The stability of income inequality in Brazil, 2006-2012: an estimate using income tax data and household surveys

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Abstract *Object: the level and evolution of income inequality among adults in Brazil between 2006 and 2012. Objectives: to calculate the level of inequality, its trend over the years and the share of income growth appropriated by different social groups. Methodology: We combined tax data from the Annual Personal Income Tax Returns (Declaração Anual de Ajuste do Imposto de Renda da Pessoa Física - DIRPF) and the Brazilian National Household Survey (Pesquisa Nacional por Amostra de Domicílios - PNAD) to construct a complete distribution of total income among adults in Brazil. We applied Pareto interpolations to income tax tabulations to arrive at the distribution within income groups. We tested the results, comparing the PNAD to the Brazilian Consumption and Expenditure Survey (Pesquisa de Orçamentos Familiares - POF) and to data from the Census Subsample Survey (Census. Results: We found evidence that income inequality in Brazil is higher than previously thought and that it remained stable between 2006 and 2012; in making these findings, we thus diverged from most studies on the dynamics of inequality in Brazil.. There was income growth, but the top incomes have appropriated most of this growth.* **Key words** *Social Inequality, Social Conditions, Social Class, Income, Income Distribution*

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Introduction

The levels of income inequality in a society both affect and are affected by various dimensions of public policies. On the one hand, income inequality is related to education levels[1,2], health[3,4], nutrition[5,6], mortality[7], violence[8,9] and many other features of a society, both determining and being determined by these features. On the other hand, the concentration (or lack thereof) of income establishes how a tax system that is the source of funds for almost all public policies functions in practice[10-15]. Thus, there is no doubt the impact of income inequality extends far beyond the economic dynamics.

Our objective is to evaluate the evolution of income inequality among adults in Brazil between 2006 and 2012 using a combination of tax data from the Annual Personal Income Tax Returns (Declaração Anual de Ajuste do Imposto de Renda da Pessoa Física - DIRPF)and the Brazilian National Household Survey (Pesquisa Nacional por Amostra de Domicílios - PNAD). This is the first time that this evaluation has been undertakenin Brazil. To this end, we calculated the level of inequality, its past behavior and the share of income growth appropriated by different population groups. We also discussed the implications of using different methodological procedures or alternative data sources and the effect that such procedures and/or data sources would have on our results. More specifically, we evaluated the potential effects of altering the PNAD-DIRPF merging point and combining the DIRPF with the Brazilian Consumption and Expenditure Survey (Pesquisa de Orçamentos Familiares - POF) and/or with data from the Census Subsample Survey (Census).

After combining the PNAD and DIRPF data, we drew conclusions we consider relevant to the study of inequality in Brazil, which we discuss in detail below. However, we also provide some qualifications and recommend caution in interpreting our results. We found evidence that income inequality in Brazil is higher than previously thought and that it remained stable between 2006 and 2012. By asserting that total inequality is not declining, we diverge from most studies on the recent dynamics of inequality in Brazil, which are generally based on per capita household income from household surveys. There were changes at the bottom of the distribution, but the concentration at the top remained almost constant. The substantial weight of top incomes on inequality determined a trend toward stability

rather than a decline in inequality. However, it is notable that inequality in Brazil began to decline before 2006, and as Soares[16] shows, this was in part due to reductions in top incomes. Thus, there was income growth, but if Brazil grew for everyone, the top incomes have appropriated most of this growth.

The main reason for using the DIRPF data is that the PNAD, much like other Brazilian household surveys, may underestimate the country's income inequality in an important way. If true, both the level and behavior of inequality may be somewhat different from what has been believed until now. If the underestimation is at the top of the distribution, i.e., among the top incomes, then inequality is higher than what is commonly calculated. If these top incomes are more resistant to the decline in inequality – as the household surveys themselves seem to indicate – then the decline in inequality in Brazil that has been observed since the late 1990s in earned income and from the early 2000s until 2011 in both total adult income and per capita household income may be less than what has been observed, may not exist or may even be reversed, although this latter possibility seems remote.

In general, the Brazilian literature seems to conclude that household surveys, in particular the PNAD, underestimate the country's income inequality by underestimating top incomes[17-19]. There is, however, disagreement regarding this conclusion: the PNAD might underestimate income, but this underestimation would not be greater at the top, may even be greater at the bottom and, in any case, would not have a significant impact on inequality[20]. A more recent study, however, once again insists upon the notion that the PNAD underestimates income at the top and indicates that the PNAD reports higher incomes at the bottom than the Census[21].

Based on tax data, the literature on other countries tends to support the argument that household surveys underestimate inequality. These data would supposedly better capture income at the top of the distribution. In fact, the results of these studies indicate that levels of inequality calculated with the assistance of tax data are much higher than those estimated with household surveys[22-38]. Although it seems certain that household surveys underestimate inequality when compared with tax data, it is unclear what would happen to trends in inequality over time because of such an underestimation. The literature on this topic indicates that the differences between tax data and household surveys

mostly occur at the very top of the distribution, with more significant divergences above the top 1% of incomes; moreover, there is good convergence between these data sources at the lower levels[39-41].

The comparison undertaken in Atkinson et al.[42] concludes that there is good correlation over time between the Gini index of the household surveys and the top income shares in the tax data (at least in the 13 countries they studied), i.e., the levels of inequality measured by these two data sources move in the same direction. However, if the direction is shared, the same cannot be said of the speed of the changes. In the United States, for example, both sources indicate increasing inequality since at least the 1980s, but the tax results show a much greater increase since that time[41]. Piketty[33] compiles the results of studies in many countries worldwide and reaches the same conclusions: much of the behavior that is favorable to equality at the bottom is neutralized by the immense influence that the very top incomes have on overall inequality. To all appearances, Brazil is no exception.

The evidence thus far for Brazil suggests that a more accurate measure of top incomes would reduce the rate of inequality decline calculated in the PNAD, but would not reverse its direction. For example, Souza[21] shows that the decline in inequality measured in the Census is lower than that measured in the PNAD and presents results indicating that a major part of the differences between the two surveys is due to the top of the distribution, which is best captured in the Census. In fact, in all of the PNAD surveys since 2001, income appropriated by the very top of the distribution shows much more stability than at lower levels. In fact, the end of Brazil's uninterrupted decline in inequality in 2012 is largely related to an increase in the top incomes, which can be observed in the richest tenth but is strongly concentrated in the top 1%. The introduction of studies based on tax data in Brazil reinforces the idea that the downward trend in inequality is very different from what has been observed until now[43].

Our general conclusionsdo not change when we make changes to the methodology used and are unlikely to be reversed– to the contrary, they might be amplified – by the use of other household surveys. However, there is always an inherent risk in combining different databases, and this risk makes our conclusions vulnerable to the possibility that our results might be affected by differences between the incomes captured by the PNAD and the DIRPF. We believe it remains pos-sible to improve our study and that we depend on more evidence to bolster our findings. In particular, our calculations would surely be better if we were able to employ microdata. Moreover, because we depend on interpolations, the results we present should be interpreted with caution. However, to all appearances, concentration in top incomes determines much of the level and evolution of inequality in Brazil.

Methodology

To construct the complete income distributions, we combined data from the PNAD, which is conducted by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE), and the DIRPF from 2006, 2009 and 2012,as received by Brazil's Internal Revenue Service (Receita Federal do Brasil - RFB).For purposes of comparison, we also used data from the 2008-2009 Brazilian Consumption and Expenditure Survey (Pesquisa de Orçamentos Familiares - POF) and the 2010 Census Subsample Survey (Census). In all of the household surveys, we used microdata with weights updated in December 2013. Details regarding how income is captured in these surveys and the implications this has for the study of inequality are discussed in Souza[21] and Barbosa[44]. For some of the evaluations performed, Gross Domestic Product (GDP) and family income data were obtained from the IBGE's national annual and trimestral accounts and were treated using the definitions and methodology of Medeiros et al.[43] to obtain the gross monetary incomes of families.

The DIRPF data comes from Castro's[45] study on tax progressivity in Brazil. The reason for analyzing three years (2006, 2009 and 2012) is that these are the only years for which we have a more refined level of tabulations in the lowest part of the top fifth of the distribution. Combining Castro's tables, we were able to construct a distribution with seventeen income brackets. In 2012, for example, the lowest brackets ranges from R$ 1 to R$ 2,100 per year and the top bracket encompasses incomes R$ 149,000 and higher. Only 1.6% of the country's adult population earned incomes above this latter threshold. It is worth pointing out that the bottom of the distribution in the DIRPF is necessarily underestimated because most of the low-income population are not required to file tax returns. Tax returns with inconsistent values were discarded, but the total number discarded, 2,800cases, was minimal

compared with more than 70 million returns considered.

As we used tabulated data, it became necessary to employ interpolations to obtain intermediate values within each category. Although there are different methods for interpolating[46,47], we chose the method that is used most frequently in studies on income distribution based on tax data: Pareto interpolation, adopting Piketty's[48] procedures. The parameters of the Pareto function have local validity, i.e., they vary in each data interval. We follow Feenberg and Poterba[49] and use the parameters calculated from the lower limit of the observed income bracket that was closest to the distribution quantile to be estimated.

All of our definitions of population, income and procedures for validating the interpolation with Brazilian data follow Medeiros, Souza and Castro[43]. Briefly, in the household surveys, we considered the total gross income of adults aged 18 or older, discarded individuals with missing income data, and annualized monthly incomes when necessary, adding the equivalent of a thirteenth monthly salary for formal and retired employees (an annual bonus determined by law), and a third of the salary as legal holiday bonuses for formal employees. The annualization raises income levels but has little effect on inequality. The variations in the Gini coefficient both before and after annualization are less than 2%.

We treat the tax units, i.e., each return, as individuals; this is generally accurate, particularly for the higher incomes levels, but there are exceptions. There are joint filings, which means that some of the population has been counted twice. Unfortunately, we cannot separate these cases in the tabulated data and have no way of knowing what type of bias this may introduce into the results.

The DIRPF population includes people under the age of 18. We could not exclude this population and thus treat the data as if they all referred to adults. However, this should not pose a serious problem. There are indications that the number of returns submitted by people under the age of 20 is approximately 10%; a reasonable share of this group is people aged 18 years or older and frequently their incomes are low. Altering the minimum ages in the household surveys would most likely change the level of inequality but not its behavior[43]. The DIRPF includes people living abroad, but we were unable to identify these taxpayers, and they seem to be too few to pose a major problem for our study.

To obtain population totals, we used projections of the resident population aged 18 years or older, according to the 2013 revision of the IBGE's official projections. The populations from the sample surveys are those obtained in the microdata of the surveys themselves, which are different from the estimates in the projections, although they remain very close. The total differences between the two are less than 2% for all years.

Results

Stability of inequality

Inequality in Brazil is very high and stable. The richest 1% of the adult population receives more than a quarter of the country's entire income. Almost half of all of the country's income accrues to the top 5%. The concentration is such that one thousandth of the population captures more income than the poorest half of the population together. Except for a slight decline over the six years analyzed, these levels of concentration are virtually the same between 2006 and 2012. There is no clear trend indicating that there has been a change in inequality over time. The Gini coefficients from 2006, 2009 and 2012 are 0.696, 0.698 and 0.688, respectively, and thus reflect a small increase followed by decline. Its variation over the period, however, is only 1%.

These levels are greater and more stable than those obtained by studies based solely on data from household surveys and on the PNAD in particular. To all appearances, the PNAD underestimates the top incomes and, in doing so, does not fully portray the behavior of total inequality. The PNAD indicates a persistent fall in inequality from 2006 to 2011[50], which is only interrupted in 2012. When incomes at the top of the distribution are adjusted using the tax data, the persistent decline in inequality ceases. Clearly, this must be analyzed in still greater detail, preferably using complementary information from previous periods.

However, analyses that do not depend on combining data sources reinforce these results. The ratio between the income of the richest 1% (measured by tax data) and GDP, for example, indicates a large and stable concentration of income, with a slight upward trend, from 2006 to 2012. The ratio between the income shares of the richest 1% and the top 5%, which does not depend on the GDP calculation, also suggests high concentration and stability[43].

Actually, there were previous indications of some of these results in other household surveys;

some of these findings could even be observed through a more detailed analysis of the trends at the top of the income distribution in the PNAD itself. The Census Subsample Survey (which have always shown a greater ability to collect information on high incomes)already indicated a slower decline in inequality in several different distributions, including that of per capita household income[21]. In the PNAD, the top 1% of the distribution had also been showing more resistance to the decline in inequality than the lower income classes. This has not gone unnoticed: the risk that underestimation is affecting the behavior of inequality was already listed as a qualification in what was one of the first studies on the decline in Brazil's inequality[16]. Data from income tax returns, instead of simply confirming these trends, has the advantage of allowing them to be evaluated more accurately.

However, these results should be interpreted with caution. For one, it is possible that our calculations underestimate real inequality. The Pareto function used in the interpolations may underestimate the incomes at the very top[47], and our data do not include income appropriated indirectly by individuals through legal entities, such as companies. If there is underestimation, the trend in inequality over time may fluctuate in uncertain directions. In addition, we identified an increased number of tax filers and a high growth of total reported incomes in the DIRPF, much higher than the growth of incomes reported in the PNAD. This is discussed below. We still have no evidence to refute this growth of tax filers and incomes. Yet, if there is some type of bias or error in the data that we have been unable to identify, it is possible that the general trend of inequality changes from stability to a slight decline over the years, as we may infer by observing the different growth rates. It also must be acknowledged that the PNAD and the DIRPF do not measure exactly the same income concepts, which may introduce some type of bias in the conclusions. On these three points, unfortunately, we have no way to make a more precise evaluation.

Shares of accumulated income

Graph 1 presents the shares of income accumulated by each population fraction in a Lorenz curve. This figure shows, across the entire distribution, the high concentration of incomes and the stability of inequality. The shape of the curves indicates high levels of concentration. The stability of inequality, in turn, is indicated by the

lack of significant variation in these shapes over the years.

The poorest half of the adult population, for example, does not even accumulate 10% of all of the country's income. In part, this occurs because there is a large number of people with zero income at the bottom of the curve – a group comprised of the unemployed, the elderly without retirement income, students and others who do not participate in the labor market, do not receive social protection nor have other sources income. The income accumulated by 90% of the population – income that up to this point is obtained from the PNAD – accounts for approximately 40% of total income. Most of the country's income – now measured using tax data – is concentrated in the top 10% of incomes. Almost half of the income accrues to the top 5% of incomes, a third to the top 2% of incomes, a quarter to the 1% at the top and a fifth by the very top 0.5%; in 2012, this group totaled 700 thousand in a population of 140 million adults.

The stability of the country's inequality across the entire distribution is shown in the constant shape of the Lorenz curves between 2006 and 2012. In fact, they all intersect at some point on the distribution – i.e., there is no Lorenz dominance – and it is therefore impossible to
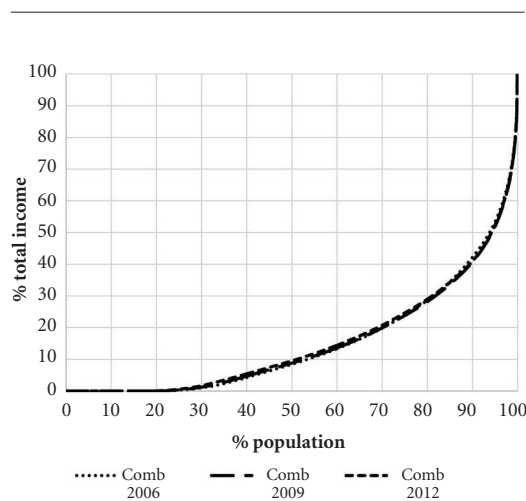
Graph 1. Lorenz curve of individual income, combined distributions, Brazil, 2006-2012.

Source: From 0% to 90% of the population, PNAD 2006-2012 IBGE, microdata. From 90% to 100% of the population, interpolation of data fromthe Annual Personal Income Tax Return, 2006-2012.

unequivocally determine which year has a higher level of inequality. Although it is possible to compare inequality by using indices that summarize the distributions, the behavior of inequality will vary depending on the index selected. The most cautious interpretation is thus that the general pattern is of stability. A safer interpretation of trends would be possible if the series included results for the period prior to 2006.

For example, the areas of the Lorenz curves measured by the aforementioned Gini coefficients (0.696, 0.698 and 0.688) indicate no change, with a minimal increase in inequality between 2006 and 2009 and a minimal decline between 2009 and 2012. Other measures of inequality indicate different fluctuations. The ratio between the income accumulated by the richest 1% and the poorest 50%, for example, varies with a distinct trend, falling from 8.8 in 2006 to 8.3 in 2009 and falling again to 7.8 in 2012. Much of this decline is the result of an 11% increase in the share of income accruing to the poorest 50%, rising from 8.5% to 8.8% and rising again to 9.5%. Part of this increase's effect on total inequality was offsetby a growth of the share appropriated between the population's top 50% and 80% incomes. Combining the upward and downward trends, inequality remained generally stable.

Signs of this stability had previously been observed in household surveys. Beginning in 2006, the 1% invariably earned approximately 13% of total income in the PNAD, with small fluctuations. This figure rises to 16% in the POF and 19% in the Census, which is something closer to what we obtain in the DIRPF. These signs were ignored, however, because of the prevailing interpretation that there was a systematic decline in inequality. Most of the research about the trends of inequality in Brazil did not take into account the fact that the household surveys' underestimation might be biasing the results, even after a series of studies in other countries indicated that this bias should not be overlooked[22-38,51].

Income levels

To determine the differences in the country's absolute income levels, Graphs 2 and 3 present the Pen's parades (quantile curves) of the combined PNAD and DIRPF distributions between 2006 and 2012. Figure 3 reproduces only a section of the curves, to make viewing easier. All of the values have been adjusted to June 2014 by the Consumer Price Index (Índice Nacional de Preços ao Consumidor - INPC).

Graph 2 shows a distribution profile that is already familiar. Brazil is marked by a large mass of low-income population that is distinguished from a small and very rich elite. There is, obviously, inequality among the poorest as well as among the elite, but there is little doubt whatsoever that Brazil is defined by a highly polarized society. Graph 2 does present some new information: the differences between top incomes and the remaining incomes are even more extreme than that shown by the household survey data.

The social differences are so great that the scale necessary to represent them causes the curves in Graph 2 to overlap completely. Graph 3 thus shows only one part of the distribution: the section representing the group that begins at 80% of the population and ends when annual income reaches 100,000 reais, which occurs at approximately at the 98% quantile of the distribution. The values above 98% (i.e., the top 2% of incomes) are so high that it is more convenient to present them in tables.

Graph 3 shows that the income at 85% of the population is just over 20,000 reais annually, in June 2014 values. At the 90th percentile, annual income remains well below 40,000 reais in 2006, but grows to almost this amount in 2012. Above the 90th percentile, i.e., the section in which the
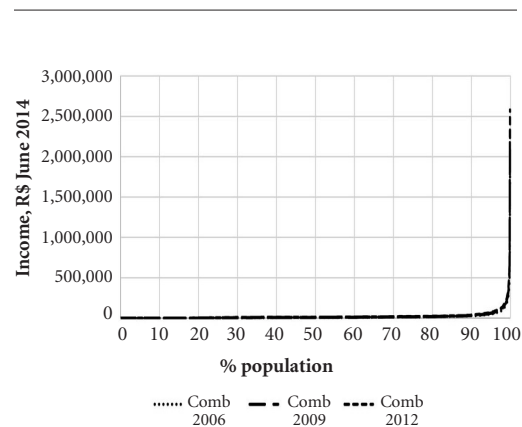
Graph 2. Pen's parade of individual income, 0% to 100% of the population, combined distributions, Brazil, 2006-2012.

Source: From 0% to 90% of the population, PNAD 2006-2012 IBGE, microdata. From 90% to 100% of the population, interpolation of data from the Annual Personal Income Tax Return, 2006-2012.

data comes from the DIRPF, the absolute differences begin to grow rapidly. Although the exact shape of the curve from that point on is determined by Pareto interpolation, it is important to remember that a number of intermediate points, from 90% to 100%, were actually observed for distribution levels as high as 98.4%. Most of these observed points are easily identifiable in the small jumps of discontinuity presented by the curves.

It is also clear that there is real income growth from 2006 to 2012. By the spread of the curves, it may be inferred that the mass of income at the top follows a relatively stable pattern of expansion from 2006 to 2009 and between 2009 and 2012, i.e., absolute growth at the top was about the same during both time intervals.

Due to income growth, the thresholds for the income fractiles of the population vary over time. In 2012, those earning over 226,938 reais annually, in June 2014 values, would belong to the richest 1% of the population, as measured by interpolated DIRPF data but close to the observed data. In 2006, this cutoff was 169,593 reais, as Table 1 shows. Variations are observed throughout the entire distribution. The top 5% income threshold, for example, rises from approximately 50,900 reais to 60,551 reais and 70,256 reais in the years 2006, 2009 and 2012, respectively. Me-

dian incomes increased from about 7,236 in 2006 to 9,661 in 2012.

Appropriated growth

There was real income growth during this period, and we are interested in knowing who benefitted from it. Table 2 thus present show much of the total growth was appropriated by each segment of the Brazilian population. We measure cumulative growth, i.e., the accumulated fraction of total growth captured by different population groups from 2006 to 2009 in one column and the same fraction between 2006 and 2012 in the other.

The gains from income growth during the period between 2006 and 2009 were unequal. Most of the increase in income accrued to a small fraction of the population, which is due to the country's extreme income concentration. The poorest half of the population appropriated only 12% of the entire growth from 2006 to 2012. By contrast, the top 5% of incomes got half of the total growth, and the top 1% captured 28%, i.e., each person belonging to the small elite of the richest 1% of the population appropriated a fraction of income growth that was 117 times higher than the people in the poorest half of the country.

The fraction of growth captured by the lower income population slowly increased between 2009 and 2012. A deconcentration of growth has taken place, but this deconcentration was rela-
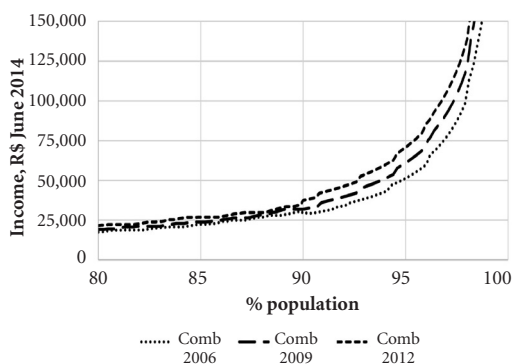
Graph 3. Pen's parade of individual income, 80% to 98% of the population, combined distributions, Brazil, 2006-2012.

Source: From 0% to 90% of the population, PNAD 2006-2012 IBGE, microdata. From 90% to 100% of the population, interpolation of data from the Annual Personal Income Tax Return, 2006-2012.

Table 1. Thresholds for the income fractiles for total individual income, Brazil, 2006-2012.

P% Population 18+	2006	2009	2012
50.0%	7,236	8,197	9,661
75.0%	14,472	15,903	18,073
80.0%	17,574	19,084	21,457
90.0%	29,000	31,757	37,744
95.0%	50,945	60,551	70,256
99.0%	169,593	201,180	226,938
99.9%	703,699	855,183	974,182

Note: constant values for June 2014, deflated by the INPC

Source: From 0% to 90% of the population, PNAD 2006-2012 IBGE, microdata. From 90% to 100% of the population, interpolation of data from the Annual Personal Income Tax Return, 2006-2012.

tively small. Finally, it cannot be forgotten that, at least in the short run, higher income growth rates for the very poorest income strata do not necessarily have strong impacts on total inequality, due to the very low income share of this group. For inequality, calculating the growth of poorer classes is less important than knowing the share of total growth captured by these classes.

Alternative distributions

Merging point

The distribution of total income was obtained by combining data from the PNAD and the DIRPF. To undertake this combination, it was necessary to determine a merging point for the two databases, i.e., a threshold below which the distribution would be represented by the PNAD data and above which it would be represented by the DIRPF data. The point utilized was the 90th percentile; thus, the DIRPF represents only the country's top 10% of incomes. Because changes in the merging point alter the distribution, we analyze the extent to which these changes alter the study's main results.

Graph 4 shows the section of the Pen's parade (quantile curve) for the distribution of total income among adults that goes from the 75th percentile to the top of the distribution in both data sources in 2012. Incomes are expressed in constant June 2014 reais, using the INPC as a deflator. In the DIRPF distribution, the 25 million returns are ordered from highest to lowest income,

part of which has its exact values determined by interpolation within the ranges of tabulated data. These returns correspond to 19% of the population. Incomes were not imputed to the remaining 81%.

In 2012, income tax returns were mandatory for those with annual incomes over R$ 27,443 (2014 values), which is equivalent to the 87th percentile in the 2012 DIRPF distribution. The mandatory limit for each year is located close to the same point of the distribution: 87% in 2006 (R$ 23,306) and 86% in 2009 (R$ 22,814). Because there are also other mandatory criteria, in addition to the possibility of voluntarily submitting a return, there are individuals with annual incomes below these limits. Although they find themselves ordered in the upper part of the distribution, it is quite possible that their actual position corresponds to sections representing the poorest parts of the population.

Up to the 85th percentile, the PNAD values are higher than the DIRPF values. In the section from 85th to the 90th, the two distributions are similar; therefore, it makes little difference to lower the merging point of the two data sources to 85%, and it makes no sense to bring it down below this point. From the 91th percentile onward, they begin to diverge, and this divergence increases as one moves up the distribution. We

Table 2. Accumulated share of total growth appropriated by population groups, Brazil, 2006-2012.

P% Population 18+	2006 – 2009	2006 a 2012
50%	10%	12%
75%	23%	26%
90%	34%	38%
95%	46%	50%
99%	69%	72%
100%	100%	100%

Note: constant values for June 2014, deflated by the INPC

Source: From 0% to 90% of the population, PNAD 2006-2012 IBGE, microdata. From 90% to 100% of the population, interpolation of data from the Annual Personal Income Tax Return, 2006-2012.
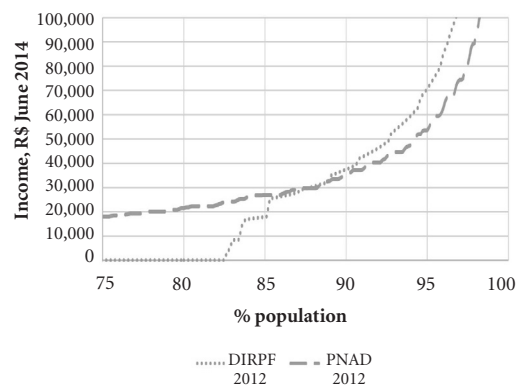
Graph 4. Pen's parade of individual income by data source, 75% to 100% of the population, Brazil, 2008-9 to 2012.

Source: PNAD 2012 IBGE, microdata. Interpolationof data from the Annual Personal Income Tax Return, 2012.

chose to place the merging point at the 90th percentile, i.e., immediately before the data source divergence becomes more important.

Changing the merging point would not substantially alter the general trends. Of course, when the merging point becomes very high, the DIRPF comes to account fora much smaller part of the distribution and inequality thus comes to reflect that measured in the PNAD. Because the DIRPF contains higher incomes, giving the PNAD predominance in the distribution, i.e., raising the merging point, reduces the mean, inequality and income growth over the years, as Table 3 shows.

When the merging point is the 90th percentile, i.e., when incomes above the last percentile of the PNAD are substituted by the DIRPF, inequality remains high, the appropriation of growth results remains concentrated, and the trend of the Gini coefficient over time shows a decline of approximately 3% in the six years that are the subject of our analysis. However, other inequality measures do not indicate an increase in inequality because the Lorenz curves intersect. The fact that 2012 is the year in which the decline in inequality in the PNAD is interrupted should not be ignored. Because there is no Lorenz dominance during the period, it is prudent to posit that even in this case, there is no guarantee that inequality will continue declining. This pattern shows that top incomes determine a large part of the level and behavior of inequality in Brazil. Thus, the top of the distribution is central to understanding inequality in Brazil.

The bottom of the distribution

An alternative way of constructing the distribution of income in Brazil would be to combine the DIRPF data with sources other than the PNAD. Therefore, it is worth evaluating the implications of changing the manner in which the bottom end of the distribution is determined. This evaluation can be undertaken by comparing the PNAD to two other Brazilian household surveys: the Consumption and Expenditure Survey (Pesquisa de Orçamentos Familiares - POF) and the Census Subsample Survey.

These surveys present several differences. The first is the sample size. The PNAD sample is approximately twice as large as the POF sample (over 100,000 versus more than 50,000 households), and the Census is many times this difference (6 million households in 2010). The second difference involves the sample design, which causes the PNAD to tend to favor larger municipalities. The third difference is the detail of the

Table 3. Appropriation of growth, with different merging points, selected measures, Brazil 2006 – 2012.

Measure	2006	2009	2012
Merge quantile	**0.900**	**0.900**	**0.900**
Growth approp. 50%	-	0.102	0.116
Growth approp. 99%	-	0.688	0.720
Gini	0.696	0.698	0.688
Average income	16,814	19,607	22,536
Merge quantile	**0.850**	**0.850**	**0.850**
Growth approp. 50%	-	0.101	0.114
Growth approp. 99%	-	0.691	0.724
Gini	0.696	0.698	0.688
Average income	16,664	19,507	22,513
Merge quantile	**0.950**	**0.950**	**0.950**
Growth approp. 50%	-	0.109	0.123
Growth approp. 99%	-	0.668	0.703
Gini	0.696	0.696	0.685
Average income	16,864	19,430	22,156
Merge quantile	**0.900**	**0.900**	**0.900**
Growth approp. 50%	-	0.132	0.144
Growth approp. 99%	-	0.597	0.651
Gini	0.688	0.681	0.666
Average income	16,358	18,345	20,674

Note: Income growth up to the reference quantile since 2006, all values constantin June 2014 reais, deflated by the INPC.

Source: From 0% to 90% of the population, PNAD 2006-2012 IBGE, microdata. From 90% to 100% of the population, interpolation of data from the Annual Personal Income Tax Returns, 2006-2012.

questionnaire, which is much more complete in the POF, followed by the PNAD and then by the Census. The fourth is how the collected data are treated, including error detection and imputations of missing data. All these differences may affect income distribution, mainly because of the highly concentrated nature of income in the country. The inclusion (or lack thereof) of complete incomes from very few individuals can thus disproportionately affect the levels and behavior of inequality.

Souza[21] analyzes different aspects of Brazilian household surveys, creates a comparison methodology and arrives at the following conclusions:

a) The PNAD has incomplete coverage at the top of the distribution due to its smaller sample size and non-responses. The Census, with larger samples, has better coverage capacity, which can be observed in both the 2000 Census and the 2010 Census. The income share of the top 1% in the Census is almost twice as large as that in the PNAD, and they also have absolute incomes

that are 25% to 50% higher; in the top 0.1%, the difference is even greater, between approximately 100% and 150% more. One consequence is a lower level of inequality recorded in the PNAD, in addition to top incomes having less of an influence on the behavior of the distribution. In the center of the distribution, the two data sources are similar.

b) The PNAD and the Census capture income with a similar degree of detail, limited to income "usually received" in a reference month. The POF presents a much higher degree of detail and a reference period of one year, which allows for more types of income to be collected, including the 13th monthly salary (bonus), inheritances and proceeds from asset sales. The mean levels of income in the POF are much higher than in the PNAD, but the inequality levels are relatively close. The PNAD and the Census, both underestimate incomes. We will see below that this underestimation occurs mostly at the top of the distribution rather than at the bottom.

c) In the PNAD, there is an artificially high proportion of individuals with ignored income (or non-responses), and these individuals tend to be among the top incomes. In the 2010 Census, there is an even greater proportion of people with no income, and all signs indicate that this is an error: zero income was simply the mechanism used by census takers to record ignored income. The Census thus underestimates the bottom of the distribution more than the PNAD.

For our purposes, what matters is the bottom of the distributions. Souza's[21] conclusions suggest that the PNAD records the highest incomes at the bottom, when compared with other household surveys – although for different reasons. This comparison can be observed in Graph 5, which shows the level of income, in June 2014 reais, received by different shares of the adult population. In the year of the 2010 Census, there was no PNAD. To enable a comparison that takes into account changes occurring in the distribution, we generated an interpolated 2010 PNAD, resulting from the mean of the distribution points from the 2009 and 2011 PNAD.

As a general trend, the PNAD records higher incomes for all years in the poorest half of the population and virtually the same level and behavior as the other household surveys from the 50th up to the 80th percentile. Graph 5 truncates the distribution at the 80th percentile, but up to the 95th percentile, the curves remain very close. It is only after this point that the 2010 Census and the 2008-9 POF begin to have markedly higher

levels than those of the equivalent PNAD for each year, where the difference clearly accentuated within the richest 1%. Consequently, merging the DIRPF and the PNAD tend to generate the lowest levels of inequality among the possible alternatives available.

Furthermore, considering that inequality declines faster in the PNAD than in the Census, our method also generates distributions that should be more likely reveal a decline in inequality over the years. Therefore, the stability of inequality that we identified between 2006 and 2012 would almost certainly also be observed if the comparisons were based on combining the DIRPF with the Census or with the POF.

The PNAD may underestimate incomes at the bottom, at least hypothetically, which may partially result from the not recording certain types of income. However, there is no clear evidence that this underestimation amounts to a high share of total income. For total inequality, the amount of income underestimated matters more than the number of underestimated cases. If the underestimated share of income is not large, our overall results remain the same, even when underestimation occurs in many cases.

However, if total underestimated income is high, our study – and almost all Brazilian studies on inequality to date – may be compromised, be-
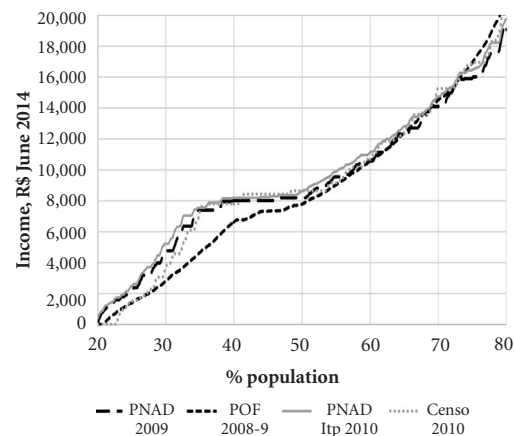
Graph 5. Pen's parade of individual income by data source, 20% to 80% of the population, Brazil, 2008-9 to 2012.

Source: 2009 PNAD and 2012 PNAD, 2010 Census and 2008-9 POF, IBGE, microdata.

cause the PNAD clearly underestimates incomes at the top. If it also greatly underestimates incomes at the bottom, studies are using data that do not adequately represent the country. The discussion regarding inequality in the near future should not focus on its level, evolution and causes; it should instead be about how to correctly observe it for the first time. Needless to say, it would also undermine studies of a particular type of inequality, i.e., the difference between the poor and the rest, as well as many of our policy evaluations. The truth, however, is that the evidence points in the opposite direction, i.e., that the PNAD captures income at the bottom of the distribution reasonably well, except for small problems that, for our study, are only of minor importance[21].

The PNAD income is markedly lower than its equivalent in the national accounts, and this difference has been growing over the years. Following the methodology of Medeiros et al.[43], we calculated the gross monetary income of families in the Annual National Accounts (Renda Monetária Bruta das Famílias nas Contas Nacionais Anuais – RMBF-CNA) and also estimated the RMBF in the trimestral national accounts for 2012. In the definitions of the national accounts, the RMBF shows the income that is closest to the annualized PNAD. The ratio between PNAD income and the monetary income of families has been decreasing, from 76% in 2006 to 74% in 2009 and to 72% in 2012.

However, when the PNAD is combined with the DIRPF, this underestimation is drastically reduced and its evolution changes direction. The PNAD and DIRPF combination adds up to 91% of the monetary income of families in 2006, 95% in 2009 and 97% in 2012. In practice, this indicates a lack of underestimation that warrants more attention after the databases are combined – and particularly after 2009 –unless our underestimation of the concentration at the very top of the distribution is too high or if the Brazilian national accounts are wrong.

In other words, the difference between the PNAD and the national accounts, which suggests a possible underestimation of almost a quarter of the income, is worsening, and it appears that this increase has been caused by changes at the top of the distribution. It is therefore possible that part of the accelerated decline in inequality measured by the PNAD results from underestimating growth among top incomes.

Of course, depending on where the 9% difference in 2006 is located, the inequality over the years might be increasing (unlikely) or declining (most likely) in relation to our calculations. However, because we do not know how to determine whether this difference is actually an underestimation of the PNAD-DIRPF, an overestimation of the RMBF or simply an error resulting from our methodology, we prefer to merely mention its existence and make qualifications regarding its implications.

Accelerated growth

There was rapid income growth according to the income tax data in the 2006-2012 period compared with GDP or PNAD growth. Compared to 2006, income in the DIRPF increased 25% by 2009 and 52% by 2012. Using the same deflators (INPC/Consumer Price Index – CPI from September),to avoid deviations caused by the price index, GDP grows 17% and 33%, respectively, and PNAD income grows between 14% and 34%.

To examine this phenomenon in more detail, the table below shows year-to-year income growth in the DIRPF, the PNAD and the National Accounts. There is also an increase in the number of DIRPF tax filers, but given the magnitude of the differences, we cannot exclude that it is possible that part of the income growth captured by the DIRPF may be associated with some type of bias or error that we were unable to identify. We have no concrete evidence of this bias, but if it exists, it might be influencing the behavior of inequality over time, and the trend of inequality might be slightly declining, although it is nonetheless likely to be less accelerated than what the household surveys estimate.

We have no evidence that this growth indicates an error, particularly because we do not have data prior to 2006 to determine the extent to which this year is a suitable base for comparison. Bearing in mind that, between 2006 and 2009, GDP grows more rapidly than the income measured in the PNAD, most of the DIRPF's high-income growth is likely to be real. In absolute terms, the amount of income from the DIRPF's income growth differential in relation to GDP is compatible with GDP growth in periods following 2008.

Conclusion

Income inequality in Brazil remained very high and stable between 2006 and 2012.When the

PNAD and the DIRPF are combined, nearly half of the country's income accrues to the top 5%, and over a quarter goes to in the top 1%. The richest thousandth concentrate more income than the entire poorest half of the population. This reflects a distributive profile that is already acknowledged in the literature: Brazil is marked by a large low-income population that is distinguished from a small, but very rich, elite.

This profile does not change significantly over time. There are changes among the bottom 90%, but the concentration at the top is quite stable, particularly above the 99th percentile. The Lorenz curves representing this inequality in each year intersect and almost overlap. Certain measures indicate a slight increase in inequality in time, others a slight decline, but the overall trend is characterized by stability.

Income has grown over the years, but the appropriation of this growth has been unequal. Only about a tenth of all of the growth accrued to country's bottom half. Half of the growth was captured by the top 5% of incomes, and, within this group, 28% by the top 1%. On the one hand, this is due to the country's extreme concentration of income; on the other hand, it perpetuates itself over time. There has been a mild deconcentration of growth, but it has been slow.

These results contradict those analyses of inequality based only on the PNAD. We do not know what occurred between 2001 and 2005, the period during which the inequality of per capita household income measured by the PNAD was declining, partly because of reductions in income at top of the distribution, but this subject certain-

ly deserves further research. The same applies for the late 1990s, when income inequality in the labor market began to decline.

Our analysis of the distribution of total income among adults in 2006, 2009 and 2012 is undertaken by combining data from the PNAD, which represents the poorest 90% of the population, with data from the DIRPF for the top 10% of incomes. The merging points of the two distributions may be altered within certain limits, but the general trends observed would not change substantially, which reveals that the concentration in the top incomes determines a very large part of the level and behavior of inequality in Brazil.

When the merging point is raised to a very high cutoff, such that the DIRPF provides data only for the top 1% and the PNAD accounts for the rest of the population, the Gini coefficient shows a similar declining trajectory as in the PNAD (as can be reasonably be expected). However, other measures of inequality indicate stability, as the Lorenz curves intersect. Most importantly, this suggests that it is not only the extremely rich who are influencing the dynamics of inequality. For obvious reasons, even higher merging points would result in the PNAD having more importance in the dynamics of inequality.

It is possible that our calculations underestimate Brazil's levels of inequality. The interpolation methodology we used for the DIRPF data may underestimate incomes at the very top, and although our data include various incomes received by "pessoas jurídicas", that is, companies and other legal entities, part of these incomes is not reported in the DIRPF, although these incomes invariably accrue to specific individuals. It is less likely that the annualized PNAD are significantly underestimating incomes for the poorest bottom of the distribution, to the point of affecting our main results. However, we are unable to speculate how wrong our estimates might be. It is only important to note that our calculations consistently generate the lowest levels of inequality among the possible combinations of databases. The stability of inequality between 2006 and 2012 would most likely remain the same if the DIRPF was combined with the Census or the POF.

Combining databases has inherent risks and thus requires caution in interpreting our results. The DIRPF measures incomes that the PNAD was not designed to measure and this is a source of bias. Perhaps this characteristic may not be important at the bottom of the distribution, as the incomes from the POF, which has a more refined collection instrument, are lower than those

Table 4. Total income growth rate, 2006 base, Brazil.

Year	DIRPF	GDP	PNAD
2006	1.00	1.00	1.00
2007	1.03	1.07	1.03
2008	1.23	1.14	1.10
2009	1.25	1.17	1.14
2010	1.37	1.30	n.a.
2011	1.47	1.33	1.22
2012	1.52	1.33	1.34

Note: Real income growth since 2006, all values deflated by the INPC. There was no PNAD in 2010. 2006 = 1

Source: PNAD 2006-2012, IBGE, microdata. Annual Personal Income Tax Return, 2006-2012. RFB, special tabulations. System of National Accounts, IBGE, annual from 2006 to 2009, trimestral from 2010 to 2012.

from the annualized PNAD through the first half of the distribution and are nearly equal to those in the PNAD until almost the top 10% of incomes. The bias is likely to be due to differences at the top. Caution should therefore be a constant when interpreting our results.

In addition to the fact that the concentration of income in the country is very high, it is clear that it is extremely important to understand what makes the top incomes capture such a large share of the income. Although this is not the focus of this study, there is no doubt that top incomes should be treated as a priority issue on the inequality research agenda.

Finally, the potential consequences of our results for research on the effects of inequality cannot be ignored. As the concentration of income is higher than the already high concentration that was measured in Brazil in the household surveys, it is important to begin to assess the implications this has for our public health, education and labor policies, for example, as well as the implications of this inequality for the creation of public funds to finance policies and programs under the tax system. Although this latter topic is not within the scope of our study, it seems important to emphasize the subject for future research.

Collaborations

M Medeiros, PHGF Souza and FA Castro participated equally in all stages of preparation of the article.

Aknowledgments

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