LUND UNIVERSITY
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Master in Economic Development and Growth

Regional Disparities in Agricultural Transformation, Growth and Poverty Reduction: Brazil in a historical perspective

Bertha Rohenkohl Cruz
eut15bro@student.lu.se

Abstract: This paper aims to improve the understanding of economic development in Brazil since the 1950s by studying the relationship between structural transformation and poverty reduction at the state-level. Results from a modified shift-share analysis and analysis of an indicator of agricultural transformation suggest that structural transformation is a rather heterogeneous process within the country, highlighting the importance of a regional perspective. In addition, to a large extent, success is path dependent. Initially richer and more productive states were found to also be at the top of the ranking 60 years later. Furthermore, the sectoral composition of economic growth affects poverty reduction. Growth elasticities of poverty reduction change over time, as the structural transformation takes place. States with higher growth elasticity of poverty from non-agriculture were also the ones with presence of a more dynamic agricultural sector. This analysis of the case of Brazil and its states echoes the findings of other studies and supports the idea that a successful structural transformation leads the way to economic development.

Key words: economic development, economic growth, structural transformation, poverty reduction, Brazil

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1 Introduction

The discussion on the role of agriculture for economic growth has been an object of debate among development economists for decades. In the early studies from the 1950s, agriculture was seen as a passive agent of economic growth, with the function of supplying labour, food and resources to other sectors. New ideas became popular during the 1960s and 70s, arguing that the agricultural sector could generate growth actively through increases in productivity and linkages to other sectors. After agriculture-related development policies disappeared from the agenda during the 80s and 90s, there has been a recent return to the subject and a growing body of literature is dedicated to it.

The cross-country evidence indicates that all successful developed countries have experienced a powerful structural transformation involving three main transition processes: a declining share of agriculture in overall employment and economic output, migration from rural to urban areas with a rapid process of urbanization, and a demographic transition associated with low rates of births and deaths (Timmer & Akkus, 2008, Timmer, 2009). The agricultural transformation is regarded as a defining feature of the process of development and presents a dual relationship to economic growth, as both cause and consequence.

The literature on agricultural transformation related to economic development in Brazil is quite limited. Therefore, this paper aims to contribute to the discussion as a study of the process of structural transformation in Brazil in the long-run, since the 1950s, and its relations with economic growth and poverty reduction. In Brazil, agriculture played a major economic role throughout history and society still struggles with poverty and high income inequality. In 1950, more than 60% of employed Brazilians were working in agriculture, as opposed to less than 20% in 2010 – a number that is still high compared to developed countries. At the same time, agriculture contributed to 30% of the Brazilian GDP in 1950, and around 6% in 2010. Furthermore, a large and continuous labour productivity growth was observed in this sector since the 50s. All these facts indicate an ongoing process of structural change in the Brazilian economy.

A more thorough examination of these characteristics at the state-level indicates the presence of great heterogeneity across states, regarding trajectories of transformation and its consequences to economic growth and poverty. Hence, taking an empirical perspective, the main objective of this paper is, within the context of the interaction between agricultural transformation, economic growth and poverty reduction in Brazil, examine regional disparities observed at a state-level. To make it feasible, the analysis is sub-divided in two parts, and two main research questions. The first part addresses the characteristics of structural transformation across states. Making use of shift-share techniques, I examine the heterogeneous patterns of transformation and calculate an indicator of agricultural transformation for each state. In the second part, using a panel data framework I extend the analysis to a social perspective, examining how the contribution of sectoral growth relates to poverty reduction and how the evolution of structural change might have implications to the effectiveness of growth to reduce poverty. The analysis at the state-level gives an advantage as opposed to cross-country studies as it provides an opportunity to study comparatively the process for different "units" that were subject to a similar macroeconomic context and to formal and informal institutions.

The main findings corroborate the expectations that the structural transformation process has not been a homogeneous process throughout the country. Different states experienced different

trajectories of development, with different timings and with some being relatively more successful than others. To a large extent, relative success is found to be path dependent, but there was also space for catching-up, even among certain initially very poor states. The reallocation of labour from agriculture and the productivity increases within this sector played an important role in the transformation. In addition, I find that the sectoral pattern of growth does matter for poverty reduction in Brazil, with the capacity of each sector to reduce poverty mirroring the structural transformation process. Finally, an exploratory analysis of the contribution of non-agricultural growth to poverty reduction indicates that this effect is increased when the agricultural sector is more dynamic.

The remainder of this paper is organised as follows. Section 1.1 clarifies the aims and research questions to be addressed by this study. Section 2 presents a brief review of the literature and theoretical framework. Section 3 presents a historical background and contextual evidence for Brazil and states. Section 4 presents the data underlying the empirical analysis, as well as the methodological framework. Section 5 discusses results and Section 6 concludes.

1.1 Aim and Research Questions

Within the context of the long-term relationship between structural change, economic growth and poverty reduction in Brazil, this study has two main objectives. First, to examine the heterogeneity of structural transformation processes at the state-level from 1950 to 2009. Second, to study the connection between sectoral patterns of growth and poverty reduction in Brazil since 1980.

Building on a vast body of literature in economic development, I investigate the heterogeneity of experiences of development observed across states in Brazil regarding the evolution of structural transformation and economic growth. First, I describe the dimensions of the sectoral transformation within each state, focusing on the contributions of agriculture and non-agriculture to labour productivity growth. The use of shift-share methods serves to this purpose and allows a thorough investigation of the drivers of the changes in labour productivity across states and over time. Then, a new way of looking into the Brazilian agricultural transformation is presented, based on the indicator proposed by Peter Timmer[1] (2009). These findings combined may provide insights about what are the characteristics and outcomes of a relatively more successful transformation. The second part of this study builds on the proposition that sectoral patterns of growth matter to changes in poverty. In this sense, the progress and characteristics of the process of structural change may have implications to the effectiveness of growth to poverty reduction. In previous cross-country studies, agricultural growth was found to be more poverty reducing in many developing countries. For Brazil, growth in services was found to be more poverty reducing than other types.

With this in mind, the main research questions addressed by this study are:

1. *How has the structural transformation differed across states?*
    a. *How have sectoral changes evolved at state-level?*
    b. *Which are the drivers of total labour productivity growth over time?*
    c. *Which states had a relatively more successful transformation?*

2. *Does the sectoral pattern of growth matter for poverty reduction?*
    a. *What is the role of agriculture? How does it change over time?*
    b. *How does this relate to the progress of structural transformation?*

[1] Peter Timmer is also referred to as "P.Timmer" and not to be confused with Marcel Timmer, referred to as "M. Timmer". Both authors are frequently mentioned and cited throughout this paper.

2 Literature Review

2.1 Agricultural Transformation and Economic Growth

The theoretical work on the relationship between the agricultural sector and economic growth is extensive and goes back to the 1950s. At that time, early development theory believed that agriculture played an insignificant role, as an inefficient and labour abundant sector with little potential to contribute to development (Lewis, 1954; Rosenstein-Rodan, 1943). As a consequence, the main focus of these studies was industry – and more specifically, how to industrialise quickly.

In the classical dual models by Lewis (1954) and Ranis and Fei (1961), during early stages of development, the lower productivity of agriculture relative to the modern sector would favour the liberation of redundant labour supply to the latter, as a response to higher wages. This would have the capacity to generate economic growth without negatively affecting agricultural output. On the contrary, it could even raise its labour productivity.

For these authors agriculture is only important in the sense that changes in sectoral composition (of output and employment) are closely related to productivity growth. Schultz (1964) thought of the agricultural sector as a provider of food, capital and labour to other sectors. This view is also shared by Kuznets (1966), where he describes the role of agriculture in economic development as a supplier of cheap food and low wage labour to the modern sector. However, he emphasizes that in order to provide to other sectors, agriculture had to be dynamic, with continuously increasing productivity. Structural change is a necessary condition and integral part of the process of generating modern economic growth (Kuznets, 1966, p.120). Nonetheless, without significant productivity increases, the whole process could stop after an initial surge.

Structural change and structural transformation are often broad and vague concepts in the literature of development economics. In this paper, I assume the definition by Syrquin (1988), who defines structure as referring to the relative importance of sectors in the economy, in terms of production and factor use – with structural change being a modification of this structure. Structural transformation is then the "interrelated processes of structural change that accompany economic development" (Syrquin, 1988, p.206).

Structural changes are at the centre of modern economic growth, acting as a cause and consequence of this process (Syrquin, 1988). As a natural result of the advancement of the structural transformation process, many authors describe the gradual reduction of importance of the agricultural sector, both in terms of share of labour force participation and value added to the economy (Kuznets, 1966; Syrquin, 1988; Timmer, 1988; Timmer, 2009). Thus, the agricultural transformation is one facet of the structural transformation, characterized by growth in the agricultural sector and a simultaneous decline of its relative importance to the whole economy (Timmer, 1988). As a general pattern, countries with higher income have proportionally smaller agricultural sectors (Johnston & Kilby, 1975). The observation of this stylized fact could help to understand why agriculture has been neglected as a source of growth for a long time. Nevertheless,

as P.Timmer (1988) clarifies, it is not paradoxical that agricultural growth is associated with agriculture's relative decline (of importance)[2].

After the 1960s other studies started to focus on the linkages and spillovers that agriculture can generate towards other sectors. The agricultural surplus of labour was regarded as especially important to the beginning of the process of development (Johnston & Mellor, 1961; Johnston & Kilby, 1975). Aside from the direct importance of agriculture for food, savings and labour and even generation of foreign exchange, this sector also contributes to economic growth through the so called Johnston-Mellor linkages of production and consumption (Johnston & Mellor, 1961; Timmer, 2002, 2005). In the conclusion of their classic paper, Johnston and Mellor (1961, p.590) state: "It is our contention that 'balanced growth' is needed in the sense of simultaneous efforts to promote agricultural and industrial development". With emphasis on the indirect effects of agriculture, this sector started to be regarded as an important and active engine of growth. This view echoed in the literature, as other authors started recognising that agriculture plays a positive role in stimulating growth in the non-agricultural part of the economy. For instance, agriculture can provide inputs to non-agricultural sectors (food processing, clothing, etc.), as well as demand factors and services from them (farm equipment, fertilizers, transport, logistics, etc.). As an implication, investments and reforms targeting agriculture could have a broader effect and yield total economic growth, even though growth in agriculture might be on average slower than in other sectors.

When there is no continuous equalization of factor returns across sectors, several studies suggest an important role for intersectoral shifts of resources to sectors with higher productivity as a way to boost total productivity growth, at least temporarily (Syrquin, 1988; Timmer & de Vries, 2009). Empirically, there is still a debate surrounding the role of the agricultural sector in promoting structural transformation and contributing to economic growth.

Among recent theoretical advances defending the importance of agriculture to economic growth, Peter Timmer (2002, 2005, 2009) argues that agriculture is important in stimulating growth in the overall economy and poverty alleviation, through increasing labour productivity and wages. Other empirical studies have bolstered the idea that the importance of agriculture goes beyond this sector's contribution to total GDP and employment. Self and Grabowski (2007) present evidence suggesting a positive correlation between different measures of agricultural productivity and average growth of GDP per capita over 1960-1995 for a cross-section of countries. In another study, P.Timmer (2002) shows evidence of a positive correlation between growth in agricultural GDP and its lagged values and non-agricultural GDP growth for a panel of 65 developing countries over 1960-1985. Tiffin and Irz (2006) use the concept of Granger causality to examine the relation between agricultural value-added per worker and GDP per capita for a panel of 85 countries. Their results suggest that the direction runs from agriculture to the rest of the economy in developing countries, indicating a positive effect of agriculture on economic growth. Bravo-Ortega and Lederman (2005) use panel data tools to estimate the effect of agricultural growth on non-agricultural growth in developing countries. Using data from 1960-2000 and the concept of Granger causality, they find that an increase in agricultural GDP increases non-agricultural GDP in developing countries, while a reverse relation occurs for developed countries.

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[2] P.Timmer (1988) highlights the role of two mechanisms in this process: the Engel's law and rise of productivity in agriculture.

Even though there is a large literature defending the positive role of agriculture to economic growth through direct and indirect linkages, other studies are more agro-pessimistic (Gollin, 2010) and argue that this relation might not be true in all cases. Gardner (2005) analyses a panel of 52 developing countries and concludes that agriculture does not seem to be a primary force behind total GDP growth. Dercon (2009) studies a set of African countries and concludes that agricultural growth is only an engine for growth in some very particular settings, such as landlocked and resource-poor countries. Again for the case of Africa, Dercon and Gollin (2014) argue that agricultural development strategies should be adapted to the heterogeneity present between and within countries, as they find that agricultural growth is not a pre-requisite to overall growth in all contexts.

Albeit imperfect and with several methodological drawbacks, a vast body of evidence is very suggestive that the role of agriculture might be positive and significant in numerous cases. Especially for developing countries, it is worth investigating this relationship. This is exactly what this study proposes, using the case of Brazil, and considering the heterogeneity within the country as a potential factor influencing the opportunities, costs and benefits of agricultural growth.

2.2 Sectoral Growth and Poverty Reduction

There is a fair consensus that aggregate economic growth contributes to poverty reduction (Dollar & Kraay, 2002; Quibria 2002) and that increased productivity in the economy is a necessary condition for improving living standards (Timmer, 2002). In its turn, long-term gains in productivity imply structural change (Kuznets, 1966; Syrquin, 2006). One important feature of the structural change is the reallocation of labour from low-productivity sectors to high productivity sectors (Syrquin, 1988; Timmer & de Vries, 2009). Therefore, structural change consists of an important mechanism to growth and poverty reduction simultaneously (McMillan & Rodrik, 2011) – thus leading the way to economic development. The underlying idea to this argument is that different sectors might have a different impact on poverty reduction.

In the recent years, many authors have emphasized the role of agricultural development to reduce poverty. In general three main channels were identified: wages and jobs, reduction of food prices and increase in availability and multiplier effects to other sectors. The notion that the agricultural sector has many important linkages to the modern sectors makes it an important instrument for poverty reduction (Dethier & Effenberger, 2012; De Janvry & Sadoulet, 2010). Agricultural growth reduces poverty directly, through generation of farm jobs and profits, but also indirectly, through induction of jobs in other sectors as a response to higher domestic demand. As P.Timmer (2002) explains, the rural economy has important linkages to incomes of the poorest and, in some cases, agriculture plays a big role in alleviating poverty and reducing income inequality. In this sense, structural change is often seen as seen a sustainable (long-run) way out of poverty. This has often been a reason supporting economic policies towards the agricultural sector. The Sustainable Development Goals, for instance, targets the agricultural food producing sector as a driver to the end of hunger and poverty by 2030.

The role of sectoral contributions to the reduction of poverty is still on debate. Even though the view that agriculture is an important engine of pro-poor growth has attracted attention of policy makers, some authors disagree. Valdés and Foster (2008) argue that intersectoral links have no longer the same force due to increasingly integrated markets. With the increasing tradability of

agriculture, productivity gains would be transmitted more through higher employment and wages, and less via food prices. In this sense, the pro-agriculture strategy alone would not be enough for poverty reduction in open economies (Christiaensen et al., 2011).

Empirically, a few studies have tried to estimate the growth-poverty relation. The main issue faced in this type of analysis is how to prove the relation of causality between these factors. In general, the idea that agricultural growth has a greater capacity for poverty reduction is supported. However, as these studies have used different measures for poverty and different indicators of growth, it becomes difficult to compare results.

Several studies investigate the impact of sectoral growth on the occurrence of poverty. They argue that, while overall growth matters, some patters of growth are more effective in reducing poverty. The preponderance of evidence suggests that agricultural growth offers better marginal welfare outcomes. When comparing income, poverty and agricultural development across countries, these studies usually find a correlation between higher levels of agricultural development and lower levels of poverty. Bravo-Ortega and Lederman (2005) estimated the effect of sectoral increases in labour productivity on GDP growth and income of the poorest quintile. They found that this group is more positively affected by agricultural growth than non-agricultural growth. However, the opposite relation was observed for Latin American and Caribbean countries.

Other authors have studied the relation between sectoral growth and poverty by estimating the elasticity of poverty reduction to GDP growth in different sectors. Typically, they observe that this elasticity is higher for agriculture than non-agriculture. Ligon and Sadoulet (2007) estimate the effect of agricultural growth on the distribution of expenditures for a panel of 42 countries and found that agricultural growth has a particular positive effect on the income of the poorest households, in terms of expenditures .Loyaza and Raddatz (2010) present evidence for a cross-section of countries that the composition of growth matters for poverty alleviation, as growth in sectors that are more labour intensive, such as agriculture, have a larger impact in reducing poverty. In contrast,

There are also interesting case studies for individual developing countries. In within-country analyses, frequently the questions include the variation of poverty reduction across time and space and its relation to initial conditions. Ravallion and Chen (2007) show that for the case of the provinces in China, from 1980-2001, sectoral composition of growth has mattered in the fight against poverty and inequality, with growth in agriculture yielding four times larger impacts than growth in non-agriculture. However, they also found that the progress was uneven across time and provinces. For the case of India, Ravallion and Datt (1996) found evidence that the sectoral rate of growth matters for poverty reduction, with poverty measures (headcount index, poverty gap index and squared poverty gap index) responding more to rural than to urban economic growth. Christiaensen et al. (2011) investigated the same question for sub-Saharan countries and found that agriculture had two to three times larger impacts on poverty reduction than non-agriculture. They have also found heterogeneity in this impact, related to country characteristics and initial conditions. Hasan and Quibria (2004) suggest that the relation between sectoral growth and poverty are very context-specific, as it presents considerable variations across regions. In some settings, agriculture might be the most pro-poor, but they find that in Latin America growth in services had a greater impact on poverty reduction.

As these studies suggest, historical lessons applied to the study of connections between sectoral growth and reductions in poverty could consist of a powerful tool to development policies directed to enhance efficiency and improve living standards (Timmer, 2009). Structural change and agricultural development seem to walk hand in hand and be both relevant factors affecting the capacity of poverty reduction.

For Brazil, only few studies investigate the relationship between sectoral composition and poverty reduction. Ferreira et al. (2010) found that growth in services has a greater impact on poverty reduction than does growth in industry or agriculture. In another exploratory study, Tochetto et al. (2004) found that growth of non-agriculture was more poverty reducing. Even so, most studies have as their main focus the country as a whole, while geographical disparities in the relation between growth and poverty-reduction within Brazil are less documented. In the next section, I will present an introduction to the historical and economic context of Brazil since 1950 and to the inequalities of growth and poverty reduction across states.

3 Brazil: Contextual Background

In this section, I present a brief overview about the evolution of structural transformation in Brazil since 1950 and situate these changes in the historical context. In addition, I present a big picture of disparities in economic development across states, with focus on economic growth and evolution of poverty.

3.1 The Ongoing Structural Transformation

As it has been observed for many other countries, along the process of development and growth, an intense structural sectoral transformation takes place. In Brazil this phenomenon can be clearly seen, as in the latest decades the relative participation of agriculture in terms of product and employment was reduced, while industry and services became more relevant.

Figure 1 and Figure 2 show the evolution of sectoral employment and output shares from 1950-2010 in Brazil. In 1950, 64% of the people employed were in the agricultural sector, 16% in industry and 20% in services. As time passed, labour reallocated from agriculture to industry and especially to services. These sectors became more productive and started to produce a bigger share of the total economic output. In terms of value-added[3], the agricultural share has fallen from 30% in 1950 to 7.5% in 2000. At the same time, we observe a rise in the participation of industry in total output, from 20% in 1950 to 40% in 2000[4], as well as services, from 48% in 1950 to 52% in 2000[5] .

Even though we observe a decline in the relative importance of agriculture in the total economy, the productivity of this sector has continuously increased during the whole period[6] and Brazil arrived in 2014 as a global agriculture powerhouse (Alston &Mueller, 2016) and important producer and exporter of many agriculture related products.

[3] In constant 2000 R$, basic prices.
[4] Industry participation peaked at around 44% in 1985, and then started to decline.
[5] Any shares not summing up to 100% is due to rounding.
[6] Gasques et al. (2010) present evidence of a continuous increase of total factor productivity in agriculture since 1970.

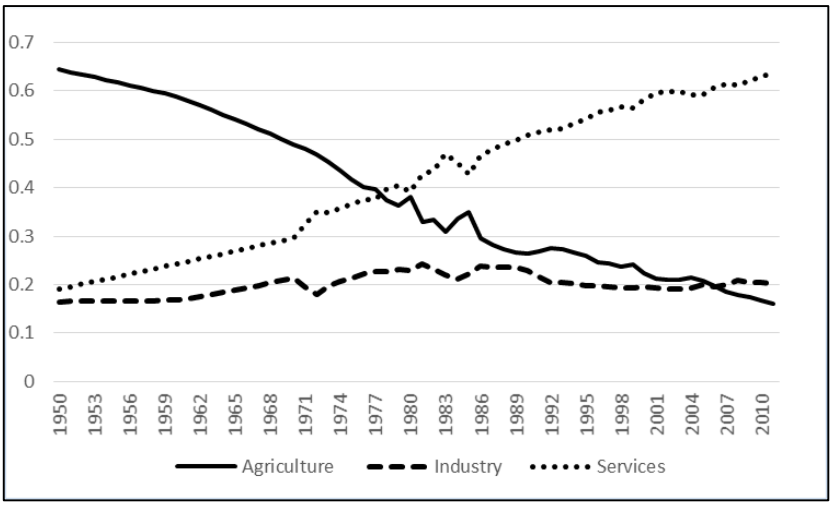

Figure 1: Sectoral Employment Shares 1950-2010, Brazil

Source: University of Groningen GGDC 10-Sector Database[7]

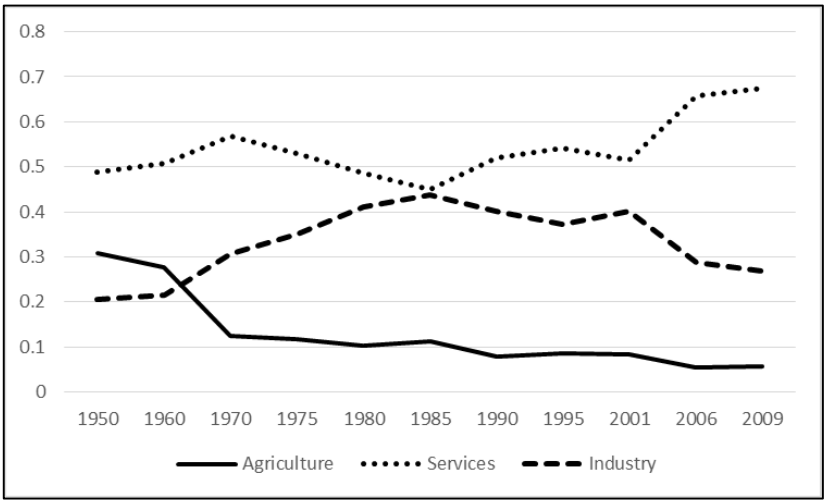

Figure 2: Sectoral Output Shares 1950-2010, Brazil

Source: Author's calculations, from IBGE.

7 Timmer, M.P., de Vries, G.J and de Vries, K. (2014). "Patterns of Structural Change in Developing Countries." GGDC research memorandum 149 .

3.2 Economic Growth and Structural Transformation in a Historical Context

Many transformations occurred in the Brazilian economy after the Second World War. According to the performance of the economy, this period can be subdivided in two: in the first period, from the post-war to the beginning of the 1980s, Brazil was one of the fastest growing economies in the world. In the second period, from the 80s onwards, economic growth slowed down and there was a period of stagnation until the beginning of 90s. Figure 3 presents the growth rates of GDP per worker from 1951 to 2008 and the decomposition of growth. In this section, I will present a brief historical overview of these two main periods, highlighting economic growth and its association with the evolution of structural transformation.

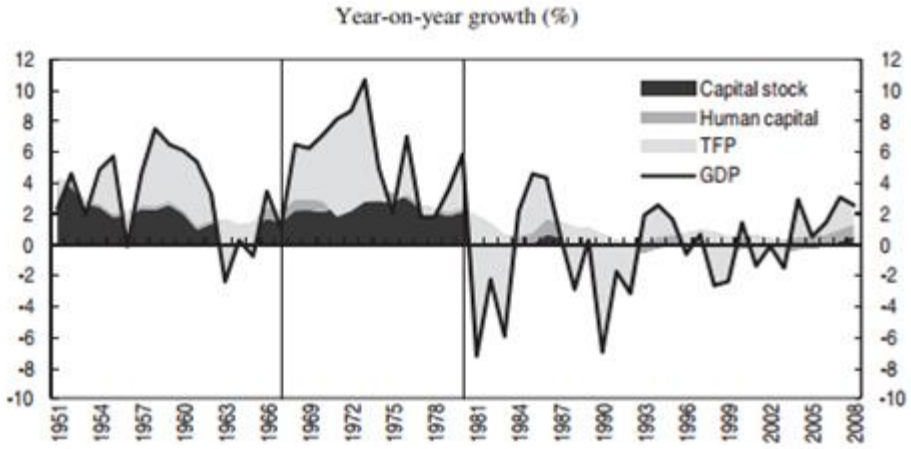

Figure 3: Growth of GDP per worker and its decomposition, 1951-2008 (Cardoso & Teles, 2010)

3.2.1 1945-1980: post-war, the military years and the Brazilian Economic Miracle

The 1950s were marked by high state intervention, trade protection, intense industrialization and strong urbanization. The government subsidised the import-substitution industrialization strategy (ISI), in the framework suggested by the ECLAC[8] . Between 1947 and 1953 a system of licensing for imports was established, along with foreign exchange controls and domestic currency became increasingly overvalued (Cardoso & Teles, 2010). This represented a stimulus to industrialisation (Silva, 2003; Ferreira & Veloso, 2013). Due to the low average productivity of agriculture at that time, as agricultural productivity increased and labour was reallocated to more productive sectors, this increased the aggregate labour productivity and, ultimately contributed to economic growth.

The end of 1954 and 1955 were marked by a political crisis that succeeded the death of President Getúlio Vargas and the transition of economic policies during these years had negative implications

[8] ECLAC is the United Nations Economic Commission for Latin America and the Caribbean (in Portuguese, CEPAL).

to growth (Bonelli, 2005). In 1956, the new President Juscelino Kubitschek created the Plano de Metas[9], which promoted fiscal expansion through inflationary financing and contributed to accelerate economic growth rapidly. There was a rapid expansion of industry, notably in the production of durables, such as automobiles. On average, industrial production was growing 13% a year, between 1957 and 1961 (Bonelli, 2005, p.313). After the 1960s, there was a shift of economic activity to the central-west region, motivated by the construction of the new federal capital, Brasília, and the expansion of the agricultural frontier, with cattle, rice, beans and soy (Reis, 2014).

The beginning of the 1960s saw the reduction of industrial activity and economic growth. The economy was facing a rise in inflation, aggravated by the attempt to increase real wages and fiscal difficulties and slow down of investments associated with the end of Plano de Metas. The growing political instability culminated in 1964 with a military coup. During the military period (1964/1985), inflation was recognised as the main economic problem and reason for the slowdown in growth. A belief in a state-led 'developmentalist' strategy marked this period (Alston & Mueller, 2016) and they acted to enhance economic growth and promote export diversification. Already in 1964, the government announced the Paeg[10], a programme of stabilization with institutional reforms that included deep fiscal adjustment, reform of the financial and tributary systems and liberalisation of trade. Its immediate consequence was an economic recession from 1965-67. But the subsequent period, from 1968 to 1973, became known as the "Brazilian Economic Miracle", in which GDP grew at rates of over 10% a year. Some authors argue that the higher growth was associated with the Paeg reforms (Veloso et al., 2008). In this phase, the developing industrial sector led the growth, growing at annual rates of 12.2%[11] . This government relied on agriculture, especially on coffee and sugar to generate foreign exchange to sustain the system (Dias & Amaral, 2001; Alston & Mueller,2016). According to Alston and Mueller (2016), the military regime sent mixed signals, supporting agriculture through supply of credit and establishing minimum prices to ensure expansion of production in the extensive margin, but maintaining an institutional setting and belief system that would have a negative impact at the farm level, unstimulating agribusiness entrepreneurship. From 1974-79, Brazil was still growing around 7% per year – less than the period before – and a consequence of the rising prices of oil, which compromised the favourable position of Brazilian exports.

3.2.2 After 1980: crisis, re-democratization and liberalisation

The 1980s were characterised by the weakness of the state, a severe external debt crisis and hyperinflation. This decade is considered by some authors as the "lost decade" and was marked by slow economic growth. The first half of the decade saw the rise of a large popular movement pro re-democratization, which culminated with the end of the military dictatorship in 1985. After several frustrated plans to control inflation, the government declared the 1987 moratorium (Cardoso &Teles, 2010). Despite this measure and other attempts, inflation and external debt crisis remained unsolved until 1993.

In the 1990s, the multiple changes in economic policy that included growing commercial liberalisation, privatisations and introduction of a new currency (the Real, R$) in 1994 put Brazil in

[9] Plan of goals.
[10] Programa de Ação Econômica do Governo. For more details, see Cardoso (2013).
[11] Silva (2003).

a trajectory of enhanced economic openness. In this period there was also a recovery of GDP growth rates. Some authors have investigated the rise in total productivity during this decade, indicating the ongoing structural transformation of the economy as the most important factor (Rossi Jr &Ferreira, 1999; Bonelli &Fonseca, 1998). They argue that the policy changes towards liberalisation in the beginning of the decade represented the initial impulse to the restructuration of the economy (Rossi Jr &Ferreira, 1999). After 1980, the labour productivity started to fall in both industry and services, what reduced the space to growth through shift of labour between sectors. Some authors argue that in this period there was even a negative effect from reallocation of labour, as it started to shift from industry to less productive services (Ferreira &Veloso, 2013).

Some authors have argued that the decline of industry in output and labour shares should not be regarded as part of a process of deindustrialization, but were rather a consequence of the faster increase of the shares attributed to the services sector (Bonelli &Pessoa, 2010; Nassif 2008).

Agriculture did not see the same decrease in labour productivity in this period, rather the opposite. Openness and improvement of terms of trade have been said to be important factors stimulating agricultural growth in more recent years (Dias &Amaral, 2001). In the recent years, after 1994, there was a considerable modernization of agriculture, which has been promoted through stable macroeconomic policies, high commodity prices and investments in research (Alston &Mueller, 2016)

3.2.3 Regional Disparities of Economic Growth and Poverty Reduction

Brazil is a federation composed of 26 states and 1 federal district. These units are characterized by a high degree of political and legal autonomy. The aforementioned changes in economic growth country-wide were markedly different across sub-periods between 1950 and 2009. In addition, the tendencies of growth were not uniform across states. Appendix A presents a map with the geographical distribution of the states.

Table 1 presents rates of growth of GDP per capita for most Brazilian states[12] over 1950-2009 and sub-periods and the levels of GDP per capita in 1950 and 2009. Overall, there was an increase in GDP per capita in all states, though at the same time the variation of GDP levels across states became larger in 2009. This relates to the fact that during this 60-year period from 1950-2009, average annual rates of growth varied across states from 1.7% to 4.7%[13]. High average growth rates (larger than 3.5%) were mostly observed for the states that had the lower levels of income per capita in 1950, indicating the presence of a process of catching up – at least for certain states.

[12] Results for 21 states. 6 states have been considered together with others, due to changes in the territories since 1950. The exact grouping of states is described later on, in footnote 18.

[13] Not considering 8.7% annual growth rates in Distrito Federal. Distrito Federal is the federal district created to contain Brasília, the federal capital. Brasília was only built in 1960, hence the high rates of growth throughout the period 1960-2009. The values for Distrito Federal in 1950 are actually from 1960.

During the 1980s, the economic slowdown had different implications for GDP growth across the states. States with the most dynamic economies and higher GDP per capita suffered more, while the poorer states continued to experience some growth.

There is a strong positive correlation between the initial level of GDP per capita in 1950 and the level of GDP per capita in 2009. The Spearman correlation coefficient[14] ($\rho = 0.76$) indicates the presence of a high correlation, which was statistically significant. This suggests that the trajectory of GDP growth is largely path dependent. That is, states that had a higher GDP in 1950 are more likely to have a higher GDP in 2009. This is consistent with the historical literature, which highlights certain states as being traditionally rich, such as São Paulo or Rio de Janeiro, while others have been regarded as traditionally poor, such as Piauí and Maranhão. Nevertheless, throughout the whole period 1950-2009, one can observe that average growth rates were generally higher for initially poor states, what could indicate a tendency of catching up for certain states. In addition, growth in Brazil seems to go hand in hand with decreasing inequality of regional income per capita. In 1950, the ratio of GDP per capita in the richest state (Rio de Janeiro) to the poorest state (Bahia) was >10-1, while in 2009 this ratio was 8.5-1, between Distrito Federal and Maranhão. Not only has this ratio changed, but also the ranking of poorest states has modified.

Table 1- Growth Rates of GDP per capita 1950-2009, by state

	Growth GDP per capita (average annual rates) in %				GDP per capita [1]	
State	**1950-1980**	**1980-1995**	**1995-2009**	**1950-2009**	**1950**	**2009**
Alagoas	4.3%	1.6%	1.1%	2.9%	1.3	7.3
Amazonas	6.7%	2.2%	2.5%	4.7%	1.0	14.8
Bahia	5.3%	3.4%	1.8%	4.1%	0.9	9.9
Ceará	3.8%	2.6%	1.3%	3.0%	1.4	8.4
Distrito Federal [2]	18.7%	-2.8%	1.2%	8.7%	0.0	55.1
Espírito Santo	5.0%	0.7%	2.3%	3.3%	2.9	20.7
Goiás	4.6%	1.0%	2.0%	3.1%	2.3	14.5
Maranhão	4.2%	0.3%	2.1%	2.8%	1.3	6.5
Mato Grosso	5.3%	0.7%	3.1%	3.7%	2.1	18.0
Minas Gerais	4.9%	0.5%	1.3%	3.0%	2.8	16.1
Pará	5.0%	-0.2%	1.3%	2.8%	1.9	9.9
Paraíba	2.8%	1.6%	2.1%	2.4%	1.9	7.7
Paraná	3.3%	2.0%	1.7%	2.7%	3.8	18.5
Pernambuco	3.7%	2.2%	1.6%	2.9%	1.8	10.0
Piauí	4.3%	1.4%	2.5%	3.2%	1.0	6.7
Rio de Janeiro	3.1%	-0.5%	0.9%	1.7%	9.1	24.3
Rio Grande do Norte	3.7%	4.5%	1.7%	3.5%	1.2	9.8
Rio Grande do Sul	4.6%	1.0%	1.2%	2.9%	3.8	21.7
Santa Catarina	5.3%	0.6%	1.3%	3.2%	3.6	23.6
São Paulo	4.0%	-0.7%	1.0%	2.1%	8.0	27.9
Sergipe	4.5%	5.2%	1.9%	4.2%	1.0	11.3
BRAZIL	**4.3%**	**0.2%**	**1.3%**	**2.6%**	**3.9**	**18.3**

Source: Author's calculations, from IBGE. Obs.: [1] GDP per capita level in thousand R$ (2000 R$, constant market prices); [2] Distrito Federal is the federal district created to contain Brasília, the federal capital. Brasília was only built in 1960, hence the high rates of growth throughout the period 1960-2009. The values for Distrito Federal in 1950 are actually from 1960.

[14] All values presented in Table 11, Appendix B.

As a result, one would expect that the experience of structural transformation would also have varied across states, both in degree and timing, mirroring the regional income differentials. Industrialisation, for instance, was never a national process. Some regions, such as the Southeast and South have historically concentrated the largest industry sector. In fact, until the early 70s, São Paulo concentrated most of the industrial production of the country, contributing to 44% of Brazil's industrial production (Diniz, 1993). According to Diniz (1993), since then, there has been a process of reversing this polarisation – though only to certain regions and states and not uniformly across the country. In1990, the participation of São Paulo in industrial production was reduced to 26%.

A distinctive factor of the more recent period, after 1990, in Brazil was the return to the issues of social development, including rural development. Until the 1980s, economic development was not associated with increase of human capital and social development. In 1980, 27% of the population 15 years or older were illiterate and the average years of schooling was only 2,8 (Ferreira & Veloso, 2013, p.156). As expected, the consequences of poor education policies were felt with the increase of educational inequality[15] and income inequality in Brazil. From 1960-1980 there was an important decrease in absolute poverty, but this was partially compensated by the worsening of income distribution (Hoffmann, 1995). After 1980 and especially throughout the 1990s, there was a large investment in education. In addition, there was a substantial expansion of social security and social assistance systems (Ferreira et al.,2010). Evidence suggests that the increase in social expenditure in the recent years, notably of conditional cash transfers, contributed to a more equal income distribution (Ferreira et al., 2008; Menezes-Filho &Vasconcellos, (2007) and improvement of other social indicators.

Similarly to what has been observed with rates of GDP per capita growth, poverty reduction was not uniform across states. Disparities in the levels of living across Brazil are well known and documented (IPEA,2010; Barros, 2013). Consistent with other cross-section studies for developing countries and for states in India, measures of poverty tend to decline with economic growth (Ravallion &Datt, 1996; Ravallion &Datt, 2002). Figure 4 and Figure 5 illustrate the negative relation between GDP per capita and poverty in 1980 and 2009. States with a higher GDP per capita (Y-axis) have a lower poverty headcount index[16] (X-axis). There was a general tendency towards increasing GDP per capita and reducing poverty common to the vast majority of states, but the magnitude of these changes varied. Some states, such as São Paulo and Rio de Janeiro, experienced poverty reduction without much change in income per capita. Others, such as Bahia, Piauí, Sergipe, Ceará and Maranhão experienced a large reduction in poverty associated with an increase in GDP per capita. In two curious cases, Pará and Amazonas, the increase in GDP per capita is associated with an increase in poverty. Even when the growth and poverty reduction appear to be high, there are areas that systematically stay behind. These dynamics are associated with the distribution of income within the states and with a historical spatial inequality[17]. It is possible that in some states, a large inequality in income distribution dissipates the potential effects of growth to poverty reduction.

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[15] Barros and Mendonça (1995) argue that educational inequality explains the high income inequality in Brazil. Not only educational inequality is high, but also the wages are very sensitive to variations in level of education.

[16] Measuring the proportion of the population that is poor.

[17] Reis (2014).

In the next part of this study, I will investigate the links between economic growth and poverty reduction across states – and how the intensity of these linkages are associated with the different experiences of structural transformation of the economy.

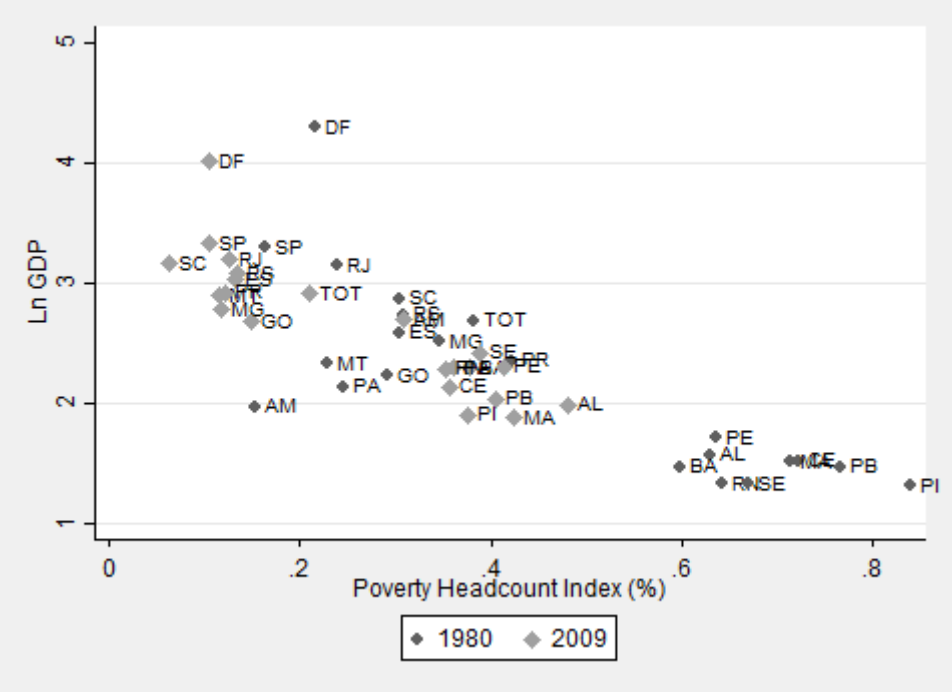

Figure 4: GDP per capita and Poverty in 1980 and 2009

Source: Author's calculations, from IBGE and Ipeadata.

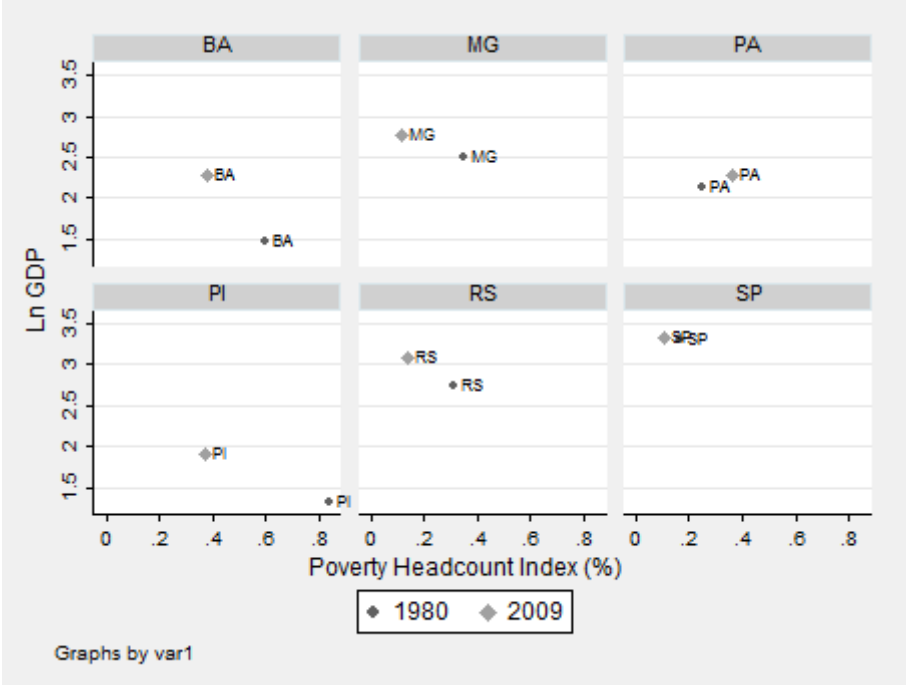

Figure 5: GDP per capita and Poverty in 1980 and 2009, selected states

Source: Author's calculations, from IBGE and Ipeadata.

4 Data and Methodological Framework

4.1 Data and Sources

To empirically study the regional patterns of structural transformation and poverty reduction, I combine employment and sectoral output data with socioeconomic variables. All data is disaggregated at the state level. Data on state-level[18] total and sectoral value-added and employment for the period 1950-2009 has been collected from official sources of the Brazilian government – economic and demographic censuses and household surveys - available through IPEA[19] and IBGE[20]

The IBGE via Regional Account Statistics and the National Household Survey (PNAD) provided information related to economic growth and employment. Variables such as poverty headcount, education and Gini coefficient were taken from Ipeadata, a database elaborated by IPEA. These figures are generally calculated by IPEA based on the results from the Censuses and the PNAD, being the collection of this data of IBGE's responsibility.

The variables that capture economic growth include value added - total and by sector - (in constant 2000 R$[21], basic prices) and GDP per capita (in constant 2000 R$, market prices). Because of a lack of data for hours worked at the state-level, labour productivity for each year refers to value added (in constant 2000 R$, basic prices) per person employed. In order to study the impact of sectoral growth on poverty reduction, the regional account data has been combined with household data from the PNAD. Poverty is measured by the headcount index, the percentage of the population living in households with income per person below state-level poverty lines. Educational levels are proxied by the average years of study for individuals aged 25 or more. The Gini Index is the one provided by Ipeadata for each state. Poverty, Education and Gini refer to the period 1980-2009, because of absence of data for the previous years.

This data is representative for all states and Brazil. However, the effort of combining data from regional accounts and household surveys should be taken with a pinch of salt. Data collection for this long period of time required the combination of various economic and demographic censuses, which sometimes employed slightly different definition of variables over the years. For more

[18] Brazil is nowadays composed of 26 states and 1 federal district. Due to a few changes in state territory since 1950, I opted to group certain states. Hence, "Amazonas" includes the current states of Amazonas, Acre, Roraima and Rondônia; "Goiás" includes Goiás and Tocantins; "Mato Grosso" includes Mato Grosso and Mato Grosso do Sul; "Pará" includes Pará and Amapá; "Minas Gerais" includes Minas Gerais and, when it existed, Serra dos Aimorés. In total, I am left with 20 states and 1 federal district.

[19] IPEA, Instituto de Pesquisa Econômica Aplicada is the Institute of Applied Economic Research.

[20] IBGE stands for Instituto Brasileiro de Geografia e Estatística, the Brazilian Institute of Geography and Statistics

[21] Brazilian Reais

detailed information about these variables and sources, as well as descriptive statistics, please refer to Appendix B.

Due to the structure of the available data and the main objective of this study, I opted to carry out the analysis dividing the Brazilian economy in two major sectors: "agriculture", together with related activities[22] , and "non-agriculture", which includes industry and all kinds of services[23] . Of course, this approach may be subject to criticism, as each sector probably contains a heterogeneous group of economic activities, for which many differences will not be observed. Even so, a comprehensive view of the structure and agricultural transformation of the economy adequate to my purposes should be possible.

4.2 Structural Transformation at State-Level

In this section, I present the methodology used to analyse the first research question, regarding the trajectories of structural transformation across states and the decomposition of labour productivity growth.

4.2.1 Shift-Share Analysis: decomposition of labour productivity growth

To study the dimensions of the structural transformation in Brazilian states, labour productivity growth has been decomposed using shift-share techniques on output and employment data for the period 1950-2009. The use of shift-share analysis makes it possible to explore the effects of structural change to productivity growth. This method was first proposed by Fabricant (1942) and has been largely used in studies of economic history in its various modified forms. In short, this technique allows the decomposition of labour productivity growth, where two types of contributions must be distinguished. Each sector can contribute to total growth in two ways: shifts of employment shares between sectors (referred to as between- or shift-effect) and productivity growth within sectors (referred to as within- or intra-effect).

The standard equation yields:

Equation 1

$$P_T - P_0 = \sum_i^n (P_i^T - P_i^0).S_i^0 + \sum_i^n (S_i^T - S_i^0).P_i^T$$

On the left hand side, change in economy-wide (aggregate) labour productivity levels. On the right hand side, the first term represents the effect within-sectors, technological effect or *intra-effect*, which measures the sectors' contribution to productivity assuming that the share of labour

[22] "Agriculture" includes agriculture itself, fishing, forestry, livestock and aquaculture (IBGE, 2008).

[23] "Industry" refers to manufacturing and mining, construction, generation/distribution of public utilities and "Services" includes a wide range of activities related to trade, repairing, housing and catering, transport, storage and mail, information services, financial services, insurances, education, health, public administration, as well as domestic and personal services (IBGE, 2008).

participation remained the same. The second term measures the changes in labour productivity due to reallocation of labour between sectors, which will be called between-effect or *shift-effect*. It comprises both a static effect, of changes in relative participation in each sector and a dynamic effect measuring measures the changes in labour participation relative to the changes in productivity.

In the original model, the division between within- and between-effects is based on the assumption that marginal and average productivity are equal for each sector. This, however, might not be true in earlier stages of development, when there is surplus labour in agriculture. In this case, the standard shift-share equation would measure this as within-sector effect in agriculture and lead to an underestimation of the shift effect associated with reallocation of labour (Wang & Szirmai, 2008, p.847). There have been a handful of suggestions of modifications to account for this surplus in the agricultural sector (Broadberry, 1998; Timmer & de Vries, 2009; Van Ark & Timmer, 2003). In this paper, I follow the approach of Van Ark and M.Timmer (2003), which allows for flexibilisation of the assumption that marginal productivity equals average productivity. To do this, I calculate a counterfactual labour productivity for agriculture ($P*_A^T$), as follows:

Equation 2

$$P*_A^T = \frac{Y_A^0 + \varepsilon_A\left(L_A^T - L_A^0\right).P_A^0}{L_A^T} \text{ when } L_A^T < L_A^0$$

$$P*_A^T = P_A^0 \text{ otherwise}$$

Where Y_A^0 is the value-added in agriculture at time 0, ε_A represents the ratio of the marginal and average labour productivity of agriculture in the base year, L_A^T and L_A^0 represent the number of workers in agriculture at time T and 0 respectively, and P_A^0 is the productivity of agriculture at time 0.

Here, we assume that if there is surplus in agriculture, the productivity of those leaving agriculture is smaller than that of the workers who stay, and so $0<\varepsilon_A<1$ (Van Ark & Timmer, 2003). In contrast, when $\varepsilon_A = 1$, we return to the standard Equation 1, where each worker leaving agriculture will contribute to a reduction in productivity equal to the average productivity of the remaining workers; and when $\varepsilon_A = 0$[24], the marginal productivity in agriculture equals zero, which is representing the Lewis hypothesis of unlimited labour supply in agriculture.

Another modification that has been proposed to the standard equation aims to account for the reallocation of shift effects to sectors with expanding labour shares. Van Ark and M.Timmer (2003) and Wang and Szirmai (2008) suggest the allocation of all shift effects off shrinking (in labour shares) sectors to expanding sectors, in order to make interpretation of shift-effects more intuitive. To do so, the contribution of each sector *i* is divided in two:

[24] For instance, this is assumed in the modification by Broadberry (1998). For Van Ark and M.Timmer (2003, p.12), Broadberry's modification is not consistent with the surplus labour hypothesis as it recalculates the counterfactual productivity relative to declining shares of labour, as opposed to *absolute* numbers.

Equation 3

$$C_i = C_i^{\text{INTRA}} + C_i^{SHIFT}$$

Thus, for agriculture (A) and non-agriculture (NA), we have:
Intra-effects:

Equation 4

$$C_{NA}^{\text{INTRA}} = (P_{NA}^T - \text{P}_{\text{NA}}^0).\bar{S}_{NA}$$

$$C_A^{\text{INTRA}} = (P_A^T - \text{P}*_{\text{A}}^{\text{T}}).\bar{S}_A$$

Shift-effects:

For shrinking sectors ($\forall i \in J$): zero

For expanding sectors:

Equation 5

$$C_i^{\text{SHIFT}} = (S_i^T - \text{S}_i^0).\left(\bar{P}_i - \bar{P}_J\right) + (P*_A^T - \text{P}_{\text{A}}^0).\bar{S}_A \quad \forall i \in K$$

To make the decomposition invariant to a particular base, Van Ark and M.Timmer (2003, p.10) indicate the use of period averages as weights, with a bar indicating the arithmetic average over [0,T].

As a consequence of this formulation, the shift-effect will be reallocated to the sector that is receiving workers. It will be positive if the average productivity of expanding sectors ($\bar{P}_i$) is higher than the average productivity of shrinking sectors ($\bar{P}_J$) – and negative if the opposite is true.

Even with the above mentioned modifications, there are still shortcomings inherent to the methodology of shift-share analysis (Timmer & Szirmai, 2000; Van Ark & Timmer, 2003). Firstly, these calculations only consider labour productivity, and all non-labour inputs are being excluded. In most cases, however, due to a lack of capital data at industry level, the inclusion of these inputs in the analysis is unfeasible. Secondly, the size of intra- and shift-effects can vary according to the base year chosen for the output series. This also refers to limitation of the data. In this particular case, the output series were only available with 2000 as the base year. Thirdly, shift-share analysis do not account for unemployment. Lastly, this approach assumes constant returns to scale. However, it seems there are no available modifications for this (Timmer & de Vries, 2009). In summary, the "shift-share methods provide fruitful and systematic insights in the sectoral contributions to growth, but one should see them as lower-bound estimates of the importance of structural change" (Wang & Szirmai, 2008, p.847).

4.2.2 Agricultural Transformation Indicator

The indicator of agricultural transformation as proposed by Peter Timmer (2009) is calculated by the difference between the agricultural value-added output share and the agricultural employment share for each state *i* in time *t*:

Equation 6

$$ATI_{i,t} = \theta_{A\,i,t} - S_{A\,i,t}$$

Combined with the results from the shift-share analysis, this indicator can show important patterns of transformation with a specific focus on agriculture, serving to the main purpose of this paper. The idea behind this indicator is that it represents the evolution of the process of structural transformation. In early stages, there is a considerable gap between the share of labour force employed in agriculture and the share of GDP generated by this sector (Timmer, 2009). Then, as the non-agricultural sector starts to grow rapidly, the gap becomes initially larger. With the progress of the structural transformation process, this difference will get smaller and smaller and approach zero, representing a convergence of labour productivity among all sectors. Indeed, the final outcome of the process, as already experienced by rich countries, is an economy where agriculture has no distinguishable characteristics from other sectors, in terms of productivity of labour or location of poverty (Timmer &Akkus, 2008, p.4).

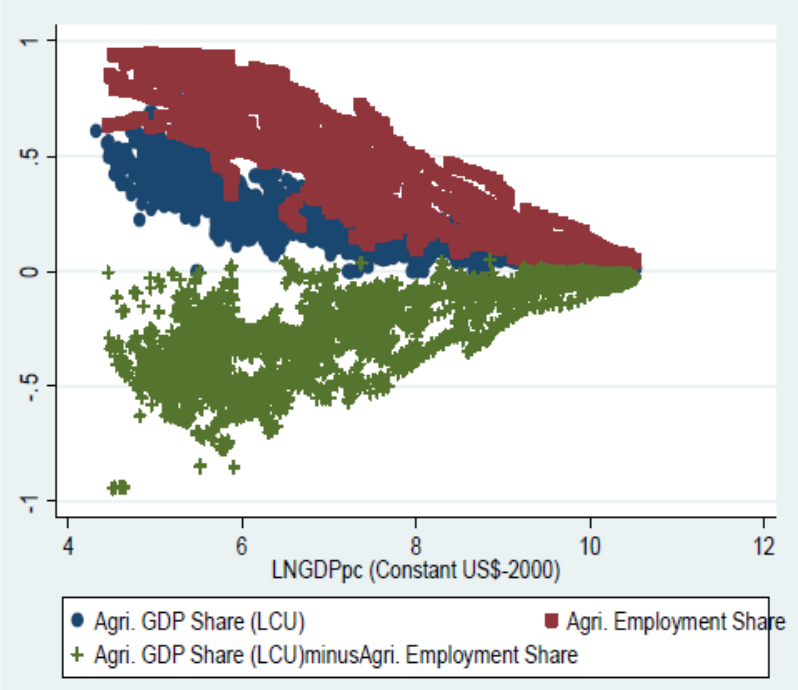

Figure 6: Structural Transformation in 86 countries: 1965-2000 (Timmer, 2009)

4.3 Sectoral Composition of Growth and Changes in Poverty

In this section, I will introduce the methodological framework related to the second research question, to study the importance of sectoral patterns of growth to poverty reduction.

As discussed during the literature review, other studies have found evidence supporting the view that not all growth processes generate the same amount of poverty reduction. In order to investigate this proposition for Brazil since 1980, I follow a common approach from this literature (Christiaensen et al., 2011; Ferreira et al., 2010; Loyaza & Raddatz,2010; Ravallion & Chen, 2007), estimating the changes in poverty measures related to changes in the composition of growth and sectoral participation. To do so, poverty measures derived from nationally representative household surveys (PNAD) are used in combination with sectoral data from regional accounts.

To motivate the specification choice, let us first consider the basic relation:

Equation 7

$$dlnP_i = \delta_i dlny_i$$

Where P_i is a decomposable measure of poverty, y_i is GDP per capita and δ_i is the GDP elasticity of poverty. Here, the proportionate change in poverty is equal to GDP elasticity of poverty. Approximating the growth of Y_i as the sum of share of weighted GDP growth of the agricultural (A) and non-agricultural (NA) sectors, this equation can be rewritten as:

Equation 8

$$dlnP_i = \varepsilon_{Ai} s_{Ai} dlnY_{Ai} + \varepsilon_{NAi} s_{NAi} dlnY_{NAi}$$

with s_{Ai} and s_{NAi} being the share of agriculture and non-agriculture in total output in state *i*.

In summary, four elements link sectoral growth to poverty reduction in this framework (Christiaensen et al., 2011). The direct effects from the growth component of agriculture and non-agriculture, the indirect effects from spillovers of growth in one sector to growth in the other sector, the participation component of each sector and the relative size of the sector in the economy (share component).

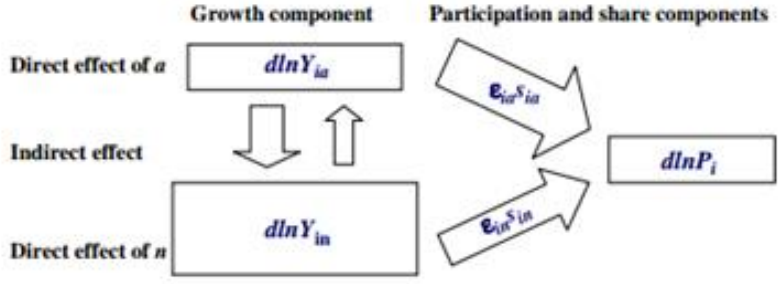

Figure 7: The relative role of agricultural and non-agricultural growth to poverty reduction (Christiaensen et al., 2011)

Empirically, Equation 8 is estimated in first-differences, in the form:

Equation 9

$$\Delta lnP_{it} = \beta_0 + \beta_{1i}\, s_{Ait-1} \Delta lnY_{Ait} + \beta_{2i}\, s_{NAit-1} \Delta lnY_{NAit} + \pi + u_{it}$$

Where s_{Ait-1} is the share of agriculture in GDP in state *i* in t-1 and s_{NAit-1} the share of the non-agricultural sector. I also include a time trend, represented by π. As Ferreira et al. (2010, p.25) highlight, the estimation of this equation in levels would embody the improbable assumption of constant elasticities over time. In the context of the ongoing structural transformation in Brazil, one could not expect that this would be the case. In order to address this issue and also to capture state's fixed effects[25], I estimate the equation in its first-differences form.

In Equation 9 we have the share weighted sum of the contributions to poverty from agricultural and non-agricultural sectors. Loyaza and Raddatz (2010) and Ravallion and Chen (2007) argue that weighing sectoral growth rates by the sector's size has the advantage of allowing for the direct test whether the sectoral composition of growth really matters. If both growth elasticities from Equation 9 are equal ($\beta_{1i}\, s_{Ait-1} = \beta_{2i}\, s_{NAit-1}$), we return to Equation 7. However, these growth elasticities of poverty might differ across sectors for two main reasons. Firstly, one sector might be bigger than the other ($s_{Ait-1} \neq s_{NAit-1}$). Secondly, even if they are equal in size, the marginal effect on poverty from an additional percentage point of overall GDP growth might differ between the sectors ($\beta_{1i} \neq \beta_{2i}$). And again, in addition to the differences in the participation and share components, the role of growth in agriculture and non-agriculture to poverty reduction will be related to the magnitude of direct and indirect growth effects in both sectors.

[25] Non-observed states' characteristics might be a potential source of bias, if they are correlated with sectoral growth rates and affecting poverty measures independently. In order to account for this heterogeneity regarding specific non-observed time invariant characteristics, the equation is estimated in first-differences.

5 Empirical Analysis and Discussion

5.1 Structural Transformation at State-Level

5.1.1 Shift-Share Analysis: Drivers of Labour Productivity Growth

Using the sectoral data described in Section 4.1, the aggregate labour productivity growth was decomposed into intra- and shift-effects considering two sectors in the economy: agriculture and non-agriculture. This section presents the results for both the whole of Brazil and individual states.

Table 2 presents the results of the decomposition for Brazil for the whole period 1950-2009 and sub-periods, shifting the base to the year where each period starts. In this shift-share analysis, labour productivity growth is attributed to either intra- or shift-effects. The first column of data presents the labour productivity growth, with average annual rates of growth (%). Columns 2 and 3 show the results for intra- and shift-effects, respectively, using the modified equation which adjusts to existence of disguised employment (or surplus labour) in agriculture (ε_A=0.3). In columns 4 and 5 this assumption is changed to allow for ε_A=0.7 and ε_A=1, the latter corresponding to the standard decomposition equation with no modifications.

Table 2 – Drivers of Labour Productivity Growth 1950-2009, Brazil

	Aggregate Labour Productivity Growth	Aggregate Labour Productivity Growth explained by:			
			Adjustment for surplus labour in agriculture		
BRAZIL	Average annual growth rates (%)	**Intra[1]**	**Shift εa=0.3**	**Shift εa=0.7**	**Shift[2] εa=1**
1950-1960	2.5%	3.23%	-0.71%	-0.71%	-0.71%
1960-1970	7.3%	4.89%	2.37%	2.37%	2.37%
1970-1975	6.1%	5.44%	0.62%	0.62%	0.62%
1975-1980	4.22%	1.60%	2.63%	2.63%	2.63%
1980-1995	-1.05%	-2.8%	1.76%	1.72%	1.7%
1995-2009	-0.28%	-1.1%	0.83%	0.80%	0.78%
1950-2009	**1.96%**	**1.11%**	**0.85%**	**0.85%**	**0.85%**

Source: Author's calculations, from IBGE and IPEA. Decomposition of labour productivity growth into: i) part due to labour productivity growth in sectors (intra-sector effect) and ii) shift of labour between sectors (shift-effect), shifting the base to the year where each period starts. Any percentages not adding up to 100% is due to rounding. Obs [1]:Intra-effects when ε_A=0.3; Obs [2]: if ε_A=1, return to the original Equation 1.

Column 1 shows that the largest increases in aggregate labour productivity occurred during the 1960s and the 1970s, which coincides with the periods of highest GDP growth associated with the implementation of the Paeg and with the so-called Brazilian Economic Miracle. In contrast, the period of lowest productivity growth, namely 1980-1995 corresponds to the "lost decade", when Brazil was struggling with external debt crisis, fiscal restraint and hyperinflation.

Columns 2 and 3 show that the intra-effect is dominant in explaining changes in labour productivity growth for most periods – whether these changes are positive or negative. For example, from1960-1970, the intra-effect explained 67% of labour productivity growth, while the shift-effect explained the remaining 33%. Until 1975, the large positive rates of labour productivity growth were explained by a positive large intra-effect. Whereas after 1980, the negative rates of labour productivity growth were mostly explained by the negative intra-effect. This means that for most periods the main source of variation in labour productivity growth rates came from within-sector effects, such as technological advancements or shift of labour to more productive activities within the same group. The only period that is markedly different is 1970-75, where the shift-effect was responsible for most of the (positive) contribution to labour productivity growth. In addition, the results show that between 1960 and 1970 and 1975 and 1995 the shift-effects from agriculture were particularly large, indicating the presence of structural change bonus associated with the reduction of disguised employment in agriculture. For instance, from 1975-1980 the shift-effect seems to be predominantly important for the whole country, explaining 62% of labour productivity growth in this period. However, as Van Ark and M.Timmer (2003, p.14) emphasize, it is worth remembering that shift-effects do not necessarily consist of a physical transfer of workers between sectors. Rather, they relate to changes in labour shares between sectors. In economies with high population growth rates, labour shares may decline, even though there is an increase in absolute employment for all sectors.

This seems to be what happened in Brazil until 1980. Columns 4 and 5 show the different shift-effects estimated when allowing for other values of ε_A. As mentioned before, the standard equation with no modification is represented in Column 5, when ε_A=1. Hence, the adjustments for labour supply in agriculture (Columns 3 and 4) indicate that the shift effects are usually underestimated when there is a decrease in (absolute) agricultural labour force. For Brazil, the consequences of such adjustment in the results can only be observed after 1980, as before this year the absolute number of agricultural workers had been continuously increasing. For the remainder of this paper, all shift-share estimations consider ε_A=0.3.

Now we come to look at the results obtained for the shift-share analysis at the state-level. In the sequence, Table 3 and Table 4 present disaggregated results of the shift-share decomposition of labour productivity growth, highlighting the contribution of agriculture and non-agriculture over time, as well as the relative importance of intra- and shift-effects. Table 3 stresses the contribution of intra- and shift-effects, and Table 4 emphasises the variation in average annual growth rates of labour productivity in agriculture and non-agriculture. Combining these results, it is possible to perceive differences across states and over time within the same state. As discussed before, from 1950-2009 there were decreasing regional income differentials among certain states. Thus, one could expect a reduction of regional productivity differentials for these states. On the other hand, if there is a tendency of concentration of industrial activity in specific areas, this could counteract the decrease in regional inequality.

Table 3 – Decomposition of Labour Productivity Growth at the State-Level, 1950-2009

			1950-1980			
			Agriculture		Non-Agriculture	
	P0	Annual Growth Rate (%)	Intra	Shift	Intra	Shift
Bahia	1942.7	5.8%	0.6%	-2.2%	7.4%	0.0%
Ceará	2032.9	4.1%	0.0%	-0.1%	4.2%	0.0%
Espírito Santo	3683.8	4.9%	0.8%	0.0%	-10.6%	14.7%
Goiás	2519.1	4.9%	1.3%	0.0%	2.5%	1.1%
Minas Gerais	3351.5	5.1%	0.9%	0.0%	2.6%	1.5%
Mato Grosso	3087.3	5.2%	1.6%	-0.3%	3.9%	0.0%
Pará	2135.3	5.7%	0.7%	-54.4%	59.4%	0.0%
Piauí	1098.9	4.6%	0.1%	5.7%	-1.3%	0.0%
Rio de Janeiro	8720.3	3.4%	0.0%	0.0%	3.1%	0.3%
Rio Grande do Sul	5023.1	4.4%	0.7%	0.0%	2.3%	1.4%
São Paulo	7890.1	4.2%	0.2%	0.0%	3.0%	0.9%
			1980-1995			
Bahia	11249.99	-1.4%	0.0%	0.0%	-12.9%	11.6%
Ceará	7000.69	0.4%	-0.1%	0.0%	-1.2%	1.7%
Espírito Santo	16019.66	-1.2%	-0.1%	0.0%	-2.6%	1.5%
Goiás	11115.77	-1.7%	-0.2%	0.0%	-3.6%	2.2%
Minas Gerais	15478.03	-0.9%	-0.3%	0.0%	-2.1%	1.4%
Mato Grosso	14813.30	-1.6%	-0.1%	0.0%	-3.1%	1.6%
Pará	11802.81	-1.0%	1.3%	0.0%	-75.8%	73.5%
Piauí	4389.40	0.5%	0.1%	0.0%	1.5%	-1.1%
Rio de Janeiro	24894.78	-1.4%	0.0%	0.0%	-1.6%	0.2%
Rio Grande do Sul	19103.17	-0.4%	0.2%	0.0%	-2.5%	1.9%
São Paulo	28003.93	-1.2%	0.2%	0.0%	-1.7%	0.3%
			1995-2009			
Bahia	9046.59	-0.4%	-0.1%	0.0%	-3.2%	2.8%
Ceará	7492.36	-0.4%	-0.1%	0.0%	-2.5%	2.2%
Espírito Santo	13298.67	0.5%	0.1%	0.0%	-0.2%	0.6%
Goiás	8469.23	2.0%	0.7%	0.0%	1.0%	0.3%
Minas Gerais	13398.48	-0.8%	0.1%	0.0%	-1.5%	0.6%
Mato Grosso	11424.04	1.6%	1.2%	0.0%	0.4%	0.0%
Pará	10086.72	-1.9%	-1.1%	0.0%	-2.5%	1.7%
Piauí	4768.58	0.6%	0.2%	0.0%	-3.5%	4.0%
Rio de Janeiro	19796.62	0.0%	0.0%	0.0%	0.0%	0.1%
Rio Grande do Sul	17966.24	-0.9%	-0.1%	0.0%	-1.5%	0.7%
São Paulo	23099.68	-0.5%	-0.2%	0.0%	-0.4%	0.1%

Source: Author's calculations, from IBGE and IPEA. Here, assuming ε_A=0.3. Annual growth rates of aggregate labour productivity and contribution from intra- and shift-effects from agriculture and non-agriculture. States selected to represent all groups: poor, middle-income and richest. The large values observed for Espírito Santo (cont.next page)

in 1950-80 and Pará in 1950-80 and 1980- 95 are probably a result of a very particular economic development in these areas. See footnotes[26] and [27].

Table 4 – Labour Productivity Growth in Agriculture and Non-Agriculture 1950-2009, Brazil and selected states

Annual Average LP	1950-2009		1950-1980		1980-1995		1995-2009	
Growth Rates	Agr	NA	Agr	NA	Agr	NA	Agr	NA
BRAZIL	**1.4%**	**1.0%**	**1.7%**	**4.3%**	**1.1%**	**-3.0%**	**0.8%**	**-1.2%**
Bahia	1.2%	0.8%	2.3%	9.0%	0.2%	-10.0%	-0.1%	-3.4%
Ceará	-0.2%	2.0%	0.1%	6.0%	-0.8%	-1.3%	0.0%	-2.6%
Espírito Santo	1.6%	-3.4%	3.0%	-5.0%	-0.8%	-2.9%	1.0%	-0.3%
Goiás	2.7%	1.4%	3.2%	4.5%	-0.1%	-4.4%	4.2%	1.1%
Minas Gerais	1.7%	0.9%	3.3%	3.8%	-1.4%	-2.3%	1.5%	-1.6%
Mato Grosso	3.2%	2.2%	4.1%	6.3%	-0.3%	-4.1%	4.9%	0.5%
Pará	1.9%	1.3%	3.2%	16.8%	5.7%	-20.1%	-4.7%	-3.0%
Piauí	0.9%	2.5%	0.3%	*	1.4%	*	1.5%	-3.6%
Rio de Janeiro	0.8%	1.2%	0.9%	3.3%	1.2%	-1.6%	-0.1%	0.0%
Rio Grande do Sul	2.0%	0.4%	2.8%	3.1%	2.2%	-2.8%	0.0%	-1.7%
São Paulo	0.8%	1.2%	1.8%	3.5%	5.3%	-1.8%	-5.9%	-0.4%

Source: Author's calculations, from IBGE and IPEA. The table presents agricultural (Agr) and non-agricultural (NA) labour productivity growth rates (average annual rates for each period). Obs *: There are data measurement limitations[28] for Piauí for 1975 and 1980 regarding employment, which impede the accurate estimation of non-agricultural productivity for the 1950-80 and 1980-95 periods.

Overall, aggregate labour productivity growth was larger in the first sub-period, from 1950-1980. Also, during these years, growth of productivity in non-agricultural sectors was much larger than in agricultural sectors in most states. This initial period coincides with the government-led industrialisation era, where increases in the labour productivity of the non-agricultural sector were highly motivated by new investments, new machinery and technological changes. In the shift-share analysis, these investments and advancements of industry are captured by the intra-effect in non-agriculture. Therefore, it would be expected that intra-effects from non-agriculture would consist the main source of labour productivity growth for the majority of states during this first period. For the whole of Brazil in 1950-1980, the non-agricultural sector experienced average annual labour productivity growth rates of 4.3%, compared to 1.7% of agriculture. In this period, the intra-effect of non-agriculture contributed to 75% of the whole aggregate labour productivity growth, whereas intra-effect of agriculture contributed to 6.3% and the shift of (surplus) labour from agriculture contributed with 18.6%. At the regional level, one can see that most states follow this same pattern,

[26] In Espírito Santo, the big effects observed in non-agriculture are probably related to the development of new industries and services in the early 1970s, such as cellulose, mining and commerce and logistics with the construction of important ports (e.g. Tubarão port, in 1966). Until 1960, this state was mainly a producer of coffee. For more, see Macedo and Magalhães (2011).

[27] In Pará, the big shift-effect to agriculture during 1950-1980 might be due to the development of agriculture in the region after the creation of SUDAM in 1966, when the military government subsidised a programme for the occupation of the south of Pará with agriculture. Later on, with the discovery of one of the biggest reserves of minerals in the world, the mining industry was established in Pará in the end of 1970s – now it is its main source of income.

[28] Both sources of sectoral employment data, Ipeadata and IBGE are official. However, as these official sources recognize, there are limitations of measurement and inconsistency of data regarding sectoral and total employment. Aside from Piauí, this is also an issue for Amazonas (1975-85), Maranhão (1960-1985) and Sergipe (1970-75) – years for which agricultural employment is declared higher than total employment.

but some see much more effects of structural change than others. Espírito Santo appears as an exception, with a larger contribution to aggregate productivity growth from the shift-effect. There, labour productivity was increased by the transfer of labour from agriculture to non-agriculture, and coincided with the crisis of the coffee production and beginning of industrialisation of this state (refer to footnote 26). To a lesser extent, the structural change was an important source of growth for many other states in this period (Minas Gerais, Goiás, Rio de Janeiro, São Paulo, Rio Grande do Sul)[29], as the modern industry developed and urbanization rates accelerated. In some cases, a movement was observed in the other direction. Pará had a big shift-effect to agriculture, associated with internal migration (refer to footnote 27), and a smaller effect was also observed in Bahia, Ceará, Mato Grosso and Piauí[30].

After 1980 labour productivity growth declined across the country, aggravated by the macroeconomic hostile environment. In the shift-share decomposition, this is mostly attributed to a reduction of productivity within the non-agricultural sector, which could probably be related to the decline of activity in the most productive industries and reallocation of labour to other sectors, with lower productivity. It is interesting to observe that in certain states, for instance Pará, Bahia, and Rio Grande do Sul the movement of workers from agriculture to non-agriculture (shift-effect) remained as an important source of productivity increase throughout the 1980s and acted as a countervailing force to the decrease in the productivity of the non-agricultural sector.

In the more recent period, from 1995-2009 there was a recovery of labour productivity growth rates. For most states, growth rates were still negative during these years, but at smaller values than before. This relative recovery was mostly driven by the improvement of non-agricultural productivity after the slowdown of the "lost decade". Some states recovered even faster in this period and had even positive growth rates of productivity. These are particularly those where agricultural productivity could rise rapidly and with larger intra-effects of agriculture, such as Mato Grosso and Goiás. In addition, the shift-share decomposition shows that shift-effects were still present in certain states during these years, though with a smaller contribution than before. Such states are also the ones with lower aggregate productivity in 1995 (Piauí, Bahia, Ceará).

Productivity Growth in Agriculture and Non-agriculture

From this analysis, it becomes clear that the relative magnitude of agriculture and non-agriculture labour productivity growth has changed over time. As Figure 8 shows, in the national average, non-agriculture was growing at faster rates until 1975, but this situation was reversed after that, when both sectors observed a decline in labour productivity and this decline was smaller for agriculture. Thus, after 1980, labour productivity growth was more intense in agriculture. This might simply reflect equilibrating movements of labour from agriculture to non-agriculture, as a response to higher marginal labour productivity and wages in the non-agricultural sector, what would induce a convergence of labour productivity between sectors. Alternatively, the faster growth of productivity in agriculture could be result of technological advancements and investment in this sector. In this case, the productivity gains would be a cause of movements of labour from agriculture, rather than a consequence of it. The interpretation of the shift-share analysis suggests that on average for the whole country, the overall intra-effects were more important than the shift-

[29] Not presented in Table 4, but this was also true for Pernambuco, Paraíba, Paraná, Rio Grande do Norte and Santa Catarina.

[30] Piauí again with a note for careful interpretation due to the data limitations highlighted in footnote 28.

effects from agriculture during the period post-1980 even though both gave significant contributions. And the evidence at the state-level also indicates that, most probably, both forces have been at work.

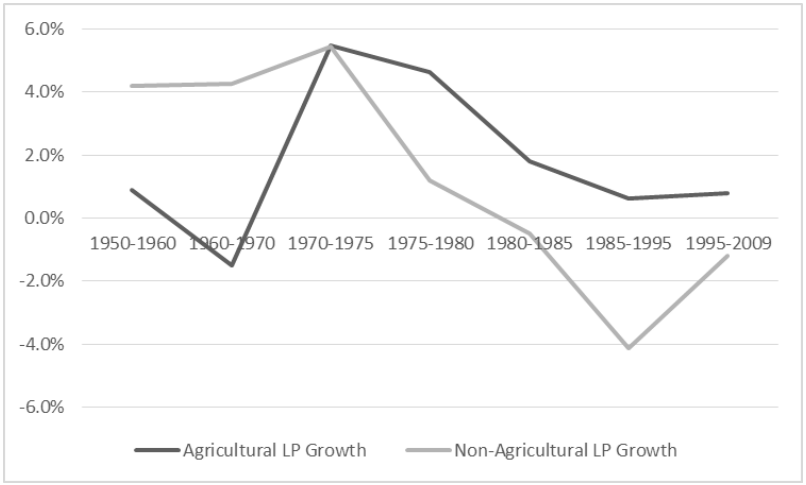

Figure 8: Labour Productivity Growth in Agriculture and Non-agriculture 1950-2009, Brazil

Source: Author's calculations, from IBGE and IPEA.

Agriculture has continuously increased its labour productivity from 1950 to 2009, as is shown in Figure 8 by the permanently positive growth rates in agriculture. The sharpest increase occurred in the 1970s and was mostly due to the shift of labour to the non-agricultural sector. In the subsequent years, the movement of workers from agriculture has continued and was of great importance to enhance labour productivity in certain states during the 1980s. Intra-effects, or increases in sectoral productivity of agriculture have also been present during the transformation. Other authors have highlighted the great expansion of rural credit, with interests below inflation, and the international commodities prices of agricultural exports during the 1970s as important stimulating factors for agriculture in Brazil (de Lucena &de Souza, 2001). In more recent years, the increase in land productivity and investments in research have been emphasized (Dias & Amaral, 2001). From this decomposition, we can argue that agricultural intra-productivity growth and sectoral shifts in employment were important sources of economic growth, especially after 1980.

These findings relate to those of previous studies that have focused on the evolution of Total Factor Productivity (TFP) of agriculture in Brazil (Gasques & Conceição 2000, Gasques et al., 2010), which present evidence of a continuous increase of this variable. These studies report a continuously growing number of agricultural establishments until 1980, signalling the expansion of agriculture in the extensive margin, with the occupation of new areas of land (Gasques et al., 2010). After that year, this number has gradually decreased, perhaps an indicator of a change to expansion in the intensive margin. In addition, the authors argue that the reduction of average size of establishments since 1970 is a by-product of the increased productivity of agriculture through increased productivity of labour and other factors (land, machinery, etc.), investments in research, qualification of labour force and agricultural policies (Gasques et al., 2010).

Nevertheless, when decomposing the agricultural TFP growth, Gasques et al. (2010) observed that since 1970 the labour productivity growth in agriculture was a more important contributor to growth than land productivity growth. And that the improvement in the qualification of agricultural workers was a relevant factor to increasing labour productivity. Combined, both intra- and shift-effects seem to have favoured the increase of labour productivity in agriculture in the more recent

years, as this sector has not experienced the same degree of productivity reduction as the non-agricultural activities. In contrast, the large non-agricultural intra-effect observed in many states is probably capturing a shift-effect happening within the non-agricultural group, from activities with higher labour productivity towards sectors with lower productivity, such as low productivity industries and some types of services.

These differences in the evolution of aggregate labour productivity across states and the differences in the magnitude of the contribution of shift-effects from agriculture to non-agriculture suggest that the process of structural transformation is not happening uniformly across the country. In order to examine further key characteristics and patterns in the process of structural transformation, I proceed with the analysis of the indicator of agricultural transformation examining the relation between growth of agricultural and non-agricultural labour productivities and structural transformation.

5.1.2 Indicator of Agricultural Transformation: the gap of labour productivity growth between agriculture and non-agriculture

The results for the indicator of agricultural transformation in the models of what has been proposed by Peter Timmer present an interesting pattern in Brazil. As described in Section 4.2.2, this indicator consists of the difference between the share of value added in agriculture and the share of workers in this sector. The evidence from a large cross-section of developing countries showed that as GDP per capita increases, the gap between the two shares would become smaller and smaller, gradually approaching zero[31] (Timmer, 2009). This is to say that with advancement of economic development, there would be convergence between labour productivity in agriculture and non-agriculture. Alternatively, one could measure this convergence of labour productivity by taking the ratio of the two values[32] .

For Brazil, the evolution of the indicator is presented in Figure 9. Only after an initial worsening of the indicator (increase of the "minus"), the gap starts to close– forming a "U-shaped" curve. McMillan and Rodrik (2011) claim that such U-shaped curve is a stylized fact of economic development, as the labour productivity gap between agriculture and non-agriculture presents a non-monotonic behaviour.

Peter Timmer's idea underlying the elaboration of such indicator reflects the notion that in early stages of development, a large number of agricultural workers is needed to produce a certain agricultural output –that is, labour productivity in agriculture is very low. With the progress of the structural transformation economy-wide, the shift of the agricultural labour surplus to other sectors and the advancements in agriculture-related technologies, it becomes possible that fewer agricultural workers will produce a larger agricultural output. But because other sectors have grown and the total economy is larger, the agricultural GDP represents a smaller share of the total. This process represents the transformation of the agricultural sector from low productivity to high productivity. According to P.Timmer and Akkus (2008, p.4), the final outcome visible on the horizon would be an economy and society where agriculture has no distinguishing features from

[31] It is possible to have positive values when the agricultural sector is comparatively super productive.
[32] In fact, this is the approach suggested by McMillan and Rodrik (2011).

other economic activities in terms of labour and capital productivity growth and location of poverty.

Source: Author's calculations, from IBGE and IPEA

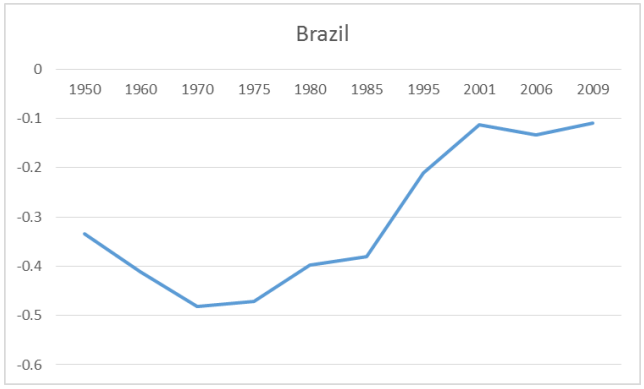

Figure 9 : Indicator of Agricultural Transformation, Brazil

So what is behind the increasing of the gap observed in Brazil in the earliest years? Is it that the labour productivity of agriculture has first became smaller to only later start increasing? It does not seem to be the case. In fact, agricultural labour productivity has continuously grown in most states and most periods. The downward slope initially observed is not because of lack of growth of agricultural labour productivity *per se*, but rather because of its performance relative to the labour productivity growth in the non-agricultural sector. As Table 4 presented, in the earlier periods the growth of labour productivity was generally larger in non-agricultural than in agricultural sectors. Mc Millan and Rodrik (2011, p.10) explain that this reflects the fact that initially, in early stages of development, a country normally has low labour productivity in both agriculture and non-agriculture, so there isn't a large gap. With investments towards the modern, urban, non-agricultural sector, this sector expands and increases its productivity at faster rates. That is, rapid economic growth starts to increase the productivity gap between agriculture and non-agriculture. The shift of (surplus) labour from agriculture to non-agriculture and the technological progress in agriculture act together as opposing forces, increasing the labour productivity of agriculture. It is expected that after a certain point, these forces will become dominant, and the labour productivity levels among sectors will start to converge (McMillan & Rodrik, 2011). This moment is represented by the turn into a positive slope in the indicator's curve. That is, the indicator only starts to approach zero (closing gap) when the productivity of agriculture increases more than the productivity of non-agriculture, leading to an overall convergence of labour productivity between all sectors.

It is interesting to observe how the U-shaped curve has different characteristics across Brazilian states. Different states have different low points, signalling a smaller or larger duality in the economy, and they also present different timings at which the slope becomes positive. So the curves assume rather dissimilar shapes. For instance, São Paulo had a lower point of -0.20 in 1960 and after that year the gap only got smaller. In contrast, Bahia and Goiás had a lower point in 1985, but at -0.78 and -0.37, respectively. Figure 10 exemplifies some of the different shapes observed across states. Table 13 (Appendix) presents the values of this indicator for all years and states.

Figure 10: U-shaped curve of Agricultural Indicator for selected states

Source: Author's calculations, from IBGE and IPEA

So, differences across states in the turning point of the U-shaped curve would correspond to different speeds and intensities of economic development.

The forces towards reducing the gap of the indicator of agricultural change can become dominant because i) agricultural labour productivity grows significantly (e.g large intra- and shift-effects); ii) non-agricultural labour productivity does not grow significantly, or even shrinks. This could be both due to low technological advancements and investments in industry, or shift effect occurring within the non-agricultural group, towards sectors with lower productivity; iii) both forces combined. In this shift-share analysis, as the economy is divided in two sector, shift-effects within the non-agricultural sector are allocated as intra-effects. The evidence indicates that Brazil is following the third path, a combination of enhanced labour productivity in the agricultural sector with a slowdown of labour productivity growth in the non-agricultural part.

Even though there has been, in general, continuous advancements in agricultural labour productivity, they alone might not be sufficient to boost this sector's labour productivity to values close to the non-agricultural sector. Several authors have examined the slow-down of non-agricultural productivity in the recent years in Brazil, attributing this phenomenon to the transition to lower-productivity services, rather than to a process of deindustrialisation[33]. McMillan and Rodrik (2011) refer to the expansion of an unproductive non-tradable sector in Brazil, including activities like personal and community services. With a more disaggregated analysis by sectors, they were able to capture shift-effects within the non-agricultural group. They argue that these effects have a growth reducing role, as labour is directed to low productivity sectors.

[33] Bonelli and Pessoa (2010) and Nassif (2008) argue that Brazil is not going through a process of deindustrialization in the recent years.

5.1.3 Relative Successes and Failures

With these different patterns, structural transformation in Brazil seems to have picked its favourites in terms of generating economic growth. All states appear to have unique characteristics and a distinctive historical path of development. Nevertheless, some interesting suggestive patterns can be gathered from the sample.

Table 5 presents a perspective of evolution of regional productivity differentials over time. In the light of the decreasing disparities of GDP per capita in Brazil, one would also expect that productivity differentials are decreasing. Interestingly, this only happened in the first period, from 1950-1980. Between 1980-1995, the regional productivity differentials were constant, and after 1995 they have increased. The 3 periods are characterised by the same productivity champions: São Paulo, Rio de Janeiro and Distrito Federal[34].

Table 5 – Regional Disparities in Labour Productivity Levels, by state

	Ratio of Regional to Total LP			
State	**1950**	**1980**	**1995**	**2009**
Alagoas	0.41	0.47	0.45	0.52
Amazonas	0.57	0.90	0.93	0.85
Bahia	0.43	0.63	0.60	0.58
Ceará	0.45	0.39	0.49	0.48
Distrito Federal	0.00	1.82	2.11	3.19
Espírito Santo	0.81	0.89	0.88	0.98
Goiás	0.55	0.62	0.56	0.78
Maranhão	0.28	0.28	0.27	0.44
Minas Gerais	0.74	0.86	0.88	0.82
Mato Grosso	0.68	0.82	0.75	0.99
Pará	0.47	0.66	0.66	0.52
Paraíba	0.49	0.34	0.44	0.57
Pernambuco	0.59	0.54	0.66	0.63
Piauí	0.24	0.24	0.31	0.36
Paraná	1.21	0.86	0.96	1.01
Rio de Janeiro	1.91	1.38	1.30	1.37
Rio Grande do Norte	0.54	0.47	0.52	0.56
Rio Grande do Sul	1.10	1.06	1.18	1.08
Santa Catarina	0.88	1.04	1.00	1.09
Sergipe	0.39	0.48	0.59	0.63
São Paulo	1.73	1.56	1.52	1.47
TOTAL LP Brazil	4555.5	17978.8	15192.3	14561.8
Mean	0.69	0.78	0.81	0.90
Standard deviation	0.47	0.42	0.44	0.61
Coefficient of Variation	0.68	0.54	0.54	0.67

Source: Author's calculations, from IBGE and IPEA

Regarding the structural transformation, one can observe cases where it was relatively successful, based on the inference about outcomes of the process in 2009. A more successful structural transformation is associated with the increase of productivity in both agricultural and non-agricultural sectors and convergence of labour productivity between them.

[34] Not considering 1950 for Distrito Federal, as the state did not exist.

As the gap reduces and labour productivity converges between agriculture and non-agriculture, the potential for reallocation of labour from agriculture is diminishing, which is shown by the reduction of the contribution from shift-effects, especially after 1995. This is a sign of transition towards development and could be interpreted as indication of a more dynamic transformation of agriculture, also driven by internal productivity growth in this sector.

From Table 11 (Appendix), we observe that the level of GDP per capita in 2009 is positively correlated to agricultural productivity in 2009 (ρ =0.76) and even more to the non-agricultural productivity in the same year (ρ =0.95). In addition, a large agricultural productivity in 1950 is highly related to a high productivity in 2009 (ρ =0.74) and to a higher productivity in non-agriculture in 2009 (ρ =0.86). From this, it would seem that enhancing agricultural productivity as well might be a condition for a successful transformation in Brazil. Some states, such as Rio de Janeiro, São Paulo and the south (Rio Grande do Sul, Santa Catarina, Paraná) seem to have been more successful in this sense, presenting in 2009 simultaneously a smaller gap of the indicator and a higher GDP per capita. In contrast, Piauí stands out as an example of the indicator's trap - or of a less successful, or incomplete structural transformation. With a gap of only -0.07, this state has the lowest agriculture and non-agricultural levels of productivity in 2009 and, in this same year, is the second poorer state in GDP per capita terms.

In addition to an expected high positive correlation between GDP per capita in 1950 and 2009 (ρ = 0.76), indicative of a tendency of path dependence where richer states tend to remain richer, the negative correlation between the same GDP in 1950 and total labour productivity growth rates throughout the period could be sign of occurrence of some convergence of income across the states. This suggests that, to a large extent, success is path dependent. Initially richer and more productive states were also at the top of the ranking 60 years later. Nevertheless, among the initially poor states, there was some space for catching up.

As we have seen, there are probably a myriad of country-wide factors that contributed to changes in the relative importance of the intra- and shift-effects over time. Studying the experiences of separate states might not clarify those factors. However, comparing these different experiences can increase our understanding about conditions that contributed to a certain pattern of transformation. In this paper, the relatively more successful cases were the ones identified by a high GDP per capita in 2009, small gap and high labour productivity in both sectors (Table 14 – Relative Successes and Failures, Appendix). They are Rio de Janeiro and São Paulo, states where the structural transformation started relatively early. Using the same reference, we can also observe the presence of catching up states among the initially middle/high income (Rio Grande do Sul, Santa Catarina, Espírito Santo) and also among the initially very poor states (Bahia, Sergipe). These catching up states had all very large gaps in the agricultural transformation indicator in 1950, so they went through a considerable agricultural transformation over this 60 year period. However, the middle- and high income had a turning point sooner and the poorer states later.

In summary, it seems that to a large extent the success of structural transformation was persistent, with initially smaller gaps and larger initial income corresponding to a better GDP in 2009. However, we have also seen that some states – among poor and middle income – have found opportunities to catch up. Returning to the idea that economic development is more complex than only growth of labour productivity or growth of GDP per capita, this analysis proceeds to look at one dimension of social development, with the examination of sectoral composition of growth and poverty reduction.

5.2 Sectoral composition of Growth and Poverty Reduction in Brazil: 1980-2009

In this second part of the empirical analysis, we turn to the investigation of the second research question, examining the association of sectoral composition of growth and poverty reduction, with a focus on the evolution of the role of growth in agriculture. Then, at the state-level, this is observed in relation to the progress of structural transformation.

5.2.1 Does the Sectoral Composition of Growth Matter?

As proposed by previous studies, growth in different sectors might have different impacts on reducing poverty (Ferreira et al., 2010; Loyaza & Raddatz,2010; Ravallion & Datt, 1996; Ravallion & Chen, 2007). In this section, I will present the main results for my estimations of agricultural and non-agricultural growth elasticities of poverty reduction for Brazil. Using the data described in Section 4.1, I estimate a first-differences specification of Equation 9, with agricultural and non-agricultural growth rates weighted by these sectors' respective initial output shares. As emphasised in the methodology section, this method has the advantage of allowing to eliminate states' time-invariant fixed effects.

Estimations of Participation and Share Components

The main estimation results are presented in Table 6[35]. In this model specification, an explanatory variable will increase (decrease) poverty if it has a positive (negative) coefficient. Note that when the model is written is this form, the growth elasticities of poverty reduction are not given by the regression coefficients itself, but rather by the product of the estimated coefficients and initial output shares. This important matter will be further addressed in the sequence.

Model (1) presents the results for the most basic model, where the growth of poverty is only explained by the growth of agriculture and non-agriculture. Here the coefficient of agriculture is much larger and highly significant, while the coefficient of non-agriculture is very small. Wald test results for $H_0: \beta_{1i} = \beta_{2i} = \beta$ allow to reject the null hypothesis at 1% level[36] .Had this hypothesis not been rejected, we would return to Equation 7 in which the sectoral growth decomposition would not matter for poverty reduction. However, these results indicate that sectoral pattern of growth does matter for poverty reduction in Brazil. Model (2) represents the basic model, including a time trend. The inclusion of a time trend with a dummy for each period is regarded as a sensible decision after visual examination of the dependent variable, as poverty growth presents an inconstant pattern across the period[37] . It can be used to capture period-specific shocks common to all states. Models (3) and (4) represent extensions of the standard specification with the addition of two control variables: education and inequality. Improvement in human capital is highly

[35] Heteroscedasticity and serial correlation were addressed via robust standard errors.
[36] P value=0.0071
[37]See Figure 13 (Appendix).

correlated with poverty reduction and income inequality at the state-level is also highly associated with a lower capacity of poverty reduction from growth (Menezes-Filho & Vasconcellos, 2007). Education, here represented by average years of study has a negative and statistically significant coefficient. Inequality here has been included as the Gini[38] index. The Gini variable does have an expected positive coefficient, as an increase in the Gini index (representing more inequality) would contribute to increase poverty in a region. That is, higher inequality diminishes the poverty reducing effects of growth. Model (5) presents the model with inclusion of intercepts to capture individual states' trends. The H0 that all these states intercepts are equal is easily rejected. The main difference observed in this last, more complete model is that now the coefficients of agricultural growth and non-agricultural growth are both significant at 5%.

Table 6 – Results: First Differences Estimations of Sectoral Growth Impacts on Poverty

	Poverty Headcount Index				
	(1)	(2)	(3)	(4)	(5)
Agricultural growth (per capita, weighted share)	-0.857***	-0.796**	-0.795***	-0.675**	-0.685**
	(0.295)	(0.332)	(0.290)	(0.292)	(0.262)
Non-Agricultural growth (per capita, weighted share)	-0.0259	-0.0197	-0.0285	-0.0345	-0.298**
	(0.0519)	(0.0412)	(0.0392)	(0.0359)	(0.133)
Education			-0.651**	-0.731***	-0.605**
			(0.250)	(0.263)	(0.278)
Gini				0.931**	0.569
				(0.381)	(0.349)
Time trend		x	x	x	x
State-intercepts					x
Constant	-0.110***	0.101***	0.179***	0.147***	0.209***
	(0.0190)	(0.0290)	(0.0421)	(0.0427)	(0.0648)
					x
Observations	126	126	126	126	126
R-squared	0.057	0.508	0.539	0.573	0.707

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The overall results hold when including time and state dummies and after extending the model. In general, the coefficients of agricultural growth would seem more relevant to poverty reduction than those of non-agricultural growth. Nevertheless, as pointed out previously, the growth elasticities of poverty are not the regression coefficients itself, but are given by the product of these coefficients by the initial sectoral shares of output. Table 7 presents the growth elasticities of poverty calculated from the coefficients of Model (5) for each state.

The calculation of the actual growth elasticities of poverty makes it clear that even though the coefficients estimated for agriculture were bigger, the weighted elasticities are actually much higher

[38] It is worth remembering that the Gini Index only capture changes in the centre of the income distribution. Nevertheless, this is the common measure of inequality most used in the related literature.

for growth of non-agriculture. This is consistent with the findings of Ferreira et al. (2010) for Brazil, which have found that services are more poverty-reducing than agriculture and industry.

Table 7 – Sectoral Growth Elasticities of Poverty 1980-2009, by state

	Agriculture			Non-Agriculture		
States	1980	1995	2009	1980	1995	2009
Alagoas	-0.16	-0.09	-0.05	-0.23	-0.26	-0.28
Amazonas	-0.08	-0.04	-0.08	-0.26	-0.28	-0.27
Bahia	-0.11	-0.09	-0.05	-0.25	-0.26	-0.27
Ceará	-0.11	-0.07	-0.03	-0.25	-0.27	-0.28
Distrito Federal	0.00	0.00	0.00	-0.30	-0.30	-0.30
Espírito Santo	-0.10	-0.06	-0.05	-0.25	-0.27	-0.28
Goiás	-0.19	-0.13	-0.10	-0.21	-0.24	-0.25
Maranhão	-0.22	-0.15	-0.11	-0.20	-0.23	-0.25
Minas Gerais	-0.12	-0.07	-0.06	-0.25	-0.27	-0.27
Mato Grosso	-0.25	-0.16	-0.16	-0.19	-0.23	-0.23
Pará	-0.14	-0.19	-0.05	-0.24	-0.22	-0.28
Paraíba	-0.12	-0.14	-0.04	-0.25	-0.24	-0.28
Pernambuco	-0.08	-0.07	-0.03	-0.27	-0.27	-0.28
Piauí	-0.16	-0.11	-0.07	-0.23	-0.25	-0.27
Paraná	-0.14	-0.06	-0.05	-0.24	-0.27	-0.28
Rio de Janeiro	-0.01	-0.01	0.00	-0.29	-0.29	-0.30
Rio Grande do Norte	-0.09	-0.05	-0.04	-0.26	-0.28	-0.28
Rio Grande do Sul	-0.11	-0.10	-0.07	-0.25	-0.26	-0.27
Santa Catarina	-0.11	-0.10	-0.06	-0.25	-0.25	-0.27
Sergipe	-0.12	-0.08	-0.04	-0.25	-0.26	-0.28
São Paulo	-0.03	-0.04	-0.01	-0.29	-0.28	-0.29

Source: Author's calculations. Growth elasticities of poverty reduction calculated with the coefficients from Model (10).

The growth elasticities of poverty were larger for agriculture in 1980. After that year, it would seem that the agricultural sector was "penalized" by its gradually reducing share in the total output, one of the features of the agricultural transformation. That is, with the advancement of the process of structural transformation, agriculture has a diminishing direct potential to reduce poverty, as shown in Figure 11. On the other hand, direct effects from non-agriculture seem to have been more constant throughout the period.

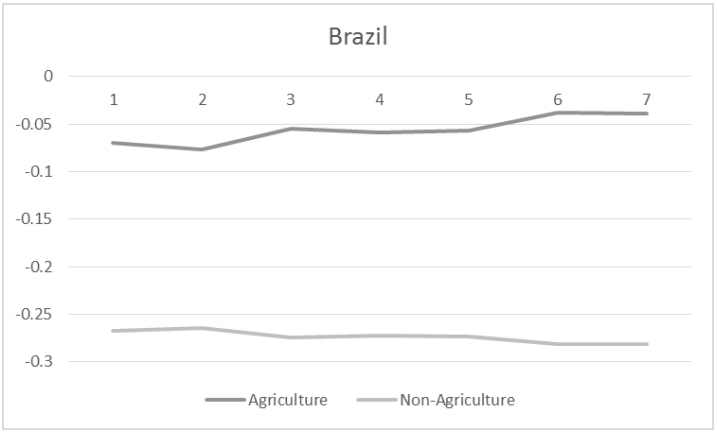

Figure 11- Growth Elasticities of Poverty in Agriculture and Non-Agriculture

Source: Author's calculations, from coefficients from Model (10).

How is this related to the share of employment in agriculture and development of productivity in agriculture? By definition of the growth elasticities of poverty, the states with higher potential for poverty reduction through growth are the ones that generate more GDP. In the first case, generating growth in agriculture could have a much higher impact if the participation of agriculture in total GDP was high. Thus, a high elasticity in 1980 identifies a state which has just started the structural transformation, or where it is occurring at a slow pace. This is the case of Paraíba, Alagoas and Maranhão. 30 years later, a high elasticity in agriculture identifies mostly agriculture-oriented states. In 2009, most states in which agriculture generates a large share of output (Mato Grosso, Goiás and Amazonas) are states with highest values of agricultural productivity. The exception is Maranhão, where the participation of agriculture is high, but productivity still very low.

The dynamism of agriculture could be one factor that determines the extent of this sector's capacity to reduce poverty. Over this period, productivity in agriculture has risen, more in some states than others. In summary, these findings suggest that with the progress of structural transformation, the power of the effects from participation and share components of agriculture to poverty reduction declines, as labour is allocated to non-agricultural sectors. This suggests that agriculture is potentially important, but the variation in its power to reduce poverty depends on many other factors. For instance, it is reasonable to think that these direct effects would depend on the structure of agricultural production – concentration of land, degree of mechanisation and use of skilled/unskilled labour.

Direct and Indirect effects

Regarding the direct effects from growth potential across sectors, the evidence shows that for all states agricultural GDP growth has lagged behind non-agricultural GDP growth (Appendix GRO1). One could think of agriculture as an inherently backward sector when looking only at these values. However, as presented previously, during 1980-2009 labour productivity growth was larger in agriculture than non-agriculture. This indicates that while agricultural GDP growth has been largely driven by labour productivity growth, non-agricultural growth has been driven by other factors (population growth, capital accumulation). As Christiaensen et al. (2011) explain, while the direct growth effect is likely to be smaller for agriculture, evidence shows that in particular contexts (agriculture more tradable), agricultural productivity and growth can be substantial. This is to refute the idea that investments and policies directed to agriculture are automatically less effective in generating growth than when they are directed to non-agriculture.

As to what concerns the indirect effects of sectoral growth on poverty, it is more difficult to ascertain the magnitude and direction of such effects without additional evidence. Other papers have argued that the Johnston Mellor linkages from agriculture to non-agriculture are larger than from non-agriculture to agriculture (Valdés & Foster, 2010), but such findings are very context-dependent. For Brazil, a study by Furtuoso and Guilhoto (2003) estimated the Johnston-Mellor linkages from the agricultural sector to industry and generation of non-farm employment linked to agriculture. These authors estimate a new GDP for the agro-business industry. Their results show that this sector accounts for 27% of national GDP in 2000 – as opposed to the "direct" shares which represent around 6% - suggesting that the importance of agriculture goes beyond its GDP share.

Thus, it is likely that the role of agriculture will be underestimated if we only look at the participation and share effects from each sector. Most likely, some of the effects from agriculture

are being captured by the non-agriculture sector. For instance, with the boom of commodities, agriculture's demand of services (transport, logistics) increases radically – but in the model this would be shown as an impact strictly from non-agriculture. So, one should not consider automatically that investing in non-agriculture is always better.

5.2.2 Going further: an exploratory analysis of variation in non-agricultural growth elasticities of poverty across states

Returning to the regional perspective, this section presents the results of a tentative analysis of examining potential variations on the growth elasticities of poverty from agriculture and non-agriculture across states.

Estimating the most basic model with no pooling restrictions[39], we can reject that the coefficients of non-agriculture (share-weighted growth of non-agriculture) are equal for all states, while this is not true for the coefficient of agriculture (share-weighted growth of agriculture). Hence, the next step is an exploratory analysis, where I estimate the final model, leaving the coefficient of non-agricultural to vary across states, while maintaining constant coefficients for agriculture, education, Gini and the time trend, and retaining the state's individual trends in the intercepts . A similar approach has been proposed by Ravallion and Datt (2002) when studying growth and poverty reduction for states in India.

The complete results for the parameters of the estimated model (6) are presented in Table 16 (Appendix). In short, the coefficients of non-agricultural growth (per capita, share-weighted) are reported statistically different across states, and also different from the agricultural growth (per capita, share weighted) coefficient. Agricultural output continues to have a negative and highly statistically significant coefficient, although smaller than before. On the other hand, as expected, non-agricultural elasticities vary across states. The coefficient of non-agricultural growth is reported very statistically significant for certain states. In addition, while the majority of non-agriculture coefficients is negative, as it would be expected, in some cases it is positive. Gini and Education coefficients have the expected signs. However, they are reported not significant, perhaps because these are instead captured by the individual level trend.

[39] Ideally, one should estimate the final model with all the variables and no pooling restrictions. In this case, however, because of limitations related to the small sample size and few degrees of freedom, it is not possible to run a separate regression with all variables for each state. Instead, I let the elasticities of agriculture and non-agriculture vary across states in the model (2) and test (F-test) if the coefficients are equal across states. Only the coefficients of non-agriculture were reported statistically different between states (p_value=0.0001).

The most interesting findings relate to the differences of non-agricultural growth elasticities of poverty across states. Here too I calculate these elasticities for each state and time, multiplying the coefficients by the initial share of output for each sector. In Table 8 growth elasticities of agriculture and non-agriculture are presented for 1980 and 2009.

Table 8 - Growth Elasticities of Poverty 1980-2009 – Variation of non-agricultural coefficients by state

	Agriculture			Non-Agriculture			
States	**1980**	**1995**	**2009**	**1980**	**1995**	**2009**	**Coefficient**
Alagoas	-0.09	-0.05	-0.03	0.08	0.10	0.10	0.11
Amazonas*	-0.05	-0.02	-0.04	-1.03	-1.11	-1.04	-1.17
Bahia	-0.06	-0.05	-0.03	-0.38	-0.39	-0.42	-0.45
Ceará	-0.06	-0.04	-0.02	-0.08	-0.09	-0.09	-0.10
Distrito Federal*	0.00	0.00	0.00	-1.04	-1.04	-1.04	-1.05
Espírito Santo***	-0.06	-0.04	-0.03	-1.67	-1.78	-1.83	-1.96
Goiás*	-0.11	-0.07	-0.06	-0.83	-0.95	-0.99	-1.16
Maranhão	-0.12	-0.08	-0.06	-0.08	-0.09	-0.10	-0.12
Minas Gerais**	-0.07	-0.04	-0.03	-3.24	-3.24	-3.24	-3.24
Mato Grosso**	-0.14	-0.09	-0.09	-0.80	-0.80	-0.80	-0.80
Pará***	-0.08	-0.10	-0.03	1.27	1.15	1.46	1.58
Paraíba	-0.07	-0.08	-0.02	-0.21	-0.20	-0.24	-0.25
Pernambuco	-0.04	-0.04	-0.02	0.02	0.02	0.02	0.02
Piauí	-0.09	-0.06	-0.04	0.32	0.35	0.37	0.41
Paraná	-0.08	-0.03	-0.03	0.04	0.04	0.04	0.04
Rio de Janeiro	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
Rio Grande do Norte	-0.05	-0.03	-0.02	-0.16	-0.17	-0.17	-0.18
Rio Grande do Sul	-0.06	-0.05	-0.04	0.73	0.75	0.78	0.87
Santa Catarina	-0.06	-0.06	-0.03	-1.10	-1.12	-1.21	-1.32
Sergipe	-0.07	-0.04	-0.02	-0.17	-0.19	-0.20	-0.21
São Paulo	-0.01	-0.02	-0.01	-0.96	-0.96	-0.96	-0.96

Source: Author's calculations. Growth elasticities of poverty reduction calculated with the coefficients from Model (6)

These results show a clear heterogeneity of non-agricultural elasticities across states. Almost always the elasticity is higher in 2009 than in 1980, indicating an increase in output share of non-agriculture. Non-agricultural growth assumes larger elasticities and becomes statistically significant for certain states, namely Amazonas, Distrito Federal, Espírito Santo, Goiás, Mato Grosso and Minas Gerais. This indicates that for these places the increase in growth of industry/services output would be poverty reducing – and much more relevant than agricultural growth, at least through participation and share effects. In addition, some states present a positive elasticity of non-agricultural growth – meaning that increasing this sector's GDP would increase the proportion of poor individuals. This could be related to a worsening effect of growth on income distribution, increasing the income of the richer and diminishing the income of the poor. One interesting case is Pará[40], where not only is the coefficient positive, but highly significant.

Why would the participation and share effect of non-agriculture vary across states?

One hypothesis is that this variation is related to variable characteristics observed within the non-agricultural sector. Other studies for Brazil have found that in the recent period, growth in the

[40] The high positive elasticity for Pará is probably reflecting the large mining sector in the state. Growth of output of this industry is generally not redistributed throughout the economy.

services sector was more poverty-reducing than growth in agriculture or industry (Ferreira et al, 2010). For many states, in this last estimation, elasticities of non-agriculture were larger than for agriculture. In addition, it has been argued by other studies that sectoral concentration of poverty affects the potential capacity of growth to reduce poverty (Christiaensen et al., 2011). This notion follows from two propositions: poor face more obstacles connecting to growth elsewhere in the economy, and often the political economic framework does not favour the redistribution of income among sectors (Christiaensen et al., 2011; Dercon, 2009). Following this logic, if the poor are concentrated in agriculture, it would be expected that growth in this sector would benefit them more than growth outside of agriculture. Now, if the poor are rather concentrated in services, for instance, growth in this sector could have a larger impact on poverty reduction. Another factor that might affect the sectoral capacities of poverty reduction is the intensity of unskilled labour. The findings by Loyaza and Raddatz (2010) suggest that the poverty reduction potential of a sector is related to the proportion of unskilled labour employed. When this proportion is higher, the potential to reduce poverty is greater.

These sectoral characteristics are naturally related to how the structural transformation takes place. The next natural step to improve this analysis would be analysing the probable causes of these differences across states in the long-run. One suggestion in literature comes from studies which propose that these differences in rates of poverty reduction can be explained in by looking at the initial conditions for each state. For instance those related to concentration of land, rural development, health and human capital accumulation (Datt &Ravallion, 1998; Ferreira et al., 2010). For example, a more equal distribution of land is associated with a bigger capacity of agricultural growth for poverty reduction, while human capital accumulation is thought to contribute to lower poverty through increasing participation effects of non-agriculture.

In this sense, it is possible that the same conditions that favour a more successful transformation are related to a higher capacity of non-agriculture for the reduction of poverty. With the exception of Paraná and Rio de Janeiro (positive coefficients, not statistically different from zero), all other states presented as relative successes of structural transformation had estimated coefficients larger than 0.84. Examining closely these cases with a (negative) large and statistically significant non-agricultural elasticity, one observes that these states were middle-income in 1980, right below the national average GDP per capita and the agricultural transformation indicator indicates that they were already in the process of transformation (with most turning points before 1985). In addition, these were states with high agricultural TFP growth[41] (Mato Grosso, Espírito Santo, Minas Gerais, Amazonas) and most of them had very high rates of agricultural labour productivity growth from 1980-2009. It seems that having a larger negative elasticity for non-agriculture is related to having a more dynamic agricultural sector[42]. This can be interpreted as non-agriculture capturing indirect effects generated by the agricultural sector.

[41] Gasques & Conceição (2000) showed that Mato Grosso had the largest agricultural TFP growth since 1970. Rondônia (here included in Amazonas), Espírito Santo and Minas Gerais had agricultural TFP growth above average, and Pará below average.

[42] With the exception of Distrito Federal, where the participation of services in output, and especially public services, could explain a larger non-agricultural growth elasticity of poverty reduction.

6 Conclusions

This paper contributes to the discussion as a study of the regional disparities in the process of structural transformation in Brazil in the long-run, since the 1950s, focusing on the role of agriculture and its relationship with economic growth and poverty reduction. It had two main objectives: first, to study the different trajectories of structural transformation at the state-level. Secondly, it aimed to examine the relation between sectoral patterns of growth and poverty reduction in Brazil.

How has the structural transformation differed across states? The results from the shift-share analysis and analysis of an indicator of agricultural transformation for 1950-2009 indicate that some states had a relatively more successful transformation, in terms of economic growth and productivity growth during this 60-year period. As the gap reduces and labour productivity converges between agriculture and non-agriculture, the potential for reallocation of labour from agriculture is diminishing, which is a sign of transition towards development. This could be interpreted as a sign of a more dynamic transformation of agriculture, driven by internal productivity growth in this sector. In addition, the results suggest that a more successful transformation is associated with a rise in both agricultural and non-agricultural labour productivity – and ultimately with a convergence of labour productivity between these two sectors. To a large extent, success is path dependent. Initially richer and more productive states were also at the top of the ranking 60 years later.

In the second part, with an analysis of sectoral composition of growth and poverty reduction at the state-level, I find that growth from agriculture and non-agriculture do have different impacts in poverty reduction. The participation and share effect from agriculture reduces over time, while this effect for non-agriculture increases, mirroring the advancement of the structural transformation. Nevertheless, the participation effect is only one possibility, and I argue that it is likely that the impact of agriculture is captured through indirect linkages. The evidence suggests that the growth elasticity of poverty from non-agriculture varies across states. This variation is could be related to the sectoral concentration of poor and unskilled labour and to initial conditions of the states. In addition, we observe that states with higher growth elasticity of poverty from non-agriculture are the generally the ones with very dynamic agriculture, which can indicate that the effect from non-agriculture captures indirect effects generated in agriculture.

In summary, the results showed that development experiences can be very different even within the same country, highlighting the importance of a regional perspective. They support the idea that structural transformation leads the way to economic development in the long-run, and that it depends on rising productivity of both agricultural and non-agricultural sectors. Regarding the debate, this paper lends support to the view that agriculture plays an important role in economic development, if the policy objectives combine economic growth *and* poverty reduction (Timmer 2005, 2009; Valdés & Foster, 2010).

This is not to say that one should primarily invest in agriculture-led strategies in all contexts. Nor automatically discard agriculture as a potential source of economic development. It is reasonable to think that growth in agriculture will not come in isolation, but with interaction with the rest of the economy. Though it remains to be investigated whether agricultural growth can be pursued in a cost-effective manner. Therefore, this study advocates for a more careful assessment of the relative benefits in each context, of investing in agriculture as opposed to investing in other sectors. Even within the same country, these opportunity costs might differ.

It is important to highlight some caveats of this study. First, the incapacity of taking into account regional migration between the states. Within a country like Brazil, labour is very mobile and the shifts of labour between regions probably plays a role in the structural transformation dynamics. Secondly, there are limitations regarding the variables in the model of estimation of sectoral growth effects on poverty reduction. For instance, it is possible that the covariates included do not capture all possible determinants of poverty at the state-level. Even with the first-differences approach, time variant variables that vary across states are not considered. As it has been discussed by the related literature, it would be desirable to include other control variables. One that strikes as especially important in Brazil is the (federal and state) government expenditures in education, health and cash transfers. Many authors have highlighted these factors when examining regional disparities in Brazil (Barros &Mendonça, 1995; Menezes-Filho &Vasconcellos, 2007). However, for this long time series, collecting and interpreting correctly this type of data at a state-level is not trivial, and would require precise knowledge of suitability of price deflators. From 1950 to 2009 there were seven changes of currency, being five of them during 1985-1994, the decade of hyperinflation. Thus, this is left as one important suggestion for future research on the topic. In terms of the econometric approach, a more rigorous analysis of the potential issues regarding spatial correlation and endogeneity between the variables is recommended.

The findings of this paper are not at all conclusive. Rather, they open up the way to many possibilities of research about Brazil. Several aspects that have come to attention during this study are worth further research. Firstly, one important avenue to be pursued is the estimation of production and consumption linkages between agriculture and non-agriculture. Apart from the work of Furtuoso and Guilhoto (2003), to my knowledge there are no other studies addressing this issue in Brazil. This evidence could contribute to assess more accurately the effects of agricultural growth to poverty reduction and how the impact of non-agriculture is capturing indirect linkages. Secondly, as other studies have suggested (Ferreira et al. 2008; Ferreira et al. 2010) the evolution of income inequality and the disparities observed at the state level seem to be a key factor to understand the potential of poverty reduction from growth. Thirdly, and related to the last suggestion, a complementary research to this paper could make a study of regional convergence of growth and sectoral transformation, and consider how this relates to initial conditions of the states. Finally, it might be interesting to investigate further characteristics regarding the timing and threshold of income observed at the turning point of the agricultural indicator.

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Appendix A

Figure 12 : Map of Brazil

Source: IBGE [pdf] [Online]. Available at: http://7a12.ibge.gov.br/images/7a12/mapas/Brasil/brasil_grandes_regioes.pdf. [Accessed 20160520]

Appendix B

Data Sources

All the data used in this study came from official databases of the Brazilian Institute of Geography and Statistics (IBGE) and the Institute of Applied Economic Research (IPEA).The IBGE via Regional Account Statistics and the National Household Survey (PNAD) provided information related to economic growth and employment. Variables such as poverty, education and Gini were taken from Ipeadata, a database elaborated by IPEA. These figures are generally calculated by IPEA based on the results from the Censuses and the PNAD, being the collection of the data of IBGE's responsibility. Ipeadata also contains the historical series of economic growth and employment, though this data from the original data by IBGE.

Despite the fact that all data comes from official sources, there are limitations regarding the combination of information from different Censuses and Surveys. Although necessary to build a long time series, this is an issue, especially for the earliest years, as the definition of variables was frequently being modified to meet new standards. The variables and its sources are described below.

Variables

Output: Data on state-level GDP is given in constant market prices (in 2000 R$) and data on state-level value-added from agriculture and in total are given in constant basic prices (in 2000 R$). GDP per capita is calculated as the ratio between total GDP (market prices) and resident population.

Employment: Data for total employment is taken from Censuses for 1970-2000, available through Ipeadata. After 2000, data on total employment was obtained directly from the microdata of the Pesquisa Nacional por Amostra de Domicílios (PNAD), versions 2001, 2006 and 2009. For 1950 and 1960, the Census definition of economic active population excluded voluntary and involuntary unemployment. Thus, for these years, the economic active population equals the total employed population (IBGE, 1990; Reis, 2014). These values for 1950 and 1960 were collected from IBGE (1990). Data on agricultural employment was obtained from IBGE Censuses of Agriculture (through Censo Agrícola for 1950 and 1960 and Censo Agropecuário for 1970-1995) and from the PNAD for 2001, 2006 and 2009. Data on non-agricultural employment is obtained as the residual.

Poverty: Poverty is measured by the headcount index, the percentage of the population living in households with income per person below state-level poverty lines. Extreme poverty lines are calculated by IPEA with PNAD data, based on the value of a basic food basket that included the necessary minimum calories according to FAO and WHO standards. Different states have different extreme poverty lines. The poverty line is calculated as two times the extreme poverty line. Data on poverty headcount was obtained from Ipeadata, based on these calculations. There was no data on poverty headcount available for 1980, so this value has been approximated by averaging the values for 1979 and 1981.

Education: Average years of study for individuals aged 25 or more. Obtained from Ipeadata.

Gini Index: provided by Ipeadata for each state.

Table 9 – Employment in Agriculture: Censuses and PNAD, 1950-2009

	Census								PNAD		
State	1950	1960	1970	1975	1980	1985	1995	2006	2001	2006	2009
Alagoas	274,985	362,979	430,279	493,661	543,524	624,588	432,104	435,163	473,776	503970	411,118
Amazonas	103,732	204,719	374,247	615,979	750,293	1,006,888	782,991	677,020	124563	637631	606904
Bahia	1,282,771	1,819,712	2,125,809	2,518,925	2,662,835	3,202,483	2,508,590	2,321,905	2047538	2235309	2212746
Ceará	498,803	801,492	1,021,712	999,721	1,069,258	1,271,800	1,170,724	1,143,004	934802	1054218	975569
Distrito Federal	0	2,510	7,284	8,582	14,628	17,178	14,037	22,167	12861	13020	14066
Espírito Santo	272,992	285,165	299,647	312,062	349,510	399,033	351,461	300,394	380288	346116	365589
Goiás	299,334	499,207	547,647	688,033	780,749	855,820	665,878	577,846	584994	607408	683046
Maranhão	368,625	951,618	1,182,711	1,494,705	1,672,502	1,672,820	1,331,864	994,144	1108378	1031462	907540
Minas Gerais	1,901,933	2,271,486	1,979,935	2,189,945	2,284,550	2,660,130	2,000,046	1,860,797	1952736	2105103	1982617
Mato Grosso	86,279	186,703	373,039	520,311	549,553	613,214	532,507	563,724	539065	602796	556315
Pará	222,770	339,309	559,777	796,668	1,031,318	1,231,646	900,585	810,921	183,364	658,691	700883
Paraíba	434,143	553,330	584,656	799,632	648,607	763,958	479,987	489,403	393403	481297	361374
Pernambuco	879,844	1,263,146	1,128,264	1,137,787	1,218,871	1,307,160	975,288	955,454	990686	1036420	871438
Piauí	206,307	358,333	518,736	613,521	790,326	818,465	666,465	830,812	546608	674637	643441
Paraná	507,607	1,284,698	1,981,471	2,079,174	1,807,826	1,855,063	1,287,632	1,097,438	1068158	1003202	821317
Rio de Janeiro	293,271	264,370	245,649	278,564	301,688	321,912	174,274	157,492	150820	143412	117634
Rio Grande do Norte	234,737	299,419	307,881	382,488	432,188	432,317	332,516	247,204	268524	296080	294404
Rio Grande do Sul	1,071,404	1,334,039	1,446,813	1,893,935	1,747,230	1,747,932	1,376,985	1,219,510	1253277	1273114	1131357
Santa Catarina	370,912	575,294	763,501	858,734	836,755	887,287	718,694	567,526	562690	619859	572926
Sergipe	154,721	249,146	268,782	298,307	295,055	348,069	313,271	269,717	197157	203821	194064
São Paulo	1,531,664	1,727,310	1,420,040	1,364,942	1,376,463	1,357,113	914,954	873,087	943,055	1,003,376	968,806
TOTAL Brazil	**10,996,834**	**15,633,985**	**17,567,880**	**20,345,676**	**21,163,729**	**23,394,876**	**17,930,853**	**16,414,728**	**14,716,743**	**16,530,942**	**15,393,154**

Source: IBGE.

Table 10 - Output Share of Agriculture 1950-2009

Estado	1950	1960	1970	1975	1980	1985	1990	1995	2001	2006	2009
Alagoas	0.44	0.50	0.29	0.27	0.24	0.24	0.23	0.13	0.11	0.08	0.07
Amazonas	0.37	0.33	0.26	0.20	0.12	0.12	0.08	0.05	0.05	0.09	0.11
Bahia	0.43	0.40	0.23	0.21	0.16	0.19	0.10	0.14	0.11	0.08	0.08
Ceará	0.49	0.41	0.19	0.21	0.15	0.15	0.12	0.10	0.05	0.07	0.05
Distrito Federal	.	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Espírito Santo	0.50	0.42	0.21	0.20	0.15	0.21	0.07	0.09	0.05	0.10	0.07
Goiás	0.63	0.57	0.35	0.37	0.28	0.20	0.15	0.18	0.17	0.11	0.15
Maranhão	0.47	0.50	0.43	0.42	0.32	0.27	0.20	0.22	0.17	0.17	0.17
Minas Gerais	0.48	0.38	0.18	0.17	0.18	0.18	0.11	0.10	0.07	0.08	0.09
Mato Grosso	0.45	0.48	0.37	0.32	0.37	0.31	0.21	0.23	0.28	0.21	0.24
Pará	0.25	0.20	0.21	0.23	0.20	0.26	0.33	0.27	0.22	0.09	0.08
Paraíba	0.54	0.57	0.27	0.28	0.18	0.21	0.15	0.20	0.12	0.07	0.06
Pernambuco	0.31	0.30	0.14	0.12	0.11	0.14	0.10	0.10	0.08	0.05	0.05
Piauí	0.47	0.47	0.32	0.31	0.23	0.18	0.12	0.15	0.10	0.10	0.10
Paraná	0.52	0.55	0.28	0.30	0.21	0.24	0.12	0.09	0.13	0.08	0.08
Rio de Janeiro	0.08	0.07	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Rio Grande do Norte	0.50	0.47	0.19	0.21	0.13	0.09	0.08	0.08	0.02	0.06	0.05
Rio Grande do Sul	0.36	0.36	0.23	0.20	0.16	0.17	0.12	0.14	0.14	0.09	0.10
Santa Catarina	0.44	0.44	0.25	0.21	0.16	0.19	0.14	0.15	0.13	0.07	0.08
Sergipe	0.36	0.43	0.21	0.17	0.17	0.08	0.11	0.11	0.06	0.05	0.06
São Paulo	0.26	0.18	0.06	0.05	0.04	0.06	0.05	0.05	0.06	0.02	0.02
TOTAL Brazil	0.31	0.28	0.13	0.12	0.10	0.11	0.08	0.09	0.08	0.05	0.06

Source: Author's calculations, from IBGE. Obs.: Output was given in constant (2000 R$) basic prices.

Table 11 - Spearman Correlation Coefficients

	Shift Effect	AT Indicator	GDPpc 1950	GDPpc 2009	Agriculture PG	Non-Agr PG	Total PG	Agr Prod 1950	Agr Prod 2009	Non-Agr Prod 2009	Non-Agr Prod 1950
Shift Effect	1										
AT Indicator	-0.4361	1									
GDPpc 1950	0	0.2481	1								
GDPpc 2009	-0.0857	0.3955	0.7639	1							
Agriculture PG	-0.3368	0.3985	0.0436	0.2511	1						
Non-Agr PG	-0.8436	0.2571	-0.412	-0.3278	0.203	1					
Total PG	-0.3053	0.1774	-0.6677	-0.4526	0.5038	0.609	1				
Agr Prod 1950	-0.2015	0.2256	0.785	0.8481	0.0602	-0.206	-0.5624	1			
Agr Prod 2009	-0.3474	0.4421	0.606	0.7609	0.6782	-0.0632	-0.1023	0.7383	1		
Non-Agr Prod 200	-0.0226	0.2526	0.7128	0.9474	0.194	-0.3624	-0.412	0.8647	0.7248	1	
Non-Agr Prod 195	0.5504	-0.0015	0.7038	0.7338	-0.0451	-0.8421	-0.6211	0.5789	0.412	0.7714	1

Source: Author's estimations, from IBGE and IPEA.

Table 12 - Correlations: regression variables

	HC Poverty	VA Agr	VA Non-Agr	Share Agr	Share Non-Agr	Educ	Gini
HC Poverty	1.00						
VA Agr	-0.15	1.00					
VA Non-Agr	-0.78	-0.14	1.00				
Share Agr	0.33	0.62	-0.58	1.00			
Share Non-Agr	-0.33	-0.62	0.58	-1.00	1.00		
Educ	-0.87	-0.18	0.75	-0.55	0.55	1.00	
Gini	0.61	-0.33	-0.29	0.01	-0.01	-0.48	1.00

Source: Author's estimations, from IBGE and IPEA.

Descriptive Statistics – Sectoral Growth and Poverty Reduction

Balanced Panel, all states have 7 observations from 1980-2009

Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
	Alagoas				Amazonas				Bahia			
VA Share Agriculture	0.16	0.08	0.07	0.24	0.09	0.03	0.05	0.12	0.12	0.04	0.08	0.19
VA Share Non-Agriculture	0.84	0.08	0.76	0.93	0.91	0.03	0.88	0.95	0.88	0.04	0.81	0.92
VA Agriculture (p.c)	0.40	0.19	0.22	0.64	0.48	0.18	0.25	0.70	0.43	0.18	0.28	0.77
VA Non-Agriculture (p.c)	2.14	0.34	1.86	2.70	4.81	0.37	4.41	5.33	3.11	0.34	2.63	3.70
Poverty Headcount Index	0.62	0.07	0.48	0.70	0.25	0.08	0.15	0.37	0.56	0.10	0.38	0.65
Education (years)	3.51	1.18	2.10	5.00	5.70	0.89	4.20	7.00	3.97	1.24	2.50	5.80
Gini Index	0.59	0.04	0.54	0.64	0.54	0.03	0.49	0.57	0.59	0.03	0.55	0.65
	Ceará				Distrito Federal				Espírito Santo			
VA Share Agriculture	0.10	0.04	0.05	0.15	0.00	0.00	0.00	0.01	0.11	0.05	0.05	0.21
VA Share Non-Agriculture	0.90	0.04	0.85	0.95	1.00	0.00	0.99	1.00	0.89	0.05	0.79	0.95
VA Agriculture (p.c)	0.26	0.10	0.13	0.40	0.07	0.02	0.04	0.10	0.63	0.33	0.29	1.27
VA Non-Agriculture (p.c)	2.39	0.40	1.87	3.11	18.39	6.43	12.83	30.86	5.40	0.98	4.58	7.00
Poverty Headcount Index	0.59	0.15	0.36	0.74	0.20	0.07	0.10	0.31	0.27	0.10	0.13	0.41
Education (years)	3.87	1.41	2.30	5.90	7.86	1.25	6.20	9.60	5.46	1.24	3.90	7.20
Gini Index	0.59	0.04	0.54	0.63	0.60	0.02	0.58	0.62	0.58	0.04	0.53	0.65
	Goiás				Maranhão				Mato Grosso			
VA Share Agriculture	0.18	0.05	0.11	0.28	0.22	0.06	0.17	0.32	0.26	0.06	0.21	0.37
VA Share Non-Agriculture	0.82	0.05	0.72	0.89	0.78	0.06	0.68	0.83	0.74	0.06	0.63	0.79
VA Agriculture (p.c)	0.70	0.19	0.49	1.04	0.37	0.09	0.26	0.51	1.36	0.37	0.85	1.90
VA Non-Agriculture (p.c)	3.35	0.97	2.64	5.06	1.43	0.51	1.04	2.28	3.84	0.98	2.98	5.67
Poverty Headcount Index	0.28	0.08	0.15	0.37	0.64	0.12	0.42	0.81	0.23	0.07	0.11	0.32
Education (years)	4.86	1.28	3.30	6.90	3.49	1.39	2.00	5.60	5.16	1.28	3.50	7.00
Gini Index	0.56	0.04	0.52	0.61	0.56	0.03	0.50	0.59	0.55	0.02	0.51	0.57
	Minas Gerais				Pará				Paraíba			
VA Share Agriculture	0.12	0.04	0.07	0.18	0.21	0.09	0.08	0.33	0.14	0.06	0.06	0.21
VA Share Non-Agriculture	0.88	0.04	0.82	0.93	0.79	0.09	0.67	0.92	0.86	0.06	0.79	0.94
VA Agriculture (p.c)	0.64	0.23	0.39	0.97	0.68	0.34	0.24	1.22	0.32	0.10	0.19	0.45
VA Non-Agriculture (p.c)	4.85	0.41	4.40	5.54	2.59	0.31	2.27	3.01	2.12	0.61	1.48	3.13
Poverty Headcount Index	0.27	0.10	0.12	0.38	0.29	0.07	0.22	0.40	0.60	0.14	0.41	0.77
Education (years)	5.16	1.23	3.60	6.90	5.77	0.96	4.30	6.90	4.00	1.07	2.60	5.60
Gini Index	0.57	0.03	0.51	0.61	0.52	0.02	0.49	0.55	0.60	0.03	0.56	0.66
	Paraná				Pernambuco				Piauí			
VA Share Agriculture	0.14	0.06	0.08	0.24	0.09	0.03	0.05	0.14	0.14	0.05	0.10	0.23
VA Share Non-Agriculture	0.86	0.06	0.76	0.92	0.91	0.03	0.86	0.95	0.86	0.05	0.77	0.90
VA Agriculture (p.c)	0.86	0.37	0.56	1.51	0.30	0.10	0.17	0.44	0.24	0.05	0.17	0.30
VA Non-Agriculture (p.c)	5.63	0.82	4.55	6.94	3.04	0.27	2.69	3.51	1.53	0.48	1.03	2.35
Poverty Headcount Index	0.30	0.12	0.12	0.42	0.56	0.08	0.41	0.64	0.66	0.17	0.38	0.84
Education (years)	5.39	1.55	3.40	7.50	4.44	1.23	2.90	6.20	3.37	1.30	1.80	5.20
Gini Index	0.55	0.03	0.50	0.58	0.58	0.02	0.55	0.62	0.60	0.05	0.53	0.67
	Rio de Janeiro				Rio Grande do Norte				Rio Grande do Sul			
VA Share Agriculture	0.01	0.00	0.00	0.01	0.07	0.03	0.02	0.13	0.13	0.03	0.09	0.17
VA Share Non-Agriculture	0.99	0.00	0.99	1.00	0.93	0.03	0.87	0.98	0.87	0.03	0.83	0.91
VA Agriculture (p.c)	0.08	0.03	0.04	0.14	0.21	0.08	0.07	0.32	1.03	0.23	0.68	1.28
VA Non-Agriculture (p.c)	8.69	0.62	7.60	9.38	2.79	0.51	2.22	3.60	6.76	0.39	6.30	7.53
Poverty Headcount Index	0.24	0.08	0.13	0.34	0.54	0.12	0.35	0.69	0.24	0.07	0.13	0.31
Education (years)	6.81	1.08	5.40	8.30	4.36	1.22	2.80	6.10	5.89	1.18	4.30	7.50
Gini Index	0.57	0.01	0.54	0.58	0.58	0.02	0.56	0.61	0.54	0.03	0.50	0.57
	Santa Catarina				São Paulo				Sergipe			
VA Share Agriculture	0.13	0.04	0.07	0.19	0.04	0.02	0.02	0.06	0.09	0.04	0.05	0.17
VA Share Non-Agriculture	0.87	0.04	0.81	0.93	0.96	0.02	0.94	0.98	0.91	0.04	0.83	0.95
VA Agriculture (p.c)	0.94	0.23	0.56	1.24	0.43	0.17	0.17	0.61	0.33	0.11	0.20	0.48
VA Non-Agriculture (p.c)	6.39	1.07	5.44	8.22	9.82	0.88	8.49	11.00	3.52	1.03	2.14	5.32
Poverty Headcount Index	0.21	0.11	0.06	0.32	0.16	0.04	0.11	0.22	0.53	0.11	0.39	0.67
Education (years)	5.77	1.46	3.90	7.80	6.37	1.34	4.70	8.20	4.24	1.46	2.40	6.30
Gini Index	0.51	0.04	0.46	0.57	0.53	0.02	0.49	0.55	0.56	0.02	0.52	0.59

Appendix C

Table 13 - Indicator of Agricultural Transformation

States	1950	1960	1970	1975	1980	1985	1995	2001	2006	2009
Alagoas	-0.34	-0.36	-0.62	-0.67	-0.68	-0.69	-0.38	-0.32	-0.33	-0.26
Amazonas	-0.11	-0.37	-0.73	-1.02	-0.92	-0.98	-0.48	-0.03	-0.15	-0.11
Bahia	-0.41	-0.54	-0.71	-0.78	-0.75	-0.78	-0.46	-0.26	-0.27	-0.24
Ceará	-0.13	-0.36	-0.64	-0.50	-0.49	-0.53	-0.39	-0.24	-0.21	-0.19
Distrito Federal	.	-0.04	-0.04	-0.03	-0.03	-0.03	-0.01	-0.01	-0.01	-0.01
Espírito Santo	-0.48	-0.39	-0.46	-0.37	-0.36	-0.28	-0.21	-0.20	-0.10	-0.13
Goiás	-0.19	-0.27	-0.29	-0.29	-0.33	-0.37	-0.12	-0.03	-0.06	-0.03
Maranhão	-0.29	-0.70	-0.79	-0.94	-0.99	-0.95	-0.56	-0.29	-0.22	-0.17
Minas Gerais	-0.30	-0.35	-0.40	-0.39	-0.32	-0.33	-0.20	-0.16	-0.13	-0.10
Mato Grosso	-0.11	-0.19	-0.40	-0.49	-0.26	-0.25	-0.09	0.04	-0.03	0.03
Pará	-0.36	-0.49	-0.66	-0.76	-0.78	-0.72	-0.20	0.12	-0.11	-0.13
Paraíba	-0.30	-0.36	-0.62	-0.81	-0.61	-0.63	-0.23	-0.18	-0.22	-0.18
Pernambuco	-0.48	-0.67	-0.63	-0.55	-0.51	-0.48	-0.29	-0.22	-0.23	-0.20
Piauí	-0.21	-0.48	-0.76	-0.79	-0.99	-0.94	-0.56	-0.34	-0.35	-0.31
Paraná	-0.21	-0.36	-0.60	-0.54	-0.43	-0.36	-0.25	-0.10	-0.11	-0.07
Rio de Janeiro	-0.10	-0.05	-0.07	-0.06	-0.06	-0.06	-0.02	-0.02	-0.02	-0.01
Rio Grande do Norte	-0.32	-0.42	-0.58	-0.60	-0.62	-0.56	-0.32	-0.21	-0.16	-0.15
Rio Grande do Sul	-0.41	-0.40	-0.41	-0.52	-0.39	-0.33	-0.18	-0.09	-0.13	-0.10
Santa Catarina	-0.34	-0.46	-0.63	-0.60	-0.47	-0.38	-0.18	-0.07	-0.12	-0.08
Sergipe	-0.37	-0.54	-0.82	-0.84	-0.69	-0.79	-0.45	-0.21	-0.18	-0.15
São Paulo	-0.19	-0.20	-0.17	-0.13	-0.10	-0.06	-0.01	0.01	-0.03	-0.03
Brazil	-0.33	-0.41	-0.48	-0.47	-0.40	-0.38	-0.21	-0.11	-0.13	-0.11

Source: Author's calculations, from IBGE and IPEA.

Table 14 - Relative Successes and Failures

State	ATI 1950	ATI 2009	GDP pc 1950	GDP pc 2009	Agri Prod 2009	NA Prod 2009	Agr Prod Growth	NA Prod Growth	Year Turning Point
São Paulo	-0.19	-0.03	8.0	27.9	7359	22048	0.8%	1.2%	1960
Rio de Janeiro	-0.10	-0.01	9.1	24.3	6121	20110	0.8%	1.2%	1970
Santa Catarina	-0.34	-0.08	3.6	23.6	7789	17514	2.1%	0.9%	1975
Rio Grande do Sul	-0.41	-0.10	3.8	21.7	7949	17659	2.0%	0.4%	1975
Espírito Santo	-0.48	-0.13	2.9	20.7	4837	16571	1.6%	-3.4%	1970
Paraná	-0.21	-0.07	3.8	18.5	7536	15909	1.1%	0.8%	1975
TOTAL Brazil	-0.33	-0.11	3.9	18.3	4933	16484	1.4%	1.0%	1975
Mato Grosso	-0.11	0.03	2.1	18.0	16952	13852	3.2%	2.2%	1975
Minas Gerais	-0.30	-0.10	2.8	16.1	5533	13475	1.7%	0.9%	1970
Amazonas	-0.11	-0.11	1.0	14.8	6257	14004	1.9%	2.5%	1985
Goiás	-0.19	-0.03	2.3	14.5	9440	11830	2.7%	1.4%	1985
Sergipe	-0.37	-0.15	1.0	11.3	2601	10986	1.8%	1.6%	1985
Pernambuco	-0.48	-0.20	1.8	10.0	1799	11534	0.9%	0.5%	1970
Pará	-0.36	-0.13	1.9	9.9	2815	8816	1.9%	1.3%	1985
Bahia	-0.41	-0.24	0.9	9.9	2046	11571	1.2%	0.8%	1985
Rio Grande do Norte	-0.32	-0.15	1.2	9.8	2141	9634	0.6%	0.6%	1980
Ceará	-0.13	-0.19	1.4	8.4	1466	8888	-0.2%	2.0%	1985
Paraíba	-0.30	-0.18	1.9	7.7	1970	10256	0.5%	0.8%	1975
Alagoas	-0.34	-0.26	1.3	7.3	1680	10443	0.8%	1.3%	1985
Piauí	-0.21	-0.31	1.0	6.7	1296	7997	0.9%	2.5%	1985
Maranhão	-0.29	-0.17	1.3	6.5	3183	8085	2.4%	1.8%	1985

Source: Author's estimations, from IBGE and IPEA. Obs.: The table presents the values of the agricultural transformation indicator (ATI), GDP per capita (2000 R$) and productivity of agriculture and non-agriculture for 1950 and 2009. In addition, the agricultural and non-agricultural productivity growth from 1950-2009 and the year of the turning point of ATI, when the slope becomes positive.

Appendix D

Table 15 - Complete Regression Results, Models 1/5

	Poverty Headcount Index				
	(1)	(2)	(3)	(4)	(5)
Agricultural growth (per capita, weighted share)	-0.857***	-0.796**	-0.795***	-0.675**	-0.685**
	(0.295)	(0.332)	(0.290)	(0.292)	(0.262)
Non-Agricultural growth (per capita, weighted share)	-0.0259	-0.0197	-0.0285	-0.0345	-0.298**
	(0.0519)	(0.0412)	(0.0392)	(0.0359)	(0.133)
year 1990		-0.203***	-0.186***	-0.169***	-0.183***
		(0.0483)	(0.0457)	(0.0469)	(0.0514)
year 1995		-0.275***	-0.284***	-0.224***	-0.273***
		(0.0446)	(0.0424)	(0.0464)	(0.0495)
year 2001		-0.0647	-0.0497	0.00568	-0.0169
		(0.0461)	(0.0444)	(0.0475)	(0.0492)
year 2006		-0.395***	-0.388***	-0.295***	-0.307***
		(0.0561)	(0.0555)	(0.0627)	(0.0601)
year 2009		-0.330***	-0.353***	-0.293***	-0.303***
		(0.0347)	(0.0359)	(0.0417)	(0.0456)
Education			-0.651**	-0.731***	-0.605**
			(0.250)	(0.263)	(0.278)
Gini				0.931**	0.569
				(0.381)	(0.349)
Amazonas					0.134*
					(0.0761)
Bahia					-0.0241
					(0.0515)
Ceará					-0.0350
					(0.0645)
Distrito Federal					0.748*
					(0.377)
Espírito Santo					-0.103
					(0.0770)
Goiás					-0.0474
					(0.0717)
Maranhão					0.00956
					(0.0692)
Mato Grosso					-0.0621
					(0.0580)
Minas Gerais					-0.135**
					(0.0597)
Pará					0.0567
					(0.101)
Paraíba					-0.0399
					(0.0613)
Paraná					-0.145**
					(0.0608)
Pernambuco					-0.0201
					(0.0556)
Piauí					-0.0345
					(0.0931)
Rio de Janeiro					-0.0904
					(0.0823)
Rio Grande do Norte					-0.0400
					(0.0509)
Rio Grande do Sul					-0.104
					(0.0697)
Santa Catarina					-0.207**
					(0.0847)
São Paulo					-0.0498
					(0.0775)
Sergipe					-0.0146
					(0.0684)
Constant	-0.110***	0.101***	0.179***	0.147***	0.209***
	(0.0190)	(0.0290)	(0.0421)	(0.0427)	(0.0648)
Observations	126	126	126	126	126
R-squared	0.057	0.508	0.539	0.573	0.707

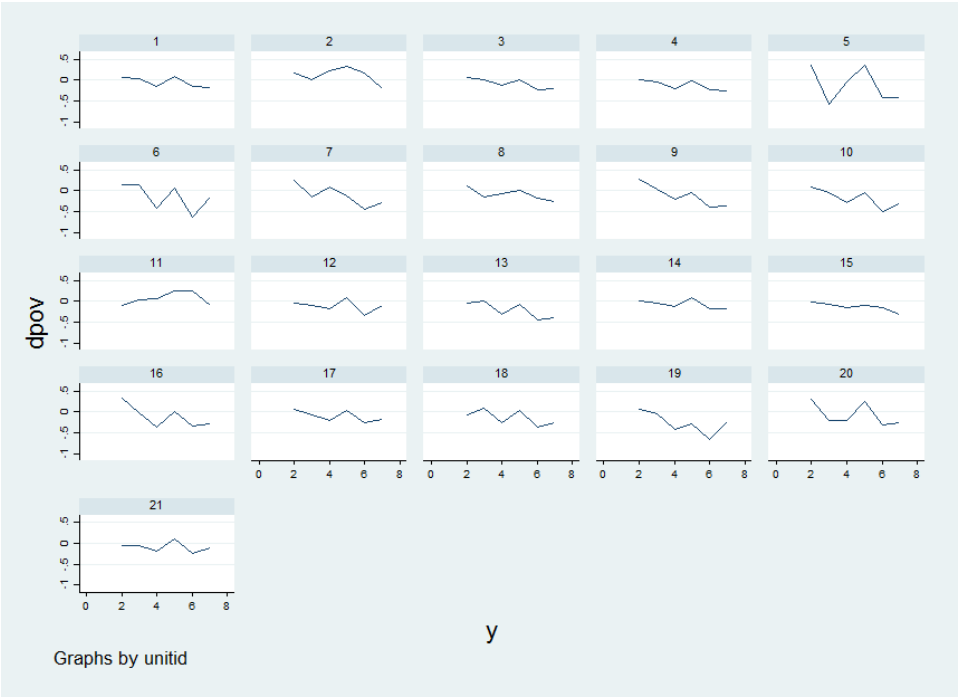
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 16 - Complete Regression Results, Variation of elasticities of non-agricultural growth across states (Model 6)

	Poverty Headcount Index	
Agricultural growth (per capita, weighted share)	-0.382*	(0.206)
Non-Agricultural growth (per capita, weighted share)		
Alagoas	0.107	(0.509)
Amazonas	-1.171*	(0.608)
Bahia	-0.456	(0.511)
Ceará	-0.0994	(0.615)
Distrito Federal	-1.047*	(0.544)
Espírito Santo	-1.961***	(0.490)
Goiás	-1.167*	(0.678)
Maranhão	-0.115	(0.566)
Mato Grosso	-1.264**	(0.488)
Minas Gerais	-3.940**	(1.511)
Pará	1.583***	(0.529)
Paraíba	-0.247	(0.617)
Paraná	0.0461	(0.801)
Pernambuco	0.0197	(0.714)
Piauí	0.411	(0.795)
Rio de Janeiro	0.00489	(0.688)
Rio Grande do Norte	-0.185	(0.518)
Rio Grande do Sul	0.862	(1.083)
Santa Catarina	-1.318	(0.956)
São Paulo	-1.000	(0.732)
Sergipe	-0.214	(0.522)
Education	-0.176	(0.228)
Gini	0.152	(0.293)
Time dummies	Yes	***
State dummies	Yes	
Constant	0.155**	(0.0634)
Observations	126	
R-squared	0.834	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 13- Stationarity Poverty Headcount Index



Obs.: Testing for stationarity: Poverty is I(1) (including trend) according to the fixed-T Breitung test for panels with small T. For the other variables, I can also reject at 5% the H0 of presence of unit root, when they are in the differenced form, meaning that they are also I(1).