What caused poverty reduction in Brazil during the 2000s: sectoral growth or public expenditures

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ABSTRACT

We ask what caused poverty to decline in Brazil during the first decade of the 21st century. Our contribution lies in the introduction of a structural change perspective to assess the evolution of poverty by considering the sectoral impact of growth and the social policies at the federal, state and municipal level. By structural change we mean the recomposition of output and employment over time. We run a first difference model to estimate the effects of mean income per capita by sector and of disaggregated public expenditures, without any attempts to infer causality. We confirm previous findings in the literature that the service sector rather than agriculture contributes the most to the sustained poverty reduction. Strikingly, the public administration is the leading sub-sector. We also find that state and municipal expenditures in human capital contribute more to poverty reduction than federal expenditures associated with conditional cash transfer programs; investment in infrastructure does not seem to contribute to poverty reduction. In short, we conclude that the payoffs of decentralized policies associated with human capital can be seen in the short run and therefore raise

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the bar for politicians to maintain and care for these policies. Furthermore, the public service sector, which is one of the main employers in today´s economy, must find ways to innovate and improve productivity if poverty reduction is to be sustainable in the long run.

Key words: poverty, structural change, decentralization, social policies.

¿Qué causó la reducción de la pobreza en Brasil durante la década de 2000: crecimiento sectorial o gasto público?

RESUMEN

Qué causó la disminución de la pobreza en Brasil durante la primera década del siglo 21 es la pregunta principal en este estudio. Nuestra contribución radica en incorporar una perspectiva de cambio estructural para evaluar la evolución de la pobreza en un contexto de altos precios en la agricultura y decentralización de la política social a nivel federal, estatal y municipal. Presentamos, entonces, un modelo de primeras diferencias para captar los efectos de ingreso medio por sectores y de gasto público descentralizado, sin ningun afán de comprobar causalidad. Confirmamos hallazgos previos en la literatura de que el sector de servicios, en lugar de la agricultura, es el que más contribuye a la reducción sostenida de la pobreza. Sorprendentemente, la administración pública es el principal subsector en rama de servicios. También encontramos que los gastos estatales y municipales en capital humano contribuyen más a la reducción de la pobreza que los gastos federales asociados con los programas de transferencias condicionales de efectivo. En resumen, afirmamos que los beneficios de las políticas descentralizadas asociadas con el capital humano se pueden ver a corto plazo y, por lo tanto, elevan el nivel de los políticos para mantener y cuidar estas políticas. Además, el sector de servicio público, que es uno de los principales empleadores en la economía actual, debe encontrar formas de innovar y mejorar la productividad para que la reducción de la pobreza sea sostenible a largo plazo.

Palabras clave: pobreza, cambio estructural, decentralización, política social.

INTRODUCTION

We are living through one of the best periods of our nation's life," exulted the newly inaugurated Brazilian president, Dilma Rousseff, in January 2011". Brazil had an average growth rate per capita over 3% between 2002 and 2010, and Rousseff and the governing Workers Party (PT) took credit for pushing over 10 million out of poverty and another 10 million more into the middle class. Many believed that well targeted government expenditures had significant impact on poverty during this period (Hoffman, 2006; Rocha, 2006) as well as increases in the minimum wage during the period (Paiva, Falcão & Bartholo, 2013). However, some contend that the so-called conditional cash transfers, the flagship of social policies during the 2000s, did not contribute to the decline of poverty across Brazilian states between 2000 and 2008 (Marinho, Linhares & Campelo, 2011; Schwartzman, 2006).

Taking a long term perspective, the consensus holds that there is no way out of poverty without the transformation of agriculture (Kuznets, 1973; Timmer, 1988), and Brazil had become a global powerhouse in agriculture over the last two decades, and the third largest agricultural exporter after the US and the European Union (Nin-Pratt, Falconi, Ludena & Martel, 2015). In this line, countless studies show that the elasticity of poverty reduction with respect to growth is stronger when growth originates in the agricultural sector (Dethier & Effenberger, 2011). However, claims that agriculture did not play a large role in the reduction of poverty during the 1990s, still resonated (Ferreira, Leite & Ravallion, 2010).

Noting the dual nature of Brazil´s economy, students of structural change agree that the impact of growth on poverty reduction varies across sectors and states in a systematic way (De Janvry & Sadoulet, 2009; Ferreira *et al.*, 2010; Loayza & Raddatz, 2010; Ravallion, 2011). By structural change we mean the recomposition of output and employment over time (Bustos, Caprettini & Ponticelli, 2016; Diao, McMillan & Rodrik, 2017). In this line, we introduce a structural change perspective to assess the evolution of poverty during the two presidential terms of Luis Inácio Lula Da Silva, perhaps the most important politician in Brazil since the end of military rule. Lula Da Silva, a former union worker, got elected by reassuring investors that the market stability would be maintained. He fulfilled his promises but also pursued an social liberalist agenda that put conditional cash transfer programs from the federal government as the key policy in their fight against poverty.

In order to clarify the unprecedented improvement of the income distribution during Lula's term, we address sectoral growth and disaggregated public expenditure as the main factors behind the reduction of poverty for the period 2002-2009. We run a first difference model to estimate the effect of mean income per capita by sector on poverty, considering that the poverty impact of growth will depend on the sectoral size. Agriculture has therefore lower chances to reduce poverty despite its rebound during the high prices in the 2000s. The sectoral shares are lagged to keep the panel balanced and ensure sectoral GDP per capita remains weighted by its share in a given year. We also allow the coefficients to vary by state for each sector. Our second model will include the government expenditures disaggregated in three categories. Our main expectation was that decentralized policies are more likely to be poverty reducing than centralized policies. Specific tests for serial autocorrelation and homoscedasticity are run.

The first finding is that the service sector, not agriculture, contributes the most to the sustained poverty reduction during Lula´s presidential term between 2003 and 2009. The results were large and statistically significant, casting light onto the importance of the government budget on economic activity through production and not solely through policy. However, we concede that the agricultural commodity boom was indeed beneficial for the Brazilian economy, and the linkages across factors and product markets have indirect effects that our statistics are not able to catch at this stage of the transformation process.

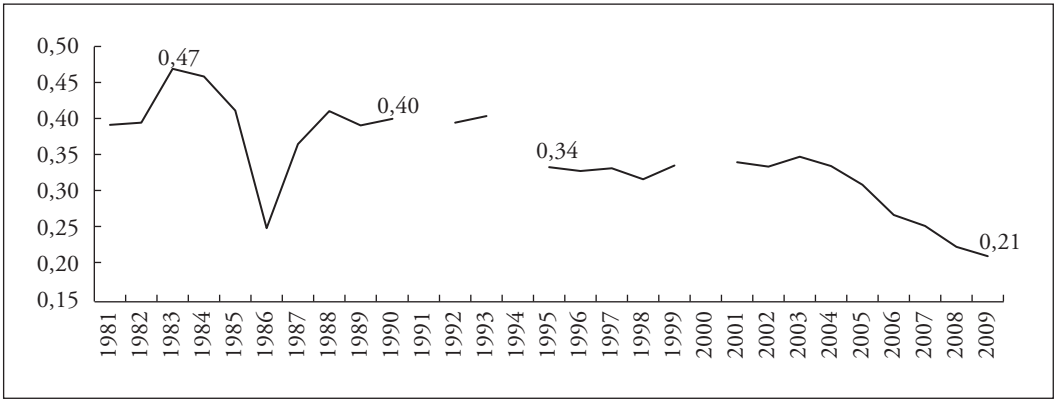
The second finding is that federal transfers associated with conditional cash transfers such as Bolsa Familia appear to contribute little to poverty reduction in the short run across Brazilian states. In contrast, social policies in human capital at the state and municipal level contribute more to poverty reduction than Bolsa Família did in the short run. This is somehow impressive since these effects of government expenditures in human capital are usually expected in the long run. In other words, investments in education and health have provided short-term effects on reducing poverty. Furthermore, federal and capital transfers, which are associated with investments in infrastructure, did not have a poverty reducing impact during Lula's term as President.

Even though the social policies during Lula´s presidential terms may be labeled as equality enhancing, the main implication is that there is no conflict between redistribution and growth, or equity-growth trade off, in particular if policies are aimed at improving human capital. We conclude that the payoffs of such policies can be seen in the short run and therefore raise the bar for politicians to maintain them. Furthermore, the public service sector, which is one of the main employers in today´s economy, must find ways to innovate and increase productivity if poverty reduction is to be sustainable in the long run.

1. POVERTY REDUCTION AND SECTORAL GROWTH

Poverty in Brazil has been a main feature of its economic development during the second half of the 20th century (see figure 1). More than half of the population lived in poverty until

Figure 1
Proportion of individuals considered poor within Brazilian population (1981-2009, in %)



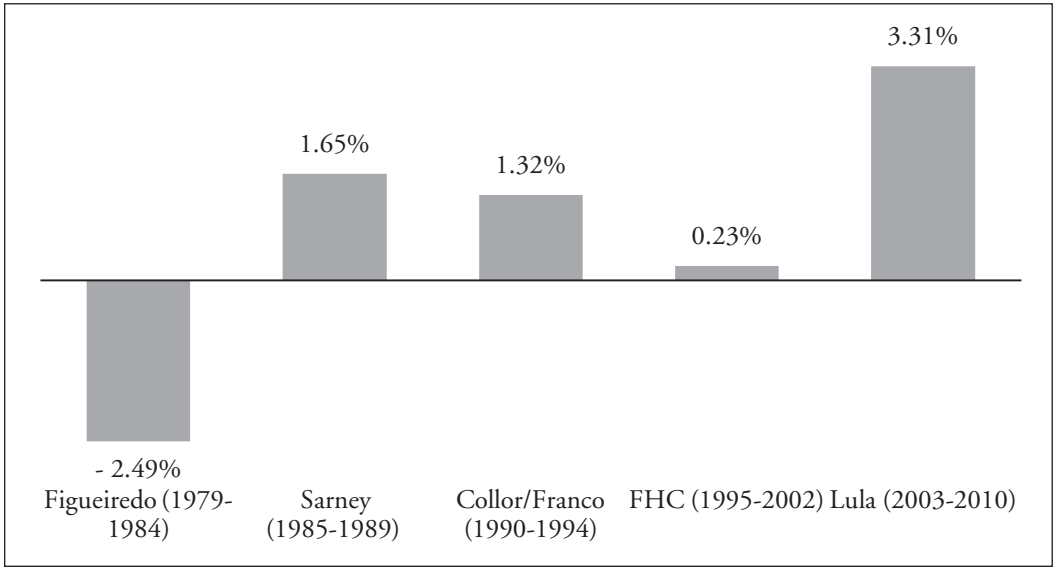
Source: Authors calculations from the database of the Institute of Applied Economic Research (IPEA)

the mid-1980s, which coincides with the end of the military rule. Military rule, which lasted from 1964 to 1985, produced no significant improvements in the income distribution (Graham, Gauthier & de Barros, 1987). The transition into democracy began with President Sarney between 1985 and 1989 and came along with structural economic adjustments to an economy overwhelmed in high inflation and unemployment (Reis, 2014).

The annual growth rate per capita was barely above 1% between 1990 and 1994, when Franco became the president after the fallout of Collor de Mello (figure 2). Between 1995 and 2002, which coincides with the presidential terms of Cardoso, the annual per capita growth was 0.23%. Yet, under these conditions, poverty fell to around a third of the population by the turn of the century.

True, poverty in Brazil fell during the period 1985-2004 in spite of the lack of growth. Ferreira *et al.* (2009) write, "largest sources of poverty reduction over this period (…) were driven by the substantial reduction in inflation rates and by the expansion in social security and social assistance spending by the Federal government". In other words, macroeconomic stability and redistribution (i.e., fiscal transfers at different government levels) had been the main policy tools to induce positive changes in the income distribution. After 2003, the downward trend in poverty continued and fell

Figure 2
Compound Annual Growth Rate of the GDP per capita during the last 5 presidential terms



Source: Authors calculations from the database of the Institute of Applied Economic Research (IPEA)

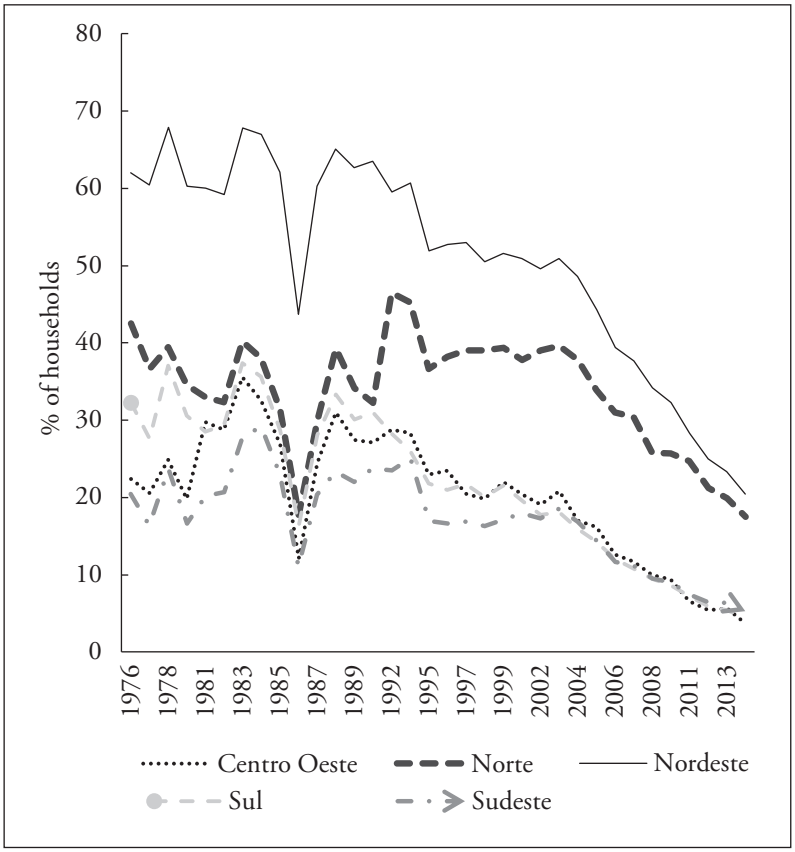
to 21% of the population in 2010. The annual growth per capita was 3.3% between 2003 and 2010, which coincides with the two terms of President Lula Da Silva.

During the second half of the 20th century, the process of structural change in the Brazilian economy continued with strong reallocation effects of labour across some sectors of the economy. There is no reliable data prior to 1970s but the national account data taken from the Groningen Growth and Development Centre (GGDC) indicates that during the military period (1964-1985) the share of the labor force in agriculture fell from 55% to 35%, and its sectoral share of GDP from 10% to 5%. The reallocation into manufacturing had already reached its peak in the 1970s and did not absorb the surplus labor. Thus, poverty remained high during the period. In 2010, over 17% of the labor force still worked in agriculture, and the sectoral share of agricultural GDP is close to 6%. In other words, the reallocation of agricultural labor to other sectors is not complete, and may explain that today around 21% of the Brazilian population are poor.

Ferreira *et al.* (2009) argue that "marked differences in the poverty reducing effect of growth across different sectors, with growth in the services sector being consistently more pro poor than either agriculture or industry" (p. 33). The general implication of the finding is that agriculture is not, at least during this period, the engine behind the structural changes in the developing economy of Brazil. However, some argue for a recent resurgence of the agricultural sector in Latin America, particularly in Brazil, with clear implications on the income distribution. For instance, Andersson and Palacio (2017) examined the period 1995 and 2010 and confirmed the previous finding that agricultural productivity in labor has been three times larger than that in manufacturing (Andersson & Palacio Chaverra, 2016).

However, the relationship between structural change and poverty is not automatic. One of the reasons is that the sectoral capacity to employ labor outside the agricultural sector, especially in services is difficult to predict if there is no convergence between labor and capital in the economy and therefore into higher levels of productivity. Hence, the contribution to growth of those sectors absorbing labor with low productivity will end up reducing it at the aggregate level (Diao *et al.*, 2017). Another reason is how the political pressures organized themselves to promote redistribution. Lula Da Silva reassured investors that the market stability would be maintained and put conditional cash transfer programs from the federal government as the key policy in their fight against poverty. In this line, Kuznets prediction (1973) that the turn of the inequality curve was associated with growing income per capita across sectors and therefore with growing political voice and participation fit the recent history of Brazil. In sum, the political elites have not hijacked power for their own purposes alone, and the moral and economic imperatives to reduce and eliminate poverty go along with the deepening of political and civil rights (Stiglitz, 2012).

Figure 3
The evolution of regional poverty



Source: Authors calculations from the database of the Institute of Applied Economic Research (IPEA)

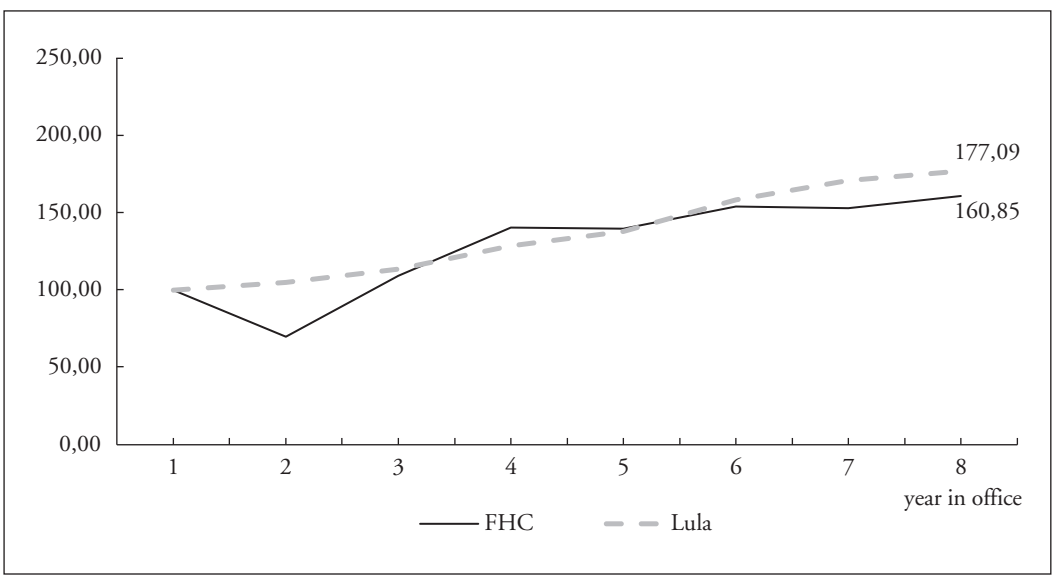
2. POVERTY AND THE DECENTRALIZATION OF SOCIAL POLICIES

Sectoral economic growth is indeed central to explain the reduction of poverty, but we also know about how uneven growth can be at the regional level (Loayza & Raddatz, 2010). Some regions grow faster than others do, and the differences may support the persistency of income gaps within a country. Brazil is indeed a good example of different levels of development within a country. For instance, the Northeast region is less developed than the southern regions. The relative backwardness of the Northeast region has been on the government agenda since the late 19th and has

persisted during the 20th century, but with little success (De Vreyer & Spielvogel, 2005). Not surprisingly, the poverty level in the Northeast was three times that of the southern regions in 2000 (see figure 3).

With the end of the military rule between 1964 and 1985, the aim of the 1988 Federal Constitution was to restore individual rights that had been suppressed for two decades and to diminish regional inequalities in health, education, social security, work, leisure, and child protection, in other words, to improve the well-being for all (art.203-204 of the Federal Constitution). To implement these goals, decentralization and universal policies were called upon. Brazil is a federative republic consisting of States, Municipalities and the Federal District. Consequently, not all expenditures are the responsibility of the Federal government. States and municipalities have a certain level of autonomy on setting expenditures on health, education and social assistance. The municipalities, which had played a secondary role in the policy arena, gained in political, fiscal and administrative importance as they were called to provide these services to its citizens (Rodrigues-Silveira, 2011).

Figure 4
Evolution of aggregated SME for each president's year in office (First year in office=100)



Source: Author's calculation from the State and Municipal Accounts/IBG. The values that allowed this index can be found on Section 9.2 in the Appendix. All values are in Reais (R$) of 1995.

The new institutional arrangement played out well during the Sarney administration between 1985 and 1990 and continued during the short-lived administration of Fernando Collor's presidency between 1990 until 1992. The states, which used to have a veto power over national policies, saw their power diminished (Fenwick, 2009). Yet, the Federal Government was not able to support and monitor large-scale social programs until the macroeconomic fundamentals stabilized during Fernando Henrique Cardoso administration (1995-2003).

During Cardoso's term, the state and municipal expenditures grew at a rate of 7% per year, which is 1.5 percentage points below that during Lula Da Silva´s term (figure 4). The macroeconomic stabilization during Cardoso´s term came in tandem with condition-based social programs aimed at investing in education and food and gas for the bottom of the population between 1999 and 2002. First, the Bolsa Escola (School Allowance) was a conditional cash transfer program that provided financial assistance to low-income families for sending their children to school instead of using them as labor. Second, the Bolsa Alimentação (Food Allowance) and Auxílio Gás (Cooking Gas Assistance) were aimed at increasing food security of low-income families. Unlike the other two, the Auxílio Gás, was a cash transfer without formal conditions. It was a small payment for each family whose income was below half a minimum wage per capita for the acquisition of gas cylinders for cooking purposes. The program came from the understanding that malnourishment was not related to food scarcity but of means to cook the food properly. These three social programs merged into one during Lula da Silva's administration and were unified under the label Bolsa Família. As one single program, Lula's administration expanded its coverage: over 13 million families, or 47 million individuals, were registered in 2013.

Furthermore, the sudden increase towards Social Security and Social Assistance during Lula's term is related to Federal expenditures on cash transfers, in particular Bolsa Família, established during the second year of Lula's presidency in 2004. Bolsa Família became indeed a cornerstone in the politics and policies to reduce poverty in Brazil. As noted above, the program covered almost 47 million people but takes up only 0.5% of the Federal budget. It appears to be efficient, but there are voices concerned with the ability of the State to target and monitor these payments. Schwartzman (2005, p. 1) writes, "these policies are not properly grounded in search, and are based on wrong assumptions" (Schwartzman, 2005). In the same line, Marinho *et al.* (2011, p. 283), examine the period between 2000 until 2008 and conclude that Bolsa Família did not affect or did not contribute for the decrease of the poverty level on Brazilian states" (Marinho *et al.*, 2011). Many observers suggested that Lula Da Silva would not have been reelected without the expansion of Bolsa Familia (Freitas, 2007; Moura, Silva & Galvão, 2007). Yet the evidence indicates that recipients of Bolsa Familia voted indistinctly during both elections (Bohn, 2011). The study shows recipients of Bolsa Familia voted for Lula Da Silva as the same as non-recipients during his reelection.

Lula's administration also established other poverty reducing programs such as "Minha Casa, Minha Vida" (My House, My Life). The aim was to fund housing for poor and middle class families. The Prouni Program is another example. It offered partial or full scholarships for undergraduate studies for students of families with monthly income below 1.5 minimum wage. More than 1 million students have benefited from the program as it continued during Dilma Rousseff's administration between 2010 and 2016.

Rousseff's administration also continued the expansion of Bolsa Família under the broader Brasil Sem Miséria (Brazil Without Extreme Poverty). It provided a conditional cash transfer plus public services such as medical and dental care, electricity, sanitation and daycare to poor areas. Another social program was the Brasil Carinhoso (Caring Brazil) that aimed to provide an additional benefit for families with children below the age of 6 years. Alongside the Prouni program mentioned above, the Pronatec was created to provide scholarships for technical level studies.

In sum, poverty has been a long-lasting feature of the Brazilian economy. While the country struggled with political and economic crisis throughout the 1970s and 1980s, little was done to alleviate the problem. However, the macroeconomic stabilization during the 2000s and fast economic growth caused by the commodities' boom were important conditions for setting up social policies aimed at improving human capital attainment. Fighting poverty, however, is a long time endeavor, and many have attacked such policies even though everyone agrees on their central role in the 1988 Federal Constitution. The last three administrations (Cardoso, Lula Da Silva and Rousseff) were committed to maintaining and improving the coverage of the social policies while honoring the new role of municipalities in catering for the needs of their inhabitants.

3. TESTING THE LINK BETWEEN POVERTY, SECTORAL GROWTH AND DECENTRALIZED SOCIAL POLICIES

In this exercise, we follow the econometric specification proposed by Ferreira *et al.* (2009) in order to ensure comparability with their estimates for the period 1985-2004. Our dependent variable is the most common measure of poverty: the Head Count ratio. The Head Count ratio is an absolute measure of poverty that accounts for the number of poor individuals based on a poverty threshold. It can be estimated using the Foster-Greer Thorbecke class estimator, and we use Regional Account Statistics and the National Household survey data from the Brazilian Bureau of Statistics (IBGE, 2013). The poverty threshold is based on WHO/FAO benchmark to estimate the cost of a food basket that provides 2100 calories intake per day. The series are deflated using the regional price estimations estimated by Ferreira *et al*. (2003) and the Consumer Price Index (IPCA), whose baseline is Reais of 2003. The estimated food basket represents a monthly income of 106.4 Reais per capita in any given household, and therefore individuals living in a household below that threshold are poor (see table 1 below). We fail however, to account for wealth in our measure of poverty.

Table 1
Head count ratios

Year	HC
2002	40,2%
2003	41,2%
2004	39, 4%
2005	36,5%
2006	31,8%
2007	30,2%
2008	26,8%
2009	25,5%

Source: Author´s calculation from IPEA/PNAD

We have two (2) independent variables that complement each other. First, structural change, which is captured through the sectoral GDP of agriculture (incl. livestock, extractive agriculture and forestry), manufacturing (mining, manufacturing, construction and public utilities) and services (commerce, transport, communications, financial services, real state, public administration, other services not provided by public administration, education & health, lodging & food and domestic services). The data is provided by IBGE and is disaggregated by sector and state. We built a strongly balanced panel of 27 Brazilian states with 216 observations, with IBGE weights to avoid any sampling biases and ensure national representativeness. These series were also deflated using the Consumer Price Index (IPCA) with 2003 as the baseline.

Second, decentralization is captured through government expenditures at the federal, state and municipal level. The data comes from the Institute of Applied Economic Research (IPEA). Here we classify government expenditures into three categories:

1. State and Municipal Expenditures (SME) include health and sanitation, education & culture and social security.
2. Capital Transfers (CT) include infrastructure investments made by states and municipalities.
3. Federal Transfers (FT) include social security and social assistance made by Federal government (see table 3). The main Federal programs include:
   - Continued Social Assistance Benefit (BPC, in Portuguese): A monthly transfer of a minimum wage for any disabled or elderly (65 or older) individual in a household with a per capita income of less than 1/4 of the minimum wage. By 2009, 1.65% of the Brazilian population received it.
   - The Lifelong Monthly Income (RMV, in Portuguese): the predecessor of the BPC mentioned above, which was established in 1974. Since 1996, the BPC has gradually replaced the RMV and represented 0.17% of the Brazilian population in 2009.
   - Bolsa Família (BF): A conditional cash transfer program for poor families established in 2004. The benefit varies according to the household income per capita and the number of children alongside their age. The fulfillment conditions such as school attendance and vaccination for the children are necessary in order to be

granted the benefit. By 2009, the number of families that were registered as beneficiaries surpassed 11 million, in other words, 47 million citizens, roughly 25% of the total population.

Table 2
Classification of social policies by government expenditures

	Centralized (Federal District)	Decentralized (States and Municipalities)
Targeted	Conditional cash transfer program "Bolsa Família" (education and health)	Social assistance to children, elderly, handicapped and unemployed
Universal	Social security (BPC and RMV)	Health and sanitation, education & culture and social security

In other words, we suggest the following function:

Head count ratio = sectoral GDP per capita + government expenditures + state dummies + time trend + other controls

Based on the broad specification, we realize that a first difference model is the most suitable choice to estimate the effect of mean income per capita by sector on poverty. Hence, we acknowledge that the poverty impact of growth will depend on the sectoral size. Agriculture has therefore lower chances to reduce poverty. The sectoral shares are lagged to keep the panel balanced and ensure sectoral GDP per capita remains weighted by its share in a given year. We also allow the coefficients to vary by state for each sector. Our second model will include the government expenditures disaggregated in three categories. Our main expectation is that decentralized policies are more likely to be poverty reducing than centralized policies. Specific tests for serial autocorrelation and homoscedasticity are run.

4. RESULTS

In table 3 we show that agriculture had indeed little impact on the reduction of poverty during Lula´s term. The size and the significance of the coefficients indicate that manufacturing and services, not agriculture, do reduce poverty. Note that these are not elasticities. The contribution of the non-agricultural sectors is similar in size and almost twice that of State and Municipalites Expenditures (SME) in models 1-3. While Ferreira *et al.* (2009) explore the years from 1985 to 2004; this study updates their conclusion about the role of services in reducing poverty in Brazil. The agricultural commodity boom was indeed beneficial for the Brazilian economy, but the effects are more likely to be indirect. In the light of this finding, we argue that poverty dynamics during Lula's term in Presidency, at least concerning economic growth, followed the same pattern estimated for the previous period.

We also find that decentralization of social policies, which is captured through SME contributes the most to poverty reduction during Lula´s term. Models 3 and 4 show that

Table 3
Poverty regression on sectoral income per capita and government transfers

	Model 1	Model 2	Model 3	Model 4
Agriculture	0. 60**	0.34	0.33	0.40
Manufacturing	-0.62**	-0.56**	-0.53**	-0.14
Services	-0.77**	-0.59**	-0.61**	
Non-public services				0.23
Public services				-0.80**
SME		-0.34**		
Education and culture			-0.17**	-0.12**
Health and Sanitation			-0.12*	-0.16**
Social Assistance/Security			-0.04	-0.03
Capital transfers		-0.02	-0.02	-0.00
Federal transfers		-0.03	-0.04	-0.02
Time trend	X	X	X	X
R squared	49%	56%	53%	64%
Number of obs.	189	189	189	189

Note: Statistical significance is indicated as * at the 10%, ** at the 5%.

the disaggregation of this expense between Education & Culture, Health & Sanitation were significant on poverty reduction, which is somehow impressive since these effects are usually expected in the long run. In other words, investments in education and in health have provided short-term effects on reducing poverty. In contrast, the impact of social assistance and security appears to be negligible, but it is also reducing poverty.

We see in model 4 that a disaggregation between public and non-public services indicates that public services related to the State are also key in the reduction of poverty. Services provided by the public administration contribute to the poverty reduction during the last decade. The results were large and significant and cast light on the importance of government impacts on economic activity through production or employment and not solely through policy.

We confirm also that federal transfers attached to Bolsa Familia appear to contribute little to poverty reduction in the short run across Brazilian states. That finding goes in line with concerns on the ability of the Brazilian Federal government to target poor individuals alongside its capacity to track the program through time (Marinho *et al.*, 2011; Schwartzman, 2005, 2006). In contrast, we believe that the value given to the beneficiaries might not be enough to leverage ones' income enough to leave the poverty threshold. The implication is that the program should have its average

ticket increased if poverty is to be affected in the short run. Considering that more than 13 million families were beneficiaries of the program in 2013 –representing roughly 25% of the Brazilian population– there is definitely not a problem with coverage, which leaves either the benefit or its efficiency as potential explanations for any given insignificant effect found on the literature.

We also find that Federal and Capital transfers do not have any significant effect on reducing poverty. When it comes to Capital Transfers, no statistical significant effects were found. This is in line with Ferreira *et al.* (2009). The result reveals that investments and capital transfers made by different government levels concerning infrastructure did not have a poverty reducing impact during the 80s, 90s or even during Lula's term as President. These findings on government expenditures or transfers are not shocking. First, programs as BPC and RMV cover less than 2% of the Brazilian population. Second, Bolsa Família, even though with a massive coverage of roughly 25% of the population, does account for 1% of the GDP between 2002 and 2009. Thirdly, the average benefit Bolsa Família have paid to its beneficiaries was R$ 70.19 per month in 2009. That means, in US dollars of 2003, an average benefit of US$ 29.19; in other words, less than a dollar a day. It is hard to believe that a program that provides such a small benefit will have any significant impact on poverty reduction through its cash handout, especially when setting a poverty line based on a caloric-intake. Yet as highlighted by Paes-Sousa *et al.* (2013) "long term interventions"; therefore, the present study results should not be interpreted as advocating to the end of such programs (Paes-Sousa, Regalia & Stampini, 2013).

CONCLUSIONS

We ask what caused poverty to decline in Brazil during the two terms of President Lula Da Silva in Brazil. In order to tackle the question, we introduced a structural change perspective to assess the evolution of poverty by considering the impact of sectoral growth and the social policies at the federal, state and municipal level. We find that government expenditures in human capital at the state and municipal level contribute more to poverty reduction than federal expenditures associated with conditional cash transfer programs. We also confirm that the service sector, not agriculture, contributes the most to the sustained poverty reduction. The leading subsector within services is public administration. This finding does not mean that agriculture is not important for poverty reduction but the effects may be indirect given the process of structural transformation in the Brazilian economy. Hence, decentralization of social policies aimed at human capital rather than infrastructure may contribute to the reduction of poverty regardless of growth outcomes. The payoffs of such policies can be seen in the short run. Therefore, it raises the bar for incumbent politicians to maintain these policies in place. Furthermore, the public service sector, which is one of the main employers in today´s economy, must find ways to innovate and improve productivity if poverty reduction is to be sustainable in the long run. In other words, a call for policymakers about the redistributive role of social policies in the midst of

structural changes in the economy regardless of growth outcomes.

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APPENDIX

The variables of this study can be divided in four groups: poverty measures, economic growth, government expenditures and auxiliary covariates. These four groups are going to be detailed within this subsection while highlighting its descriptive statistics.

- Poverty measures

The definition of a robust and representative poverty line is one of the cornerstones on poverty studies and permeates the whole subject alongside its possible measurements. However, the need to compute this index generates two immediate problems: accounting the poor and setting a poverty threshold.

To shed some light into the first immediate problem – accounting the poor - the framework developed by Foster *et al.* (1984), could be used as a starting point. This measure for poverty is also known in the literature as the Foster-Greer-Thorbecke class estimator and is built as it follows:

$$FGT_a = \frac{1}{N}\sum_{i=1}^{H}\left(\frac{z - y_i}{z}\right) * a \qquad (1)$$

Where:

"N" is the number of observations; "z" is the poverty threshold; "H" is the number of individuals with income below "z"; "y" is the income of each observation "i" and "a" is a weighting measure. By analyzing (1), it is easy to note that when a=0, the poverty measurement collapses to *H/N*, which is regarded in the literature as the Headcount Index. When a=1, the measurement is called the Poverty Gap. For the purposes of this study, the Headcount Index is going to be used. However, as it can be noted, this is an absolute way of measuring poverty since it accounts purely if a given individual is above or below a previously defined poverty threshold. Naturally, some criticism might arise from this choice since an absolute measure might be regarded as an incomplete way of accounting for poverty.

In fact, poverty as a relative – rather than an absolute – concept has received a lot of attention in the literature surrounding the subject. Moreover, this discussion was presented

even in the foundation of classic economics when Adam Smith (1776) poses that "necessities" were more than just the minimum required for subsistence, but also what society regarded as a basic need:

> By necessities, I understand not only the commodities which are indispensably necessary for the support of life, but what ever the custom of the country renders it indecent for creditable people, even of the lower order, to be without. (p. 351).

Other authors such as Karl Marx (1887) argued that "(…) in a given country (…) the average quantity of the means of subsistence necessary for the laborer is practically known" (p. 121), also implying, as Adam Smith, that the measure of poverty is conditional to the collective perception. Orshansky (1969) on his attempts to measure poverty in the United States also highlight that poverty "is a value judgement" and "lies in the eyes of the holder" (p. 244). Sen (1976), despite arguing against a purely relative perspective – he cites famine as a way of identifying poverty regardless any collective standard thus, with an absolute component -, perceived a purely absolute measure as the Headcount Index as "very crude" (p. 219).

In the light of the aforementioned literature, it seems contradictory to use the Headcount Index. However, even its critics have come to recognize its importance as Sen (1976) does when citing a collection of studies published between 1970-1971 that explored the poverty dynamics in India and have generated profound debates on the issue (p. 220). Nonetheless, this index is still widely used in contemporary literature as it is possible to verify not just for the Indian case on Ravaillon & Datt (1996, 1998a, 2002) but also for other developing countries on Ferreira *et al.* (2003, 2008, 2009), Aryeetey & McKay (2007), Christiansen & Demery (2007) and Ravaillon (2009), just to cite some well-renowned studies.

The use of an index that is widely found on the literature – contemporary or not – allows the study to be comparable in a more direct way as well as to analyze long-term trends and evolutionary aspects concerning the subject, therefore, it is also from methodological importance. Nonetheless, the Headcount Index can be estimated in a way that relative poverty is considered thus, minimizing the problems of purely absolute measurements. One way of doing so is by correcting consumption data and calculating class-specific deflators, allowing heterogeneous populations to be jointly analyzed. With that in mind, it is possible to address the second problem underlying poverty measurements: setting a threshold.

It is important to define a constant living standard across sectors and regions over the period of analysis so poverty becomes comparable. A widely adopted method is the estimation of the income level necessary to acquire a basket of goods capable of providing a minimum food-energy intake. A prompt literature analysis reveals that estimations for both the caloric level as well as the cost of the food basket vary considerably across countries and sectors with no clear benchmark. However, most of the studies follow the WHO/FAO recommendations on caloric intake to a certain extent. Ferreira *et al.* (2003), for example, uses WHO/FAO as a bench-

mark to estimate the cost of a food basket that provides 2288 calories intake per day when defining a poverty threshold for the Brazilian case. In their study, data regarding consumption patterns was considered in order to assess the cost of the aforementioned food basket in different regions of the country. After deflating the series geographically and temporally, the results were applied on poverty measurements.

This study will follow the same structure. It will consider the same caloric line of 2288 calories per day and will deflate the each Household Survey geographically according to Ferreira *et al*. (2003) regional price index estimations[1]. By doing so, it is possible to compare incomes within each Household Survey. However, in order to also make the incomes per capita to be comparable across the years, each Household Survey was deflated temporally through the Consumer Price Index (IPCA) considering the baseline as Reais (R$) of 2003. The proposed food basket was estimated to represent a monthly income of R$ 106.41 per capita in any given household.

From that point, all individuals living in households with income per capita below the 106.41 reais threshold are accounted as poor. The headcount index is obtained following equation (1). It is important to note that only households with non-declared income were excluded from the analysis. Despite the fact that this methodology seeks to generate a robust poverty index, there are evidences that poverty dynamics are extremely sensitive to the chosen poverty index and threshold. Ravaillon & Sen (1996) demonstrate for the case of Bangladesh that even when poverty estimators were taken from the same survey, they could still present some "worrying discrepancies" to the point that "past studies have come to different conclusions about the directions of change in poverty over time" (p. 785). These findings are in line with Kakwani (1993) on his study to test statistical inference in poverty measurement, concluding that " (…) empirical results suggest that observed differences in values of poverty measures may lead to misleading conclusions without the statistical tests" (p. 638).

Therefore, in order to bring more robustness to any future finding, this study will also consider a second poverty measure that is available on the Institute of Applied Economic Research (IPEA) database and provides the number of people in households with per capita income below the poverty line. The poverty line was defined through "an estimate of the value of a basket of food with the least amount of calories needed to adequately supply a person,

[1] Ferreira (2003) estimates geographic deflators based on the Living Standards Survey (PPV, in Portuguese) of 1996. In this survey, consumption patterns are analyzed across different Brazilian regions and the geographic deflator is generated through the comparison of a specific consumption pattern with the weighted average consumption pattern. Ferreira (2003) have chosen the metropolitan region of São Paulo as the "star" region, therefore, other regions are deflated according to São Paulo standards.

based on FAO and WHO recommendations"[2]. The estimated values are deflated geographically according to 24 different regions of the country and are calculated from the responses from the National Household Survey. Even though not available in the methodological annex of the series, it came to the knowledge of this study after questioning the Institute that the "caloric threshold" was set on 2100 calories per day. With the two measures computed, it is possible to note some differences despite the small gap in the caloric threshold:

Table 1
Headcount Index (%)

Year	IPEA/PNAD	Author's
2002	40.26	33.66
2003	41.24	33.12
2004	39.49	32.19
2005	36.52	29.95
2006	31.87	25.60
2007	30.28	23.60
2008	26.86	20.29
2009	25.57	18.93

Source: Author's calculation from PNAD

Due to its lower caloric threshold, IPEA's headcount index is systematically higher than the index calculated by the present author. Despite these differences, the trend is the same, with consistent reduction year over year. Another difference between the indexes is the deflator. While the present author deflated the series geographically according to Ferreira *et al.* (2003) regional deflator index – that, in turn, was derived from the Survey of Living Standards from 1996/1997 – IPEA's series were geographically deflated according to Household Budget Survey (POF).

Before closing this section, I would like to underscore that poverty is being measured solely by income in this study. By doing so, an unexplored field is left open since income does not fully capture wealth. It is possible to illustrate this situation in a household where the income per capita is zero though the individuals living in the household can still suffice their basic needs due to accumulated wealth; therefore, are maintained above the poverty line based on past incomes, inheritance or any favorable initial allocation. This situation could apply, for example, to highly skilled but unemployed professionals or even to individuals who are unemployed but do not actively seek to join the labor force. Some studies have discussed this subject more thoroughly such as Barros *et al.* (2003) while proposing an index that accounts for an individual HDI measurement. Following the same concern regarding the multidimensionality of poverty, Kageyama & Hoffmann (2006) adopted an index that considers income alongside non-

[2] Freely translated from portuguese. Description available in http://www.ipeadata.gov.br/ in the comments section of the "Número de indivíduos pobres - Linha de Pobreza Baseada em Necessidades Calóricas" series.

monetary measurements such as the presence of a bathroom inside the house, piped water and electricity.

- Economic Growth

Variables regarding economic growth were taken the Regional Account Statistics that is maintained by IBGE. The data is found disaggregated per state and per sector. The sectors, however, are represented by fifteen broad categories. In this study, similarly to Ferreira *et al.* (2009), a breakdown between agriculture, industrial and services sector is what is being pursuit, therefore, it is necessary to group these sectors accordingly. The categories are presented as follows:

1- Agriculture, livestock production, extractive agriculture and forestry;
2- Mining Industry;
3- Manufacturing Industry;
4- Construction Industry;
5- Electricity, gas and water provider industries;
6- Commerce;
7- Transport
8- Communications;
9- Financial Services;
10- Real State institutions;
11- Public Administration
12- Collective, social and individual services not provided by public administration;
13- Education and Health;
14- Lodging and Food;
15- Domestic Services.

While category 1 represents the Agricultural sector, categories 2 to 5 were grouped together as to represent the Industry sector. The remaining categories (6 to 15) were all designated as part of the Service sector. It is important to note that all these categories are presented in their nominal values, therefore, the values must be deflated temporally. There is some debate around the best way to deflate a GDP series for the Brazilian case; the Brazilian Bureau of Statistics, for example, recommends an official measure of GDP deflator available on their database. However, the recommendation is mostly due to the big structural shocks Brazil had on its economy during the 90's - especially between 1993 and 1995 – when a period of hyperinflation was experienced. An elucidative discussion regarding the use of different indexes can be found in Ferreira *et al.* (2009).

Since this study does not aim to reach the time series as back as the 90's, any noise or distortion that the Consumer Price Index might contain due to structural shocks will not apply for this dataset, therefore, all the GDP series were temporally deflated according to the Consumer Price Index (IPCA) being the base unit Reais (R$) of 2003. As the table below shows, we can note a consistent economic growth in the aggregated GDP.

The Service sector is clearly the most important component of the Brazilian GDP. Nonetheless, the aforementioned sector is the one that grew the most during the period, accumulating 53% of growth from 2002-2009. While the industry sector have also provided a consistent upward trend through the period,

Table 2
Yearly Brazilian GDP disaggregated by sector in billions (R$ of 2003)

Year	Agriculture	Industry	Services	Total
2002	93.31	371.46	913.26	1,378.03
2003	108.62	409.50	952.49	1,470.61
2004	107.06	466.33	975.18	1,548.57
2005	92.47	474.22	1,053.28	1,619.98
2006	95.12	498.71	1,140.64	1,734.47
2007	103.87	519.32	1,244.11	1,867.30
2008	117.62	554.88	1,316.22	1,988.72
2009	116.17	553.90	1,394.51	2,064.57

Source: Author's calculations from the Regional Account Statistics/IBGE

its importance to the aggregated GDP is more modest. Agriculture is the sector that presented the most inconsistent trend, though it had accumulated 24% of growth during the period. The volatility for this specific sector is expected once it is acknowledged that Brazil is a strong player in the global food market and, therefore, is more susceptible to shocks from commodities' prices.

Sectoral composition also reveal some variation. Due to the faster pace in which the Service sector was growing in Brazil, it is natural that its participation was increased in comparison to the other two sectors, as it can be seen on Table 3 below.

Table 3
Sectoral composition of the GDP (%)

Year	Agriculture	Industry	Services
2002	11.06	23.13	65.81
2003	12.07	23.41	64.52
2004	11.22	25.03	63.75
2005	9.92	24.64	65.45
2006	9.21	24.35	66.44
2007	9.21	23.72	67.07
2008	9.94	23.73	66.33
2009	9.40	22.70	67.90

Source: see table 2

- Government expenditures

Provided by Institute of Applied Economic Research (IPEA, in Portuguese), the State and Municipal Expenditure Accounts provides information regarding municipal, state and federal level expenditures disaggregated by type. For the present analysis, the government expenditures were classified in three different categories, being the first the "State and Municipal level Expenditures" (SME, for brevity) that

comprises the expenditures of municipalities and states regarding health and sanitation, education and culture and social security.

The second category is defined as "Capital Transfers" (CT) and accounts for all investments, inversions and capital transfers made by municipalities and states concerning infrastructure. The last category is the "Federal Transfers" (FT), where all the Federal expenditures concerning social security and social assistance are accounted. Unfortunately, the availability of these figures within IPEA is just for the month of December of each year. For the purposes of this study, however, this is not going to be a problem since a model specification relying on first-differences will be used[3]. This category comprises three main federal social programs:

- *Continued Social Assistance Benefit (BPC, in Portuguese)*: The BPC is a monthly transfer of a minimum wage for any disabled or elderly (65 or older) people who have a per capita income of less than 1/4 of the minimum salary. By 2009, 3.1 million of individuals benefited from the program, representing 1.65% of the Brazilian population.
- *The Lifelong Monthly Income (RMV, in Portuguese)*: Established in 1974, is a monthly transfer of a minimum wage for any elderly or disabled people who has at least 12 months of social security contributions. Since 1996, the Continued Social Assistance Benefit (BPC), which is independent of any contribution, has gradually replaced the RMV. However, transfers to people who were already beneficiaries before 1996 are still recorded as RMV. Since it is a benefit that is currently being replaced by the BPC, the number of individuals that are still registered as beneficiaries is considerably smaller than the other Federal programs –roughly 322 thousand by 2009– and represents solely 0.17% of the Brazilian population by the end of the period of interest.
- *Bolsa Família (BF)*: is a conditional cash transfer program focused on poor families. It has been established in 2004. The benefit varies according to the household income per capita, number of children and their age alongside the fulfillment of other conditions such as school attendance and vaccination. As already briefly discussed on section 2.2, this is a social program that aims massive coverage. By 2009, the number of families that were registered as beneficiaries surpassed 11 million. In number of individuals, this represents more than 47 million citizens, roughly 25% of the total population.[4]

3 Specification relying on first-differences aim to capture the variation of the variable across time rather than its sheer size. Since this dataset allows a comparison year over year at the same period, it is possible to capture a variation throughout time.

4 Soares *et al*. (2009) presents a thorough discussion regarding the BF's size and acuraccy.

Following the same standard of the data provided by the State and Municipal Expenditure Accounts, these categories are presented in their nominal values and were deflated temporally using the IPCA index. The base unit, naturally, is the same throughout all the dataset (R$ of 2003). Once the series were deflated, we can observe a consistent increase in government expenditure at all levels, as Table 4 shows:

Table 4
Disaggregated Government Expenditures in billions (R$ of 2003)

Year	SME	CT	FT
2002	149.64	9.59	0.50
2003	151.21	9.12	0.56
2004	158.56	9.41	1.04
2005	171.66	9.89	1.22
2006	194.44	11.92	1.46
2007	208.45	11.59	1.64
2008	239.54	13.97	1.75
2009	258.31	14.20	2.06

Source: Author's calculation from the State and Municipal Expenditure Accounts/IBGE

It was already presented in subsection 5.2.2 that Brazilian's economic activity have consistently grown during 2002 to 2009, therefore, it is natural that the same phenomena is verified on government expenditures, which usually corresponds to a fixed proportion of the GDP. However, it is important to note the sudden increase on FT after 2004 representing the Bolsa Família program. Despite this increase, the FT is still considerably lower when compared to CT and SME.

By finishing this subsection, all the monetary variables were presented. In the next subsection, variables that aim to capture variation in human capital, unemployment and inequality are going to be presented alongside an inflation index. These variables are going to be called Auxiliary Covariates.

- Auxiliary Covariates

This subsection aims to present all the non-monetary covariates in order to capture effects of human capital, unemployment, inequality and inflation on poverty. Human capital is going to be represented by the average years of education for the population with 25 years of age or more; meanwhile, inequality is going to be captured through the Gini index. Inflation and unemployment are going to be represented by its respective rates. All of the variables were extracted from the IPEA database; however, as it was already commented in subsection 5.1, IPEA calculates and organizes the data on its database even though the collection is made from IBGE through the PNAD.

As Table 5 shows below, unemployment rates have reached its record low on 2008, despite some inconsistent trend. Average educational level shows a consistent upwards trend while the Gini index demonstrates that inequality is decreasing considerable throughout the period. The inflation rate, even though above the upper inflation target set by the Brazilian Central Bank of 6.5% - with the lower bracket set on 2,5% - on the years of 2002, 2003 and 2004 have maintained a downward trajectory and from 2004 and beyond have consistently

stayed between the target limits, reaching its record low on 2006.

Table 5
Alternative Covariates over time

Year	Unemp. (years)	Educ. (years)	CP I (%)	GINI Index
2002	9.9	6.10	12.53	0.589
2003	10.5	6.30	9.30	0.583
2004	9.7	6.40	7.60	0.572
2005	10.2	6.50	5.69	0.570
2006	9.2	6.70	3.14	0.563
2007	8.9	6.90	4.46	0.556
2008	7.8	7.00	5.90	0.546
2009	9.0	7.20	4.31	0.543

Source: Institute of Applied Economic Research (IPEA)

All the variables to be used in this study were presented through the previous subsections. The next step in this study is to define a model specification that takes into account the poverty dynamics over time and space during the period of interest.

- Methods

As already discussed in previous subsections, the dataset consists in a panel of 27 states through 8 years, totalizing 216 observations. Since this study is interested in evaluate spatial and temporal dynamics of poverty in Brazil, the estimation of a model that is able to capture these dimensions is needed. Therefore, let us consider the following model:

$$lnP_{it} = \beta_i^A lnGDP_{it}^A + \beta_i^I lnGDP_{it}^I + \beta_i^S lnGDP_{it}^S + \gamma_i t + \mu_i + \varepsilon_{it} \quad (2)$$

(i=1,2…, N; t=1,2…,N)

Where represents P poverty measures; GDP accounts for the economic growth through the Gross Domestic Product; the superscripts A, I and S represents the agricultural, industrial and service sectors respectively; the subscript *i* represents the spatial dimension captured by each state and *t* is the time dimension measured in years. The error term is represented by μ and ε, being the first the time-invariant component and the latter the time-variant one. Finally, γ denotes a time-trend.

Even though the equation (2) allows an estimation through ordinary least squares (OLS) with fixed effects, if it is taken as is, it might be perceived as a poor model. As Ravaillon & Chen (1997) have already suggested, a more appropriate model to capture the effects of economic growth on poverty can be estimated through the growth in incomes rather than just the growth in output. Considering that Brazil is an extremely unequal country, it is expected that sheer growth rates might not translate into poverty reduction due to the asymmetric income distribution. In that case, an estimation that takes into consideration the GDP per capita would be a more suitable premise for this study. Once this change is made; the model can be rewritten as:

$$lnP_{it} = \beta_i^A lnGDP'^A_{it} + \beta_i^I lnGDP'^I_{it} + \beta_i^S lnGDP'^S_{it} + \gamma_i t + \mu_i + \varepsilon_{it} \quad (3)$$

(i=1,2…, N; t=1,2…,N)

Where GDP' represents the GDP per capita for any given sector, therefore, mean income is going to be accounted rather than absolute economic growth. Equation (3), similarly to (2), can be estimated though OLS (Ordinary Least Squares) with fixed effects. The strategy behind this technique is to eliminate all time-invariant variables that are not accounted in this model thus, reducing a potential source of omitted variables bias. In order to demonstrate this procedure, let us take the fictive equation (4), as follows:

$$Y_{it} = \alpha + X_{it}\beta + \mu_i + \varepsilon_{it} \quad (4)$$
$$(i=1,2\ldots, N;\ t=1,2\ldots,N)$$

Where X_{it} is a vector of exogenous covariates; μ_i and ε_{it} are the respective time-invariant and time-variant components. In order to eliminate the time-invariant component, it is possible to conduct an OLS with fixed effects – or also called within estimation – when estimating the β parameter. This procedure is useful, for example, in cases that is not possible to infer or collect data in all time-invariant components.

In order to conduct the within estimation, individual-specific averages over time must be calculated, as (5) aim to illustrate:

$$\overline{Y_i} = \alpha + \overline{X_i}\beta + \overline{\mu_i} + \overline{\varepsilon_i} \quad (5)$$

Where:

$$\overline{Y_i} = \frac{1}{T}\sum_{t=1}^{T} Y_{it};\ \overline{X_i} = \frac{1}{T}\sum_{t=1}^{T} X_{it};$$
$$\overline{\varepsilon_i} = \frac{1}{T}\sum_{t=1}^{T} \varepsilon_{it};\ \overline{\mu_i} = \frac{1}{T}\sum_{t=1}^{T} \mu_{it}$$

Therefore, equation (5) is capturing individual averages. By subtracting (5) from (4), we have:

$$Y_{it} - \overline{Y_i} = X_{it}\beta + \mu_i + \varepsilon_{it} - \overline{X_i}\beta - \overline{\mu_i} - \overline{\varepsilon_i}$$

By noting that $\mu_i = \overline{\mu_i}$, then:

$$Y_{it} - \overline{Y_i} = \left(X_{it} - \overline{X_i}\right)\beta + (\varepsilon_{it} - \overline{\varepsilon_i}) \quad (6)$$

Since μ_i has been "removed" from the equation through this procedure, it means that the controls are implicitly made by all individual-specific factors over time. The interpretation of β becomes the effect of a within-unit change in the covariate X. It is worth mentioning that in equation (6), X represents an exogenous vector of covariates, in other words, X represents any given number of covariates that could be added to the model. If taken equation (3) as an example, X represents the sectoral GDP's per capita. Therefore, the difference is that instead of estimating one β coefficient, three coefficients would be estimated in that case.

As demonstrated, the estimation through OLS with fixed effects is capable of minimizing the problems with omitted variable bias while producing consistent results. An alternative way, however, to deal with unobserved variables is through first-differences. The procedure is similar when compared to the within-estimator. Nevertheless, instead of demeaning the equation, we take advantage of a longitudinal dataset to compute first-differences instead. Through the aforementioned equation (4), this procedure can be easily demonstrated:

$$Y_{it} = \alpha + X_{it}\beta + \mu_i + \varepsilon_{it}$$

By taking the first-differences:

$$Y_{it-1} = \alpha + X_{it-1}\beta + \mu_i + \varepsilon_{it-1} \quad (7)$$

Then, by subtracting (7) from (4):

$$Y_{it} - Y_{it-1} = X_{it}\beta + \mu_i + \varepsilon_{it} - X_{it-1}\beta - \mu_i - \varepsilon_{it-1}$$

It should be noted that μ_i is time invariant, therefore, its first difference is equal to the level. By rearranging the terms:

$$Y_{it} - Y_{it-1} = (X_{it} - X_{it-1})\beta + (\varepsilon_{it} - \varepsilon_{it-1}) \quad (8)$$

Therefore, as it can be seen on (8) the first-differences also eliminate the time-invariant component from the equation, acting similarly to the model with fixed effects. It is worth mentioning that for T=2, both procedures will provide the exact same results. For T>2, the results are not going to be the exact same due to differences in the way the error term is computed between the two methods. However, the results should be similar; furthermore, one procedure should not contradict the other, otherwise, there is evidence of external time-specific shocks that affect both Y and X and is not being properly captured. If this condition is true, there is violation of the "strict exogeneity" assumption and, consequently, the estimator β will be inconsistent.

The choice between the two specifications mostly follow practical terms than formal ones. Studies adopting each of the methods can be found in the literature. For this study, however, the specification with first-differences was chosen. Given this choice, equation (3) is specified as:

$$ln\Delta P_{it} = \beta_i^A \Delta lnGDP'^A_{it} + \beta_i^I \Delta lnGDP'^I_{it} + \beta_i^S \Delta lnGDP'^S_{it} + \gamma_i + \Delta\varepsilon_{it} \quad (9)$$

Where Δ represents the first-differences operator. All other variables follow the same description given on equation (3). Note that the time-invariant error component (μ_i) has been removed from the equation and should not be confused with the time-trend γ_i, that lost its t component during the first-differences procedure since $\gamma_i t - [\gamma_i (t-1)] = \gamma_i$.

This specification, as already demonstrated, addresses the problem with omitted variable bias. However, by maintaining (9) as specified, this study might be working with an unrealistic assumption implying that the proportional impact of each sector on poverty is the same. To illustrate, let us imagine an economy where only 1% of its output come from the industry sector and 99% comes from agriculture; in that case, it would be risky – not to say wrong – to assume that the proportional impact of industrial growth on poverty would be the same as agriculture due to its considerable differences in terms of representativeness.

In order to correct this assumption, Ravaillon & Datt (1995) have proposed a specification that accounts for each sector's respective share in economy. This specification is also adopted by Ferreira *et al.* (2009) while arguing that "the differential poverty impact of growth will naturally depend on the sector's size" (p. 25). By adding these considerations to the model, we reach the following specification:

$$
\begin{aligned}
ln\Delta P_{it} = {} & \beta_i^A s_{t-1}^A \Delta lnGDP'^A_{it} + \\
& \beta_i^I s_{t-1}^I \Delta lnGDP'^I_{it} + \\
& \beta_i^S s_{t-1}^S \Delta lnGDP'^S_{it} + \\
& \gamma_i + \Delta\varepsilon_{it}
\end{aligned} \tag{10}
$$

Where s_{t-1}^A, s_{t-1}^I and s_{t-1}^S account for the share of agriculture, industry and services respectively. Note that each share is lagged $(t-1)$ due to the loss of one panel of 27 states when first-differencing the series, therefore, this correction is needed to keep the panel strongly balanced and to ensure that each year's sectoral GDP per capita is properly weighted by its respective share in the given year. It is easy to note that in a theoretical perfectly balanced economy where $s_{t-1}^A = s_{t-1}^I = s_{t-1}^S$, then (10) would collapse to (9).

The importance of having disaggregated economic growth is the possibility to further test if $\beta^A = \beta^I = \beta^S$. This is an important relation to this study because, if rejected, it provides evidence from the importance of the "pattern of growth" when studying poverty. If unable to reject, however, the equation would collapse solely to the relationship between poverty and economic growth as a whole. Even though this relationship is not theoretically wrong, it would definitely raise questions about the precision of the estimates since such specification would disregard any sectoral effect on poverty, which is counterintuitive to say the least.

While (10) allows the analysis of sectoral economic growth's impacts on poverty, this is not the only effect that aims to be explored by this study. As already defined in previous subsections, it is also interesting to capture effects concerning government expenditures and the auxiliary covariates. In order to facilitate future references of these additions, they are going to be divided in two equations, being (11) the equation that represents a model with the sectoral growth and government expenditures and (12) the equation representing the complete model with all the covariates proposed in this study:

$$
\begin{aligned}
ln\Delta P_{it} = {} & \beta_i^A s_{t-1}^A \Delta lnGDP'^A_{it} + \\
& \beta_i^I s_{t-1}^I \Delta lnGDP'^I_{it} + \\
& \beta_i^S s_{t-1}^S \Delta lnGDP'^S_{it} + \\
& \Delta_{it}^J X_{it}^J + \gamma_i + \Delta\varepsilon_{it}
\end{aligned} \tag{11}
$$

$$
\begin{aligned}
ln\Delta P_{it} = {} & \beta_i^A s_{t-1}^A \Delta lnGDP'^A_{it} + \\
& \beta_i^I s_{t-1}^I \Delta lnGDP'^I_{it} + \\
& \beta_i^S s_{t-1}^S \Delta lnGDP'^S_{it} + \\
& \Delta_{it}^J X_{it}^J + \varphi_{it}^K Z_{it}^K + \gamma_i \\
& + \Delta\varepsilon_{it}
\end{aligned} \tag{12}
$$

Where the covariate X represents the government expenditures that are disaggregated according to the superscript J in State and Municipal Expenditures; Capital Transfers and Federal Transfers. The covariate Z represents all alternative covariates that are disaggregated through the superscript K representing the inflation rate, Gini index, average education level and unemployment rates.

Equation (12) represents the most comprehensive model that will be estimated in this study. The results will be presented in the next section alongside a discussion of the estimates. The equation of interest is (12), however, equation (10) and (11) are also going to be

presented with estimated values so it is possible to analyze whether or not the dynamics of poverty change when adding other covariates.

The entire general methodological framework was presented in order to motivate the chosen specification. However, in order to further evaluate the consistency of the estimates, robustness tests have to be performed.

It was already mentioned in previous subsections that sectorial economic growth was collected repeatedly across time through the Regional Account Statistics. That leads to the possibility of correlation between a given sector's GDP and itself during subsequent time intervals. In other words, past GDP values might affect future GDP values. This possibility is hard to refute theoretically and it does not apply solely to the GDP figures. Government expenditures and auxiliary covariates such as education, unemployment, inflation rates and inequality levels might as well follow this pattern. Therefore, unless there is a sound theoretical background that refute such possibility, statistical tests that verify the existence of serial correlation are needed in order to ensure the efficiency of the estimator.

Wooldridge (2002) has proposed a test for serial correlation in linear panel models. Drukker (2003), while exploring the capabilities of this test found it to have "good size and power" and to be robust to in the presence of heteroscedasticity (p. 168).

The test procedure – which is not going to be demonstrated in the present study – consists in estimating the parameters of the given model in first-differences and collecting the error terms. After that, the error terms are regressed against the lagged variables of the first-differenced model. From that procedure, it is easy to note that the correlation between the error terms and the lagged error terms is being pursuit. The test is set with a null hypothesis that there is no first-order autocorrelation, therefore, a good model will not reject the null, since the rejection would imply that the observations in $t + 1$ are correlated with t; that being the case, there would be serial correlation.

Serial correlation, as mentioned, impairs the efficiency of the estimator. However, unbiasedness and consistency are kept. That means that statistical tests might lose its power due to non-efficient standard errors. One of the assumptions for running an OLS through a Panel Data is that all observations are independent from each other; in other words, observations are independent across groups and within their own group. The first case refers to endogeneity and is addressed through first differencing the series; the second case refers to the serial correlation and requires a proper treatment. Therefore, a variance-covariance matrix that relaxes the assumption concerning independence within group must be estimated in order for the coefficients to have robust standard errors. Should the error terms of a given linear panel model be serially correlated, this procedure will be adopted and will be properly discussed whenever necessity arises.

Alongside this specific test for serial autocorrelation, tests regarding the homoscedasticity of the residuals as well as a joint significance of the coefficients are also going to be presented in order to make it possible to analyze not only the results but also the robustness of the estimates.

This subsection ends after a thorough methodological discussion regarding the model specification and the tests in which this model will be subjected. In the next section, the results of the estimates are going to be presented and, naturally, discussed.