School of Economics and Management

TECHNICAL UNIVERSITY OF LISBON

Department of Economics

Antonio Carlos Moretto, João Dias, João Carlos Lopes, Rossana Lott Rodrigues

Effects of demand shocks in the Brazilian economy: new production and value added multipliers

WP 22/2013/DE/UECE

WORKING PAPERS

ISSN Nº 0874-4548

Effects of demand shocks in the Brazilian economy: new production and value added multipliers[1]

Antonio Carlos Moretto[2]
João Dias[3]
João Carlos Lopes[4]
Rossana Lott Rodrigues[5]

Abstract: Assuming that the traditional input-output multipliers lead to a misinterpretation of macroeconomic concepts for multisectoral analysis of a given economy, the aim of this article is to calculate the new multipliers of variation in the final demand on the production and value added by the sectors of the Brazilian economy in the period between 1995 and 2009. Using the Euclidean distance method proposed in Amaral et al (2012) and data from input-output tables, the main results showed that: a) the structural change effect was more important than the scale effect, both for the production and for the value added, although it was less important for the latter; b) Brazil is still a major exporter of unprocessed products which will generate jobs, income and taxes abroad, depriving the country of this important benefit; c) the main key sectors were Agricultural (1), Mining (2), Steel industry (4), Chemistry (11), Food industry (16) and some service sectors, such as Public Utilities (18), Trade, (20) Transportation (21), Communication (22), Public administration (24) and Other services (25), revealing the gain in importance of these activities in the national economy.

Keywords: input-output; Euclidean distance multipliers; structural changes; Brazil

JEL codes: C57; D67

1. INTRODUCTION

Demand multipliers are an important issue in input-output analysis. Although this subject is well discussed, there is a growing interest in research in this area with the adoption of new models and important results for the evaluation of projects and economic policies, both at national and regional levels (OOSTERHAVEN and STELDER, 2002; DIETZENBCHER, 2005).

The multipliers have been used on a large scale, to measure the direct and indirect effects of the final demand of the sectors, notably on important economic variables, such as production, employment, income, value added and others. The use of Hirschman-Rasmussen demand multipliers (Rasmussen, 1956 and Hirschman, 1958) has shown some limitations since the changes in the final

[1] **Acknowledgments.** This paper was prepared during a post doc program of Antonio Carlos Moretto and Rossana Lott Rodrigues in UECE, a research center supported by FCT (Fundação para a Ciência e a Tecnologia). These authors acknowledge the financial support of the State University of Londrina, Brazil, during the post doc.
[2] Department of Economic- State University of Londrina - UEL E-mail address: acmoretto@uel.br
[3] School of Economics and Management - ISEG, Lisboa University - UL, and Research Unit on Complexity and Economics – UECE. E-mail address: jdias@iseg.utl.pt
[4] School of Economics and Management - ISEG, Lisboa University - UL, and Research Unit on Complexity and Economics – UECE. E-mail address: jcflopes@iseg.utl.pt
[5] Department of Economic- State University of Londrina - UEL. E-mail address: rlott@uel.br

demand result from shocks in a particular sector without considering their impact on the others. This limitation reduces the fullness of the use of these multipliers.

It can be argued that the use of traditional multipliers leads to a misinterpretation of macroeconomic concepts for the multisectoral analysis of a given economy. From the macroeconomic point of view, it may be irrelevant as the monetary unit is distributed among all sectors as these are considered together. On the other hand, from the multisectoral point of view it becomes important to know if the unit increase in total final demand is directed entirely to a particular industry or is distributed equally among all sectors.

It is argued that the multipliers are inadequate as they are not able to compare the impacts of changes in output (value added, employment, etc.), due to changes in the final demand, which are equidistant from a given initial vector. In any n-dimensional context, the distance from a given initial state is given by the vector of the shock module and not by the sum of its components. Therefore, spending an additional monetary unit in sector one and none in sector two is not comparable to a situation in which you spend additionally half the monetary unit in sector one and half in sector two. The demand shock in the first case is more intense because there is, at the same time, a sharp change in the structure of the final demand (AMARAL et al. 2012).

Based on the above considerations, this study aims to calculate the new multipliers of variation in final demand for the Brazilian economy in the period 1995-2009. Specifically it is intended to verify the impact of a unit change in final demand on the output and value added of the sectors of the national economy in the study period.

2 THEORETICAL FRAMEWORK: intersectoral Euclidean distance multipliers

Consider an economy with n sectors and the standard Leontief model $\mathbf{x} = \mathbf{Ax} + \mathbf{y}$, where $\mathbf{x}$ and $\mathbf{y}$ are the n-component vectors of output and final demand, respectively, and $\mathbf{A}$ is the $n \times n$ matrix of technical coefficients. The solution of the model is given by $\mathbf{x} = \mathbf{Ly}$, where $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$ is the Leontief inverse (Miller and Blair 2009). A generic element (l_{ij}) of the Leontief inverse quantifies the direct and indirect requirements of the total output of sector i that are needed to produce one unit of final demand of sector j, the so-called output multiplier.

According to Amaral et al. (2012), when this solution is used for studying the potentialities for growth of an economy in response to final demand shocks, at least three problems can be considered.

The first one is to find, for a new situation, the largest increase in production resulting from a unitary increase in final demand, supposing that, in this new situation, no sector will decrease its final demand in relation to the initial level. This problem is easily solved using the Hirschman-

Rasmussen multipliers. The unitary increase in final demand should be allocated to sector j in such a way that the Rasmussen multiplier $\Sigma_i l_{ij}$ ($i = 1,\ldots,n$) is maximum.

The second problem is to find the largest increase in production resulting from a unitary increase in final demand, assuming that the final demand for each sector can vary and supposing that, in the new situation, this variation will not lead to a negative final demand for that sector (a negative final demand for a given sector has no meaning, with the possible exception of the existence of large stocks for that sector in the initial situation, a case that we rule out). Again, it is easy to deal with this problem. All of the final demand (the total value of final demand in the initial situation plus one additional monetary unity) should be allocated to sector j with the largest $\Sigma_i l_{ij}$, while for the other sectors final demand should be zero.

These two problems above mentioned are easily solved, but both are of limited interest because of their lack of realism, which is more pronounced in the case of the second one. For the first situation, the macroeconomic bias is clear. It is assumed that it is possible to increase the final demand of any sector by one monetary unity (m.u.) and at the same time keep final demand constant for the other sectors, an assumption that a genuine multisectoral analysis cannot accept.

This is why it is worth considering a third alternative problem. The classical multipliers are normally used for purposes of both analysis and economic policy. As far as analysis is concerned, they can be used to study the effects that a change in the final demand of a given sector will have on the output of all sectors. From the point of view of economic policy, a discretionary variation in the final demand of one sector can be programmed in order to obtain a change in the output of all sectors that will make it possible to obtain certain pre-established objectives.

However, in each of these cases, the hidden effects of a change in the final demand of just one sector are overlooked. Such effects have to do with the change in the structure of final demand that results from a change in the final demand of a given sector when the demand of all the other sectors remains constant.

A change in the structure of final demand may have impacts that are not taken into account and which may lead to errors of analysis when the model is used for this purpose or may have negative effects on policy objectives when it is used for the purposes of economic policy. In the latter case, for example, sudden changes in the structure of final demand may lead to destabilizing behavior through possible price changes in some sectors.

It may therefore be useful, for the purposes of both analysis and economic policy, not to compare alternatives that correspond to the use of an alternative m.u. in the final demand of sectors (as is the case when working with classical multipliers), but instead to compare alternatives that correspond to a shock of an equivalent size on final demand, even when these alternatives differ from one another in the amount that is to be spent (or saved) on final demand.

For example, from the point of view of economic policy, it may be useful, in certain situations, to compare alternatives that are equivalent in terms of the potential destabilizing effects that they may provoke due to changes in final demand, and then, after this comparison has been made, to choose from among these alternatives the one that is best suited to obtaining the objectives of economic policy, rather than simply looking for the best effect of spending a certain amount of money on final demand, without taking into account the effects that this will have on its structure.

The problem, thus, is to find the variations of the vector of final demand within the neighborhood of a given initial vector that maximize (or minimize) the distance of the resulting vector of production or, more usually, the resulting value-added vector in the new situation in relation to the initial production or value-added vector, respectively

One important characteristic of this third problem is the use of the Euclidean distance between vectors to measure the variations in relation to the initial situation. A vector resulting from concentrating all of the increase in final demand in one sector is at a greater distance from the original final demand vector than a vector that results from evenly distributing an increase in final demand of the same magnitude, which means that the Euclidean distance effectively distinguishes between two situations that must be treated as different. This is a genuine multisectoral approach.

To see this, suppose that we analyze the economy from an aggregate point of view. One type of question that can be asked (and answered) for an open economy is: what is the impact on production of a demand shock consisting of an increase of one m.u. in final demand? From a multisectoral point of view, this question does not make sense. As said before, spending an additional monetary unity in sector1and nil in sector 2 is not comparable to the situation where you spend additionally (say) ½ monetary unity in sector1and 1/2 monetary unity in sector 2. So, a genuinely multisectoral analysis should focus on the comparison between final demand variations that give rise to new vectors located at the *same distance* from the original vector. In the same way, the output impact of these final demand variations should be measured by the Euclidean distances between the new and the original output vectors.

Note that multipliers of this kind are different from the usual ones. The standard use of multipliers calculates the effect on production of an increase of one monetary unity in final demand. This increase of one monetary unity may be distributed by sectors according to the structure of final demand or, as mentioned before, can be allocated to just one sector, supposing that the other sectors keep their respective contributions to final demand constant.

Our problem is different and should not be seen with the eyes of the preceding analysis. What we intend to do is to study how the production of a given economy deviates from an initial vector of production when final demand suffers a shock that leads to a new final demand vector that is at a distance of one monetary unity from the previous one. Our methodology may be a useful tool for studying the behavior of the production system of an economy. It is indeed important for a number of reasons to evaluate the sensitivity of an economy to demand shocks. There are economies where the scope of variation of output in response to a unitary variation of final demand is larger than in other economies. Economies of the first type are, in this very specific sense, more sensitive than the others (AMARAL, et al., 2012).

3. METHODS AND DATA

3.1. Source of data

For the accomplishment of this study the annual input-output tables from Brazil for 1995, 2000, 2005 and 2009 were used, structured into 25 sectors, aggregated according to IBGE (2004), and estimated by Guilhoto and Sesso Filho (2005 e 2010) methodology, available at http://www.usp.br/nereus

3.2 Procedures for the calculation of multipliers

Following the procedures described in Amaral et al. (2012), consider the initial final demand vector $\mathbf{y}^s$ and the corresponding output vector $\mathbf{x}^s$, given by the input–output relation $\mathbf{x}^s = \mathbf{L}\mathbf{y}^s$. Given a neighborhood β of $\mathbf{y}^s$, V($\mathbf{y}^s$,β), the objective is to find the vector $\mathbf{y}^* \in$ V, such that the distance between $\mathbf{x}^*(\mathbf{y}^*)$ and $\mathbf{x}^s$ is maximum.

Consider, for the sake of simplicity, that $\beta = 1$. In this case, a vector at a unitary distance of $\mathbf{y}^s$ is not necessarily a final demand vector in which the sum of all its elements exceeds the sum of all the elements of the initial vector by exactly one monetary unity. This is only true when all of the (unitary) increase in final demand is concentrated in one sector. In general, and excluding this particular case, it is a vector that represents a monetary expenditure that is more than one unit higher than the total expenditure of vector $\mathbf{y}^s$.

Particularly, in studies of economic growth, it is more interesting to consider the output impacts of final demand vectors at a given distance from an initial vector than to consider only the output growth of unitary increases in final demand.

Suppose that we want to study the impact upon the distance from the initial output vector $\mathbf{x}^s$ to the vector $\mathbf{x}^*$ of a change in final demand from $\mathbf{y}^s$ to $\mathbf{y}^*$, in which:

$$(\Sigma\left(y_j^* - y_j^s\right)^2 = \beta^2$$

It is a case of maximizing (with β equal to1, according to our hypothesis):

$$(\mathbf{x}^* - \mathbf{x}^s)' (\mathbf{x}^* - \mathbf{x}^s) = (\Delta\mathbf{x}^s)' (\Delta\mathbf{x}^s),$$

subject to:

$(\mathbf{y}^* - \mathbf{y}^s)' (\mathbf{y}^* - \mathbf{y}^s) = 1$

Since $\mathbf{x}^s = \mathbf{L}\mathbf{y}^s$,the corresponding *Lagrangian* is:

$$(\mathbf{y}^* - \mathbf{y}^s)' \mathbf{L}'\mathbf{L} (\mathbf{y}^* - \mathbf{y}^s) - \lambda[(\mathbf{y}^* - \mathbf{y}^s)' (\mathbf{y}^* - \mathbf{y}^s) - 1]$$

After differentiating and equalizing to zero:

$$\mathbf{L}'\mathbf{L} (\mathbf{y}^* - \mathbf{y}^s) = \lambda (\mathbf{y}^* - \mathbf{y}^s) \qquad (1)$$

Because **L'L** is symmetric, all its eigenvalues are real. Since it a case of maximizing a definite positive quadratic form, all the eigenvalues are positive.

Furthermore, multiplying both members of (1) by $(\mathbf{y}^* - \mathbf{y}^s)'$ and considering only vectors **y** such as $(\mathbf{y}^* - \mathbf{y}^s)' (\mathbf{y}^* - \mathbf{y}^s) = 1$, we have:

$$(\mathbf{y}^* - \mathbf{y}^s)' \mathbf{L}'\mathbf{L} (\mathbf{y}^* - \mathbf{y}^s) = \lambda$$

and so the maximum distance between $\mathbf{x}^*$ and $\mathbf{x}^s$ is obtained for the greatest value of λ, i. e. for the greatest eigenvalue, and the minimum distance for the smallest one.

An economy is more variable in terms of its final demand structures, the greater the amplitude of variation of the distance between $\mathbf{x}^*$ and $\mathbf{x}^s$ in response to a unitary final demand shock.

The amplitude of variation attainable for the distance between $\mathbf{x}^*$ and $\mathbf{x}^s$ can be measured by the difference $s(\mathbf{L}'\mathbf{L}) = (\lambda_{max} - \lambda_{min})$, i. e. the *spread* of $\mathbf{L}'\mathbf{L}$, and it is certainly an important property of each technological structure **A** (the input coefficients matrix) and its corresponding Leontief inverse, $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$.

Similarly, one can check the impact of final demand on the vector of value added (va). In this case, the concern is to maximize

$$(\mathbf{va}^* - \mathbf{va}^s)' (\mathbf{va}^* - \mathbf{va}^s) = (\Delta\mathbf{va}^s)' (\Delta\mathbf{va}^s)$$

subject to:

$$(\Delta\mathbf{y}^s)' (\Delta\mathbf{y}^s) = 1$$

Using $\widehat{\mathbf{V}}$ to denote a diagonal matrix with value-added coefficients in the main diagonal, we have,

$$\mathbf{va} = \widehat{\mathbf{V}}\mathbf{x}^s = \widehat{\mathbf{V}}\mathbf{L}\,\mathbf{y}^s = \mathbf{D}\mathbf{y}^s,$$

and condition (1) becomes:

$$\mathbf{D}'\mathbf{D} (\mathbf{y}^* - \mathbf{y}^s) = \mu (\mathbf{y}^* - \mathbf{y}^s) \qquad (2)$$

and

$$(\mathbf{y}^* - \mathbf{y}^s)' \mathbf{D}'\mathbf{D} (\mathbf{y}^* - \mathbf{y}^s) = \mu$$

All the other results for **L** are now valid for **D**, with **D** = **VL**.

3.3. Homothetic scale and structure effects

As we saw previously, there are two vectors of final demand variations that result in maximum output movement: the vector in which all the final demand components increase and the other vector that is symmetric to this. If we are interested in the vector of increasing output, we will consider the vector $\Delta \mathbf{y}^s$ (= $\mathbf{y^*}$ - $\mathbf{y}^s$), in which all the components are positive. The corresponding output vector, $\Delta \mathbf{x}^s$, is $\mathbf{L}\Delta \mathbf{y}^s$, and this variation can be decomposed into two components: a scale effect and a structure effect.

Without structural changes, we would have a proportional increase in all sectors

$\Delta \mathbf{x}^s = \delta_0 \mathbf{x}^s$ ($\delta_0 > 0$)

However, in general, we do not observe this proportional change. On the contrary, $\Delta \mathbf{x}^s$ is a result of the combination of economic expansion in keeping with the existing structure and economic development as given by structural changes in the economy (an identical decomposition can be made for the "optimal" impulse vector of final demand, $\Delta \mathbf{y}^s$).

Formally:

$\Delta \mathbf{x}^s = \mathbf{SC} + \mathbf{ST}$

where **SC** and **ST** are the scale vector and the structural change vector, respectively. Defining δ such that

$$\delta = \text{mim}\left\{\frac{\Delta x_1^s}{x_1^s}, \frac{\Delta x_2^s}{x_2^s}, \dots, \frac{\Delta x_n^s}{x_{n1}^s}\right\}$$

we have for the scale vector,

$\mathbf{SC} = \delta \mathbf{x}^s$

The vector **ST** is then obtained by

$\mathbf{ST} = \Delta \mathbf{x}^s - \mathbf{SC}$

Our measures for the scale and the structure effects are then the Euclidean norms of **SC** and **ST**, respectively.

In the empirical application, we present the values for the length of $\Delta \mathbf{x}^s$ and $\Delta \mathbf{va}^s$, besides the scale effect (**SC)** and the structure change (**ST)**, in order to compare both with the overall effect. So, the impact of a unitary length variation of final demand on both production and value added is analyzed.

4. RESULTS AND DISCUSSION

Starting from the method described above and using the information of the Brazilian economy in the period 1995-2009, it is possible to see in Tables 1 and 2 the results for the product and the value added when a shock is applied in the final demand for the national economy.

With regard to the spread of the production, it is observed initially, that the maximum distance between the estimated and actual production showed increasing trend, with a slight decrease in 2009. On the other hand, the distance has remained relatively stable over the period. Consequently, the spread, which shows the difference between the maximizing and minimizing of the impacts was also high until 2005, revealing that the production response to shock in the final demand would be more positive at the beginning of the period.

Regarding the scale and structure effects, on Table 1 it can be observed that in the case of the production, the structural change effect was much more important for the Brazilian economy in the period 1995-2009 than the scale effect. The ratio structural change effect/scale effect that in 1995 was 8.29 times rose to 11.16 in 2009, reinforcing the dominance of that.

This is a characteristic of peripheral regions, where the structure of the productive system subject to limitations, responds more strongly to stimuli. It was the case in Brazil in the period under review in which the national economy was characterized by important changes and diversification in its production system, performing technologically more complex and better able to compete in the competitive market in which it was inserted.

Indeed, from the 1990s, despite macroeconomic instability and reflections from external crises which damaged the performance of the national productive sectors, it is observed in Brazil the reorientation of the development model, which went from protective in the industrial sector to intensifier of the trade liberalization process, which brought the need for restructuring which brought the need for restructuring large productive sectors of the national economy, then forced to face openly, global competitors, within the prevailing international conditions.

Table 1. Impacts of changes in final demand and results for the output, Brazil, 1995-2009.

	1995	2000	2005	2009
λ_{max}	4.15	4.47	4.85	4.34
λ_{min}	0.76	0.78	0.72	0.76
Spread	3.39	3.69	4.13	3.58
SC: scale effect	0.93	0.86	0.76	0.74
ST: structural change effect	7.96	8.13	8.45	8.26
SC+ST	8.89	8.99	9.21	9.00

Source: Elaborated by authors.

Study from IPARDES (2002) asserts that in the 1990s, "it can be considered that the overall performance of the domestic industry was more linked to the transformations of its productive structure than the general expansion of its product levels and capacity" (IPARDES, 2002, p.3).

Thus, during the 90s the Brazilian economy experienced a period of rapid and profound structural and regulatory changes, with industrial and technological policy that combines sectoral and systemic dimensions with the privatization of major sectors of the economy, sectors such as electricity and telecommunications, with the increase in the presence of high-tech industries, higher productivity and greater ability to compete, for example, the communications, electronics and computers sectors, with a stabilization plan (Plano Real), based on an cambial anchor with important impact on the whole economy

However, it is important to remember that the scale effect also occurred in the domestic manufacture in the 1990s, although differently across sectors. The investment rate, which increased from 14% at the beginning of the decade to 18.6% at the end, promoted growth of the installed capacity and consequently increase in manufacturing supply of durable and nondurable goods, such as automobiles, home appliance, food, drinks, etc. On the other hand, the investments in additional capacity in the steel, petrochemical, pulp and paper, in capital goods and infrastructure sectors (transport and energy) occurred more slowly (IPARDES, 2002).

In the case of impact on the final demand on the value added, higher values for the maximum distance between the estimated and actual value added can also be observed, although these values themselves showed lower compared with the product. As the minimum distance has remained virtually constant, as shown in Table 2, the value added spread was lower than the product spread. This lower value added response to demand shocks can reveal that despite the change in the national productive structure in the period, there is still need for the Brazilian economy to implement adding value to their products. In other words, Brazil is still a major exporter of unprocessed products that will generate employment, income and foreign taxes, depriving the country of this important benefit.

Table 2. Impacts of changes in final demand and results for the value added, Brazil, 1995-2009.

	1995	2000	2005	2009
μ_{max}	1.31	1.21	1.18	1.23
μ_{min}	0.08	0.06	0.06	0.06
Spread	1.23	1.15	1.12	1.17
SC: scale effect	0.28	0.21	0.20	0.23
ST: structural change effect	1.67	1.60	1.54	1.56
SC+ST	1.95	1.81	1.74	1.79

Source: Elaborated by authors.

Regarding the effect of structural change on the value added, its effect on the prevalence scale continued, although the ratio structural change effect / scale effect has risen less relating to the ratio to the product, of 5.96 times the scale effect in 1995 to 6.78 in 2009 (Table 2).

Considering value added the structural change effect is most important in economies with per capita income, relatively less high, like Brazil. Amaral et al. (2012), in a study conducted for four regions, Spain, Balearic Islands, Portugal and Azores, found structural change effect smaller than the scale effect for the first two regions, which had the highest per capita income. On the other hand, to Portugal and the Azores the structural change effect was clearly the most important, about three times larger than the scale effect in both cases.

Thus, in less developed economies, such as Brazil, demand shocks have a greater impact production and value added through structural change effect than the scale effect. In the case of the national economy, the context in which the shocks were promoted was particularly favorable to these changes, multiplying them and distributing them by all sectors, though not necessarily evenly.

The substantial adjustments promoted by the Brazilian industry in the 90s were not limited to production and employment[6]. The qualification[7], productivity[8], and wages[9] also adjusted themselves in response to the intensification of trade liberalization in progress from the beginning of the decade. Everything leads us to believe that these events result from the effects of the restructuring process of the domestic industry, based primarily on the implementation of modern management techniques and quality control and on technology adoption with bias towards skilled labor, resulting in elevated competitiveness and value added in the economy.

Another issue that emerges from this process and certainly contributed to the better performance of the national economy was the movement of concentration, both in terms of productive and patrimonial (mergers, acquisitions, entry of large firms in oligopolistic market, expanding production scales, etc..), involving even a regional dimension, with subnational government (state) adopting industrial policies embodied in aggressive strategies to attract investments and increasing its already significant share in national GDP and / or state (VASCONCELOS; CASTRO, 1999 and BONELLI , VEIGA, 2003)

From this point, we present the results by sector. Thus, Tables 3-6 show the results of maximizing the sectoral Euclidean distance applied to the Brazilian economy in the period in question, which allows us to evaluate the importance of the sectors in the economy and their effects of variation in final demand on output and value added. In other words, the following tables show the sectoral composition in terms of final demand, product and the value added and, in the last four columns, the optimal changes, or changes in the product and in the value added when a monetary unit shock is applying in the final demand for the sectors of the Brazilian economy in the period of study.

Table 3. Sectoral share in final demand (y^s), the product (x^s) and value added (va^s) and optimal changes in x^s and va^s, Brazil, 1995.

---

[6] See Sabóia (2001) for an overview on decentralization of industrial production and employment in the 90s.

[7] See Arbache (2001), Fernandes; Menezes-Filho (2002) and Menezes-Filho; Rodrigues Junior (2001), among others, to the complementarity between technology and skilled labor.

[8] See Chamon (1998), Cacciamali; Bezerra (1997), Rossi Junior, Ferreira (1999), Considera; Silva (1993), Silva et al. (1993), Feijoo; Gonzaga (1993 and 1994), Salm at al. (1997), Hidalgo (2002), Bonelli; Fonseca (1998), Carvalho (2000), among others.

[9] See Chamon (1998) and Campos (2004).

	Sectors				Focal Variable:			
					Product		Value Added	
		y^s	x^s	va^s	Δy^s	Δx^s	Δy^s	Δva^s
1	Agriculture	2.97	4.74	5.61	3.52	4.35	4.09	0.80
2	Mining	0.41	1.20	0.65	4.21	4.56	3.64	0.73
3	Non metallic mineral products	0.18	1.00	1.02	3.55	2.48	3.43	1.05
4	Steel industry	1.36	2.85	2.00	5.31	6.07	3.30	1.07
5	Machine and Equipment	1.40	1.23	0.83	3.90	2.75	2.87	0.96
6	Electrical / electronic material	3.61	3.71	2.21	4.69	4.34	3.26	1.23
7	Transport Material	3.56	3.22	1.73	4.40	3.57	3.26	1.33
8	Wood and furniture	1.49	1.32	1.25	2.59	1.90	2.61	1.13
9	Pulp, paper and printing	0.84	1.83	1.38	4.19	3.94	3.54	1.57
10	Rubber Industry	0.15	0.31	0.20	4.43	2.70	2.78	1.25
11	Chemistry	1.63	4.27	1.96	8.56	11.31	3.41	1.92
12	Pharmaceutical and veterinary	1.48	1.31	1.23	3.02	2.01	3.08	1.86
13	Plastic articles	0.19	0.92	0.56	5.40	4.10	2.84	1.81
14	Textile	0.69	1.33	1.08	3.58	3.35	2.83	1.96
15	Clothing and footwear articles	2.94	2.10	1.55	2.93	1.85	2.72	1.91
16	Food Industry	7.62	6.73	3.23	4.41	3.63	3.54	2.73
17	Others industries	0.32	0.33	0.28	3.05	1.76	2.51	2.15
18	Industrial Services of Public	1.42	2.54	2.69	3.30	3.99	4.19	3.81
19	Building	7.95	5.67	5.53	2.56	1.73	2.69	2.51
20	Trade	7.92	8.37	11.25	3.68	5.99	7.99	8.10
21	Transport	3.23	4.20	4.36	4.39	5.41	5.06	6.61
22	Communication	0.50	0.87	0.71	3.34	2.33	5.03	6.85
23	Financial Institutions	5.32	7.39	8.72	4.44	6.81	7.89	11.08
24	Public Administration	21.29	13.05	15.26	1.99	1.37	3.74	5.79
25	Others services	21.52	19.51	24.72	4.58	7.68	9.71	29.78
	Total	100	100	100	100	100	100	100

Source: Elaborated by authors.

Through the years studied, we observed that in general, the sectors that participated in the final demand, on output and value added remained, namely, Other Services (25), which include services provided to families, businesses services, rental properties and private households, Public administration (24), Trade (20) and Building (19). In a position of less emphasis is the Food industry (16) Transport (21) Financial Institutions (23) and Agriculture (1)

With regard to the optimal change only in the product between 1995 and 2000, the most important sectors were Mining (2) Chemistry (11), Steel Industry (4) Trade (20) Transport (21), Financial institutions (23) and Other Services (25), while only with optimal change in value added sectors stood out Trade (20) Transport (21) Communication (22) Financial Institutions (23), Public Administration (24) and Other services (25) (Table 3).

It is noteworthy that not all sectors with significant involvement in the final demand, production and value added is highlighted in the responses to final demand shocks. On the other hand, sectors like Mining (2) Chemistry (11) and Steel Industry (4), which did not show so high participation in those variables, when suffered final demand shocks, showed high response in production in the period, revealing strategic sectors for incentive policies (Tables 3 and 4). These are basic sectors that require high capital investment. In the context of the transformation of the national economy of the period, these were key sectors to be driven by public policy since they are regarded as major suppliers to other sectors of the economy.

Table 4. Sectoral share in final demand (ys), the product (xs) and value added (vas) and optimal changes in x^s and va^s, Brazil, 2000.

	Sectors				Focal Variable:			
					Product		Value Added	
		y^s	x^s	va^s	Δy^s	Δx^s	Δy^s	Δva^s
1	Agriculture	3.01	4.78	5.52	3.84	4.53	4.17	0.63
2	Mining	0.55	1.75	1.61	4.32	5.42	4.22	0.70
3	Non metallic mineral products	0.18	0.94	0.71	3.46	2.40	3.18	0.79
4	Steel Industry	1.45	2.85	2.00	5.03	5.63	3.29	0.90
5	Machine and Equipment	1.53	1.29	0.93	3.47	2.46	2.73	0.84
6	Electrical / electronic material	3.00	2.79	1.70	3.73	3.12	2.92	1.07
7	Transport Material	3.56	2.93	1.50	3.73	2.76	2.98	1.14
8	Wood and furniture	1.28	1.13	1.00	2.99	2.07	2.74	1.28
9	Pulp, paper and printing	0.99	2.11	1.72	3.98	3.83	3.71	1.81
10	Rubber Industry	0.18	0.32	0.19	4.91	2.86	2.74	1.47
11	Chemistry	2.44	5.76	2.30	9.92	13.63	3.44	2.10
12	Pharmaceutical and veterinary	1.64	1.41	1.24	3.37	2.17	3.23	2.03
13	Plastic articles	0.15	0.89	0.47	5.92	4.24	2.81	2.03
14	Textile	0.58	1.11	0.82	4.10	3.57	2.96	2.17
15	Clothing and footwear articles	2.42	1.68	1.29	3.04	1.82	2.71	2.04
16	Food Industry	7.31	6.39	2.82	4.59	3.65	3.66	2.88
17	Others Industry	0.31	0.34	0.28	3.23	1.83	2.55	2.06
18	Industrial Services of Public	1.94	3.33	3.52	3.62	4.71	5.06	4.56
19	Building	8.11	5.62	5.52	2.56	1.71	2.77	2.71
20	Trade	7.28	7.71	10.15	3.56	5.73	8.08	8.96
21	Transport	3.52	4.60	4.75	4.51	5.59	5.26	6.33
22	Communication	1.62	3.52	3.62	2.97	3.36	5.36	7.10
23	Financial Institutions	4.18	5.55	5.85	3.52	4.72	5.80	8.02
24	Public Administration	18.78	11.34	14.49	1.56	1.09	3.32	5.05
25	Others services	23.99	19.85	26.03	4.08	7.10	10.31	31.33
	Total	100	100	100	100	100	100	100

Source: Elaborated by authors.

Regarding the great changes in the product, it is worth emphasizing also the elevation of the responses of the sectors Agriculture (1), Food industry (16), Industrial Services of Public Utility (18) Transport (21) Communication (22) throughout the 1990s, sectors that would be stimulated by increased consumption and wages, by the resumption of consumer credit and by the stabilization of prices after the implementation of the Real Plan in 1994.

With regard to the optimal change in value added, the importance of the sectors related to trade and services, (20) to (25) is highlighted in the 1990s, with growth for the sectors (20, (22) and (25).

Tables 5 and 6 show the optimal changes for the product and value added for the years 2005 and 2009, respectively. In the case of the product, was found the increase of the responses of sectors Agriculture (1), Food Industry (16), Trade (20), Transport (21), Communications (22), Financial Institutions (23), Public Administration (24) and Other services (25), while the Mining (2), Chemistry (11) and Industrial Services of Public Utilities (18) were reduced in this period.

Throughout the period 1995-2009 it was observed that the activities traditionally linked to the producer services sector maintained its importance in terms of optimal changes in output and value added in the Brazilian economy, according to the importance that they represent in an economy transformation, which moves towards the incorporation of modern technologies and promote productive revolution in the industrial apparatus, since it is estimated that much of the industrial work is dedicated to the production of services (Bonelli, Veiga, 2003).

Of the industrial base, the ones that have stood out in the period in terms of response in output and value added were Mining (2), Steel Industry (4) and Chemistry (11) (Tables 3-6). These sectors, which require high capital investment, were key to be driven by public policies since they are regarded as important suppliers of other sectors, as mentioned earlier.

The sectoral panorama above mapped, confronted with important structural changes undergone by the Brazilian economy in the period 1995-2009, seems to indicate that there was a virtuous path, and somehow, proportional of the national economy sectors in terms of production modernization and increase of productivity gains, increased after the second half of the 1990s, in response to the changes that occurred not only in Brazil, but which are common to several countries.

In other words, the productive structure was modernized in a balanced way, in general, maintaining stable the sectoral participation in the final demand, in product and in value added. Regarding the responsiveness of sectors in terms of output and value added, to demand shocks, the Brazilian economy has revealed that there is still room for the incorporation of new technologies and adding more value added in the production system.

Table 5. Sectoral share in final demand (y^s), the product (x^s) and value added (va^s) and optimal changes in x^s and va^s, Brazil, 2005.

	Sectors				Focal Variable:			
					Product		Value Added	
		y^s	x^s	va^s	Δy^s	Δx^s	Δy^s	Δva^s
1	Agriculture	3.19	3.19	5.60	4.36	4.89	4.10	0.64
2	Mining	1.36	1.36	2.51	4.81	6.55	4.40	0.79
3	Non metallic mineral products	0.19	0.19	0.68	3.39	2.31	3.17	0.67

4	Steel Industry	2.10	2.10	2.88	5.59	6.88	3.60	1.00
5	Machine and Equipment	2.07	2.07	1.02	3.97	2.66	2.93	0.88
6	Electrical / electronic material	2.96	2.96	1.58	3.77	2.96	3.01	1.04
7	Transport Material	4.56	4.56	1.68	4.72	3.79	3.13	1.15
8	Wood and furniture	1.27	1.27	0.90	3.18	2.13	2.89	1.32
9	Pulp, paper and printing	0.99	0.99	1.39	3.86	3.33	3.49	1.85
10	Rubber Industry	0.17	0.17	0.25	4.95	2.86	2.78	1.55
11	Chemistry	2.67	2.67	2.82	9.85	14.19	3.61	2.08
12	Pharmaceutical and veterinary	1.51	1.51	1.03	3.37	1.92	3.09	1.98
13	Plastic articles	0.08	0.08	0.53	5.80	4.04	2.86	1.87
14	Textile	0.48	0.48	0.72	3.68	3.06	3.15	2.33
15	Clothing and footwear articles	2.04	2.04	1.03	2.96	1.71	2.86	2.15
16	Food Industry	8.31	8.31	3.23	4.82	3.87	3.67	2.95
17	Others Industry	0.31	0.31	0.28	3.22	1.75	2.59	2.36
18	Industrial Services of Public	1.89	1.89	3.92	3.52	4.87	5.49	5.58
19	Building	6.55	6.55	4.81	2.41	1.55	2.66	2.88
20	Trade	7.40	7.40	10.63	3.38	5.66	8.23	9.64
21	Transport	3.62	3.62	4.97	4.74	5.77	4.92	6.36
22	Communication	1.97	1.97	4.03	2.55	3.11	4.97	6.93
23	Financial Institutions	4.28	4.28	6.79	2.32	3.47	6.18	8.95
24	Public Administration	19.69	19.69	14.59	1.42	0.94	3.31	5.28
25	Others services	20.36	20.36	22.13	3.37	5.72	8.89	27.76
	Total	100	100	100	100	100	100	100

Source: Elaborated by authors.

It is possible to include here a qualification so that there is no doubt regarding the modernization balanced mentioned above. Admittedly some sectors were more privileged than others by various public and private agents, with regard to incentives and explicit sectoral policies, such as the automotive, textile, clothing and footwear, electronics, information technology and automation, telecommunications and infrastructure. Structural and regulatory changes that these sectors were submitted certainly impacted the profile of the sector, the conformation of supply, investment and growth of its production. However, these reflexes were not restricted to these industries. The other suppliers and demanders sectors were benefited. In other words, the changes that occurred in some sectors were extended to the entire structure of the Brazilian economy. Certainly, some sectors responded promptly but, over the years, increased competitiveness and productivity were permeating other sectors of the national productive structure enabling the reduction of their differences, whether in terms of management, process, product quality, technology etc.. This is the meaning of the term 'balanced modernization' used here.

Table 6. Sectoral share in final demand (ys), the product (xs) and value added (vas) and optimal changes in x^s and va^s, Brazil, 2009.

Sectors				Focal Variabel:			
				Product		Value Added	
	$\mathbf{y^s}$	$\mathbf{x^s}$	$\mathbf{va^s}$	$\mathbf{\Delta y^s}$	$\mathbf{\Delta x^s}$	$\mathbf{\Delta y^s}$	$\mathbf{\Delta va^s}$

1	Agriculture	3.28	5.04	5.52	4.49	5.28	4.20	0.70
2	Mining	1.35	2.38	1.88	4.85	5.81	4.20	0.94
3	Non metallic mineral products	0.12	0.95	0.73	3.51	2.55	3.23	0.85
4	Steel Industry	1.31	3.09	2.25	5.28	6.28	3.44	1.12
5	Machine and Equipment	1.99	1.54	1.03	3.73	2.56	2.93	1.08
6	Electrical / electronic material	2.50	2.27	1.42	3.76	2.94	3.15	1.22
7	Transport Material	4.29	3.83	1.76	4.51	3.66	3.15	1.29
8	Wood and furniture	1.00	0.86	0.73	3.06	2.08	2.93	1.45
9	Pulp, paper and printing	0.83	1.53	1.22	3.72	3.19	3.53	1.81
10	Rubber Industry	0.11	0.31	0.22	4.11	2.49	2.71	1.51
11	Chemistry	2.23	5.52	2.75	8.79	11.92	3.63	2.07
12	Pharmaceutical and veterinary	1.62	1.21	1.01	3.31	1.92	3.20	1.89
13	Plastic articles	0.11	0.79	0.51	4.83	3.50	2.85	1.92
14	Textile	0.41	0.74	0.56	3.69	2.99	3.11	2.20
15	Clothing and footwear articles	1.82	1.20	0.98	2.75	1.59	2.88	2.13
16	Food Industry	7.64	6.76	2.87	5.30	4.27	3.83	2.95
17	Others Industry	0.27	0.30	0.26	2.96	1.68	2.63	2.20
18	Industrial Services of Public	1.77	3.11	3.23	3.69	4.58	4.48	4.13
19	Building	7.52	5.21	5.23	2.59	1.74	2.78	2.66
20	Trade	8.64	9.00	11.94	3.96	6.51	8.56	10.36
21	Transport	3.68	4.94	4.85	5.06	6.19	4.88	6.24
22	Communication	1.89	3.77	3.66	3.17	3.54	4.70	6.17
23	Financial Institutions	4.19	5.67	7.02	3.21	4.85	6.83	9.70
24	Public Administration	20.93	12.51	15.86	1.54	1.02	3.17	4.96
25	Others services	20.47	17.45	22.51	4.13	6.87	8.99	28.46
	Total	100	100	100	100	100	100	100

Source: Elaborated by authors.

5. Concluding remarks

In this work we applied the Euclidean distance multipliers method proposed in Amaral et al (2012) to the Brazilian economy as an alternative to overcome the limitations of traditional multipliers commonly used in studies based on input-output matrices, notably Rasmussen and Hirschman multipliers, which consider fixed the productive structure of the economy and show that the impact of changes in production, value added and employment, due to changes in the final demand, are equidistant from a given initial vector.

Using the input-output tables of Brazil for 1995, 2000, 2005 and 2009, the study found that the spread of the product was high during the period, showing that the production of the national economy showed significant capacity to respond to demand stimulus. On the other hand, the spread of value added showed lower values than the production, indicating that the response of this variable to demand shocks were more limited and showed that there is plenty of space in the Brazilian economy to implement adding value to their products. In other words, that Brazil is still a major exporter of primary products that will generate foreign employment, income and taxes, depriving the country of this important benefit.

In the case of maximizing the spread, the impacts were decomposed into two effects: scale and structure change. For the Brazilian economy in the period under study it was found that the structural change effect was more important than the scale effect, both for the product and for the value added. These results confirm the condition of the peripheral region of national economy, characterized by low per capita income, in which the structure of the productive system, still subjected to limitations, responds more strongly to structural changes stimulus.

For the Brazilian economy it is not difficult to explain this behavior due to the positive evolution in terms of the production structure between 1995 and 2009. This was a period of normalization of the political conditions, economic stabilization, inclusive social policies, change in industrial policy and foreign trade not negligible, breaking monopoly, privatization, international economic integration and growth relatively strong and convergent at a macroeconomic level.

Thus, it was expected that changes in national output and value added between 1995-2009, resulting from changes in the final demand, were due mainly to the modernization of the productive structure of the economy, which was more diverse, more technologically complex and with greater possibility of evolution. However, notice that the scale effect also had its contribution in some sectors.

In relation to key sectors, the application of the method of Euclidean distance multipliers has shown that the main sectors were Agricultural (1) Mineral extraction (2) Steel (4), Chemistry (11), Food industry (16), Industrial Services of Public Utility (18), Trade (20) Transport (21), Communication (22), Public Administration (24) and Other Services (25).

As an indication for future studies we suggest the application of the method to compare regions within Brazil and the state of Paraná in order to detect their economic specificities and sectoral responses, considering the availability of input-output tables.

REFERENCES

AMARAL, J. F. do; DIAS, J. ; LOPES, J. C. A new kind of production and value-added multiplier for assessing the scale and structure effects of demand shocks in input–output frameworks. **Annals of Regional Science**, v. 49, p. 103-115, 2012.

ARBACHE, J. S. Trade liberalisation and labour market in developing countries: theory and evidence. University of Kent, **Department of Economics Discussion Paper** 01/12, jun. 2001.

BONELLI, R.; FONSECA, R. **Ganhos de produtividade e de eficiência**: novos resultados para a economia brasileira. Rio de Janeiro: IPEA, 1998, Texto para Discussão.

BONELLI, R.; VEIGA, P. da M. A dinâmica das políticas setoriais no Brasil da década de 1990: continuidade e mudanças. **Revista Brasileira de Comércio Exterior**, v. 75, abr.-jun. 2003.

CACCIAMALI, M. C.; BEZERRA, L. de L. Produtividade e emprego industrial no Brasil. **Revista Brasileira de Economia**, v. 51, n. 1, p. 77-91, jan./mar., 1997.

CAMPOS, M. de F. S. de S. **Abertura comercial, comércio intra-indústria e desigualdade de rendimentos na indústria de transformação brasileira**. Tese (Doutorado em Economia). PIMES/UFPE, Recife, 2004.

CARVALHO, P. G. M. de. **As causas do aumento da produtividade da indústria brasileira nos anos 90.** Tese (Doutorado em Economia). Rio de Janeiro: UFRJ/IE, 2000.

CHAMON, M. **Rising wages and declining employment**: the Brazilian manufacturing sector in the 90s. Rio de Janeiro: IPEA, 1998, (Texto para Discussão 552).

CONSIDERA, C. M.; SILVA, A. B. **A produtividade da indústria brasileira**. Rio de Janeiro: IPEA/DIPES, 1993 (Sumário Executivo 1).

DIETZENBACHER, E. More on multipliers. **Journal of Regional Science**, v. 45:421–426, 2005.

FEIJÓ, C. A.; GONZAGA, P. Os novos caminhos da produtividade na indústria brasileira. **Revista de Indicadores de Qualidade e Produtividade**. Rio de Janeiro: IPEA, 1993.

_________. Sete teses equivocadas sobre o aumento da produtividade em anos recentes. **Boletim de Conjuntura do IPEA**, Rio de Janeiro: IPEA, v. 14, n. 2, 1994.

FERNANDES, R.; MENEZES FILHO, N. A. Escolaridade e demanda relativa por trabalho: uma avaliação para o Brasil nas décadas de 80 e 90. In: SEMINÁRIO DE ECONOMIA APLICADA, 2.,IPEA/UnB/MTE, II, 2002. IPEA/UnB/MTE. **Anais ...** Brasília, nov. 2002.

GUILHOTO, J. J. M., U. A. SESSO FILHO. Estimação da Matriz Insumo-Produto Utilizando Dados Preliminares das Contas Nacionais: Aplicação e Análise de Indicadores Econômicos para o Brasil em 2005”. Economia & Tecnologia. UFPR/TECPAR. Ano 6, v. 23, out., 2010.

GUILHOTO, J. J. M., U. A. SESSO FILHO. Estimação da Matriz Insumo-Produto a Partir de Dados Preliminares das Contas Nacionais. **Economia Aplicada,** v. 9, n. 2, p. 277-299, abr./jun., 2005.

HIDALGO, A. B. O processo de abertura comercial brasileira e o crescimento da produtividade. **Economia Aplicada**, v.6, n.1, p. 79-95, 2002.

HIRSCHMAN, A. O. **The strategy of economic development**. New Haven: Yale University Press, 1958. 217p.

IBGE. Instituto Brasileiro de Geografia e Estatística. **Classificação Nacional de Atividades Econômicas**. Rio de Janeiro: IBGE, 2004.

IPARDES. Instituto Paranaense de Desenvolvimento Econômico e Social. **Crescimento, reestruturação e competitividade industrial no Paraná – 1985-2000**. Instituto Paranaense de Desenvolvimento Econômico e Social. – Curitiba: IPARDES, 2002. 84p.

MENEZES-FILHO, N. A.; RODRIGUES JÚNIOR, M. Abertura, tecnologia e qualificação: evidências para a manufatura brasileira. In: WORKSHOP LIBERALIZAÇÃO COMERCIAL IPEA/UnB/MTE, **Anais...** Brasília, abr. 2001.

MILLER, R. E.; BLAIR, P. D. **Input-output analysis**: foundations and extensions. 2nd ed. UK, Cambridge University Press, 2009.

OOSTERHAVEN, J.; STELDER, D. **Net Multipliers Avoid Exaggerating Impacts: With a Bi-Regional Illustration for the Dutch Transportation Sector**, *Journal of Regional Science*, vol. 42(3), pp. 533–543, 2002.

RASMUSSEN, P. N. **Studies in intersectoral relations**, Amsterdam: North-Holland, 1956.

ROSSI JÚNIOR, J. L.; FERREIRA, P. C. Evolução da produtividade industrial brasileira e abertura comercial. **Pesquisa e Planejamento Econômico**, v. 29, n. 1, p. 1-36, 1999.

SABÓIA, J. **A dinâmica da descentralização industrial no Brasil**. Rio de Janeiro: UFRJ/Instituto de Economia (Texto para Discussão IE/UFRJ n. 452), 2001.

SALM, C.; SABÓIA, J.; CARVALHO, P. G. M. de. Produtividade na indústria brasileira: questões metodológicas e novas evidências empíricas. **Pesquisa e Planejamento,** v. 27, n. 2, p. 377-396, 1997.

SILVA, A. et al. Retrospectiva da economia brasileira. **Perspectivas da Economia Brasileira - 1994**, cap. 1. Rio de Janeiro: IPEA, p. 13-41, 1993.

VASCONCELOS, J. R. de; CASTRO, D. **Paraná: economia, finanças públicas e investimento nos anos 90**. Brasília: IPEA. Texto para discussão n. 624, 1999.