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Recent patterns of structural change and specialization of the Brazilian industry: an input-output decomposition analysis

Laura de Carvalho[*]
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Abstract

This paper has intended to find the causes of the premature specialization process of the Brazilian industrial structure, by the demand side. In a first section, a preliminary analysis of value added composition indicates that this process was launched in the first half of the 90's and deepened in the years of 2000, and particularly with an overall increase in the share of lower-technologically complex sectors (what does not seem to have occurred in the case of other developed and developing countries). Based on three distinct periods (1985-1990, 1990-1996 and 1996-2004), the second part of this study accomplishes a Structural Decomposition Analysis of Brazilian input-output matrices in terms of value added and employment and concludes that it was not a single factor which led to this recent path of structural change. In general terms, low dynamism of domestic demand and trade liberalization seem to have jointly created this result.

Key-words: structural change, diversification, specialization, input-output analysis, Brazilian industry

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1 Introduction

Though a long-term analysis of Brazilian industry evolution, Bonelli and Goncalves (1998) distinguish four distinct stages in Brazilian industrial growth path. During a first stage of the country's industrialization process, from 1932 to 1962, the average industrial growth reached an average of 9% a year. Within this period, particularly since the 50's, Brazil has launched a process of industrialization though imports substitution, which resulted in significant structural changes in the domestic industry. Later, during a second stage, Brazil experienced the so-called period of "economic miracle" (1967-1973), in which industrial output grew more than 13% a year, while GDP was growing at 12% on average. During this period, the process of imports substitution was deepened, and has allowed for the incorporation of new sectors in the domestic industry, especially of capital goods.

However, this accelerated industrial growth path was reversed during the 80's, when industrial output started having a bad performance, growing only at 2% a year. During this third stage, sectors considered by the authors as more dynamic, such as "modern" intermediate goods (metallurgical, chemical, plastics, paper and rubber), capital goods and part of durable goods, have reduced its share. Finally, the 1990's have been characterized by a modest recovery of the industry when compared to the previous decade, but with a performance far below the one observed throughout the post-war period.

By adopting a conventional point of view based on the concept of comparative advantages, the authors consider that during the last decades, Brazil has simply undergone a process of convergence to the normal pattern found for other countries, taking over a pro-industry bias inherited from the period of imports substitution. The third and four stages of industrial growth described above wouldn't be reasons for concern, by this point of view. Through similar approaches, authors such as Ferreira (2005) and Canedo-Pinheiro et alli (2007) argue that the Brazilian economy has gone too far in its process of diversification of the output structure, deviating resources that could have been used for the expansion of industries in which the country has well-known comparative advantages, and thus decelerating economic development. According to this view, there would be no reasons for the use of instruments of vertical industrial policy, i.e. for the promotion of sectors considered as strategic for the economic development of the country.

Indeed, as highlighted Ferraz, Kupfer and Iootty (2004), the 1990's was marked in Brazil by two competitive shocks: the economic liberalization and the monetary stabilization. The liberalizing reforms sought, in general, the deregulation of the economy, the liberalization of the external sector (reduction of tariff and non-tariff barriers and opening of the capital account) and privatization of the processing and public utilities industries. This set of measures, combined with the macroeconomic changes that followed the Real Plan, created a new competitive environment for the Brazilian industry, characterized by an overvalued exchange rate, high interest rates and by the reduction of barriers to entry for foreign companies. As the authors argue, the outcome of this scenario was a deterioration of the Brazilian trade balance and the massive entry of foreign capital to finance this deficit, which in turn increased the external vulnerability of the economy. Moreover, the 1990's were for the Brazilian economy a period of very low growth rates in both investment and GDP.

After examining the impact of liberalization on composition and productivity levels of the Brazilian industrial structure, Ferraz, Kupfer and Iootty (2004) conclude that the domestic industry has adapted in different ways to the reforms, becoming more competitive in a few sectors. Nonetheless, part of the increase in productivity levels have been generated, according to the authors, by the higher imports of intermediate goods, which have contributed to the disruption of some important links of the country's production chain. In short, as points Kupfer (2003), trade liberalization has led to a modernization through simplification of products and processes and outsourcing of inputs, which in turn have generated a once-and-for-all increase in the productivity levels of the industry, but has not being able to stimulate a sustained increase this same level. In addition, the reforms could have caused a so-called "regressive specialization" in the foreign trade pattern, with an increase in the proportion of simpler products in exports and of greater sophistication in imports.

Broadly speaking, as in the theoretical framework on structural change and economic development, the conventional view in Brazil supports the idea that specialization based on comparative advantages, whatever its nature is, is a better solution for the welfare promotion. Alternatively, critics of this view mostly believe that the sectors are distinct in their ability to affect each other and the whole economy, especially when it comes to their different income- and price-elasticities and potentials for technological innovation. Under this view, the pattern of specialization matters both to the level and to the pace of economic development, and thus the recent trends in the industrial development should be reason for worries.

Simultaneously to this debate, the economic literature has been exploring a connected but quite different topic. At least in economies that are still in early stages of development, some arguments are given against specialization as the best path of structural change in terms of its impact on economic development, and in support of sectoral diversification as a more efficient alternative trajectory. The controversy related to the structural dilemma between specializing the output structure in a few sectors or moving toward a more diverse industry has stimulated the accomplishment of a large number of empirical studies, some of which have been successful in establishing relevant stylized facts.

Among these, is the econometric work of Imbs and Wacziarg (2003), which by correlating indexes of sectoral concentration of output and employment with per capita income for a group of different countries over time, has found an normal U-shaped pattern in the path of specialization of these countries, meaning that countries diversify their industrial structure until reaching a certain level of per capita income, after which they start specializing again. Moreover, as the study shows, the turnaround point of this path seems to occur at a relatively high level of per capita income, leading to the conclusion that countries in general, only start specializing after reaching development.

However, as points out Rodrik (2004), the conclusion that, generally speaking, only developed countries launch their process of specialization, and that, therefore, specialization follows development, contradicts the so-called Ricardian trade theory, which treats specialization as a pre-condition for economic development. Alternatively, it would be more plausible to consider that the diversification of the output structure has contributed to the progress of these economies and thus should best path of structural change to be followed by least-developed countries in order to achieve higher rates of economic growth.

Thus, as in the debate on "positive" and "negative" de-industrialization (Rowthorn and Wells, 1987), the U-shaped pattern of specialization found by Imbs and Wacziarg (2003) should be carefully seen when dealing with developing countries. By

following a view similar to that of Shafaeddin (2005), who argues that trade liberalization tends to stimulate already mature sectors of the economy, which in the case of developing countries usually means promoting sectors of lower technological complexity, it is likely that an 'early' specialization process brings negative consequences on economic development for these countries. It should be clear, therefore, when this U-shaped path is just the natural result of a successful economic development process, and when, in contrast, the inflection of this trajectory is accelerated by exogenous factors, such as trade liberalization. In the latter case, it would be interesting to investigate whether this shift in the pattern of structural change is not detrimental to the economic development of the country concerned.

In this context, as a contribution to the debate on the need for industrial policy in Brazil, it seems relevant not only to determine the path of structural change which has been followed by the Brazilian industry during the last decades, especially in terms of its higher or lower level of diversification, but also the investigation of the endogenous and exogenous factors that affected such process, for a possible evaluation of the impact of these changes on the country's economic development level and pace.

In Carvalho and Kupfer (2007), the aim was to estimate the path of structural change followed by the Brazilian industry in relation to its levels of per capita income, in order to compare it with the pattern found by Imbs and Wacziarg (2003) and to the individual trajectory of some selected countries. The accomplishment of an empirical study based on local non-parametric regressions correlating degrees of sectoral specialization-diversification with levels of per capita income for several countries resulted in U-shaped curves for almost all countries studied, including Brazil. However, the comparison with the specialization paths found for countries such as US, UK, Korea and Taiwan has shown that the structural transition toward specialization in the Brazilian industry took place in much lower levels of per capita income than in all other studied countries.

Starting from this result, this article seeks to find the explaining factors for this apparently premature process of specialization of the Brazilian industry. To meet this objective, the study focuses in the first section on an analysis of value added composition of the Brazilian industrial structure in the last decades, in order to assess the dynamics of specialization over time and, more specifically, the direction towards which this specialization is occurring (share of the different sectors). Then, a second section is concerned with determining and quantifying the demand-side factors leading to such estimated path of structural change, through a so-called Structural Decomposition Analysis, using data from Brazilian input-output matrices. Finally, the last section presents some considerations about the two empirical studies conducted in the article, seeking to draw implications for the debate on the paths that have and should have been pursued by the Brazilian industrial structure in terms of its impact on economic development, as a conclusion to the paper.

2 The Brazilian path of structural change

Trying to follow the same method used by the authors for the determination of a relationship that varies over time, but this time for individual countries, the previous paper of this research agenda (Carvalho and Kupfer, 2007) also chose to use an econometric procedure based on non-parametrical local regressions (*lowess*), in order to

extract a smoothed curve from the data, and thus, establish results with a better graphic representation. As in Imbs and Wacziarg (2003), the dependent variable *y* in these regressions corresponds to a measure of the level of sectoral concentration, and the independent variable *x* is the per capita income of the country (in 1990 international dollars). The distinct observations of *x* and *y* are the annual values of each index for the considered country.

For measuring the level of industrial specialization, the study used the Gini-Hirschmann coefficient (GH), which simply normalizes to the interval of 0 to 100 the square ratio of the Hirchmann-Herfindahl Índex (IHH), usually employed for the determination of levels of market concentration. The GH of a country *j* is given by:

$$GH_j = 100 \cdot IHH^{1/2} = \left(\sum_{i=1}^{n} \left(X_{ij} / X_j \right)^2 \right)^{1/2},$$

in which X_{ij} is the value added of the activity *i* produced by country *j* ;

X_j is the total value added in country *j*' s industry.

and *n* is the number of sectors in its industrial structure.

Thus, the higher the GH index, more specialized (less diversified) is the industrial structure of the country. The GH assumes the maximum value of 100 when the specialization is complete, meaning that there is only one industrial activity in the country. Inversely, when the production is much diversified, the share of each sector in the industrial structure will be low, leading to a GH close to zero[1].

For the Brazilian regressions, value added and employment data were extracted from the Annual Industrial Survey of the IBGE (Brazilian Institute of Statistics and Geography). Since data were given in distinct classifications before and after 1995, the construction of a long time series (1966-2003[2]) has required a previous work of aggregation in 17 sectors[3]. Moreover, values corresponding to the net output/employment of oil sectors (refining and production) were excluded from the analysis for different statistical and methodological reasons (as it is well-known by Brazilian industrial economists, the way these activities are accounted in the Brazilian statistics has changed a lot during this period, making difficult to obtain consistent results for a long series when these sectors are included).

Graphs 1A e 1B present the estimated curves for the Brazilian industry, in terms of Value Added in current prices and Employment. In the considered period (1966-2003), the GH index calculated through de shares of each sector both in value added and employment seem to have followed an U-shaped path, as has occurred in most of the other studied countries. Nonetheless, the inflection of this path in the Brazilian case took place at a level of per capita income much lower than those verified in all the other studied countries, at a per capita income of about I$ 4,000 of 1990 (against about I$ 20,000 in some advanced countries and I$ 8,000-10,000 in East-Asian countries as Korea and Taiwan).

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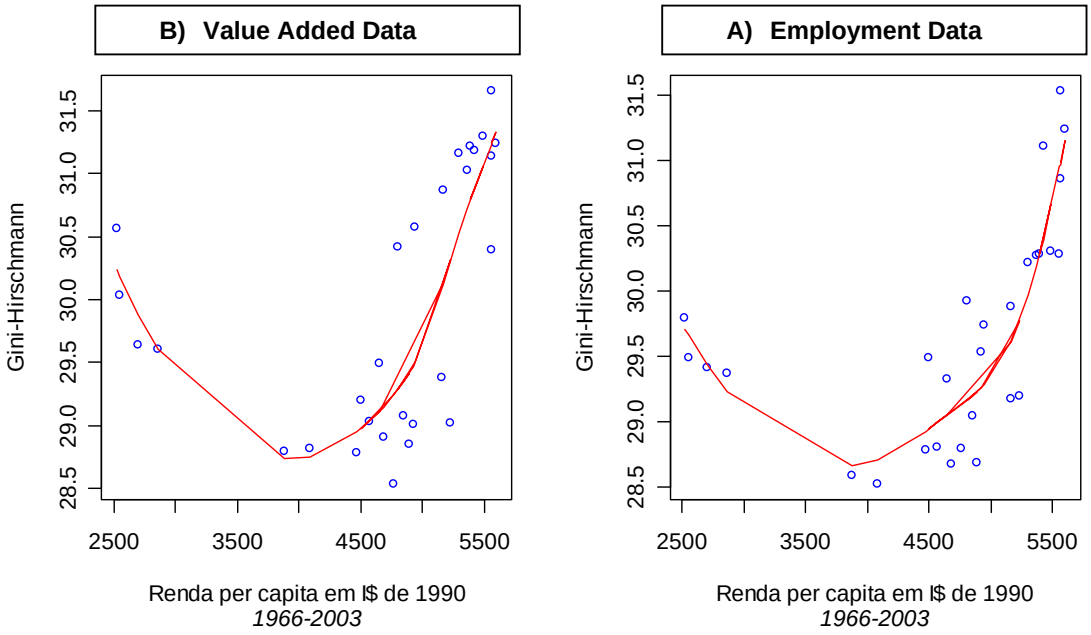
[1] The theoretical limit of the GH index depends on the number of existing sectors in the industrial classification used, being as close to zero, as more uniformly distributed is production in a large number of industrial sectors.

[2] Data are missing for several years of the series, since the Industrial Annual Survey has not been accomplished in 1970, 1971, 1972, 1975, 1980, 1985, 1986, 1987 e 1991.

[3] The aggregation was also done for reasons of compatibility with the database used for other countries in the study (Groningen 60-Industry Database available in www.ggdc.net)

Graph 1

Curves estimated through a LOWESS procedure for the Brazilian path of industrial specialization



Source: Carvalho and Kupfer (2007)

Considering this comparative result, a first dimension that deserves a deeper analysis for a better understanding of the path of specialization estimated for the Brazilian industry is to look at the changes in the structure over time, instead of in relation to per capita income (which can sometimes be misleading for a country of the size of Brazil). In this context, a very simplistic evidence of the trends in the country's industrial structure comes with the simple observation of the evolution of the share of different activities and of specialization indexes over the same period considered for the econometric analysis. This observation allows for a glimpse of the specialization pattern that has been occurring in Brazil and, more specifically, helps determine whether it was toward sectors of higher or lower technological intensity.

For that purpose, Tables 1 to 4 below show the evolution of the industrial value added composition in Brazil, at current prices, excluding the oil sector (extraction and refining), for the years available in the Brazilian Industrial Survey database within the period of 1966 to 2005. It is important to emphasize that the analysis of value added composition at current prices has the disadvantage of allowing for a higher oscillation in the shares because of changes in relative prices. However, the analysis in terms of employment, which is much affected by productivity differentials across sectors, could undermine a possible determination of the direction of this process of specialization, particularly in terms of its technological intensity, since high-technology sectors usually require relatively fewer jobs and tend to have a higher productivity growth rate.

The tables also show, in the last rows, the values obtained for the GH (Gini-Hirschmann) index, which were used in the non-parametric regressions; and also the Gini coefficient, usually used for measuring concentration of income, but also used by Imbs and Wacziarg (2003) to account for the level of specialization of industrial

structures, and finally a summary index based on the OECD High-Technology Sector and Product classification which was formulated to measure the overall technological intensity of the structure[4] (the index varies between 0 and 1, assuming value 1 in the hipothetical situation in which all the industrial value added is concentrated in sectors classified as high-tech). In addition, considering the problems of a measure of diversification/specialization that is based on an excessively aggregated classification, which may not be sensitive to an important process of diversification within a big sector, for example, the GH index was also calculated based on 3-digits data for the years after 1996, when the Brazilian Annual Industrial Survey started being available in such classification. Although at 3-digits the index may vary too much, its obervation is worthy to test the hypothesis that the apparent specialization process is only due to problems of aggregation and classification.

Table 1
Evolution of industrial valued added composition in Brazil (in % of the total) between the 60's and 70's

Classificação agregada	1966	1967	1968	1969	1973	1974	1976	1977	1978	1979
Food and beverages	17.39	17.61	15.52	16.03	14.11	12.75	13.14	13.57	13.44	13.06
Rubber and plastics	3.24	3.59	3.97	3.98	4.25	4.48	4.12	3.93	4.16	4.00
Other industries	2.14	1.91	1.81	1.76	2.07	2.54	2.21	2.39	2.40	2.57
Printing and publishing	2.72	3.16	3.06	3.06	3.33	3.26	3.32	3.19	2.95	2.74
Mining and quarrying	3.16	2.68	2.69	2.96	2.58	2.69	2.59	2.68	2.63	2.73
Tobacco	1.13	1.52	1.46	1.51	1.21	1.12	1.10	1.18	1.05	1.16
Wood	2.47	2.23	2.54	2.69	3.31	3.25	2.69	2.51	2.46	2.49
Transport materials	9.50	8.68	8.17	8.89	7.79	7.30	7.56	7.57	8.03	6.82
Electrical and communication materials	6.06	6.32	6.61	6.44	5.90	5.90	6.11	6.13	6.89	6.46
Mechanical engineering	4.59	5.24	5.55	6.17	8.97	9.39	10.71	10.71	10.66	10.53
Basic Metals	11.31	10.82	11.91	11.75	12.29	14.75	12.36	13.17	12.58	12.91
Non-metallic mineral products	5.04	5.76	6.11	5.99	5.14	5.45	6.24	6.53	6.15	5.75
Products of wood and cork	1.69	1.75	1.68	1.63	2.03	1.87	2.03	1.98	1.96	1.86
Pulp, paper and paper products	2.46	3.34	2.79	2.73	3.06	3.80	2.66	2.58	2.72	3.32
Chemicals	11.86	11.10	11.02	10.51	10.00	9.84	10.89	10.44	10.49	11.16
Textiles	11.13	10.18	11.23	10.37	9.56	7.49	7.14	6.57	6.46	7.07
Clothing, leather and footwear	4.10	4.10	3.88	3.56	4.41	4.12	5.13	4.87	4.96	5.37
GH	**30.56**	**30.04**	**29.64**	**29.61**	**28.79**	**28.81**	**28.78**	**29.03**	**28.91**	**28.85**
Gini	**0.403**	**0.385**	**0.381**	**0.379**	**0.354**	**0.350**	**0.355**	**0.362**	**0.360**	**0.355**
TIP	**0.316**	**0.312**	**0.319**	**0.323**	**0.325**	**0.336**	**0.348**	**0.349**	**0.357**	**0.348**

Source: Built from the Brazilian Industrial Annual Survey/IBGE database

[4] More precisely, based on the review of the OECD high-tech industries and product classification by Hatzichronoglou (1997), this study has created a measure of technological intensity of the industrial structure in a year *t* as follows:

$$PIT_t = 0.\sum s_i + \frac{1}{3}\sum s_j + \frac{2}{3}\sum s_k + \sum s_l$$

Where s_i is the share in value added or employment of the sectors classified as low tech, s_j is the share in value added or employment of the sectors classified as medium-low tech, s_k is the share in value added or employment of the sectors classified as medium-high tech and s_l is the share in value added or employment of the sectors classified as high tech.

When it comes to the evolution of value added composition of the Brazilian industry between 1966 and 1979 (Table 1), in spite of the relatively slow process of structural change that can be observed, three sectors appear as the "share losers" and one as the big "share winner" of the period. The "losers" are mainly *Food and Beverages*, which accounted for 17,39% of the value-added in 1966 and represents only 13,06% in 1979; *Transport Materials* (which includes mainly the car industry), and *Textiles*. The main "winner" of these decades was the *Mechanical Engeneering* sector, which used to represent 4,59% of the industrial value added in 1966 and increases its share to 10,53% in 1979. However, many other small sectors (which accounted for a relatively low share of total value added), have increased its weight during this period, such as *Rubber and Plastics*, *Electrical and Communication Materials*, *Pulp, Paper and Paper products* and *Clothing, Leather and Footwear*.

Thus, during the period of imports substitution, both the increase in the share of sectors that used to account for a small portion of the total value added and the decrease or stagnation in the share of the activities which used to represent the higher share of value added have characterized the so-called process of diversification of the Brazilian industrial structure (value added becomes more equally distributed across sectors). This process can also be directly noticed through the summary-indexes of specialization: the GH decreases its value from 30.56 in 1966 to 28.85 in 1979 and in a similar way the Gini index is reduced from 0.403 to 0.355. Finally, besides the process of diversification, it seems that the period was marked by an overall increase of the technological intensity of the industrial structure (the TIP was of 31,6% in 1966 and increases to 34.8% in 1979.

Table 2
Evolution of industrial valued added composition in Brazil (in % of the total) in the 80's

Classificação agregada	1981	1982	1983	1984	1988	1989
Food and beverages	12.56	13.03	14.32	14.23	12.38	11.42
Rubber and plastics	3.72	4.03	3.77	3.56	4.14	4.36
Other industries	2.25	2.16	2.46	2.08	2.57	2.75
Printing and publishing	2.98	3.66	2.46	2.07	1.83	1.86
Mining and quarrying	2.85	2.98	5.32	8.72	3.92	5.00
Tobacco	1.27	1.15	1.03	1.00	1.29	1.09
Wood	2.28	2.49	1.53	1.61	1.04	1.19
Transport materials	7.64	7.55	8.53	7.00	9.61	9.12
Electrical and communication materials	7.19	6.91	6.52	5.70	9.27	9.41
Mechanical engineering	11.28	10.34	9.02	8.49	9.53	9.37
Basic Metals	11.50	10.97	10.27	10.78	12.55	13.78
Non-metallic mineral products	5.79	5.91	4.77	4.25	4.19	3.92
Products of wood and cork	1.67	1.76	1.38	1.33	1.03	1.20
Pulp, paper and paper products	2.63	3.03	3.14	3.63	3.50	3.62
Chemicals	12.80	11.85	13.42	14.04	12.05	10.37
Textiles	6.59	6.25	5.71	5.73	5.12	5.21
Clothing, leather and footwear	4.98	5.91	6.34	5.78	5.97	6.33
GH	**29.08**	**28.54**	**29.20**	**29.49**	**29.38**	**29.02**
Gini	**0.366**	**0.347**	**0.372**	**0.382**	**0.383**	**0.370**
TIP	**0.371**	**0.355**	**0.361**	**0.352**	**0.393**	**0.387**

Source: Built from the Brazilian Industrial Annual Survey/IBGE database

When we look only to the changes between the first and last years[5] of Table 2 (1981 and 1989), it is easily observable that the 80's, or the so-called "lost decade", reflects a period of higher stagnation and in some cases of reversion in the previous trends of evolution in the Brazilian value added composition. One of the general changes that still can be observed was in the Mechanical Engeneering sector, which reverts its growth path during the decade, reducing its share from 11.28 in 1981 to 9.37% in 1989. The specialization indexes also vary very little during this period.

In Table 3, which presents the same data for the 90's, the direction of the process of specialization becomes more evident. Even if occurring at a lower pace during the second half of the decade (oscillations between 1995 and 1998), both of the specialization indexes have increased significantly during this period of deepening in the trade liberalization process – GH and Gini vary respectively from 29.01 and 0.372 in 1990 to 31.21 and 0.417 in 1999. Even if calculated through the 3-digits classification, the GH index increases between 1996 and 1999. Moreover, the Technological Intensity Parameter shows a significant and continuous decrease sofre redução expressiva during the decade, from 38.3% in 1990 to 35.5% in 1999 (value very close to the one achieved in 1970).

Table 3
Evolution of industrial valued added composition in Brazil (in % of the total) in the 90's

Classificação agregada	1990	1992	1993	1994	1995	1996	1997	1998	1999
Food and beverages	12.43	15.49	15.23	16.08	17.04	18.51	18.63	18.91	18.25
Rubber and plastics	3.94	4.34	3.66	3.71	3.75	4.37	4.31	4.27	4.20
Other industries	2.52	2.17	2.09	2.27	2.09	0.99	0.97	1.06	1.03
Printing and publishing	2.29	2.06	2.12	2.64	3.70	5.29	5.58	5.61	4.64
Mining and quarrying	5.51	4.56	3.57	3.64	3.69	2.37	2.39	2.78	3.29
Tobacco	1.41	1.24	1.17	0.99	0.87	1.18	1.10	1.01	1.15
Wood	0.89	0.81	1.15	0.87	0.76	1.19	1.20	1.17	1.54
Transport materials	9.06	10.88	10.62	12.42	12.62	9.63	10.31	9.79	8.30
Electrical and communication materials	8.94	7.99	8.91	7.52	7.36	8.08	8.06	7.87	7.70
Mechanical engineering	8.95	7.30	6.68	6.48	6.25	7.32	7.37	6.84	6.38
Basic Metals	11.15	11.08	11.37	10.82	10.63	9.91	10.17	10.12	10.43
Non-metallic mineral products	3.50	4.33	4.03	4.14	3.94	3.66	3.88	4.35	4.09
Products of wood and cork	1.10	0.64	0.85	0.96	0.95	1.47	1.45	1.53	1.35
Pulp, paper and paper products	3.32	3.32	2.95	3.33	4.36	4.02	3.64	3.75	4.46
Chemicals	12.58	14.11	14.57	14.36	14.23	13.61	13.66	13.56	15.50
Textiles	5.62	4.61	5.19	4.60	3.78	3.51	3.04	3.14	3.40
Clothing, leather and footwear	6.80	5.10	5.85	5.19	3.99	4.88	4.24	4.23	4.28
GH	**29.01**	**30.42**	**30.58**	**30.86**	**31.16**	**31.02**	**31.29**	**31.19**	**31.21**
GH (3-digits)	**-**	**-**	**-**	**-**	**-**	**13.62**	**13.56**	**13.74**	**14.17**
Gini	**0.372**	**0.414**	**0.420**	**0.423**	**0.424**	**0.422**	**0.432**	**0.425**	**0.417**
TIP	**0.383**	**0.384**	**0.385**	**0.380**	**0.375**	**0.356**	**0.362**	**0.355**	**0.355**

Source: Built from the Brazilian Industrial Annual Survey/IBGE database

[5] Through a more precise analysis of Table 2, it is possible to observe a certain break in the evolution of the value added composition within the period, at about 1983/1984. However, even if there was a higher oscillation in the industrial structure during the decade, probably caused by relative prices movements, it doesn's seem that the country has started any significant process of structural change (of specialization or diversification) during the 80's.

Food and Beverages and *Chemicals* are the two big sectors that have increased even more their share in Brazilian industrial net output during the 90's, and thus which basically explain the overall increase in the specialization indexes. In contrast, sectors as *Electrical and Communication Materials, Mechanical Engineering*, *Basic Metals, Textiles* and finally *Clothing, Leather and Footwear* have reduced their share in value added during the period.

From Table 4, it is possible to conclude that the 2000 years have reproduced or deepened the structural transformations launched in the 90's. GH and Gini indexes have increased continuously their levels during the period (even at 3-digits), while the TIP index decreases from 36.8 to 35.6% between 2000 and 2005. The observed trends for the different sectors in the 90's also seem to have been reproduced in the current decade, especially when it comes to the increase in the share of *Food and Beverages* and the reduction of *Electrical and Communication Materials*.

Table 4
Evolution of industrial valued added composition in Brazil (in % of the total) in the 2000's

Classificação agregada	2000	2001	2002	2003	2004	2005
Food and beverages	16.35	18.41	18.66	19.18	18.00	19.35
Rubber and plastics	4.24	3.63	3.70	4.50	3.95	4.16
Other industries	1.06	0.88	0.84	0.82	0.79	0.83
Printing and publishing	4.75	4.22	3.70	3.59	3.43	3.51
Mining and quarrying	3.18	3.26	3.33	3.29	3.62	4.58
Tobacco	0.93	1.00	0.98	0.83	0.85	0.79
Wood	1.39	1.44	1.62	1.93	1.92	1.69
Transport materials	9.74	9.76	10.35	10.93	11.42	11.35
Electrical and communication materials	9.03	9.16	7.47	6.01	6.22	6.68
Mechanical engineering	6.15	6.78	6.96	6.65	6.86	6.26
Basic Metals	11.02	10.83	11.65	12.05	14.37	14.04
Non-metallic mineral products	4.30	4.38	4.48	4.24	3.81	3.51
Products of wood and cork	1.46	1.41	1.36	1.22	1.13	1.15
Pulp, paper and paper products	4.99	4.41	5.17	5.08	4.48	3.97
Chemicals	13.85	13.24	12.80	13.12	12.83	12.17
Textiles	3.31	2.91	2.81	2.57	2.53	2.41
Clothing, leather and footwear	4.24	4.31	4.12	4.01	3.78	3.54
GH	**30.40**	**31.14**	**31.23**	**31.65**	**31.83**	**32.17**
GH (3-digits)	**15.88**	**15.04**	**15.01**	**16.16**	**15.90**	**17.32**
Gini	**0.407**	**0.425**	**0.428**	**0.436**	**0.444**	**0.451**
TIP	**0.368**	**0.367**	**0.356**	**0.348**	**0.358**	**0.356**

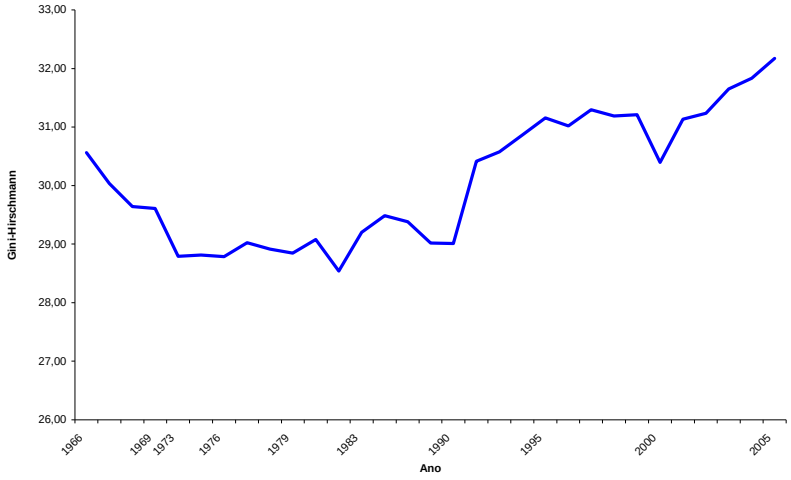
Source: Built from the Brazilian Industrial Annual Survey/IBGE database

In short, the evolution of value added composition shows signs of some structural rigidities in the Brazilian industry, which, in addition to some small swings in the shares (most likely due to movements in relative prices), hinder a more conclusive analysis of the tables. Even though, the data show that only one industry lost weight continuously over the almost forty years covered by the data. This sector is the one of *Textiles*, which reduced its share from 11.1% in 1966 to only 2.4% in 2005. *Food and Beverages,* which in 2005 accounted for over 19% of the total net output, as well as activities related to

the production of *Pulp and Paper*, *Basic Metals* and *Transport Materials* have increased their share if we consider the net effect of the last two decades of the sample. On the other hand, some sectors considered as involving a higher technological intensity showed increases in the share in value added during the first half of the entire period and reduction during the last two decades. This is the case of the *Electrical and Communication Materials*, and *Mechanical Engineering* activities.

Graph 2

Evolution of Gini-Hirchmann (GH) specialization index for the Brazilian industry from 1966 to 2005

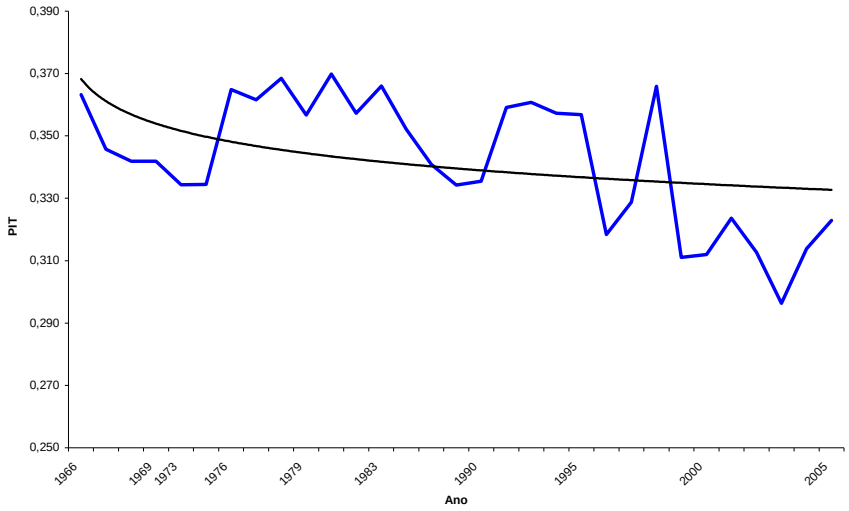


Broadly speeking, four main aspects related to the Brazilian industry's structural change process can be stated after this section:

1. Ths Brazilian industrial structure has pursued an U-shaped path of specialization in relation to its levels of per capita income, as in the normal pattern found by Imbs and Wacziarg (2003).
2. The beginning of the specialization stage in Brazil seem to have occurred at lower levels of per capita income when compared to advanced and non-developed countries, both in terms of value added and employment.
3. In spite of the rigidity in the Brazilian industrial structure during the last 40 years, this process of specialization can be observed after the end of the 80's for value added data, as summarized in Graph 2.
4. Such process of specialization has in general not been toward sectors involving a high technological complexity, but toward traditional and commodity sectors (as summarized by the evolution of the TIP index, *cf*. Graph 3).

Graph 3

Evolution of the technological complexity of the Brazilian industrial structure (TIP) from 1966 to 2005



However, as shown in Carvalho and Kupfer (2008), a study of the evolution of the TIP for a selected group of advanced and emergent countries in relation to their stages of diversification shows that the beginning of specialization, which as already stated, usually occurred at relatively high levels of per capita income in these countries, has not been accompanied by a decrease in their industry's overall technological complexity, as seem to have been the case in Brazil. All these results suggest that the recent process of specialization of the Brazilian industry, besides being early, may have been detrimental to the economic development of the country. A better understanding of this process, though, is only possible through the distinction amongst its various explanatory factors.

3 Explanatory factors of the Brazilian process of specialization

If we look at specialization as a relative loss in the share of some industrial sectors in relation to others, it becomes clear that the empirical investigation on the contribution of the three main groups of factors broadly considered in the debate on industrialization / de-industrialization normal patterns (domestic demand, technological change and foreign trade) for the increase or decrease in the share of economic activities can also be useful to explain a specialization pattern. Hence, the following analysis aims to assess the importance of these three main factors for the process of structural change pursued in Brazil during the last two decades, so that it becomes possible to evaluate the impact of trade liberalization but also of other aspects of the economy for this specialization pattern.

For the evaluation of the explanatory power of such three main groups of factors to the path of specialization pursued by the Brazilian industrial structure, the study will decompose the effects of these factors on the changes in the share of the different sectors in value added and employment, through a procedure similar to the one used in Chenery (1960), Chenery, Robinson and Syrquin (1986), among other seminal works.

3.1 Methodology

Analogously to the method used in Chenery, Robinson e Syrquin (1986), this section is based on an *ex-post* analytical tool of structural decomposition, the so-called "Structural Decomposition Analysis", SDA, in a more recent Brazilian version developed by Kupfer, Freitas and Young (2003) and improved by Dweck, Kupfer and Freitas (2008) for the application in Brazilian input-output matrices. As the latter work points out, this method challenges the framework of neoclassical models which consider economic growth as a process limited by the supply side. This study considers that this sort of framework is particularly not appropriate for the analysis of economies in which growth is not even remotely constrained by the availability of resources, especially labor factor, as in the Brazilian case.

Alternatively, the SDA can be seen as a procedure of growth account by the demand side. Basically, this method allows for the comparison between the contribution of different components of domestic demand (final and intermediate), foreign trade (imports and exports) and technological change on the loss or gain of share of each sector in the industrial structure.

As state Dweck *et alli* (2008), there are many ways of implenting a SDA procedure. The decomposition accomplished in Kupfer *et alli* (2003) and in Dweck *et alli* (2008) were developed on the basis of the equations (1), (2) and (3) as follows:

$$g^d = (1 - A^d)^{-1} f^d \quad (1)$$

$$f = f - f^M \quad (2)$$

$$A^d = A - A^M \quad (3)$$

Where g is the output vector of the industry; A is matrix of input-output coefficients and f is the vector of final demand. The superscripts M and d correspond, respectively, to the imported and domestic amounts (a letter without superscript refers to the total value).

Equation (1) indicates that the variation in the output level can be decomposed in both the variation of the technical coefficients and the variation in the final domestic demand. These latter changes can, in turn, be partially explained by changes in the total value or changes in imports, as shown in equations (2) and (3)[6].

Starting from these basic equations, changes in output, employment or value added can be decomposed in:

i. Effect of domestic demand: number of new jobs or increase in value added that is purely caused by the expansion in output that is necessary to attend the growth of domestic demand observed in the period (includes households and government consumptions plus the capital formation). This effect is calculated through a sort of comparative statics exercise, i.e., assuming that the output in the end of the period has been achieved with the same technology (same

[6] In the case of changes in employment or value added, the decomposition is based in the same 3 equations, and considering that:

$$VA = v.g$$

$$L = l.g$$

Where coefficients *v and l* represent, respectively, the ratio of the value added over the total output and the ratio of the total labor over the total output. Thus, changes in employment and value added can be also expained by changes in these ratios. Changes in any of the coefficients, including the input-output coefficients are included in the technological change component.

coefficients) and same structure of exports and imports observed in the beginning of the period and *vice-versa*.

ii. Effect of exports: in a similar way, indicates the number of jobs or the amount of value added that was generated by the expansion of exports, assuming that the other factors were kept at the same level of the initial period and *vice-versa*.

iii. Effect of imports: analogous to that of exports, with the difference that the expansion of imports tends to eliminate jobs and decrease value added.

iv. Effect of Technical Change: indicates the variation on employment or value added created by changes in the production processes which affect the input-output coefficients, and in the case of employment, labor-output ratios, in the different sectors. In this latter case, these effects reflect changes in the efficiency and productivity levels, that when positive, tend to imply in a reduction of employment. As in the previous comparative statics exercises, this effect is calculated, for example, by means of a comparison between the number of jobs correspondent to the output of the end of the period with the one obtained through the use of the technical coefficients of the initial period, and *vice-versa*[7].

Since the Brazilian Instititute of Statistics and Geography (IBGE) has still not published the input-output matrices of 2000 and 2005, a 2004 I-O matrix was generated by means of an updating procedure based on Tables of Sources and Uses of 2004, and the input-output matrix of 1996, as executed in Dweck *et alli* (2008)[8].

This study has estimated the contribution of domestic demand, exports, imports and technological change on the growth of industrial[9] employment and value added for three distinct periods: 1985-1990, 1990-1996 and 1996-2004. These breakdowns are more connected to data availability than to an effective choice based on possible structural transitions. However, considering that the process of specialization seems to have been launched in the beginning of the 90's, as observed in the previous section, these three periods of analysis seem sufficiently adequate for an explanation of the specialization process. To allow for comparisons between distinct years, all the output data were sectorally deflated to constant prices of 2003.

For the presentation of results in this paper, in order to maintain the connection with the previous section, the database has been aggregated in 16 sectors, through a classification as close as possible to the one used for the long-term composition analysis. Moreover, for an overall analysis of the explanatory factors of the specialization process, which as interpreted before is here understood as a loss of weight of some sectors and the consequent increase in the share of others, the decomposition of these components was re-aggregated in two large groups of sectors according to the evolution of employment and value added composition in the period 1985-2004, as presented in Appendix 1:

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[7] In this sense, estimations based on input-output matrices do not take into account the also important effects on employment of the introduction of product innovations (jobs generated by the advent of new activities for the creation of new products, for example).

[8] The updating procedure has the failure of replicating for 2005 the shares of the different activities in the structure of imports referred to 1996.

[9] Industry here includes manufacturing and mining and quarrying activities (excluding the oil sector, to keep the connection with the previous chapter), but services and agriculture are not excluded from the input-output matrices for the demand calculus, since they respond for a part of the intermediate demand of the industrial sectors.

i. Group 1: "Winners", i.e., sectors that have increased their share in industrial employment/value added from 1985 to 2005;
ii. Group 2: "Losers", i.e., sectors that have decreased their share in industrial employment/value added from 1985 to 2004.

3.2 Results of the SDA

By a preliminary analysis from information in Table 5[10], it is already possible to do some remarks on the importance of the main components of final demand and technological change on employment growth in the distinct sectors and in the total industry in the entire period of analysis (1985-2004). In first place, we observe that in the aggregate level, industrial employment grew only 12.25% in the almost twenty years covered by this study, with the domestic demand being responsible for 12.1% of growth, the net effect of foreign trade (substracting imports from exports contribution) accounting for 8% of growth, and technological change explaining a reduction of 7.7% in industrial employment. From this point of view, the main component to affect employment in the industrial structure in the entire period seems to have been domestic demand, followed by foreign trade balance and finally by technological.

Table 5
Employment growth decomposition for 16 Brazilian industrial sectors between 1985 and 2004

Group	Aggregate classification	Domestic Demand	Exports	Imports	Technological Change	Stocks	Total
Group 1	Food and beverages (incl. Tobacco)	6.03%	2.19%	-0.50%	-3.35%	0.01%	4.37%
	Rubber and Plastics	0.66%	0.69%	-0.62%	0.30%	-0.09%	0.94%
	Other industries	1.08%	0.77%	-0.79%	-0.08%	0.22%	1.20%
	Wood (incl. Wood products)	-0.68%	3.98%	-0.68%	-0.47%	-0.26%	1.89%
	Mechanical Engineering	2.62%	1.63%	-1.02%	-1.18%	0.17%	2.23%
	Paper and Pulp (incl. Printing and Publishing)	1.61%	1.32%	-0.66%	-1.18%	-0.09%	1.00%
	Clothing, Leather and Footwear	-6.90%	2.17%	-1.44%	9.90%	-0.15%	3.59%
Group 2	Mining and Quarrying	0.38%	1.28%	-0.47%	-1.71%	-0.16%	-0.68%
	Transport materials	1.00%	1.88%	-0.91%	-1.98%	-0.29%	-0.30%
	Electrical and communication materials	1.49%	0.77%	-1.37%	-1.51%	-0.02%	-0.64%
	Basic metals	2.62%	2.81%	-2.08%	-2.26%	-0.01%	1.06%
	Non-metallic mineral products	1.20%	0.72%	-0.59%	-1.69%	-0.01%	-0.37%
	Chemicals	1.36%	0.62%	-0.96%	-1.14%	-0.08%	-0.20%
	Textiles	-0.32%	0.35%	-1.00%	-1.30%	0.44%	-1.84%
	Total industry	12.14%	21.17%	-13.09%	-7.66%	-0.32%	12.25%

Source: Built from I-O matrices of 1985 and 1996 /IBGE and uptaded matrix of 2004 (Dweck *et alli*, 2008).

[10] Information in Table 5 reflects already the sum of scale and composition effects of each component, in which the scale effect is the absolute increase on employment due to each component and the composition effect reflects the variation on the share of each sector on total employment (the sum of both effects being the real contribution of each component on each sextor for the employment). In addition, the domestic demand component was calculated by adding the contribution of households consumption, government consumption and capital formation to employment growth, and the penetration/substitution of imports effect includes the contribution of final and intermediate demand for imported goods in the sector (negative sign indicates penetration of imports and positive sign would correspond to imports substitution).

However, an aggregate analysis is not enough to explain the generation of a specific structural change and specialization pattern. Indeed, some sectors seem to have been differently affected by the effects of these components. It is true thath domestic demand has been the most important effect in many of these sectors, as in the aggregate level (Food and Beverages, Mechanical engineering, Chemicals, Paper industry and Rubber and Plastics), but in other activities the technological component had a bigger contribution for employment variations, such as in Mining and Quarrying, Transport materials, Electrical and communication materials, Non-metallic mineral products and others.

Since we are interested in evaluating what have changed in terms of the contribution of these components during the 90's, and thus have shaped the path of specialization described in the previous section, the next step is to look at what happened in the disaggregated level for the three different periods. These results are summarized for employment in Graph 4, but can be examined in the detail in Appendix 2.

First of all, when it comes to the growth of employment, as presented in Graph 4, it is noticeable that the industrial growth rate between 1985 and 1990 was higher than in the average of the entire period. In addition, differently than what is observed for the period 1985-2004, between 1985 and 1990 the Group 2 of sectors ("Losers") was not suffering a reduction in its share in the industrial employment. In third place, it can be observed that the differences between the two groups of sectors in terms of the contribution of the distinct components of final demand (and technological change) were not very significant during this period: domestic demand accounts for a modest growth of employment in both groups; the foreign trade component causes a small net reduction in employment in both groups, and, finally, the technological component is the most important one in the explanation of employment growth in the two groups, but especially in Group 1.

Between 1990 and 1996, mainly through the technological effect, which contributes to a significant reduction of employment in the two groups of sectors, the total industrial employment is reduced in 23.3%. More precisely, the small effect of the domestic demand is partially annulated by the negative impact of the trade balance in both groups (the small growth generated by the exports expansion, especially in Group 2, is offset by the imports penetration).

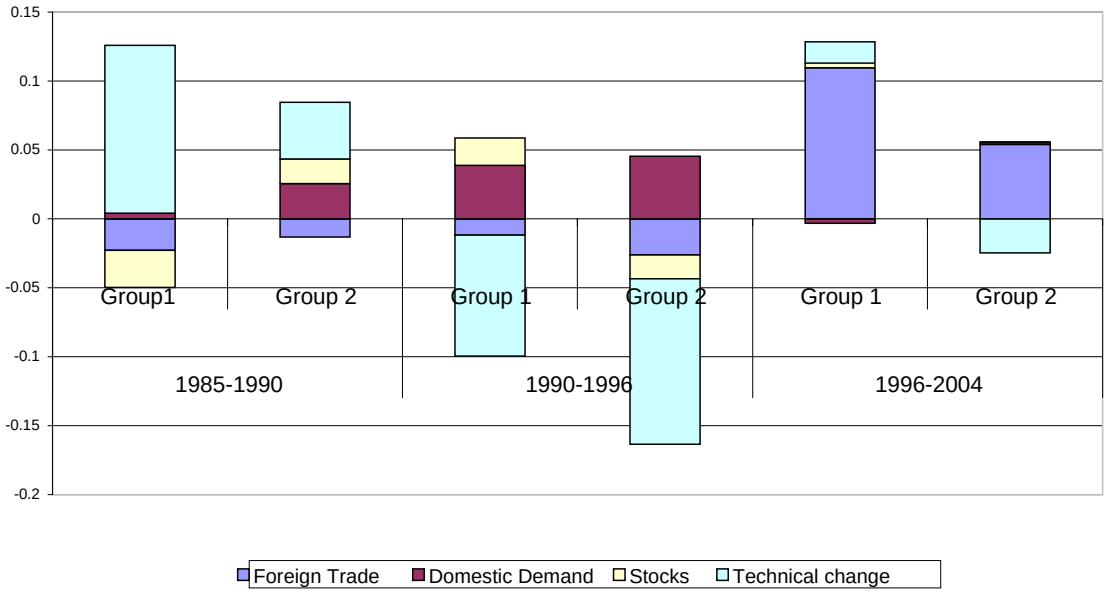
Finally, it is in the period 1996-2004 that emerge the greater differences between the two groups of sectors, making the analysis ot this last time period crucial to the comprehension of the industrial specialization process. Firstly, during this period, Group 1 contributes to a growth of 12.5% in employment, against 3.1% of Group 2. Secondly, the growth rate of employment in Group 1 is explained almost exclusively by the positive contribution of the foreign trade component (11%), which in turn is caused by the impact of exports with a small penetration of imports. Domestic demand does not contribute to growth in employment of Group 1(-0.3%) and the technological component only generates a 1,5% of growth.

In Group 2, the low growth can be explained as follows, As in Group 1, the domestic demand does not contribute for the variation in employment (0,1% of contribution). However, in this case, the technological component has a negative impact of about 2.5% and the trade balance effect is not big enough to cover this negative contribution.

Generally speaking, in none of the three studied time periods, the domestic demand is the most important component in any of the two groups of sectors, or for the explanation of the differential growth rates between these groups. Particularly between

1996 and 2004, when the differences between the two groups become relevant, the impact of this component to the employment growth is close to zero in both groups.

Graph 4: Summary SDA results for employment growth in Brazilian industry



Source: Built from I-O matrices of 1985 and 1996 /IBGE and uptaded matrix of 2004 (Dweck *et alli*, 2008).

Thus, in all periods, either the foreign trade, either the technological change components appear as the most important, not only in terms of its contribution to the employment growth in industry, but also in generating inequality between the growth rates in the two groups, and, hence, for the direction and pace of structural change of the industrial employment. Before 1996, the higher contribution and the higher differentials were created by the technical component, while between 1996 ans 2004 the trade balance became the main determinant of the industrial employment growth , especially in the Group 1, of "Winner sectors". Within this effect, it is the exports expansion the main responsible for this growth, but the imports penetration also vary between the two Groups, being very low in Group 1.

Since, by definition, the technological component has a higher impact on employment than on value added (in the former case it also includes changes in the labor-output coefficients), the analogous decomposition of growth in value added can allow for a more precise conclusion on the importance of foreign trade and domestic demand for the recent process of specialization of the Brazilian industrial structure.

As in Table 5, Table 6 presented below shows the impact of the different components on the growth in value added of the different sectors in the whole period 1985-2004. We can see that in the aggregate level, industrial net output grew 40.9% in this period, in which domestic demand accounted for 30% of growth, the net effect of foreign trade was 12.4% of growth and technical change contributed for a reduction 3.8% in value added.

Table 6
Value added growth decomposition for 16 Brazilian industrial sectors between 1985 and 2004

Group	Aggregate classification	Domestic Demand	Exports	Imports	Technological Change	Stocks	Total
Group 1	Food and beverages (incl. Tobacco)	6.42%	3.17%	-0.49%	0.57%	0.33%	9.99%
	Other industries	1.02%	0.69%	-0.69%	-0.01%	0.20%	1.21%
	Mechanical Engineering	5.80%	3.62%	-2.04%	0.68%	0.42%	8.49%
	Basic metals	3.76%	6.37%	-3.43%	2.41%	3.37%	12.48%
	Paper and Pulp (incl. Printing and Publishing)	2.03%	2.09%	-0.74%	-0.11%	-0.10%	3.17%
	Chemicals	3.34%	3.14%	-2.77%	1.70%	-0.08%	5.32%
Group 2	Rubber and Plastics	1.34%	1.21%	-1.07%	-0.50%	-0.18%	0.80%
	Mining and Quarrying	0.36%	1.84%	-0.47%	-0.82%	-0.18%	0.73%
	Wood (incl. Wood products)	-0.23%	1.51%	-0.27%	-0.93%	-0.10%	-0.02%
	Transport materials	2.39%	3.84%	-1.57%	-1.84%	-0.37%	2.46%
	Electrical and communication materials	3.17%	1.50%	-2.85%	-1.58%	-0.01%	0.24%
	Non-metallic mineral products	1.19%	0.83%	-0.60%	-0.77%	0.01%	0.65%
	Textiles	-0.28%	0.27%	-1.07%	-2.12%	0.27%	-2.92%
	Clothing, Leather and Footwear	-1.53%	0.78%	-0.40%	-0.49%	-0.10%	-1.74%
	Total industry	**28.77%**	**30.86%**	**-18.46%**	**-3.78%**	**3.48%**	**40.86%**

Source: Built from I-O matrices of 1985 and 1996 /IBGE and uptaded matrix of 2004 (Dweck *et alli*, 2008).

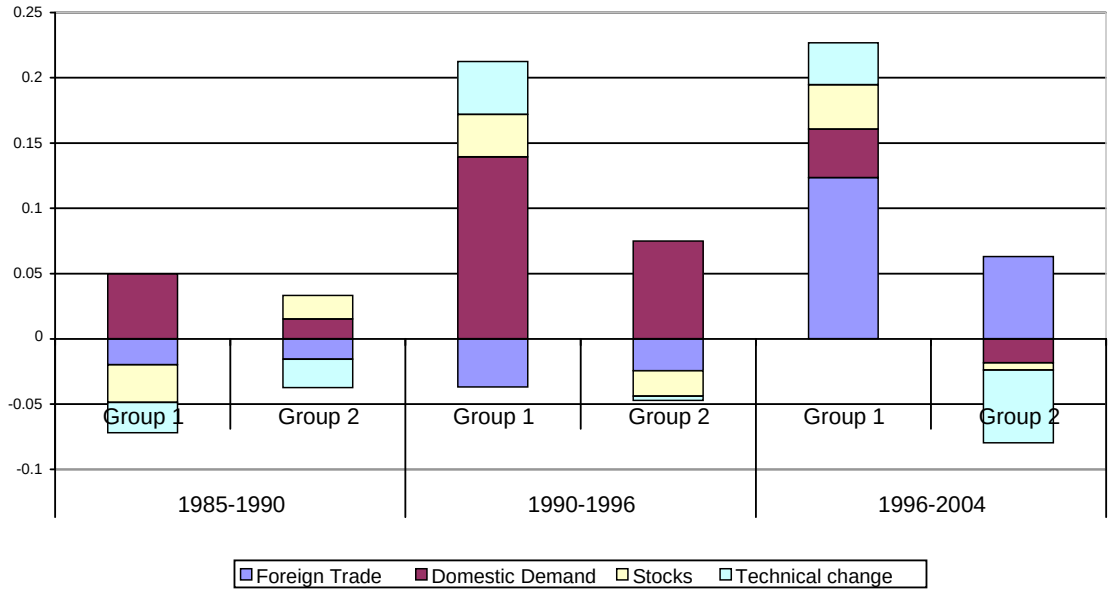
As in the case of employment, it seems important to look at the relative importance of each component of growth at a disaggregate level. Considering the relatively low importance of technical change in the case of value added and the partial or total offsetting of the positive effect of exports by the imports penetration in almost all sectors, domestic demand seems to be the most important component also in the sectoral level, except for Mining and Quarrying, Wood and Textiles industries. Nonetheles, the ranking of the importance of the three components change significantly from a period to the other, as can be observed in detail in Appendix 2 and summarized in Graph 5.

Broadly speaking, in the first period of analysis (1985-1990), growth in value added was negative in the two groups of sectors, with a reduction even higher in Group 2. Foreign trade and technological change had similar effects in the two groups of sectors, both leading to a decrease of about 2% of value added. In contrast, expansion of domestic demand seems to have contributed more to the growth of value added in Group 1 (about 5% against 1.5% in Group 2), being responsible, therefore, for the differential growth of the two groups.

In a second moment, during the first half of the 90's, there is a positive growth of value added in both groups of industries, but with inequality between them: growth of Group 1 is of about 18.3%, against 6.6% of Group 2, adding up to about 25% of total industrial growth in the period. This inequality essentially from comes two effects: domestic demand, which contributes to almost 14% of growth in Group 1 (and 7.5% in Group 2) and technological change, which explains more than 4% of growth in value added in Group 1 (and a reduction of 0.3% in Group 2). Because of a high penetration of imports, the trade balance component generates a negative impact in the growth of both groups, with a higher absolute effect in Group 1.

The second half of the 90's seems to be marked by a process of structural change generated by different factors. Such as in the case of employment, it is in this period that the differences across the two groups of sectors are deepened: while value added of Group 1 grew at 22.7%, Group 2 has reduced its net output in 6.7%. These differences are also observable through the contribution of the distinct components of growth. In this period, domestic demand gives place to foreign trade as the main component to affect growth in the two groups of sectors. Within this latter component, contribution of exports is responsible for the higher portion of total growth and also for the disequilibrium between the two groups of industries (account for 14.4% of growth in Group 1 and 9.3% in Group 2). However, this inequality is increased by the higher imports penetration in Group 2.

Graph 5: Summary SDA results for net output growth in Brazilian industry



Source: Built from I-O matrices of 1985 and 1996 /IBGE and uptaded matrix of 2004 (Dweck *et alli*, 2008).

In short, as expected, the impact of the technological component on the growth of value added was relatively small in all three periods (slightly higher in the first period, when both groups have reduced their value added). Moreover, until 1990, the importance of the three different components on growth of value added has been more equally distributed within each group (with domestic demand assuming a slightly more relevant role than the other components in Group 1). However, by observing Graph 3, it is clear that domestic demand and foreign trade have not accounted for a constant contribution on growh over the entire period. Conversely, during the period 1996-2004 there is an inversion in the role of these two components, both in terms of its absolute contribution to the growth of value added in each group and in terms of the inequality of this impact between these two distinct groups.

Furthermore, while in the beginning of the 90's domestic demand was the main responsible for growth in value added in the two groups of activities (in a lower scale in

Group 2), between 1996 and 2004, when growth differentials increase between these groups, it is the foreign trade net effect that accounts for most of this phenomenon. When it comes to what has occured in Group 2 alone, trade balance is actually the only factor leading to an increase in value added during the last period (domestic demand and technological change accounted for a negative growth). Finally, even if in Group 1 all the components have generated positive growth in value added, foreign trade has been the most important one (notice that this same effect was leading to a negative growth in the group's net output from 1990 to 1996).

Thus, from the Structural Decomposition Analysis of employment and value added growth, it becomes clear that the recent process of specialization of the Brazilian industrial structure verified in the previous section with data from the Brazilian Annual Industrial Survey and reforced in this section with data from national accounts, was not caused my a single factor, but my a combination of effects. Low dynamism of domestic demand and high growth of exports seem to have jointly shaped the pace and the direction of the recent process of specialization of Brazilian industry. Furthermore, these results can allow for some other secundary interpretations.

When it comes to the employment structure, trade liberalization seems to have played a double role on the process of industrial development. From 1990 to 1996, possibly due to foreign competion and outsource of inputs, trade openness may have provoked an increase in the industry's productivity levels (and especially on the labor-output ratios), thus generating a fall in employment levels in most sectors (though the technical component). However, the contribution of this component to employment growth has not been sustained in the next period, confirming a well known result of some Brazilian industrial studies, that trade openness is only capable of creating a once-and-for-all effect on productivity levels. Conversely, from 1996 to 2004, the effect of trade liberalization starts appearing directly through the foreign trade component, which turns to be the main responsible for generating growth in industrial employment and for determining which sectors decrease and increase their share in the process of specialization.

In the case of value added, the impact of trade liberalization seems essentially to be the direct one on the foreign trade component, but it also varies over time. Between 1990 and 1996, the impact of imports penetration is greater than the contribution of exports, causing a negative net contribution of this component to the industry's value added. In contrast, in the 1996-2004, in the absence of expansion of domestic demand, this factor becomes the only one to stimulate industrial growth in the economy, especially in the activities of Group 1 (which are the ones revealing a higher international competitiveness).

4 Final remarks

After a first step of this research agenda which by means of local non-parametric regressions for a selected group of countries, found that the Brazilian industrial structure is experiencing a relatively early process of specialization in relation to its level of development, both in terms of value added and employment, an analysis of this process over time indicates that this phenomenon was launched in the beginning of the 90's and deepened in the years 2000, with the gain of share of some sectors that already accounted for a high portion of the industrial net ouput. Furthermore, a preliminary analysis shows that the overall technological intensity of the country's industrial structure (in terms of the share of more high-tech sectors) has not increased during the

last decades, reversing the increasing path of the same index that characterized the stage of diversification and imports substitution in the 70's. As studied in Carvalho and Kupfer (2008), this does not seem to be the case of the specialization stage in other countries.

Both of these results support the hypothesis that this process of specialization is ocurring prematurely in Brazil, and might have been caused by factors exogenous to its own process of economic growth. To address this question, this paper has accomplished a Structural Decomposition Analysis of Brazilian input-output matrices, allowing for the comparison of the roles of domestic demand, foreign trade and technological change in this recent process of specialization.

Based on three distinct periods of analysis (1985-1990, 1990-1996 and 1996-2004), the results of the SDA for value added and employment growth rates suggest that it was not a single factor that pushed the Brazilian structural change during the last two decades. Generally speaking, the low dynamism of domestic demand, together with the trade liberalization reforms seem to have been crucial not only for the configuration of such process of specialization, but also for the directions it is taking (the so-called "winner and loser" sectors in this process).

Indeed, the results suggest a double effect of trade liberalization for this process. In a first moment, growth differentials across sectors in the case of employment seem to have been provoked by an increase in labor productivity levels (or labor-output coefficients), which in turn may have been the consequence of the competitive shock of imported goods after trade openness. In a second moment, trade liberalization is affecting mostly through its direct impact on foreign trade, both though exports and penetration of imports. This latter effect is also true for the case of value added in the last period of analysis, when domestic demand stops contributing to industrial growth.

It seems evident that when facing a low dynamism of domestic demand, the sectors which grow faster are those which are capable to export more and suffer less with penetration of imports, or equivalently, the most competitive ones (or as argued by Shaffaeddin (2005), the already mature industries). In the Brazilian case, it is not surprising then that the almost null expansion of domestic demand together with the effects of trade liberalization have led to a specialization towards more traditional activities, involving lower technological complexity, as shown in the first section.

These hypotheses bring to the top some considerations which are not in the scope of this study, but take part in the research agenda on this subject: it is reasonable to assume, as opposed to the conventional view, that the impact of both the low dynamism of domestic demand and trade liberalization could have been minimized by the execution of well designed industrial policies, as argued by Rodrik (2004). Consequently, policies focused on the diversification of the industrial structure and on the re-establishment of some important links in the Brazilian production chain could still reverse this apparently negative path of structural change and generate a higher rythm of economic development.

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Appendix 1

Composition of employment in the Brazilian Industry: definition of Groups 1 and 2 and GH evolution for employment

Group	Aggregate Classification	1985	1990	1996	2004
Group 1	Food and Beverages (incl. Tobacco)	14.53%	15.57%	18.26%	16.83%
	Rubber and Plastics	2.73%	2.96%	2.88%	3.27%
	Other industries	2.95%	2.85%	2.84%	3.70%
	Wood and wood products	9.85%	9.45%	10.52%	10.45%
	Mechanical engineering	6.23%	5.59%	5.13%	7.54%
	Paper, Pulp and Paper products (incl. Printing and Publishing)	4.69%	4.93%	5.20%	5.06%
	Clothing, Leather and Footwear	22.53%	22.71%	23.74%	23.30%
Group 2	Mining and Quarrying	3.78%	3.24%	2.54%	2.76%
	Transport materials	4.38%	4.29%	3.59%	3.63%
	Electrical and communication materials	3.56%	3.94%	3.12%	2.59%
	Basic metals	10.07%	9.85%	9.42%	9.92%
	Non-metallic mineral products	5.51%	5.87%	5.36%	4.57%
	Chemicals	4.48%	4.38%	4.37%	3.82%
	Textiles	4.71%	4.39%	3.03%	2.56%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
	GH	**33.36**	**33.67**	**35.39**	**34.79**

Source: Built from I-O matrices of 1985 and 1996 /IBGE and uptaded matrix of 2004 (Dweck *et alli*, 2008).

Composition of value added in the Brazilian Industry: definition of Groups 1 and 2 and GH evolution for value added

Group	Aggregate Classification	1985	1990	1996	2004
Group 1	Food and Beverages (incl. Tobacco)	13.87%	15.60%	17.04%	16.93%
	Other industries	2.45%	2.73%	2.36%	2.58%
	Mechanical engineering	9.58%	9.97%	10.82%	12.84%
	Basic metals	13.25%	13.46%	13.67%	18.28%
	Paper, Pulp and Paper products (incl. Printing and Publishing)	6.23%	5.36%	5.52%	6.71%
	Chemicals	13.00%	12.90%	13.07%	13.04%
Group 2	Rubber and Plastics	4.55%	5.34%	5.12%	3.77%
	Mining and Quarrying	3.73%	2.94%	2.32%	3.17%
	Wood and wood products	4.35%	4.19%	3.72%	3.08%
	Transport materials	6.98%	6.13%	7.86%	6.72%
	Electrical and communication materials	5.51%	6.01%	6.40%	4.04%
	Non-metallic mineral products	4.92%	5.70%	5.31%	3.97%
	Textiles	5.23%	5.01%	3.14%	1.63%
	Clothing, Leather and Footwear	6.36%	4.66%	3.66%	3.26%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
	GH	**29.97**	**30.57**	**31.63**	**33.63**

Source: Built from I-O matrices of 1985 and 1996 /IBGE and uptaded matrix of 2004 (Dweck *et alli*, 2008).

Appendix 2

Decomposition of employment growth for two group of sectors of Brazilian industry between 1985 and 1990 (%)

Group of Sectors	Domestic Demand				Foreign Trade			Technical change	Total growth
	Capital Formation	Government consumption	Household consumption	**Total**	Exports	Imports	**Total**		
Group 1	0.59	0.09	-0.27	**0.41**	-1.32	-0.97	**-2.29**	**12.18**	7.60
Group 2	1.20	0.05	1.31	**2.56**	-0.58	-0.73	**-1.31**	**4.11**	9.47
Total industry	**1.79**	**0.14**	**1.04**	**2.97**	**-1.90**	**-1.70**	**-3.60**	**16.29**	**17.07**

Decomposition of employment growth for two group of sectors of Brazilian industry between 1990 and 1996 (%)

Group of sectors	Domestic Demand				Foreign Trade			Technical change	Total growth
	Capital Formation	Government consumption	Household consumption	**Total**	Exports	Imports	**Total**		
Group 1	1.14	0.30	2.45	**3.89**	2.31	-3.49	**-1.18**	**-8.77**	-14.85
Group 2	1.51	0.11	2.92	**4.54**	0.99	-3.61	**-2.62**	**-11.99**	-8.46
Total Industry	**2.65**	**0.41**	**5.37**	**8.42**	**3.30**	**-7.10**	**-3.80**	**-20.76**	**-23.31**

Decomposition of employment growth for two group of sectors of Brazilian industry between 1996 and 2004 (%)

Group of sectors	Domestic Demand				Foreign Trade			Technical change	Total growth
	Capital Formation	Government consumption	Household consumption	**Total**	Exports	Imports	**Total**		
Group 1	0.89	0.52	-1.74	**-0.32**	11.84	-0.88	**10.96**	**1.54**	**12.52**
Group 2	0.51	0.18	-0.55	**0.14**	8.14	-2.74	**5.40**	**-2.47**	**3.08**
Total Industry	**1.40**	**0.70**	**-2.29**	**-0.19**	**19.98**	**-3.62**	**16.37**	**-0.93**	**15.60**

Decomposition of net output growth for two group of sectors of Brazilian industry between 1985 and 1990 (%)

Group of Sectors	Domestic Demand				Foreign Trade			Technical change	Total growth
	Capital Formation	Government consumption	Household consumption	**Total**	Exports	Imports	**Total**		
Group 1	0,70	0,11	4,15	**4,96**	-0,68	-1,32	**-2,00**	**-2,33**	-2,25
Group 2	1,08	0,04	0,40	**1,52**	-0,84	-0,72	**-1,56**	**-2,21**	-4,46
Total Industry	**1,78**	**0,15**	**4,55**	**6,48**	**-1,52**	**-2,04**	**-3,55**	**-4,54**	**-6,71**

Decomposition of net output growth for two group of sectors of Brazilian industry between 1990 and 1996 (%)

Group of sectors	Domestic Demand				Foreign Trade			Technical change	Total growth
	Capital Formation	Government consumption	Household consumption	**Total**	Exports	Imports	**Total**		
Group 1	4,15	0,53	9,24	**13,92**	3,22	-6,92	**-3,71**	**4,06**	18,34
Group 2	2,11	0,16	5,22	**7,50**	1,88	-4,34	**-2,46**	**-0,32**	6,63
Total Industry	**6,26**	**0,70**	**14,46**	**21,42**	**5,09**	**-11,26**	**-6,17**	**3,74**	**24,97**

Decomposition of net output growth for two group of sectors of Brazilian industry between 1996 and 2004 (%)

Group of sectors	Domestic Demand				Foreign Trade			Technical change	Total growth
	Capital Formation	Government consumption	Household consumption	**Total**	Exports	Imports	**Total**		
Group 1	2,61	0,68	0,42	**3,71**	14,36	-2,01	**12,35**	**3,23**	22,68
Group 2	-0,07	0,16	-1,94	**-1,85**	9,32	-3,01	**6,30**	**-5,59**	-6,72
Total Industry	**2,54**	**0,84**	**-1,51**	**1,86**	**23,67**	**-5,02**	**18,65**	**-2,36**	**15,96**

Source: All tables were built from I-O matrices of 1985 and 1996 /IBGE and uptaded matrix of 2004 (Dweck et alli, 2008).