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# Productive Structure and Income Distribution: The Brazilian Case

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## 1. Introduction

Brazil is one of the most unequal countries in the world in terms of income distribution. This situation is quite stable and remains almost unchanged for decades (Baer, 2001). Barros and Mendonça (1997) indicate that economic growth alone would not be able to solve the problem, and that some specific policies should be put in place. Some authors argue that opening of the economy to external market could help reducing inequality (Rocha, 1998, dealing with regional aspects; Green et al., 2001, analyzing labor market changes; Gurgel et al., 2003, on trade liberalization). Azzoni et al (2005) and Ferreira-Filho and Horridge (2005). Indicate that even a huge reduction in trade barriers by developed countries would produce very limited impacts on income distribution in Brazil.

According to Radar Social Brasileiro<sup>1</sup>, Brazil is only worse than Sierra Leoa in terms of income inequality in a group of 130 selected countries. The Brazilian Gini inequality index is two and a half times the ones for Austria and Sweden; it is substantially worse even than Mexico's indicator. As a whole, Brazil must not be considered as a poor country, and yet its income distribution is equivalent to very poor countries. Barros, Henriques and Mendonça (2000) identified the heterogeneity of schooling of labor force as the main determinant of wage inequality in Brazil. Moreover, the authors found that the process of economic development experienced by the country reinforces such heterogeneity. The analysis of labor demand and supply indicate that the inequality levels are due to a conflict between a highly technology-intensive economy facing an inefficient education system. While labor demand becomes more and more sophisticated, the capacity of the educational system to provide the necessary supply of skilled workers create such a situation. Educational policies are needed, thus. However, the capacity of the educational system to provide the necessary labor supply is

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<sup>1</sup> [www.ipea.gov.br/Destaques/livroradar.htm](http://www.ipea.gov.br/Destaques/livroradar.htm)

highly limited. Social programs are alternatives, but their reach is also limited, as all evidence on recent programs as Fome Zero suggest.

The 90s were a period of intense economic changes in Brazil. Until 1990, the Brazilian economy was quite closed, with most of final, as well as intermediate, consumption being supplied by Brazilian companies. Even exports were a small part of final demand. In a few years time, the economy was opened-up at a fast pace, generating opportunities and creating problems at a very rapid rate. As a whole, the decade was marked by low product growth, many stabilization plans, changes of currency etc. The weak economy was highly vulnerable to external crises, such as Mexico, 1995, Southeast Asia, 1997, and Russia, 1998. On top of that, the Argentinean crisis and energy supply problems helped generating a low-growth, stop-and-go economy, with an overall poor economic performance.

In order to be able to design efficient policies, a better diagnosis of income inequality and its causes is in order. Although growth was not impressive in the period, important structural changes took place. The objective of this paper is to assess the impacts of some of the important changes occurred within Brazilian economy in the 90s on income distribution. For that, the productive structures existing in 1992 and 2002 will be presented and compared. A series of simulation will be performed in order to establish the distributive impacts of such changes on income distribution. It follows the steps of Baer e Haddad (1997), who analyzed the influence of income distribution on employment absorption in the 60s<sup>2</sup>.

The paper is organized in 5 sections. Section 2 presents the methodology employed, based on the Leontief-Miyazawa type of model. In section 3. the data sources are presented and some general features are discussed. Results are presented and discussed in section 4. The last section presents the conclusions of the study.

## **2. Methodology and data base**

### **2.1. The Pure Leontief and the Leontief-Miyazawa Models**

In the open input-output model, the vector of final demands is treated as completely exogenous to the system (Leontief model). However, for the model to be closer to reality, as

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<sup>2</sup> Figueroa (1975) presents a similar analysis for Peru.

suggested by Miyazawa (see Miyazawa, 1976), the final demands should be broken down into internal consumption demands and exogenous demands (Leontief-Miyazawa model). In this section both models are presented.

The intersectoral flows existing in a given economy, which are determined by both technological and economic factors, can be described by a system of simultaneous equations represented by  $X = AX + Y$  (1) where  $X$  is a vector (nx1) with the total output of each sector,  $Y$  is a vector (nx1) with each sector's final demand, and  $A$  is a matrix (nxn) with the technical coefficients of production (see Leontief, 1951). The sectoral final demands are usually treated as exogenous to the system and, therefore, the output vector is uniquely determined given the final demand vector, that is,

$$X = (I - A)^{-1} Y \quad (2)$$

where  $I$  is the (nxn) identity matrix.

The vector of final demands, however, is the sum of a vector of consumption demands and a vector of exogenous demands (i.e., government expenditures, investment, and exports):

$$Y = Y^c + Y^e \quad (3)$$

where  $Y^c$  is the (nx1) vector of consumption demands and  $Y^e$  is the (nx1) vector of exogenous demands.

Moreover, it has been pointed out that, to make this model more realistic, the consumption demands should not be treated as exogenous parameters but, instead, as functions of income, in the tradition of Keynes and Kalecki (see Miyazawa, 1960, 1963, and 1976).

The multisectoral consumption function is defined as

$$Y^c = CQ \quad (4)$$

where  $C$  is a matrix (nxr) with the consumption coefficients, and  $Q$  is a vector (rx1) with the total income of each income group.

In addition to incorporating this multisectoral consumption function into the Leontief equations, one must also introduce in the model the structure of income distribution since "(...) the consumption structure generally depends on the structure of income distribution" (Miyazawa, 1976, p. 1).

The income-distribution structure can be represented by the simultaneous equations.

$$Q = VX \quad (5)$$

where  $V$  is a matrix (rxn) with the value-added ratios. The simultaneous equations (5) represent the fact that to a given productive structure prevailing in a country is associated a structure of income distribution.

To calculate the solution for the static model we start by substituting (3), (4), and (5) into (1), getting

$$X = AX + CVX + Y^e \quad (6)$$

whose solution is

$$X = (I - A - CV)^{-1} Y^e \quad (7)$$

Moreover, it is convenient to express the matrix in (7) as the product of  $(I - A)^{-1}$  which reflects the production flows - and another matrix reflecting the endogenous consumption flows, that is,

$$X = B(I - CVB)^{-1} Y^e \quad (8) \text{ where}$$

$$B = (I - A)^{-1} \quad (9)$$

Finally, substituting (8) into (5), the multisectoral income multiplier is given by

$$Q = VB(I - CVB)^{-1} Y^e \quad (10)$$

which shows that the group incomes (and, of course, the aggregate income) will have different values depending on the sectors' shares in the exogenous final demand (see Miyazawa, 1963 and 1976).

## 2.2. Inequality indicators

For measuring inequality the Gini index will be employed. Since we only have data by category, the methodology presented by Hoffman (1998) will be utilized. Let population  $N$  be divided into  $k$  classes

$$N = \sum_{h=1}^k n_h$$

The population mean is  $\mu$ , and  $x_{hi}$  ( $h = 1, \dots, k; i = 1, \dots, n_h$ ) is income received by the  $i^{\text{th}}$  person in the  $h^{\text{th}}$  income stratum. The fraction of income is given by

$$y_{hi} = \frac{x_{hi}}{N\mu}$$

The share of the  $h^{\text{th}}$  stratum is  $Y_h = \sum_{i=1}^{n_h} y_{hi}$ , and the average income is  $\mu_h = \frac{1}{n_h} \sum_{i=1}^{n_h} x_{hi} = \frac{Y_h}{\pi_h}$ .

We thus have:  $G = G_e + \sum_{h=1}^k \pi_h Y_h G_h$ , in which  $G$  is the Gini index for the whole population,  $G_e$  indicates the between strata inequality, and  $G_k$  indicates inequality within  $k$ 's stratum.

$G_e = 1 - \sum_{h=1}^k (\phi_h + \phi_{h-1}) \pi_h$ , with  $(\phi_h + \phi_{h-1})$  being the sum of incomes. Since we do not know the values within each stratum, it is impossible to calculate  $G_k$ , and therefore  $G$ . Thus,  $G_e$  will be considered as the inequality measure for the distribution. The data restriction causes underestimation of the true inequality, since the within-stratum inequality is not taken into account. Therefore, the values calculated in this study for the indicators are expected to be smaller than the ones calculated with census data (full information). Since we are mainly considering changes in situations, this limitation is not of great concern.

### 3. Data

Two I-O matrices were used in this study: the one produced for IBGE for 1992, and one estimated for 2002 according to the methodology developed by Guilhoto and Sesso-Filho (2005). We have used income data from the 1992 and 2001 PNAD<sup>3</sup> to estimate the payment of wages by different sectors to households, and data from POF<sup>4</sup> 2002 to identify the consumption patterns of families in different income strata.

<sup>3</sup> Pesquisa Nacional por Amostra de Domicílios, IBGE

<sup>4</sup> Pesquisa de Orçamentos Familiares, IBGE

### 3.1. Income sources

Based on PNAD 1992 and 2001, we considered the sum of monthly income to all persons living in the household, except for retirement payments, and domestic servants. For each of the 31 sectors we have the total payment of wages, which were allocated to ten income classes according to PNAD data. Inflation between 1992 and 2002 was considered through the IPCA, from IBGE, so that we work with constant Reais. Table 1 presents the income classes defined and the proportion of income in each of them in both years. It can be observed that only the shares of the two highest income classes have augmented in the period, especially in the highest income class.

**Table 1 – Income classes (monetary and non monetary income)**

R\$/month	Minimum Wages	Share of total labor income	
		1992	2002
Up to 400 (1)	Up to 2 (1)	5,51%	5,32%
> 400 to 600	> 2 to 3	6,18%	5,40%
> 600 to 1.000	> 3 to 5	12,79%	11,51%
> 1.000 to 1.200	> 5 to 6	5,96%	5,33%
> 1.200 to 1.600	> 6 to 8	10,18%	8,91%
> 1.600 to 2.000	> 8 to 10	8,28%	8,34%
> 2.000 to 3.000	> 10 to 15	13,94%	13,74%
> 3.000 to 4.000	> 15 to 20	9,75%	9,73%
> 4.000 to 6.000	> 20 to 30	11,15%	11,88%
> 6.000	> 30	16,25%	19,84%

(1) Includes people without income

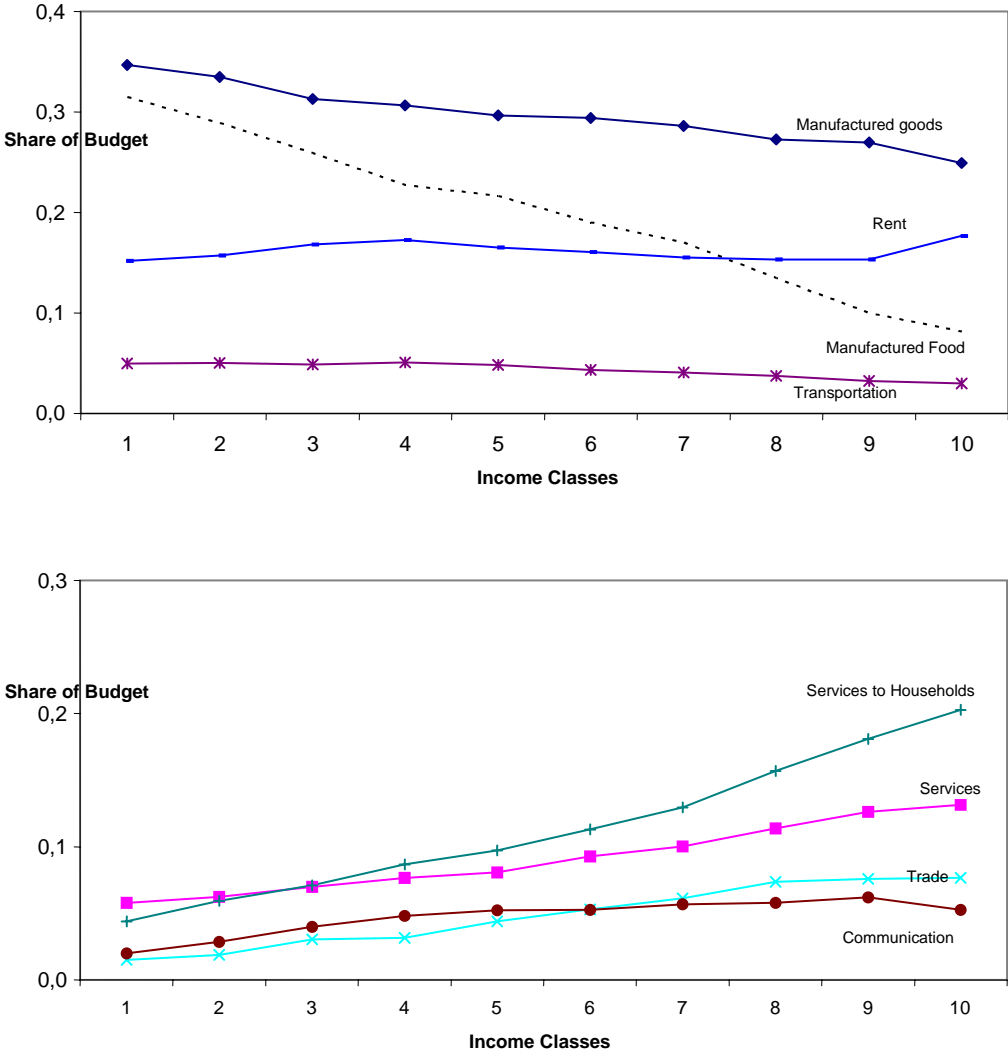
### 3.2. Consumption patterns estimated from POF data

The survey from POF was implemented in 2002 and 2003, at the household level. It includes monetary and non monetary income, as well as monetary and non monetary consumption. A total of 48.470 households were interviewed, and for each of them the sources of income were identified, as well as the expenditure pattern. Households were split into 10 income classes. Expenditure by households is allocated to 10,429 types in POF 2002.

These were aggregated to form 80 types in this study. We have thus for each income class, expenditure in 80 different products or services.

Figure 1 below presents some information on consumption patterns by income class, for highly aggregate groups of products. It is clear, as expected, that poorer households spend a larger percentage of income on Manufactured Food, Manufactured Goods, and Transportation. These products clearly present decreasing importance on household budget as income increases. On the other hand, Services in general, Services do Households, Trade, and Communication, present a clear up-ward trend from low to high income classes. This sort of information is available for each of the 31 sectors, allowing to the calculation of the induced effects of any shock to the system.

**Figure 1: Share of different goods services in budget**





## 4. Results

### 4.1. Existing inequality

We start by presenting the inequality measures for 1992 and 2002. In Table 3 we present the global Gini, as well as the Gini for each sector, in order to indicate the ones with the highest wage inequality. The global Gini increased from 0.427 in 1992 to 0.5145 in 2002, with an impressive change of 23.6%. These numbers are compatible with the Gini calculated with data on individuals, which, as mentioned before, tend to produce higher values. As Figure 2 indicates, the values for 1992 and 2002 are, respectively, 0,5835 and 0,589, presenting thus a similar increasing pattern. However, the figure also shows a declining trend after 2003, which we can not replicate with our end-year-only data.

**Figure 2: Gini calculated with individual data**



Figure 3 displays inequality within each sector in relation to the national average in each year. In 1992, only 9 sectors displayed below-average inequality; in 2002, this number changed to 21. Thus, on a sector-count basis, there was an improvement during the period. The 45-degree line indicates sectors that presented inequality identical to the national mean in both years. Sectors above the line are those with relatively higher inequality in 2002 than in

1992; sectors below the line improved their internal income inequality during the period. Sectors in the increasing inequality area are: Communications, Public Administration, Services do Households, Services to Business, Wood and Furniture, Other Manufacturing, Chemicals, Trade, and Shoes. The most unequal sector in 1992, Textiles, is located below the average in 2002, thus presenting an impressive improvement. Agriculture, one of the most unequals in 1992, also improved, but not enough to be positioned below the average in 2002.

**Figure 3: Inequality internally to sectors**

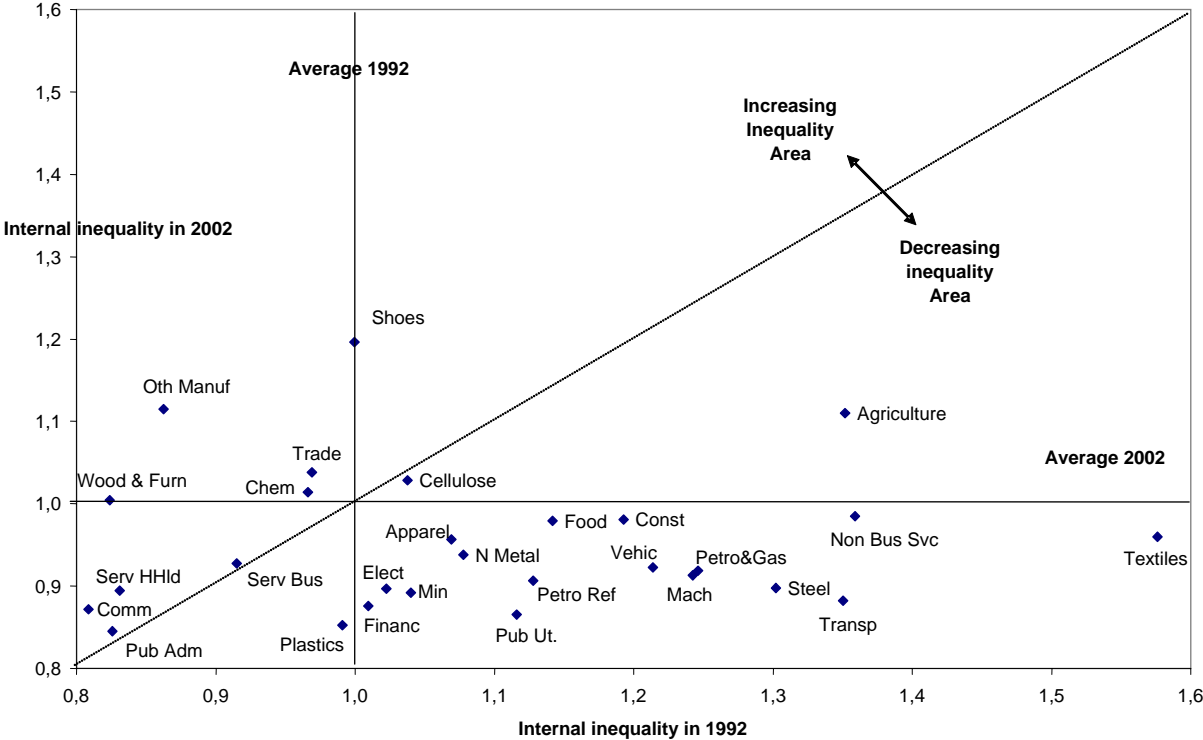


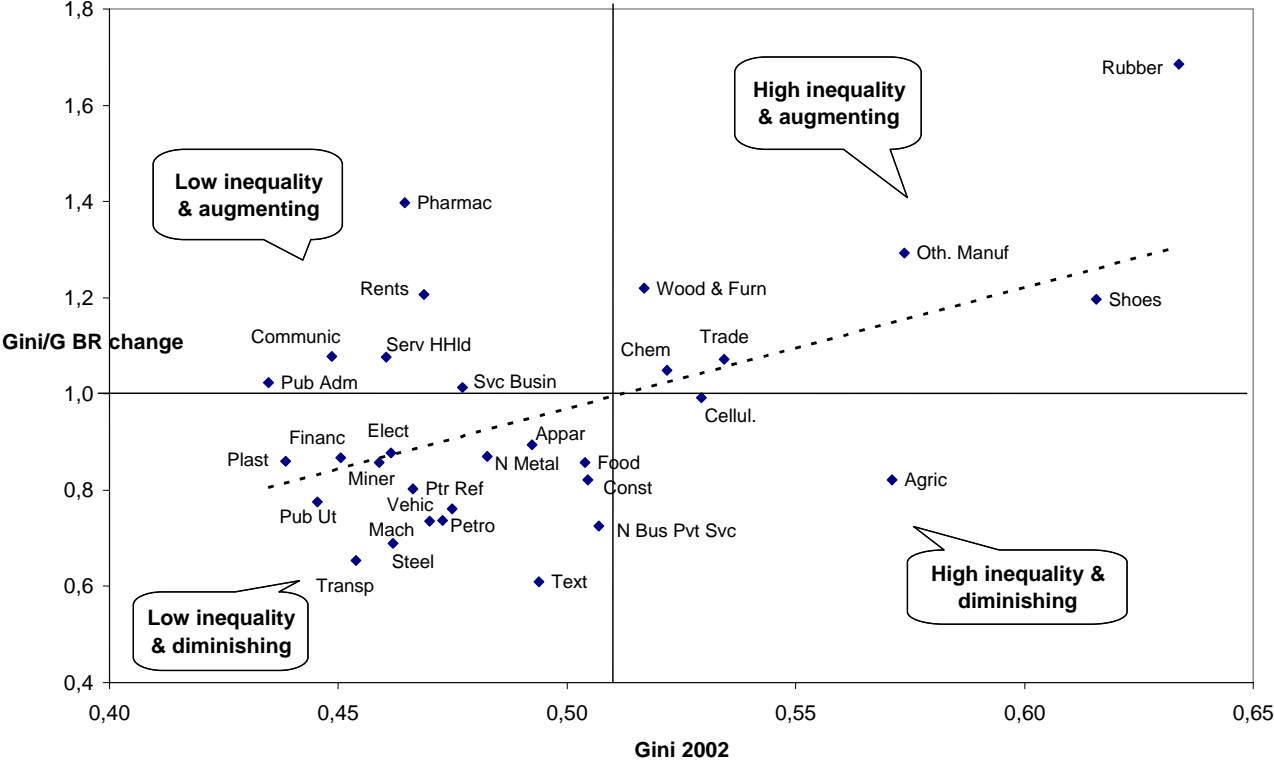
Figure 4 presents the level of inequality produced in one sector in 2002 in the horizontal axis. The vertical axis exhibits the change in inequality, in relation to the average, between the two cases. A sector such as Rubber, located in the first quadrant of the figure, presents high inequality in 2002, and the simulations revealed that the difference in inequality produced by this sector in relation to the average is increasing. As such, this is a sector that contributes to inequality, and whose perverse contribution is augmenting. On the other extreme, in quadrant three are those sectors that produce an inequality level below the average, and whose distance to the average is increasing. That is, they are becoming even more equal as compared to the average. The second quadrant includes low-inequality sectors that are augmenting their distance to the mean, that is, the changes between 1992 and 2002 produced perverse results.

Finally, the fourth quadrant presents the only two sectors that was above average in terms of inequality and presented an evolution favorable to equality (Agriculture and Cellulose). It can be seen that the villains are Rubber, Shoes, Other Manufacturing, Trade, Chemicals, and Wood and Furniture, which are sectors with an above-average inequality and increasing distance to the average. Worrying sectors are those which presented below-average inequality, but whose changes over the decade were above-average, that is, sectors which are becoming more unequal. These are: Pharmaceuticals and Veterinary, Rents, Communications, Services to Households, Services to Business, and Public Administration.

**Table 2 – Inequality internally to sectors: 1992 and 2002**

Sectors	1992		2002		Change 2002/1992
	Gini	In relation to average	Gini	In relation to average	
Agriculture	0,577	35,2%	0,571	8,2%	-1,1%
Mineral extraction (except fuel)	0,444	4,0%	0,459	-13,1%	3,3%
Petrol and gas	0,533	24,7%	0,473	-10,4%	-11,2%
Non-metallic minerals	0,461	7,8%	0,483	-8,6%	4,8%
Steel and Non-ferrous metallurgy	0,556	30,2%	0,462	-12,5%	-17,0%
Machinery and equipment	0,531	24,2%	0,470	-11,0%	-11,5%
Electric material and electronic equipment	0,437	2,3%	0,462	-12,6%	5,6%
All types of vehicles	0,518	21,4%	0,475	-10,1%	-8,4%
Wood and furniture	0,352	-17,6%	0,517	-2,1%	46,8%
Cellulose, paper and printing	0,443	3,8%	0,529	0,3%	19,4%
Rubber	0,312	-26,9%	0,634	20,0%	102,9%
Chemical	0,413	-3,4%	0,522	-1,1%	26,5%
Petrol refining	0,482	12,8%	0,466	-11,7%	-3,2%
Pharmaceutical and veterinary	0,276	-35,4%	0,465	-12,0%	68,3%
Plastics	0,423	-0,9%	0,439	-16,9%	3,6%
Textiles	0,673	57,6%	0,494	-6,5%	-26,6%
Apparel	0,457	6,9%	0,492	-6,7%	7,8%
Shoes	0,427	0,0%	0,616	16,6%	44,2%
General food	0,488	14,2%	0,504	-4,6%	3,3%
Other manufacturing	0,369	-13,7%	0,574	8,7%	55,7%
Public utility services	0,477	11,6%	0,445	-15,6%	-6,6%
Construction	0,510	19,3%	0,505	-4,4%	-1,0%
Trade	0,414	-3,1%	0,534	1,2%	29,1%
Transportation	0,577	35,0%	0,454	-14,0%	-21,3%
Communication	0,346	-19,1%	0,449	-15,0%	29,8%
Financial institutions	0,431	1,0%	0,451	-14,7%	4,5%
Services to households	0,355	-16,9%	0,460	-12,8%	29,7%
Services to business	0,391	-8,5%	0,477	-9,6%	22,0%
Building Rent	0,322	-24,5%	0,469	-11,2%	45,4%
Public administration	0,353	-17,4%	0,435	-17,7%	23,2%
Non-business private services	0,581	35,9%	0,507	-4,0%	-12,7%
<b>BRASIL – all sectors</b>	<b>0,427</b>	<b>0,0%</b>	<b>0,5145</b>	<b>0,0%</b>	<b>23,6%</b>

**Figure 4: Inequality level and contribution to change by sector**



**4.2. Simulations**

In order to assess the impacts of different factors in shaping the observed pattern of income inequality in 2002, some simulations were produced. For that, a positive shock of R\$ 1 million was introduced in each sector at a time. Each shock spreads into the economic structure through the technical coefficients (indirect effects) and through the consumption patterns (induced effects), changing the payments of wages to different income classes, and, therefore, changing income inequality. Since each sector has a different repercussion pattern to other sectors, these different shocks will lead to different inequality patterns. If the resulting pattern of the shock produces inequality higher than the average, one concludes that the sector contributes to augmenting inequality. If not, it contributes to diminishing inequality. The difference between these results and the ones presented before, is that those relate to the within-sector inequality, and these to the national inequality produced by the

shock in the sector. The first could be considered as the direct impact on inequality, and the later as the direct + indirect + induced effects.

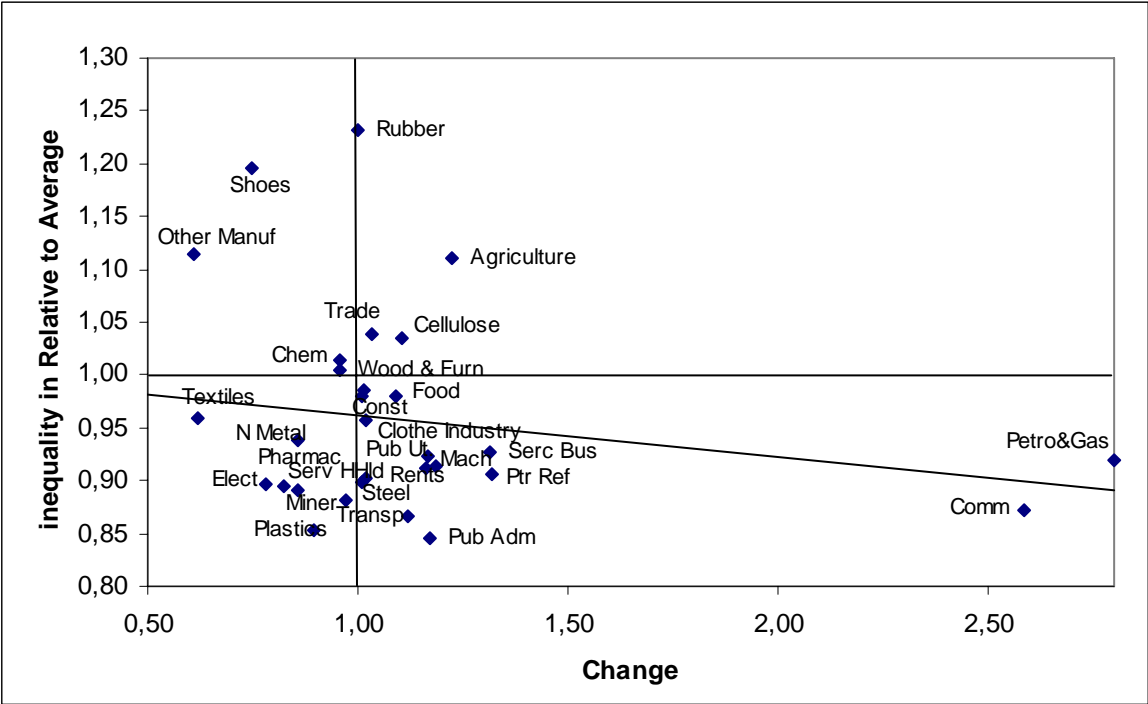
#### **4.2.1. Changes in sectoral shares**

The first simulation considers what inequality would be if the sector shares remained the same as in 1992. As analyzed in Baer (2001, Chapter 18), some sectors increased their importance, others decreased over time. Were those changes contributors to increasing inequality?

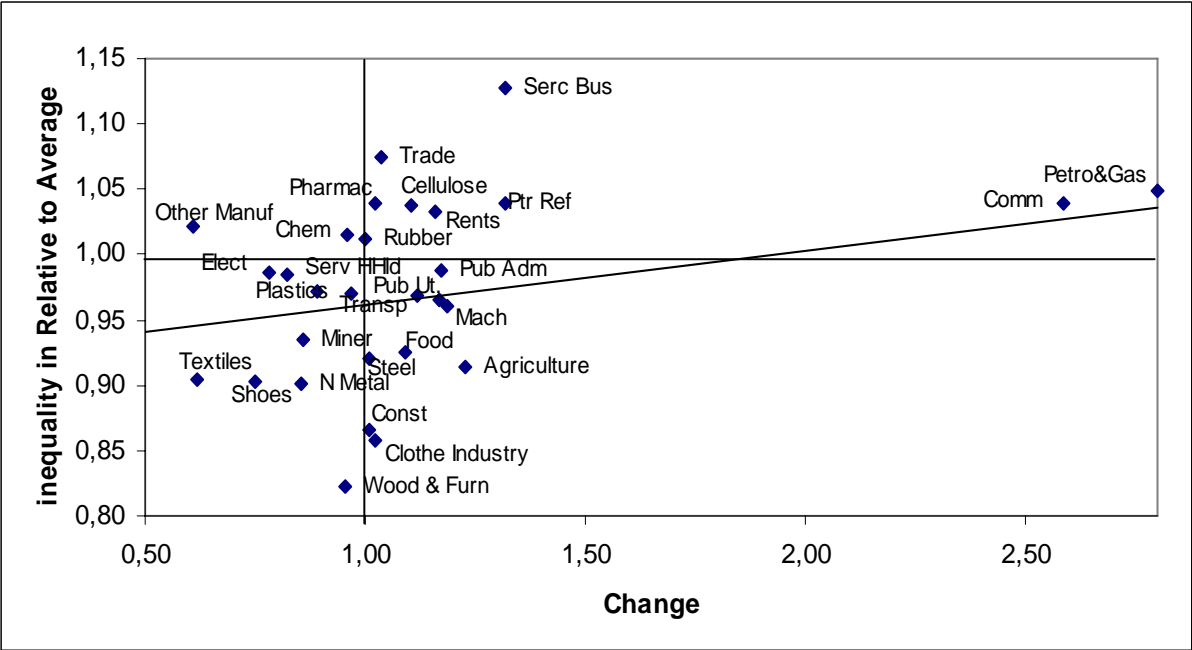
In order to check that aspect, the vector of sectoral shares in 1992 was introduced into the 2002 system and the two inequality levels were compared. As to the question above, the results provide a negative answer: the new Gini, considering the structural distribution of 1992, is 0.528, which is 2.61% larger than the observed 0.5146 Gini of 2002. That is, without the changes in sector shares, inequality would be even worse in 2002. It indicates that the sectors that gained share were the ones with better distributive profiles.

Figures 5 and 6 below offer additional information on this aspect. Their horizontal axes present the change in the sectoral shares from 1992 and 2002. Sectors that augmented their shares present numbers larger than 1, which indicates no change in share. Sectors that have lost importance, present values lower than 1 in those axes. The vertical axes indicate the inequality level within the sector (Figure 5) and generated by the sector (Figure 6). As the first figure indicates, sectors that increased their shares were, in general, those who presented lower-than-average internal inequality in 2002. Thus, this movement contributed to reduce income inequality in the country, since the sectors that were gaining importance were more equitable than the average. However, when de indirect and induced effects were considered (Figure 6), it is clear that this pattern vanishes. That is, although the fast-growing sectors were more equitable themselves, their connection patter to other sectors produced a final unequal outcome. Their growth probably stimulated sectors whose inequality pattern are above average.

**Figure 5: Structural Change and Income Inequality – Direct Effects**



**Figure 6: Structural Change and income Inequality – Global Effects**



#### **4.2.2. Changes in the distributive pattern within each sector**

The above situation portrayed a case in which each sector maintained the pattern of wage distribution to the 10 income classes, but the importance of the sectors have changed. In this simulation we keep the shares constant, and simulate changes in the distribution pattern of wages to different income classes.

Table 3 presents the results of the shocks. Column A shows the national Gini resulting from an R\$ 1 million shock in each sector, given the way they distributed income in 2002; column B presents the same result, except that with the income distribution pattern of 1992 in each sector; column C presents the changes. Figure 7 presents the results in a more meaningful way. The horizontal axis presents inequality in 2002, with the wage distribution of 1992, while the vertical axis presents the same, only with the wage distribution observed in 2002.

The simulations intend to highlight some of the important changes occurring during the period. As the numbers in Table 4 indicate, changes were observed internally to each sector in the way its wage bill is allocated across income classes. In order to measure the impact of that, the same wage distribution observed in 1992 was introduced into the 2002 system. The results of this simulation indicate what the income distribution would be if no change had happened within the sectors. If the results indicate a smaller simulated global Gini, we can conclude that this sector had a negative distributive impact.

Results are presented in Table 3. In columns A and B the numbers indicate the global (national) Gini index resulting from a shock in each sector at a time. In column A the observed situation in 2002 is portrayed; column B shows what the global distribution would be if each sectors distributed their 2002 wage bill as they did in 1992. Column C presents the changes.

**Table 3 – National Gini resulting from a R\$ 1 million increase in each sector**

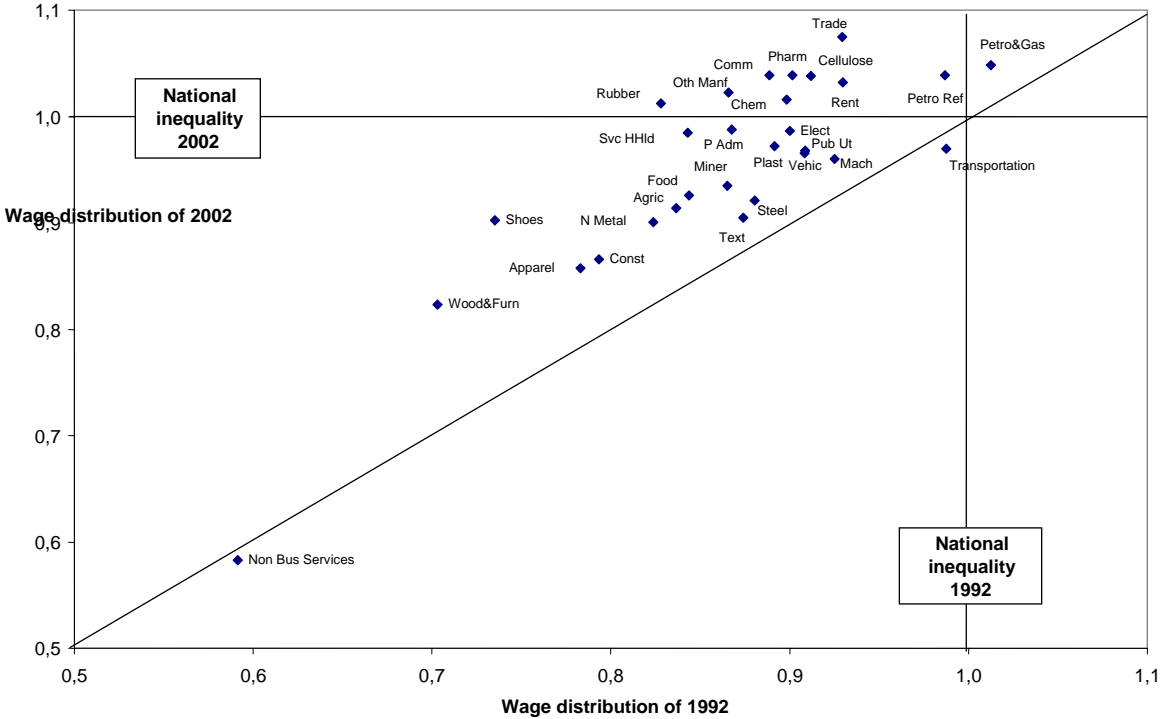
Sector	2002 wage distribution (A)	1992 wage distribution (B)	Change (C)
Agriculture	0,4703	0,4417	-6,09%
Mineral extraction (except fuel)	0,4810	0,4568	-5,03%
Petrol and gas	0,5393	0,5347	-0,86%
Non-metallic minerals	0,4633	0,4350	-6,12%
Steel and Non-ferrous metallurgy	0,4738	0,4649	-1,87%
Machinery and equipment	0,4940	0,4884	-1,14%
Electric material and electronic equipment	0,5077	0,4753	-6,39%
All types of vehicles	0,4968	0,4796	-3,45%
Wood and furniture	0,4235	0,3712	-12,36%
Cellulose, paper and printing	0,5342	0,4815	-9,87%
Rubber	0,5210	0,4372	-16,10%
Chemical	0,5227	0,4743	-9,26%
Petrol refining	0,5346	0,5211	-2,52%
Pharmaceutical and veterinary	0,5344	0,4759	-10,94%
Plastics	0,5002	0,4708	-5,88%
Textiles	0,4656	0,4615	-0,87%
Apparel	0,4413	0,4135	-6,30%
Shoes	0,4644	0,3882	-16,40%
General food	0,4763	0,4454	-6,47%
Other manufacturing	0,5260	0,4571	-13,09%
Public utility services	0,4981	0,4798	-3,67%
Construction	0,4455	0,4189	-5,98%
Trade	0,5530	0,4907	-11,27%
Transportation	0,4991	0,5215	4,49%
Communication	0,5344	0,4693	-12,18%
Financial institutions	0,5702	0,5435	-4,70%
Services to households	0,5068	0,4452	-12,16%
Services to business	0,5803	0,5286	-8,91%
Building Rent	0,5312	0,4909	-7,59%
Public administration	0,5081	0,4581	-9,85%
Non-business private services	0,3000	0,3122	4,06%

If the number in column A for a specific sector is smaller than 0.5145, which is the national Gini for 2002, the shock will contribute to improve income distribution; if it is higher, it will produce further income concentration. Results for 2002 alone are displayed in Figure 4, which shows that 7 sectors produce an inequality profile that is worse than the average profile, thus contributing to worsening income distribution: Rubber, Shoes, Other Manufacturing, Agriculture, Trade, Cellulose Paper and Printing, and Chemicals. The sector Wood and Furniture produces an inequality patten exactly equal to the national average. All other sectors produce improvements in income distribution, and the ones that do it more



intensively are Public Administration, Plastics, Public Utility Services, Communication, Financial Institutions, Transportation, Mineral Extraction, and Services to Households.

**Figure 7: National Inequality due to Shocking each sector**



**5. Conclusions**

This study deals with the impacts of structural changes on income distribution in Brazil in the period 1992-2002. A Pure Leontief Model and a Leontief-Miazawa Model were utilized to portray the structure of the economy in both years, and to perform counterfactual simulations on some important changes occurring during the period.

The methodology allowed for the identification of the high and low inequality sectors in both years, and to their contribution to the increasing inequality during the period. It is interesting to notice that some sectors with low internal inequality ended-up provoking increased global inequality through their interaction pattern with other sectors in the economy, and through the consumption structure.

The results also indicate that the change in sectoral shares in the period contributed to diminishing inequality. Therefore, the causes for increasing inequality remains within the distribution of wages within the sectors.

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