# THE EVOLUTION OF INCOME DISTRIBUTION IN BRAZIL: DIFFERENT CHARACTERISTICS OF THE AGRICULTURAL SECTOR

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## ABSTRACT

This paper analyzes the characteristics and the evolution of income distribution in the Brazilian agricultural sector considering two dimensions: the per capita household income and the income of occupied persons. The main data source is the National Household Sample Survey (PNAD). The per capita household income was divided into nine components (for Brazil and considering only the agricultural households) to evaluate their contributions to the decrease in inequality. In the second part, the paper analyzes the characteristics of occupied persons and the determining factors of their income, comparing the agricultural and non-agricultural sectors. The estimated effects were analyzed over the period 1992-2009, adjusting one earnings equation for each year. In both cases (per capita household income and earnings of occupied persons), the agricultural sector showed markedly different behavior compared to the non-agricultural sector.

**Key words:** Per capita household income; occupied persons; agricultural; non-agricultural.

**JEL:** D31, J31, J43.

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## 1. INTRODUCTION

In the recent period, the Brazilian economy showed important social changes. Even though it is still one of the most unequal economies of the world, an important decrease in inequality and extreme poverty is observed from 2001 on. Barros et al. (2006 and 2007a) present several studies that highlight this fact and show which are the main causes and determinants of this recent decline in poverty and inequality.

Among the determinants, the increase in transfers (pensions[1] and cash transfers programs such as *Bolsa Família*) as a share of household income showed a significant contribution to the decrease in inequality. Besides transfers, changes in the labor market were also important, such as the increase in the mean income of occupied persons, the reduction of the income differentials associated with different levels of schooling, the decrease in inequality between geographical regions, the expansion of the formal sector in the labor market, the systematic growth of the real minimum wage, etc.

Considering the recent decline in inequality in Brazil, the paper analyzes more accurately the determinants of the decline, comparing the agricultural and non-agricultural sectors. The agricultural sector is very heterogeneous, with strong differences between geographic locations and particular characteristics of the production process. Additionally, the changes in this sector occur more slowly, as illustrated by the fact that the level of schooling of persons occupied in agriculture is still far below the national average.

Thus, the paper analyzes the evolution of the income distribution in the agricultural sector in two dimensions: the evolution of the composition of the household income and occupied persons earnings, comparing the agricultural sector with Brazil's total economy or with the non-agricultural sector. As the income from work (earnings) is still the main share of household income, it will be examined in more detail.

The paper is organized as follows: the next section shows the recent changes in the household income distribution; the third section analyses the evolution of earnings,

[1]It is noteworthy that overall official pensions are a regressive component of the total household income, and contributed to increase inequality from 2001 to 2007, according to Hoffmann (2009). However, Hoffmann (2010) found that pensions paid by the Official Social Security (INSS in the acronym in Portuguese) for the private sector workers are a progressive component of the household income.

schooling and other characteristics of persons occupied in the agricultural and the non-agricultural sectors; in the fourth section earnings equations are adjusted for each year (in the period 1992-2009), in order to analyze the evolution of the effects of several factors on earnings; the corresponding methodology is described in each section; a short fifth section shows the changes in inequality between regions and between Federal Units; the last section presents the conclusions.

## 2. CHANGES IN THE PER CAPITA HOUSEHOLD INCOME DISTRIBUTION

The paper uses data from the National Household Sample Survey (PNAD) to analyze the evolution of the per capita household income distribution in Brazil in the last decades. In this section, the analysis is limited to the period 1995-2009, considering that extremely high inflation rates, which make it difficult to analyze the evolution of real mean income, do not occur from 1995 on, and that the 2009 PNAD is the last one available.

The per capita household income is defined as the ratio between the household income (that is, the sum of all incomes received from all sources by the persons in the household) and the number of persons in the household, excluding persons that are boarders in the house, domestic employees and their relatives residing in the employers' house.

All the monetary values are expressed in Reais (R$ - Brazilian currency) of September-October 2009. All the values prior to the 2009 PNAD were updated using the geometric mean of the National Index of Prices (INPC) in September and October in each year.

It is known that in such a survey the respondent tends to understate his income[2] (the data is collected through a self-declaration questionnaire). The degree of understatement varies according to the type of income: it is smaller for formal payments (paid by the government) and for regular payments, and larger for informal and or irregular receipts.

[2] See, for example, Hoffmann (1988).

The rural areas of the states of Rondônia, Acre, Amazonas, Roraima, Pará and Amapá (the former Northern region) were excluded from the sample, as they were not covered by PNAD before 2004. Thus, in this paper "Brazil" shall be understood as "Brazil, excluding the rural area of the former Northern region."

Table 1 shows the evolution of the main characteristics of the per capita household income distribution in Brazil from 1995 to 2009. Table 2 shows the same indicators, considering only households in which the reference person's main activity is in the agricultural[3] sector (agricultural households).

It should be noted that the "agricultural households" subsample excludes not only the households in which the reference person's main occupation is non-agricultural, but also the households in which the reference person is not occupied.

There is a huge difference between the per capita household income of the households classified as "agricultural" in comparison with all households. In 2009, the average per capita household income of Brazil was 91% higher than the average of the agricultural households. Moreover, half of the agricultural households showed a per capita household income under R$204.0 per month (i.e., less than one half of the minimum wage - R$465.0 in September-October 2009). The comparison between the average and the median of per capita household income shows that despite the reduction in inequality, the distribution is still strongly asymmetric.

According to all the indicators, there is a tendency to reduce inequality, especially from 2001 on. The same can be observed, in Table 2, considering only the agricultural households.

[3]Only permanent private households (variable V0201 = 1) were considered. The household is considered "agricultural" if the reference person's main job is in the agricultural sector- variable V4709 = 1 (until the 2001 PNAD) or variable V4809 = 1 (from 2002 on). All estimates were computed using the weights or sample expansion factors available in the data files.

**Table 1.** Per capita household income distribution in Brazil[(1)], from 1995 to 2009: average, median and inequality measures.

| Year | Average[(2)] | Median[(2)] | Inequality measures | | | | % of income appropriated by | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gini (*G*) | Mehran (*M*) | Piesch (*P*) | Theil (*T*) | Poorest 50% | Richest 10% | Richest 5% | Richest 1% |
| 1995 | 520.9 | 254.5 | 0.599 | 0.730 | 0.533 | 0.727 | 12.5 | 47.7 | 34.0 | 13.7 |
| 1996 | 530.0 | 260.3 | 0.600 | 0.735 | 0.533 | 0.726 | 12.2 | 47.3 | 33.6 | 13.4 |
| 1997 | 529.1 | 260.4 | 0.600 | 0.734 | 0.533 | 0.731 | 12.2 | 47.5 | 33.8 | 13.6 |
| 1998 | 534.8 | 268.4 | 0.598 | 0.730 | 0.532 | 0.728 | 12.4 | 47.6 | 34.0 | 13.8 |
| 1999 | 504.5 | 257.7 | 0.592 | 0.724 | 0.526 | 0.706 | 12.8 | 47.1 | 33.4 | 13.1 |
| 2001 | 511.8 | 258.4 | 0.594 | 0.726 | 0.528 | 0.720 | 12.7 | 47.2 | 33.8 | 13.8 |
| 2002 | 512.3 | 262.5 | 0.587 | 0.718 | 0.522 | 0.705 | 13.1 | 46.8 | 33.5 | 13.4 |
| 2003 | 482.1 | 254.8 | 0.581 | 0.713 | 0.515 | 0.680 | 13.3 | 46.0 | 32.7 | 13.0 |
| 2004 | 498.1 | 269.3 | 0.569 | 0.700 | 0.503 | 0.656 | 14.0 | 45.0 | 31.9 | 12.8 |
| 2005 | 528.5 | 289.1 | 0.566 | 0.697 | 0.501 | 0.651 | 14.2 | 45.0 | 32.0 | 12.9 |
| 2006 | 577.9 | 321.4 | 0.560 | 0.690 | 0.495 | 0.635 | 14.6 | 44.5 | 31.6 | 12.6 |
| 2007 | 592.4 | 336.9 | 0.552 | 0.684 | 0.486 | 0.614 | 14.9 | 43.6 | 30.8 | 12.3 |
| 2008 | 620.7 | 365.1 | 0.543 | 0.674 | 0.477 | 0.594 | 15.5 | 42.8 | 30.2 | 12.0 |
| 2009 | 637.7 | 380.0 | 0.539 | 0.670 | 0.473 | 0.589 | 15.7 | 42.5 | 30.0 | 12.0 |
| Δ% 95-03 | –7.4 | 0.1 | –3.0 | –2.3 | –3.4 | –6.5 | 6.4 | –3.6 | –3.8 | –5.1 |
| Δ% 03-09 | 32.3 | 49.1 | –7.2 | –6.0 | –8.2 | –13.4 | 18 | –7.6 | –8.3 | –7.7 |

Source: National Household Sample Survey (PNAD)
(1) Excluding the rural area of the former Northern region.
(2) In Reais (Brazilian Currency - R$) of September-October 2009.

According to Tables 1 and 2, it can be observed that despite the decline in inequality in both cases, the income share appropriated by the poorest 50% increased less in the case of the agricultural households in the period 1995-2003 and also in the period 2003-2009. Thus, the decrease in inequality among the agricultural households occurred mainly through changes in the higher tail of the distribution or among the richest 50%.

**Table 2.** Per capita household income distribution in Brazil[(1)], from 1995 to 2009, considering only agricultural households: average, median and inequality measures.

| Year | Average[(2)] | Median[(2)] | Inequality measures | | | | % of income appropriated by | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gini (*G*) | Mehran (*M*) | Piesch (*P*) | Theil (*T*) | Poorest 50% | Richest 10% | Richest 5% | Richest 1% |
| 1995 | 224.4 | 118.8 | 0.582 | 0.702 | 0.522 | 0.779 | 14.1 | 47.9 | 36.5 | 17.4 |
| 1996 | 224.6 | 115.1 | 0.590 | 0.713 | 0.529 | 0.811 | 13.5 | 48.1 | 36.6 | 18.0 |
| 1997 | 222.5 | 114.7 | 0.588 | 0.709 | 0.527 | 0.789 | 13.7 | 48.2 | 36.4 | 17.3 |
| 1998 | 221.3 | 119.3 | 0.571 | 0.693 | 0.510 | 0.742 | 14.4 | 46.5 | 34.9 | 16.9 |
| 1999 | 216.6 | 118.7 | 0.558 | 0.682 | 0.496 | 0.676 | 15.1 | 45.2 | 33.5 | 15.1 |
| 2001 | 231.4 | 122.9 | 0.577 | 0.701 | 0.515 | 0.744 | 14.0 | 46.6 | 35.0 | 16.7 |
| 2002 | 239.9 | 129.7 | 0.567 | 0.689 | 0.506 | 0.737 | 14.7 | 46.0 | 34.5 | 17.0 |
| 2003 | 240.5 | 129.8 | 0.569 | 0.693 | 0.507 | 0.729 | 14.4 | 45.8 | 34.1 | 16.7 |
| 2004 | 251.9 | 139.4 | 0.559 | 0.684 | 0.497 | 0.696 | 14.9 | 45.0 | 33.2 | 15.7 |
| 2005 | 266.1 | 148.0 | 0.559 | 0.682 | 0.497 | 0.718 | 15.1 | 45.1 | 33.7 | 16.5 |
| 2006 | 296.1 | 170.5 | 0.551 | 0.679 | 0.488 | 0.677 | 15.2 | 43.8 | 32.4 | 15.7 |
| 2007 | 301.8 | 174.4 | 0.541 | 0.675 | 0.475 | 0.602 | 15.4 | 42.1 | 30.0 | 12.8 |
| 2008 | 330.3 | 195.4 | 0.540 | 0.670 | 0.476 | 0.646 | 15.7 | 42.5 | 31.2 | 14.9 |
| 2009 | 333.6 | 204.0 | 0.526 | 0.661 | 0.459 | 0.579 | 16.0 | 40.4 | 28.8 | 13.0 |
| Δ% 95-03 | 7.2 | 9.3 | –2.2 | –1.3 | –2.9 | –6.4 | 2.1 | –4.4 | –6.6 | –4.0 |
| Δ% 03-09 | 38.7 | 57.2 | –7.6 | –4.6 | –9.5 | –20.6 | 11.1 | –11.8 | –15.5 | –22.2 |

Source: National Household Sample Survey (PNAD)
(1) Excluding the rural area of the former Northern region.
(2) In Reais (Brazilian Currency - R$) of September-October of 2009.

Figure 1 illustrates the evolution of the average per capita household income and of the Gini index for total Brazil and considering only agricultural households. It should be noted that from 1995 to 2003 the overall average decreases but the average of the agricultural households increases. This movement is certainly related to the modernization and increase of productivity in Brazilian agriculture.

Figure 1 shows the well-known process of systematic decline in inequality in the distribution of the per capita household income in Brazil from 2001 on, with a decrease of the Gini index from 0.594 to 0.539. Considering the period 1995-2009, the reduction in the Gini index is slightly higher, because its value is 0.599 in 1995. For the agricultural households, the changes in the Gini index are more irregular (partly due to the smaller sample) and, additionally, the reduction in inequality only becomes systematic from 2003 on. It can be noted that from this year on, in Figure 1 the lines representing the changes in

the Gini index of both distributions fall almost in parallel. However, as will be seen below, the factors associated with this reduction are not the same.

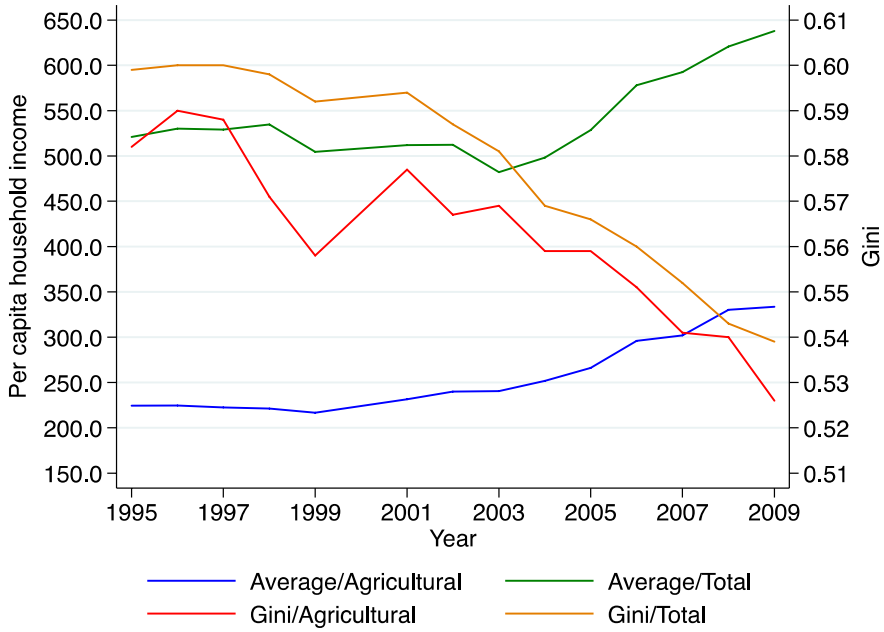


**Figure 1.** Average and Gini index of per capita household income, Brazil and only agricultural households, from 1995 to 2009

To analyze the factors associated with the changes in the Gini index, a method of decomposition of this index briefly described below will be used. If the per capita household income of the *i*-th person ( $x_i$ ) has *k* components ( $x_{hi}$ , with $h = 1,...,k$ ), so that

$$x_i = \sum_{h=1}^{k} x_{hi} \quad \text{for every } i, \tag{1}$$

it can be deduced that the Gini index is equal to a weighted average of the concentration ratios of each component:

$$G = \sum_{h=1}^{k} \varphi_h C_h \tag{2}$$

with $\varphi_h$ indicating the share of the *h*-th component in total income and $C_h$ indicating the respective concentration ratio.

Being $\mu$ the average of per capita household income and $\mu_h$ the average of $x_{hi}$ for the *n* persons of the population, the Gini index can be defined as

$$G = \frac{2}{n\mu}\operatorname{cov}(i, x_i) \tag{3}$$

and the concentration ratios are

$$C_h = \frac{2}{n\mu_h}\operatorname{cov}(i, x_{hi}) \tag{4}$$

Using subscripts 1 and 2 to indicate the values of $\varphi_h$, $C_h$ and $G$ in two different periods and defining

$$\varphi_h^* = \frac{1}{2}(\varphi_{1h} + \varphi_{2h}), \tag{5}$$

$$C_h^* = \frac{1}{2}(C_{1h} + C_{2h}) \tag{6}$$

and

$$G^* = \frac{1}{2}(G_1 + G_2), \tag{7}$$

the change in the Gini index $(\Delta G = G_2 - G_1)$ can be decomposed as follows:

$$\Delta G = \sum_{h=1}^{k}(C_h^* - G^*)\Delta\varphi_h + \sum_{h=1}^{k}\varphi_h^*\Delta C_h \tag{8}$$

In the second part of the expression (8), the first term is the sum of the composition-effects, associated with changes in $\varphi_h$, and the second term is the sum of the concentration-effects, due to changes in $C_h$.

The contribution of the *h*-th income component to the change in the Gini index is given by

$$(C_h^* - G^*)\Delta\varphi_h + \varphi_h^*\Delta C_h \qquad (9)$$

Thus it is possible to analyze the contributions of the different components of the per capita household income to the change in the Gini index in a given time period.

Here the per capita household income will be divided into nine components[4], described as follows:

1. CSM: earnings of civil servants and military personnel
2. EMP: earnings of other employees
3. SLF: earnings of self-employed workers
4. YER: earnings of employers
5. PE1: official pensions paid by the official social security (INSS) or by government overall
6. PE2: other pensions
7. DON: donations received from other households
8. RNT: rents
9. IBF: interest, shares, government transfers (such as those from the *Bolsa Família* program) and other incomes.

Table 3 shows the shares $(\varphi_h)$ of these nine components of the per capita household income in 1998 and 2009, the correspondent concentration ratios $(C_h)$ and the decomposition of the observed reduction in the Gini index (of the per capita household income) in Brazil in this period.

[4]Note that the components of the household income must be exhaustive and mutually exclusive.

**Table 3**. Decomposition of the change in the Gini index of the per capita household income distribution in Brazil between 1998 and 2009.

| Component | Share $(\varphi_h)\%$ | | Concentration Ratio $(C_h)$ | | Effects, in % of $\Delta G = -0.059$ | | |
|---|---|---|---|---|---|---|---|
| | 1998 | 2009 | 1998 | 2009 | Composition | Concentration | Total |
| 1. CSM | 9.90 | 11.30 | 0.734 | 0.746 | –4.1 | –2.1 | –6.2 |
| 2. EMP | 39.61 | 40.86 | 0.510 | 0.435 | 2.0 | 50.6 | 52.6 |
| 3. SLF | 17.57 | 13.37 | 0.509 | 0.473 | –5.5 | 9.4 | 3.9 |
| 4. YER | 12.25 | 10.65 | 0.862 | 0.836 | 7.6 | 4.9 | 12.5 |
| 5. PE1 | 15.47 | 18.81 | 0.595 | 0.564 | –0.6 | 8.9 | 8.3 |
| 6. PE2 | 1.24 | 1.32 | 0.641 | 0.493 | 0.0 | 3.2 | 3.2 |
| 7. DON | 0.89 | 0.44 | 0.413 | 0.391 | –0.7 | 0.2 | –0.5 |
| 8. RNT | 2.40 | 1.56 | 0.803 | 0.774 | 3.1 | 1.0 | 4.1 |
| 9. IBF | 0.87 | 1.69 | 0.764 | −0.105 | 3.3 | 18.7 | 22.1 |
| Total | 100.0 | 100.0 | 0.598 | 0.539 | 5.2 | 94.8 | 100.0 |

Over 50% of the decrease in the Gini index is associated with changes in earnings of the private sector employees and more than 20% is due to changes in the IBF component. The small share of this last component almost doubled (an increase of 94%) and the respective concentration rate declined strongly (from 0.764 to –0.105). This can be explained by the large expansion of government transfers, especially the *Bolsa Familia*[5] program.

Official pensions (PE1) contributed substantially to the decrease in inequality from 1998 to 2009 as well. It can be verified that this effect is associated with the growth in the real value of the minimum wage (MW). The PE1 income was split into two ranges, creating a subcomponent with pensions near or below the MW (below the rounded integer value closest to 1.095 times the MW), and it was verified that the share of these poorer pensions in per capita household income increased from 3.37% in 1998 to 6.08% in 2009, and at the same time its concentration ratio increased from 0.028 to 0.163. The overall effect of this clearly progressive subcomponent explains 10.9% of $\Delta G = -0.059$.

[5] There are many studies showing this relation. They disaggregate the IBF component, separating transfers from other incomes included in this component: Soares *et al.* (2006), Barros *et al.* (2007c) and Hoffmann (2007).

The other PE1 subcomponent is regressive ( $C_h = 0.756$ in 2009) and contributed to increase the inequality (total effect equal to –2.6% of $\Delta G$).

Table 4 shows the same information as Table 3 but considering a more recent period: 2003-2009. The major contributions to reduce inequality are still associated with the components EMP and IBF. Note the stronger effect of PE1 and also the negative effect (a contribution to inequality increase) of military and civil servants' wages[6].

**Table 4.** Decomposition of the change in the Gini index of the per capita household income distribution in Brazil between 2003 and 2009

| Component | Share $(\varphi_h)$% | | Concentration Ratio $(C_h)$ | | Effects, in % of $\Delta G = -0.042$ | | |
|---|---|---|---|---|---|---|---|
| | 2003 | 2009 | 2003 | 2009 | Composition | Concentration | Total |
| 1. CSM | 10.03 | 11.30 | 0.734 | 0.746 | –5.4 | –3.1 | –8.5 |
| 2. EMP | 39.15 | 40.86 | 0.484 | 0.435 | 4.1 | 47.0 | 51.1 |
| 3. SLF | 15.83 | 13.37 | 0.504 | 0.473 | –4.2 | 10.7 | 6.5 |
| 4.YER | 11.66 | 10.65 | 0.860 | 0.836 | 7.0 | 6.3 | 13.2 |
| 5. PE1 | 18.48 | 18.81 | 0.594 | 0.564 | 0.1 | 13.1 | 12.9 |
| 6. PE2 | 1.35 | 1.32 | 0.570 | 0.493 | 0.0 | 2.5 | 2.4 |
| 7. DON | 0.71 | 0.44 | 0.403 | 0.391 | –1.0 | 0.2 | –0.9 |
| 8. RNT | 1.74 | 1.56 | 0.801 | 0.774 | 1.0 | 1.1 | 2.0 |
| 9. IBF | 1.05 | 1.69 | 0.337 | –0.105 | 6.8 | 14.5 | 21.2 |
| Total | 100.0 | 100.0 | 0.581 | 0.539 | 8.0 | 92.0 | 100.0 |

As shown in Figure 1, in the period from 2003 to 2009 the Gini index of the per capita household income distribution in Brazil and the corresponding Gini index considering only agricultural households fell almost in parallel, showing a very similar evolution. However, the components of these reductions of the Gini index are quite different, as can be seen by comparing Tables 4 and 5.

Many differences are simply due to the fact that the agricultural households are relatively poor, as shown by the lines of the average per capita household income in Figure 1. Thus, the IBF component (which includes income from the *Bolsa Família* program) is much more important in the case of agricultural households and its

[6] For a detailed analysis of the influence of the public servants' earnings on the per capita household income distribution in Brazil from 1995 to 2009, see Daré (2011).

contribution to the decline of the Gini index between 2003 and 2009 exceeds 46% (Table 5).

The contribution of the EMP component, 51.1% according to Table 4, falls to only 9.9% in Table 5 when considering only the agricultural households. Partially, this is due to the fact that the minimum wage, which functions in general as a "lighthouse" for the lower wages, has no such effect for the informal[7] employees in the Brazilian agricultural sector, as shown in Oliveira (2010) and Oliveira and Hoffmann (2011).

**Table 5.** Decomposition of the change in the Gini index of the per capita household income distribution for agricultural households, in Brazil, between 2003 and 2009

| Component | Share $(\varphi_h)$% | | Concentration Ratio $(C_h)$ | | Effects, in % of $\Delta G = -0.043$ | | |
|---|---|---|---|---|---|---|---|
| | 2003 | 2009 | 2003 | 2009 | Composition | Concentration | Total |
| 1. CSM | 2.58 | 3.04 | 0.727 | 0.671 | –1.6 | 3.7 | 2.1 |
| 2. EMP | 27.52 | 31.53 | 0.361 | 0.372 | 17.0 | –7.1 | 9.9 |
| 3. SLF | 26.78 | 23.39 | 0.508 | 0.538 | –2.0 | –17.9 | –19.9 |
| 4. YER | 18.84 | 13.29 | 0.935 | 0.920 | 49.3 | 5.8 | 55.1 |
| 5. PE1 | 19.98 | 21.71 | 0.608 | 0.589 | –2.1 | 9.4 | 7.4 |
| 6. PE2 | 0.43 | 0.64 | 0.537 | 0.501 | 0.1 | 0.4 | 0.6 |
| 7. DON | 0.45 | 0.29 | 0.297 | 0.232 | –1.1 | 0.6 | –0.5 |
| 8. RNT | 1.29 | 1.42 | 0.877 | 0.878 | –1.0 | 0.0 | –1.0 |
| 9. IBF | 2.12 | 4.69 | 0.105 | –0.073 | 32.0 | 14.3 | 46.3 |
| Total | 100.0 | 100.0 | 0.569 | 0.526 | 90.8 | 9.2 | 100.0 |

Table 5 indicates that the YER component (earnings of employers) contributed to more than 50% of the decrease in the Gini index between 2003 and 2009. This is essentially a composition effect due to the substantial reduction of the participation (from 18.8% to 13.3%) of a strongly regressive component of the per capita household income. An important part of this reduction may be associated with changes in the legal structure of production units, which have allowed transforming employers' earnings into executive salaries (which also helps to explain the growth of the concentration ratio of the EMP component).

[7]According to Oliveira and Hoffmann (in press), the informal employees represented, in 2009, 64.1% of all agricultural employees.

## 3. OCCUPIED PERSONS EARNINGS

The distinction between agricultural and non-agricultural sectors becomes clearer when considering only occupied persons. Thus, this section analyzes the distribution of earnings (including all jobs of each occupied person and excluding unpaid workers). In the data files used, only persons that are 10 or more years old are classified as occupied or not. As it is intended to use subsequently the same sample to estimate earnings equations, in this section the observations that do not contain information about any of the variables included in those equations are excluded.

Therefore, are excluded from the sample persons with no declaration of age, schooling, earnings, color, working hours per week or those classified as "worker in production for own consumption", "worker in construction for own use" or "unpaid workers". Equally excluded are the persons whose color is declared as "indigenous" (due to the very small number in the sample) and those whose working hours (in all jobs) are either less than 15 or above 98 hours per week.

It is important to bear in mind that the "labor income" (or earnings), as defined in the survey, includes the salary of employees but in the case of employers and self-employed it includes "monthly withdrawals" from their businesses. Obviously, in the case of a farmer, for instance, the "earnings" can include profits and land rent. Thus, these earnings should not be confused with wages or with the classic-Marxist concept of labor income. It would be better to call it "income from activity" performed by the person, but it was preferred to keep the terminology already established by the Brazilian research Institute (IBGE).

In the 2009 PNAD it is found that, for the data previously delimited, about 21% of occupied persons are self-employed and almost 5% are employers. Thus, less than ¾ of the occupied persons are employees. In the agricultural sector more than 41% of occupied persons with positive earnings are self-employed.

Figure 2 shows the evolution of the mean and of the Gini index of the distribution of earnings, considering all occupied persons in Brazil, in the agricultural sector and in the non-agricultural sector. It can be observed that for the total economy and for the non-agricultural sector the mean decreases from 1996 to 2004 and then rises systematically

until 2009. In Figure 1 the decline in the average per capita household income from 1996 to 2004 is less intense and the growth from 2004 on is stronger due to the systematic reduction of the number of members per household, which falls from 3.87 in 1995 to 3.25 in 2009.

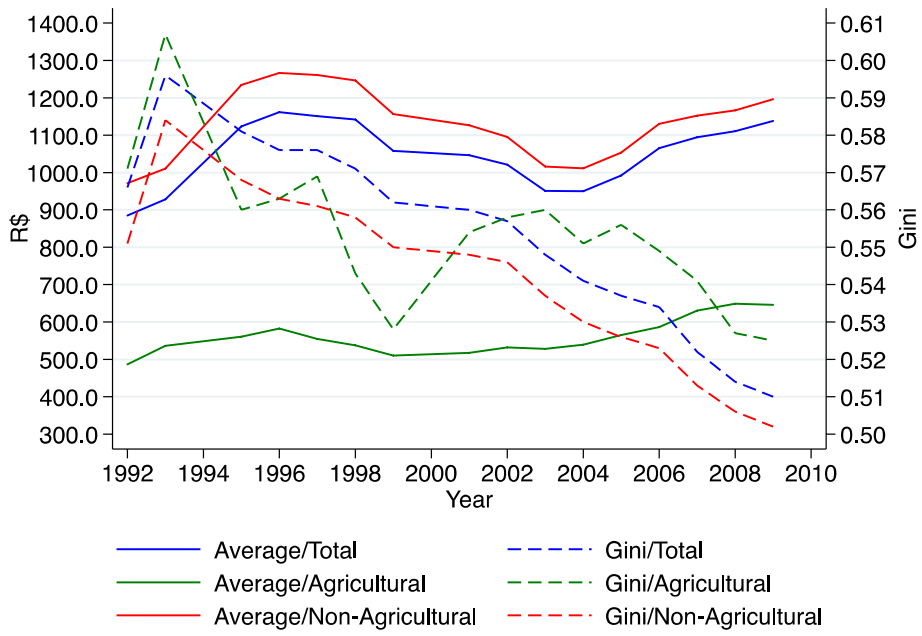


**Figure 2.** Average and Gini index of the earnings distribution in Brazil, from 1992 to 2009: total, agricultural sector and non-agricultural sector**.**

Both the average earnings and the Gini index have very similar trajectories for Brazil and for the non-agricultural sector, but the trajectories are different for the agricultural sector (Figure 2). In the 1999-2004 period the average falls in the non-agricultural sector but increases in the agricultural sector, a fact related to the end of the exchange-rate anchor in 1999 (with a devaluation of Brazilian currency), favoring exports of agricultural products.

The Gini index for the total and for the non-agricultural sector decreased systematically from 1993 to 2009, but the behavior of the Gini index is more irregular in the agricultural sector, with a less intense declining trend.

Figure 3 shows that the occupied persons' mean age tends to grow and is always higher in the agricultural sector. The data presented are consistent with the well-known

trend of the population's aging. The younger generations in the agricultural sector look for non-agricultural occupations, expecting better wages and living conditions. Thus, the average age of occupied persons in agriculture is greater than the average of Brazil and of the non-agricultural sector.

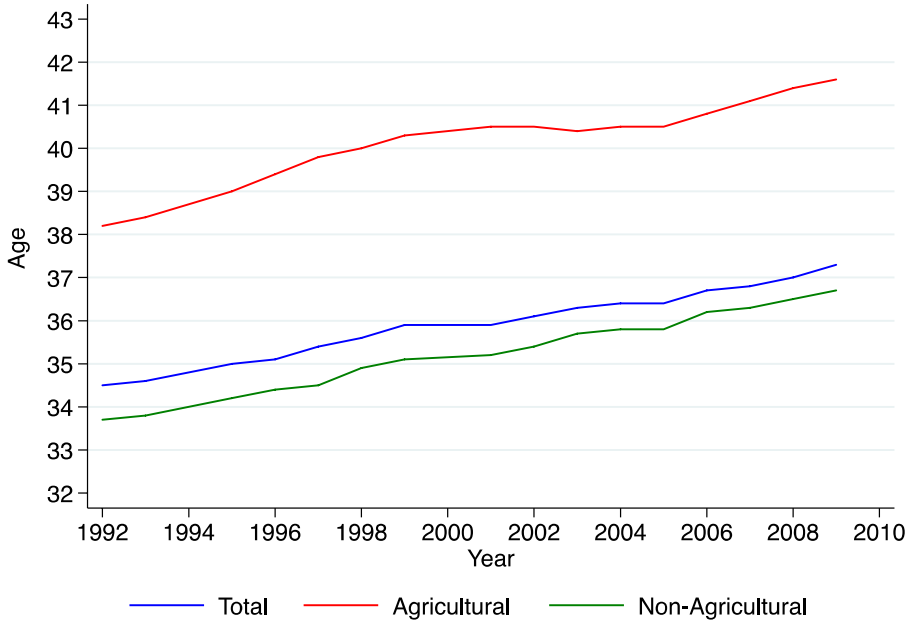


**Figure 3.** Growth of the mean age of occupied persons with positive earnings in Brazil, from 1992 to 2009: total, agricultural sector and non-agricultural sector.

Figure 4 shows that the average of weekly working hours tends to decrease, and is always higher in the agricultural sector. The line for the number of hours worked in the agricultural sector is steeper, indicating a sharper decline rate. These results are consistent with IPEA (2009), showing a reduction in the average hours of work in Brazil. The study also shows that the agricultural sector stands out, with a drop of 26.3% in the average number of hours of work between 1988 and 2007[8].

[8]It should be mentioned that the 1988 National Constitution reduced the regular maximum of weekly working hours from 48 to 44 but the effect of this legal change was not immediately felt, especially in the agricultural sector. Moreover, there was an intense process of modernization in the agriculture sector in Brazil throughout the entire country (obviously with regional differences), increasing productivity and reducing the amount of labor demanded. These two facts are related to the decrease in the weekly hours of work in the agricultural sector.

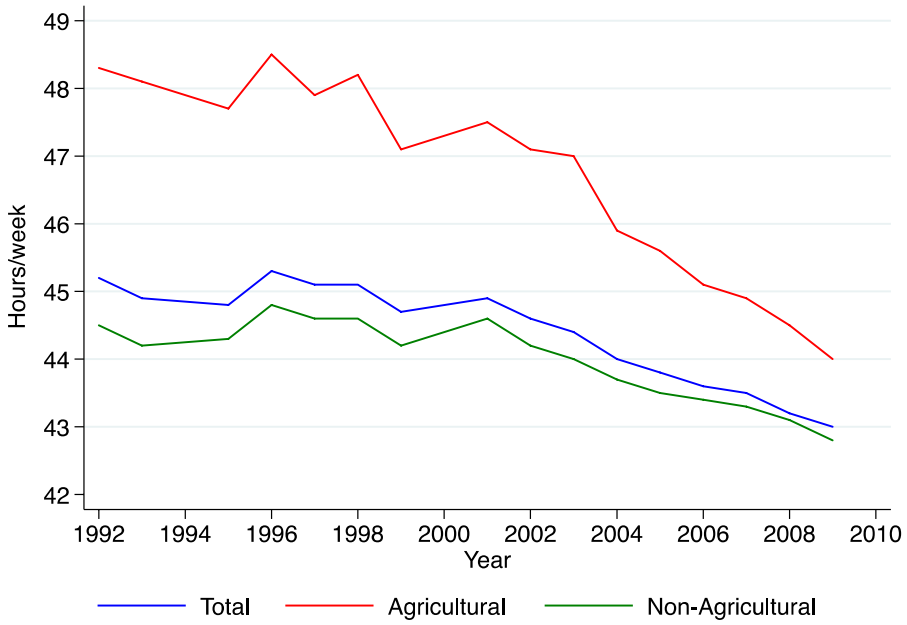


**Figure 4.** Evolution of the average weekly working hours of occupied persons with positive earnings in Brazil, from 1992 to 2009: total, agricultural and non-agricultural sectors.

In Figure 5 and Table 6 it is observed that mean schooling is much higher in the non-agricultural sector than in the agricultural sector (9.3 and 4.1 years, respectively, in 2009). In both cases there is a systematic growth[9], but not with the same intensity. The ratio between the average schooling of non-agricultural and agricultural occupied persons falls from 2.9 in 1992-1995 to 2.3 in 2008-2009.

[9]Schooling is defined by the most advanced degree achieved by the person, with 0 (zero) meaning "no schooling or less than one year". For the category "15 years or more" (variable V4703 or V4803 of PNAD) was attributed the value 17.

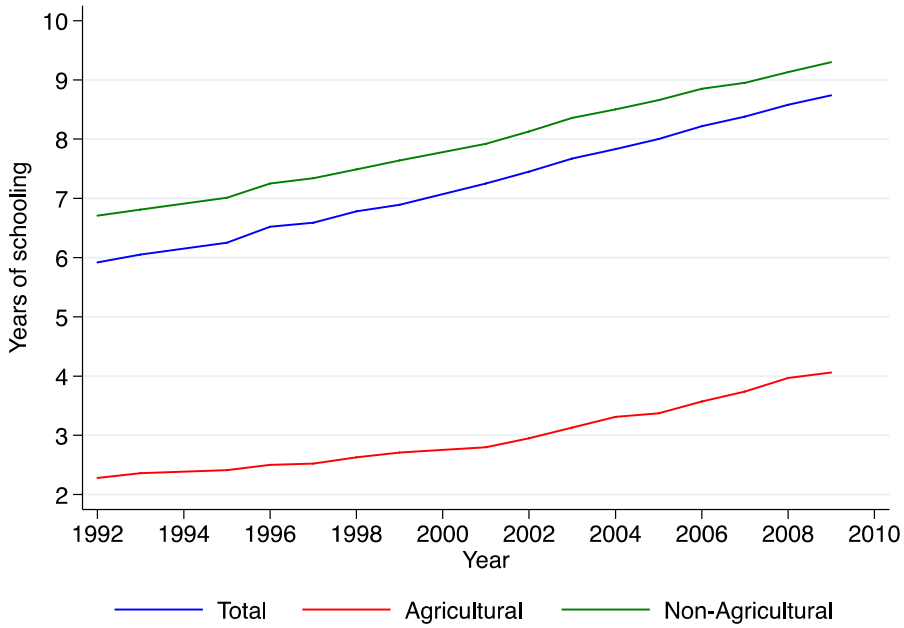


**Figure 5.** Growth of average schooling of occupied persons with positive earnings in Brazil, from 1992 to 2009: total, agricultural sector and non-agricultural sector.

Besides the average schooling, Table 6 shows the value of the mean absolute difference, which is a measure of the dispersion of the distribution (such as the standard deviation, $\sigma$). It is important to distinguish the concepts of dispersion and inequality of a distribution. Note that there are inequality measures, such as the Gini index ($G$) and the coefficient of variation ($C$), which are measures of relative dispersion, since

$$G = \frac{\Delta}{2\mu} \qquad \text{and} \qquad C = \frac{\sigma}{\mu} \tag{10}$$

with $\mu$ indicating the mean of the distribution.

In Figure 6 it is observed that the inequality of the distribution of occupied persons' schooling shows a declining trend both in the agricultural sector and in the non-agricultural sector. However, Figure 7 shows that the dispersion of schooling tends to increase in the agricultural sector and in the non-agricultural sector it tends to decrease from 1998 on.

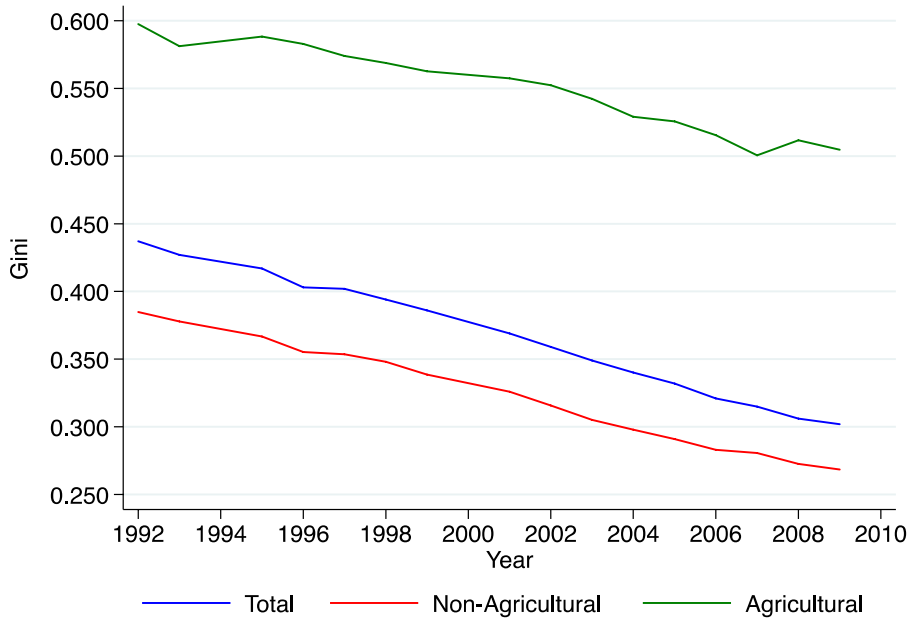


**Figure 6.** The decreasing trend of the Gini index of occupied persons' schooling distribution in Brazil, from 1992 to 2009: total, agricultural sector and non-agricultural sector.

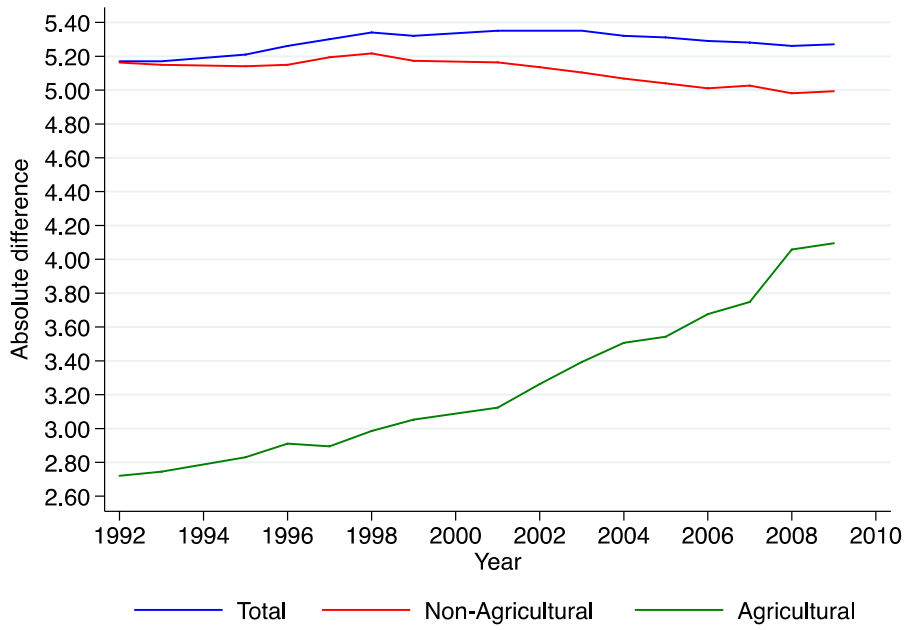


**Figure 7.** Variation of the mean absolute difference of occupied persons' schooling in Brazil, from 1992 to 2009: total, agricultural sector and non-agricultural sector.

Figure 8 presents the relation between the mean absolute difference (Δ) and the mean schooling in Brazil, based on the values of the two first columns of Table 6. The shape of the curve is almost the same if, instead of Δ, the standard deviation of schooling is used, as done by Barros *et al*. (2007b) and Lorel (2008). This empirically observed relation resembles the famous and controversial Kuznets' Curve relating inequality and average of the income distribution.

This relation between the mean and the dispersion of schooling will be used subsequently to help explaining the different evolution of the earnings inequality among persons occupied in the agricultural sector[10].

**Table 6.** Average and mean absolute difference (Δ) of the distribution of schooling among occupied persons in Brazil, from 1992 to 2009: total, agricultural sector and non-agricultural sector.

| Year | Total | | Agricultural sector | | Non-agricultural sector | |
|---|---|---|---|---|---|---|
| | Average | Δ | Average | Δ | Average | Δ |
| 1992 | 5.92 | 5.17 | 2.28 | 2.72 | 6.71 | 5.16 |
| 1993 | 6.05 | 5.17 | 2.36 | 2.75 | 6.81 | 5.15 |
| 1995 | 6.25 | 5.21 | 2.41 | 2.83 | 7.01 | 5.14 |
| 1996 | 6.52 | 5.26 | 2.50 | 2.91 | 7.25 | 5.15 |
| 1997 | 6.59 | 5.30 | 2.52 | 2.89 | 7.34 | 5.19 |
| 1998 | 6.78 | 5.34 | 2.63 | 2.99 | 7.49 | 5.22 |
| 1999 | 6.89 | 5.32 | 2.71 | 3.05 | 7.64 | 5.17 |
| 2001 | 7.25 | 5.35 | 2.80 | 3.12 | 7.92 | 5.16 |
| 2002 | 7.45 | 5.35 | 2.95 | 3.26 | 8.13 | 5.13 |
| 2003 | 7.67 | 5.35 | 3.13 | 3.39 | 8.36 | 5.10 |
| 2004 | 7.83 | 5.32 | 3.31 | 3.51 | 8.50 | 5.07 |
| 2005 | 8.00 | 5.31 | 3.37 | 3.54 | 8.66 | 5.04 |
| 2006 | 8.22 | 5.29 | 3.57 | 3.68 | 8.85 | 5.01 |
| 2007 | 8.38 | 5.28 | 3.74 | 3.75 | 8.95 | 5.03 |
| 2008 | 8.58 | 5.26 | 3.97 | 4.06 | 9.13 | 4.98 |
| 2009 | 8.74 | 5.27 | 4.06 | 4.10 | 9.30 | 4.99 |

[10] Barros *et al*. (2009) used the relation between standard deviation and mean schooling to explain the decline in inequality in the distribution of income in Brazil, evaluating the contribution of changes in schooling to reduce the Gini index from 2001 to 2007.

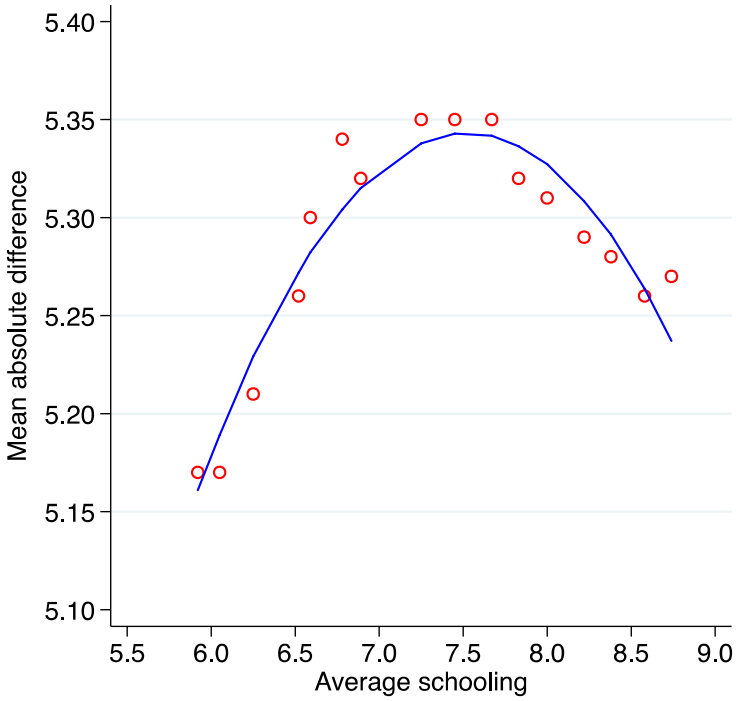


**Figure 8.** Relation between the mean absolute difference and the average schooling of occupied persons in Brazil, from 1992 to 2009.

The curve illustrated in Figure 8 reaches a maximum when the average schooling roughly equals 7.5 years. As the average schooling in the non-agricultural sector is already above this value and as in the agricultural sector this average is well below, the trend of the schooling dispersion is radically different in the two sectors.

Figures 7 and 9 show that in the period 1992-2009, as the average schooling increases, the mean absolute difference (Δ) of schooling tends to increase in the agricultural sector but tends to decrease in the non-agricultural sector. This has important implications for the evolution of the inequality of the earnings distribution in both sectors.

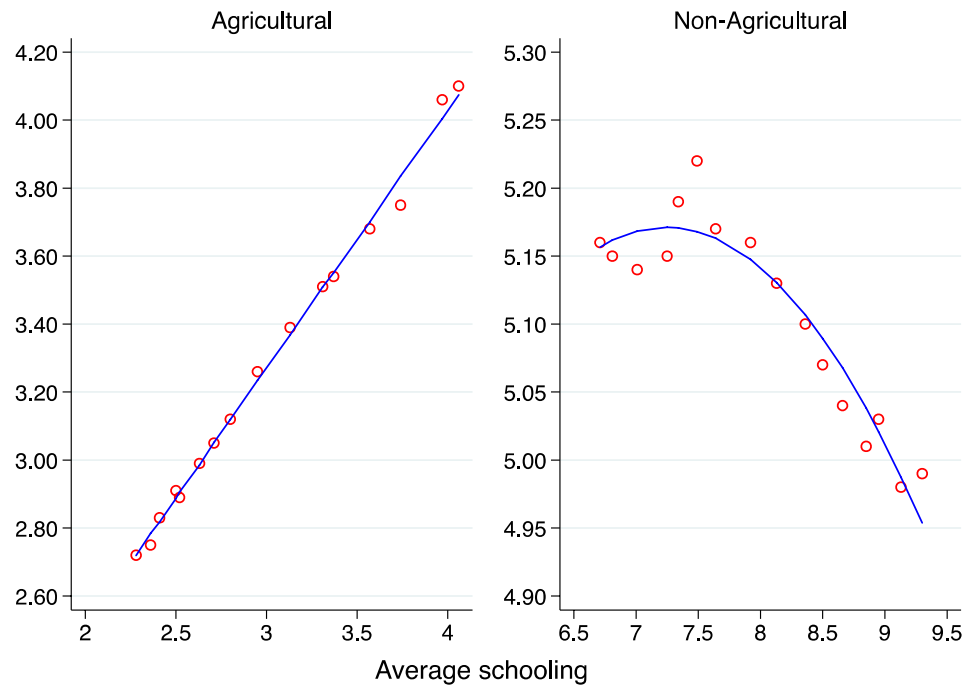


**Figure 9.** Relationship between the mean absolute difference and the average schooling for agricultural and non-agricultural sectors from 1992 to 2009.

Figure 10 highlights the evolution of the values of three quantiles of the earnings distribution in the agricultural and the non-agricultural sectors: the first decile, the first quartile and the median (which is also the second quartile or the fifth decile). Since the earnings are much lower in the agricultural sector, different scales were used on the ordinate axis. In the two graphs that compose Figure 10, a fourth line (in blue) representing the evolution of the real value of the minimum wage (MW) was included. In the agricultural sector, from 2001 to 2009, the MW is generally equal to the median. In the non-agricultural sector, on the other hand, the MW coincides with the first quartile from 2002 to 2009 and with the first decile in 1995, 1996 and 1997[11].

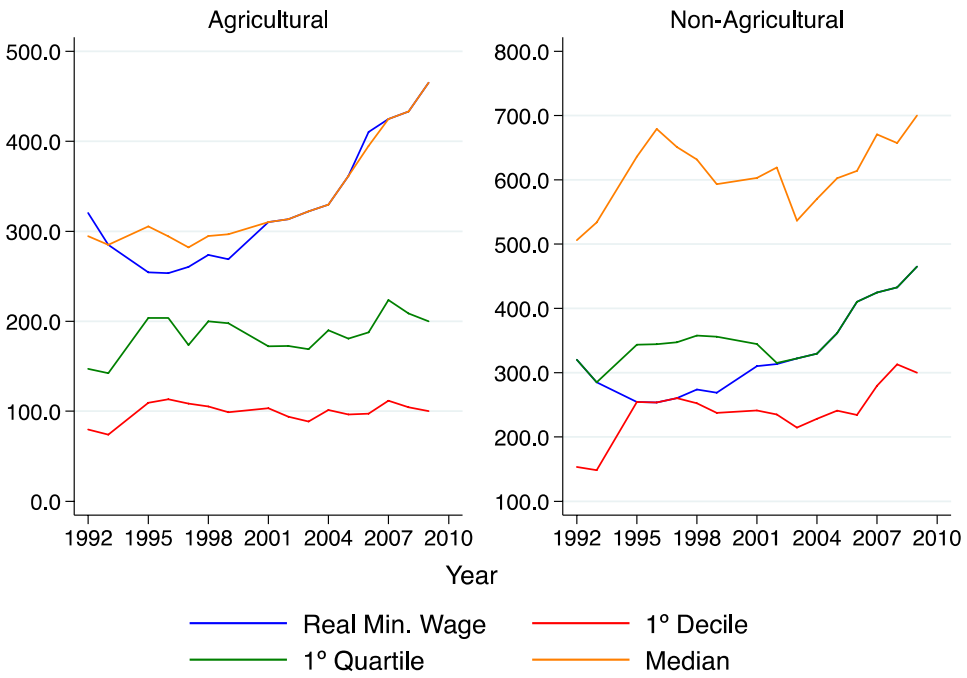


**Figure 10.** Evolution of the real minimum wage and of three quantiles (the first decile, the first quartile and the median) of occupied persons earnings' distribution in Brazil, from 1992 to 2009.

[11] For a detailed analysis of the impact of the MW on earnings of agricultural employees, see Oliveira and Hoffmann (2011).

Figure 11 shows the evolution of four inequality measures of the earnings distribution in the two sectors: the Gini index, Theil's *L* and *T* indices and the proportion of total earnings received by the richest tenth.

In Figure 2 it was possible to observe that, from 1992 to 2001, the Gini index in the agricultural sector is at times higher and at other times lower than the non-agricultural sector's index. As the inequality decreases systematically in the non-agricultural sector, from 2002 on the Gini index in the agricultural sector is systematically higher than in the non-agricultural sector. Figure 11 shows a very similar picture of the values of Theil's *L* index in the two sectors. As the Theil's *T* index is more sensitive to changes in the upper tail of the distribution, the fact that this index is always higher in the agricultural sector indicates that this sector is characterized by income concentration in its upper tail. Note that the proportion of the total income appropriated by the richest tenth is also systematically higher in the agricultural sector than in the non-agricultural sector.

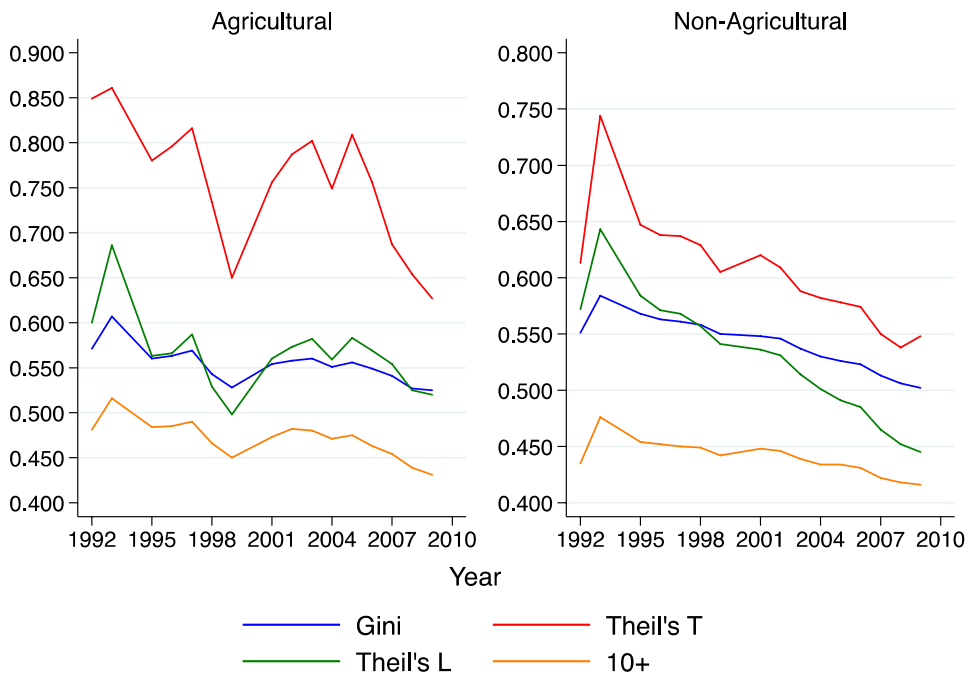


**Figure 11.** Inequality measures of the occupied persons earnings' distribution in Brazil, from 1992 to 2009.

Figure 12 contrasts the participation in the total earnings of the richest one hundredth (1+) and the poorest half (50–). Note that the origin of the ordinate axis is not the same for the two graphs. The proportion of the total income appropriated by the richest 1% is always much greater in the agricultural sector.

In the non-agricultural sector, in 2003, the share of the richest 1% was even greater than the share of the poorest 50% (both around 14%). From this year on, the share of the poorest 50% increases systematically, reaching almost 19% in 2009, when the share of the richest 1% was 12%.

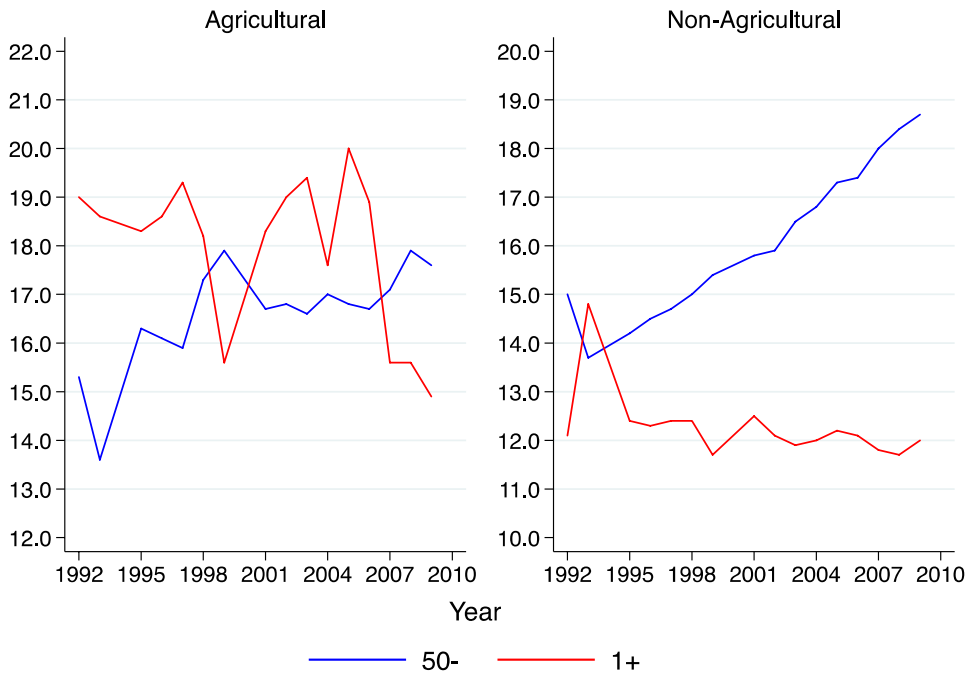


**Figure 12.** Percentage of the total income appropriated by the richest 1% and the poorest 50% in the occupied persons earnings' distribution in Brazil, from 1992 to 2009.

In the agricultural sector the share of the poorest 50% also showed an increasing trend, but less intense and much more irregular. From 2001 to 2006, the share of the richest 1% was higher than the share of the poorest 50% in total agricultural earnings.

## 4. EVOLUTION OF THE EFFECTS ESTIMATED FITTING EARNINGS EQUATIONS FOR EACH YEAR

The estimation of earnings equations is a well-established methodology to analyze how different factors (age, education, gender, etc.) affect earnings. Using the data described in the previous section and the Weighted Least Squares method (WLS), earnings equations were fitted for each year from 1992 to 2009 in order to analyze how the effect of the factors varied over this period.

The general regression model is:

$$\ln Y_j = W_j = \alpha + \sum_i \beta_i X_{ij} + u_j \qquad (11)$$

The dependent variable, $W_j$, is the natural logarithm of monthly earnings from all jobs per occupied person (given the restrictions described at the beginning of the previous section), $\alpha$ and $\beta_i$ are model parameters, $X_{ij}$ indicates the explanatory variables (characteristics of the persons and their occupations) and $u_j$ represents a random error with the usual statistical properties.

The explanatory variables are described in the following list.

a) A binary variable with value 1 for females and value 0 for males.
b) The age of the person, measured in decades, and the square of such number of decades. Age is measured in decades only to avoid extremely small coefficients. Denominating as $c_1$ and $c_2$ the estimates of the coefficients for age and for the square of age, respectively, the estimate of the age in which earnings reach their maximum value is $-10c_1/(2c_2)$ years.
c) Schooling of the person (*E*), varying from 0 to 17. Values 0 to 14 correspond to the level of schooling achieved by the person, and the value 17 is attributed to persons with 15 or more years of schooling. As rates of return for schooling show a very substantial change around 10 years of schooling, a binary variable *Z* was created, with $Z = 0$ for $E \leq 10$ and $Z = 1$ for $E > 10$. Thus, the model for the

earnings equation includes terms $\beta_1 E$ and $\beta_2 Z(E-10)$, corresponding to a polygonal with vertex at $E$=10, declivity $\beta_1$ for $E \leq 10$ and declivity $\beta_1 + \beta_2$ for $E$>10. Being $b_1$ and $b_2$ the estimates of $\beta_1$ and $\beta_2$, the estimate of the rate of return for schooling is $100[\exp(b_1)-1]$ for $E \leq 10$ and is $100[\exp(b_1+b_2)-1]$ for $E$>10.

d) The logarithm of weekly working hours in all jobs. The coefficient of this variable is the income elasticity of earnings in relation to the number of hours worked per week.

e) Five binary variables to distinguish six regions of the country: North; Northeast (adopted as the reference category); the grouping of the tree states of Minas Gerais, Espírito Santo and Rio de Janeiro; São Paulo state; South; and Midwest.

f) A binary variable equal to 1 when the person is a resident in rural areas and equal to 0 when the person resides in urban areas[12].

g) Three binary variables to distinguish between four categories of skin color, according to what the respondent declared in the survey: white (category adopted as reference), black, Asian, and mulatto or mixed.

h) Finally, three binary variables to distinguish four occupational positions: employees with a labor contract (taken as reference), employees without a labor contract, self-employed and employers.

In the earnings equations, if $Y$ is the value of earnings and $X$ is a continuous explanatory variable, and if the value of the all other terms of the equation is indicated by $\Theta$, it is possible to write

$$\ln Y = \beta X + \Theta \qquad (12)$$

[12] It is important to mention the fact that the delimitation of urban areas was updated in the 2000 Census, obeying the laws of each municipality. So, the definition of urban areas remained fixed in the survey (PNAD) from 1992 to 1999, suffering a change in 2000 and remaining fixed again from 2001 to 2009. When interpreting the corresponding coefficient and its evolution it is necessary to take these changes into account.

Fixing the value of all other explanatory variables, it follows that

$$\frac{dY}{Y} = \beta dX \quad \text{or, approximately,} \quad \frac{\Delta Y}{Y} = \beta \Delta X \tag{13}$$

The first term of this equation represents the relative variations in earnings, which corresponds to the concept of inequality in the distribution of earnings. Thus, it can be verified that the inequality tends to increase with the absolute value of the coefficient $\beta$ and with the variations (dispersion) of $X$.

It is important to keep in mind that, in the earnings equation, it is the *dispersion* of schooling (measured by standard deviation or by the mean absolute difference), and not its *inequality*, that is directly associated with the earnings' inequality.

If $b$ is the estimated coefficient of a binary variable, the *effect* of this variable is defined as the percentage variation in the earnings value when the binary variable changes from zero to one, as follows:

$$100[\exp(b) - 1] \tag{14}$$

In the case of a continuous variable the same equation provides the percentage increase in the expected earnings due to a unitary increase in the explanatory variable.

Figures 13 to 18 show the evolution of the effects of the selected explanatory variables from 1992 to 2009.

The graph for the non-agricultural sector in Figure 13 shows that the rate of return to schooling up to 10 years shows a clear downward trend and the rate of return to schooling that is above the threshold of 10 years increased until 2002 and then started to decrease.

It was observed, in Table 6, that the dispersion of schooling in the non-agricultural sector (measured by the mean absolute difference) tends to decrease from 1998 on. Thus, from 2002 on, schooling is contributing to reduce inequality in the earnings' distribution in the non-agricultural sector, due to its lower dispersion and also

to the reduction in the rate of return to schooling for those with relatively high schooling (over 10 years).

In the agricultural sector a similar trend can be observed regarding the rate of return to schooling for persons with more than 10 years of formal education, although the peak of this rate occurred in 2005 and not 2002, as observed for the non-agricultural sector. Regarding the dispersion of schooling, however, the phenomenon is totally different because, as was seen earlier, the dispersion of schooling in the agricultural sector is increasing and contributes to increase the inequality of the earnings' distribution.

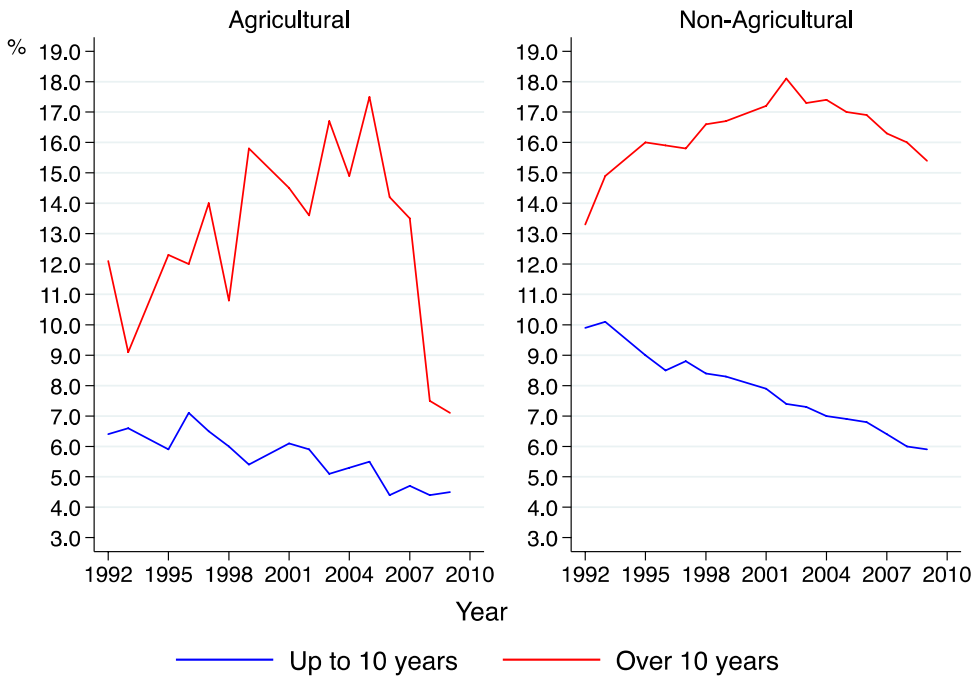


**Figure 13.** Rate of return up to 10 years of schooling and over 10 years of schooling for occupied persons in Brazil, from 1992 to 2009.

Figure 14 shows the evolution of the effect of being black, mulatto or female, a white male taken as the reference category. It can be seen that the absolute effect of being female is diminishing in both sectors, and it is always greater in the non-agricultural sector. The effects of being black or mulatto are quite similar and unfortunately there is no trend of reduction.

It is simplistic to interpret the effect of being black or mulatto as resulting from discrimination alone since, as shown by Figure 15, the effect of being asian is positive, and it would be strange to consider that there is "discrimination" in favor of the asians. It is worth noting that the value of the effect of being asian shows a downward trend in both sectors.

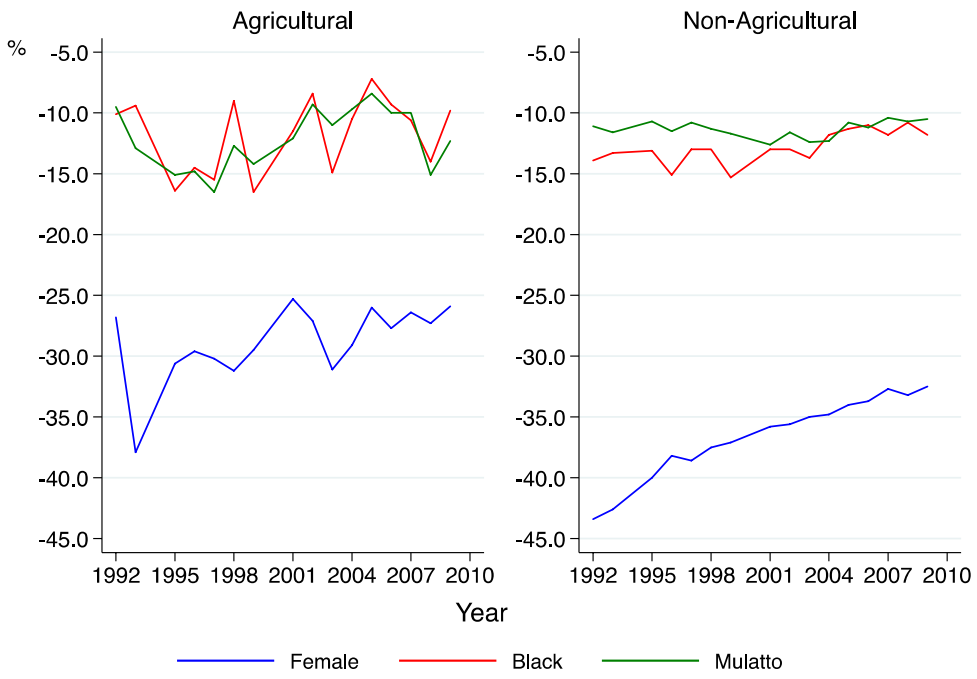


**Figure 14.** Effect of being female, black or mulatto on occupied persons' earnings in Brazil, from 1992 to 2009.

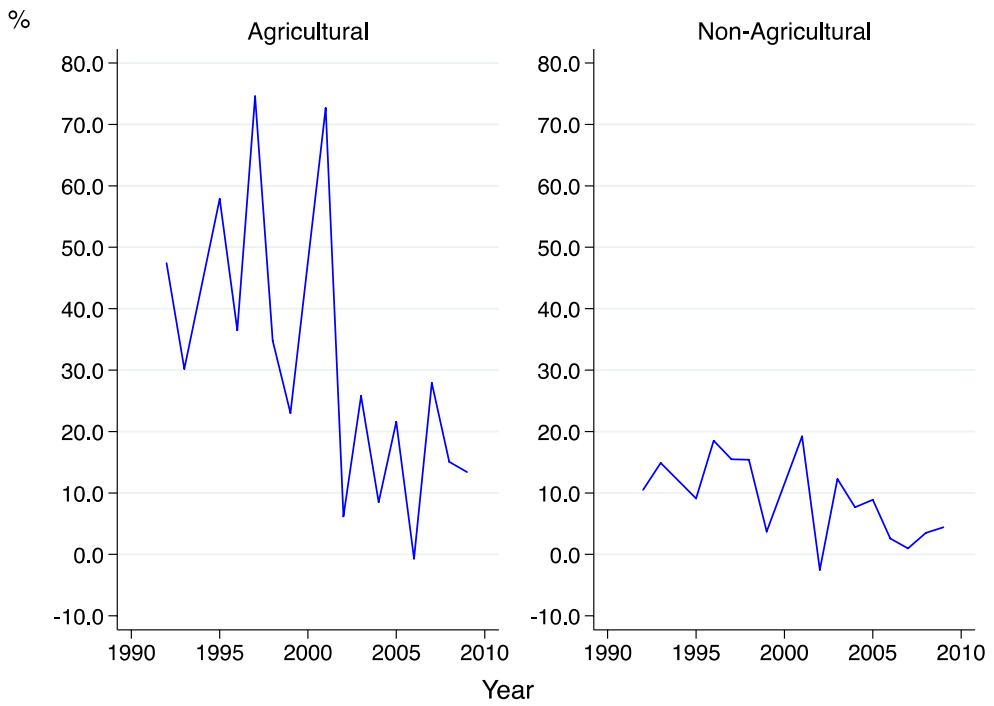


**Figure 15.** Effect of being asian on occupied persons' earnings in Brazil, from 1992 to 2009.

As the poorest region of the country was taken as the reference category (Northeast), the effects associated to the other regions are always positive, as shown in Figure 16. In the graph for the non-agricultural sector, it is observed that the effect associated to São Paulo (SP), which was initially well above the other regions, tends to decrease, contributing to reduce interregional inequality. The same does not occur in the agricultural sector.

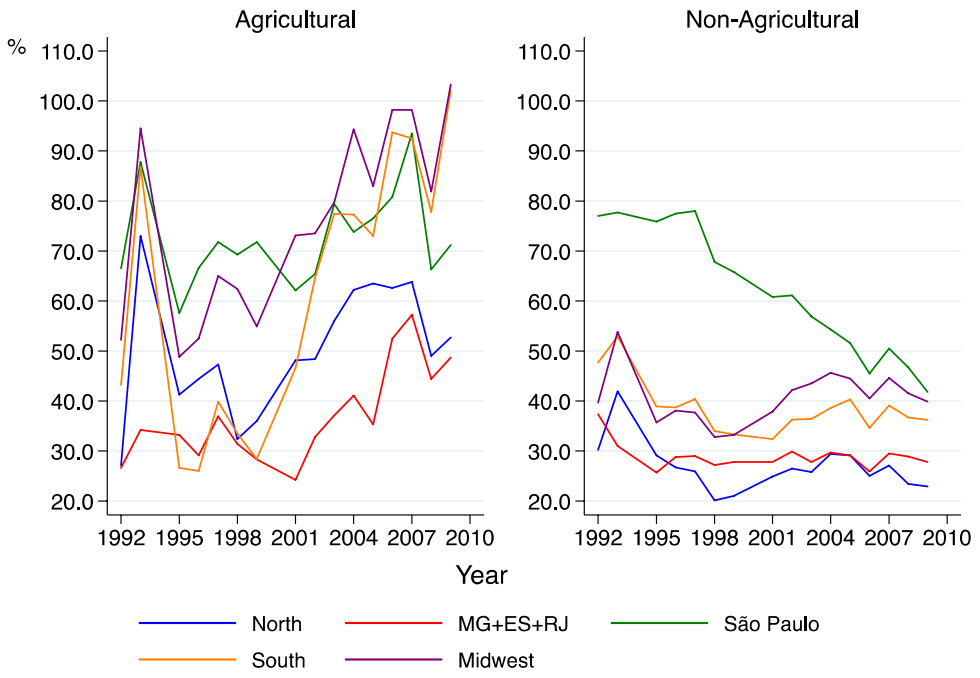


**Figure 16.** Effect associated to the regions (Northeast taken as reference) on occupied persons' earnings in Brazil, from 1992 to 2009.

Figure 17 shows the evolution of the effects of being self-employed or employee without labor contract compared to the reference category (employee with labor contract). These effects are always more negative in the agricultural sector. It should be noted that from 1996 on the effect of not having a labor contract tends to be increasingly negative in the agricultural sector. Certainly, this is related to the growth of the real value of the minimum wage in the period and also to the fact that this growth benefits more the employees with a labor contract (see Oliveira and Hoffmann, 2011). In the non-agricultural sector, the evolution of the effect of not having a labor contract is quite different.

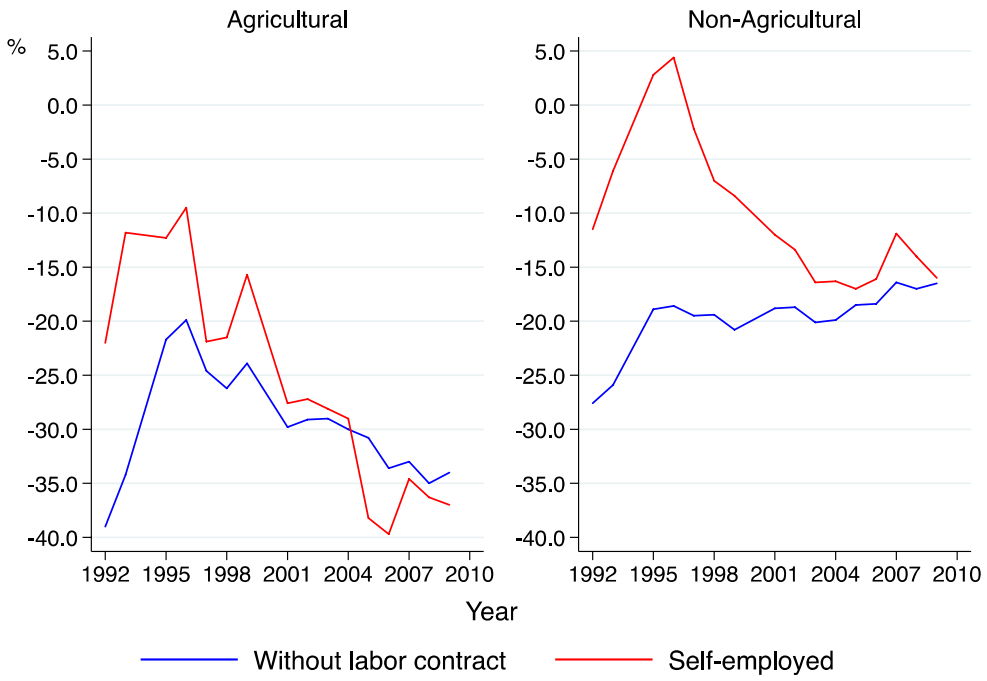


**Figure 17.** Effect of not having a labor contract or of being self-employed (in comparison with an employee with a labor contract) on occupied persons' earnings in Brazil, from 1992 to 2009.

Figure 18 shows that the effect of having residence in rural areas is stronger in the non-agricultural sector, but in both cases its absolute value shows a decreasing trend, indicating some convergence between rural and urban areas (still with great disadvantage for rural areas).

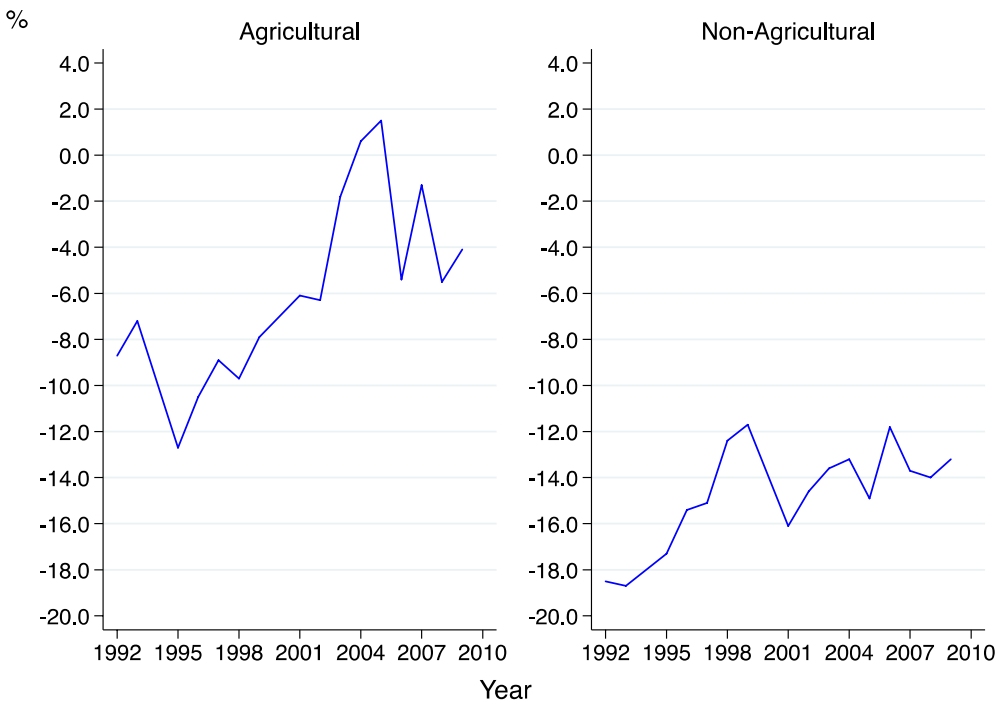


**Figure 18.** Effect of rural residence on occupied persons' earnings in Brazil, from 1992 to 2009.

## 5. Earnings' inequality among 6 regions or among the 27 Brazilian Federation Units

Figure 19 shows the evolution of the components of the Theil's indexes (*T* and *L*) related to the earnings inequality between six regions or between the 27 Brazilian Federation Units (FUs). The different behavior of the interregional inequality in the two sectors is evident, and only in the non-agricultural sector a clear reduction of the inter-regional inequality after 1997 can be observed.

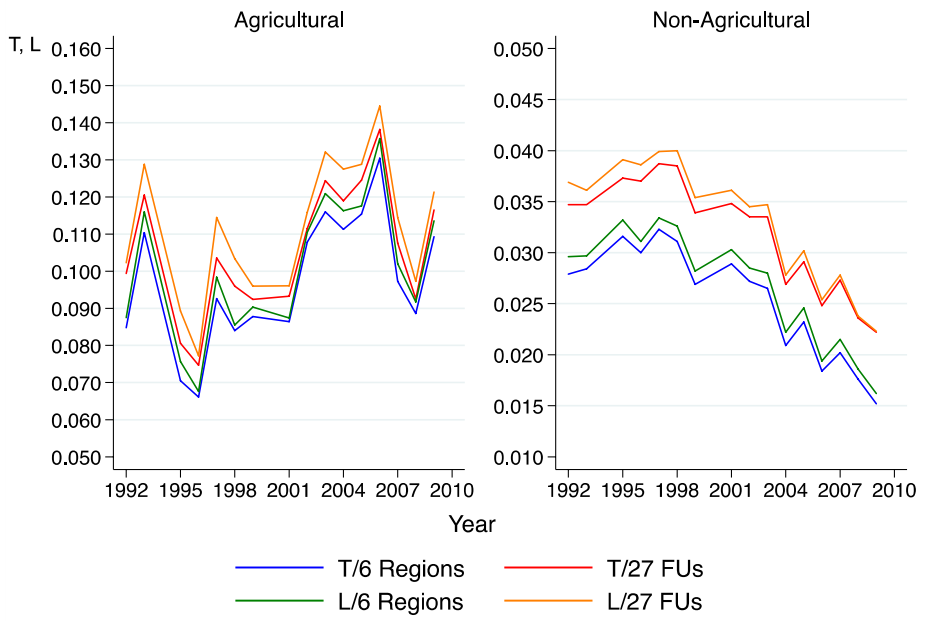


**Figure 19.** Theil's *L* and *T* indexes of earnings of occupied persons' inequality between six regions or between 27 Federation Units in Brazil, from 1992 to 2009.

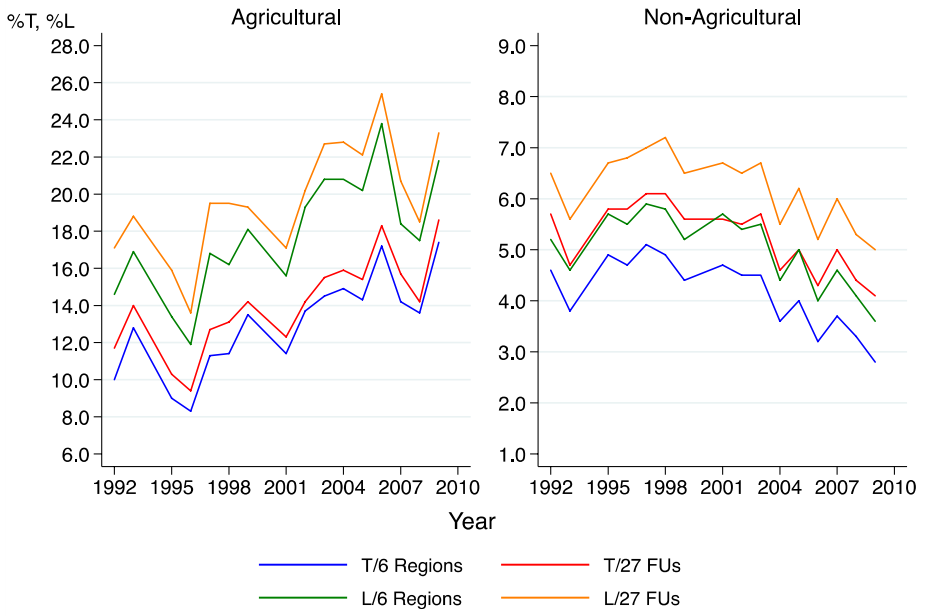


**Figure 20**. Percentages of the Theil's *T* and *L* indexes of occupied persons' earnings distribution related to the inequality between 6 regions or between 27 Federation Units in Brazil, from 1992 to 2009

## 6. CONCLUSIONS

The data from the national households sample survey (PNAD) show that the agricultural sector presents a differentiated behavior considering changes in the income distribution in Brazil. Regarding the per capita household income, although from 2003 on the reduction rate of inequality among agricultural households is similar to the one observed in Brazil as a whole, the determinants associated with this reduction are clearly different in the agricultural sector. Considering all households, between 2003 and 2009 about 21% of the reduction in the Gini index of per capita household income distribution can be attributed to the IBF component, which includes government transfers such as the *Bolsa Família* (besides interests, dividends and other incomes). In the case of agricultural households this percentage reaches 46%.

Another important result is that, in the case of the agricultural sector, the contribution of the share of employees' earnings (EMP) in reducing inequality is substantially lower compared to Brazil (10% versus 51% between 2003 and 2009).

Concerning the income of occupied persons, the reduction in inequality is less intense and more irregular in the agricultural sector compared to the non-agricultural sector. The different factors that determine the income of occupied persons also presented distinct behaviors for the agricultural and non-agricultural sectors. The evolution of the dispersion of schooling is radically different for the two sectors. In the period 1998-2009, as the average schooling increases, the dispersion tends to grow in the agricultural sector but tends to decrease in the non-agricultural sector.

For the persons occupied in the agricultural sector the real minimum wage is close to the median of earnings (from all jobs). On the other hand, in the non-agricultural sector the minimum wage coincides with the first quartile of the earnings distribution over the period 2002-2009.

Analyzing the evolution of the effects estimated by fitting earnings equations for each year from 1992 to 2009, it was found that the effects of being black or mulatto (taking a white person as basis) are very similar in both sectors and show no tendency to decrease. The earnings difference between men and women decreased, especially in the agricultural sector, but women are still in disadvantage (mainly in the agricultural sector).

It was verified that the differences associated with geographic location are still strong, but in the case of the non-agricultural sector there is a convergence trend, with reduction in inequality among six regions or among the 27 Federation Units from 1997 on. This is not observed for the agricultural sector, which even presents an increasing trend of the measures of inequality among the six regions or the 27 Federation Units.

Finally, it is worth mentioning that, from 1996 on, the effect of being employed without a labor contract (taking the employees with labor contract as the reference category) tends to be increasingly negative in the agricultural sector. This fact is associated with changes in the real minimum wage, which benefit more the employees with a labor contract.

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