What are the main drivers of Brazilian income distribution changes in the new millennium?

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Abstract: After three decades of persistently high income inequality, from 2001 Brazil experienced a downward inequality trend followed by rising household income growth. Both movements lasted until 2015. This work synthesizes the results of six papers, describing Brazilian income distribution trends and their close determinants. A common approach pursued looks jointly at inequality, mean, and social welfare growth rates. We use a vast array of data sets and empirical methodologies to fill the gaps found in the literature. Top incomes movements reduced income inequality fall but increased mean income growth, suggesting complex measurement and interpretation challenges. Overall, most of the inequality fall was driven by labour earnings, a channel dominated by firm-specific effects. Rising schooling and falling returns also played a key role, especially if parents' educational background is taken into account. Missing income values—or whether gross or disposable incomes concepts are used—did not affect inequality measures. Direct and indirect taxes increased inequality trends, while official monetary benefits did help, in particular conditional cash transfers. The Bolsa Familia programme was better targeted than all other transfers, most of which were linked to the Brazilian minimum wage.

Keywords: income inequality, fiscal redistribution, top incomes, education premiums
JEL classification: H22, I31, I38, C63

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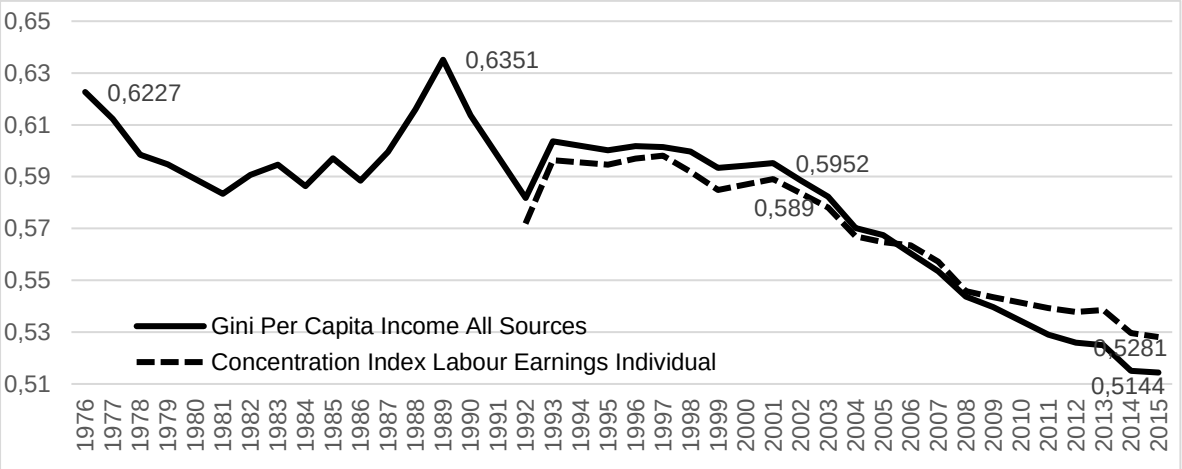
1 Introduction

1.1 Overview

Since the beginning of the 1970s, Brazil has been known as one of the most unequal countries in the world (Bacha and Taylor 1978; Fishlow 1972; Langoni 1973; Ramos 1993). Its per capita income inequality presented high instability but no clear trend until 2001, as shown in Figure 1. After the start of the new millennium, inequality fell every single year until 2014 (Barros et al. 2006; Kakwani et al. 2014; Neri 2004). This falling trend was shared with earnings inequality, as shown in Figure 1 (Ferreira et al. 2016; IPEA 2013; Neri and Camargo 2002).

Figure 1: Inequality of per capita income (Gini) and of individual earnings (Concentration), 1976–2015



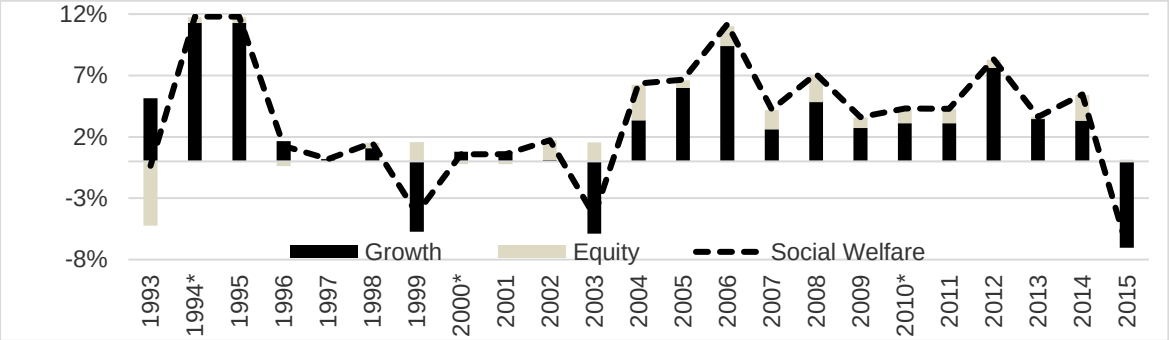
Note: Harmonized series in terms of regional coverage.

Source: Author's illustration based on PNAD/IBGE microdata.

In 2003, the income equalizing movement was coupled with an acceleration of GDP growth and, on top of that, mean household income grew even faster. The above-mentioned inequality trend has a clear parallel with the rest of Latin America, while its household income growth is at odds with other countries of the region and with Brazil's own National Accounts statistics. As a result, until 2014, Gini index-based social welfare grew three times faster than GDP. In this period Brazil followed a middle path, where the well-being distribution improved simultaneously on these three fronts. Roughly speaking, social welfare growth was evenly divided between falling inequality of household income, the differential of mean incomes between surveys and national accounts, and real GDP growth (Neri 2014). Figure 2 presents the annual growth evolution of mean, equity, and social welfare, all based on household per capita income.

This paper synthesizes the main results of the Brazilian component of the 'Inequality in the giants' project supported by UNU-WIDER. It describes the evolution of Brazilian income distribution and its close determinants between 1994 and 2015. A joint look at inequality and mean growth rates is key to providing a more complete picture of impacts in terms of social welfare within Brazil and world inequality. Moreover, measurement and causal issues that affect inequality have implications on the mean and vice-versa. This means analysing the second moment of income distribution without losing sight of the first moment, or existing synergies between them. The other general point in all the contributions to this project is that changes of inequality and mean income should be emphasized, and not only their respective levels. This helps us to address the various period-of-analysis restrictions across different datasets. Differences across time are also a way to deal with measurement issues and to identify causality.

Figure 2: Growth, equity (Gini), and social welfare—annual growth rates, 1993–2015



* interpolated between years

Source: Author's illustration based on PNAD/IBGE microdata (per capita income all sources).

The key objective here is to assess the relative role of different public policy ingredients in income distribution changes. The channels behind these changes are diverse, such as increasing education levels, falling education and experience premiums, the diffusion of social programmes such as conditional cash transfers (CCTs), and the expansion of contributory and non-contributory social security benefits and other programmes linked to the minimum wage, which also rose sharply in this period, to name only a few.

1.2 Organization

In these studies, we offer a description and an interpretation of the main causes of income distribution changes in Brazil in the last 25 years. Section 2 presents an overview of the main socio-economic developments and the main economic challenges ahead. We attempt to time the evolution of income distribution and surveys methodology, setting 2003–15 as the central period of analysis. We also assemble the main pieces of mean income growth and inequality trends in this period using household surveys. The appendix found in the end of this paper formalizes a decomposition methodology with income sources, labor ingredients, aggregate price and demographic components into smaller pieces.

The rest of the paper attempts to fill the gaps about income distribution changes in the previous literature. I connect the main questions of the overall project and specific contributions exploring new empirical possibilities, applying various techniques to a vast array of data sets. Table 1 presents a schematic view of the main empirical strategies pursued, described in sequence.

Identified administrative records such as RAIS (*Registro Anual de Informações Sociais* from the Labour Ministry) has no top coding, which allows us to look at the upper part of the earnings distribution and test the main determinants of overall earnings distribution changes. In particular, RAIS makes it possible to construct merged employer–employee records and to measure the role of firms mediating labour earnings inequality (Section 3).

Moreover, the longitudinal aspect of RAIS allows us to measure the extent to which the gender-gap changes over the life cycle occur within or between establishments, and to what extent they are driven by the firm's sector of activity or occupational choices (Section 4).

Next, the 1996 and 2014 special supplements to the national household survey PNAD (*Pesquisa Nacional de Amostras a Domicílio* from the Brazilian Institute of Geography and Statistics (IBGE)), with additional information on the individuals' education background is used. This information allows us to assess before and after the bulk of Brazilian inequality changes intergenerational education changes and to measure better the changes in the returns to education—in particular, how measurement errors and omitted variables biases affect the impact of education on the earnings distribution (Section 5).

Table 1: Inequality in Brazil by topic, technique, dataset, period of time, and income concept

Paper/Inequality topic	Technique	Dataset/Period used	Income concept
1. Firm effects	J-Divergence decompositions	RAIS 1994–2015 (matched employer–employee)	Individual formal earnings
2. Gender gap	Regression models	RAIS 1994–2015 (matched employer–employee)	Individual formal earnings
3. Intergenerational transmission of education & returns estimation	Omitted variables, measurement error and Markov regressions	PNAD supplements 1996 & 2014 (household survey)	Individual earnings
4. Missing incomes imputation	Combine regressions and stochastic imputation	PNAD 2001–15 (household survey)	Per capita (all sources)
5. Fiscal policy instruments	Dynamic microsimulation	PNAD + POF + AR 2003–15 (income & expenditures surveys and administrative records)	Per capita (all sources)
6. Top incomes	Pareto interpolation	PNAD + PIT - 2007–15 (household survey and income tax records)	Individual (all sources)

Source: Author's illustration.

Besides exploring new data sources, the project analyses already available surveys using a new lens. Although PNAD is the main Brazilian household survey used in inequality studies, it is the only official survey with no explicit imputation for missing incomes values. A new imputation methodology is another by-product proposed here. Brazil has a well established tradition of welfare measurement but has not paid much attention to issues like imputed rents and income measurement period, addressed here (Section 6).

In particular, PNAD does not ask questions on direct or indirect taxes and some of the questions on the official cash transfers are not very detailed We develop a microsimulation framework that details the role played by individual fiscal instruments in income distribution changes using actual data across different points in time (Section 7).

Finally, Brazil recently released detailed personal income tax (PIT) tabulations from the Brazilian Internal Revenue Service. Combining these with household surveys gives us a clearer view of the top end of the income distribution. Once again, we address mean income growth and social welfare changes and their causes, adding new insights to the previous literature (Section 8). The last section presents the main conclusions of the paper.

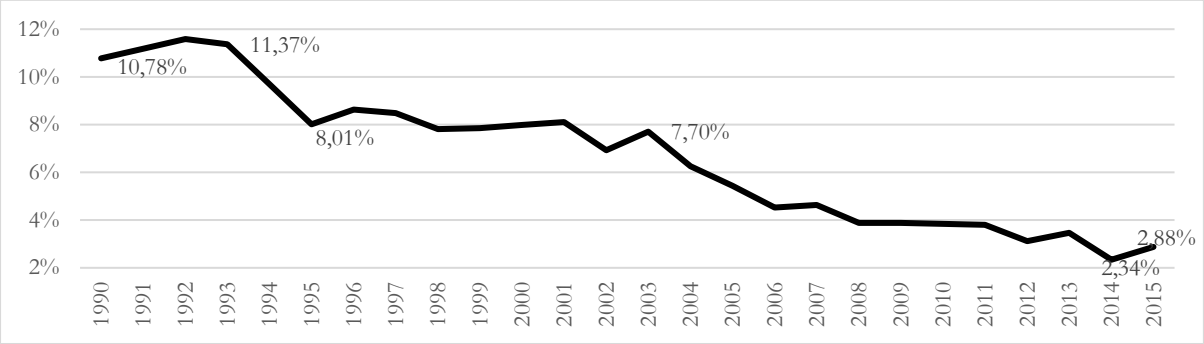
2 Brazilian social and economic developments

This section presents a big picture of Brazilian evolution in the last three decades, using international social indicators such as the Human Development Index (HDI), Millennium Development Goals (MDGs), and Sustainable Development Goals (SDGs), with an emphasis on poverty and shared prosperity goals. We connect these developments with the economic policy agenda, especially with regard to structural reforms. We also attempt to relate Brazilian income distribution changes to household surveys methodological adaptations, avoiding temporal comparisons across different concepts. Finally, we assess the role played by different policy-related components on income distribution trends for the 2003–15 period. The overall objective here is to set the stage for the specific contributions of the project.

2.1 Poverty

The first and main goal of the MDGs was to reduce poverty by 50 per cent between 1990 and 2015. In this period the proportion of extremely poor fell by 73.3 per cent in Brazil and 70.2 per cent worldwide. This global poverty reduction is due to the combination of the economic miracles in China and India, nations that once housed half of the world's poor (Deaton 2013). Throughout the 1990–2015 period, Brazil had direct elections for president, and since 1994 it has achieved price stability, which is no small achievement for a nation that held the world inflation record between 1970 and 1995. Poverty reduction in Brazil between 1990 and 2015 had a roughly equal contribution of mean growth and reduction of inequality components. This movement was reversed in 2015, when extreme poverty rose by 23.5 per cent (Figure 3).

Figure 3: Extreme poverty—proportion below US$1.25 per day PPP (MDG 1), 1990–2015



Notes: Harmonized series before 2004 not including North rural region; linear interpolations were made in 1994, 2000, and 2010.

Source: Author's calculation based on PNAD/IBGE microdata.

2.2 Human development

The recession and unemployment crisis that emerged in 2015 may be viewed as a sign of unsustainability, with gains only in income-based social indicators. However, the Brazilian HDI had risen by 0.85 per cent yearly (above the global average of 0.74 per cent) since 1990, when the so-called 'citizenship' Constitution came into effect. In 1990 Brazil had average African HDI levels observed in 2015. In 1991, about 85 per cent of Brazilian municipalities had very low HDI. In 2010, this statistic was 0.6 per cent. There was a profound social transformation. The problem is that Brazil disconnected its social policy from its economic agenda and as result presented stagnated labour productivity and increasing fiscal imbalances.

The inconsistencies between social and economic progress can be captured in the three HDI components. Federal public spending as a proportion of GDP in Brazil rose from 10.8 per cent in 1991 to 19.7 per cent in 2016. The main driving force of public spending was social security payments. In 1980 life expectancy was 62.5 years; by 2016 this had risen to 75.8 years. That is, every three years, life expectancy advanced by more than a year. Fertility also fell sharply. The population pyramid aged considerably, yet Brazil did not implement broad pension reform. Brazil spends 13 per cent of its GDP on pensions and retirement benefits, while Japan, the longest-living nation in the world, spends 10 per cent. Japan's share of people over 65 years old is currently 350 per cent higher than Brazil's. However, Brazil will multiply its elderly population share by five in the next 50 years.

Education has also advanced in Brazil. In 1990, 16 per cent of children aged between 7 and 14 were out of school. By 2018, this share was less than 2 per cent, with low quality of inputs. Brazil

increased school coverage but required only four hours a day of school time. In 1980 the adult population had only three years of schooling, on average, while in 2015 it had eight years. But although education has increased, labour productivity has not. In 1980, Brazil's productivity was equal to South Korea's. Today, it is just one third of the Korean productivity level due to several factors, including lack of education quality and connection with economic demands, an inhospitable business environment, closure to immigration, and a lack of engineers. Brazil has followed an educational agenda focused on citizenship that has its merits, as the above-mentioned life-expectancy increase suggests, but has had little impact on labour productivity.

In addition, there has been an increase in mean labour remuneration above mean labour productivity (Neri 2014). Disaggregated data reveal that the wage gains distribution has not been accompanied by improvements in the remuneration fundamental, namely productivity distribution (Alvarez et al. 2017). The social advancements manifested in the transformation of the trilogy of HDI components were largely disconnected from productivity and fiscal adjustment considerations, the main two main Brazilian macroeconomic challenges.

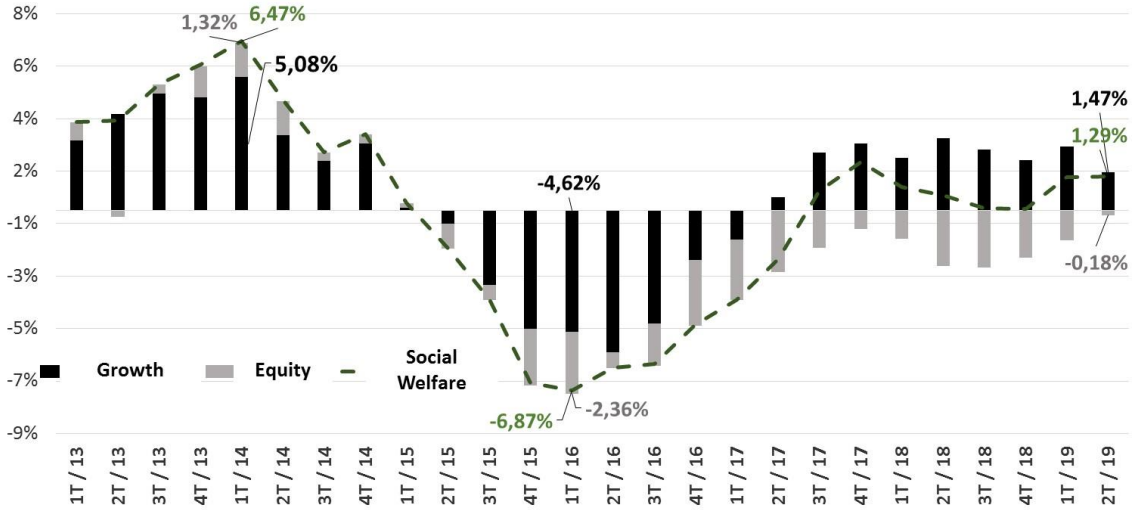
2.3 Inclusive growth

From 1930 to 1980 Brazil was the second country in the world in terms of GDP growth, behind only Japan. From 1980 onwards growth reduced but democracy and social dimensions progressed. After 2000 inequality fell every single year until 2014. In 2003, the income-equalizing movement was coupled with an acceleration of GDP growth, and mean household income grew even faster.

The inequality fall was around the mean for Latin America countries, while the excess of household income growth with respect to GDP is Brazil-specific. Between 2002 and 2012 Brazil was 3rd among the 17 Latin American countries in terms of household income growth but 10th in terms of GDP growth. In most of the world's emerging or developed countries, GDP grew more than household incomes and inequality rose. These contrasts make Brazil an interesting case to study.

Figure 4 illustrates the major reversal of all distributive-growth trends presented in Figure 2, beginning in the labour market, which was the main driver behind the above-mentioned changes. In particular, from the second quarter of 2015 every annual variation shows an inequality increase until the second quarter of 2019. This means that labour inequality rose for 17 quarters in a row.

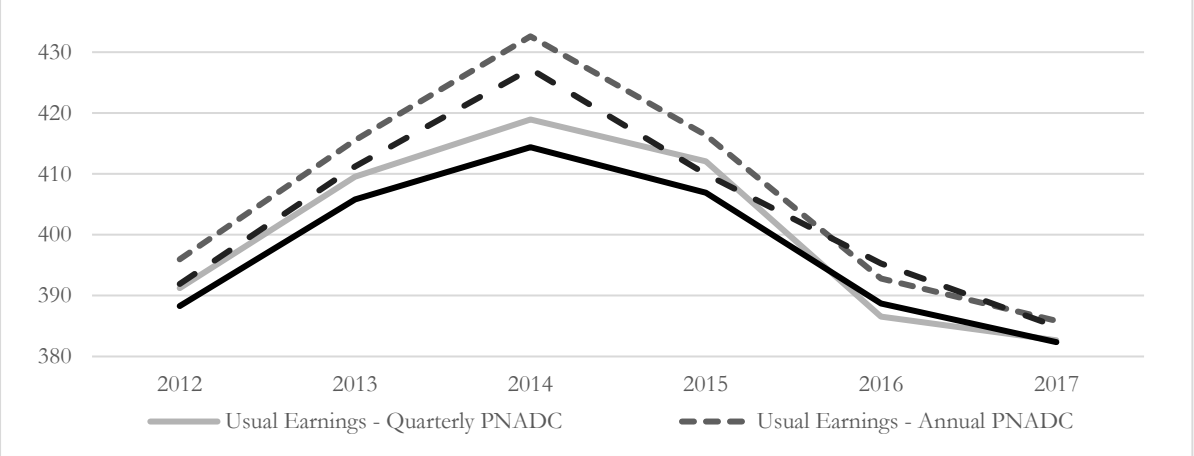
Figure 4: Growth, equity (Gini), and social welfare—annual growth rates across quarters, 2013–18



Source: Author's illustration based on PNADC Quarterly/IBGE microdata on per capita habitual earnings.

In late 2015 the main Brazilian household surveys, PNAD and PME (*Pesquisa Mensal de Emprego*), were replaced by a new national survey, PNADC (*Pesquisa Nacional de Amostras a Domicilio Contínua*), in both quarterly and annual versions, and also in habitual and effective earnings concepts, corresponding to four different measurement possibilities of the same object. It should be noted that the rise and fall of Brazilian mean earnings and their equality between 2012 and 2019 is not a robust result across all the empirical possibilities offered by the new surveys. Nevertheless, in all four cases social welfare trends based on all income sources follow a mountain shape, where 2012 and 2017 represent the base of the mountain and 2014 its peak, as shown in Figure 5.

Figure 5: Social welfare levels (Gini based) across different income concepts and data sets, 2012–17



Source: Author's illustration based on PNADC microdata on per capita household earnings of 15–59-year-olds.

2.4 Shared prosperity

Given the major revision in the main Brazilian household surveys at the end of 2015 and the changing inequality trends noted above, we focus on the 2003–15 period, looking first at individual incomes of different groups to capture horizontal inequality trends. Mean income grew in real terms by 3.79 per cent per year, while the income of traditionally marginalized groups grew at faster yearly rates: blacks (4.8 per cent), females (5 per cent), Northeast region (5 per cent), rural areas (5.3 per cent), illiterate individuals (5.6 per cent), mulattos (6 per cent), and spouses (6 per cent).[1]

SDG 10 captures inequality by focusing on the income growth of the 40 per cent poorest of the population (Basu 2001; Kakwani et all. 2014)). It is interesting to compute how much the yearly growth rate between 2003 and 2015 in the mean income of the whole population (3.79 per cent) differs from that of the bottom 40 per cent (6.39 per cent). The -2.60 per cent difference is a useful measure of inequality trends. It allows us to disentangle in an additive fashion the main drivers of this inequality fall, namely: other income sources (-0.65 per cent); years of schooling (-2.02 per cent), hourly wages per year of schooling (-0.51 per cent), hours worked (0.29 per cent), occupation rate (0.09 per cent), and labour supply (0.41 per cent). This labour ingredients decomposition suggests that the faster growth of the bottom 40 per cent is mostly due to years of schooling expansion and returns to schooling fall. The other point worth noting is that the impact of other income sources on mean growth and inequality is relatively small, suggesting the dominance of labour earnings effects in inequality trends.

[1] Other productive attributes of workers that are in general positively related with earnings, such as technical education, formalization, job tenure, and firm size, increased their share in the workforce, but those individuals without those attributes presented the highest wage growth rates in the period of falling inequality (Neri 2014).

Another policy perspective is to disentangle different per capita income inequality trends. Fiscal microsimulation exercises reveal that in the 2003–15 period market incomes inequality fell by 2.2 per cent; when we add to that official cash transfers, gross income inequality fell 2.7 per cent. If we consider the effect of direct taxes, inequality fell by 2.69 per cent, a similar amount. Finally, when we consider the effects of indirect taxes, final income inequality fell by 2.56 per cent. Section 7 provides details using the Gini index, the role played by specific private income sources, and official cash transfers.

Disposable income-based mean and inequality trends are similar to those based on gross income. If we move to the upper disposable income shares, the respective 2003–15 period yearly growth rates fall: whereas the bottom half grows by 5.91 per cent, the upper half grows by 3 per cent, the top 10 per cent by 2.19 per cent, and the top 1 per cent by 2.02 per cent.

Finally, we need to complete the missing pieces of the pure growth puzzle. Household income grew on average 1.88 per cent a year above GDP in the 2003–15 period. This difference is almost equal to the difference between labour remuneration and labour productivity. We are able to decompose for the 2003–13 period the 1.9 per cent a year difference. Only 18 per cent is due to nominal and timing differences, which is good news—first, because for social welfare purposes CPI is more relevant than implicit deflators; and second, because it puts the burden of the difference explanation outside National Accounts versus household surveys information sets.

Instead, we must look at differences between the GDP implicit deflator and the official consumer price index (IPCA) inflation rates. We see that 20.7 per cent of the residual gap is due to terms of trade (meaning domestic demand over total demand in an open economy); 29.3 per cent is due to differences between private consumption and domestic demand; and the residual half is due to differences between CPI and the private consumption implicit deflator. Social welfare growth cannot be sustained if the costs of goods and services purchased in the markets rises less than the cost of producing them captured by the implicit deflator.

We have based our understanding of income distribution trends in Brazil during this century and their main policy determinants on the main national household survey (PNAD). This takes into account the impact of different income sources (labour, rents, social security, official cash transfers) and of classical labour ingredients (participation, unemployment, hours, hourly wages, school premiums). We have also decomposed the reasons behind the gap between mean household income and GDP growth (nominal differences, and related to deflators (terms of trade, domestic demand, and consumption)). In the rest of the paper we will incorporate step by step new data and methodological possibilities explored in the project to provide a more detailed picture[2].

3 Are firms effects driving formal earnings inequality?[3]

The vast majority of the empirical literature on income distribution in developing countries uses household surveys. Brazil established this tradition in the early 1970s. Recently a series of papers have documented inequality based on personal income tax (PIT) records. Establishment-level administrative records are also available in Brazil, but these have rarely been used in studies on

[2] The appendix found in the end of this paper formalizes a decomposition methodology that adds a demographic component by disentangling household size (i.e. the denominator of per capita income) into smaller pieces.

[3] This section is based on Neri et al. (2018a).

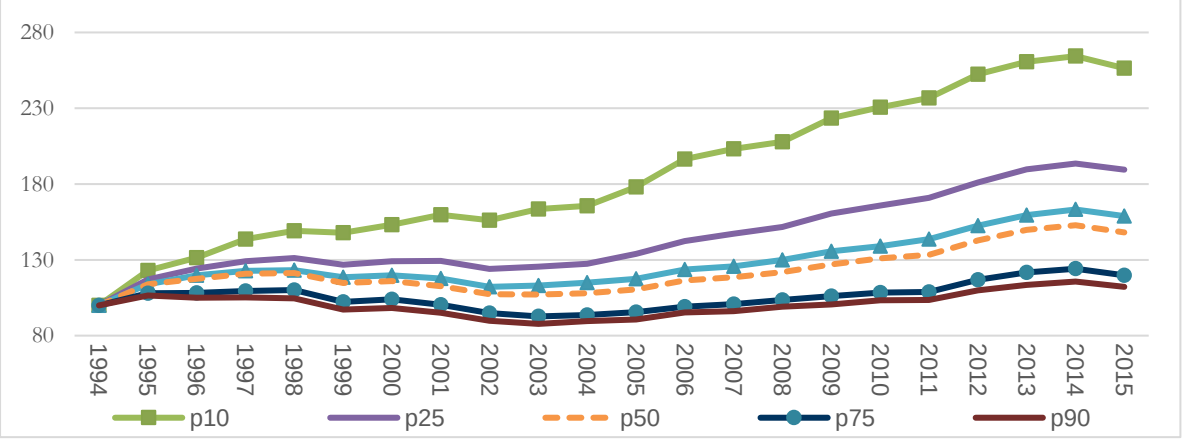
income inequality. RAIS (*Registro Anual de Informações Sociais*) is a matched employer–employee database containing around 30 million observations per year on workers over the last two decades. RAIS depicts formal employment and wage differentials dynamics. It is a powerful complement to other data sources (Alvarez et al. 2017; Engbom and Moser 2017). This section documents the evolution and the main determinants of earnings inequality in the Brazilian formal sector from 1994 to 2015 using RAIS.

A broad inequality diagnosis using Lorenz curves and the main inequality indexes used in the literature, such as earnings ratios across different percentiles, the Gini index, and the Theil indexes, shows a consistent formal earnings inequality fall. Using RAIS, we also compare these results with broader household surveys, which also present falling trends. For example, the Gini of labour earnings in RAIS fell by 12.5 per cent between 1995 and 2015, while the concentration index obtained with PNAD data fell by 19.3 per cent in the same period.

3.1 Top earnings

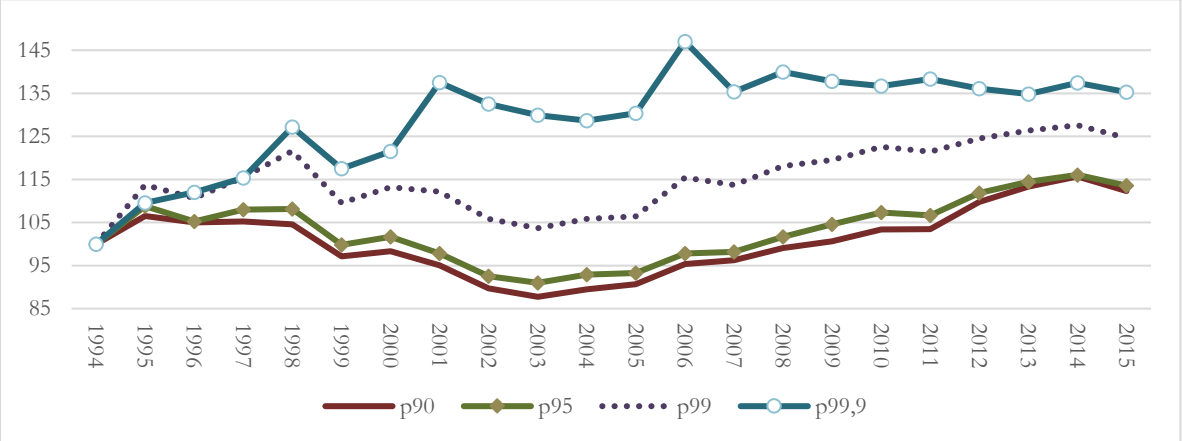
RAIS allows to measure wages at the very upper end of the formal earnings distribution. In spite of the overall inequality fall, the monotonic decrease of earnings growth continues only until the 90th percentile; above this point the trend is reversed, as shown in Figures 6 and 7. This evidence is in line with PIT data, which is explored in Section 8 (Medeiros et al. 2015a, 2015b).

Figure 6: Cumulative growth curve, 1994–2015—lower percentiles



Source: Author's calculation based on RAIS microdata 1994–2015.

Figure 7: Cumulative growth curve, 1994–2015—top percentiles



Source: Author's calculation based on RAIS microdata 1994–2015.

J-Divergence measures allow us to disentangle the role played by specific categories of different variables, including income itself. The share of inequality explained by the top 10 per cent, 1 per cent, and 0.1 per cent rose between 1995 and 2015: by 20.2 per cent, 43.1 per cent, and 90.1 per cent, respectively. Similarly, in spite of falling mean schooling returns, the share of inequality explained by those with a high school diploma rose by 29.5 per cent in the same period (Hecksher et al. 2017; Rohde 2016).

3.2 Breaking down inequality

Standard inequality decompositions based on information theory help us to understand the main determinants of formal earnings dispersion. These include workers' characteristics (such as gender, race, age, education, and spatial location) and firms' characteristics (sector of activity, firm size, legal nature, etc.). In general, the results indicate the predominant role played by the 'within' component in explaining total inequality, for the entire historical series of 1994–2015. However, looking at the 'between' effect for the educational categories, we observe a relatively higher contribution. For instance, in 1994, schooling explained 24.1 per cent of the total inequality measured by the J-Divergence index, while in 2015 this statistic reached 32.8 per cent.

As we found for several individual workers' characteristics above, the between–within decomposition for firms' characteristics shows the predominance of the 'within' component in determining total inequality. Nonetheless, when we look at a highly disaggregated level by considering firm fixed effects (i.e. each firm being a category itself), the results show a remarkable contribution of individual firms. For the 1994–2015 period, the contribution of firm-specific factors explains around 65 per cent of total inequality in each year considered. In 2015, the portion of the total inequality, as measured by the J-Divergence index, explained by the between component reached 64.7 per cent.

Taken together, our findings suggest that, among several workers' characteristics, differences in schooling were a primary factor in explaining total inequality in the Brazilian formal labour market. Firm fixed effects have an even more pronounced explanatory power.

3.3 Inequality changes

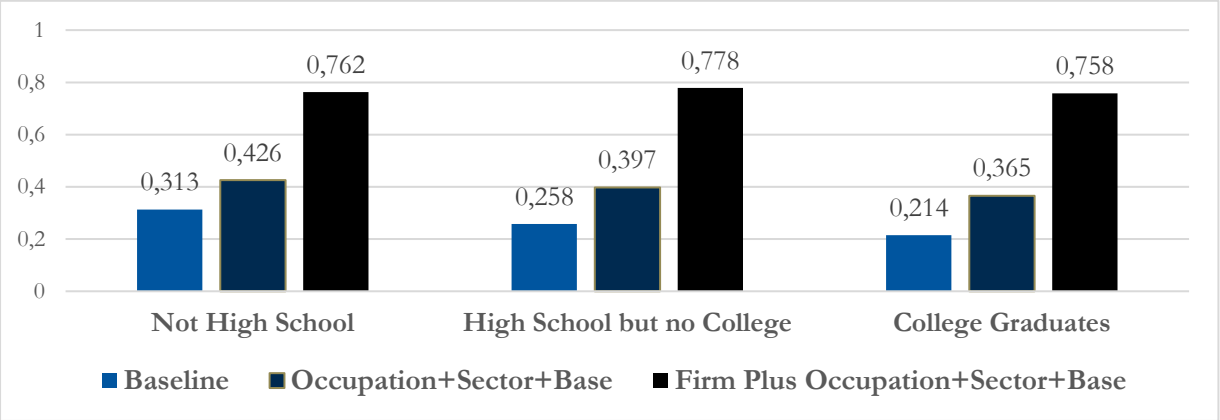
When one looks at the changes observed from 1994 to 2015, the power of individual firm effects to explain the fall in inequality observed is 64.5 per cent. Applying the same type of analysis across time to different characteristics, we also found the following contributions to inequality fall: education (-4.3 per cent), gender (2.55 per cent), age (8.8 per cent), macro-region (1.96 per cent), sector of activity (9.92 per cent), nature of the firm (-2.61 per cent from 1995 to 2015), and firm size (3.06 per cent). The firm effects explain the total inequality fall between 1994 and 2015 around three times more than the combined contribution of all the other characteristics considered.

The other striking result is the increasing impact of education on inequality in this period, which is not intuitive. This effect disappears with a more recent period of analysis. From 2001 onwards, there is a clearer inequality downward trend; hence, it may also be advisable to consider this period. Education explained 33.3 per cent of the marked inequality fall observed and thus assumes the role of the second-highest explanatory variable on the inequality fall observed from 2001 to 2015. Once again, firm effects explain most (75.9 per cent) of the inequality fall observed between 2001 and 2015. This means that the gross explanatory power of individual firms to explain inequality in the Brazilian formal labour market is almost twice that for education. In sum, in the context of inequality change, firms also appear as the main driving variable.

In the next section we apply a regression framework to analyse the gender gap specifically. We use these results here to discuss the broader determinants of inequality within education groups shown in Figure 8 (Alvarez et al. 2017; Machado et al. 2018). We mention here just the results for people

who finished high school, but without a college education. However, as the results are similar, we can generalize them for the other categories. The baseline model with basic socio-demographic categories explains 25.8 per cent of the overall variance of logs of earnings. When we add occupation and sectoral dummies, the cumulative explanatory power reaches 39.7 per cent. If we add firm fixed effects, it reaches 77.8 per cent.

Figure 8: Different sets of variables net contribution to inequality (variance of logs), 1994–2015



Source: Author's calculation based on RAIS microdata 1994–2015.

3.4 Main findings

This section has documented the evolution and the main close determinants of earnings inequality in the Brazilian formal sector from 1994 to 2015 using establishment-level administrative records. Changes in the earnings distribution in the formal sector share are among the trends observed in household surveys, which evidence in particular a marked fall in inequality between 2001 and 2014. However, the distributive decompression is observed only until the 90th percentile, which is in line with PIT-based evidence. The analysis of specific groups shows that the share of inequality explained by the top 1 per cent and 0.1 per cent income-earners rose by 43 per cent and 91 per cent, respectively. We will come back to top income issues, looking at broader population and income concepts, in Section 7.

In 2015, schooling explained 33 per cent of overall inequality. Firm effects explain 65 per cent of total inequality. Firms are also central to explaining the marked inequality fall observed. Moreover, firms seem to drive overall inequality in developed countries such as the US and Germany (Card et al. 2013; Song et al. 2015).

4 How the gender gap evolved across time and over the life cycle?[4]

The recent gender gap earnings literature in developed countries has shown a decline over time in the gender wage gap, but the gap has been expanding over the life cycle. We study the wage gender gap over time and over the life cycle in the formal labour market in Brazil, a large developing country that has experienced a simultaneous process of overall inequality reduction, formalization, and a massive entry of women into the workforce.

Gender earnings gap patterns throughout the life cycle may be influenced by the combination of two different processes: the career path within an employer, due to wage rises and promotions

[4] This section is based on Machado et al. (2018).

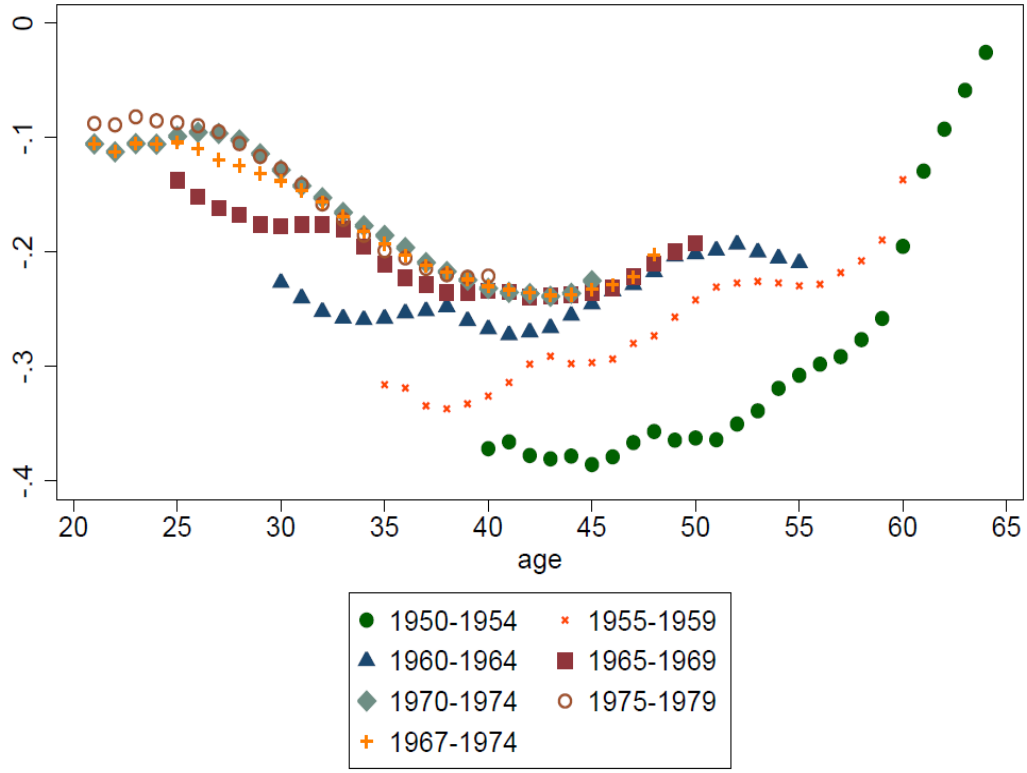
over time; and the sorting into high-paying versus low-paying employers. In sum, we explore how much of the change in the gender gap over the life cycle occurs within or between establishments and how much of it is driven by the firm's sector of activity or occupational choices (Bertrand et al. 2010; Goldin and Mitchell 2017).

4.1 Cohorts

The study of the trajectory of the gender gap in the labour market over the life cycle also uses RAIS from 1994 to 2015. In addition, in order to investigate the gender gap throughout the life cycle for different education groups, we track specific educational groups of workers (male and female) who were working in 1994.

We start by plotting the results without any controls, as can be seen in Figure 9. The gender gap expands over the life cycle until around the age of 40, when it starts to reduce until the end of the career. However, it is worth noting that the gender wage gap has been reducing over generations, as the curves are displaced upwards across time.

Figure 9: Evolution of the earnings gender gap throughout the life cycle by birth date



Source: Author's calculation based on RAIS microdata 1994–2015.

We then split the cohort born in 1967–74 into three groups according to their schooling: those with schooling only up to high school, those with a high school education, and those with a college degree. We follow this generation for two decades after leaving school. We find that the gender explanatory power for the variance of log earnings increases with education levels: from 1.14 per cent for workers with no high school education to 4.17 per cent for workers with high school education and 5.46 per cent for those with higher education.

4.2 Controls

We then introduce different types of controls systematically in order to evaluate among other variables the gender impact exerted on overall earnings inequality. Through this regression framework, we are able to expand the share of the variance of logs explained from less than 32 per cent using employees' characteristics to more than 75 per cent including the roles that occupation/industry, staff size, and firms fixed effects play in these processes (see Figure 8).

The gender marginal impact of 1.14 per cent for those with less than high school education rises to 2.16 per cent when it includes other worker characteristics such as age, state, exact years of schooling, and year fixed effects. It falls back to 1.27 per cent when sectoral and occupation controls are added to the analysis and to 0.451 per cent when firm controls (size, average earnings, and fixed effects) are incorporated into the model. In none of the three groups of schooling covered does the marginal contribution of gender exceed this level of explanatory power. This finding reveals that a large part of gender inequality can be explained by a sorting between high-paying and low-paying companies rather than inequality within firms.

Moreover, the marginal contribution of the gender variable becomes negligible when we consider the full model with all the controls, suggesting that the nature of gender wage inequality has been captured by the empirical exercise performed.

4.3 Main findings

Gender gap dynamics depend on many factors, such as age, educational level, time since leaving school, marital status, having small children, worked hours, and work flexibility.

Although the gender earnings gap has been falling across time and generations, it expands over the life cycle until the age of 40, when it starts to reduce until the end of the career. This finding parallels that for developed countries.

The gender gap also increases with the educational level. At 40 years of age, women without a high school education earn 28.8 per cent per cent less than men. For those with a high school education and college degree, this difference is 32.6 per cent and 47.4 per cent, respectively.

For all of the education groups, and independently of age, the gender earnings gap reduces when occupational/industry controls are added to the model. The inclusion of firm controls accounts for an even greater share of the gender gap in earnings. This suggests that industry and, in particular, firm-specific policies and choices are key drivers of female wages. After controlling for the occupation/industry and firm characteristics, the remaining gender wage gap is less than 20 per cent and greater than 10 per cent over the entire career, independent of the educational level.

5 What is the role of education background?[5]

Education changes are often viewed as the main driver of changes in earnings distribution. In the case of Brazil, there is low intergenerational mobility and strong dependence on family background. In contrast with most other countries, Brazil has experienced a strong reduction in educational premiums in the last two decades. However, omitted variable and measurement error biases possibly affect the econometric estimates of these effects.

There was also a sharp fall in individual labour earnings inequality between 1996 and 2014. Coincidently, supplements to the national household sample survey (PNAD) on family background in these two specific years allow us to clarify the role played by falling education

[5] This section is based on Neri and Bonomo (2018).

returns. This section takes advantage of this information to provide new estimates of the returns to education in Brazil using traditional Mincerian regressions, quantile regressions, and pseudo panels. We also study the intergenerational transmission of education in Brazil using Markovian regressions.

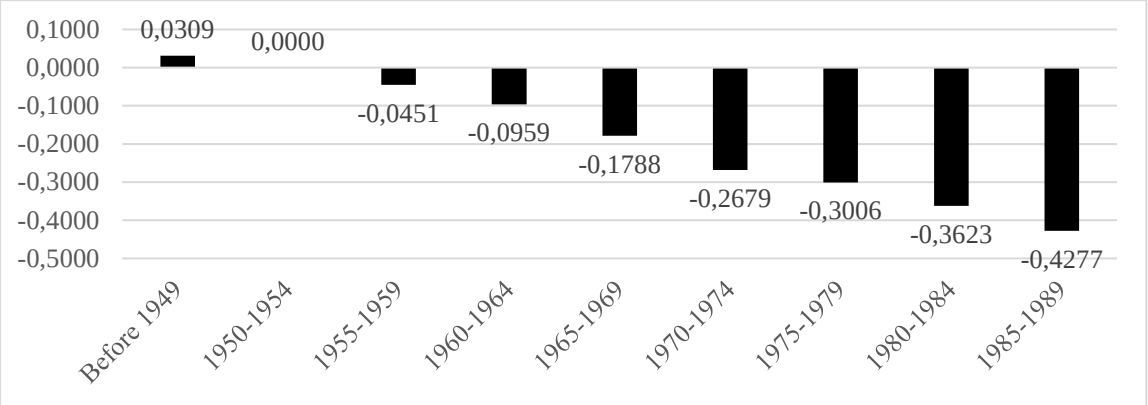
The main questions posed here are: How has intergenerational mobility in education evolved? (Behrman et al. 2001; Ferreira and Velloso 2003; Lam and Schoeni 1993). What has been the evolution of wage premiums with respect to schooling? And, in particular, how has parents' education affected the returns and the educational level of their children? (Card 2001; Lam et al. 2015)?

5.1 Intergenerational inertia

Brazil is a country marked by low intergenerational mobility in education. For example, in 2014 among fathers with completed higher education, 70.7 per cent of their children achieved the same level and 7.09 per cent got a Master's or a PhD degree. However, how has educational mobility evolved in recent years? A simple Markovian model shows a strong reduction in the mean intergenerational persistence of education between the years 1996 and 2014, which went from 0.7 to 0.47. It is important to stress that this result still places Brazil among the countries with the highest levels of education inertia across generations (between Germany with 0.2 in 1997 and Colombia with 0.7 in 2001). Indeed, Brazil is now closer to where Mexico and Peru were at the end of the last century.

Cohort effects regarding intergenerational mobility show that the fall in the persistence of education is stronger for younger cohorts, coinciding with the fall in education premiums when we take into account family background data in the regressions (Figures 10 and 11).

Figure 10: Intergenerational mobility of education by cohorts—interaction between fathers' education and cohort effects



Source: Authors calculation based on PNAD 1996 and 2014 supplements microdata.

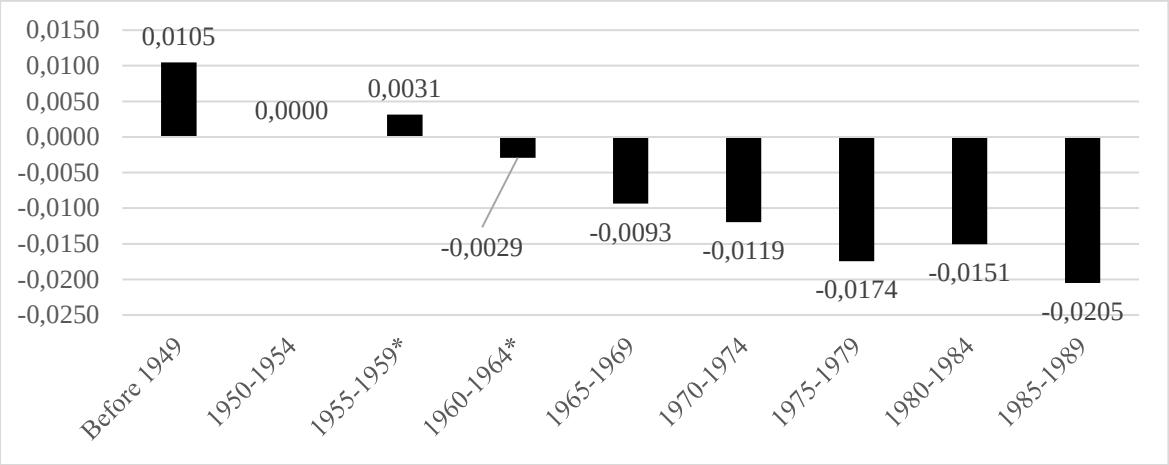
Finally, quantile regressions enable us to assess how the intergenerational persistence in education changed along the income distribution between 1996 and 2014. Comparing directly the coefficients for the two years, we find that, except for the first two vintiles, the persistence is smaller for 2014 than for 1996, especially in the middle and upper part of the income distribution. In fact, we find stronger reductions in the intergenerational persistence of education for the richest individuals.

5.2 Education premiums

The two PNAD supplements allow us to address econometric issues of omitted variable and attenuation bias. First, omitting parents' education information while accounting for selectivity issues reduces education premium estimates by 24 per cent. Perhaps more importantly, the fall in

education premium is heavily underestimated when we do not take into account family background. Quantile regressions show that the highest fall in returns occurred for intermediary levels of education and income (Figure 11). Cohort effects also show that the reduction in the education premium has been going on over several generations, as shown in Figure 10.

Figure 11: Differences in the education premiums by cohorts—interaction between schooling and cohort effects



Source: Author's calculation based on PNAD 1996 and 2014 supplements microdata.

Information on which member of the family responded to the survey questionnaire was used to assess measurement error, controlling for availability bias. We find evidence of attenuation bias, reducing schooling returns by between 14 per cent and 32 per cent.

5.3 Main findings

The empirical exercises performed show that the fall in education premium in Brazil is underestimated when we do not take into account family background impacts. In particular, when we measure omitted variables bias for the years 1996 and 2014, we find that they did not cancel out each other over time. This result reinforces the importance of using two points in time to address the close determinants of earnings inequality fall.

Although the fall in the intergenerational persistence of education in Brazil (from 0.7 in 1996 to 0.47 in 2014) is contemporaneous with the introduction and dissemination of CCT programmes such as *Bolsa Escola* and *Bolsa Familia* with the same objectives, a causal connection between these factors cannot be established at this point.

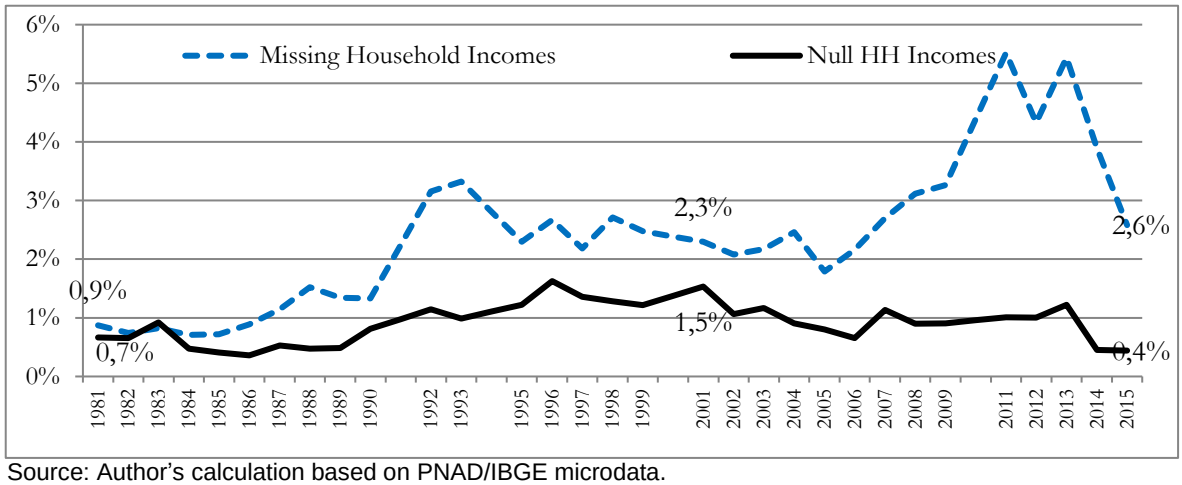
6 Does missing income affect distribution?[6]

Incomes are information-sensitive and vulnerable to non-response in any household survey. PNAD, collected by the Instituto Brasileiro de Geografia e Estatística (IBGE), is the main household survey used in inequality studies for Brazil (the others are the Demographic Census, PME, PNADC, and POF). However, it is the only one with no explicit imputation for missing income values. The incidences of missing values and null incomes are in proportions that vary over time, as shown in Figure 12. The movement of inequality reduction observed in PNAD in the 21st century might be affected by the treatment that is given to both the null and unavailable incomes. In addition, some inequality indexes with useful special properties cannot be estimated

[6] This section is based on Hecksher et al. (2018).

in the presence of null incomes. This section opens with a description of the new imputation methodology developed. There follows a thorough analysis of the impact of null and unavailable incomes on income distribution-related statistics.

Figure 12: Share of null and unavailable household income on PNAD, 1981–2015



Source: Author's calculation based on PNAD/IBGE microdata.

6.1 New imputation method

PNAD investigates multiple sources of income that were received in a given month, relative not only to the people interviewed but to all eligible residents of each sampled household. Generally, income non-response on surveys tends to be more frequent at top incomes. This is identified as differential non-response and therefore requires a statistical treatment to correct the resulting estimates for potential bias. This issue results from the way the survey is conducted (on the PNAD, the reference period corresponds to one month only) and does not occur with comparable surveys in many other countries (De Waal et al. 2011).

The income imputation process began by fitting the regression models with observations classified as potential donors. The expected theoretical relations between the income variables to be imputed and all the other variables available in PNAD guided the initial choice of the potential predictor variables to be considered in each model. Then, using 2015 data, model selection was performed considering the complex sampling design of PNAD when testing the statistical significance of the predictor variables. In 2015, 2.9 per cent of the (weighted) sample had the per capita household income altered by the imputation procedure.

The process of imputing individual incomes generally resulted in higher mean incomes and slightly higher levels of inequality than the ones estimated in 2001 and 2015 without the imputation. The increase in mean incomes caused by imputation is higher in 2001 than in 2015. Therefore, after imputation in these two years, real growth in labour income decreases from an annual average of 1.52 per cent to 1.48 per cent, and the annual growth in per capita household income decreases from 2.53 per cent to 2.46 per cent. The point estimates of the Gini index for labour income and per capita household income increase by 0.003 in 2001 and 0.002 in 2015. Thus, the Gini index fall in both indicators between 2001 and 2015 becomes only 0.001 more intense.

We also study the behaviour of inequality in terms of poverty alleviation objectives. The idea is to increase the weights given to the bottom part of the per capita income distribution, since traditional measures such as the Gini index place more weight on the upper part of the income spectrum. Any income increase up to the 75th percentile approximately yields Gini index reductions in Brazil.

Here we focus on the P^1 measure using the U$S3.20 a day PPP poverty line, in which imputation reduces 2015 poverty by 16.8 per cent or 0.9 percentage points. Poverty differences across time are much smaller, not exceeding 0.4 percentage points. In our benchmark scenario, these

differences amount to 0.1 percentage point. Although poverty levels present some differences, poverty change estimates—at least in the 2001–15 period—are not affected by imputation procedures.

6.2 Policy-related marks and imputed rents

Our analysis takes advantage of strong points of the methodology to add a rent imputation into income-based social measures and to study pressure points associated with minimum wage law in Brazil. With respect to the latter, in our simulated income exercises, social security benefits and earnings among informal employees are affected by wage floors together with low skilled formal employees, preserving key policy-related features of Brazilian income distribution.

Poverty with imputed rent estimates is, as expected, lower. For example, in 2015 using the U$S3.20 a day PPP line the poverty gap (P^1) is 48.9 per cent lower. The P^1 between 2001 and 2015 falls from 8.4 to 5.8 percentage points using imputed rents. Using Datt-Ravallion-type decomposition the share of poverty fall explained by inequality reduces from 45.87 per cent to 30.38 per cent. Although imputed rent does reduce the relative importance of the inequality component of poverty reduction, it does not affect the Gini coefficient trends.

6.3 Main findings

Missing income data in Brazilian surveys is more frequent among people expected to be extremely poor or extremely rich than in the middle of predicted income distribution, potentially affecting inequality measurement. We propose a new imputation method and apply it to PNAD, the main Brazilian household survey. Our method preserves both random variability and empirical relations between variables. It also preserves discontinuities related to Brazilian institutional factors such as labour earnings and various official cash transfers with values exactly equal to the minimum wage. The imputed values preserve yearly specificities of different income sources distributions among different groups (e.g. employers, self-employed, formal employees, and informal employees).

From 2001 to 2015 imputation increases the level of mean income, decreases the main poverty indicators, and slightly increases inequality indexes. It reduces the mean income growth rate but does not affect inequality or poverty trends in the period.

7 How taxes and transfers steered distributive changes?[7]

After decades in which the Gini coefficient was stuck around 0.60, it started declining every year from 2001 to 2014, to a Gini of 0.52. However, the main Brazilian household surveys provide information neither on taxes paid by households nor on some relevant transfers. International comparisons of income inequality show that Brazil presents high market income inequality and the state does a poor redistributive job, especially in comparison with OECD countries, transforming it into disposable income inequality. Previous studies assessed the distributional incidence of the Brazilian tax and benefit system at specific points in time (Higgins and Pereira 2013; Immervoll et al. 2009; SEAE/MF 2017). There is no previous microsimulation study in Brazil that evaluates the actual impact of fiscal policy on income distribution using different surveys over time.

The objective here is to shed light on the role of fiscal policy in determining inequality and poverty trends in Brazil. To this purpose, we estimate the redistributive effects of the fiscal system in the

[7] This section is based on Neri et al. (2018b).

period 1995–2015 using PNAD surveys plus a nationwide expenditure survey (POF) for 2003 and 2009. We also applied microsimulation techniques, and public tax and spending accounts. For the four selected years 1995, 2003, 2009, and 2015 the analysis includes specific cash transfers and direct taxation initiatives. For most years indirect taxation was taken into account.

7.1 Welfare decomposition

The decomposition methodology derived step by step allows us to evaluate causes and consequences in an integrated manner through growth and inequality components pointing to Gini social welfare function and standard poverty measures. It enables the assessment of the societal well-being level in a given year through its two main components (mean income and equality). The method also allows us to disentangle the contribution of specific official spending and taxation to mean and social welfare growth over time. The decomposition methodology further yields direct policy targeting indicators, comparing the welfare gains generated through each policy in comparison with its associated fiscal costs. Table 2 synthesizes the outcome of this methodology with additive static and dynamic properties.

Table 2: Income, equality, and social welfare—contribution to growth ordered by disposable income

Income type	2003–15 (annual)		
	Mean income	Equality	Welfare
Initial income	0.0276	0.0072	0.0349
Cash transfers	0.0110	0.0055	0.0165
Public pensions	0.0083	0.0016	0.0099
Poor elderly/disability benefits	0.0010	0.0013	0.0023
Wage bonus + Family wage	0.0004	0.0003	0.0008
Unemployment benefit	0.0004	0.0004	0.0008
Family grant	0.0013	0.0022	0.0034
Gross income	0.0387	0.0127	0.0514
Direct taxes	0.0038	–0.0010	0.0028
Personal income tax	0.0018	–0.0013	0.0005
Social security contribution	0.0021	0.0003	0.0023
Disposable income	0.0348	0.0137	0.0486
Indirect taxes	0.0080	0.0029	0.0109
Final income	0.0269	0.0108	0.0377

Source: Author's calculation based on PNAD/IBGE microdata.

We have focused on simulated per capita disposable income changes between 2003 and 2015. Gini index-based social welfare grew by 4.86 per cent per year in this period. This annual welfare increase can be disentangled into a component of mean income growth (3.48 per cent per year) on the one hand, and a component of equality growth (1.37 per cent) on the other. The respective welfare growth rate for disposable income is higher than for initial income (4.36 per cent) and final income (4.47 per cent), but not for gross income (4.91 per cent). The only two cash transfers that had a higher contribution to equality than mean income growth were the Family Grant and the Poor Elderly/Disability Benefits (69 per cent and 30 per cent, respectively). Direct and indirect taxes contributed negatively to welfare growth, reducing its annual growth rate. However, direct taxes contributed to inequality reduction, since the PIT contribution to equality growth (0.13 per cent) offset the negative impact of the workers' contribution to social security on income distribution (-0.03 per cent). Indirect taxes also had a negative impact on equity (-0.29 per cent), thus increasing inequality.

7.2 Poverty

Our analysis of inequality links with concentration curves and emphasizes the impact of fiscal policies on poverty indicators, increasing the weight attributed to the lower end of the income distribution. We apply standard Ravallion-Datt poverty decomposition to growth and inequality components to assess their relative roles. Around 57 per cent of our benchmark poverty measure fall was explained by the mean income growth component and 43 per cent by the inequality fall. Using the same U$S3.20 a day line, the poverty fall in the 2003–15 period amounted to approximately 69 per cent. This means that the poverty fall in Brazil was nearly twice that targeted in the UN's first MDG in less than half the period.

The model outcomes allow us to assess the anti-poverty role played by specific fiscal instruments among various taxes and cash transfer programmes. The Family Grant, the best-targeted policy, was in action between 2003 and 2015. If one compares the Family Grant poverty impact with the second-best targeted cash transfer programme, each monetary unit spent generated a 119.7 per cent higher impact. The Family Grant concentration curve dominates the perfect equity line and all official cash transfers considered. Thus, the Family Grant gives relatively more to the poorest. Its contribution to the rise of social welfare is 2.7 times its contribution to the rise of mean income. However, since its creation in 2003, the programme has become less and less targeted towards the poor, maybe as a consequence of its steep expansion over time (Campello and Neri 2013).

Targeting differences also affects aggregate demand multipliers on GDP. Campello and Neri (2013) presents these multipliers within a social accounting matrix framework: Family Grant (1.78); Poor Elderly/Disability Benefits (1.19), Wage Bonus and Family Wage (1.06), unemployment insurance (1.06), and social security benefits (0.53, including public pensions). This means that the contractionary effects of fiscal adjustments, in particular social security reforms, can be mitigated by increasing pro poor public spending, e.g. through the Family Grant. Incidentally, the minimum wage[8] acts as the numeraire of the benefits and/or eligibility criteria of almost all official cash transfers, including social security benefits. The only relevant transfer insulated from minimum wage effects is the Family Grant. This means that minimum wages do not have a very progressive impact profile in terms of Brazilian Government transfers. The highest minimum wage impact is a little above the median of per capita income.

7.3 Main findings

This section interacts household survey data with fiscal rules and explores an analytical framework applied to cover income distribution and poverty changes observed over two decades of Brazilian fiscal policy. Per capita disposable income for the poorest fifth of the population in 2015 was 153 per cent higher than in 1995, compared with a growth of 20 per cent for the richest fifth, once inflation was accounted for. The welfare growth of 4.86 per cent per year between 2003 and 2015 is due more to mean income growth (72 per cent) than inequality reduction (28 per cent).

The Gini coefficient reduction caused by cash benefits increased from 3.5 percentage points in 1995 to 8.9 percentage points in 2015. The results suggest that official cash transfers accelerated the growth of social welfare (+1.65 per cent), while direct and indirect tax changes operated in the opposite direction (reductions of 0.28 per cent and 1.09 per cent, respectively). In a time of tight fiscal constraints, the Family Grant should be a model for all official cash transfers, vindicating any budget adjustment decisions in terms of cost-efficiency. Gini reductions due to the

[8] The Brazilian minimum wage was increased by 79 per cent in real terms in the 2003–15 period.

introduction of more progressive taxes are still limited in Brazil and are another area of reform towards higher equality.

The poverty gap fall according to the US$3.20 line was almost equally explained by income growth and inequality reduction between 2003 and 2015. This indicated that Brazil followed a sort of a middle path driven by distributive and growth dimensions.

8 Combining personal income tax records and surveys?: words of caution[9]

8.1 A wider scope

The assumption that Brazilian personal income tax (PIT) tabulations for 2007–15 are representative of top incomes trends suggests that mean income experienced an unnoticed 'economic miracle', while household surveys, National Accounts, and other sources incurred underestimation errors. We evaluate the impacts of combining surveys with PIT in terms of growth, inequality, and social welfare. While the previous literature focused on the impacts of these data combination exercises on inequality, there are new sources of understanding about the economic causes and social consequences behind them (Medeiros et al. 2015a, 2015b).

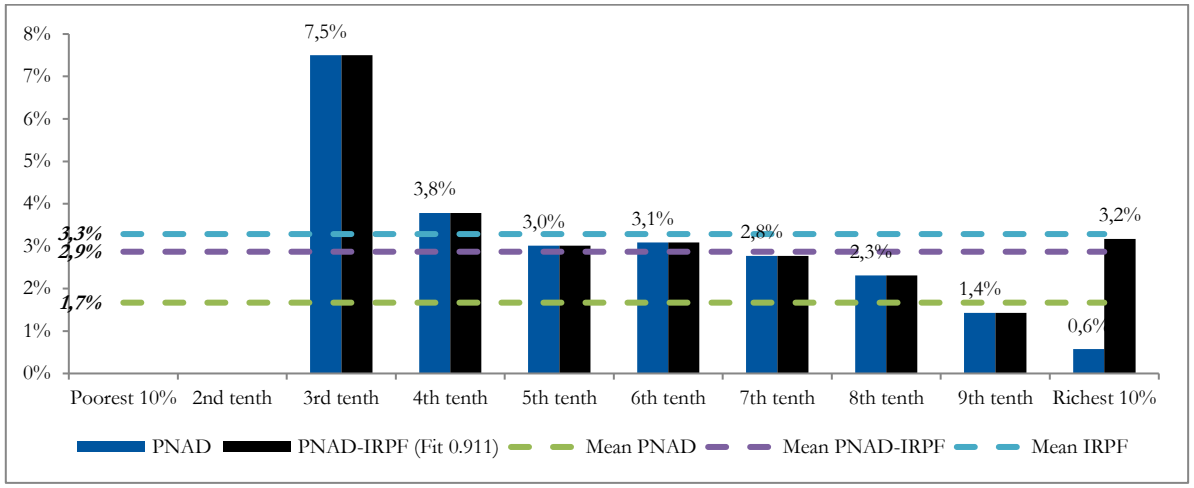
First, if the level of inequality measured rises when higher top incomes replace previous lower estimates based on surveys, this same exercise also increases unequivocally by construction the mean and the social welfare level associated with it. Not only is this true for social welfare functions found in the economic literature, but it also satisfies the Pareto efficiency criteria; that is, everyone is better off, or at least remains the same as before. We refer to a country more unequal but more prosperous or the same for all segments in the population.

Second, a similar story seems to hold for income distribution comparisons across time. While the empirical evidence analysed here shows that the movement of these combined estimates presents a slower inequality trend fall, income mean growth trends also rise at a much faster pace, which poses possibly higher social welfare growth rates than suggested by household surveys and new measurement-related issues. In fact, the social welfare index proposed by Sen (1973)—which results from multiplying mean income by the Gini inequality index complement—grows faster when PNAD's top incomes are replaced by PIT data.

Figure 13 shows the effects of combining PNAD and PIT on growth rates vis-a-vis PNAD. The two poorest tenths do not feature in the graph because 20.2 per cent of adults had null income in 2007. The graph reveals that the poorest 60 per cent of the adult population increased their share of total income even in the combined database. The 10 per cent richest also had a growth rate (3.2 per cent) higher than average (2.9 per cent) but not as high as rates observed in the third and fourth tenths (7.5 per cent and 3.8 per cent, respectively).

[9] This section is based on Neri and Hecksher (2018).

Figure 13: Real growth rate of income by decile per year, 2007–15



Source: Author's calculation based on microdata from PNAD and combined PNAD-PIT databases.

8.2 Is all this money new?

Annual growth of PIT taxpayers' average declared income (10.1 per cent) was much higher than that of GDP (3 per cent) from 2007 to 2011. Would the rich filers of PIT have experienced an 'economic miracle' unnoticed by the National Accounts? Not necessarily. Deflators and formalization can explain the difference.

From 2007 to 2015, this income growth gap is smaller: 4.88 percentage points per year (ppy), reduced to 2.75 ppy when we use nominal values neutralizing differences in deflators used. Almost all the remaining difference can be explained by the formalization of incomes, which reduces the gap by 2.56 ppy to 0.19 ppy—less than 4 per cent of the original discrepancy.

As part of the formalization movement, new laws encouraged 5.7 million people to register from 2009 to 2015 as individual microentrepreneurs, whose incomes up to a legal ceiling imposed could be declared as exempt by PIT filers or dependants, allowing an extra tax deduction in the last case. These new incentives may have increased the declared share of small business exempt incomes, the ones that grew the most among all declared income sources.

8.3 Taxpayers vs. demography

The use of income tax data to adjust for estimates about the income distribution assumes that individuals earn at least what it they declared to the IRS, on the basis that no one would want to pay higher taxes than necessary. But the argument does not apply to non-taxable income sources, which grew three times faster than taxable incomes from 2007 to 2015.

The observed rise of exempt retirement income of people 65 years old or above is consistent with a reduction in the number of elderly declarants and their reallocation as dependants of their sons and daughters. From 2007 to 2015, the declarant population aged 41 or above fell by 15.9 per cent, while in PNAD it grew by 30.3 per cent. At the same time, the number of dependants per person up to 40 years of age doubled. All in contrast with well established demographic trends. What seem to explain this discrepancy are new incentives introduced in the tax system.

After 2008, the obligation to submit a PIT form in order to obtain a valid fiscal number (CPF) was abandoned, which may have affected the choice to move to dependant status in the PIT records. Tax legislation allows the individual to declare as dependants their parents and grandparents and to incorporate their social security benefits and pensions up to a threshold as exempt income. This institutional change created an additional incentive for younger people to incorporate their parents'

incomes in their PIT declarations as dependants. Besides explaining the gap in age structure between PNAD and PIT, this may also have contributed to the marked rise in exempt income after 2008 and its impact on PIT income growth.

8.4 Main findings

In the economic evaluation of income distributions, one should not look just at their second moment without considering the first. A wider scope also leads to additional evidence with respect to measurement issues. Trying to correct top incomes of PNAD based on PIT tabulations slows the inequality fall from 2007 to 2015 but accelerates mean income and social welfare growth. This difference was more dramatic in the 2007 to 2011 period. The annual growth of PIT taxpayers' mean declared income (10.1 per cent) was much higher than that of GDP (3 per cent). Deflators and formalization of workers can explain most of this gap.

We document a rise in exempt non-taxable incomes and changes in the profile of tax filers and their dependants very different from well known demographic changes. What drove PIT income growth was exempt incomes. As the population ages, PIT taxpayers become younger and declare more dependants and non-taxable incomes. At least part of this difference is linked to changes in the incentives provided by Brazilian tax laws. It is risky to conclude on the trend of Brazilian inequality after taking available PIT tabulations at face value.

9 Conclusions

This paper synthesizes the main results of the Brazilian component of the UNU-WIDER 'Inequality in the giants' project. We assess the main drivers of income distribution changes and related measurement issues during the last quarter of a century. We start providing an integrated picture of Brazilian income distribution using household surveys, disentangling the effects of various policy-related components on inequality, mean income, and social welfare growth rates. The paper attempts to fill the blanks of this analysis using other data sources and various techniques.

In 1990, after 50 years of strong growth performance and dismal social indicators, Brazil started an upward trend in its social performance. Until 2015, there was a poverty reduction of 73 per cent, above the global fall of 70 per cent. There was also an improvement of the Brazilian Human Development Index above global trends. Life expectancy at birth increased by one year every three years. However, social security parameters remained unchanged, implying increasing fiscal deterioration. At the same time, the recovery of part of the secular delay of the years of study of the Brazilian population occurred without any noticeable progress in labour productivity. Similarly, the gain in individual labour remuneration was independent of productivity gains. It was as if the social improvement observed missed the economic fundamentals that could provide greater long-term sustainability. The recent Brazilian crisis illustrates that. The crisis emerged initially in macroeconomic indicators in 2012 but social indicators kept improving and suffered only a major deterioration from 2015 onwards.

Nevertheless there was a major income distribution change in this millennium that is worth analysing. In the 2003–15 period, Gini-based social welfare grew three times faster than GDP, while for the bottom 5 per cent it was a fivefold difference. Social welfare growth was roughly evenly divided into falling inequality, real GDP growth, and the differential of mean incomes between surveys and National Accounts. We decompose these different pieces of income distribution trends considering the impact of different income sources, labour market ingredients,

and price deflators. Social programmes expansion, education expansion impacts on earnings distribution, and consumer price inflation below producers' costs inflation were the highlights.

We brought new data and methods to create a more detailed picture. When personal income tax data are used to substitute the top end of income distribution in household surveys, inequality falls less but mean incomes and social welfare growth rates are also much higher. We are also able to reconcile these discrepancies with the expansion of non-taxable income sources. Income inequality was very high and had no clear trend until 2001 but after that, according to most data sources, it experienced a falling trend that lasted until 2014.[10] Most of the inequality fall was driven by earnings inequality, which was dominated by firm effects, at least in the formal sector. Minimum wage rises seemed to affect this channel, creating a wedge between labour productivity and remuneration but also affecting informal employees. Falling schooling returns also played a key role in earnings inequality, especially if one takes into account the effects of parents' educational background. Education expansion reduced intergenerational education inertia.

Missing values did not affect income inequality measured trends. Nor did the choice of whether to use gross or disposable incomes concepts. Direct and indirect taxes played against inequality fall, while official monetary benefits worked in the other direction, in particular conditional cash transfer programmes. The Family Grant programme had a much lower fiscal cost/social benefit ratio than all other programmes, most of which were indexed to the rising minimum wage in Brazil. Minimum wage hikes exerted a direct effect on fiscal accounts without much impact on the bottom part of the income distribution.

[10] These results are robust using top income shares, bottom 40 per cent, absolute poverty inequality component, and standard Gini and Theil T indexes. Any income increase below the 75th and the 82nd percentiles respectively reduces these last two inequality measures. They all present a steep inequality decline since the start of the millennium.

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Appendix: Sketching Alternative Social Welfare Functions, Inequality Measures and Dynamic Decompositions by Income Sources, Labor Ingredients, Demographic Factors and Price Indexes

The objective of is to develop an empirical framework associated with inequality measures directly derived from different social welfare functions. The advantage of this common approach pursued is to make explicit the assumptions and normative values associated with each dimension used. This approach also allows disentangling the effects of different sociodemographic variables, economic influences and policy related variables on income distribution. We depart from a simple decomposition analysis that allows gauging the contribution in levels and changes across years a myriad of variables into Social Welfare components (see further below).

A) Using different Social Welfare Functions:
    a. Gini SWF type; Log Utility; Gini weights with Log utility,
    b. Population Shares in Income: top 10%, Bottom 40% (Shared prosperity from SDGs), Palma ratio etc.

B) The types of decompositions addressed are:
    a. By income sources, (labour, social security benefits, social programs, private sources, imputed incomes etc.).
    b. By classic labour ingredients (participation rate, unemployment rate, hours, earnings, schooling etc.).
    c. By demographic components (new element) , decomposition by household size and related variables percentage of mothers among adult females, number of kids per mother, etc (the denominator of per capita income).
    d. By aggregate price deflators, (the difference between CPI´s and implicit National Accounts deflators explains the bulk of relevant differences in mean income growth between National Accounts and household surveys.).

1. A general description of social welfare functions (SWF)

A social welfare function is like a rule that provides a way to aggregate different utilities enjoyed by individuals in the society. Suppose there are n individuals in the society who have income distribution denoted by

$$\tilde{x} \approx [x_1, x_2, - - - - - - x_n]$$

then one can construct utility functions, $u_i(\tilde{x})$ that summarizes value judgments:

The mean welfare of the society is:

$$W = \int_0^{\infty} w(x)\, u(x) f(x) dx = \mu(1 - I) = \mu\, E \quad (1)$$

This is the form of social welfare function that Atkinson (1970) proposed. where the total weight adds to 1. $\int_0^{\infty} w(x) f(x) dx = 1$

As Sen (1974) noted from (4) that the Gini social welfare function is the weighted average of incomes of all individuals with weight *v(x)* given by $v(x) = 2[1 - F(x)]$. In the case of Brazil in 2014 any i per capita income based marginal increase below the 75th percentile makes the Gini falls. If we include top incomes in the analysis, the corresponding percentile will rise. Kakwani, Neri et Son (2010) propose a different measure of inequality Combine Gini weights with Log utility as in Atkinson inequality measures with (epsilon =1) $u(x) = log(x)$ and gives the social welfare function:

$$\log(x^*) = 2\int_0^{\infty} [1 - F(x)] \log(x) f(x) dx \quad (2)$$

One can derive directly *I* is a measure of inequality that can be nicknamed as LINI

$$\log(I) = 2\int_0^{\infty} [1 - F(x)][\log(\mu) - \log(x)] f(x) dx \quad (3)$$

where *I* is a measure of inequality more sensitive than the Gini to bottom incomes. An alternative that will be also done is to derive inequality from standard FGT poverty measures.

Going back to the more general case, taking logarithm of both sides of (1) gives

$$Ln(W) = Ln(\mu) + Ln(E)$$

which on taking the first difference gives

$$\gamma^* = \gamma + g \quad (4)$$

where $\gamma^* = \Delta Ln(W)$ is the growth rate of social welfare W, $\gamma = \Delta Ln(\mu)$ is the growth rate of average income of the society and $g = \Delta Ln(E)$ is the equality growth rate, which will be positive if growth is inclusive.[11]

[11] The income source decomposition developed below for the pure Gini case gets highly non linear in the case above but it can be done using a Shapely type of decomposition.

2. Decomposition by Income sources

It can be shown that

$$\Delta Ln(\mu_t) \sim \frac{1}{2}\sum_{i=1}^{k}\left(\frac{\mu_{i(t-1)}}{\mu_{(t-1)}} + \frac{\mu_{it}}{\mu_t}\right)\Delta Ln(\mu_{it}) \qquad (5)$$

which shows that the growth rate of per capita mean income is the weighted average of the growth rates of individual income components - the weights being proportional to the average of income shares in each period. This equation informs the magnitude of the contribution of each income component to the growth rate of per capita mean (average standard of living).

Suppose W_t is the social welfare in year t and W_{it} is the social welfare of the i^{th} income component, then we have

$$W_t = \sum_{i=1}^{k} W_{it}$$

Then it can be shown that

$$\Delta Ln(W_t) \sim \frac{1}{2}\sum_{i=1}^{k}\left(\frac{W_{i(t-1)}}{W_{(t-1)}} + \frac{W_{it}}{W_t}\right)\Delta Ln(W_{it}) \qquad (6)$$

which shows which shows that the growth rate of social welfare is the weighted average of the growth rates of social welfare of individual income components – the weights being proportional to the average of social welfare shares in each period. This equation informs the magnitude of contribution of each income component to the growth rate of social welfare.

The pro-poor growth rate from (7) is given by

$$g_t = \Delta Ln(W_t) - \Delta Ln(\mu_t)$$

Which in view of (5) and (6) gives the contribution of each income component to the pro-poor growth rate of per capita total income.

3. General Labor Market Decomposition

In order to determine the factors in labour market that have resulted in inclusive growth according to various SWF we have a series of product between the following variables:

1. Occupation rate: Employed persons as the share of labour force: *e*
2. Hours worked per employed persons: *h*
3. Labour force participation rate as share of the population: *l*
4. Labour productivity: Labour income earned per hour of work: p=y/h

The linkage between growth rate of per capita labour income and growth rates of the four labour force characteristics is provided through the following identity:

$$Ln(y) = Ln(e) + Ln(h) + Ln(l) + Ln(p)$$

where y is the labour income per person. Using this identity, it is easy to show that the growth rate of per capita labour income is a sum of the growth rates of four labour force characteristics:

$$\gamma(y) = \gamma(e) + \gamma(h) + \gamma(l) + \gamma(p) \quad (8)$$

The first factor is the occupation rate. Growth in occupation rate positively contributes to growth in per capita labour income. A similar interpretation is given to the other factors.

This equation is derived for the whole population mean but a similar equation can be derived for a different weighting scheme

$$\gamma(y_s) = \gamma(e_s) + \gamma(h_s) + \gamma(l_s) + \gamma(p_s) \quad (9)$$

The inclusive growth in per capita labour income is given by

$$\gamma(y_s) - \gamma(y) ,$$

which can be written as the sum of growth rates of four labour force characteristics:

$$\gamma(y_s) - \gamma(y) = [\gamma(e_s) - \gamma(e)] + [\gamma(h_s) - \gamma(h)] + [\gamma(l_s) - \gamma(l)] + [\gamma(p_s) - \gamma(p)] \quad (10)$$

This equation quantifies the contributions of each of the labour force characteristics to the inclusive growth in the labour income.

4. Decomposing Population by Household Size and Other Demographic Components

One of the most marked demographic change is the reduction of household size, which implies in diseconomies of scale and combines with changes in household composition. As in the case of labour market decomposition it follows a multiplicative fashion Starting at the aggregate and static level then we can move as in the multiplicative fashion above:

Population (Pop) is number of households (H) times household size:

Pop = H.N

Household size function of the number of kids Nk:

Pop = H. (N/Nk) . Nk

The north is to capture the impact of the quantity of kids.

Pop = H. (N/Nk) . Nkm .%m

Nkm=number of kids per mother

%m=share of mothers

Does it matter if number of kids rise due to m more kids per mother or if there are more mothers in the population?

Pop = H. Nkm .(%m/%k)

%k=share of kids

Pop = H. (Nkm/Nkam). Nkam.(%m/%k)

%a=share of kids born alive

Nkam=number of kids born alive or not per mother

Pop = H. Nkam.(%m//(%k.%a))

Population increases with number of households, number of kids born per mother, share of mothers; and falls, with share of kids in population and share of kids born that are alive. What are the consequences of these different components on social outcomes?

We can apply rates of change (log) and we can analyse the distributive aspect of it using Concentration curves (e.g. by total per capita income percentile) and apply specific weighing w(x) (e.g. Gini style (1-F(x)). An advantage is that all these parameters are observable for the whole Brazilian society and at individual household level with PNAD.

5. Decomposing Different Price Indexes Trends

The final decomposition is of an aggregate nature relating growth rates between Household Concepts such as per capita incomes and National Accounts concepts such as GDP (or alternatives as in Stiglitz et all 2010). Preliminary analysis suggested that at least since 2003 in Brazil there is a detachment between these two series as well as labour productivity and labour remuneration. Both detachments are in real terms, not in nominal terms. To understand these phenomena we should understand the difference in trends in inflation index. A series of simple transformations can also be applied to also follow a multiplicative form as below.

CPI/ GDP Implicit Deflator (YID) =

CPI/ Private Consumption Implicit Deflator (CID)

. CID/ Domestic Demand Implicit Deflator C+G+I (DDID)

. DDID / GDP Implicit Deflator C+G+I+X-M (YID)

This simple analysis allows to test if National Accounts and Household surveys real income decompositions are due to CPI measurement related issues, terms of trade impacts and so on.