Área 10 - Economia Agrícola e do Meio Ambiente

Título do artigo: Sugar cane in Brazil, poverty and equity: evidences for the 1992-2006 period.

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Abstract: The sugar cane is on of the most important agriculture sector in Brazil, (16,5% of agriculture GDP in 2006). Besides it is becoming a world strategic sector because of the biofuels demand increase. In the past decade this sector in Brazil has passed through important transformations, especially due to the higher mechanization. Since it is a sector that employs a significant part of the population in some states, a possible reduction in the sector poverty impact would considerably improve their living standard. Using PNAD micro data from 1992 to 2006, first we will describe some aspects of the sugar cane sector, giving an overview of the changes that is has experienced, second we will decompose the Gini index and finally estimate how pro-poor the sugar cane production growth has been.

Key-words: Sugar cane, poverty, equity, Gini, agriculture, Brazil.

Resumo: A cana-de-açúcar é um dos setores mais importantes da agricultura no Brasil, representando em 2006 aproximadamente 16,5% do PIB total da agricultura. Além disso, ela está se tornando um setor estratégico no mundo, em razão do aumento da demanda dos bio combustíveis. Na ultima década este setor vivenciou importantes transformações, especialmente devido à maior mecanização. Apesar do grande aumento da produção desta cultura no Brasil nos últimos anos, nós não sabemos claramente qual o seu impacto social. Tendo em conta que este é um setor que emprega uma parte considerável da população em alguns estados brasileiros, uma possível redução da pobreza neste setor, poderia melhora substancialmente o padrão de vida desses estados. Utilizando os micro dados da PNAD, de 1992 até 2006, primeiro iremos descrever alguns aspectos do sector, dando uma visão geral das mudanças que o setor passou, segundo será feita uma decomposição do índice de Gini, e finalmente estimaremos o quanto pró-pobre foi o crescimento da produção da cana-de-açúcar.

Palavras-chave: Cana-de-açúcar, pobreza, equidade, Gini, agricultura, Brasil.

Código *JEL:* Q01

Sugar cane in Brazil, poverty and equity: evidences for the 1992-2006 period

Introduction

The production of sugar-cane has a substantial participation on the Brazilian agricultural GDP. According to IBGE data, in 2006, the output value of sugar cane represents alone 17% of the total Brazilian agricultural output value (www.ibge.gov.br). Sugar cane planted area has systematically increased in the past few years, to reach 6 millions hectares in 2006. With 28% of the world sugar cane production and 25% of the world sugar exports (Olarreaga and Krivonos, 2006), Brazil is the largest producer and exporter of sugar. This trend will probably reinforce in the future thanks to the perspective growing demand for biofuels. According to Abramovay (2008), sugar cane production shall increase from 425.7 million tons in 2006/07 to 727.8 million tons in 2012/13.

Who is likely to be the largest winner of the sector growth within Brazil? Some have argued that, given the structure of the sugar sector (capital and land concentration) and the large mechanization it has experienced in recent years, very few economic gains will accrue to small farmers and agricultural workers in Brazil. Some civil society institutions, as for example CPT (Comissão Pastoral da Terra), affirm that rural poverty has always been linked with the sugar cane economy, particularly in the North-Eastern region.

On the other hand, the Brazilian government strongly supports that the expansion of sugar cane is a way to reduce poverty and negative environmental externalities, as shown for example by the recent declaration of the Brazilian President at ONU. Moreover, a significant part of sugar-cane is planted in poor Brazilian States.

This paper aims at analyzing how pro-poor has been sugar cane growth during the last 15 years. A general presentation of the sector is made in section 1 with an analysis of some social indicators evolution for the sector. Section 2 analyzes the contribution of the sugar cane income and of agricultural income to equity in Brazil. Section 3 analyzes the impact of economic growth on poverty for the primary, secondary and tertiary sectors as well as for the sugar cane sector.

1. Sugar cane main features and recent transformations in Brazil

According to IPEADATA, between 1992 and 2006, the sugar cane sector participation to the Brazilian GDP has oscillated between 10% and 16,5%, which underlines its importance in the Brazilian economy. The Institute of Sugar and Alcohol (IAA), which controlled sugar and alcohol domestic markets, was dissolved in 1990, leaving markets and competitiveness being the main drivers of the sector growth.

The two main sugar cane production basins are Center-Southeast and Center-Northeast (see Table 1). Approximately 300 plants are processing sugar cane, almost 75% of them are located in the Center-Southeast (Olarreaga and Krivonos, 2006). The State of São Paulo alone represents 58 % of the national production in 2006. Cane yields, 82 tons/ha in 2006 (www.ibge.com.br) in this State, are also much higher that in other States. This is mainly explained by the land better quality and the higher level of mechanization.

Table 1 – Distribution of the Sugar cane planted area and production (2006)

States	Acreage		Quantity Produced (ton)	
	Total	%	Total	%
SP-São Paulo	3.084.752	53,33%	254.809.756	60,43%
PR-Paraná	404.520	6,99%	29.717.100	7,05%
AL-Alagoas	391.464	6,77%	22.804.389	5,41%
PE-Pernambuco	367.022	6,34%	17.115.218	4,06%
MG-Minas Gerais	349.104	6,04%	25.386.038	6,02%
MT-Mato Grosso	204.993	3,54%	12.549.739	2,98%
GO-Goiás	192.976	3,34%	15.353.525	3,64%
RJ-Rio de Janeiro	168.229	2,91%	7.552.745	1,79%
MS-Mato Grosso do Sul	136.803	2,36%	9.513.818	2,26%
PB-Paraíba	105.403	1,82%	4.975.797	1,18%
BA-Bahia	91.026	1,57%	5.592.921	1,33%
ES-Espírito Santo	64.358	1,11%	4.240.547	1,01%
RN-Rio Grande do Norte	53.713	0,93%	3.275.373	0,78%
CE-Ceará	35.098	0,61%	1.787.126	0,42%
MA-Maranhão	31.728	0,55%	1.968.414	0,47%
RS-Rio Grande do Sul	31.643	0,55%	889.116	0,21%
SE-Sergipe	26.867	0,46%	1.777.372	0,42%
SC-Santa Catarina	16.714	0,29%	601.869	0,14%
PI-Piauí	9.966	0,17%	647.675	0,15%
PA-Pará	7.301	0,13%	505.348	0,12%
AM-Amazonas	5.740	0,10%	340.027	0,08%
TO-Tocantins	2.762	0,05%	161.873	0,04%
AC-Acre	717	0,01%	25.690	0,01%
RO-Rondônia	700	0,01%	49.228	0,01%
DF-Distrito Federal	498	0,01%	25.638	0,01%
RR-Roraima	375	0,01%	1.290	0,00%
AP-Amapá	72	0,00%	1.755	0,00%

Source : IBGE

One crucial feature of the sugar cane industry is that sugar mills and sugar cane planted area can not be too distant because sugar cane is highly perishable. Sugar mills must thus be located inside the sugar cane area and they usually own the sugar plantations: around 75% of sugar cane is grown by mills, which hire seasonal workers at hourly wages, while the rest belongs to independent producers (Moraes, 2004). Moreover, small farmers are almost inexistent in this sector (Abramovay, 2008). The main possible sector positive or negative impacts on poverty has thus to be analyzed mainly through employment levels and conditions evolution.

Table 2 shows the distribution of employment in the sugar cane sector amongst the main producing states. Sao Paulo which has 53,33% of total sugar cane acreage represents

only 28,1% of sugar cane total employment. On the other hand, Pernambuco and Alagoas, representing much lower acreage, ranks high in term of employment generation. The higher mechanization in the Southeast region is thus confirmed.

Table 2 – Employment and LQ[1] using employment as variable of sugar cane sector

States	Employment		LQ of income	
	Total	%	1992	2006
SP	172.960	28,10%	1,16	1,24
PR	13.699	2,23%	1,01	0,37
AL	79.853	12,97%	12,03	9,64
PE	135.669	22,04%	3,69	5,44
MG	47.473	7,71%	0,46	0,72
MT	12.248	1,99%	0,34	1,30
GO	11.101	1,80%	0,28	0,58
RJ	5.827	0,95%	0,59	0,12
MS	12.839	2,09%	0,81	1,61
PB	19.335	3,14%	1,47	1,65

Source: Elaboration of the authors based on PNAD Data

Sugar cane loading, transport and cultivation is almost 100% mechanized and harvesting is around 35% mechanized. This has reduced the demand for workers, especially for those with low skills and education (Guilhoto et al., 2002). It has particularly occurred in the Southeast region, because land are mainly flat and allow for mechanization.

Table 2 also shows the Location Quotient (LQ) in 1992 and 2006. The LQ higher than one means that the share of this sector in local income is higher than for the all country. Except for SP, in 2006, the sugar cane LQ was higher than one only in poor Brazilian States (AL, PE, MT, MS and PB). Between 1992 and 2006, the sugar cane LQs increase in almost all poor states (PE, MT, GO, MS and PB), except for Alagoas. On the other hand, except for São Paulo, LQs have decreased in all rich states (PR, MG and RJ). These results suggests that some Brazilian poorest states have reinforced their specialization in sugar cane.

According to Balsadi and Gomes (2007), living conditions of agricultural workers have generally improved in Brazil between 1992 and 2004. However, there are still nowadays large difference between rural and urban families, between *pluriactives* and *monoactives* families and between temporary and permanent workers. Worst living conditions are found in families living in rural areas, depending mainly on agriculture and with temporary jobs.

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[1] 1- The location quotient (LQ) is the ratio of the production (or income) of sector *i* in the State *j (Ei)j* and sector *i* national production (income) (*Ei*), divided by the ratio of the State production (*Ej*) and national production (*E*), see Isard (1960).

$$LQ_{ij} = \frac{E_{ij}/E_i}{E_j/E}$$

From PNAD data, some indicators have been selected to have a better idea of the evolution of working conditions and poverty levels in the sugar cane sector. From 1992 to 2006, with the exception of Mato Grosso, informality has significantly decreased, probably improving workers living conditions. Table 4 shows that child labor has also decreased, which is a good indicator of social improvement.

Table 3 – Informality and Sugar cane 1992-2006

States	1992-2006		
	Variation of people with portfolio signed	Variation of people without portfolio signed	Variation of people with portfolio signed/total (%)
SP	6.183	-21.803	10,94
PR	-13.755	-22.067	31,54
AL	14.151	-83.225	42,4
PE	11.366	-14.346	11,3
MG	10.361	2.019	10,42
MT	4.470	2.878	-4,12
GO	7.789	-3.377	63,69
RJ	-10.929	-19.710	28,18
MS	4.675	569	2,38
PB	919	-9.111	30,81

Source: Elaborated by the authors based on PNAD data

Table 4 – Child Labor in the sugar sector 1992 and 2006

States	% of young (10-18 years)	
	1992	2006
SP	16,8	1,49
PR	30,33	4,35
AL	29,89	8,88
PE	23,49	6,38
MG	17,47	10,76
MT	16,65	2,51
GO	20,02	2,94
RJ	15,31	0
MS	11,54	4,77
PB	32,61	13,95

Source: Elaborated by the authors based on PNAD data

The percentage of the poor[2], and has been reduced from 1992 to 2006, both in total as in the sugar cane sector of each state (Table 5). In 1992 and 2006, the poverty level in the sugar cane sector is lower than in the total of each state.

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[2] Following IPEA we call poor the people with household per capita income less than ½ of minimal wage (minimal wage of 2006).

Table 5 – Percentage of Poor in Brazil and sugar cane sector 1992-2006

States	% of poor in Brazil		% of poor in sugar cane sector	
	1992	2006	1992	2006
SP	52,37	29,04	6,02	1,01
PR	60,29	36,65	19,1	4,35
AL	69,34	56,01	31	13,61
PE	69,66	40,97	26,25	12,3
MG	60,02	38,11	25,14	23,9
MT	62,98	42,23	16,65	10
GO	59,28	38,24	4,99	2,94
RJ	52,2	35,85	-	-
MS	60,28	37,98	7,68	2,38
PB	72,37	49,77	48,89	25,58

Source: elaborated by authors, PNAD

The social indicators constructed through PNAD data seem to have improved in the sugar cane sector during the last decades, despite some higher concentration of the sector. Of course, one must not forget that the sector has also some negative social records. According to the data collected by CPT (Comissão Pastoral da Terra), between 2003 and 06/2008, the sector ranks second in term of number of workers that have been freed after denunciation of working conditions similar to slavery[3]. Because of harsh working conditions, *Maria Aparecida de Morais Silva concluded that the useful life of a sugar-cane cutter is shorter than that of a slave (cited in Abramovay 2008: 28).*

Moreover, it is necessary to use some more sophisticated tools to better understand if and how poverty and equity index have changed since 1992. Poverty can no be analyzed without analyzing equity as uneven income distribution is the main source of persisting poverty in Brazil (Barros and al., 2000).

2. Decomposition of Brazilian inequality between sectors.

2.1. Data description

Equity decomposition and poverty impacts of economic growth in Brazil are analyzed using Brazilian national household surveys (*Pesquisa Nacional de Amostra Familiar* - PNAD) from IBGE (*Instituto Nacional de Geografia e Estatistica* – IBGE). The annual data have been considered from 1993 to 2006, with the exception of the years 1994 and 2000.

Poverty headcount (H) index has been built using total household per capita incomes. Incomes have been deflated spatially, using Azzoni Carmo and Menezes (2003) regional price index, and temporally using price deflator series from national consumer price index (INPC) for the PNAD reference months. Incomes are expressed in January 2006

[3] http://www.reporterbrasil.org.br/documentos/estatisticas_CPT_09_07_08.pdf

Brazilian Reais (R$). The poverty headcount index from the PNAD survey is the percentage of the population living in household with income person below the poverty line (defined as ½ Brazilian minimal wage in 2006).

2.2. Dynamic and decomposition of the Brazilian Gini index between 1992 and 2006.

In it last World Development Report (World Bank 2008), the World Bank insists on the role of agriculture to reduce poverty and improve equity in developing and emerging countries. Brazil, despite its important agricultural resources, belongs to the group of urbanized countries as agricultural GDP is less than 10 % of the national GDP. In such group, in order to improve the pro-poor impact of agriculture, smallholders participation should be promoted, particularly through better market insertion, and good job opportunities shall be developed (World Bank 2008).

In the case of sugar cane in Brazil, it has been mentioned in the first section that smallholders participation was incipient. First indicators have shown that employment conditions have improved during the last decades, with the reduction of child labor and of informality. The issues further analyzed here is to what extent employment creations in the sugar cane sector, and in the agricultural sectors in general, reduce or not inequity. The analysis will be done for Brazil and for two important and contrasting sugar producing regions, the States of São Paulo (Southeast) and Pernambuco (North-East).

Graphic 1 : Gini Index – Brazil, São Paulo, and Pernambuco 1992-2006
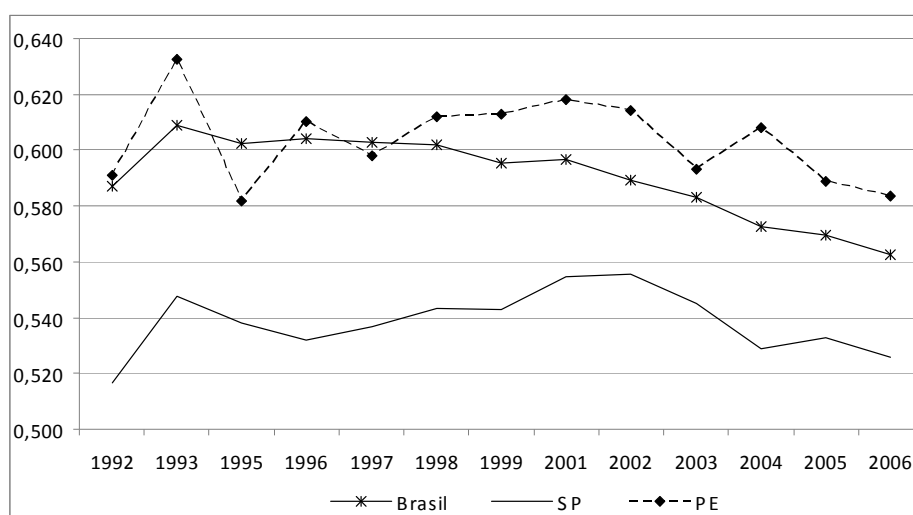

Source : elaborated by the authors based on the PNAD Data

Graphic 1 shows the evolution of the Gini index for Brazil, São Paulo and Pernambuco. As it has already been shown by some authors (Barros and al 2000), the good new is that the national Gini index has decreased during the last 15 years, the bad new is that its level in 2006 (0,562) still underlies very high uneven income distribution. Contrary to the gradual decrease found at the national level since the beginning of the 1990s, in

São Paulo and Pernambuco, equity has only started to improve since the beginning of the years 2000.

Graphics 2 and 3 shows the evolution of the concentration coefficient in each region for agricultural incomes and other incomes. The purpose here is to analyze better the possible participation of agricultural income to the improvement of equity observed.

**Graphic 2: Concentration coefficient for agricultural income – 1992 -2006**
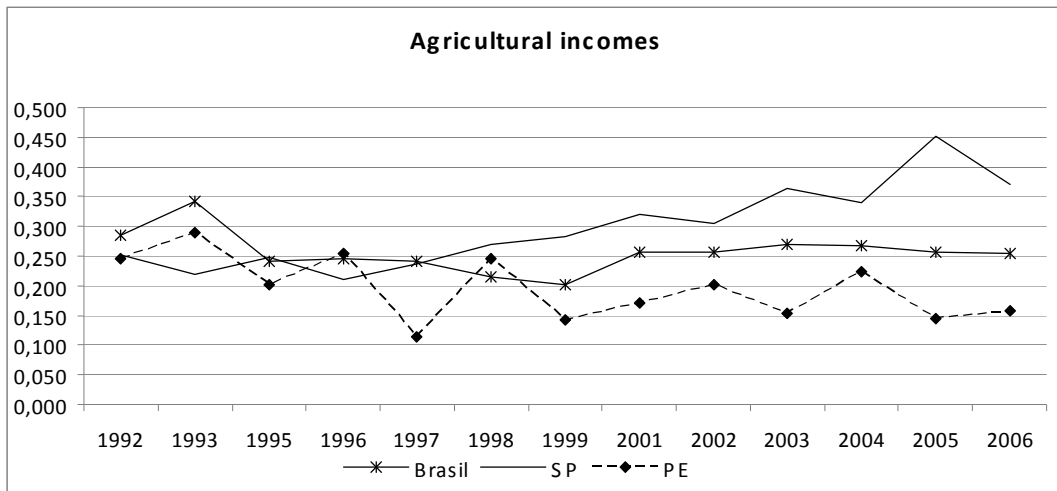
Two important results emerge. First, the Gini index decrease is mainly linked to other income fairer distribution at the national level and in each of the two States analyzed. Moreover, whereas in the State of Pernambuco agricultural incomes have rather improved equity, the sector in the São Paulo state appears to have the opposite effect, quite strongly concentrating incomes. At the national level, agricultural incomes have almost no effect on Gini Index decrease observed since the last 15 years.

Graphic 3: Concentration coefficient for others income – 1992 -2006
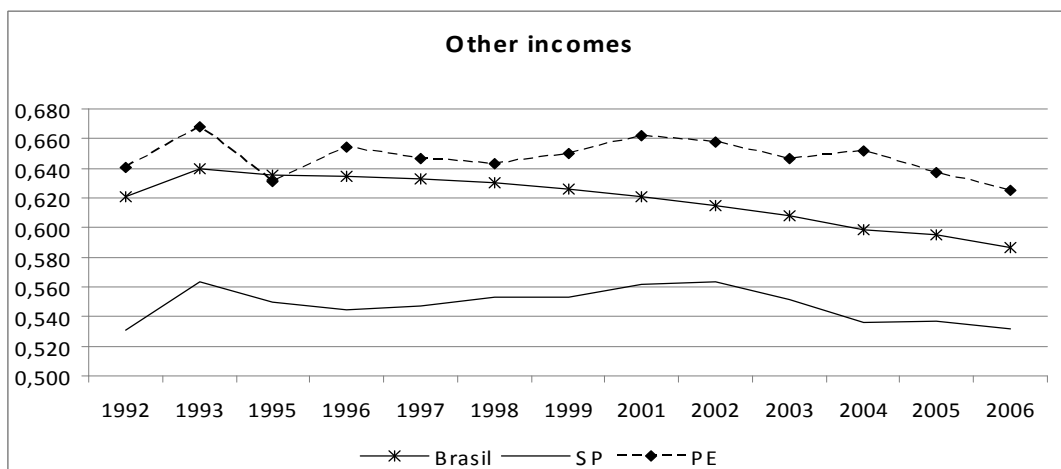
Graphic 4: Concentration coefficient for sugar cane sector incomes 1992 -2006
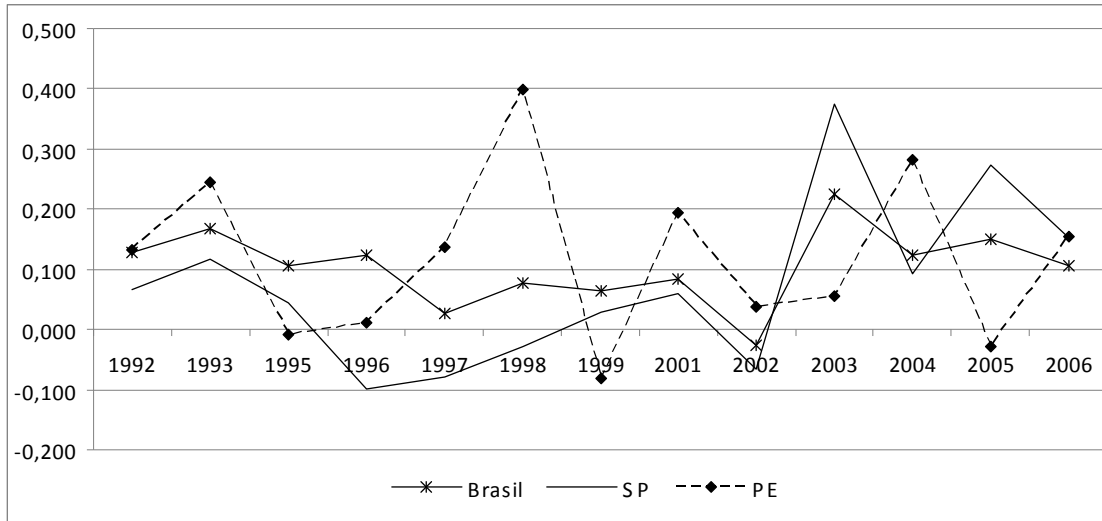
Looking more specifically at income from the sugar cane sector, graphic 4 shows no specific trend toward improving or reducing equity for the all period 1992 – 2006. Contrasted impacts are observed depending on the period as it will be now analyzed.

The sample has been divided in three periods. The period 1993-1996 is the inflation period and the beginning of monetary stabilization program. The second period, 1996-1999, is marked by the fixed exchange rate monetary policy. Finally, from 1999 to 2006, inflation is controlled and exchange rate fluctuates.

The Gini coefficient has been then decomposed to better analyze the impact of agriculture and sugar cane sectors on national income inequality reduction. The impact of each sector national income concentration could be measured by Gini Coefficient (G) decomposition in the following way:

$$\Delta G = \sum_{i=1}^{n} \left(\overline{C}_i - \overline{G} \right) \Delta \alpha_i + \sum_{i=1}^{n} \overline{\alpha}_i \Delta C_i \ , \qquad\qquad (1)$$

Where: $\qquad G_{t-1} = \sum_{i=1}^{n} \alpha_{it-1} C_{it-1} ; \qquad G_t = \sum_{i=1}^{n} \alpha_{it} C_{it} ; \qquad \overline{G} = \frac{1}{2} \left(G_t + G_{t-1} \right) \qquad$ and

$$\Delta G = \sum_{i=1}^{n} \left(\alpha_{it\backslash} C_{it} - \alpha_{it-1} C_{it-1} \right) \ ,$$

with i {sugar cane, agriculture and others}, α_I, the share (or participation) of sector i in total income and C_i, the concentration coefficient of sector i. In turn, this coefficient comes from the concentration curve, as for the Gini index, but the population is sorting in function of individual income instead of in function of the income of people working in sector i.

More specifically, defining β_i as the area between the concentration curves of sector i and the abscissas axle, the concentration coefficient is given by:

$$C_i = 1 - 2.\beta_i \qquad , \tag{2}$$

We can show that $-1 < C_i < 1$. Such interval differs from the Gini index ($0 \leq G < 1$) because the axle is sorted following the total individual income. Therefore, the concentration curve is not increasing, as in the case of the Lorenz Curve, actually it is not-decreasing.

For two periods, *t* and *t-1* it is possible to observe that Gini index is determined by the variation of concentration coefficient (concentration-effect) and how much of the variation comes from the differences between the sector shares in total consumption expenditure (participation-effect). Notes that, if the sector whose concentration coefficient is smaller (bigger) than the Gini index have their consumption share increased, it would contribute to reduce (increase) inequality (Hoffman (2006)).

Graphic 5: Participation of sugar cane incomes in total income by States from 1992 to 2006
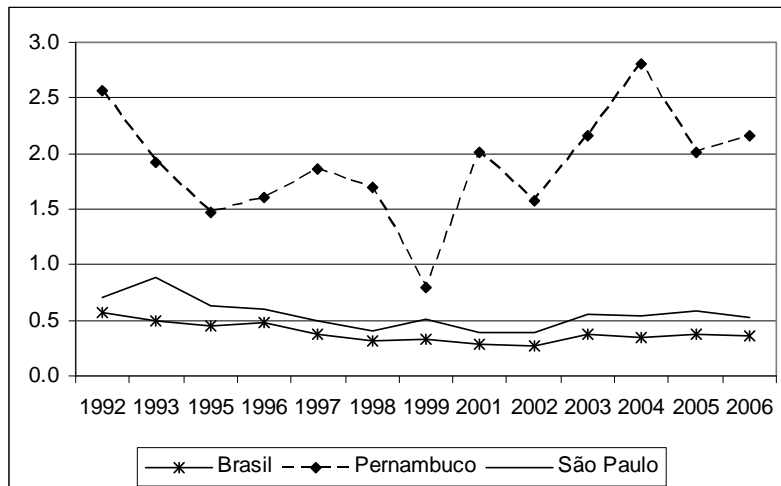
Graphic 6: Participation of Agriculture incomes in total income by States from 1992 to 2006
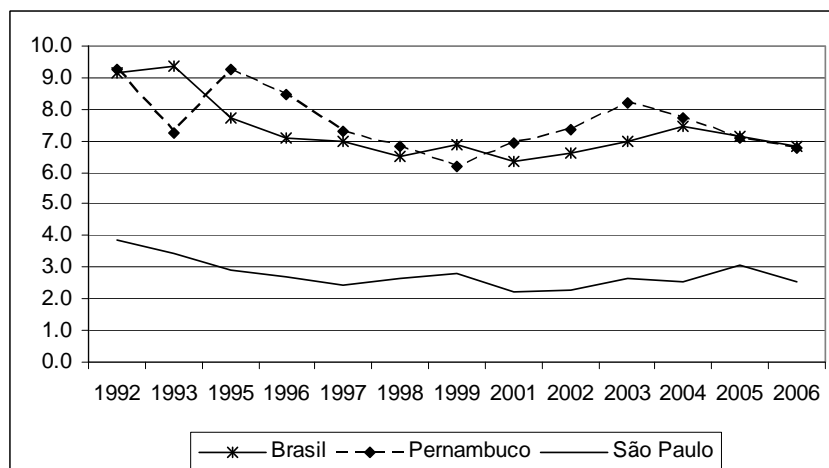
**Table 6: Concentration and Participation Effect of sugar cane incomes,
agricultural incomes and non agricultural incomes on equity in Brazil (1993-2006
/ 1993-1996 / 1996-1999 / 1999-2006)**

	Total Income	Sugar cane Income	Agriculture Income	Other sectors Income
1993-2006				
Concentration effect	118.46	0.57	14.95	102.94
Share effect	-18.46	-1.29	-15.60	-1.56
Total contribution	100	-0.72	-0.65	101.37
1993-1996				
Concentration effect	267.06	4.60	164.34	98.11
Share effect	-167.06	-2.25	-150.21	-14.59
Total contribution	100	2.35	14.13	2.35
1996-1999				
Concentration effect	118.66	2.62	34.11	81.93
Share effect	-18.66	-8.09	-9.33	-1.24
Total contribution	100	-5.47	24.78	80.69
1999-2006				
Concentration effect	99.82	-0.43	-10.92	111.18
Share effect	0.18	0.48	-0.30	0.00
Total contribution	100	0.04	-11.22	111.18

Source : Elaborated by the authors from the PNAD data

From 1993 to 2006, sugar cane and agriculture have a negative contribution for Gini reduction respectively: -0.72 and -0.65 (table 6). The reasons are that both sectors have a concentration coefficient smaller than Gini and that their participation is decreasing (Graphics 6 and 7).

For the periods 1993-1996 and 1996-1999, the Gini index decreases and the participation and concentration effect of the agricultural and of the sugar cane sector are also decreasing. From 1993 to 1996, the concentration reduction is stronger than participation reduction and both sectors have a positive impact on Gini index diminution, respectively 2.35 and 14.13 (table 6). From 1996 to 1999, sugar cane has a negative impact on Gini index reduction, because the participation effect (-8.09) is higher than concentration effect (2.62). For the agricultural sector, it has still a positive impact on Gini reduction (24.48) mainly linked to the decreasing concentration effect.

In the recent period (1999 to 2006), the agricultural sector has been increasing concentration and has a negative impact on Gini reduction. The sugar cane sector increase its participation and concentration effects. Because the positive participation effect (0.48) is larger than the negative concentration effect (-0.43), the overall contribution of the sector to Gini reduction is positive, but very small.

We can conclude from these results that, during the inflation period and when the Brazilian exchange rate was fixed, the sugar cane and agricultural sectors have

decreased income concentration but their participations have also decreased. However, after 1999 they have both increased concentration.

As for Brazil, São Paulo Gini index decreases from 1992 to 2006 (from 0.548 to 0.526). However, both the agricultural and the sugar cane sector increase concentration and decrease participation (table 7). Therefore agriculture and sugar cane sectors have a negative impact on Gini index reduction.

The situation observed in São Paulo is quite similar to the national one, with an even stronger concentration effect of the sugar cane sector during the last period (1996-2006). Between 1993 and 1999, the sugar cane and agricultural sectors decrease concentration and participation, but in the last period (1999-2006) both sectors increase concentration, resulting on a negative impact on Gini coefficient reduction.

Table 7: Concentration and Participation Effect of sugar cane incomes, agricultural incomes and non agricultural incomes on equity in São Paulo State (1993-2006 / 1993-1996 / 1996-1999 / 1999-2006)

	Total Income	Sugar cane Income	Agriculture Income	Other sectors Income
1993-2006				
Concentration effect	117.09	-1.14	-20.62	138.86
Share effect	-17.09	-6.47	-9.99	-0.63
Total contribution	100	-7.61	-30.61	138.23
1993-1996				
Concentration effect	125.04	9.94	1.34	113.76
Share effect	-25.04	-9.37	-14.76	-0.91
Total contribution	100	0.56	-13.42	112.85
1996-1999				
Concentration effect	96.68	6.40	17.84	72.44
Share effect	3.32	4.96	-1.67	0.03
Total contribution	100	11.36	16.17	72.47
1999-2006				
Concentration effect	102.48	-3.80	-13.83	120.12
Share effect	-2.48	0.62	-2.99	-0.11
Total contribution	100	-3.19	-16.83	120.01

Source : Elaborated by the authors from the PNAD data

In the State of Pernambuco (Table 8), the concentration effect of the sugar cane sector and more broadly the agricultural sector start sooner, at the middle of the 1990s, but as their participation is increasing the total contribution of these two sectors on equity remains positive.

Table 8: Concentration and Participation Effect of sugar cane incomes, agricultural incomes and non agricultural incomes on equity in Pernambuco State (1993-2006 / 1993-1996 / 1996-1999 / 1999-2006)

	Total Income	Sugar cane Income	Agriculture Income	Other sectors Income
1993-2006				
Concentration effect	101.93	3.72	18.77	79.44
Share effect	-1.93	2.02	-3.76	-0.19
Total contribution	100	5.74	15.01	79.25
1993-1996				
Concentration effect	86.18	18.47	12.37	55.35
Share effect	13.82	-6.91	19.10	1.62
Total contribution	100	11.56	31.47	56.97
1996-1999				
Concentration effect	-457.89	-38.51	-284.30	-135.07
Share effect	557.89	181.25	332.47	44.18
Total contribution	100	142.73	48.16	-90.90
1999-2006				
Concentration effect	61.92	-11.90	-3.62	77.44
Share effect	38.08	25.96	9.46	2.66
Total contribution	100	14.05	5.85	80.10

Source : Elaborated by the authors from the PNAD data

3. Agricultural and sugar cane incomes and poverty

How much did agricultural sector growth in general and sugar cane sector growth in particular affect poverty levels? In this section, we are not working with northern states because we have almost no data for the sugar cane sector. Therefore, a panel data of 21 states and 10 years is built to highlight the impact of sugar cane income variation on poverty in Brazil. Following Ferreira et.al. (2007), the mechanical effect of initial state poverty rates is controlled including state-level fixed effect. State-specific time trends and differential poverty reduction effect of each sector growth rate are also allowed[4].

3.1 Methodology

Following Pontual et. al. (2006) and Ferreira et al. (2007), we assume that:

$$\ln P_{it} = \beta_i^{SC} \ln Y_{it}^{SC} + \beta_i^{P} \ln Y_{it}^{P} + \beta_i^{S} \ln Y_{it}^{S} + \beta_i^{T} \ln Y_{it}^{T} + \pi_i t + \eta_i + \varepsilon_{it} \tag{3}$$
$$(i = 1,...,N; t = 1,...,T)$$

Where, P_{it} denotes a poverty headcount index (H) in state i on year t. The superscript *SC, P, S* and *T* denotes respectively: sugar cane, primary (agriculture)n secondary (industry) and tertiary (services) sector incomes. Thus Y_{it}^{k} is income per capita for sector $k = SC, P, S, T$ in state i at year t. A time trend in included in regression and the error

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[4] We decided to estimate the income growth impact on poverty only after 1996, because of the high inflation periods and stabilization packages that have changed relative prices before 1996.

term includes a state fixed effect (η_i) as well as a time-varying component (ε_{it}), which might be auto-correlated.

In order to solve equation (3) specification problem and to eliminate the error term fixed effect, according to Ravallion and Datt (1996), we have:

$$\Delta \ln P_{it} = \sum_i \beta_i^{SC} s_{it-1}^{SC} \Delta \ln Y_{it}^{SC} + \beta_i^P s_{it-1}^P \Delta \ln Y_{it}^P + \beta_i^S s_{it-1}^S \Delta \ln Y_{it}^S + \beta_i^T s_{it-1}^T \Delta \ln Y_{it}^T + \pi_i + u_{it} \quad (4)$$

where $s_{it-1}^J = Y_{Jt-1}/Y_{it-1}$ is the income share of sector J at beginning of each period and $\Delta Y_{it} = \sum_{J=SC,P,S,T} s_{it-1}^J \Delta Y_{Jit}$.

Equation (4) allows to test whether the sector and geographic "pattern of growth" matter (rejection of null hypothesis that $H0$: $\beta_i^{SC} = \beta_i^P = \beta_i^S = \beta_i^T = \beta$).

Following Ferreira et. al (2007), it is possible that our estimates be biased by the presence of omitted poverty determinants varying non-linearly over time (for example state-level public expenditure or regional inflation rates). To control for both problems, the average years of education and the regional cost of living are included in the model. A dummy variable for the years prior to 1999 is also introduced in order to take account for the end of the fixed exchange rate period. When model (5) is estimated instead of model (3) the coefficient cannot be interpreted as elasticities.

$$\Delta \ln P_{it} = \sum_i \beta_i^{SC} s_{it-1}^{SC} \Delta \ln Y_{it}^{SC} + \beta_i^P s_{it-1}^P \Delta \ln Y_{it}^P + \beta_i^S s_{it-1}^S \Delta \ln Y_{it}^S + \beta_i^T s_{it-1}^T \Delta \ln Y_{it}^T$$
$$\Delta \ln ICVR + \Delta \ln EDUC + \pi_i + u_{it}$$
$$(5)$$

The rate of poverty reduction given by (5) can be decomposed into pure growth component, a component due to the sector composition of growth and components due to others factors. The pure growth component is defined as:

$$G \equiv E\left[\left(\beta^P s_{it-1}^P + \beta^S s_{it-1}^S + \beta^T s_{it-1}^T + \sum_i \beta_i^{SC} s_{it-1}^{SC}\right) \Delta \ln Y_{it}\right]$$

This is the contribution to poverty reduction of a (hypothetical) balanced growth process in which $\Delta \ln Y_{it}^P = \Delta \ln Y_{it}^S = \Delta \ln Y_{it}^T = \Delta \ln Y_{it}^{SC} = \Delta \ln Y_{it}$.

The sector component of the mean rate of poverty reduction is given by:

$$S^P \equiv E[\beta^P s_{it-1}^P (\Delta \ln Y_{it}^P - \Delta \ln Y_{it})]; \quad S^S \equiv E[\beta^S s_{it-1}^S (\Delta \ln Y_{it}^P - \Delta \ln Y_{it})];$$
$$S^T \equiv E[\beta^T s_{it-1}^T (\Delta \ln Y_{it}^P - \Delta \ln Y_{it})] \quad and \quad S^{SC} = E[\sum_i \beta_i^{SC} s_{it-1}^{SC} (\Delta \ln Y_{it}^P - \Delta \ln Y_{it})]]$$

They can be interpreted as the contribution of the sector composition of income evolution to poverty levels changes.

3.2. Results

The table (8) shows the estimated coefficient by (5). The null hypothesis, i.e. that the pattern growth does not matter, once the coefficients for primary, secondary and tertiary sectors are assumed to be constant across states, is rejected at the 1% level. Moreover, the agriculture and industry coefficients, on average, are not significantly different from zero. On the other hand, the tertiary sector income has a significant impact on poverty reduction. These results are similar to Ferreira et al. (2007) and Pontual et. al.(2006).

The coefficient of sugar cane income shows strong variations depending on the states (from 0.005 in Santa Catarina to -0.30 in Paraná). However, it is only significant in five states (Paraíba, São Paulo, Paraná, Mato Grosso e Goias). In Paraiba, the coefficient is positive suggesting that the sugar cane income growth increases poverty.

Table 8: Regression for poverty at state level allowing coefficients to vary across sectors and states

	Coefficient	SE
Agriculture Sector Average Income	-0.087	(-0.059)
Industrial Sector Average Income	-0.095	(0.106)
Sevice Sector Average Income	-0.541	(0.119)**
Sugar Cane Sector Average Income	**Ki**	
COL between states	0.620	(0.489)
State Average Years of Education	-0.548	(0.342)
State Dummy	Yes	
	Ki	**SE**
PI	0.028	(0.020)
MA	0.044	(0.058)
CE	-0.001	(0.035)
RN	0.013	(0.021)
PB	0.134	(0.065)*
PE	-0.132	(0.220)
AL	0.045	(0.181)
SE	0.019	(0.020)
BA	0.039	(0.042)
MG	-0.026	(0.052)
ES	0.005	(0.013)
RJ	0.146	(0.195)
SP	-0.237	(0.128)+
PR	-0.302	(0.059)**
SC	0.023	(0.043)
RS	-0.009	(0.021)
MS	-0.066	(0.038)+
MT	0.140	(0.163)
GO	-0.204	(0.084)*
time dummy	-0.030	(0.009)**
Observations	160	

	Ch2 (df)	p-value
H0: β_{ij} β	6.40 (116)	0.0000
H0: β_i^{SC} $\beta_{..}^{SC}$ ~	2.49 (116)	0.0015
H0: $_{..}^{P} = {}_{..}^{S} = {}_{..}^{T} = 0$	4.29 (116)	0.0089

Robust standard errors in parentheses

+ significant at 10%; * significant at 5%; ** significant at 1%

The poverty decomposition is found in table 9. Poverty rose during 1996-2000 but the trend reverses after 1999. Between 1996 and 1999, the service and sugar cane sectors contribute to reduce poverty. After 1999, industry and services are the drivers of poverty reduction. Despite the expansion of agriculture and particularly the sugar cane sector after 1999, we observe a positive participation of these sectors to poverty increase. When the period is taken as a whole only service has a substantially poverty reduction effect.

Table 9: Decomposition of overall poverty reduction

	1996-2000	2000-2006	1996-2006
Rate of reduction in headcount index	0.00125	-0.04900	-0.03225
Sector Pattern of Growth	0.00303	-0.00313	-0.00113
Primary Sector Pattern of Growth	0.00015	0.00033	0.00027
Secondary Sector Pattern of Growth	0.00268	-0.00059	0.00047
Tertiary Sector Pattern of Growth	-0.00342	-0.00264	-0.00289
Sugar Cane Sector Pattern of Growth	-0.00097	0.00214	0.00113

4. Conclusion

This paper aims at analyzing if the sugar cane sector growth may contribute to reduce inequity and poverty in Brazil. Looking at the past Brazilian experience and despite some social improvements, the sugar cane sector does not significantly participate to reduce poverty and inequity. Since the beginning of the years 2000, it may even have the opposite effect. The same kind of results is found for the agricultural sector as a whole. In the state of São Paulo, during the recent period, agriculture and sugar cane have a significant positive impact on income concentration.

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