} = \frac{d\left(\frac{T_N}{T_S}\right)T_S}{dt}\frac{T_S}{T_N} = a - cTG - bz \tag{10}$$

The differential equation (10) suggests that the pace of the technological gap between South and North countries is influenced by the actual technological gap level itself (*TG*) and the degree of diversification of the economy, captured by the *z* produced goods. The parameter *a* is the autonomous component of the pace of the technological gap and is expected to be positive. While the parameter *b* captures the ability of South countries to imitate innovation (both in process and products) introduced by North countries, the parameter *c* represents the opportunities and challenges posed by the actual technological gap at any time. While the expected sign of parameter *b* is positive (the more diversified the economy in producing *z* goods, the more rapid the South will catch up with North countries), the expected sign of parameter *c* is twofold: in line with Gerschenkron's (1962) hypothesis, a positive *c* means that there are larger opportunities and challenges for South countries to reduce the technological backwardness in relation to North countries over time; however, contrary to Gerschenkron's hypothesis, a negative *c*, by meaning a sharp deterioration of relative technological levels, could imply the deepening of technological backwardness of South countries over time and make it harder to catch up.

The pattern of specialization of the economy is also affected by the technological gap according the following equation (CIMOLI; PORCILE, 2010, p. 223):

$$\frac{a^*(z)}{a(z)} = A(z) = \gamma - \alpha TG - \beta z \tag{11}$$

where $\gamma$, $\alpha$ and $\beta$ are positive parameters. This implies that, if South countries are successful in reducing their relative technological gap, the curve *A(z)* in Figure 3 would be shifted to the right, meaning more diversification of South imitator countries towards a growing number of produced *z* goods.

To determine the growth dynamics in both groups, Cimoli and Porcile's (2010) model assumes no capital flows, in such a way that the current account in North and South countries must be in equilibrium. Since prices are formed by a mark-up rule ($p_z = mwa_z = mwL_z/y_z$; where *p* is the price of good *z*, *m* the mark-up, *w* the wage, $a_z$ the labor requirement for producing a unit of good *z*, *L* the total labor force, and *Y* the nominal income related to each good *z*), total nominal income of South countries can be expressed as (and, symmetrically, total nominal income in North countries is related to the production of goods $1 - \tilde{z}$):

$$\int_{z=0}^{z=\tilde{z}} mwL_z\,dz = mw\int_{z=0}^{z=\tilde{z}} L_z\,dz = mwL \qquad (12)^{32}$$

The current account equilibrium can be derived from the import demand functions in each group of countries (that is, the demand of North countries corresponds to South exports and vice-versa). If each good $z$ has the same share in total nominal demand in North and South countries, the share of imports in total demand of the North and South will be, respectively, $(w^*m^*L^*)\tilde{z}$ and $(wmL)\,(1-\tilde{z})$.[33] Then, by combining these expressions, the conditions for current account equilibrium can be expressed as:

$$mwL = \left(\frac{\tilde{z}}{1-\tilde{z}}\right) m^* w^* L^* \qquad (13)$$

The relative South-North aggregate income $Y_S/Y_N$ can be expressed as a function of the pattern of specialization:

$$\frac{Y_s}{Y_N} = \frac{mwL}{m^* w^* L^*} = \frac{\tilde{z}}{1-\tilde{z}} \qquad (14)$$

If $m = m^*$ and by rearranging (14), we can express the relative wage $w/w^*$ as a function of relative production structures and employment levels:

$$\frac{w}{w^*} = \left(\frac{\tilde{z}}{1-\tilde{z}}\right)\frac{L^*}{L} \qquad (15)$$

By differentiating equation (14) with relation to time, we can obtain the long-term relative economic growth of the South countries:

$$\frac{\dot{Y}_s}{Y_N} = \frac{\dot{\tilde{z}}}{(1-\tilde{z})^2} \qquad (16)$$

By multiplying and dividing the previous result by $\tilde{z}$, we obtain:

$$\frac{Y_s}{Y_N} = \frac{1}{1-\tilde{z}}\left(\frac{\dot{\tilde{z}}}{\tilde{z}}\frac{\tilde{z}}{(1-\tilde{z})}\right) \qquad (17)$$

Expressing $\frac{Y_s}{Y_N} = \tilde{z}/(1-\tilde{z})$ and dividing both sides of (17) by $\frac{Y_s}{Y_N}$, we find the long-term relative economic growth rate of South countries:

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32 The nominal income in production of each good $z$ is defined as $p_z y_z = mwL_z$. In the aggregation, Cimoli and Porcile (2010: 228) assume that $m$ and $w$ are the same in all economies.

33 Remember that, while the South produces all goods from $0$ to $\tilde{z}$, the North produces all those from $\tilde{z}$ to 1 (or $1-\tilde{z}$).

$$\frac{\hat{Y}_s}{Y_N} = \frac{\hat{\tilde{z}}}{(1-\tilde{z})} \tag{18}$$

Equation (18) shows that the technological gap is reduced in South imitator countries if and only if this group is successful in diversifying its productive structure. This occurs when $\tilde{z} > 0$ and South countries can grow at greater rates than North countries.

The more interesting part of Cimoli and Porcile's (2010) technological gap model is when they consider a more realistic case in which goods *z* have different income elasticities of demand. The demand function expressed in equation (13) is replaced by another in which the share of goods in total expenditure rises exponentially with the number of goods *z*. Equation (13), the condition for current account equilibrium in North and South (and remembering that South countries produce goods from *0* to $\tilde{z}$), is replaced by:

$$(mwL)^{1-\tilde{z}} = (m^*w^*L^*)^{\tilde{z}} \tag{19}$$

Expressing (19) in logarithms and differentiating both sides with respect to time (assuming *m* and *m** are constants), we obtain the dynamic condition for the current account equilibrium:

$$-\dot{\tilde{z}}\ln\left(mwL\right) + (1-\tilde{z})(\hat{w}+\hat{L}) = \dot{\tilde{z}}\ln(m^*w^*L^*) + \tilde{z}(\hat{w}^*+\hat{L}^*) \tag{20}$$

As in equilibrium $z = 0$ and, therefore, $z = \tilde{z}$, we finally obtain the long-term dynamic growth rate of South countries relative to North ones:

$$\frac{\hat{Y}_s}{Y_N} = \frac{\hat{w}+\hat{L}}{\hat{w}^*+\hat{L}^*} = \frac{\tilde{z}}{1-\tilde{z}} \tag{21}$$

With such different specifications for demand functions in both countries, the result shown in equation (21) suggests two important conclusions: (i) the relative growth rate of South countries depends on their ability to diversify their economies, in such a way they will only be able to catch up with North countries if $\tilde{z} > 1/2$.; and (ii) since $\tilde{z}$ can also be interpreted as the income elasticity of demand for South exports ($\varepsilon_X$), and $(1-\tilde{z})$ as the income elasticity of demand for South imports ($\pi_M$), equation (21) can also be translated into the following expression:

$$\frac{\hat{Y}_s}{Y_N} = \frac{\varepsilon_X}{\pi_M} \tag{22}$$

Equation (22) shows the so-called balance-of-payments constrained growth rate condition required by Thirlwall's Law: the capacity of South countries to show growth rates aligned with their balance-of-payment equilibrium over time depends on the elasticity of demand for their exports being greater than elasticity of demand for their imports (THIRLWALL, 1979/2011). If so, the South entered a catching up trajectory; if not, it entered a falling behind path. As Cimoli and Porcile (2010, p. 232) conclude:

> The key role of demand growth is highlighted by this result. In effect, depending on how the demand function is defined, we have very different implications for economic growth with the same technological gap and pattern of specialization. The pattern of specialization is endogenous, supply-side (i.e. technology and productive structure) driven, but the demand functions define how a specific pattern translates into economic growth. At the end of the day, both the Schumpeterian and Keynesian sides of the growth equation must be taken into account in the model.

## 3. Empirical evidence: the case of Brazil

In this section, we will analyze the evolution of the trade patterns of the Brazilian economy between 1990 and 2016. Throughout this period, Brazil experienced a process of trade liberalization (1990-1994), the stabilization of high- inflation rates (Plano Real, 1994) and other liberalizing economic reforms, such as privatization of state enterprises, the liberalization of the domestic financial system and the openness of the capital account, among others. This section is divided into two subsections: in the first, we will briefly analyze the main reforms introduced in Brazil in this period, with emphasis on trade liberalization; in the second, we will show empirical evidence on the changes that occurred in the Brazilian trade patterns.

### 3.1 A brief analysis on Brazil's economic reforms and some previous indicators (1990-2017)

From the last quarter of the $19^{th}$ century to 1930, the Brazilian economy was highly open to international trade and, despite the presence of a few infant low-tech industries, unable to show a vigorous industrialization process. In this period, Brazilian productive and export structures were strongly concentrated on coffee and other primary products of low income and price-elasticity of demand. By depending on the export performance of these goods in the global markets, long-term economic growth in Brazil was driven by world markets and constrained by price volatility of its main exports. At the same time, in the absence of a vigorous manufacturing sector, a significant share of manufactured goods was imported (FURTADO, 1982).

The dramatic crisis of the Brazilian primary export sector resulting from the Great Depression of the 1930s put an end to the previous development model and was responsible for the spontaneous process of industrialization based on import substitution (IS) (FURTADO, 1959/1982). From the 1930s on, Brazil's long-term growth has been driven by the dynamism of the domestic market. However, the process of industrialization only gained momentum after 1950, especially under Getúlio Vargas's second-term (1950-1954) and Juscelino Kubistschek's (1956-1960) governments, which adopted several protectionist measures in favor of infant heavy industries (TAVARES, 1963).

From the mid-1950s to the beginning of the 1980s, industrial and trade policies maintained their essential elements. In each step of the IS process, governments targeted some industries as industrial policy priorities and combined high tariffs, import licenses and export subsidies (these latter especially after the 1970s) to protect the Brazilian manufacturing sector and boost exports of manufactured goods. In practice, the import license regime was only eliminated with trade liberalization in March 1990.[34] Even considering the two attempts at trade liberalization in 1966 and 1988, the economy maintained a very high protectionist structure—at least when compared to that adopted by the Asian Tigers at the height of their protectionist policies (AMSDEN, 2001)—due to the prevalence of nontariff barriers (NTB) (NASSIF, 1995).

Another peculiarity of the industrial policy in Brazil is that the country has always been open to foreign direct investment (FDI) driven by multinational enterprises (MNE). Policies for attracting MNEs in Brazil focused on the implementation of import substitution and, hence, aimed at reducing both technology and import dependencies (balance of payments issues). This contrasts with some Asian countries that were traditionally open to FDI, such as Singapore and China. These countries applied measures that ensured the transfer of technology or technological spillovers to local firms. Therefore, Brazil was not able to draw upon the best techniques available in important industries of high and even medium technologies, such as capital goods, and chemical and automotive industries (DAHLMAN; FRISCHTAK, 1993).[35]

Although the protectionist policies have been marked by several drawbacks, such as the absence of selectivity, excessive national content requirements and the survival of rent-seeking activities throughout the period 1957-1980, there was a fine coordination between industrial and trade policies, in such a way that the latter was conditioned by the main goals of the several adopted National Development

[34] An import license as a *sine qua non* condition for an import to be approved lasted from 1947 to 1970, when the former was replaced by the "*guia de importação*" (an import document issued by the Foreign Trade Department, Cacex). Although the creation of this document has been justified for fulfilling statistical purposes, in practical terms it continued to work as an instrument of administrative import control. See Nassif (1995).

[35] As Amsden (2001, p.14) commented, "China, India, South Korea and Taiwan began to invest heavily in their own proprietary national skills. In contrast, Argentina and Mexico, and to a lesser extent, Brazil and Turkey increased their dependence for future growth on foreign know-how".

Plans. Despite all the imperfections of the protectionist policies of the IS period, there is no doubt that they created the conditions for developing a diversified manufacturing sector in Brazil over time.[36]

It is important to stress that, differently from some Asian countries (e.g. China and Taiwan), which sought to finance a significant share of gross investment with domestic savings, Brazil's development strategies—as well as most Latin American countries—were highly dependent on foreign savings, especially through long-term foreign lending, which, borrowed under conditions of flexible international interest rates, was the main modality observed from the 1970s on. The shock of international interest rates in the 1979-1982 period led Brazil and several other Latin American countries to a deep crisis (the external debt crisis) that lasted until the beginning of the following decade.

In fact, the eruption of the external debt crisis in 1980, which led to the collapse in international private capital flows to Latin-American countries in 1982, meant a complete disconnection between industrial and trade policies. These policies subsequently lost their most efficient tools for promoting catching up in Brazil. In fact, since a large amount of annual expenditures on external debt (principal plus interest expenditures) had to be paid, trade policies, especially import policy, became a powerful instrument for saving foreign exchanges—rather than being an industrial policy tool. The most infamous instrument for import control was the so-called Annex C, released by Brazil's Foreign Trade Department (Cacex), through which thousands of goods were prohibited in Brazil between 1980 and March 1990. In 1984, manufactured goods included in Annex C represented 46.8% of total tariff lines. In 1989, several goods of textile & clothing, footwear, plastic and motor vehicle industries still had import prohibition (CARVALHO JR., 1992). In practice, the long duration of such import control virtually meant infinite protection for the respective domestic industries. Despite a program of tariff reduction having been adopted in 1988, the prevalence of several nontariff barriers implied that the effective protection in Brazil was practically unchanged (KUME; PIANI; SOUZA, 2000).

The decision to introduce a unilateral trade liberalization reform in Brazil between March 1990 and 1994 must be understood within this economic context. In such circumstances, the programme was planned with the goal of redesigning the structure of protection through the elimination of most NTBs, including the Annex C, as well as the reestablishment of the import tariff as the main instrument of protection for the economy. Comparatively to other experiences of trade liberalization in developing countries during the 1980s and the 1990s, the Brazilian trade reform represented a deep microeconomic shock for three reasons: first, it was

[36] For a comparison between interventionist policies and the process of industrialization in Brazil and South Korea, see Moreira (1995) and Amsden (2001, ch. 9).

concluded in a relatively rapid period of time (five years), differently from South Korea and India, whose trade liberalization reforms lasted around six (from 1983 to 1988) and more than ten years (from 1991 on), respectively;[37] second, contrary to the recommendations of trade liberalization literature, the elimination of NTBs and reduction of import tariffs were jointly introduced, and trade reform was adopted together with the liberalization of capital account as well as within a context of sharp overvaluation of the Brazilian currency;[38,39] and third, again, differently from South Korea and India, which preserved industrial policy together with their trade liberalization programs as a strategy for pursuing catching up, industrial policy practically disappeared from the government's policy focus in Brazil between 1990 and early 2000s, even after the conclusion of trade reform.[40]

Despite the negative microeconomic shocks, several studies show sound empirical evidence that between 1990 and 1998 labor productivity registered significant annual average growth rates in Brazil, reversing the low and stagnant annual average growth rates shown in the previous decade. Additionally, notwithstanding the use of different methodologies for measuring productivity, the labor productivity growth observed in the first half of the 1990s in Brazil was undeniable. In a panel data econometric model based on industrial plants, Nassif (2005), for instance, estimated that labor productivity in the manufacturing sector grew at 1.4% between 1988 and 1994, and 5% between 1994 and 1998. These results confirm similar empirical evidence of previous studies, which had also attributed such performance to the positive impacts of the Brazilian trade liberalization.[41] Nassif (2003) and Kupfer (2005) showed, however, that such efficiency growth was mainly due to a labor shortage and the renewal of machines & equipment through the import of capital goods, rather than to technical change diffusion.

Table 1 gives an updated tariff structure for Brazil compared with other selected countries.

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[37] Between 1989 and 1994, while the average nominal import tariff for all goods in Brazil was reduced from 39.6% to 11.2%, the standard deviation dropped from 14.6% to 5.9% in the same period. See Kume, Piani and Souza (2000, p. 11).

[38] For Brazil and South Korea, see Moreira (1995). For Brazil and India, see Nassif (2003; 2007).

[39] For a theoretical discussion on how the speed and sequence of trade liberalization reforms should be designed, based on stylized facts of real experiences in Latin America and Asia, see Bhagwati (1978) and Michaely, Papageorgiu and Choski (1991). For the sequence of all economic liberalizing reforms (trade, domestic financial system, capital account etc.), see McKinnon (1991).

[40] In the case of South Korea, the clear change in priorities did not mean discarding industrial policy to promote structural change. According to the OECD (2012), "since the 1980s, the government carried out research and development (R&D) and gave incentives to the private sector for investing in R&D. By the 1990s, the chaebols (Korean conglomerates), were highly committed to R&D and the government widened the policy mix for R&D to include support to venture business in line with the rising demand from the private sector". The OECD (2012, p. 24) also documents that, by 2011, the Korean government maintained industrial promotion programmes for "leading industries", "strategic industries" and "infrastructure and business support". Yet India's governments never renounced industrial policy, which continued to be included in the 5-Year Plans after trade liberalization in 1991 (NASSIF, 2007).

[41] See Hay (1997), Bonelli and Fonseca (1998), Rossi Jr. and Ferreira (1999), and Bonelli (2002).

**Table 1.** Tariff structure in selected countries (in percentage)

| | Brazil (2017) | Russia (2016) | India (2015) | China (2015) | South Africa* (2015) | South Korea (2016) |
|---|---|---|---|---|---|---|
| **Simple average tariff rate** | 11.6 | 8.3 | 13.0 | 9.5 | 8.3 | 14.1 |
| **WTO agricultural products** | 10.2 | 14.6 | 36.4 | 14.8 | 9.9 | 60.0 |
| **WTO non-agricultural products** | 11.8 | 6.5 | 9.5 | 8.6 | 8.0 | 6.6 |
| **Bound tariff lines (% of all tariff lines)** | 100 | 100 | 74.9 | 100 | n.a. | 90.1 |
| **Tariff quotas (% of all tariff lines)** | 0.4 | 0.4 | n.a. | 0.6 | n.a. | 1.9 |
| **Non-ad valorem tariffs (% of all tariff lines)** | 0.0 | 14.8 | 6.1 | 0.5 | 3.8 | 0.8 |
| **International tariff peaks (% of all tariff lines)** | 27.0 | 6.4 | 13.6 | 14.8 | 21.4 | 10.7 |
| **Minimum tariff for all applied tariff rates**[1] | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Median tariff for all applied tariff rates**[1] | 14.0 | 5.0 | 10.0 | 8.0 | n.a. | 8.0 |
| **Maximum tariff for all applied tariff rates**[1] | 41.3 | 80.0 | 150.0 | 65.0 | 55.0 | 800.3 |
| **Overall standard deviation of all applied tariff rates** | 8.4[1] | 10.3 | 16.5 | 7.5 | 14.1 | 44.1[1] |

Source: World Trade Organization, Trade Policy Review, Several Issues.

Notes: * Refers to Southern African Custom Union; [1] Data for 2014, calculated by Castilho and Miranda (2017); n.a.: not available.

Two conclusions can be drawn from Table 1. First, by comparing with some developing and developed countries, it is a myth to assert that Brazil is very close to being or is a protectionist country. The simple average tariff rate applied to all products (11.6%) in 2017 was lower than that of South Korea (14.1%) and India (13.0%).[42] The degree of dispersion of all applied tariff rates, measured by the standard deviation, is one of the lowest among the Brics countries (Brazil, Russia, India, China and South Africa) and much lower than South Korea, whose indicator was 44.1% in 2016. This suggests that the other applied tariff lines are not far from the simple average tariff line. These results do not match with Bonelli's (2015, p. 487, translated from Portuguese) assertion, according to which "Brazil is an economy with very few links to the international economy." In a similar line, Bacha (2016, p. 3, translated from Portuguese) comments that "Brazil is one of the most closed economies in the world." It is true that, by 2016, the share of trade flows (exports plus imports) in Brazil's GDP (18.3%) was very low compared with middle income countries (38.6%) or countries like India (27.5%), whose economy is, however, more protected than Brazil, as Table 1 shows. However, Brazil's low degree of trade openness can be explained by the lack of competitiveness of manufacturing exports as well as the very low annual

[42] The simple average tariff rate on Brazilian imports in 2017 kept the same level registered at the end of the trade liberalization program in 1994. However, during this period, there were several modifications in the intersectoral and intrasectoral structure of protection in Brazil. See Kume, Piani and Souza (2000) and Abreu (2004).

GDP growth rates (which imply low import volumes) observed in the last decades (only 2.4% between 1999 and 2016).[43]

Second, although the use of the international peaks covers a significant part of all tariff lines,[44] such peaks are in line with the Most Favourable Nation (MFN) tariffs negotiated multilaterally at the WTO. In any event, Brazilian effective tariff rates estimated by Castilho and Miranda (2017) for 2014 (an average rate of 16.7% and a standard deviation of 15.2% for the overall economy) suggest that the structure of protection in Brazil should be reconsidered taking into account some distortions introduced by the high tariffs of some industries (e.g. transport equipment and some intermediate goods) as well as by modifications induced by protectionist lobbies or due to macroeconomic reasons.

From 2003 on, especially during Lula da Silva's (2003-2010) and Dilma Rousseff's governments (2011-2014), industrial policy returned as one of the leading mechanisms for promoting activities considered strategic for accelerating structural change towards scale-engineering-and-knowledge-based industries as well as diversifying productive and export structures, such as capital goods, software, information and communication technologies, pharmaceutical products, biotechnology, automobiles and others. In this period, three programmes of industrial policy were announced: Foreign Trade, Technological and Industrial Policy (Pitce, in Portuguese), in 2004; the Production Development Policy (PDP), in 2008; and Brazil Major Plan (PBM, in Portuguese), in 2011.[45] All these plans had as their core goal to boost physical investment and innovation in the Brazilian economy.

These plans, however, repeated old mistakes and well-known misleading policies that had prevailed during the time of the import substitution period: lack of selectivity and performance requirements from entrepreneurs who benefited from public incentives; an excessive use of public subsidies as the main instrument of governmental support, especially credit subsidies from the Brazilian Development Bank (BNDES); and, last but not least, lack of coordination between industrial, trade and macroeconomic policies. One example

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43 The problem of the lack of competitiveness of exports will be discussed in the next subsection. Indicators on share of trade flows in GDP were drawn from the World Bank, World Economic Indicators, <https://data.worldbank.org/indicator/TG.VAL.TOTL.GD.ZS>. Accessed on 13 October 2017. Indicators on Brazil's annual GDP growth rates were drawn from the Brazilian Institute of Geography and Statistics (IBGE), Quarterly National Accounts at 1995 constant prices, <https://sidra.ibge.gov.br/pesquisa/cnt/tabelas>. Accessed on 13 October 2017.

44 Moreover, for the WTO, tariff peaks correspond to rates exceeding 15%. Other possible definitions take into account the tariff level and structure of the country. For instance, Castilho and Carvalho (2017) consider tariff peaks as the rates that exceed the sum of the tariff average and the standard deviation.

45 For an analysis of Pitce and PDP industrial policies, see Coutinho *et al.* (2012). For details on Brazil Major Plan, see the website of Brazil's Ministry of Development, Industry and Commerce (MDIC), <http://www.mdic.gov.br/index.php/competitividade-industrial/politica-industrial/o-que-e-pbm-2>. Accessed on 12 October 2017.

of coordination failure is related to the recurrent trend of overvaluation of the Brazilian *real*. Figure 4 plots the behavior of the real effective exchange rate (Reer) in Brazil since 1988.[46]

**Figure 4.** Brazil: Real effective exchange rate (Reer) – 1988 to August, 2017 (Index-base = Jun-1994=100)


Source: Brazilian Central Bank.

Figure 4 shows unequivocally that the overvaluation of the Brazilian *real* has been a recurrent trend since the early 1990s. The correction of such misalignments has only occurred after domestic or international shocks, such as the announcement of the stabilizing Plano Real in June 1994, the crisis of the electrical energy sector (*apagão*) in 2001, the electoral uncertainty during the transition from the presidency of Fernando Henrique Cardoso to Luiz Inacio Lula da Silva in 2002-2003, the aftermath of the 2008 global crisis and, finally, during the instability created by the impeachment of president Dilma Rousseff throughout 2015. After all these episodes, the Brazilian *real* has entered a new appreciation trend in real terms. In an econometric model seeking to identify the main forces that pushed the Brazilian *real* towards that appreciation trend in the period 1999-2015, Nassif, Feijó and Araújo (2017) showed that the favorable terms of trade and the sharp differential between Brazilian and international interest rates were the most significant explanatory variables.

Several studies have shown a strong correlation between the trend of overvaluation of the Brazilian *real* and the weak long-term economic performance

46 In Brazil, the exchange rate is defined as the domestic price of a foreign currency. So, while an increase in the exchange rate means a depreciation of the Brazilian *real*, a decrease means an appreciation of it. The real effective exchange rate was calculated by the Central Bank as a weighted average of the Brazilian *real* against a basket of currencies of Brazil's main trade partners, adjusted by the consumer inflation rate (IPCA).

of the Brazilian economy, expressed by a sharp premature deindustrialization[47] as well as low rates of productivity and economic growth. After having been positively impacted by trade liberalization between 1988 and 1998, as previously discussed, the annual average growth rate of labor productivity in the Brazilian manufacturing sector has been stagnant and showed negative results between 1999 and 2015 (-0.2% p.y.).[48] With such a stagnant performance, it is not surprising to verify, according to Figure 5, that the technological gap of the manufacturing sector in Brazil (measured as the ratio of Brazil's labor productivity to the US labor productivity), after having shown a slow catching up trajectory between 1970 and 1980, has tendentially widened outwards, as can be seen by the trend line.[49] Figure 5 also shows that the last period during which all segments of the Brazilian manufacturing sector significantly reduced the technological gap occurred in the aftermath of trade liberalization, especially between 1990 and 1998, as we discussed earlier. Particularly, the science-engineering-and-knowledge-based industries, after having reached almost half of the technological frontier in 1997, entered a falling behind trajectory afterwards. Although these indicators have not been updated by Eclac-Padi, such trends can hardly have registered significant changes in the opposite direction, in the face of the stagnant behaviour of the labor productivity growth in the manufacturing sector in Brazil in the last decade, as we commented earlier.

The falling behind trajectory of the Brazilian economy can also be confirmed by the results of Thirlwall's Law for the Brazilian economy between 1980 and 2010—see equation (22) in Section 2—, estimated by one of the authors in a previous paper (NASSIF; FEIJÓ; ARAÚJO, 2015), and summarized in Table 2.

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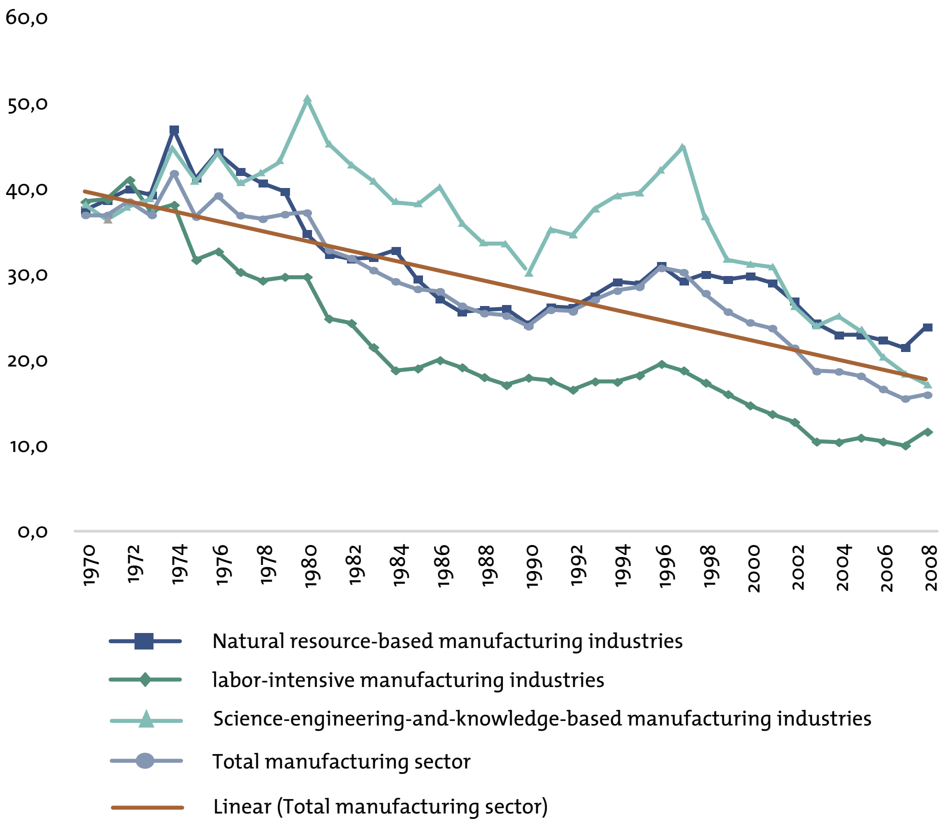
47 Several studies have attributed the real appreciation trend of the Brazilian currency as being one of the main causes of Brazil's premature deindustrialization. See, for instance, Bacha (2013), Bresser-Pereira (2010), Nassif, Feijó and Araújo (2015) and Nassif, Bresser-Pereira and Feijó (2017).

48 These results were calculated and kindly offered to the authors by Jorge N.P. Britto, from the Department of Economics at the Fluminense Federal University. The labor productivity was calculated as the ratio of the value of industrial transformation (a proxy for value added) to the number of employees directly occupied at production (these indicators are estimated, in turn, by the Annual Industrial Survey – PIA, from IBGE). The numerator was deflated by sectoral Wholesale Price Indices (IPA) of Fundação Getulio Vargas.

49 These data are estimated by the Program for the Analysis of Industrial Dynamics (Padi) of the United Nations Economic Commission for Latin America and the Caribbean (Eclac). Originally, the taxonomy of Eclac is composed by natural resource-based, labor-intensive and engineering-based manufacturing industries. As these latter industries also contain scale and science-based industries, we grouped all of them and renamed them as science-engineering-and-knowledge-based manufacturing industries.

**Figure 5.** Technological gap of the manufacturing sector in the Brazilian industries classified by factor content and technological sophistication




Source: Eclac-Padi.

**Table 2.** Thirlwall's Law and the falling behind trajectory of the Brazilian economy (1980-2010)

| Period | Income-elasticity of demand for Brazilian exports ($e_x$) | Income-elasticity of demand for Brazilian imports ($\pi_M$) | Thirlwall's Law Y_Brazil/ (Y_World^*)= ε_x/π_M |
|---|---|---|---|
| **1980:3 – 2010:2** | 1.059 | 1.993 | 0.531 |
| **1980:3 – idem** | 1.358 | 1.967 | 0.690 |
| **1999:1 – 2010:2** | 1.329 | 3.361 | 0.395 |

Source: Nassif, Feijó and Araújo (2015, p. 1.326).

Note: 1, 2, 3 and 4 refer to quarters.

According to Table 2, while between 1980 and 1998, Brazil's estimated annual average growth rate compatible with its balance of payments equilibrium was 69% lower than the world GDP growth rate, between 1999 and 2010, this rate reduced significantly to only 39.5%, confirming the falling behind path in the decade.[50]

[50] In another paper (NASSIF; FEIJÓ; ARAÚJO, 2016), we estimated Thirlwall's Law for all the Brics (Brazil, Russia, India, China and South Africa) in the period 1995-2013. The results did not alter for Brazil and revealed that only China and India showed a catching up trajectory in the period.

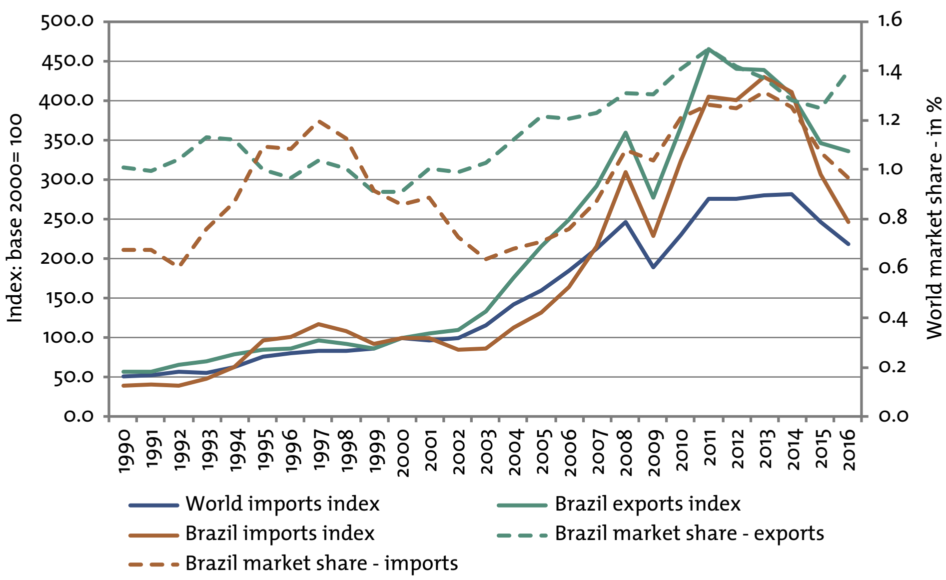
## 3.2 Brazil's trade patterns and the recent trajectory towards regressive specialization

For Brazilian international trade, the period comprised between 1990 and 2016 was characterized by a strong dynamism. During these 26 years, the total trade value was multiplied by six while world trade was multiplied by four. Brazilian exports attained US$ 336 billion and imports, US$ 246 billion.

The performance of Brazilian international trade was nevertheless very different during the 1990s and the 2000s. As shown in Figure 6, not only was the growth in trade flows stronger in the 2000s but also the dynamics of exports and imports were opposite in the two periods. During the 1990s, after the Brazilian trade liberalization and during the period marked by the overvaluation of Brazil's currency, imports grew at a faster pace than exports. From the 2000s on, Brazilian exports grew faster than imports, even though imports also increased significantly.

The Brazilian market share (total trade) evolved from 0.8% of world trade in 1990 to 1.4% in 2016.[51] During the 1990s, the Brazilian market share increase was pulled by the significant expansion of imports. The cumulated growth rate of Brazilian imports (148%) was twice the exports growth rate (75%) and well above the world trade growth rate (96%). From 2000 on, Brazilian exports grew faster than imports (236% and 147%, respectively) but both of them showed higher rates than global trade (119%). Therefore, Brazil reached its highest share

**Figure 6.** Brazilian exports, imports and market share evolution (1990-2016)




Source: Elaborated by the authors, based on Comtrade database.

51 In a longer-term perspective, Brazilian exports attained their highest world market share during the 1980s (trade statistics are available from 1962 on). The market share average was 1.3% for the whole decade (lower than the period 2010-2016) but it attained 1.7% in 1984. On the other hand, the lowest average was reached during the 1990s, when Brazilian market share was 1.0%. From then on, the share has increased both in the 2000s and during the last period (2010-2016).

in world trade in this 26-year period for exports in 2011 (1.5%) and for imports in 2013 (1.3%). The different pace of the recent decrease in world and Brazilian trade flows made the export market share recover to 1.4% (2016 data).

In Table 3, trade flows were broken down into industries according to the relative use of productive resources (resource-based *versus* labor-intensive) as well as the degree of technological sophistication, according to Pavitt's (1984) classic taxonomy (for sectoral classification, see Appendix 1). The strong increase in Brazilian trade flows over this period was accompanied by important composition changes, mainly on the export side. On the import side, the sectoral composition kept relatively stable, with the manufactured goods representing a large majority of imports. The most important change during the whole period was the reduction in oil imports in the first half of the 1990s because of the increase in the national oil production. After that, changes in import structure were minor, despite the increase in imports of labor and scale-intensive sectors.[52]

On the export side, as stated, there were important composition changes. The share of manufactured goods in exports remarkably decreased, going from 78% of total exports in 1990-1995 to 53% in 2011-2016, while the share of primary goods in total exports increased from 21% to 45% in the same period. In fact, between 1990 and 2016, the share of primary goods more than doubled and recovered the importance they used to have in exports in the beginning of the 1970s. This process has been named "export primarization" and, as mentioned in Section 3.1, several factors explain it, such as the commodities price boom in the 2000s due to the so-called Chinese demand-pull effect, the persistent overvaluation of the national currency and the dynamism of domestic demand for manufactured goods.[53] The primarization process observed in exports was not, however, observed—at least not with the same intensity—in domestic production. In fact, Torracca (2017) shows the mismatch between the structure of exports and of domestic production. While primarization is clear and strong in external trade flows, the domestic production structure is much more stable and less intensive in primary goods and resource-based sectors, even though their share in domestic production increased. These conclusions do not contradict the evidence of premature deindustrialization in Brazil, especially from the mid-2000s on. In fact, it is widely recognized that there has been a sharp reallocation of resources from the manufacturing sector to segments of low productivity in the tertiary sector in Brazil since the mid-2000s.[54]

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52 The increase in labor-intensive imports was strongly influenced by the rise in textiles, clothing, shoes and some chemical goods, while the transport equipment imports (cars, trucks and ships) were the main reason for the share of scale-intensive goods to increase.

53 See Bacha and Fishlow (2011), Bacha (2013) and Nassif, Feijó and Araújo (2017).

54 In fact, according to IBGE, the share of the agricultural sector in Brazil's GDP in real terms (1995 price) in 2016 was virtually the same as that of 1996 (6%). Yet, while the share of the manufacturing sector in total GDP was reduced from 13.8% to 9.8%, the share of the tertiary sector was increased from 57% to 60.7% during the same period. See <https://www.ibge.gov.br/estatisticas-novoportal/economicas/contas-nacionais/9300-contas-nacionais-trimestrais.html?&t=resultados>. Accessed on 25 October 2017. See Nassif (2008) for the 1947-2004 period (in current prices).

All manufacturing sectors experienced a decrease in their share in total exports at the beginning of the 1990s, except the science-based group (Table 3). The reduction in the share of manufactured goods in total Brazilian exports is, in part, explained by the exceptional increase in primary goods exports.[55]

**Table 3.** Composition and evolution of Brazilian exports and imports by product groups (1990-2016)

| | Primary goods | Resource-based industry (1) | Labour-intensive (2) | Scale-intensive (3) | Specialized suppliers (4) | Science-based (5) | n.d | Manufactured goods (1-5) | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | EXPORTS | | | | |
| | | | | | Composition (% of total exports) | | | | |
| **1990-idem** | 21.1 | 28.5 | 12.6 | 23.0 | 9.7 | 4.0 | 1.0 | 77.9 | 100.0 |
| **1996-2000** | 22.4 | 27.3 | 10.6 | 21.1 | 9.8 | 7.2 | 1.6 | 76.0 | 100.0 |
| **2001-2005** | 26.4 | 24.2 | 9.2 | 20.4 | 9.1 | 8.8 | 1.8 | 71.8 | 100.0 |
| **2006-2010** | 36.8 | 22.3 | 6.3 | 17.2 | 8.1 | 7.2 | 2.2 | 61.1 | 100.0 |
| **2011-2016** | 45.1 | 21.2 | 4.9 | 14.5 | 7.2 | 5.2 | 1.9 | 53.0 | 100.0 |
| | | | | | Average annual growth (p.y.%) | | | | |
| **1990-1995** | 5.4 | 9.7 | 7.7 | 8.2 | 10.7 | 5.6 | 10.3 | | 8.2 |
| **1996-2000** | 5.0 | (1.9) | 2.3 | 2.3 | 1.5 | 29.2 | 11.4 | | 3.5 |
| **2001-2005** | 23.4 | 13.9 | 10.4 | 18.5 | 17.7 | 7.9 | 15.2 | | 16.5 |
| **2006-2010** | 21.6 | 11.3 | 1.6 | 1.9 | 4.7 | 3.5 | 11.6 | | 11.2 |
| **2011-2016** | (2.3) | (1.3) | (0.7) | 0.9 | (0.1) | (1.7) | (8.4) | | (1.4) |
| | | | | | IMPORTS | | | | |
| | | | | | Composition (% of total imports) | | | | |
| **1990-1995** | 20.7 | 22.5 | 7.6 | 14.4 | 18.8 | 15.9 | 0.0 | 79.3 | 100.0 |
| **1996-2000** | 12.6 | 20.5 | 8.7 | 16.3 | 21.8 | 19.9 | 0.1 | 87.2 | 100.0 |
| **2001-2005** | 15.5 | 18.5 | 7.8 | 14.2 | 21.3 | 22.6 | 0.0 | 84.5 | 100.0 |
| **2006-2010** | 14.4 | 19.3 | 8.4 | 17.7 | 19.0 | 20.1 | 1.2 | 84.4 | 100.0 |
| **2011-2016** | 11.2 | 21.0 | 9.7 | 19.2 | 18.7 | 20.2 | 0.0 | 88.7 | 100.0 |
| | | | | | Average annual growth (p.y.%) | | | | |
| **1990-1995** | (1.3) | 25.3 | 33.2 | 38.2 | **19.7** | 19.1 | 39.0 | | 19.1 |
| **1996-2000** | (0.6) | (0.9) | (3.7) | (4.9) | **2.5** | 9.0 | 48.2 | | 0.7 |
| **2001-2005** | 13.1 | 2.1 | 5.5 | 6.5 | **4.6** | 5.0 | (48.2) | | 5.7 |
| **2006-2010** | 10.7 | 22.3 | 22.9 | 27.7 | **19.6** | 16.2 | 105.5 | | 19.7 |
| **2011-2016** | (7.9) | (4.2) | (2.6) | (6.8) | **(4.7)** | (1.6) | (2.8) | | (4.5) |

Source: Elaborated by the authors, based on Comtrade database.

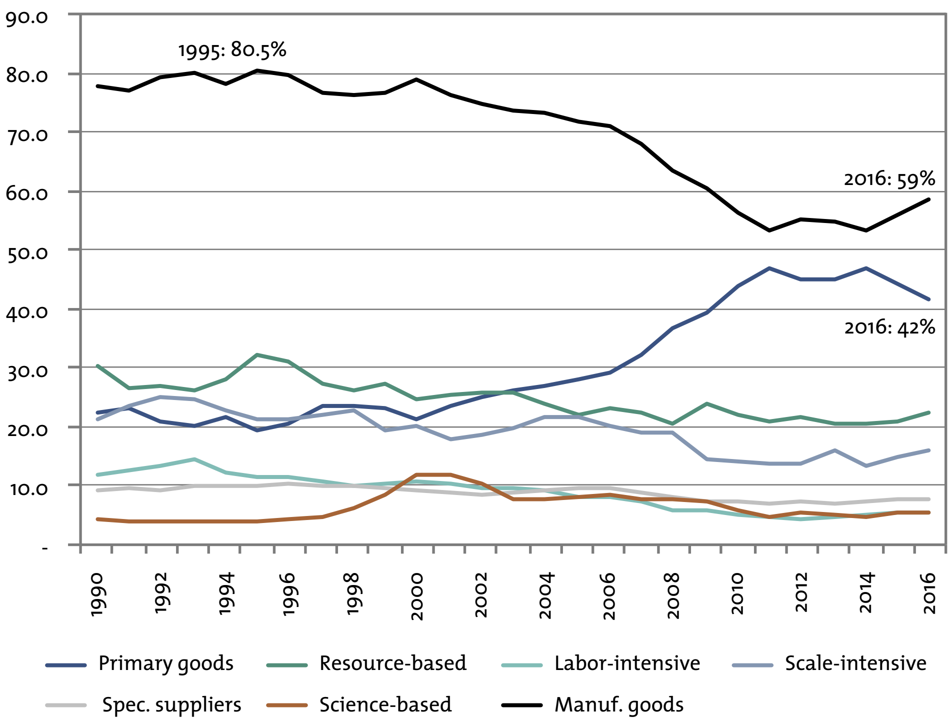
Among manufactured goods, labor-intensive goods are the product group which has lost the highest share in exports since 1990 (from 13% to 5%), since the competitiveness of Brazilian goods in global markets significantly declined. Exports of scale-intensive goods also showed a remarkable decrease especially due to the reduction of steel products. The exports of science-based goods showed

[55] The accumulated growth rate of Brazilian exports exceeded the rate of world exports for manufactured goods for the entire period 1990-2016 due mainly to the good performance between 2004 and 2013. Moreover, as shown by Castilho, Costa and Torracca. (2017), the export primarization in Brazil has a very strong geographical character since exports to China, which became the first trade partner after the financial crisis, are very concentrated in primary and resource-based goods.

quite a dynamic trajectory till 2005, when their share in total exports began to retract. In 2016, their share (5.6%) was close to the average of the 1990s. Finally, despite the loss of around one quarter of their share in total exports, resource-based and specialized suppliers were the only categories which augmented their share in manufacturing goods exports.

The different export performances of the product groups are illustrated with annual data in Figure 7. While the reduction in the share of scale-intensive, labor-intensive and resource-based goods began in the first half of the 1990s, specialized suppliers and science-based goods performed well for a longer time during the period 1990-2016. The highest export share of specialized suppliers was reached in 1996, and for science-based goods by 2000.

**Figure 7.** Brazilian exports composition by product groups (1990-2016 – % of total exports)

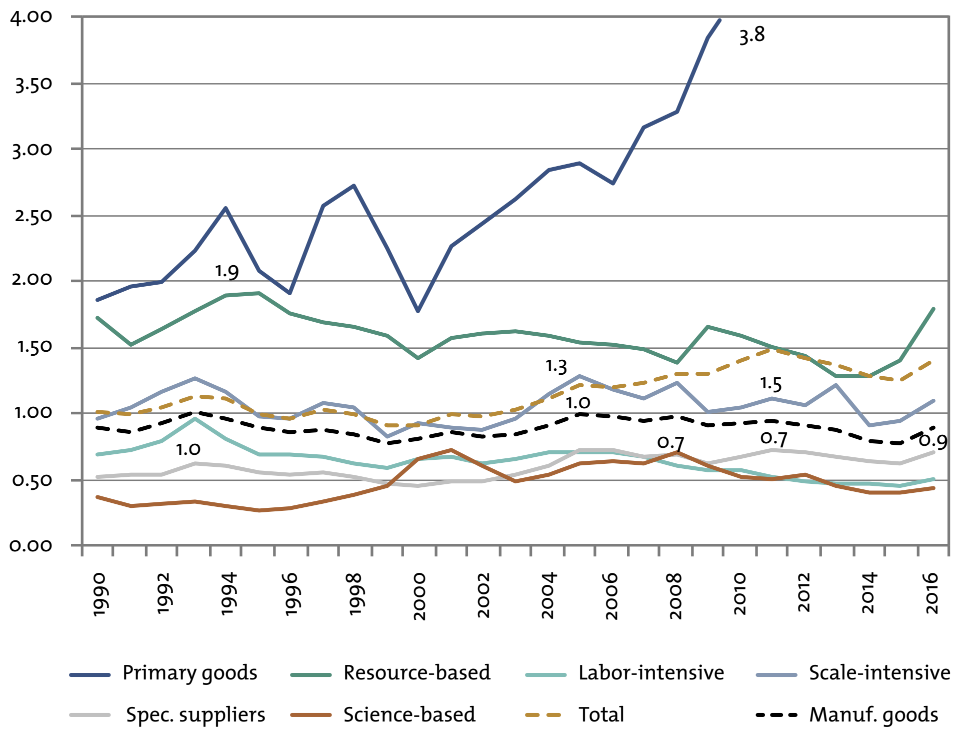



Source: Elaborated by the authors, based on Comtrade database.

Figure 8 displays the market share of Brazilian exports in total world exports. Despite the strong loss of importance of manufactured goods in Brazilian exports, their performance in world markets is less dramatic. In fact, the so-called primarization process is partially explained by the commodities price boom and affected not only Brazil but also world exports. Figure 8 shows that, for manufactured goods, Brazil kept its (low) share of 1% in world exports until 2008. In terms of world market share, the product groups performed very differently. The labor-intensive goods are the only group presenting a net reduction from

1990 to 2016—a 25% loss of its world market share. Exports in science-based goods increased their share in world exports during the 2000s and decreased from 2009 on, reaching 0.4% at the end of the period. Scale-intensive goods reached their highest share in world markets in 2005, when from this year on their share kept floating around 1%. Specialized suppliers' goods are the group with a more stable share during the period—around 0.6% over the 26-year period. Finally, resource-based goods, even showing a slightly decreasing tendency between 1995 and 2014, is the Brazilian manufacturing sector with the highest share in the world market. Primary goods presented a completely different performance: their market share, after a decade of relative stability of around 1.8% in the 1990s, was multiplied by 3.4 by 2016. Brazilian primary goods exports represented in that year 6.3% of total world exports.

**Figure 8.** Market share of Brazilian exports in world exports, by product group (1990-2016, % of world exports)



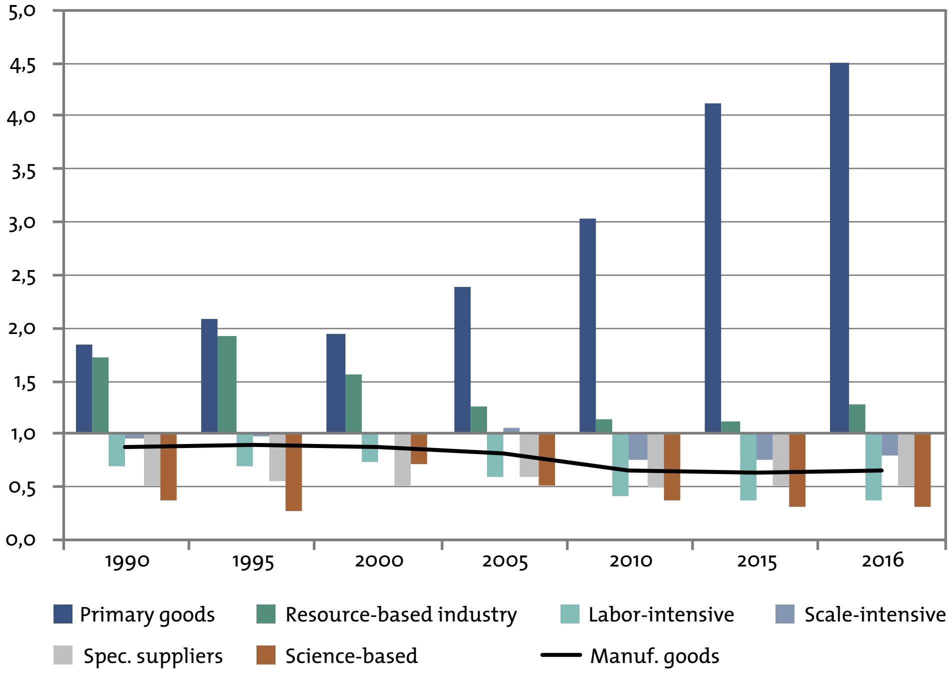

Source: Elaborated by the authors, based on Comtrade database.

A traditional indicator of a country's pattern of specialization is Balassa's (1965) Revealed Comparative Advantage (RCA) [see equation A.1 in Appendix 2], whose results are shown in Figure 9.[56] Indicators clearly register a deepening of Brazilian export specialization based on primary goods. Since it was accompanied by a continuous drop of the RCA of several manufactured goods categories (notably,

[56] If RCA is above 1, that means the country has comparative advantage, whereas if RCA is below 1, that means absence of comparative advantage—or comparative disadvantage.

labor-intensive, science-based and specialized suppliers), these results characterize a regressive specialization of Brazilian trade. Changes were stronger from 2000 on than over the 1990s.[57]

**Figure 9.** Brazilian revealed competitive advantage




Source: Calculated by the authors, based on Comtrade database.

For analyzing if, and if so the extent to which, Brazilian trade flows have been concentrated or diversified in the last decades, we used the Herfindahl-Hirschman index (HHI) as specified in equation A.2 in Appendix 2 and shown in Figure 10. As the HHI basically measures the degree of concentration (the larger the HH index, the more concentrated are the exports or imports), Figure 10 shows that Brazilian imports are currently more diversified than exports. The HHI also puts in evidence not only the difference in the concentration degree of trade flows, but also the divergent trends in the last ten years. Exports have shown a concentration trend after 2004, while imports presented a stable evolution, after their diversification in the first half of the 1990s. The maximum level of export concentration measured by the HHI was reached in 2011. This latter result reflects the emergence of China as one of the most important Brazilian trade partners after the 2008 global crisis. In fact, Brazilian exports grew sharply and became extremely concentrated in mineral ores, soybeans and oil.[58]

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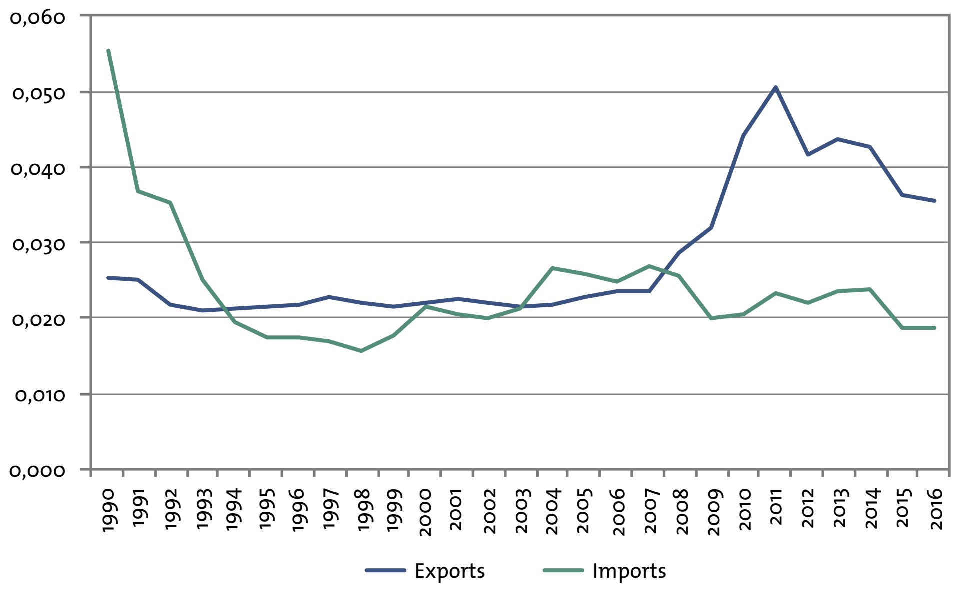
[57] These trends are also confirmed by Nassif, Feijó and Araújo's (2015) empirical study.

[58] These three products represent around 75% of Brazilian exports to China. As international prices of these commodities were very high until 2012, the share of these products in total exports rose remarkably.

**Figure 10.** Degree of concentration of Brazilian exports and imports (Herfindahl-Hirschman Index, 1990-2016)




Source: Calculated by the authors, based on Comtrade database.

Table 4 shows the HHI for exports classified by factor content and technological sophistication. The major concentration changes occurred with the science-based goods, which showed the highest degree of export concentration by 2016. This was due to the high share of aircraft exports in this group. [59] The above mentioned "China effect" has clearly influenced the high concentration of primary and resource-based goods. The group of scale-intensive goods is the one that exhibited the most stable degree of export concentration in the whole period.

**Table 4.** Concentration of Brazilian exports, by product group (HH Index, 1990-2016)

| | 1990 | 1995 | 2000 | 2005 | 2010 | 2016 |
|---|---|---|---|---|---|---|
| **Primary goods** | 0.186 | 0.181 | 0.156 | 0.149 | 0.181 | 0.149 |
| **Resource-based industry** | 0.094 | 0.077 | 0.068 | 0.072 | 0.122 | 0.117 |
| **Labor-intensive** | 0.126 | 0.107 | 0.110 | 0.097 | 0.099 | 0.116 |
| **Scale-intensive** | 0.093 | 0.086 | 0.089 | 0.086 | 0.086 | 0.084 |
| **Specialized suppliers** | 0.129 | 0.079 | 0.087 | 0.089 | 0.081 | 0.086 |
| **Science-based** | 0.190 | 0.090 | 0.331 | 0.223 | 0.192 | 0.250 |
| **Total** | **0.025** | **0.021** | **0.022** | **0.023** | **0.044** | **0.035** |

Source: Calculated by the authors, based on Comtrade database.

Another way of evaluating the degree of diversification is to measure the extent to which Brazil has exported old and established goods in the world markets (intensive margin) or new products and other goods with increasing

[59] Since 1990, airplanes have been the most important product in the science-based category. In the first half of the 1990s, they accounted for a quarter of this category's exports and reached 46% in 2016.

share in world exports (extensive margin). The intensive (IM) and extensive (EM) margins were calculated according to the methodology proposed by Hummels and Klenow (2005) and are expressed by equations A.3 and A.4, presented in Appendix 2.[60] The former corresponds to a country's market share of world exports in the products or categories in which it exports, indicating how consolidated the country is in exporting the same category of goods in the markets it traditionally acts in. The latter corresponds to the share of a country's export basket in old or new goods dynamically demanded by global markets. Then, the EM shows how important the country's export basket (or its "portfolio") is for the world market.[61]

Table 5 shows the IM and EM for both total exports and categories of goods classified according to factor content and technological sophistication. Concerning total exports, despite the loss of market share in the categories or goods that Brazil exports (intensive margin), the portfolio highly demanded by global markets (extensive margin) has gained importance in world markets.[62] The evolution of the EM may, at first sight, seem to contradict the results shown by the HHI index, which revealed a concentration trend of exports from 2007 on. Indeed, the EM considers the range of the country's exported goods demanded by the world, and, therefore, it is a measure of dynamism or adherence of the country's export basket to the world trade. In fact, Brazil has notably expanded the number of exported goods but, in terms of value in US dollar, its exports have become increasingly concentrated in primary and other commodity goods.[63] This explains why the larger increases of the EM occurred for primary and resource-based goods, showing the dynamism of these groups in the global markets in the period, while the smaller changes took place in the more technologically sophisticated sectors exported by Brazil – science-based and specialized suppliers. These different sectoral

[60] There are other different definitions such as the one used by Amurgo-Pacheco and Pierola (2008) which identifies "old" and "new" import and export products and markets of a country by comparing the existence of trade flows with a reference period.

[61] According to Hummels and Klenow (2005), export growth can result from the expansion of exports of goods already exported or from a diversification process which corresponds to the "enlargement of the variety of exported goods" (p. 3). The second source of growth is usually associated with monopolistic competition models based on Krugman (1981), whose main prediction is that big countries will produce and export a larger variety of goods.

[62] The number of products is an alternative way of measuring EM – see Carmo and Bittencourt (2014), for example. For this period, the number of products, defined at the 6-digit level of the 1992 HS classification, grew from 3,829 in 1990 to 4,263 in 2000 (out of a total of 5,036 products).

[63] To illustrate this point, we compared the EM, the number of exported goods and the share of the top 100 exported goods in Brazil, Argentina and the United States for 2016, using Comtrade exports data disaggregated at the 6-digit level of 2012 HS classification. The EM is over 90% for all these countries (92% for Argentina, 98% for Brazil and 100% for the United States), suggesting that these countries have a diversified export basket. The number of exported goods, however, is quite different for each, corresponding to 69%, 84% and 99% for Argentina, Brazil and the United States, respectively, of the set of around 5,200 goods. But the share of the top 100 exported goods in their total exports reveals a big difference in the degree of concentration in US dollar value terms: in Argentina and Brazil, the top exported goods represent, respectively, 85% and 78% of the value of their total exports, while in the United States this share is much lower – 47%. In other words, even considering that Brazil has a large number of different goods in its export basket, in value terms its exports are quite concentrated.

changes suggest that primary goods revealed a more dynamic performance, since it recovered its market share and showed a huge diversification in the global markets in the last decades.

**Table 5.** The intensive (IM) and extensive margin (EM) of Brazilian exports by product groups (1990-2016)

| | 1990 | | 2000 | | 2010 | | 2016 | |
|---|---|---|---|---|---|---|---|---|
| | EM | IM | EM | IM | EM | IM | EM | IM |
| **Primary goods** | 50.1 | 11.1 | 94.4 | 2.0 | 97.3 | 4.5 | 93.7 | 6.4 |
| **Resource-based industry** | 77.9 | 5.2 | 89.9 | 1.6 | 87.6 | 1.8 | 96.8 | 1.7 |
| **Labor-intensive** | 94.2 | 1.9 | 98.2 | 0.7 | 98.9 | 0.6 | 99.3 | 0.5 |
| **Scale-intensive** | 94.4 | 1.9 | 98.1 | 1.0 | 98.8 | 1.1 | 98.9 | 1.1 |
| **Specialized suppliers** | 96.0 | 1.2 | 99.2 | 0.5 | 99.3 | 0.7 | 99.6 | 0.7 |
| **Science-based** | 97.2 | 0.9 | 99.2 | 0.7 | 98.6 | 0.5 | 99.5 | 0.4 |
| **Total** | **88.2** | **2.6** | **96.7** | **1.0** | **96.3** | **1.5** | **98.2** | **1.4** |

Source: Calculated by the authors, based on Comtrade database.

As we analyzed in Section 3.2 and as shown by Krugman's models (1979, 1980, 1981), the share of intraindustrial trade in total trade is usually larger among countries with similar development and income levels. And as this kind of trade is driven by scale-intensive and science-based industries, it is more dynamic and leads to gains for both partners due to the joint effect of higher competition and economies of scale. Depending on the level of statistical data disaggregation, intraindustrial trade sheds light on the degree of productive integration between countries as well as the extent to which trade partners engage in regional and global value chains.

We measured Brazil's intraindustrial trade through the Grubel-Lloyd Index (GLI), as expressed by equation A.5 in Appendix 2 (GRUBEL-LLOYD, 1971). As Reis and Farole (2012, p. 35) suggest, GLI is important for not only indicating the amount of intraindustrial trade (GLI equal to 1 indicates maximum intraindustrial trade), but also for capturing the degree of diversification within an industry (GLI equal to zero indicates absence of diversification within an industry).

Table 6 shows GLI for Brazil between 1990 and 2016, which is estimated using data disaggregated at the 3-digit level of the Standard International Trade Classification (STIC; 240 products) and considers trade with all partners.[64]

[64] If on one hand, higher levels of product aggregation overestimate intraindustrial trade, on the other hand, if one intends to analyze geographical dimensions of this kind of trade (for regional integration studies, for example), it would be desirable to consider bilateral trade flows. For more details on these issues, see Fontagné and Freudenberg (1997).

**Table 6.** Brazilian intraindustry trade by product groups (Grubel-Lloyd Index, 1990-2016)

| | 1990 | 1995 | 2000 | 2005 | 2010 | 2016 |
|---|---|---|---|---|---|---|
| **Primary goods** | 0.168 | 0.184 | 0.167 | 0.094 | 0.080 | 0.098 |
| **Resource-based industry** | 0.136 | 0.217 | 0.256 | 0.257 | 0.199 | 0.212 |
| **Labor-intensive** | 0.292 | 0.329 | 0.293 | 0.298 | 0.240 | 0.243 |
| **Scale-intensive** | 0.231 | 0.328 | 0.302 | 0.268 | 0.319 | 0.324 |
| **Specialized suppliers** | 0.450 | 0.370 | 0.342 | 0.470 | 0.360 | 0.387 |
| **Science-based** | 0.457 | 0.534 | 0.305 | 0.271 | 0.397 | 0.372 |
| **Total** | **0.300** | **0.383** | **0.412** | **0.433** | **0.401** | **0.356** |

Source: Calculated by the authors, based on Comtrade database.

The index of intraindustrial trade in the Brazilian trade pattern is quite reduced (around 0.36).[65] After having grown between 1990 and 2005, the GLI showed a continuous reduction. The level and evolution of intraindustrial trade differ significantly between groups. As expected, the intraindustrial trade is more important for more elaborated goods or capital-intensive categories. As also expected, science-based, specialized suppliers and scale-intensive sectors are those with higher GLI due to their higher potential capacity to explore gains from economies of scale and product differentiation. The GL indices for science-based industries indicate that the intraindustrial trade rapidly grew in the middle of the 1990s, strongly decreased from the end of this decade onwards and vigorously recovered after the 2008 global crisis. This recovery reflects larger trade flows within Mercosur, especially automobiles and airplanes.[66] While scale-intensive industries increased their GLI between 1990 and 2016, specialized suppliers and labor-intensive showed reductions. As expected, the primary goods and the resource-based groups show the smallest values for the GLI in the period.

Table 7 shows the composition of exports and imports according to Brazil's trade partners (1990-2016). Table 7 suggests that Brazil can be classified as a "global trader" because of its large variety of trade partners. Over the period 1990-2016, there were some important changes in the geographical composition of Brazilian trade. First, its most traditional partners [the United States and the European Union (EU)][67] lost importance throughout this period. This reduction is stronger on the export side of Brazil, while on the import side, the EU kept its share in the Brazilian market. Brazil's export share in Latin American countries increased during the 1990s, when they became a major destination for Brazilian exports. Mercosur was the main market responsible for this change, which is also confirmed by the huge

65 As several empirical studies show, the index of intraindustrial trade between some developed countries used to surpass 0.50. See, for instance, Ito and Okubo (2011).

66 Mercosur is the custom union that joins Brazil, Argentina, Uruguay, Paraguay and Venezuela. Intra-Mercosur trade grew rapidly until 1997, with a notable share of intraindustry trade in automobiles and capital goods sectors. The intra-regional trade was so negatively affected by the 1998-1999 Brazilian crisis and the 1999-2001 Argentinean crisis that it did not return to the 1990s level.

67 Here we kept the 12 countries belonging to the EU in 1990 and that remained the main partners (more than 90% of EU27 trade).

rise of Argentinean share both in exports and imports. After 2000, bilateral trade with Argentina declined, affecting Latin America's total trade. Even after this decline, Latin America remained as one of Brazil's most important partners, especially on the export side. Another marked change in Brazilian trade was the increase of China's share in Brazilian trade after 2010. While in 2000, China's share for Brazilian exports and imports was around 2% of Brazil's total trade, this indicator jumped after the 2008 global crisis, reaching 19.2% and 17%, respectively, in 2016.

**Table 7.** Geographical distribution of Brazilian exports and imports (1990-2016; in percentage)

| | 1990 | | 2000 | | 2010 | | 2016 | |
|---|---|---|---|---|---|---|---|---|
| | EXPORT | IMPORT | EXPORT | IMPORT | EXPORT | IMPORT | EXPORT | IMPORT |
| **Latin America** | 11.0 | 12.5 | 24.8 | 21.7 | 21.6 | 15.3 | 19.5 | 12.1 |
| **Argentina** | 2.1 | 6.7 | 11.5 | 12.3 | 9.3 | 8.0 | 7.3 | 6.6 |
| **Mexico** | 1.6 | 0.9 | 3.2 | 1.4 | 1.9 | 2.1 | 2.1 | 2.6 |
| **United States** | 24.6 | 20.1 | 24.7 | 23.4 | 9.8 | 15.1 | 12.7 | 17.5 |
| **European Union 12** | 28.3 | 19.4 | 26.5 | 22.9 | 20.4 | 18.5 | 16.8 | 19.4 |
| **China** | 1.2 | 0.9 | 2.0 | 2.2 | 15.5 | 14.1 | 19.2 | 17.0 |
| **India** | 0.5 | 0.1 | 0.4 | 0.5 | 1.8 | 2.3 | 1.7 | 1.8 |
| **Japan** | 7.5 | 7.2 | 4.6 | 5.3 | 3.6 | 3.9 | 2.5 | 2.6 |
| **South Korea** | 1.7 | 0.4 | 1.1 | 2.6 | 1.9 | 4.7 | 1.6 | 4.0 |
| **Russia** | n.a. | n.a. | 0.8 | 1.0 | 2.1 | 1.1 | 1.3 | 1.5 |
| **World** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Source: Elaborated by the authors, based on Comtrade database.

Note: n.a.: not available.

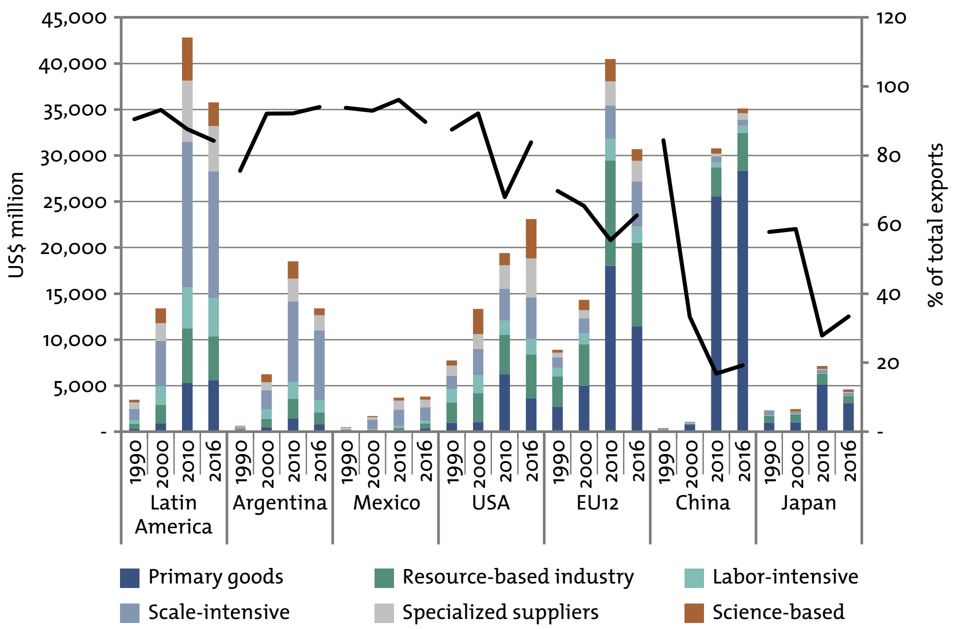
Even though Brazil's trade with other countries (South Korea, Japan, Russia and India, as described in Table 8) is not as expressive as that with China and the United States, the data suggests that there was a geographical deconcentration of Brazilian exports and, albeit to a lesser extent, of imports. In fact, during the 2000s, trade with Asia and Africa grew and diversified, even considering that trade with these two regions (except China) remained relatively weak.

The changes in geographical composition of Brazilian exports are reflected in the sectoral specialization of the Brazilian export basket. In fact, Brazil's trade structure differs according to the stage of development of its trade partners and the specialization of the partners. Bilateral trade can have a kind of North-South pattern of specialization, as analyzed in Sections 2.2.1 and 2.3. That is, Brazil's trade pattern with the European Union and China is different from that with Mercosur or other neighboring countries. As shown by Castilho, Costa and Torracca (2017), in the last decade, the Brazilian export structure was strongly influenced by trade with China, which is very concentrated in mineral and agricultural goods. In a simple simulation, they show that the share of manufactured goods in Brazilian total exports would be much higher if the China effect was not considered.[68]

[68] As stressed by the authors, in 2013, China was responsible for 19.4% of total Brazilian exports. As 72% of the exports directed to China are from two goods: soybean and mineral ore (37% and 35% of bilateral exports, respectively), only the sale of these two goods to China represented 13.7% of total Brazilian exports in that year. The share of manufactured goods in a world "without China" would go from 62% to 73% in 2013.

Such differences are illustrated by Figure 11, which shows the change in Brazilian exports over time by partner, where the left axis refers to the value in US dollars and the right axis indicates the share of each category exported in total goods exported to each region, represented by the black lines. We can clearly distinguish two groups of partners. The first group is formed by very important markets for Brazilian manufactured goods exports—basically, Latin American countries and the United States. In 2016, Argentina and the United States were responsible for 94% and 84% of Brazilian total exports, respectively. The second group of partners is composed by the European Union (EU-12) and Asian countries. The EU is one of Brazil's main trade partners and accounts for two thirds of total Brazilian exports of primary and resource-based manufactured goods. Of the total manufactured goods exported to the EU-12, 63% were related to intermediate goods. China's and Japan's shares for Brazilian manufactured goods exports represented, respectively, 19% and 33% of the total in 2016. Among manufactured goods exports, there are also differences in composition: the importance of more technologically sophisticated goods (science-based and specialized suppliers) differs significantly between these two groups of partners. While for the Americas (Latin America and the United States), such categories varied from 18% (Argentina)[69] to 36% (the United States) in 2016, for the other group, the share is much smaller (3.5% for China, 8% for Japan and 11.4% for the EU).

**Figure 12.** Evolution of Brazilian exports by selected partners (1990-2016)




Source: Elaborated by the authors, based on Comtrade database.

[69] These shares differ especially from the earlier years. In the US case, we observed that the airplane exports inflated in the later years' statistics, and the share of these two categories became weaker in the earlier years. For LA, the share of these categories in the earlier years was higher, floating around 25%.

Brazil's pattern of trade specialization as described above is typical of middle-income level countries. In fact, as theoretical models of intraindustrial trade and technological gaps predict, trade patterns depend on a country's relative level of development and is highly influenced by the technological gap itself. These models suggest that developing countries tend to have a kind of "North-South" trade pattern with developed ones and an intraindustrial trade pattern of more technologically sophisticated goods with countries of similar per capita incomes. Brazil does not escape from this general rule. However, Brazilian trade pattern with the United States is quite surprising, since it is not characterized by a typically North-South kind, as trade in manufactured goods has been important in their bilateral trade in the last few decades.

## 4. Concluding remarks

This paper analyzed the performance and composition of Brazilian trade flows in the last 26 years. Since most conventional theoretical models reviewed in this study, including the so-called "new new trade" models, take either technology or factor endowments as exogenous, they are insufficient to capture some essential elements of developing countries' pattern of specialization. In particular, as these countries are characterized by large technological and productivity gaps compared with developed countries, descriptive statistics indicators are insufficient to evaluate the extent to which unconditional engagement in free trade policies can positively or negatively affect their long-term growth. The main contribution of Structuralist-Neoschumpeterian models is to show that the extent of a country's technological gap affects its pattern of specialization and growth dynamics. Specifically, they predict that a country characterized by regressive trade specialization has low export diversification as well as income-elasticity of demand for its exports lower than income-elasticity of demand for its imports, implying a perverse long-term growth dynamics and compromising a virtuous catching up trajectory.

Empirical evidence on Brazil showed that since the early-2000s the technological gaps of the manufacturing sector (including natural resource-based segments) have significantly increased. In addition, as the income-elasticity of demand for Brazilian exports has become expressively smaller than the income-elasticity of demand for Brazilian imports after 1999, in comparison with the period 1980-1998, Brazil's estimated long-term growth rate compatible with its balance of payments equilibrium has been much lower than the world growth rate. According to Thirlwall's Law, such performance marks a falling-behind path.

The analysis of Brazilian trade pattern evidenced its regressive trade specialization. Despite the significant increase of Brazilian trade flows, the country's trade pattern did not show a virtuous trajectory between 1990 and 2016, especially with respect to the observed changes in the export structure. While the import structure remained relatively stable, with the more technologically sophisticated sectors accounting for around 40% of Brazilian imports since the mid-1990s, the export structure was marked by a severe primarization process. The export of primary goods continued to increase its share in Brazil until 2014, even after the reversal of the commodity price boom from 2011 onwards. Among manufactured goods exports, labor-intensive and technologically sophisticated ones, such as scale and specialized suppliers, were replaced by primary and resource-based ones. The share of all resource-based segments (primary and resource-based manufactured goods) more than doubled over the last 26 years, reaching 60% of Brazilian total exports in 2016.

This primarization phenomenon was reinforced by a concentration trend of Brazilian exports. Although Brazil's ability to export goods highly demanded by global markets (the extensive margin) increased for all categories of goods between 1990 and 2016, these results did not imply a true diversification trend. Indeed, despite Brazil having notably expanded the number of exported goods, its exported value in US dollars, however, became highly concentrated in commodity goods in the same period. As to the geographical composition of trade flows, although Brazil can be considered a global trader because its trade relations are relatively diversified in the global economy, its bilateral trade patterns differ considerably according to the trade partners in terms of composition, diversification and degree of sophistication. While Brazil's bilateral trade with China, which became the most important Brazilian trade partner after the 2008 global crisis, is characterized by a typical "North-South" trade pattern, the Brazilian trade pattern with Latin American countries is radically different. By being characterized by sectoral complementarities and intraindustrial trade, this suggests a major potential for generating dynamic gains from trade between Brazil and Latin America.

Since Brazil had a sharp regressive trade specialization in the last decades, such a trend has normative implications that go beyond the scope of this study. Notwithstanding, it is worth noting that appropriate industrial and trade policies finely coordinated with other economic policies (including the macroeconomic ones) are necessary for boosting productivity as well as changing this current regressive trade pattern into another characterized by diversification of Brazilian exports towards technologically sophisticated manufactured goods. This strategy could help put Brazil in a successful catching up trajectory.

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# Appendix 1

## Classification of Brazilian industries according to factor content and technological sophistication (correspondence between STIC revision 2 and Pavitt's taxonomy)

| STIC-Rev 2 | Product description | Product categories (Pavitt taxonomy) | Pavitt's Codes |
|---|---|---|---|
| 001 | Live animals chiefly for food | Primary goods | 110 |
| 011 | Meat, edible meat offals, fresh, chi | Primary goods | 110 |
| 012 | Meat & edible offals, salted, in brin | Primary goods | 110 |
| 014 | Meat & edib. offals, prep./pres., fish | Primary goods | 110 |
| 025 | Eggs and yolks, fresh, dried or other | Primary goods | 110 |
| 034 | Fish, fresh (live or dead), chilled o | Primary goods | 110 |
| 041 | Wheat (including Spelt) and Meslin, | Primary goods | 110 |
| 042 | Rice | Primary goods | 110 |
| 043 | Barley, unmilled | Primary goods | 110 |
| 044 | Maize (corn), unmilled | Primary goods | 110 |
| 045 | Cereals, unmilled (no wheat, rice, ba | Primary goods | 110 |
| 054 | Vegetab., fresh, chilled, frozen/pres. | Primary goods | 110 |
| 057 | Fruit & nuts (not includ. oil nuts), | Primary goods | 110 |
| 071 | Coffee and coffee substitutes | Primary goods | 110 |
| 072 | Cocoa | Primary goods | 110 |
| 074 | Tea and mate | Primary goods | 110 |
| 075 | Spices | Primary goods | 110 |
| 121 | Tobacco, unmanufactured; tobacco ref | Primary goods | 110 |
| 211 | Hides and skins (except furskins), | Primary goods | 110 |
| 212 | Furskins, raw (includ. astrakhan, cara | Primary goods | 110 |
| 222 | Oil seeds and oleaginous fruit, whol | Primary goods | 110 |
| 244 | Cork, natural, raw & waste (includ. in | Primary goods | 110 |
| 245 | Fuel wood (excluding wood waste) an | Primary goods | 110 |
| 246 | Pulpwood (including chips and wood | Primary goods | 110 |
| 247 | Other wood in the rough or roughly | Primary goods | 110 |
| 261 | Silk | Primary goods | 110 |
| 264 | Jute & other textile Bast fibers, ne | Primary goods | 110 |
| 265 | Vegetable textile fibers and waste | Primary goods | 110 |
| 291 | Crude animal materials, n.e.s. | Primary goods | 110 |
| 292 | Crude vegetable materials, n.e.s. | Primary goods | 110 |
| 273 | Stone, sand and gravel | Primary goods | 120 |
| 274 | Sulphur and unroasted iron pyrites | Primary goods | 120 |
| 277 | Natural abrasives, n.e.s (incl. indus | Primary goods | 120 |
| 278 | Other crude minerals | Primary goods | 120 |
| 281 | Iron ore and concentrates | Primary goods | 120 |
| 286 | Ores and concentrates of uranium an | Primary goods | 120 |
| 287 | Ores and concentrates of base metal | Primary goods | 120 |
| 288 | Nonferrous base metal waste and sc | Primary goods | 120 |
| 289 | Ores & concentrates of precious met | Primary goods | 120 |
| 322 | Coal, lignite and peat | Primary goods | 130 |
| 323 | Briquettes; coke and semicoke of co | Primary goods | 130 |
| 333 | Petrol. oils, crude & c.o.obtain. from | Primary goods | 130 |
| 022 | Milk and cream | Resource-based industry | 211 |
| 023 | Butter | Resource-based industry | 211 |
| 024 | Cheese and curd | Resource-based industry | 211 |

*(To be continued)*

*(Continued)*

| STIC-Rev 2 | Product description | Product categories (Pavitt taxonomy) | Pavitt's Codes |
|---|---|---|---|
| 046 | Meal and flour of wheat and flour o | Resource-based industry | 211 |
| 047 | Other cereal meals and flours | Resource-based industry | 211 |
| 048 | Cereal prepar. & preps. of flour of | Resource-based industry | 211 |
| 056 | Vegetab., roots & tubers, prepared/pr | Resource-based industry | 211 |
| 058 | Fruit, preserved and fruit preparati | Resource-based industry | 211 |
| 062 | Sugar confectionery and other sugar | Resource-based industry | 211 |
| 073 | Chocolate & other food preptns. con | Resource-based industry | 211 |
| 081 | Feed. stuff for animals (not incl. unm | Resource-based industry | 211 |
| 091 | Margarine and shortening | Resource-based industry | 211 |
| 098 | Edible products and preparations n. | Resource-based industry | 211 |
| 111 | Nonalcoholic beverages, n.e.s. | Resource-based industry | 211 |
| 112 | Alcoholic beverages | Resource-based industry | 211 |
| 223 | Oils seeds and oleaginous fruit, wh | Resource-based industry | 211 |
| 248 | Wood, simply worked, and railway slee | Resource-based industry | 211 |
| 263 | Cotton | Resource-based industry | 211 |
| 268 | Wool and other animal hair (excludi | Resource-based industry | 211 |
| 411 | Animal oils and fats | Resource-based industry | 211 |
| 423 | Fixed vegetable oils, soft, crude, ref | Resource-based industry | 211 |
| 424 | Other fixed vegetable oils, fluid or | Resource-based industry | 211 |
| 431 | Animal & vegetable oils and fats, pr | Resource-based industry | 211 |
| 633 | Cork manufactures | Resource-based industry | 211 |
| 634 | Veneers, plywood, improved or reconst | Resource-based industry | 211 |
| 635 | Wood manufactures, n.e.s. | Resource-based industry | 211 |
| 642 | Paper and paperboard, cut to size or | Resource-based industry | 211 |
| 035 | Fish, dried, salted or in brine; smo | Resource-based industry | 212 |
| 036 | Crustaceans and molluscs, fresh, chil | Resource-based industry | 212 |
| 037 | Fish, crustaceans and molluscs, prepa | Resource-based industry | 212 |
| 061 | Sugar and honey | Resource-based industry | 212 |
| 122 | Tobacco manufactured | Resource-based industry | 212 |
| 232 | Natural rubber latex; nat. rubber & | Resource-based industry | 212 |
| 251 | Pulp and waste paper | Resource-based industry | 212 |
| 641 | Paper and paperboard | Resource-based industry | 212 |
| 266 | Synthetic fibers suitable for spinn | Resource-based industry | 213 |
| 267 | Other man-made fibers suitabl. for s | Resource-based industry | 213 |
| 511 | Hydrocarbons nes. & their halogen. & | Resource-based industry | 213 |
| 513 | Carboxylic acids & their anhydrides | Resource-based industry | 213 |
| 514 | Nitrogen-function compounds | Resource-based industry | 213 |
| 515 | Organo-inorganic and heterocyclic c | Resource-based industry | 213 |
| 516 | Other organic chemicals | Resource-based industry | 213 |
| 522 | Inorganic chemical elements, oxides | Resource-based industry | 213 |
| 523 | Other inorganic chemicals | Resource-based industry | 213 |
| 524 | Radioactive and associated materia | Resource-based industry | 213 |
| 681 | Silver, platinum & oth. metals of the | Resource-based industry | 213 |
| 682 | Copper | Resource-based industry | 213 |
| 683 | Nickel | Resource-based industry | 213 |
| 684 | Aluminium | Resource-based industry | 213 |
| 685 | Lead | Resource-based industry | 213 |
| 686 | Zinc | Resource-based industry | 213 |
| 687 | Tin | Resource-based industry | 213 |

*(To be continued)*

*(Continued)*

| STIC-Rev 2 | Product description | Product categories (Pavitt taxonomy) | Pavitt's Codes |
|---|---|---|---|
| 688 | Uranium depleted in u235 & thorium, | Resource-based industry | 213 |
| 689 | Miscell. nonferrous base metals emp | Resource-based industry | 213 |
| 971 | Gold, nonmonetary | Resource-based industry | 213 |
| 334 | Petroleum products, refined | Resource-based industry | 214 |
| 335 | Residual petroleum products, nes. & r | Resource-based industry | 214 |
| 341 | Gas, natural and manufactured | Resource-based industry | 214 |
| 351 | Electric current | Resource-based industry | 214 |
| 269 | Old clothing and other old textile | Labor-intensive | 221 |
| 572 | Explosives and pyrotechnic products | Labor-intensive | 221 |
| 582 | Condensation, polycondensation & pol | Labor-intensive | 221 |
| 583 | Polymerization and copolymerization | Labor-intensive | 221 |
| 611 | Leather | Labor-intensive | 221 |
| 612 | Manufactures of leather/of composit | Labor-intensive | 221 |
| 613 | Furskins, tanned/dressed, pieces/cutt | Labor-intensive | 221 |
| 621 | Materials of rubber (e.g., pastes, pla | Labor-intensive | 221 |
| 651 | Textile yarn | Labor-intensive | 221 |
| 652 | Cotton fabrics, woven | Labor-intensive | 221 |
| 653 | Fabrics, woven, of manmade fibres | Labor-intensive | 221 |
| 654 | Textil. fabrics, woven, oth. than cotto | Labor-intensive | 221 |
| 655 | Knitted or crocheted fabrics | Labor-intensive | 221 |
| 656 | Tulle, lace, embroidery, ribbons & oth | Labor-intensive | 221 |
| 657 | Special textile fabrics and related | Labor-intensive | 221 |
| 658 | Made-up articles, wholly/chiefly of | Labor-intensive | 221 |
| 659 | Floor coverings etc. | Labor-intensive | 221 |
| 662 | Clay construct. materials & refracto | Labor-intensive | 221 |
| 665 | Glassware | Labor-intensive | 221 |
| 666 | Pottery | Labor-intensive | 221 |
| 667 | Pearls, precious & semiprec. stones, u | Labor-intensive | 221 |
| 696 | Cutlery | Labor-intensive | 221 |
| 812 | Sanitary, plumbing, heating, lighting | Labor-intensive | 221 |
| 821 | Furniture and parts thereof | Labor-intensive | 221 |
| 831 | Travel goods, handbags, brief-cases, p | Labor-intensive | 221 |
| 842 | Outer garments, men's, of textile fab | Labor-intensive | 221 |
| 843 | Outer garments, women's, of textile f | Labor-intensive | 221 |
| 844 | Under garments of textile fabrics | Labor-intensive | 221 |
| 845 | Outer garments and other articles, k | Labor-intensive | 221 |
| 846 | Under garments, knitted or crocheted | Labor-intensive | 221 |
| 847 | Clothing accessories of textile fab | Labor-intensive | 221 |
| 848 | Art. of apparel & clothing accessori | Labor-intensive | 221 |
| 851 | Footwear | Labor-intensive | 221 |
| 883 | Cinematograph film, exposed-develope | Labor-intensive | 221 |
| 892 | Printed matter | Labor-intensive | 221 |
| 893 | Articles of materials described in | Labor-intensive | 221 |
| 894 | Baby carriages, toys, games and sport | Labor-intensive | 221 |
| 895 | Office and stationery supplies, n.e. | Labor-intensive | 221 |
| 896 | Works of art, collectors pieces & an | Labor-intensive | 221 |
| 897 | Jewellery, goldsmiths and other art. | Labor-intensive | 221 |
| 898 | Musical instruments, parts and acces | Labor-intensive | 221 |
| 899 | Other miscellaneous manufactured ar | Labor-intensive | 221 |
| 961 | Coin (other than gold) not being leg | Labor-intensive | 221 |

*(To be continued)*

*(Continued)*

| STIC-Rev 2 | Product description | Product categories (Pavitt taxonomy) | Pavitt's Codes |
|---|---|---|---|
| 282 | Waste and scrap metal of iron or st | Scale-intensive | 222 |
| 584 | Regenerated cellulose; cellulose nit | Scale-intensive | 222 |
| 585 | Other artificial resins and plastic | Scale-intensive | 222 |
| 591 | Disinfectants, insecticides, fungicid | Scale-intensive | 222 |
| 592 | Starches, inulin & wheat gluten; albu | Scale-intensive | 222 |
| 625 | Rubber tyres, tyre cases etc. for whe | Scale-intensive | 222 |
| 628 | Articles of rubber, n.e.s. | Scale-intensive | 222 |
| 661 | Lime, cement, and fabricated construc | Scale-intensive | 222 |
| 663 | Mineral manufactures, n.e.s | Scale-intensive | 222 |
| 664 | Glass | Scale-intensive | 222 |
| 671 | Pig iron, spiegeleisen, sponge iron, i | Scale-intensive | 222 |
| 672 | Ingots and other primary forms, of i | Scale-intensive | 222 |
| 673 | Iron and steel bars, rods, angles, sha | Scale-intensive | 222 |
| 674 | Universals, plates and sheets, of iro | Scale-intensive | 222 |
| 675 | Hoop & strip, of iron/steel, hot-roll | Scale-intensive | 222 |
| 676 | Rails and railway track constructio | Scale-intensive | 222 |
| 677 | Iron/steel wire, wheth/not coated, bu | Scale-intensive | 222 |
| 678 | Tubes, pipes and fittings, of iron or | Scale-intensive | 222 |
| 679 | Iron & steel castings, forgings & st | Scale-intensive | 222 |
| 691 | Structures & parts of struc.; iron, s | Scale-intensive | 222 |
| 692 | Metal containers for storage and tr | Scale-intensive | 222 |
| 693 | Wire products and fencing grills | Scale-intensive | 222 |
| 694 | Nails, screws, nuts, bolts etc. of iron | Scale-intensive | 222 |
| 695 | Tools for use in hand or in machine | Scale-intensive | 222 |
| 697 | Household equipment of base metal,n | Scale-intensive | 222 |
| 699 | Manufactures of base metal, n.e.s. | Scale-intensive | 222 |
| 722 | Tractors fitted or not with power t | Scale-intensive | 222 |
| 761 | Television receivers | Scale-intensive | 222 |
| 762 | Radio-broadcast receivers | Scale-intensive | 222 |
| 763 | Gramophones, dictating, sound recorde | Scale-intensive | 222 |
| 774 | Electric apparatus for medical purp | Scale-intensive | 222 |
| 775 | Household type, elect. & nonelectric | Scale-intensive | 222 |
| 778 | Electrical machinery and apparatus, | Scale-intensive | 222 |
| 781 | Passenger motor cars, for transport | Scale-intensive | 222 |
| 782 | Motor vehicles for transport of goo | Scale-intensive | 222 |
| 783 | Road motor vehicles, n.e.s. | Scale-intensive | 222 |
| 784 | Parts & accessories of 722--,781--, | Scale-intensive | 222 |
| 785 | Motorcycles, motor scooters, invalid | Scale-intensive | 222 |
| 786 | Trailers & other vehicles,not motor | Scale-intensive | 222 |
| 793 | Ships, boats and floating structures | Scale-intensive | 222 |
| 885 | Watches and clocks | Scale-intensive | 222 |
| 233 | Synth. rubb. lat.; synth. rubb. & reclai | Specialized suppliers | 223 |
| 711 | Steam & other vapour generating boi | Specialized suppliers | 223 |
| 712 | Steam & other vapour power units, st | Specialized suppliers | 223 |
| 713 | Internal combustion piston engines | Specialized suppliers | 223 |
| 714 | Engines & motors, nonelectric | Specialized suppliers | 223 |
| 716 | Rotating electric plant and parts | Specialized suppliers | 223 |
| 718 | Other power generating machinery an | Specialized suppliers | 223 |
| 721 | Agricultural machinery and parts | Specialized suppliers | 223 |
| 723 | Civil engineering & contractors pla | Specialized suppliers | 223 |

*(To be continued)*

*(Continued)*

| STIC-Rev 2 | Product description | Product categories (Pavitt taxonomy) | Pavitt's Codes |
|---|---|---|---|
| 724 | Textile & leather machinery and par | Specialized suppliers | 223 |
| 725 | Paper & pulp mill mach., mach for ma | Specialized suppliers | 223 |
| 726 | Printing & bookbinding mach. and par | Specialized suppliers | 223 |
| 727 | Food processing machines and parts | Specialized suppliers | 223 |
| 728 | Mach. & equipment specialized for pa | Specialized suppliers | 223 |
| 736 | Mach. tools for working metal or met | Specialized suppliers | 223 |
| 737 | Metal working machinery and parts | Specialized suppliers | 223 |
| 741 | Heating & cooling equipment and par | Specialized suppliers | 223 |
| 742 | Pumps for liquids, liq. elevators and | Specialized suppliers | 223 |
| 743 | Pumps & compressors, fans & blowers, | Specialized suppliers | 223 |
| 744 | Mechanical handling equip. and parts | Specialized suppliers | 223 |
| 745 | Other nonelectrical mach. tools, app | Specialized suppliers | 223 |
| 749 | Nonelectric parts and accessories | Specialized suppliers | 223 |
| 751 | Office machines | Specialized suppliers | 223 |
| 752 | Automatic data processing machines | Specialized suppliers | 223 |
| 759 | Parts of and accessories suitable f | Specialized suppliers | 223 |
| 771 | Electric power machinery and parts | Specialized suppliers | 223 |
| 772 | Elect. app. such as switches, relays,f | Specialized suppliers | 223 |
| 773 | Equipment for distributing electric | Specialized suppliers | 223 |
| 791 | Railway vehicles & associated equip | Specialized suppliers | 223 |
| 271 | Fertilizers, crude | Science-based | 224 |
| 512 | Alcohols, phenols, phenol-alcohols, & | Science-based | 224 |
| 531 | Synth. org. dyestuffs, etc. nat. indigo | Science-based | 224 |
| 532 | Dyeing & tanning extracts;synth.tan | Science-based | 224 |
| 533 | Pigments, paints, varnishes & related | Science-based | 224 |
| 541 | Medicinal and pharmaceutical produc | Science-based | 224 |
| 551 | Essential oils, perfume and flavour | Science-based | 224 |
| 553 | Perfumery, cosmetics and toilet prep | Science-based | 224 |
| 554 | Soap, cleansing and polishing prepar | Science-based | 224 |
| 562 | Fertilizers, manufactured | Science-based | 224 |
| 598 | Miscellaneous chemical products, n.e | Science-based | 224 |
| 764 | Telecommunications equip and parts | Science-based | 224 |
| 776 | Thermionic, cold & photo-cathode val | Science-based | 224 |
| 792 | Aircraft & associated equipment and | Science-based | 224 |
| 871 | Optical instruments and apparatus | Science-based | 224 |
| 872 | Medical instruments and appliances | Science-based | 224 |
| 873 | Meters and counters, n.e.s. | Science-based | 224 |
| 874 | Measuring, checking, analysing instru | Science-based | 224 |
| 881 | Photographic apparatus and equip | Science-based | 224 |
| 882 | Photographic & cinematographic supp | Science-based | 224 |
| 884 | Optical goods, n.e.s. | Science-based | 224 |
| 911 | UN Special Code | n.d | |
| 931 | UN Special Code | n.d | |
| 941 | Animals, live, n.e.s., incl. zoo-anima | n.d | |
| 951 | Armoured fighting vehicles, arms of | n.d | |

# Appendix 2

**Trade indicators**

**Revealed Comparative Advantage Index (BALASSA, 1965)**

$$RCA = \frac{X_i^{BR} / X^{BR}}{X_i^{W} / X^{W}} \quad (A.1)$$

Where: $X_i^{BR}$ corresponds to Brazilian exports of product *i* and $X^W$ corresponds to total World exports.

**Herfindal-Hrishmann Index**

$$HHI = \sum_{i=1}^{n} \left( X_i / X \right)^2 \quad (A.2)$$

Where: $X_i$ corresponds to exports of product *i* and *X* corresponds to total exports.

**Intensive and extensive margins of trade (HUMMELS; KLENOW, 2005)**

$$IM = \frac{\sum_{j \ni i} X_j^{BR}}{\sum_{j \ni i} X_j^{W}} \quad (A.3)$$

$$EM = \frac{\sum_{j \ni i} X_j^{W}}{\sum_{i} X_i^{W}} \quad (A.4)$$

Where: *j* is the sub-set of *i* goods exported by Brazil (that can be named as the *country's relevant export goods*); $X_j^{BR}$ corresponds to Brazilian exports of the sub-set of products *j* and $X^W$ corresponds to total World exports ($X_j^W$ is the world exports of product *j* and $X_i^W$ is the total world exports). The IM correspond to the market share of Brazil for its "relevant goods *j*". The EM is the share of *j* products in total world exports.

**Intraindustry Trade Index (GRUBEL-LLOYD, 1971)**

$$GLI = 1 - \frac{\sum_i \left| X_i - M_i \right|}{\sum_i \left| X_i + M_i \right|} \quad (A.5)$$

Where: $X_i$ and $M_i$ correspond to a country's exports and imports of product *i*.

For avoiding aggregation bias, we employed the 6-digit Harmonized System disaggregation (around 5 thousand product lines). Yet, trade flows are multilateral (not geographically disaggregated).

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