STRUCTURAL CHANGES IN THE BRAZILIAN ECONOMY AND THE NEW MACROECONOMIC MODEL: A MULTISECTORAL APPROACH

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ABSTRACT

This paper proposes to conduct a preliminary study on the changes occurred in the productive and technological structures of the Brazilian economy during the period immediately after a few structural changes in the 1990s and the adoption of a new format for the macroeconomic policy after the exchange rate crisis of 1999. For such purpose, it was used the data from the last two Official Input-Output Matrices (IOM) made available by the Brazilian Institute of Geography and Statistics (IBGE) relative to 2000 and 2005 for the so-called Structural Decomposition Analysis (SDA). Generally speaking, the objective is to decompose the production variation at the period comprising those years in its main determinants (variation of final demand and the coefficients of the Leontief inverse matrix) for the 55 sectors of economic activities that comprise the Brazilian IOMs. The results indicate that the production variations of the activities were mainly explained by the behavior of the final demand (decomposed into scale, composition and mix effects), with reduced impact of the technical progress captured by technological effects. Emphasis on the effects on production derived from changes in the sectoral composition of the demand, which suggest that, in addition to currency devaluation, the weak performance of domestic demand, both as result of the new model of macroeconomic policy, has led some sectors, such as "Oil and Natural Gas" and "Automotive Vehicles", to increase the dependence on exports. On the other hand, the production growth of activities more focused on the domestic market, which tends to cause major impacts on the productive chain, was very impaired by these changes in the final demand, such as the activities of "Trade" and "Construction".

Keywords: Structural Decomposition Analysis, Input-Output Matrices, Brazilian Economy.

JEL classification codes: C-67; L-16.

Area: 9 Investigations into Economic Structural Change and Dynamics.

INTRODUCTION

The 1990's were marked by deep changes in the Brazilian economy in many ways. Generally, we can mention a few facts which reflect the major changes, such as trade and financial openness at the beginning of the decade, the privatization of public companies, the adoption of an overvalued exchange as an anchor to achieve price stability in the middle of the decade, succeeded, by the end of the period, by new changes in the way the macroeconomic policy is conducted, due to an exchange rate crisis.

It is expected that such events caused any significant impacts on the productive and technological structures of a country, whereas the effects of these changes do not affect homogeneously the various sectors of an economy.

In this context, this study is intended to conduct a preliminary study on the changes occurred in the productive and technological structures of the Brazilian economy at the period immediately after the latest changes in the 1990s mentioned above concerning the adoption of a new format for macroeconomic policy after the 1999 exchange rate crisis.

For such purpose, it was used the data from the last two Official Input-Output Matrices (IOMs) made available by the Brazilian Institute of Geography and Statistics (IBGE) relative to 2000 and 2005 for the so-called Structural Decomposition Analysis (SDA). Generally speaking, the objective is to decompose the production variation at the period comprising those years in its main determinants (variation of final demand and the technical coefficients) for the 55 sectors of economic activities that comprise the Brazilian IOMs. From the sectoral values decomposed by the SDA, we seek a more detailed understanding of the sectors’ performance in this period, highlighting the technological impacts and the demand behavior impacts (associated with changes in technical coefficients) and exploring possible relations of these performances with the macroeconomic policy format which was on its first steps.

The paper is divided as follows: the first section briefly presents the main characteristics which justify, theoretically speaking, the macroeconomic policy inaugurated in 1999 as well as the empirical responses of some macroeconomic aggregates after the adoption of this policy. The second section describes, briefly, the basic model of Input-Output, followed, in the third section, by the display of the SDA methodology. The fourth and last section presents and discusses the main sectoral results calculated by the SDA, followed by the conclusions and bibliography.

1 MAIN THEORETICAL FOUNDATIONS OF THE BRAZILIAN MACROECONOMIC MODEL AFTER 1999

Since 1999 the Brazilian macroeconomic policy began to adopt different paths regarding their conduct. The increase in the risk aversion in the late 1990s, in a context of a large financial openness of the Brazilian economy has generated an intense capital flight which, in turn, led to the exchange rate crisis. Thus, the Central Bank of Brazil had to abandon the strict control over the exchange rate, which formally, came to be floating. To the extent that the appreciated exchange was the pillar of the old macroeconomic model for the price stability, the main concern at the moment was that the strong depreciation of the exchange rate (almost 60% in the nominal rate between December 1998 and February 1999) could "resurrect” the terrifying inflationary spiral.

The solution found was to adopt the assumptions of what the *mainstream* at the time called “New Macroeconomic Consensus” (NCM hereafter), which proposed the establishment of clear goals of reduced inflation rates[1], with the interest base rate defined by the monetary policy being the main adjustment variable of the Central Bank for the fulfillment of the established goals. The main theoretical bases which support this format of macroeconomic policy (especially monetary) [2] are, succinctly presented below.

First, we have to emphasize that the practice of this type of monetary policy, which became known as Inflation Targeting Regime (ITR) was already occurring in some countries since the early 1990s[3], but with the development and consolidation of the NCM through the so-called new neoclassical synthesis whose main references can be found in Blinder (1997), Goodfriend & King (1997) and Clarida *et al.* (1999), this practice acquired a greater theoretical consistency.

The consolidation of the NCM theoretical framework is the result of a conciliatory effort of several theoretical contributions developed by the streams of thought prevalent in macroeconomic analyzes of the latest decades. Generally speaking, the NCM sought to develop a dynamic analysis of the general balance, assuming short-term effects of the macroeconomic policy on the basis of price rigidity. One of the critical theoretical and methodological pillars of this construction is the microfoundation, based on the maximizing behavior of households and firms regarding their functions-objective, as well as the use of "rational expectations".

Thus, jointly with the aggregate demand, we work with the idea of output hiatus (difference between actual and potential output), which would suffer the impacts of basic nominal interest rate. This happens because, according to the hypothesis of price rigidity, the changes in the nominal rate would, in the short term, affect the real interest rate which would impact the aggregate demand and, consequently, the actual product[4]. Given that we assume equilibrium dynamic, the product would be, as a rule, in its potential level. Demand shocks would then be necessary in order to divert the actual product from its balance path which would be determined by supply elements, using an idea similar to that found in standard models of neoclassical growth, inspired by Solow (1956).

In turn, the product hiatus appears as an explanatory variable in the determination of the price dynamic defended by the NCM. Thus, positive hiatuses would press inflation upwards. In addition to the hiatus, another important price determinant concerns the agents' expectations about the future inflation. At this point, inflation goals become critical important, since they serve as a reference for which agents' expectations about the future prices shall converge. To this end, we emphasize the role of credibility and transparency of the Central Bank in the conduction of the monetary policy and the fulfillment of the inflation goals[5].

The possibility of other factors such as exogenous supply shocks affecting prices is admitted by the NCM, however, with reservation regarding these elements not causing lasting effects on prices,

[1] The recommendation of the NCM advocates of an optimum inflation rate is around 3%.

[2] NCM focuses its analysis on monetary policy, dealing in a superficial way other macroeconomic policies (fiscal and exchange rate). However, it is worth emphasizing that the more general recommendations concerning the fiscal policy from the NCM advocates is the continuous generation of fiscal surpluses to ensure the sustainability and solvency of the public debt. Authors such as Setterfield (2007) and Fontana (2009) criticized the NCM negligence regarding the treatment of the tax issue. Regarding the exchange rate, NCM has recommended the absence of a specific policy, assuming a floating exchange rate regime.

[3] The earliest adopters of RMI were New Zealand in 1990, followed by Canada and Chile which began using it in 1991.

[4] The decrease in the demand is based on the intertemporal choice mechanism, in which the elevation of real interest would increase the saving instead of consumption.

[5] For more information about the influence of credibility and transparency of the monetary authority on the expectations and trust of agents, see Montes and Feijó (2007).

being grouped in a component of stationary random error. In a floating exchange rate regime, as professed by the NCM model, between these shocks would be precisely the exchange rate fluctuations, which thus came to assume a secondary role in determining prices (ARESTIS & SAWYER, 2006; SERRANO, 2006).

Thus, with a credible and transparent Central Bank, the only source capable of generating inflation persistently, in this perspective, would be the positive hiatuses of the product. So, the demand shocks would be responsible for these inflationary imbalances.

The correction of these imbalances, in turn, would take place through operations of the Central Bank itself defined by a reaction function whose adjustment variable would be the nominal interest base rate. Any positive deviations of the product relating to its potential level would require increment in interest which, in theory, should cool down the demand and lead the actual product to its balance level, eliminating the demand pressures on the price level. In the context of agents with rational expectations and BC credibility, the maintenance of a null hiatus of the product would allow both current inflation and growth future expectations of prices to quickly converge to the stipulated goals.

In short, the logic that justified the adoption of this model in Brazil in 1999 was that the inflationary control was fully feasible in an environment of floating exchange rate. For this purpose, the Central Bank would have to be persistent in achieving their goals in order to gain the confidence of economic agents in the commitment of the monetary authority to the price control and stability. It was based on this rhetoric that RMI "landed" in Brazil, directing the focus of macroeconomic policy almost exclusively to combat inflation, without worrying too much about the potential depressive effects that this form of policy conduction could provoke on the progress of economic growth or the job.

1.1 Some of the major aggregate results for the 2000/2005 period

This subsection is intended to provide some key data that reflect the performance, in more aggregate terms, of the Brazilian economy, one year after the adoption of RMI until 2005, a period for which the structural decomposition analysis was made to the extent of 55 sectors of economic activities of Brazilian IOMs.

First, we need to highlight that the RMI was able, at the period, to halt the return of the high exchange rates like those occurred in the 1980s and early 1990s, although the price index chosen as goal reference (IPCA) remained above the upper limit[6] of the stipulated goal in half the years analyzed, whether 2001, 2002 and 2003. In addition to that, it is worth noting that in 2003 and 2004 there was more than one resolution from the Central Bank, with a high inflation goal in both years, fact which made possible the goal achievement in 2004. Table 01 shows the evolution of the goal, the band, the upper and lower limits and the accumulated IPCA for the six years concerned.

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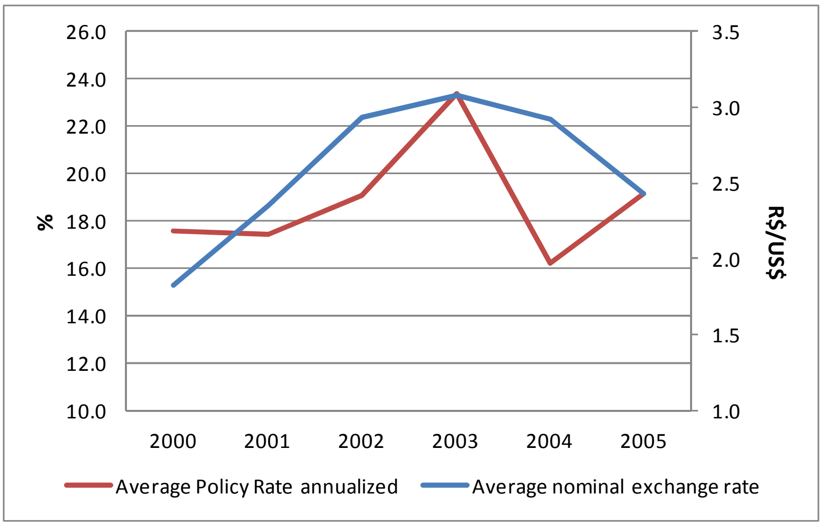
[6] Besides the goal, it is also stipulated a band that goes either up or down. The upper limit of the goal represents the sum of the goal with the band and the lower limit, the difference between the goal and the band.

Table 01: Data of the Brazilian Inflation Targeting Regime – 2000-2005

Years	Target (% a. a.)	Band (p.p)	Lower and upper limit (%)	Oficial Inflation (% a.a.)
2000	6.00	2.00	4 a 8	5.97
2001	4.00	2.00	2 a 6	7.67
2002	3.50	2.00	1.5 a 5.5	12.53
2003	3.25	2.00	1.25 a 5.25	9.30
	4.00	2.50	1.5 a 6.5	
2004	3.75	2.50	1.25 a 6.25	7.60
	5.50	2.50	3 a 8	
2005	4.50	2.50	2 a 7	5.69

Source: Central Bank of Brazil

This document does not intend to deal with the explanations and the specifications occurred in each one of the years when the targets were not accomplished. However, it is only worth to emphasize that prices in these years of higher inflation, especially in 2002 and 2003 were strongly influenced by movements of currency depreciation (SERRANO, 2010), as can be denoted in the blue line of graph 01.



Graph 01 - Nominal interest and exchange rates – 2000-2005
Source: Central Bank of Brazil

Anyway, following the theoretical guidelines of the macroeconomic model, the Central Bank responded to this persistent inflation rate above the goal by significantly increasing the nominal interest base rate, especially in 2002 and 2003, as indicated by the red line in graph 01.

In other words, based the thesis that the pressure on prices had as its main determinant the demand "excess", the monetary policy recommendation indicated the necessity for increases in interest rates, which should slow demand levels and bring the inflation rates to levels closer to the goals in effect. Although this rhetoric largely predominates in speeches, reports, or minutes of meetings of the Monetary Policy Committee (COPOM), in practice, it was evident that Brazilian inflation showed high sensitivity to exchange[7], and that the base rate could be used as a form of control of the exchange rate. Thus, increases in interest rates that should contribute to an appreciation of the local currency, could help fight inflation. In addition, sharper depreciations of the exchange would

[7] The effects of fluctuations in exchange for the price level are also known as pass-through. Economies with high pass-through, like the Brazilian economy, have an inflation strongly influenced by the behavior of the exchange rate.

provoke significant inflationary impacts. In literature, this practice of monetary policy has received the name "*fear of floating*" (CALVO & REINHART, 2000, HOLLAND, 2006).

This mix of the NCM rhetoric combined with a "*fear of floating*" practice of the monetary policy has led to a high volatility of interest rates at the period, which, as shown in graph 01, was quite subject to the exchange behavior. These results, in turn, were associated with trajectories of stagnation or low growth of various components of the demand, product and employment.

Regarding the behavior of domestic demand, it is worth noting the poor performance of two main components, namely: household consumption and investments. The first showed average annual growth of only 1.7%, a rate lower than that in the previous six years (1994-1999). Besides comprising the same number of years of period concerned, this comparison becomes more interesting to the extent that from 1994 to 1999 another form of macroeconomic policy management was in force, based mainly in the so-called fixed foreign exchange[8], introduced jointly with Plano Real as a form of combating the high inflation rates at the time[9]. In these first years after Real, where price growth could be effectively controlled[10], household consumption grew at an average rate of 2.4% per year.

The negligible consumption growth has been largely associated with the maintenance of high unemployment indices at the period, with predominance of unemployment rates (defined by the ratio unemployed population over economically active population) over 10%[11], in addition to a stagnation in the actual average revenue of the job[12]. Besides the poor performance of the employment and income indicators that are related to some results on the supply side (shown below), the high levels where the new macroeconomic model led to the basic interest rate, as well as the high volatility showed, contributed to a low credit expansion which helped in halting the consumption growth.

Investments (public and private), in turn, had an even worse performance, with average growth of 0.4% per year. If compared with the earlier investments' performance in the form of macroeconomic policy, the result reached at the period 2000-2005 is again lower. In the 1994-1999 interval, the average annual growth of investments was 1.3%.

With the reduced demand growth, many activities, particularly those related to the domestic market care, found themselves with high levels of idleness in its productive capacity, leading to a strong decline in aggregate investment projects. The high and volatile basic interest rate also negatively

[8] For more details on how this macroeconomic model worked, see Batista (1996).

[9] From 1990 to 1994, the average annual rate of inflation, according to the IPCA, was an incredible 1,320%.

[10] From 1995 to 1999, the average annual rate of inflation, according to the IPCA, was 9.5%.

[11] The peak in the unemployment history series of IBGE, in the last decade, is dated April 2004, when the rate reached 13.1%.

[12] This information is based on the new Employment Monthly Survey (PME) of IBGE, which was calculated only for the period from March 2002. However, other databases of the Labor Market, as those from Seade/Dieese, reveal, for example, that the unemployment rates in 2000 and 2001 were as high as those from the following period until 2005, always above 10%.

affects this type of expense, not only by affecting the financing cost, but also by creating an uncertainty environment regarding future interest rates, which ends up favoring movements with a more speculative nature (or the so-called speculative demand per currency), against productive investments (KEYNES, 1936).

Another important component of the aggregate demand, the expenses on government consumption, grew aligned with the GDP performance, with average annual growth of 2.5%. It is noteworthy that although fiscal policy was not part of the theoretical core that based the format of the macroeconomic policy instituted in late the 1990s, the recommendation of the RMI advocates was that the State should contribute to the inflationary control with policies of austerity and warranty for the solvency of the public debt (ARESTIS & SAWYER, 2003; LOPREATO, 2006)[13]

The component of the final demand that really responded well to the characteristics of the new macroeconomic model was the external demand, i.e. exports, with annual average growth of 8.6% against a growth of 3.1% in the previous six years. Obviously, the exchange more depreciated in comparison to that practiced in previous years contributed to this growth. However, it is worth mentioning the relation of this performance with the price growth of the agricultural and mineral commodities observed at the period analyzed, particularly from 2002/2003, greatly influenced by the strong acceleration of Chinese demand for these products. This occurs because in our list of exports the goods of this kind were predominant. Such fact continues until day.

Based on this behavior of the aggregate demand, it would not be necessary to observe the growing numbers of the supply components to infer that: with the poor performance of consumption and investment, industrial and service activities do not showed good results, and given the export growth, crops and livestock and mining had the most satisfying performances. When analyzing the official data, we can see that the inferences are in the right direction. The GDP of the processing industry and the GDP of the service activities showed an average growth rate of 2.4% per year. The farming sector grew at an average rate of 3.5% per year and the mining sector at an average of 5.3% per year. As expected, in aggregate terms, Brazil's GDP also showed a poor performance at the period, with average growth rate of 2.3% per year.

In short, it denotes that in its early years, the "new" macroeconomic model was not favorable to the growth of the main items of the Brazilian aggregate demand (consumption and investment). The small GDP growth was mainly driven by growth in exports, particularly agricultural and mineral goods. Considering that the growth in exports of these products can be justified by the global demand growth, particularly Chinese, which has little to do with the Brazilian macroeconomic policy, we can say that although the new management of macro policy has prevented an inflationary escalation, the costs, in terms of economic growth and employment, has been high.

With the general presentation of the main aggregate results concluded, the idea is to explore the behavior of demand and supply items as well as how they associated to each other at more disaggregated levels for the same period discussed above. We also use the so-called structural

[13] In addition to the concept around macroeconomic policy, the approval of the Fiscal Responsibility Law (LRF) in early 2000 greatly contributed to a better control of public expenses, especially for states and municipalities, which despite having prevented a more significant increase of the current expense, being part of the government consumption, had greater depressive impacts over public investments, particularly of state companies, which are not recorded as government consumption, but as investment. For more details on the LRF impact on public accounts, see Montes and Reis (2011).

decomposition analysis (SDA) from the information found in the last two official tables of the Input-Output Matrices (IOMs) of 2000 and 2005. Next, we will see methodological aspects, with brief description of the basic characteristics of the Input-Output model and what is a SDA

2 THE BASIC INPUT-OUTPUT MODEL

The economic model proposed by Leontief (1966) allows the construction of IOMs, for which it is possible to portray the diverse relations between sectors of a given economy, which contributes to the economic planning of the governments in their various spheres (MILLER & BLAIR, 2009). In short, the Input-Output technique is a linear model of production in which the economic system is represented in a simple way through intersectoral flow and service charts, allowing the demonstration of different industrial inter-relations, in addition to the reproductivity of the production (PRADO, 1981). This structure aims to serve the intermediate consumption among industries and the final demand of the economy (STONE, 1962), as can be seen in figure 01.

							Demanding Sectors				
		Intersectoral Relations				Final Demand					
	Products → / ↓ Inputs	(1) Industrie 1	(2) Industrie 2	...	(3) Industrie s	(4) Export	(5) Governanment Consumption	(6) Household Comsumption	(7) Gross Fixed Capital	(8) Variation of Stock	(9) Gross Product
Industries Supliers / Intersectoral Relations	(1) Product 1	q_{11}	q_{12}	...	q_{1s}	x_1	g_1	c_1	il_1	$i2_1$	q_{1s}
	(2) Product 2	q_{21}	q_{22}	...	q_{2s}	x_2	g_2	c_2	il_2	$i2_2$	q_{2s}
	⋮	⋮	⋮	...	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	(3) Product r	q_{r1}	q_{r2}	...	q_{rs}	x_r	g_r	c_r	il_r	$i2_r$	q_{rs}
	(4) Import	m_1	m_2	...	m_s						
Payments	(5) Net Taxes	t_1	t_2	...	t_s						
	(6) Value Added	va_1	va_2	...	va_s						
	(7) Expenditure Gross Output	q_1	q_2	...	q_s						

Figure 01: Input-Output Transactions for an Open Economy
Source: Prepared by the authors based on Miernyk (1974) and Richardson (1978).

Thus, mathematically speaking, a model of *n* sectors can be expressed as:

$$X_i = \sum_{j}^{n} X_{ij} + (C_i + I_i + G_i + E_i);\ \forall_{i,j} = 1,\dots,n. \quad (1)$$

Where:

X_i = Gross product;

$\sum_{j}^{n} X_{ij}$ = Intermediate Demand;

$(C_i + I_i + G_i + E_i)$ = Final Demand.

To some extent, the technique presented below has limitations and assumptions. The input-output models are simpler versions of computable general equilibrium models (HILGEMBERG & GUILHOTO, 2006) which adopt constant returns to scale, implicitly assume perfectly elastic supply and admit that the technical coefficients are invariable over time. This means that any effect regarding price changes or technological advances is not considered, while the projected changes are derived from exogenous changes in the demand (MILLER & BLAIR, 2009). However, even with the limitations presented above, the Input-Output technique is highly important for the planning of sectoral policies and, mainly, for the regional development because it provides analysis mechanisms for the efficient allocation of economic resources in poor developed areas. In this sense, the importance of the structural relations of the economy is evident. These relations should receive due attention of the policy makers (RICHARDSON, 1978; PRADO, 1981).

According to the simple Input-Output model proposed by Leontief (1966), the total effects (direct and indirect) on a particular productive structure are computed from the basic equation of model (6). In algebraic terms, its derivation occurs as follows:

$$\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_r \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1s} \\ a_{21} & a_{22} & \dots & a_{2s} \\ \vdots & \vdots & \ddots & \vdots \\ a_{r1} & a_{r2} & \dots & a_{rs} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ xs \end{bmatrix} + \begin{bmatrix} f_1 \\ f_2 \\ \vdots \\ f_r \end{bmatrix} \tag{2}$$

$$x = Ax + f \tag{3}$$

$$x - Ax = f \tag{4}$$

$$[I - A]x = f \tag{5}$$

$$x = [I - A]^{-1} f \tag{6}$$

Where:

$x = \lfloor x_j \rfloor$ is the total product vector of the economy, in which each x_j is the total quantity of the product *j*, produced by industry *j*, for every $j = 1, ..., n$.

$A = \lfloor a_{ij} \rfloor$ is the Technological Matrix, in which each a_{ij} represents the total quantity of the product *i* used as productive input in the production of a unit of the product *j*, for every $j = 1, ..., n$.

$f = \lfloor f_j \rfloor$ is the final demand vector of the product economy of each sector *j*.

$[I - A]^{-1}$ is the Leontief Inverse Matrix (L), or matrix of direct and indirect (total) requirements for the production of the vector *x*, given the final demand vector *f*

Therefore, we note that when the economic sectors interact with each other through the market, the relations between them are not established only directly, i.e. there are indirect relations that cause repercussions in other sectors and not just exclusively in those specific sectors. Thus, we have the main characteristic of the matrix *L*, which is the collection of indirect impacts among the sectors.

$$L = [I - A]^{-1} = I + A + A^2 + A^3 + ... + A^n \tag{7}$$

$L = \lfloor l_{ij} \rfloor; \forall_{i,j} = 1,...,n.$, where:

l_{ij} = value of products purchased, directly or indirectly, from sector *i*, for the production of a monetary unit of sector *j*.

The basic equation of the Leontief model, $x = [I - A]^{-1} f$, derived in this section, is crucial for the methodological development of the SDA, which is given below.

3 STRUCTURAL DECOMPOSITION ANALYSIS

The original theoretical reference about the SDA is found in the works of Leontief (1941, 1953), with significant contributions from Chenery *et al*. (1960, 1962), Carter (1970), Blair & Wyckoff (1989), Skolka (1989) and Rose & Casler (1996). From the SDA, we can observe that, for any change in the production, a part of it occurs because of the technical changes of the sectors and part of it results from changes in the final demand (CHÓLIZ & DUARTE, 2006).

Therefore, for their effective implementation, it is necessary the availability of at least two (or more) input-output matrices for different periods of a given economy, which turns interesting the disaggregation of the total amount of the change in some aspect of the national economy in contributions made by its diverse components (MILLER & BLAIR, 2009).

SDA is a comparative-static technique that can be used to decompose changes occurred in macroeconomic variables in a certain economy through IOMs, i.e. in the sectoral viewpoint. For an overview of this subject in literature, see Feldman *et al.* (1987), Dietzenbacher & Los (1998) and Miller & Blair (2009). For a more recent analysis of the SDA applied to the Brazilian economy, see Kupfer & Freitas (2004), Sesso Filho *et al.* (2010) and Araújo Júnior & Tavares (2011).

Initially, it is assumed that there are two periods of analysis, the earliest period that will be described with the superscript 0 (year 2000) and the most recent with superscript 1 (2005). This way, the vector of the total production in the year is $x^t\left(t = 0{,}1\right)$. As seen in the previous section, it is known that:

$$x^1 = L^1 f^1 \text{ and } x^0 = L^0 f^0 \tag{8}$$

Where: f^t is the final demand vector in year *t* and $L^t = \left[I - A^t\right]^{-1}$. Thus, the change observed in the total production during the period can be expressed as:

$$\Delta x = x^1 - x^0 = L^1 - f^1 - L^0 f^0 \tag{9}$$

The idea is to decompose the changes in total production in changes occurred in various components, such as technological changes $\left(\Delta L = L^1 - L^0\right)$ and changes in final demand directed to domestic production $\left(\Delta f = f^1 - f^0\right)$. Miller & Blair (2009) developed a series of algebraic manipulations, from the equations (8) and (9) as different forms of performing the analysis of the decomposition and, moreover, they mention several authors that used these different methods. Depending on which term is used to capture the variation in technical coefficients $\left(L^1 = L^0 + \Delta L\right)$ or $\left(L^0 = L^1 - \Delta L\right)$ or in the final demand $\left(f^1 = f^0 + \Delta f\right)$ or $\left(f^0 = f^1 - \Delta f\right)$, the resulting equation will take different shapes. However, Dietzenbacher & Los (1998) recommended the use of equation (10) as the most appropriate for achieving the SDA, which goes from an additive combination of two other equations and the one used in this work:

$$2\Delta x = \left(\Delta L\right) f^0 + L^1\left(\Delta f\right) + \left(\Delta L\right) f^1 L^0\left(\Delta f\right), \text{ for which we have:}$$

$$\Delta x = \frac{1}{2}\left(\Delta L\right)\left(f^0 + f^1\right) + \frac{1}{2}\left(L^0 + L^1\right)\left(\Delta f\right) \tag{10}$$

The first part of the right side of the equation shows changes in the production gross values of the activities generated by changes in the coefficients of the Leontief Inverse Matrix $\left[I - A\right]^{-1}$. The second part of the equation indicates changes originated in the final demand that is intended to domestic production (household consumption, investment, inventory variation, government consumption and exports) (ARAÚJO JÚNIOR & TAVARES, 2011).

Deepening the approach proposed, we seek to detail the variation determinants of the total final demand, as well as convert the coefficient variation of the Leontief Inverse Matrix in variations of technical coefficients itself (which compose the Technological Matrix - A), which allows the precise capture of the impacts provoked by technological changes over the activity production value.

Variations in Final Demand

Variations in final demand for domestic production can be decomposed into some elements, reflecting different effects, such as: scale changes of the total final demand, sectoral composition (distribution of demand between the *n* productive activities) and mix or distribution among different categories of final demand (MILLER and BLAIR, 2009).

For the calculation of these three determinants of the total final demand variation, we must create two auxiliary matrices, *B* and *d*. The first corresponds to a matrix with dimensions *n x p*, where *n* corresponds to the number of activities of the input-output matrix and *p* corresponds to the number of categories of final demand, composed by the sectoral composition (in percentage terms) of the three categories of the final demand. Thus, the sum of the lines in each column results in 1 or 100%. The second corresponds to a vector *p x 1*, consisting of the relative participations of each category in total final demand concerned, which sum also results in 1 or 100%.

Thus, we can rewrite the vectors of total final demand f^0 and f^1 as:

$$f^0 = f^0_{total} * B^0 * d^0 \tag{11}$$

$$f^1 = f^1_{total} * B^1 * d^1 \tag{12}$$

Therefore, the variation of total final demand Δf can be decomposed as follows:

$$\Delta f = (f^1_{total} * B^1 * d^1) - (f^0_{total} * B^0 * d^0) \tag{13}$$

Following the same logic used to define the equation (10), we can rewrite the values of the matrices or vectors at time 1 as a result of the values in time 0 increased with the variations, as well as the values of time 0 as result of the subtraction between the values of time 1 and their respective variations. Therefore, we have:

$$\Delta f = \underbrace{\frac{\Delta f_{total} * (B^0 d^0 + B^1 d^1)}{2}}_{\text{Scale effect}} + \underbrace{\frac{f^0_{total} * (\Delta B * d^1) + f^1_{total} * (\Delta B * d^0)}{2}}_{\text{Composition effect}} + \underbrace{\frac{(f^0_{total} * B^0 + f^1_{total} * B^1) * \Delta d}{2}}_{\text{Mix effect mix between categories}} \tag{14}$$

Where f^t_{total} and Δf_{total} are scale values.

It is noteworthy that changes in the coefficients of the matrices *B* and *d*, or rather the matrices ΔB and Δd will sum zero, i.e. positive changes in the agendas of different categories of final demand are outbalanced by negative changes. This way, the same occurs with the composition and mix effects, whose impacts brought upon the production variation of all sectors will be null.

Variations in the coefficients of the Leontief Inverse Matrix

At first, what is observed in equation (10), which defines a SDA, are the variations in the coefficients of the Leontief Inverse Matrix, not just the technical coefficients of Matrix A. Thus, in order to perceive the effects of the technological changes in the production variation of the different sectors, it is necessary to translate the variations of the Leontief Inverse Matrix elements into variations of the Technical Coefficient Matrix elements. For such effort, Miller and Blair (2009) present some algebraic operations, as shown below.

It is known that $L^1 = (I - A^1)^{-1}$ and $L^0 = (I - A^0)^{-1}$. Post-multiplying the first by $(I - A^1)$ and pre-multiplying the second by $(I - A^0)$, we have the following results:

$$L^1 * (I - A^1) = I = L^1 - L^1 * A^1 \tag{15}$$

$$(I - A^0) * L^0 = I = L^0 - A^0 * L^0 \tag{16}$$

Rearranging the terms of equation 15 and post-multiplying by L^0 on both sides, we have:

$$L^1 - I = L^1 * A^1 \tag{17}$$

$$L^1 * L^0 - L^0 = L^1 * A^1 * L^0 \tag{18}$$

Rearranging the terms of equation 16 and pre-multiplying by L^1 on both sides, we have:

$$L^0 - I = A^0 * L^0 \tag{19}$$

$$L^1 * L^0 - L^1 = L^1 * A^0 * L^0 \tag{20}$$

Subtracting equations 18 and 20, we get precisely the variation of the Leontief Inverse Matrix coefficients[14].

$$L^1 - L^0 = \Delta L = L^1 * A^1 * L^0 - L^1 * A^0 * L^0 \tag{21}$$

$$\Delta L = L^1 * \Delta A * L^0 \tag{22}$$

To calculate the effects that the technological changes occurred in each of the activities caused on itself and on the others, it is necessary to decompose the variations of the coefficients. Thus, we disaggregate ΔA into *n* elements, being *n* the number of production activities of the matrix.

$\Delta A = \Delta A^1 + \Delta A^2 + \cdots + \Delta A^j + \cdots + \Delta A^n$, assuming that $\Delta A^j = \sum^n \Delta a_{nj}$ = Technological change of activity *j*.

[14] Miller & Blair (2009) emphasize that the replacement of the pre-multiplication by post-multiplication in equations 18 and 20 do not cause changes in the results, producing the following identity: $L^1 * \Delta A * L^0 = L^0 * \Delta A * L^1 = \Delta L$.

For matrix calculus of the impacts of technological changes occurred in the first activity, the matrix of technical coefficient variation ΔA^1 must be formed by a first column of values resulting from the difference between the Matrix of Technical Coefficients of year 1 and year 0 for the activity concerned, with the values of the other columns equal to zero. Such procedure is used for other activities, as illustrated below:

$$\Delta A^j = \begin{bmatrix} 0 & \Delta a_{1j} & 0 \\ \vdots & \vdots & \vdots \\ 0 & \Delta a_{nj} & 0 \end{bmatrix} \tag{23}$$

At the end, the idea is to get a column vector (sum of the elements of the n matrix columns), whose values represent not only the impact of the technical progress of the activity *j* resulting of changes in its cost structure, but also the technological advances occurred in the other activities over activity *j*.

It is noteworthy that unlike the coefficient variations of matrices B and *d*, presented in the discussion on the decomposition of final demand, positive variations in technical coefficients are not necessarily outbalanced by negative variations. Technological advances are generally related to a reduction of inputs necessary for a monetary unit of production, i.e. a lower demand for intermediate goods and services. Thus, the reduction of inputs required by the productive process of an certain activity *k* creates factors to reduce the production volume of some of the input supply activities (goods and services) for the activity *k* and the production value of activity *k*, once part of this value is composed by intermediate consumption[15]. Based on the SDA form presented in Miller Blair (2009), also used in this study, negative effects derived from changes in the technical coefficients can also be associated with a large penetration of intermediate goods' imports. Such fact because the technical coefficients refer only to inputs locally produced. Increases in the relative participation of imported intermediate inputs for a same level of total intermediate demand (domestic and imported) act negatively in the calculation of which is being called technological effect, although this is not an indicative of a technical advance itself.

It is worth noting that not always the effect of a decrease in intermediate consumption of a particular activity *j* by domestic production generates a reduction in its own production value. In addition to having a positive variation of the added value more than proportional to the cost reduction[16], the impacts of this reduction can also be more than outbalanced by a large demand for other activities by the production of activity *j*. According to the methodology proposed, the biggest demand can be derived from a replacement among domestic and imported inputs, in the sense of increases at the relative portion of the domestic inputs in the total intermediate demand of the activities. These movements are associated with positive variations in the elements of the Technical Coefficient Matrix, which operates in order to raise the technological effect[17].

[15] The intermediate consumption which composes the production value, however, is measured at market price, i.e. it must record not only the intermediate demand for local production, but also the imported inputs, levies and margins (trade and transport).

[16] The production value is defined as the sum of the added value and the intermediate consumption at market prices. For the definition of intermediate consumption at market prices, see previous note.

[17] Another possibility of positive variation in the technical coefficients, and therefore, generation of positive technological effects concerns the effect of replacement between raw materials locally produced.

Concluded the calculations for the *n* activities, we must return to the initial equation (10) of the SDA for the appropriate replacement of the calculations presented, both concerning the determinants of the final demand variations and the coefficient variations of the Leontief Inverse Matrix, in order to decompose the variation of the production value of each one of the activities, i.e. of vector Δx . Finally, we achieve the following decomposition of effects:

$$\Delta x = \underbrace{(1/2)*\left[(L^1 * \Delta A^1 * L^0)\right]*(f^0 + f^1)}_{\substack{\text{Effects of technological changes in the activity} \\ \text{on the production value}}} + \cdots + \underbrace{(1/2)*\left[(L^1 * \Delta A^n * L^0)\right]*(f^0 + f^1)}_{\substack{\text{Effects of technological changes in the activity } n \\ \text{on the production value}}} +$$

$$+ \underbrace{(1/2)*(L^0 + L^1)*\left[\frac{\Delta f_{total} *(B^0 d^0 + B^1 d^1)}{2}\right]}_{\substack{\text{Effects of changes in the final demand scale} \\ \text{on the value of production.}}} + \underbrace{(1/2)*(L^0 + L^1)*\left[\frac{f^0 *(\Delta B * d^1) + f^1 *(\Delta B * d^0)}{2}\right]}_{\substack{\text{Effects of changes in the final demand composition on the} \\ \text{production value}}} +$$

$$+ \underbrace{(1/2)*(L^0 + L^1)*\left[\frac{(f^0 * B^0 + f^1 * B^1)*\Delta d}{2}\right]}_{\text{Effects of changes in the mix of final demand on the production value.}} \tag{24}$$

This methodology is applied to the Brazilian case, using the latest official Input-Output Matrices of 2000 and 2005. As for the aspects related to the final demand, although already discussed that, in aggregate terms, the poor performance at the period concerned (except imports), resulted, mostly, of the macroeconomic policy format established in the country, we can observe whether and in which activities the final demand (domestic and/or external) deviated from the average behavior.

Besides, through this methodology we seek to explore the performance in terms of technical progress of the activities, quantifying the importance of the technological advancement for the observed variation in the production of each of the activities at the period indicated[18]. In the next section, the main results are presented and discussed.

4 PRESENTATION AND DISCUSSION OF RESULTS[19]

As already mentioned, we chose to use official data rather than methodologies that update matrices for more recent periods. In this sense, the data refer to the last two sets of official tables of input-output in Brazil, prepared and disclosed by IBGE through the System of National Accounts for 2000 and 2005, disaggregated into 55 economic activities. It is worth remembering that the production and final demand data of Input-Output Tables are disaggregated into 110 products,

[18] The reduced amount of information and statistics on technological aspects for the interval concerned, particularly at the sectoral level used increases the relevance of the proposed analysis.
[19] The consolidated results are presented in the form of Attachment 01.

configuring 55x110 matrices. In order to eliminate the influence of the price change in the analysis, all the data is expressed at the prices of year 2000[20], as recommended by Miller and Blair (2009).

The calculations were made for two categories of final demand, namely: domestic demand (sum of consumption, investments and government expenses) and external demand (exports) [21] Thus, the dimension of matrix *B* in this case is 55x2 while the dimension of matrix *d* is 2x1. From the aggregate viewpoint, the production value at the period grew at the annual average actual rate of 2.1%, aligned with the GDP actual average growth rate in the same period, which was 2.3% per annum.

A first aspect that draws attention is that out of the 55 activities, 36 of them (over 65%) had average annual growth rate lower than that recorded by the total production value[22]. Among these 36 activities, some are important regarding the participation in the production total value, such as segments of "Construction" (-0.5% p.a.), "Trade" (1.6% p.a.) as well as "Steel and Derivatives" (1.6%), “Oil Refining and Coke” (0.9% p.a.), “Chemical Products” (1.6% p.a.) and “Rubber and Plastic” (-0.1% p.a.).

Next, we discuss some of the main results obtained from the calculations of the effects of composition, mix and technology for the economic activities of the Brazilian IOM, seeking to relate them to some hypotheses about the behavior of the domestic demand components (in the case of composition and mix effects) and of the activities itself (in the case of treatment of the technological effect). It is noteworthy that the effects of changes in the final demand scale, somehow, have already been approached in the first section, since they reflect the more aggregate behavior of the final demand of the economy at the period concerned, subject already discussed in that section. The only difference is that the effect of scale change calculated in the proposed exercise refers to the domestic demand intended only the local production, i.e. at base prices. The discussion made in the first section was based on the known demand components in the so-called consumer prices, which include in addition to the demand values at base prices, imports and indirect taxes free of subsidies. In any event, the conclusions about the demand scale do not change, since the performance of these two last variables was not enough to cause any major change, with average annual growth rates of 1.3% for imports, and 1.9% for the indirect taxes free of subsidies.

Regarding the effects-composition, a first aspect that draws attention refers to the fact that they have been much more influenced by changes in the export list than by changes in the profile of the domestic demand. In other words, the magnitude of the variations in the sectoral composition

[20] For the deflation, it were constructed price indices for the 110 products of the Brazilian matrix, covering both the perspective of production and demand of these products, based on the sequence of the production and demand values (nominal values and prices of the previous year) of the Table of Resources and Uses (TRU) from 2000 to 2005, considering 2000 as the base year. Regarding the production data, the indices are different for products according to the productive activity. As for the demand data, price indices can also be different for the same product depending on how the absorption occurred, whether in the form of intermediate consumption of some of the 55 activities or as a component of the final demand. Insofar as the demand values found in the Brazilian TRU are to the consumer prices, more specifically regarding the demand for the product found in the IOM, it was necessary the performance of a small adjustment in the deflation process. This occurs because, at the consumer prices, the demand values for trade of various activities or components of the final demand are null, unlike the demand values for trade at basic prices. Therefore, the cumulative price variation would also result in zero if it were used the consumer price values. The adjustment was the use of the price index calculated in the production viewpoint related to the total trade product in order to deflate the demand values through the trade at base prices which compose the IOM 2005. Based in the price indices of 2005 (base year 2000), the IOM values of 2005 were deflated at the 2000 prices, being recalculated the Market-Share Matrices, the Matrix of Technical Coefficients and the Leontief Inverse Matrix of 2005.

[21] The variation in inventories, which would be another item of the final demand, was not incorporated as a demand category, being left out of the present study.

[22] See Attachment 01.

(percentage) of exports was higher than that seen in domestic demand, consisting of household consumption, government expenses and investments. Such aspect is consistent with the previous discussion of aggregate results, which pointed to a performance of the export sector which deviates from the negligible result presented by the economy set.

Thus, it is worthy highlighting the significant changes in the values of the vectors used to calculate the effect mix, i.e. the matrix *d* shown in the methodology. In 2000, the participation of the domestic demand in the total was 89.9%, with 11.1% of the production destined to exports. In 2005, the portion corresponding to domestic demand fell to 85.6%, while the participation of exports rose to 14.4%. These numbers indicate a production growth and, therefore, the growth of Brazilian GDP, although poor at the period concerned, mainly supported on external factors.

Although the aggregate results point to the hypothesis that the growth *drivers* of exports have been basically the segments of *commodities* (agricultural and mineral), the composition data reveals other interesting sectoral aspects. In fact, the composition effect of the crops and livestock activity was slightly negative at the period concerned, with stability in the participation on the domestic demand and a slight fall in exports. The activity that presented the largest growth in relative terms in the list of exports was the Oil and Gas sector, which resulted in a very depressive composition effect of the final demand for the variation in the production of this segment. We can relate this strong increase to the greater depreciation of the exchange rate at the period and to the significant growth in the price of this commodity at the analyzed period.

Also regarding the positive effects on production due to changes in the demand composition, highlight goes to the contributions which the growth of the external demand for "Automotive Vehicles", "Trucks and Buses", and "Machinery and Equipment" had over the variation of these activities' production.

On the other hand, regarding the negative effects on production of the activities resulting from the changes in the composition of Brazilian exports, we note a greater propagation among the activities. While the increments on the relative participation in total exports were concentrated in only 22 activities, there was loss of the relative importance in the list of exports for 33 activities. To illustrate what was said, it is worth mentioning that while activities such as "Oil and Gas" and "Automobiles" had positive variations over 2 percentage points, the activity with the highest relative loss in total exports corresponds to the Metallurgy of Non-Ferrous Metals with its relative importance decreasing 1.1 percentage point, followed by Services Provided to Companies (-0.9 p.p.) and Other Transport Equipment (-0.8 p.p.).

We must also indicate which activities whose production has a greater relative importance for the Brazilian exports compared to the domestic demand were positively affected by the changes resulting from the mix effect of the final demand. This occurs because, with the already mentioned growth of the export volume in the total final demand (and decrease of the relative importance of the domestic demand), the segments which led, in the period concerned, the composition of the list of exports were benefited. Thus, the major contributions were found in the following activities: Agriculture, Silviculture and Forest Exploration, Iron Ore, Food and Drinks, Manufacture of Steel and Derivatives, Other Transport Equipment and Services Provided to Companies. Even though activities such as Iron Ore, typically exporter, showed a decrease in the relative participation of the total exported, and consequently, negative composition effect. On the other hand, the mix effect contributed positively to the expansion of the production in this segment. Such fact because it was responsible for a significant part of the total exports in both periods (above 3%) and by a practically null portion of the domestic demand, being, therefore, favored by the strong growth of the external demand and the changes occurred in the mix of the final demand.

Regarding the list of activities that compose the domestic demand, we can note a greater stability between the two analyzed years. However, given that the weight of this demand is far superior to those of the exports in the total of the final demand, percentage variations, even though being small, generated significant composition effects. In addition to that, similar to what happened to the exports, the positive variations in the list of the domestic demand were concentrated in 24 activities, with the negative variations being propagated in the other 31 activities. However, different of what was found with the exports, the greater positive variation in the list of the domestic demand was inferior compared to the greater negative variation. These variations occurred in activities which can be considered, to some extent, as substitutes, namely: Construction and Real Estate Services and Rent. While the first one suffered a decrease of 1.2%, the second one increased its relative participation in 1.04%. Such variations allowed composition effects with opposite signals and with similar magnitudes.

Assuming that an important part of the domestic demand for the production of these two activities, mainly the real estate services and rents, compose the household consumption, it is reasonable the hypothesis that there were a reduction in the construction of new houses, which led to the increase of household expenses with rents between the analyzed periods. To the extent that the construction of houses depends, mostly, of real estate credit which involves, in most cases, extensive deadlines, it is reasonable to assume that the volatile trajectory of interest during the period, as shown in graph 01, has impaired the expansion of this type of credit. The high volatility of interest tends to create an unfavorable environment, for both the borrower and the lender of credit, mainly in the long-term funding (DE PAULA, 1999). It is noteworthy that the sequencing power over the productive chains, mainly in terms of its demand for goods and services of other sectors (back sequencing) is far superior to the activity of “Real Estate Services and Rents”.

Thus, these changes in the composition of the domestic demand provoked depressive effects over the production of various other activities, considering only the direct and indirect effects obtained by the coefficients of the Leontief Inverse Matrix. If the so-called income effect is recorded (which, broadly speaking, seeks to calculate the effect that the income generated in the productive process causes in the household consumption), the impact would be even more negative regarding the referred composition change. Such fact occurs because the Construction sector, being a largely labor intensive activity, generates a payroll much more significant compared to the payroll generated in the "Real Estate Services and Rents". Moreover, due to a significant part of this mass be destined to a labor endowed with less qualification and, therefore, composed by low wages, the inclination to consume such part tends to be quite high, which positively affects the growth of domestic demand. With the decline in the importance of this activity at the period, there is another important reason for the negligible growth in the Brazilian domestic demand.

In addition, to the extent that part of the Construction production is absorbed in the form of investments (public and private), and considering that the positive composition effects are checked for the production variation of other activities that typically produce investment goods, such as Machinery and Electrical Equipment and Materials, it is also plausible to assume that the investment profile of the Brazilian economy suffered important changes. A significant part of the investment expenses directed to Construction, for example, in the construction of new plants, was replaced by the acquisition of new machinery.

Regarding the private investments, it is likely that the uncertainty increase resulting from the interest volatility, particularly from the expected future demand, also had contributed to this movement. Investments through the acquisition of machinery are generally less expensive and amplify the productive capacity in less extensive deadlines when compared to the investments involving construction expenses.

We cannot forget to mention the impact of the recession of public investments over the investment profile changes whose is mostly destined, generally, to public and infrastructure works and, therefore, represents demand for the Construction activity. As previously commented, the recommendations from the advocates and executors of the macroeconomic policy were regarding fiscal austerity and control of public expenses. To the extent that there is a greater rigidity degree in the current expenses of the public sector (recorded as government consumption) in the public accounts, with most part of them not likely to suffer restrictions, capital expenditures, or rather, public investments were more directly affected by the greater control imposed to government expenses[23].

This movement of public accounts is compatible with the decomposition results of the activities whose production absorbed by the domestic demand corresponds exclusively to the government expenses. Among them, it is noteworthy the positive effect resulting from the composition changes of the final demand over the production value of the activity “Government and Social Security”. This value basically derives from the purchase of goods and services by public institutions (intermediate consumption of these institutions) and from the wage payment to government direct servants. Such result precisely reflects the large rigidity of the current public expenses which did not pass through the same level of restriction suffered by more discretionary public expenses, such as public investments which led to an increase in its relative participation in the domestic demand.

This positive effect of composition change of the final demand over the production of the “Government and Social Security”, however, was almost outbalanced by a negative mix effect. Such fact occurred because this activity corresponds to one of the segments providing services whose production is primarily aimed at the domestic market. With the poor performance of the domestic demand and the decrease of relative importance of the total demand, not only the mentioned activity, but all the services whose main focus of the production is the domestic demand showed negative effects resulting from the mix changes of the final demand. Among them, we can highlight the activities of “Trade”, “Construction” and “Real Estate Services and Rent”, which jointly correspond to a significant portion of both production value and total PIB.

The only service activity which showed a significant positive mix effect was the “Services Provided to Companies” which reserved a significant part of its production to the external market. Even with the decrease in the relative participation in the list of exports, due to its relative weight yet relevant (above 4% of its total exported in goods and services in 2005), the mix effect of the final demand contributed to the production growth of this type of services.

Regarding the effects resulting from the changes in the technical coefficients, it is noteworthy that in the aggregate, the magnitude of the impacts (regardless of signs) was little significant, less than the effects resulting from the changes in the scale of the final demand. This shows that although the demand presented a low growth at the period, it was the main determinant of the valor variation of the activity production. As the total imports of goods and services had a poor growth at the period, of 1.3 p.a. (below the growth of the total PGV or the total GDP), it is reasonable to admit that there was no more significant influence in the calculation of these effects resulted from a greater

[23]See note 13.

penetration of imported inputs which allow us to assume that the negative effects are good indicatives of the technical progress itself. In the case of the positive variations in the technical coefficients and/or the positive technological effects over the activity production, we believe that the main determinants were supported by the replacement of imports by local production.

Out of the 55 activities, 37 of them had a negative effect of the technological changes on their respective production values. Among these located in the industrial sector, highlight goes to the technical advances of the following activities: "Pulp and Paper", "Oil Refining and Coke", "Manufacture of Steel and Derivatives", "Non-Ferrous Metallurgy" and "Electrical Machinery, Equipment and Materials". It is curious to notice that only in the case of these two last activities that the total variation of the technical coefficients was also negative. In other words, only in these two activities the negative technological impact over the production was also derived from a lower intermediate demand level aimed to these sectors. In other words, we can say that in the other cases mentioned, the technical advances predominated in the activities which demanded inputs produced by the sectors concerned, which led to a lower level of production required.

Other activities that draw attention due to the more depressive negative technological effects were: “Financial intermediation and warranties” and “Services provided to companies”. In both cases we cannot talk about technical advance of such activities, but we can talk about a reduction in the intermediate demand of the other sectors by the production of said activities. Mainly regarding “Services provided to companies” which production is very associated to investments projects of companies, the reduction of the intermediate demand by this sector is consistent with the poor performance of the investments at the analyzed period.
]
Among those that show positive values, the following activities that produce primary goods deserve some acknowledgement: “Agriculture, Silviculture and Forest Exploration”, “Livestock and Fishing” and “Oil and Natural Gas”. Although the technical advance of a lot of activities which demands the produced goods produced by these activities had shown some technical progress, reducing the demand by these, the activities mentioned raised the local content of the inputs used in its respective productive processes. The increase of the intermediate demand levels draws attention as well as the technical coefficients of the domestic inputs, directed to the activity itself. In other words, in the case of “Agriculture, Silviculture and Forest Exploration”, the increase in the demand for inputs classified as production of the activity itself. The same goes to the other two activities which produces primary goods, mentioned above.

Among the industrial activities which had positive impacts on the production value, highlight to “Parts and accessories for automotive vehicles” and “Other transport equipment”. On the first one, the contribution of this effect mainly results from the increases in the participation of the domestic inputs on the intermediate demand of the sectors, among which we can highlight, in addition to the acquisition of inputs of the activity itself, the producers of: “Rubber and Plastic Goods” and “Trade”. On the second one, it is noteworthy that, although the activity showed important technical advances (reduction of its technical coefficients), there was a strong increase in the domestic content of the intermediate goods produced by this segment, particularly the intermediate demand restricted to the activity itself which allowed a technological effect with the positive contribution over the production variation.

FINAL CONSIDERATIONS

The objective of this work was to perform a preliminary study on the changes occurred in the 1990s in the productive and technological structures of the Brazilian economy, from a structural decomposition analysis of the 55 sectors of economic activities of IOMs in Brazil (2000 and 2005), in order to relate the results with the new format of macroeconomic policy which began in 1999.

It was found that, in its early years, the "new" macroeconomic model was not favorable to the growth of the main items of the Brazilian aggregate demand (consumption and investment). The small GDP growth was mainly driven by growth in exports, particularly agricultural and mineral goods, being explained by the increase in the global demand, particularly the Chinese economy.

Beside the variation of final demand, the results showed that it is reasonable to assume that the mix of theory and practice of macroeconomic policy has contributed to: (I) changes in the relative importance between the categories of demand in favor of exports, stimulated not only by the movement of exchange rate depreciation at the period, but the "locks" imposed on the growth of domestic demand, particularly in relation to expenses of household consumption and investments; (ii) changes in the sectoral composition of the domestic demand which helped in the understanding of the poor growth of the domestic demand as a whole, once it favored a restrict number of activities instead of a greater set of activities whose productions were negatively affected by such changes. The concentration of positive effects in a smaller group of activities has resulted in a weakening of the propagation of stimulus arising from the series of productive chains, particularly when activities negatively affected are predominantly focused on the domestic market and with highly productive sequencing, as in the case of “Construction” and “Trade”.

Thus, regarding the final demand, the input-output analysis allowed us to identify important elements, complementary to more aggregate analyzes, which make it evident the forms through which final demand, although they were the main determinants of the production growth, created few stimulus for a more significant and homogeneous expansion of the set of activities of the Brazilian economy.

On the side of the variation of technical coefficients, the results point to the small contribution of technological effects for the variation in activity production. On the side of the primary activities, we can observe that the increase in the domestic content of the intermediate demand resulted in positive technologic effects. As for industrial activities, the highlight goes to the most significant technical advances of the activities of "Pulp and Paper" and "Machinery, electric equipment and materials". Still on the industrial activities, we can observe, via positive technologic effects, more significant increases in local content of the intermediate demand for activities producing "Parts and accessories for motor vehicles" and "Other transport equipment". Regarding to service activities, highlights to the significant technological negative effect related to the activity "Financial intermediation and insurance" and "Services Provided to Companies".

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Attachment 01: Results of Structural Decomposition Analysis in Brazil (2000 and 2005).

	Sectors of Economic Activity	**Effects**				
		Scale	**Composition**	**Mix**	**Technological**	**Total**
1	Agriculture, silviculture, forest exploration	3.673,41	(294,87)	2.299,02	2.603,52	8.281,08
2	Livestock and fishing	2.004,48	77,52	(265,25)	1.021,00	2.837,75
3	Oil and natural gas	416,46	3.297,80	638,30	2.118,94	6.471,51
4	Iron ore	849,03	(701,13)	2.012,60	(67,51)	2.092,99
5	Others from extractivist industry	173,53	222,98	360,85	(417,77)	339,59
6	Food and drinks	12.880,18	2.026,30	3.311,15	(403,92)	17.813,70
7	Smoking products	770,50	736,49	487,56	(36,88)	1.957,67
8	Textile materials	1.085,91	(327,82)	560,29	(460,84)	857,54
9	Vestment goods and accessories	2.356,11	(4.828,77)	(554,69)	(571,59)	(3.598,96)
10	Leather goods and footwear	1.545,68	(2.384,71)	952,87	198,44	312,28
11	Wood products – excluding furniture	497,89	(393,74)	1.056,53	(994,31)	166,37
12	Pulp and paper products	1.332,09	992,18	1.959,50	(2.040,91)	2.242,87
13	Newspapers, magazines, discs	712,21	(0,41)	(162,66)	(1.789,31)	(1.240,17)
14	Oil refining and coke	2.516,18	(71,14)	834,53	(1.548,06)	1.731,52
15	Alcohol	402,62	(724,34)	66,26	(1.019,83)	(1.275,29)
16	Alco Chemical products hol	559,37	(641,52)	1.196,87	861,37	1.976,09
17	Manufacture of resin and elastomers	263,40	(331,49)	612,56	(815,56)	(271,09)
18	Pharmaceutical products	1.497,62	(805,61)	(178,91)	(1.109,25)	(596,14)
19	Agrochemicals	97,10	46,27	177,31	377,58	698,26
20	Perfumes, hygiene and cleaning	1.191,03	234,01	(127,33)	(1.023,57)	274,14
21	Paints, varnishes, enamel paints and lacquers	121,09	(117,51)	64,50	(625,16)	(557,07)
22	Diverse chemical products and mixtures	217,37	(599,89)	407,43	(1.216,43)	(1.191,52)
23	Rubber and Plastic Goods	544,18	(1.092,47)	711,95	(762,94)	(599,29)
24	Cement	48,83	42,33	15,60	303,46	410,22
25	Other non-metallic mineral products	327,42	(192,13)	682,32	(1.113,27)	(295,66)
26	Manufacture of steel and derivatives	1.182,47	(1.341,55)	2.762,73	(1.518,72)	1.084,94
27	Metallurgy of non-ferrous metals	699,23	(1.719,41)	1.665,68	(1.638,89)	(993,38)
28	Metal products – excluding machinery and equipment	908,77	935,70	203,39	997,00	3.044,85
29	Machinery and equipment, including maintenance and repairs	3.044,57	2.172,07	1.509,87	(770,69)	5.955,82
30	Electrical appliances	715,43	426,11	(14,36)	(232,47)	894,71
31	Machinery for office and computer equipment	1.087,42	214,89	16,49	(235,09)	1.083,71
32	Electrical machinery, equipment and materials	605,46	(1.416,82)	648,52	(2.102,48)	(2.265,32)
33	Electronic materials and communication equipment	3.052,70	1.939,42	832,69	1.119,08	6.943,89
34	Medical and hospital equipment/instruments, measurement and optical	432,69	(2.013,77)	101,16	(1.068,37)	(2.548,28)
35	Automobiles, station wagons and pick-ups	4.363,61	6.129,95	1.914,40	(222,95)	12.185,01
36	Trucks and buses	1.133,09	2.101,47	745,82	46,33	4.026,71
37	Parts and accessories for automotive vehicles	965,25	(845,56)	1.955,32	2.916,39	4.991,40
38	Other transport equipment	1.585,07	915,31	2.471,30	2.249,59	7.221,28
39	Furniture and products from diverse industries	2.319,23	(1.848,03)	(24,25)	(627,37)	(180,43)
40	Electricity and gas, water, sewage and urban cleaning	3.006,68	(3.767,93)	(977,73)	231,05	(1.507,93)
41	Construction	14.388,89	(14.148,32)	(4.347,13)	(912,43)	(5.018,99)
42	Trade	14.983,27	(5.229,06)	(2.392,79)	1.397,14	8.758,56
43	Transport, storage and mail	5.928,64	(6.791,44)	200,63	3.116,43	2.454,25
44	Information services	2.905,72	1.606,94	(800,52)	3.286,48	6.998,62
45	Financial intermediation and warranties	8.506,91	5.111,06	(2.389,27)	(9.735,36)	1.493,34
46	Real Estate services and rent	18.081,51	11.528,76	(5.625,95)	(232,27)	23.752,06
47	Maintenance and repair services	1.795,85	(1.332,74)	(577,81)	(955,93)	(1.070,63)
48	Lodging and food services	5.581,31	137,71	388,72	(461,60)	5.646,13
49	Services provided to companies	2.214,76	(1.062,61)	2.347,80	(4.328,92)	(828,97)
50	Mercantile education	3.702,78	2.486,49	(1.196,11)	330,46	5.323,62
51	Mercantile health	6.200,75	(653,51)	(2.000,53)	165,50	3.712,22
52	Other services	9.206,52	522,82	(2.665,98)	(503,50)	6.559,86
53	Public education	7.640,68	331,71	(2.517,50)	(24,68)	5.430,22
54	Public health	4.873,22	2.888,48	(1.616,06)	(6,75)	6.138,89
55	Government and social security	23.853,25	8.553,50	(7.737,66)	(1.263,31)	23.405,78

Source: Preparation based on the IOMs of Brazil in 2000 and 2005, disclosed by IBGE.