INCREASING THE STATE'S REDISTRIBUTIVE ROLE IN A HIGHLY UNEQUAL COUNTRY: EVIDENCE FROM BRAZIL IN THE EARLY 21ST CENTURY

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The CEQ logo is a stylized graphical representation of a Lorenz curve for a fairly unequal distribution of income (the bottom part of the C, below the diagonal) and a concentration curve for a very progressive transfer (the top part of the C).

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ABSTRACT

This study examines the rise in the social spending in a highly unequal country, focusing on the Brazilian case. We analyze the impact of the Brazilian State's redistributive role on inequality and poverty levels, and its trajectory during the early 21st century. For this purpose, we compute the standard decomposition of Gini and the marginal effects of the cash transfers, taxes, and in-kind benefits on inequality. Furthermore, the paper introduces an innovation in the literature by applying the Lerman–Yitzhaki progressivity index, with considerable advantages over the mostly used Kakwani index. Our primary findings are: (i) the Brazilian tax system remains regressive overall, characterized by heavily regressive indirect taxes and slightly progressive direct taxes; however, (ii) the expansion of social spending during this period has introduced substantial progressive gains, leading to an (iii) increase in the State's redistributive role and a net reduction in the final income Gini index by 15.9%. We conclude that further progress towards a more progressive tax system could be achieved by reducing the burden of indirect taxes and increasing taxation on the wealthiest individuals.

JEL Codes: D31, H22; I3

Keywords: fiscal incidence; cash transfers; taxation; in-kind benefits; income inequality; poverty.

Increasing the State's Redistributive Role in a Highly Unequal Country: Evidence from Brazil in the Early 21st Century[1]

Fernando Gaiger Silveira[2] and Theo Ribas Palomo[3]

Abstract

This study examines the rise in the social spending in a highly unequal country, focusing on the Brazilian case. We analyze the impact of the Brazilian State's redistributive role on inequality and poverty levels, and its trajectory during the early 21st century. For this purpose, we compute the standard decomposition of Gini and the marginal effects of the cash transfers, taxes, and in-kind benefits on inequality. Furthermore, the paper introduces an innovation in the literature by applying the Lerman–Yitzhaki progressivity index, with considerable advantages over the mostly used Kakwani index. Our primary findings are: (i) the Brazilian tax system remains regressive overall, characterized by heavily regressive indirect taxes and slightly progressive direct taxes; however, (ii) the expansion of social spending during this period has introduced substantial progressive gains, leading to an (iii) increase in the State's redistributive role and a net reduction in the final income Gini index by 15.9%. We conclude that further progress towards a more progressive tax system could be achieved by reducing the burden of indirect taxes and increasing taxation on the wealthiest individuals.

1. Introduction

This study assesses the increase of the State's redistributive role in a highly unequal country. The motivation for evaluating the impacts of increased social spending on income redistribution stems from evidence in the economic literature. This body of work suggests that inequality negatively impacts economic growth through various channels, including heightened sociopolitical instability and distrust in institutions (Alesina and Perotti, 1996; Keefer and Knack, 2002), underinvestment in human capital (Galor and Zeira, 1993; Galor and Moav, 2004), and support for inefficient state organization (Acemoglu, Ticchi and Vindigni, 2011). Consequently, redistributive policies that lower levels of inequality could potentially foster faster and more sustainable growth in the long run (Cingano, 2014; Halter, Oechslin and Zweimüller, 2014; Berg et al, 2018).

Understanding how the States impact the inequality levels is, therefore, a critical issue. From a comparative perspective, fiscal incidence studies suggest that public transfers contribute more to reducing the Gini index in Latin America than taxes do (Goñi, López and Servés, 2011; Ocampo and Malagón, 2013; Lustig, Pessino and Scott, 2014; Hanni, Martner Fanta and Podestá, 2015; Lustig, 2016), particularly in Brazil (Silveira, 2012; Souza and Medeiros, 2013; Higgins and Pereira, 2014; Higgins et al., 2016). Furthermore, when juxtaposed with Latin American countries, Western European nations are found to engage more in redistributive policies (Goñi, López and Servés, 2011).

Despite its economic significance and political influence in Latin America, Brazil presents a compelling case study due to its high levels of inequality. The top 1% of the population concentrates 28.3% of the income, marking Brazil as one of the world's most unequal countries (UDNP, 2020). As an upper-middle-income country, this figure implies that a small population fraction has average income levels similar to (or even higher than) top-income earners in high-income countries, [4] while a significant portion faces food insecurity and poverty. [5] This explains why Brazil's high inequality is considered unfair by a large portion of its population. [6]

Throughout much of the 20th century, inequality levels in Brazil either remained relatively constant or increased (Alvaredo and Gasparini, 2015; Souza, 2016). However, this trend shifted from the 1990s onwards, particularly in the first decade of the 21st century, which saw a significant reduction in inequality (Barros et al., 2006; Hoffmann, 2006a; Foguel and Azevedo, 2007; Gasparini et al., 2011). The primary factors driving this change were government transfers (Barros et al., 2006; Hoffmann, 2006b) and transformations in the labor market. The latter were largely due to improvements in the Brazilian educational system (Barros, Franco and Mendonça, 2007; Menezes-Filho, Fernandes and Pichetti, 2007) and an increase in the minimum wage (Firpo and Reis, 2007; Niklas and Moser, 2022). However, more recent studies focusing on income concentration at the top suggest a minimal decrease (Morgan, 2017) or even relative stability (Medeiros, Souza and Castro, 2015; Souza, 2016) in inequality in the 21st century.

The present study analyzes contributes to the literature by analyzing the Brazilian State's redistributive role on inequality and poverty, and its evolution in the first decades of the 21st century. Our results points to significant changes and persistence in the period. On the one hand, the Brazilian tax system as a whole remains regressive. Indirect taxes are heavily regressive and contributed to an increase of 3.9% in the Gini index between 2002/03 and 2017/18, offsetting the 2.1% decrease in inequality from the slightly progressive incidence of direct taxes. On the other hand, the expansion of social spending via cash transfers, public education, and public health contributed to sizeable net progressive gains, reflected in a 15.9% reduction in the final income Gini index in the

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[4] Morgan (2017) shows that the top 1% in Brazil have higher average incomes than the same group in France.

[5] 36.7% of the Brazilian families reported some degree of food insecurity in the Consumer Expenditure Survey (POF) 2017/18.

[6] According to the survey *Nós e as Desigualdades* 2021, carried out by Oxfam in partnership with the Datafolha institute, 86% say that the country's progress is conditional on reducing inequality between rich and poor, and 84% defend taxation of the richest to ensure health, housing, and education.

period. As a result, social expenditures have more than compensated for the overall regressiveness of the tax system, indicating a strengthening of the State's redistributive role in Brazil. This has resulted in a considerable reduction in inequality, positioning Brazil as a reference case in Latin America in the early 21st century.

The remainder of this paper is structured as follows: Section 2 outlines the data sources and evaluation methods used in this study. Section 3 details the current role of each cash transfer, tax, and in-kind benefit on inequality, their impact on the poverty and extreme poverty headcounts, and identifies potential areas for improvement. Section 4 analyzes the evolution of the redistributive role of the Brazilian State in the beginning of the 21st century, highlighting changes and persistence observed in the period. Finally, Section 5 offers concluding remarks.

2. Data and Methods

2.1. Data

The data used in this study come from the three most recent waves of the Consumer Expenditure Survey (POF), from 2002/03, 2008/09, and 2017/18, which is better suited to this measurement exercise than the other national surveys usually adopted in the literature. [7] The primary objective of these surveys is to gather information on the composition of various income sources and expenditures of Brazilian households. This data is crucial for updating the consumption basket that serves as a reference for price indexes and for assessing the living conditions of the population. Moreover, the survey's sample design is structured to yield results that are representative at the national level, for rural areas in major regions, for urban areas in states, and for metropolitan regions.

Regarding cash transfers, the POF provides the most comprehensive source of microdata for households. Starting with the POF 2008/09, it became possible to distinguish between the two primary contributory social security pension systems: the general system, which is mandatory for all formal workers in the private sector (*Regime Geral de Previdência Social*, or RGPS), and the system for public servants (*Regime Próprio de Previdência Social*, or RPPS). From now on these transfers will be called private sector and public sector public pensions, respectively.

The POF identifies government transfers aimed at social assistance, worker protection, and research promotion. The first group includes a non-contributory pension aimed at the elderly or disabled individuals with low income (*Benefício de Prestação Continuada*, or BPC); income transfer programs for the poorest populations, the largest of which is the conditional cash transfer *Bolsa Família*; and other forms of public aid, including assistance for accident and illness and destined to food, transportation, fuel, and more. The worker protection category includes unemployment insurance, while the

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[7] Most studies pointing to a reduction in inequality in the country use the Brazilian National Household Sample Surveys (PNADs) as their main data source. However, PNAD has limited information on non-labor income and tax expenditures, and uses the previous month as the reference period. In this sense, POFs capture household income in much more detail and with a reference period of the previous 12 months.

research promotion category encompasses higher education grants and scholarships from federal funding agencies.

The survey also allows us to distinguish direct taxes on property, such as the real estate tax (*Imposto Predial e Territorial Urbano*, or IPTU) and the vehicle tax (*Imposto Sobre Propriedade de Veículo Automotor*, or IPVA), as well as taxes on income, such as the social security contributions, the personal income tax (*Imposto de Renda da Pessoa Física*, IRPF), other deductions, and other direct taxes. The later group include taxes on financial operations and union contributions, for example. Furthermore, the other deductions can be split into two categories: those related to labor income and non-related to labor income, such as deductions from pensions and aid.

Unfortunately, indirect taxes cannot be directly discerned using household survey data. To overcome this limitation, we apply indirect tax rates to the monetary expenditures on goods and services that we observe in the POF, assuming that the tax burden is entirely on the consumers. For 2002/03 and 2008/09, we adopted the rates estimated by Silveira (2012), applying the legal rates of each Brazilian states on POF products.[8] Using a different methodology, Siqueira, Nogueira and Souza (2010) calculate the effective rates through an input-output matrix and argue that the results concerning the distribution of the global indirect tax burden are very similar to that from Silveira (2012).[9] The rates used for the POF 2017/18 were those estimated by Silveira et al. (2022), also applying an input-output matrix framework.

Lastly, we incorporate in-kind benefits, specifically expenditures on public education and health. Given our aim to evaluate the redistributive role of the Brazilian State and identify the beneficiaries of these expenditures, both services are assessed in terms of government costs. For public education, the total values published by the research agency of the Ministry of Education (*Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira*, or Inep) are allocated to public students at the preschool, elementary school, high school, and higher education levels. These estimates are derived from administrative sources of government educational expenditures at the municipal, state, and federal levels.

Estimates concerning public health, which is free of charge and universal according to the Brazilian 1988 Constitution, come from two different sources. Initially, for the POFs 2002/03 and 2008/09, we used the health supplement of the National Household Sample Survey (PNAD), carried out in 2003 and 2008, to obtain information about access and use of services and health goods, such as vaccines, medicines, hospital admissions, outpatient procedures, among others. This questionnaire later became an independent household survey, the National Survey on Health (PNS), carried out in 2013

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[8] For a recent application of this method for Brazil, see Lara Ibarra, Rubião and Fleury (2021).

[9] As Siqueira et al. (2017) argue, the estimates by Silveira (2012), based on the legal rates, and those by Siqueira, Nogueira and Souza (2010), using an input-output matrix, are largely similar in terms of the global indirect tax burden distribution. Differences could arise only when the incidence is separated into groups of family expenses or indirect taxes. However, as the present study focuses on the global indirect tax burden and not on its composition, these possible differences should not affect our estimates.

and 2019. Thus, for the POF 2017/18, we use the data of PNS 2019. Additionally, we also rely on administrative records of health expenditures in different categories from Brazil's System of Health Accounts (SHA) and, for previous POFs, from the System on Public Health Budgets (SIOPS) and other administrative records of the Ministry of Health. By associating these two types of sources, it was possible to measure in-kind public health expenditures made by families and associate them with the POF, considering the heterogeneity of these expenditures across the country's various geographic regions.

2.2 Methods: income stages, the decomposition of the Gini index, and marginal effects

The distributive impacts of different types of cash transfers, taxes, and in-kind benefits on household income are assessed using the usual income concentration indicators: the Gini index, the concentration coefficients, and the decomposition of the Gini index by income source.

For this analysis, we adopt five income stages. The first one, named **market income**, consists of the income earned on the labor market, plus rents, sales, donations, alimony, and gains from savings and financial markets. In other words, all the income earned by households before adding benefits or deducting taxes. By adding public cash transfers – such as public pensions and higher education grants - we obtain the **gross income**. By deducting direct taxes from the gross income, it becomes **disposable income**, and by subtracting indirect taxes from disposable income we obtain the **post-tax income**. Lastly, the **final income** is defined as the sum of the market income with all net benefits and taxes, including the in-kind benefits (i.e., public education and health). These income stages can either be measured in monetary terms or in total terms, with the latter including the so called by POF of non-monetary income, mainly composed by the imputed rent for owner-occupied housing. From now on, non-monetary income will be called imputed rent.

There is a debate in the literature on whether pensions should be classified as market income, with the argument that they are deferred income, or as a governmental transfer. However, some features of the Brazilian public pension system make the latter definition preferred over the former. First, Social Security contributions are mandatory for all formal workers in the country, but the benefit's value is not deterministically linked to the contribution's value. This difference is even greater when we consider exceptional cases, such as public pensions for rural workers, with lower contributions and retirement age. Furthermore, although most of the elderly population in the country receives pensions, less than half of the working-age population contributes to social security. [10] In fact, the Brazilian pensions system has an intergenerational character, running a deficit of almost 5% of the GDP in 2020, financed by taxes and public debt and, thus, by governmental transfers. For these reasons, the present study allocates public pensions as

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[10] According to the PNADC 2021, 64% of the working population, or 40% of the working-age population, is affiliated with social security. However, 83% of the elderly in Brazil receive a pension. It is also important to note that the minimum value of pensions is linked to the country's minimum age, which has considerably increased in real terms, especially in the last two decades.

cash transfers, as done by Gõni, López and Servén (2011), but we also present results classifying pensions as market income in the Appendix B.

As a starting point, we estimate the Gini index for each of these different definitions of income and compare the results. However, it is important to note that changes in the inequality index between these different income stages result from two components: the degree of progressivity or regressivity of the income source weighted by its share in the final income, and the reordering that such interventions cause in the income rank of households. Due to this second component, the before-and-after analysis lacks robustness, as the overall effects of these policies depend on the order in which they are applied in the income stages, as highlighted by Lerman and Yitzhaki (1995). Another difficulty is that this analysis ignores behavioral effects.

A way to overcome these problems is to measure the impact of a marginal increase in an income source on inequality, as developed by Lerman and Yitzhaki (1985). Rather than grasping the impact on inequality from the elimination of a tax or a benefit, as intended by the before and after analysis, this method gives the marginal effects of an income source's proportional changes on inequality. Considering that most changes in fiscal systems occur through reforms, the marginal effects analysis addresses an important issue in terms of public policy and has the advantage of being independent of the order that the income sources enter in the stages, thus eliminating the reranking problems (see Appendix A for a formal derivation of the Gini decomposition and the marginal effects).

Finally, we use the progressivity measure from Hoffmann (2013), as presented in the equation below. This measure, named the Lerman–Yitzhaki progressivity index, is the difference between the final income's Gini index (G) and the concentration coefficient of the h_{th} income source (C_h), multiplied by the sign of its share in final income (φ_h). Therefore, a benefit is progressive ($\Pi_h > 0$) when the Gini is greater than the concentration coefficient ($G > C_h$) and regressive ($\Pi_h < 0$) when it is less than it. For taxes, as their sign in the final income is negative, the analysis is reversed: a tax is progressive when the concentration coefficient is greater than the Gini ($G < C_h$) and regressive when it is less than it. Formally:

$$\Pi_h = [sign(\varphi_h)](G \ - \ C_h) \tag{1}$$

The Lerman-Yitzhaki progressivity index differs from the Kakwani index, which is widely applied in the literature (*e.g.,* Cabrera, Lustig and Morán, 2015; Higgins, Lustig and Rublins, 2016; Lustig, 2016). For the former, the Gini and the concentration coefficients are defined in terms of the final income, while for the latter, it is defined in terms of market income. This implies, as argued in Hoffmann (2013), that the Kakwani index is associated with the marginal effect of the "initial" dollars of the benefit or tax, and the Lerman-Yitzhaki index is associated with their "last" dollars. Also, Hoffmann (2013) demonstrates that under some circumstances, the Kakwani index leads to inaccurate results regarding a source's progressivity. Thus, considering this previous problem and our interest in the marginal effect of the last dollars, the Lerman-Yitzhaki index is preferred.

3. The Brazilian State's redistributive role: current panorama

3.1 Cash transfers

In this section, we provide an overview of the Brazilian State's current role in redistribution, drawing on the most recent data from the POF 2017/18. Starting with the cash transfers, Graph 1 shows the composition of the gross income by deciles. Notably, the regressive nature of public sector public pensions (RPPS) becomes evident. As we move towards the top income bracket, the proportion of income derived from these benefits increases significantly, reaching 9% of total income for the top 10%. This can be largely attributed to the absence of a benefit cap for public servants, coupled with the generous rules governing benefit calculations and the provision of additional extraordinary components.

Figure 1
Composition of the gross income per capita by deciles. Brazil, 2017/18.
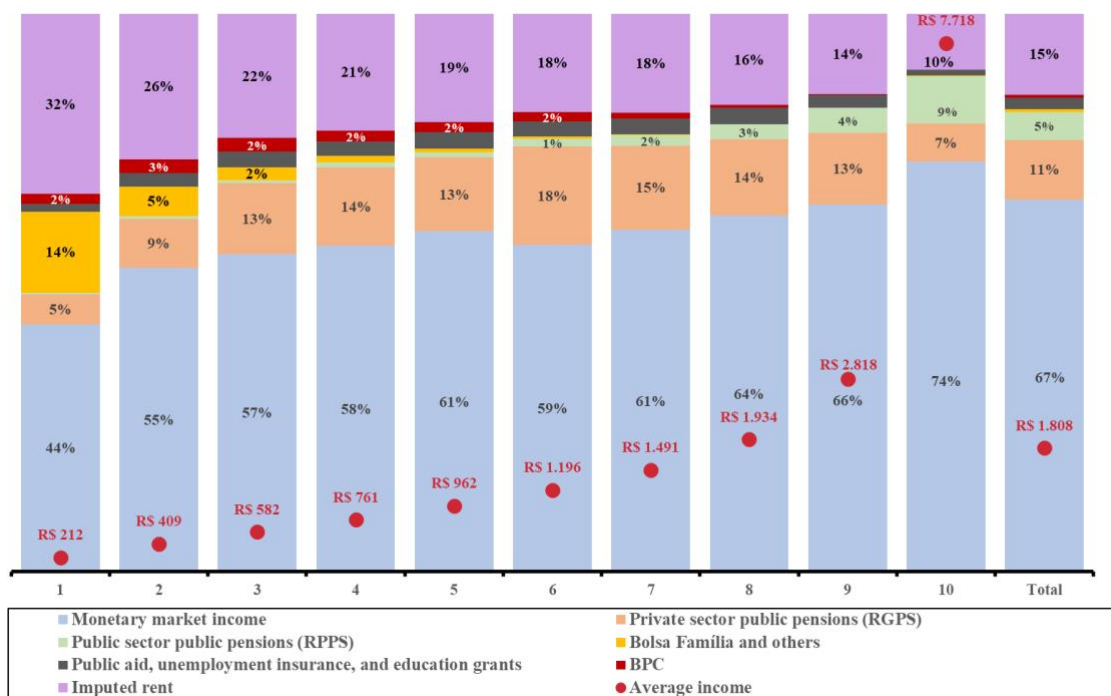
Source: own elaboration based on POF 2017/18 microdata (IBGE).

The private sector public pensions (RGPS), on the other hand, exhibit a different pattern. These contributory benefits are closely tied to earnings in the labor market, which accounts for their relatively low significance for the poorest and their higher participation among middle-income groups. As households at the lower strata face high rates of informality, unemployment, and job instability, they are less likely to fulfill the minimum contribution period required for retirement in this system. This same rationale can be applied to understand the distribution of public assistance and unemployment insurance.

The group composed mainly by the *Bolsa Família* plays a great progressive role here. This component corresponds to 14% of the gross income in the bottom 10%, a share

that decreases monotonically in the other deciles.[11] Another notable progressive transfer is the non-contributory pensions (BPC), representing approximately 2% of gross income up to the sixth income decile, and declining in the subsequent ones.

Turning our attention to the Gini index, we observe a decrease in income inequality following cash transfers. As shown in Table 1, the Gini index for monetary income declines by 11.3%, from 0.640 to 0.567, when public cash transfers are included alongside market income. However, when considering total income, the impact is somewhat attenuated due to the redistributive effect of imputed rent, which notably benefits the poor. In this context, the reduction in the Gini index is 7.3%, declining from 0.577 to 0.535.

Table 1
Gini Index, extreme poverty and poverty headcounts, and the top 10% income share of household income per capita, by income stages. Brazil, 2017/18.

Income levels		Gini	Extreme poverty headcount* (%)	Poverty headcount* (%)	Share top 10% (%)
Monetary	Market	0.640	19.5	38.8	50.2
	Gross	0.567	5.7	23.1	45.2
	Disposable	0.557	6.1	24.7	44.1
	Post-tax	0.586	10.7	32.3	46.2
	Final	0.473	1.0	8.4	39.8
Total	Market	0.577	6.8	26.0	45.8
	Gross	0.535	1.9	14.8	42.7
	Disposable	0.523	2.1	15.8	41.6
	Post-tax	0.541	4.2	21.3	42.8
	Final	0.451	0.3	3.6	37.9

Source: own elaboration based on POF 2017/18 microdata (IBGE) for cash transfers and direct taxes; Silveira et al. (2022) for indirect taxes; Inep for public education expenses; PNS and SHA for public health expenses.
*Extreme poverty and poverty are measured using the World Bank poverty lines of US$1.90 PPC and US$5.50 PPC per day, respectively.

Table 1 also highlights the impact of cash transfers on poverty reduction and the share of income appropriated by the top 10%. With regards to monetary income, we observe a significant decrease in extreme poverty and poverty headcounts by 13.8 p.p. and 15.7 p.p., respectively. Additionally, the share of income held by the top 10% experiences a reduction of 5 p.p. Notably, we find that the substantial decrease in inequality in the final monetary income, compared to inequality in the initial monetary market income, is primarily attributable to the redistributive effects of public health and education, followed by public cash transfers.

For a more detailed examination, Table 2 provides a breakdown of the Gini index for final income based on different income sources. When it comes to benefits, the lower the

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[11] Despite its acknowledged significance in economic literature (e.g., Glewwe and Kassouf, 2012; De Brauw et al., 2015), the *Bolsa Família* program was phased out in 2021 and replaced by a temporary program, the *Auxílio Brasil* transfer. Although the new program offers higher benefits and broader coverage than its predecessor, critics have questioned its long-term sustainability and pointed out shortcomings, such as a disregard for the size and characteristics of families (e.g., Paiva et al., 2021). In 2023, the *Bolsa Família* program was reinstated, retaining its conditionalities but with increased value.

concentration coefficient, the greater its progressivity. Income sources for benefits are categorized as regressive, neutral, progressive, and progressive pro-poor. Regressive transfers, such as monetary market income, public sector public pensions (RPPS), and higher education grants, have concentration coefficients that exceed the Gini index, resulting in negative Lerman-Yitzhaki indices. Neutral transfers have concentration coefficients that are equal to or very close to the Gini index, with a progressivity index close to zero. On the other hand, progressive benefits exhibit positive Lerman-Yitzhaki indices, indicating that their concentration coefficients are lower than the Gini index. If these progressivity rates are negative, the income sources are referred to as progressive pro-poor. It is worth noting that even though many transfers have relatively high concentration rates, they can still be considered progressive when high levels of income concentration are observed.

Table 2
Decomposition of final income Gini Index, Concentration coefficients, and Marginal effects by income source. Brazil, 2017/18.

Components of total final income	Concentration coefficients	% in final income	Lerman–Yitzhaki index	Marginal effects
Monetary Market income	0.558	71.3	-0.107	0.078
Imputed rent	0.379	15.5	0.072	-0.011
Cash transfers				
RGPS	0.440	11.5	0.011	-0.001
RPPS	0.816	5.3	-0.365	0.020
Bolsa família and others	-0.440	0.5	0.891	-0.005
Public aid	0.388	1.8	0.063	-0.001
BPC	-0.065	0.6	0.516	-0.003
Higher education grants	0.624	0.1	-0.173	0.000
Unemployment insurance	0.198	0.2	0.253	-0.000
Taxes				
Social security contributions	0.531	-3.1	0.080	-0.003
Personal Income Tax (IRPF)	0.831	-2.4	0.380	-0.009
Other labor income deductions	0.731	-0.1	0.280	-0.000
Other non-labor income deductions	0.741	-1.2	0.290	-0.003
Real estate tax (IPTU)	0.520	-0.7	0.069	0.000
Vehicle tax (IPVA)	0.329	-1.3	-0.122	0.002
Other direct taxes	0.532	-0.1	0.081	0.000
Indirect taxes	0.359	-12.0	-0.092	0.011
Public education and health				
Preschool	-0.227	1.0	0.678	-0.006
Elementary school	-0.235	3.9	0.686	-0.027
High school	-0.087	1.5	0.538	-0.008
Higher education	0.632	1.6	-0.181	0,003
Medical appointment	-0.108	3.9	0.559	-0.022
Hospitalization	-0.134	1.7	0.585	-0.010
Medication and others	-0.076	0.3	0.527	-0.002
Total final income	0.451	100.0		

Source: own elaboration based on POF 2017/18 microdata (IBGE) for cash transfers and direct taxes; Silveira et al. (2022) for indirect taxes; Inep for public education expenses; PNS and SHA for public health expenses.

When cash transfers are arranged in order of progressiveness, we find that the private sector public pensions (*RGPS*) exhibit the least progressiveness and can be categorized as neutral. They are followed by public aid, imputed rent, and unemployment insurance. The BPC and *Bolsa Família* programs are considered progressive pro-poor transfers, with the latter being the most progressive income source, with a Lerman-Yitzhaki index of 0.891. Combined, these programs account for 1.1% of the final income and contribute to a reduction of 0.6% in the Gini index. In contrast, public sector public pensions (*RPPS*) represent 5.3% of the final income but have a regressive effect on inequality, as indicated by their negative progressivity index. As for the RGPS, its progressivity index is close to zero, indicating a neutral effect on inequality.

Additionally, Table 2 presents the estimated changes in inequality resulting from marginal increases in each income component, employing a methodology that avoids the reranking problem. The marginal effects are influenced by two key factors: the progressivity of the income source and its weight in the final income. This explains why the two primary sources of income, namely monetary market income and imputed rent, exhibit significant absolute marginal effects.

Among the transfers, public sector public pensions are associated with the highest marginal increase in inequality, while the *Bolsa Família* makes the largest contribution to reducing inequality. Although both BPC and *Bolsa Família* are highly progressive, their marginal effect on inequality is somewhat diminished due to their relatively lower weight in the overall household income. Consequently, increasing the value of these programs could further harness their potential for reducing inequality.

3.2 Direct and indirect taxes

We now turn our attention to the redistributive role of the Brazilian State in terms of the tax system. Figure 2 illustrates the distribution of direct and indirect taxes across different total income strata. Our findings indicate that direct taxation has a limited progressive effect, with an incidence of 3.1% for the bottom 10% and 10.6% for the top 10%. Conversely, indirect taxation demonstrates the opposite pattern, with an incidence that decreases from 21.2% to 10.2% between the same income groups. In aggregate, the progressiveness of direct taxes falls short of compensating for the regressive impact of indirect taxes. Consequently, the total tax burden is 5.9 percentage points higher for the bottom 10% compared to the top 10%.

The analysis of direct taxes composition reveals that certain taxes disproportionately affect specific segments of the population. In the bottom 10%, property taxes such as the vehicle tax (IPVA) and real estate tax (IPTU) account for 41% and 19%, respectively, of the total direct taxes paid. In contrast, for the top 10%, these proportions are significantly lower at 9% and 7% respectively.

The Personal Income Tax (IRPF) stands out for its significant incidence on the wealthiest individuals. This tax is predominantly paid by the top 10%, contributing to 79.9% of the total revenue generated. This pattern can be attributed to the distribution of

income in Brazil, where households in the intermediate strata typically have total earnings below the exemption limit. Consequently, the collection of IRPF becomes concentrated in the higher income strata. However, as demonstrated by Gobetti and Orair (2016), this progressivity considerably decreases at the top of the pyramid due to tax exemptions, deductions for private expenditures, and the non-taxation of dividends.

Direct taxes exhibit a modest redistributive effect, as shown by a 2.1% reduction in the Gini index, from 0.535 to 0.523. Further, focusing on the monetary income yields a Gini reduction from 0.567 to 0.557, a -1.9% change in relative terms (Table 1). However, this comes with a slight increase in both extreme poverty and poverty headcounts, by 0.4 p.p. and 1.6 p.p. respectively, and a decrease in the top 10% income share by 1.1 p.p. These findings highlight the limited impact on inequality achieved through the primary redistributive tax instrument.

Indirect taxes present a contrasting picture, as they significantly elevate the Gini index between disposable and post-tax income — by 5.2% for monetary income and 3.4% for total income. In this scenario, the extreme poverty and poverty headcounts for monetary income increase more dramatically, by 4.6 p.p. and 7.6 p.p. respectively. Simultaneously, the income share held by the top 10% grows by 2.1 p.p. Given the pronounced inequality in Brazil, these results underscore the pronounced regressiveness of indirect taxes and necessitate reforms to diminish their weight on income.

Figure 2
Percentage share of direct and indirect taxes on total gross income per deciles.
Brazil, 2017/18.
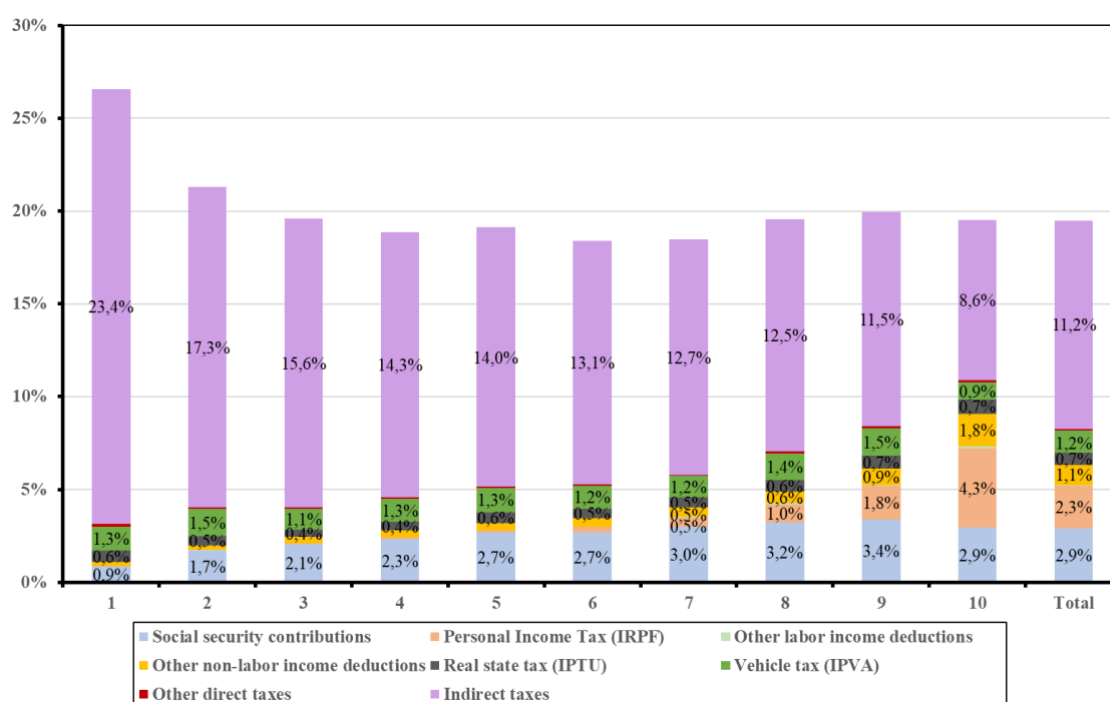
Source: own elaboration based on POF 2017/18 microdata (IBGE) for direct taxes, and Silveira et al. (2022) for indirect taxes.

To further elucidate the effect of each tax, we revisit Table 2. Notably different from our previous discussion, taxes here are treated as negative income sources, thus progressive taxes are those with a proportionally greater incidence on the wealthiest. Consequently, the higher the concentration rate relative to the Gini index, the more progressive the tax, with its final effect depending on its weight on income.

The Personal Income Tax (IRPF) emerges as the most progressive tax due to its concentration coefficient and a Lerman-Yitzhaki index of 0.380. The incidence of the IRPF, primarily borne by the top 10%, validates its progressive nature. However, its relatively low weight of -2.5% on final income diminishes its redistributive impact, despite it having the highest marginal effect on inequality reduction among cash transfers and taxes. Hence, an increased IRPF for the richest presents a considerable opportunity to reduce Brazilian inequality. The current system allows for progressive reforms, such as increasing the maximum marginal tax rate from 27.5% (compared to 35% in Mexico, Argentina, and Chile) and ending exemptions on profits, dividends, and deductions for private health and education, which mainly benefit the wealthiest.[12]

Moreover, the concentration coefficients for property taxes are notably low, which renders the Vehicle Tax (IPVA) regressive, while the Real Estate Tax (IPTU) is progressive. This outcome is particularly concerning given that wealth inequality typically surpasses income inequality, suggesting these taxes should exhibit greater progressivity. As for IPTU, its progressivity could be enhanced by regularly updating property value plans to match market values, applying progressive rates, [13] and limiting exemptions to low-value properties in under-resourced locations.

For the social security contributions, we observe a concentration coefficient very close to the one for market income. This behavior reflects, as seen in the case of RGPS pensions, the close relationship between social security contributions and the labor market. The formal workers in Brazil contribute to social security, and, in return, they receive these public pensions after retiring.

The final impact of direct taxes on inequality is mitigated as they comprise less than 10% of the final income. Additionally, the great regressiveness of the indirect taxes leads to the characteristic of the Brazilian tax system of increasing inequality. With one of the lowest concentration coefficients for taxes and a significant weight on income at -12.0%, indirect taxes result in a marginal effect of 0.011, denoting an inequality increase stemming from a marginal rise in such taxes.

3.3 In-kind benefits: public education and health

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[12] It is important to highlight that reforms in the Personal Income Tax should be accompanied by changes in the Corporate Income Tax to harmonize the system and guarantee the principles of equity. See Orair, Palomo and Carvalho (2022) for a more detailed analysis regarding the Income Tax in Brazil and a reform proposition in these lines.

[13] The implementation of progressive rates based on property value and location was authorized by Constitutional Amendment No. 29/00 in 2000.

In this subsection, we assess the changes induced in the last stage of income by including public expenditures on education and health into the post-tax income. Table 3 depicts the distribution of these components across income deciles, revealing the significant redistributive role of public expenditures.

Regarding educational expenditures, the significant weight that public education carries for the poorest deciles stands out, representing 104.9% of the total income of the bottom 10%. This is attributed to two distinct factors. Firstly, the demographic composition of each income stratum plays a role; lower-income families have, on average, more children and young people than wealthier ones. For instance, individuals under 18 constitute 46% of the bottom 10%, while only making up 13% of the top 10%.

Table 3
Percentage share of public education and health on total gross income per deciles. Brazil, 2017/18.

Decile	Preschool	Elementary school	High school	Higher education	Medical appointment	Hospitalization	Medication and others	Total benefits
1	14,5%	70,1%	16,6%	3,7%	41,0%	20,2%	3,4%	169,5%
2	6,9%	29,5%	9,2%	2,6%	20,2%	9,3%	1,6%	79,2%
3	4,2%	17,3%	6,4%	2,6%	13,4%	6,1%	1,1%	51,1%
4	2,6%	10,2%	4,5%	2,2%	9,6%	4,3%	0,8%	34,2%
5	1,8%	6,8%	3,0%	2,6%	7,1%	3,1%	0,6%	25,0%
6	1,1%	4,2%	1,9%	2,0%	5,6%	2,5%	0,5%	17,9%
7	0,8%	2,7%	1,3%	1,8%	4,2%	1,8%	0,4%	13,0%
8	0,4%	1,6%	0,9%	1,8%	2,9%	1,2%	0,3%	9,2%
9	0,2%	0,6%	0,5%	1,6%	1,8%	0,7%	0,2%	5,5%
10	0,0%	0,1%	0,1%	0,8%	0,5%	0,2%	0,0%	1,8%
Total	0,9%	3,6%	1,4%	1,5%	3,7%	1,6%	0,3%	13,0%

Source: own elaboration based on POF 2017/18 microdata (IBGE), and Inep.

The other explanatory factor is related to access to public and private services. The public education network is responsible for most enrollments for the first three levels, with 72.7% of total preschool enrollment, 83.4% in elementary school, and 88.3% in high school. However, a significant shift towards private education is observed among the wealthier strata. In the lowest decile, only 2.5% of elementary and 1.6% of high school enrollments are in the private sector, compared to 80.9% and 65.9% respectively in the top decile. There is a marked discontinuity at the higher education level where private sector enrollment takes the lead, comprising 76.0% of total enrollments.

The share of the expenses in public health for the poorest is also pronounced, with the bottom 50% receiving 59.0% of total health expenses, while the top decile receives just 5.8%. The most significant component of this in-kind benefit are medical appointment expenses, constituting on average 65.6% of total health costs, followed by hospitalization at 28.7%.[14] This underscores the significance of Brazil's public and

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[14] Medical appointments encompass expenditure on outpatient curative care, vaccinations, and other tests; Hospitalization includes general admissions, rehabilitation, and surgeries; and Medications and others

universal health system, particularly for the less wealthy who cannot afford private health insurance. [15]

The transition from post-tax to final income results in a substantial reduction in inequality. The Gini index decreases by 19.3% for monetary income and 16.6% for total income (Table 1). Public education and health also notably influence poverty rates and income concentration at the top. The poverty headcount falls by 23.9 p.p. and the extreme poverty headcount by 9.7 p.p., while the share of the top 10% declines by 6.4 p.p. for monetary income.

Referencing Table 2 for the progressivity of in-kind benefits, we find that public health and preschool, elementary, and high school education expenditures are progressive pro-poor, as denoted by their negative concentration coefficients. Specifically, elementary education spending, with a Lerman-Yitzhaki index of 0.686, is the most progressive. This, along with its 3.9% share of income, leads to the largest marginal reduction in inequality among all income sources. In contrast, higher education spending is regressive, exhibiting a positive marginal effect on inequality. Despite recent advances from the adoption of affirmative action policies for public university admission, the richest population still benefits most from higher education spending in the country, which explain this regressive effect.

4. Changes and persistence at the beginning of the 21st century

This section analyzes how the redistributive role of the Brazilian State has changed in the first decades of the 21st century. Figure 3[16] shows the Gini index for each stage of total income across the last three surveys, namely, POFs 2002/03, 2008/09, and 2017/18. To begin with, the inequality of market income has decreased from 0.607 to 0.577 between 2002/03 and 2017/18. Notably, this represents a less drastic reduction in inequality compared to what other household surveys, such as the PNAD, suggest.

We observe one of the greatest differences over time in the gross income stage. The impact of the cash transfers, measured as the gap between gross and market income, have increased significantly in the period: they were associated with a 2.4% reduction of inequality in 2002/03, 5.1% in 2008/09, and 7.3% in 2017/18.

In contrast, direct taxation maintained its low impact on inequality, with an average Gini index reduction between gross and disposable income of approximately 2.1% across the surveys. Simultaneously, indirect taxation continued to be highly regressive, raising the Gini index between disposable and post-tax income by an average of 3.9%. These results underscore that, unlike transfers, Brazilian taxation experienced no major changes during this period.

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include expenses for medicines, patient transportation, and the related emergency allowances used for such transportation.

[15] In POF 2017/18 it is possible to observe that 79.9% of the families in the top 10% have private health insurance, while this proportion is only 6.8% for the bottom 10%.

[16] In Appendix B, we present the same Figure but with pensions classified as market income.

Considering the combined impact of cash transfers and taxes, the effect of indirect taxes in 2002/03 increased the Gini index to the same level as the market income, nullifying the progressive effect of cash transfers and direct taxes. However, this pattern did not persist in subsequent years. By 2008/09 and 2017/18, the inequality reduction attributed to cash transfers and direct taxes outweighed the concentrating effect of indirect taxes, leading to a lower Gini index for post-tax income compared to market income.

Figure 3

Evolution of the Gini Index by income stages. Brazil 2002/03, 2008/09, and 2017/18
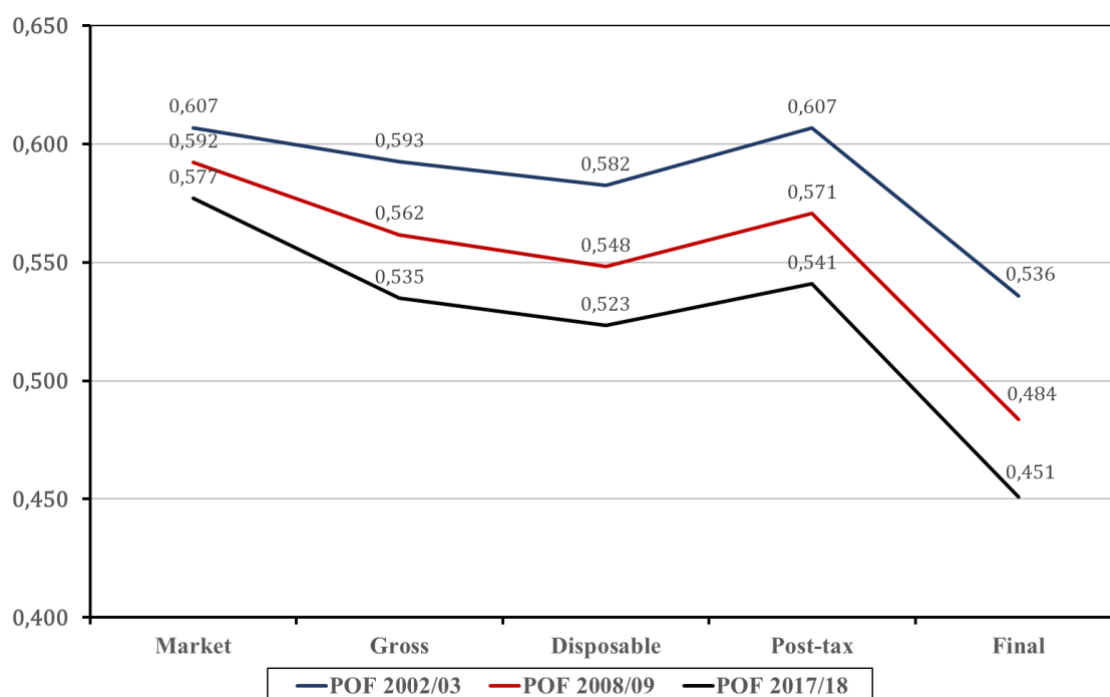
Source: own elaboration based on POFs 2002/03, 2008/09, and 2017/18 microdata for cash transfers and direct taxes; Silveira (2012) and Silveira et al. (2022) for indirect taxes; Inep for public education expenses; and PNS, SHA, SIOPS and other administrative records of the Ministry of Health for public health expenditures.

In addition to cash transfers, government spending on education and public health also changed significantly in the period. The difference between post-tax and final income shows that these in-kind benefits more than offset the regressiveness of the Brazilian tax system across all survey years. At a second-order level, their impact also significantly increased over time, leading to a reduction in the Gini index between post-tax and final income from 11.7% in 2002/03, to 15.3% in 2008/09, and further to 16.6% in 2017/18. Consequently, over the first two decades of the 21st century, Brazil experienced a significant decrease in inequality, with the final income Gini index falling by 15.9%.

When compared internationally, Brazil sees a more substantial reduction in inequality between market income and disposable income -- following the incidence of

cash transfers and direct taxes -- by 2.9 percentage points more than the average found in a sample of Latin American countries. [17] Goñi, López, and Servés (2011) also highlight that direct taxation plays a much larger role in mitigating inequality in Western European nations compared to Latin America. Furthermore, while indirect taxes are regressive in many Latin American countries, their impact is notably more significant in Brazil. [18]

As for public education and health expenditure, these systems reduce inequality in Brazil to a greater extent than in other Latin American countries. The reduction in the Gini index between post-tax and final income is greater by 1.4 percentage points compared to these countries. Nevertheless, even after accounting for transfers and taxes, Brazil still exhibits greater inequality: its market income Gini index exceeds the Latin American sample average by 14.4%, and its final income Gini index surpasses the average by 13.9%.

To better understand this period in Brazil, Table 4 shows the Gini decomposition of final income for the three surveys. Firstly, we see a reduction in the market income share in final income related to the relatively greater growth in cash transfer and in-kind benefits. Although market income remained a regressive component of final income throughout the period (as reflected by the Lerman-Yitzhaki index), its concentration coefficients have seen a decrease. Nonetheless, the decline in inequality in final income was relatively steeper compared to that of market income. Consequently, the regressive marginal effect of market income increased over the period.

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[17] This sample consists of Argentina (Del Valle et al., 2021), Bolivia (Yánes, Jimenez and Arauco, 2021), Chile (Martinez-Aguilar and Ortiz-Juarez, 2016), Colombia (Meléndez, Pabón and Peña-Tenjo, 2021), Ecuador (Llerena et al., 2014), Mexico (Scott, de la Rosa and Aranda, 2017), and Peru (Jaramillo, 2014). These are compared with the most recent data from Brazil, specifically from POF 2017/18.

[18] While the Brazilian tax burden was 32.6% of GDP for 2019, very close to the 33.4% observed for OECD countries, the average burden for Latin America is 22.9%. In addition, of the Brazilian burden, 46.6% refer to indirect taxes (Secretaria do Tesouro Nacional, 2021).

Table 4

Decomposition of final income Gini Index, Concentration Coefficients, Lerman–Yitzhaki index, and Marginal effects by income source. Brazil, 2002/03, 2008/09, and 2017/18.

Income, cash transfers, public taxes, education and health	% in final income			Concentration coefficients			Lerman–Yitzhaki index			Marginal effects		
	02/03	08/09	17/18	02/03	08/09	17/18	02/03	08/09	17/18	02/03	08/09	17/18
Total market income	100.0	91.8	86.9	0.578	0.550	0.527	-0.042	-0.066	-0.076	0.042	0.061	0.066
Cash transfers	13.2	17.8	20.2	0.555	0.526	0.494	-0.019	-0.042	-0.043	0.003	0.008	0.009
Direct taxes	-9.1	-9.4	-8.8	0.649	0.662	0.614	0.113	0.178	0.163	-0.010	-0.017	-0.014
Indirect taxes	-16.6	-14.8	-12.0	0.402	0.374	0.359	-0.134	-0.110	-0.092	0.022	0.016	0.011
Education	7.5	8.3	7.9	0.136	0.055	-0.033	0.400	0.429	0.484	-0.030	-0.036	-0.038
Health	4.9	6.2	5.8	0.001	-0.032	-0.114	0.535	0.516	0.565	-0.026	-0.032	-0.033
Total final income	100.0	100.0	100.0	0.536	0.484	0.451						

Source: own elaboration based on POFs 2002/03, 2008/09, and 2017/18 microdata for cash transfers and direct taxes; Silveira (2012) and Silveira et al. (2022) for indirect taxes; Inep for public education expenses; and PNS, SHA, SIOPS and other administrative records of the Ministry of Health for public health expenditures.

The increase in the share of cash transfers in final income is notable, rising from 13.2% to 20.2% between 2002/03 and 2017/18. This behavior can be explained in light of the faster increase in transfers than in income: while cash transfers increased by 188.8% in the period, market income only grew by 64.9%. Despite concentration coefficients declining over time, this reduction was less pronounced than the observed for the final income's Gini index. Therefore, cash transfers were neutral with respect to final income in 2002/03 and regressive in 2008/09 and 2017/18.

The primary regressive component of this group, as detailed earlier, is public sector public pensions (RPPS), accounting for 26.5% of total cash transfers for POF 2017/18. In the last decades, multiple reforms have been implemented to mitigate their

regressive effects, including unifying pension schemes, implementing stricter eligibility criteria, and introducing minimum retirement age requirements. However, the impact of these changes remains relatively minor thus far, as they only apply to new entrants into the system.

Private sector public pensions (RGPS), another crucial component, account for 57.0% of total cash transfers and are categorized as slightly progressive or neutral. It is important to note that these mainly contributory pensions are intrinsically linked to inequality in the Brazilian labor market. Consequently, the poorest are left out of this social protection system, as they are more susceptible to unemployment or undertake informal jobs. '

In this context, the regressive nature of cash transfers can be partially attributed to the RPPS. However, this factor alone does not sufficiently explain the observed increase in the regressiveness of cash transfers across the surveys. A further factor behind this counterintuitive behavior is precisely the other major changes occurred in the period. Notably, there were significant gains in the progressivity of in-kind benefits, which decreased the final income Gini coefficient to a greater extent than the reduction observed in the cash transfers' concentration coefficient, contributing to the increased regressiveness of cash transfers.

Taxation, on the other hand, has seen minimal changes over the years. The income share and marginal effects of direct taxes have remained relatively stable, contributing to a progressive effect on final income. Indirect taxes, however, have consistently exhibited high regressivity during the period, with concentration coefficients lower than the Gini index. Particularly, there has been a decrease in the final income share of these indirect taxes across the surveys, leading to a reduction in their regressive marginal effects on inequality.

This drop in income share can be understood in light of the nature of these taxes, which are largely levied on household consumption. As income rises, it is only partially accompanied by increases in consumption - between 2002/03 and 2017/18, income grew by 64.9%, while consumption grew by 47.5%. Consequently, the proportion of indirect taxes increased less than income. Therefore, the Brazilian tax system did not undergo major changes during this period and its capacity to mitigate inequality remains largely untapped.

Finally, the marginal effects of public education and health increased in absolute terms over the period, leading to a larger contribution to inequality reduction. The rise in education expenditures was slightly higher than the growth of income, resulting in a share of final income greater by 0.4 p.p. when comparing the first survey to the last. Additionally, there was a significant reduction in its concentration coefficient, shifting from being classified as progressive in 2002/03 and 2008/09, to progressive pro-poor in 2017/18.

Public health expenditures experienced a proportionately faster growth during the period, leading to a 0.9 p.p. increase between 2002/03 and 2017/18. Furthermore, their concentration coefficient turned negative from 2008/09 onwards, transitioning from progressive to progressive pro-poor. Consequently, the potential to reduce inequality

through marginal increases in public health expenditures is substantial, as evidenced by the absolute increase in marginal effects.

In summary, we observe changes and persistence in the redistributive role of the Brazilian State in the early 21st century. The country was neither able to unshackle itself from the institutional ties of a regressive tax system nor to exploit the potential of direct taxes for greater taxation on the richest. Despite these enduring issues, Brazil achieved a significant reduction in final income inequality, with a decrease of 15.9% between 2002/03 and 2017/18. This reduction positions Brazil as a benchmark among Latin American countries.

5. Conclusions and final considerations

The present paper contributes to the literature by examining the rise in the social spending in a highly unequal country, with a specific focus on Brazil. We analyze the redistributive role of the Brazilian state, its impact on inequality and poverty levels, and its evolution during the first decades of the 21st century. In line with existing literature, we employ the standard decomposition of the Gini index and the marginal effects of income sources on inequality. However, we also introduce an innovative approach by applying the Lerman–Yitzhaki progressivity index, which offers significant advantages over the widely used Kakwani index.

The paper is divided into two main parts. The first one provides a detailed evaluation of the current role of each cash transfer, tax, and in-kind benefit on inequality, their impact on the country's poverty levels, and potential areas for improvement. We underscore the regressiveness of indirect taxes and public sector public pensions (RPPS), contrasted with the high progressivity of the *Bolsa Família* program and the personal income tax (IRPF). However, the potential of the latter two components for reducing inequality is limited by their low final income share. Additionally, other significant progressive income sources include in-kind benefits, with particular emphasis on public spending on preschool and elementary school education. These expenditures contribute significantly to the largest reduction in poverty and extreme poverty headcounts in the country, by 23.9 percentage points and 9.7 percentage points, respectively.

In the second part, we delve into the changes and persistence in the Brazilian State's redistributive role during the early 21st century. The primary source of continuity is Brazil's regressive tax system. While direct taxation has remained moderately progressive, as evidenced by a drop in the Gini index between gross and disposable income of around 2.1% during the period, indirect taxation has persistently remained highly regressive. This is indicated by an average increase in the Gini index between disposable and post-taxation income of approximately 3.9%.

On the other hand, the expansion of social spending represented a major change in the period. While cash transfers reduced their concentration coefficient and increase their income share, in-kind benefits became more progressive and increased their participation in the final income leading to a Gini reduction between post-tax and final income from 11.7% in 2002/03 to 16.6% in 2017/18. In the aggregate, the changes

observed with the expansion and progressivity gains from social spending more than compensated for the persistence of the tax system's regressiveness in the period.

On the other hand, the expansion of social spending marked a major change during this period. Cash transfers not only reduced their concentration coefficient but also increased their income share. Meanwhile, in-kind benefits, playing a pivotal role in this transformation, became more progressive and expanded their contribution to final income. This led to a reduction in the Gini index between post-tax and final income from 11.7% in 2002/03 to 16.6% in 2017/18. In the aggregate, the changes observed in the expansion and progressivity gains from social spending more than offset the persistent regressiveness of the tax system during this period.

This led to an increase in the State's redistributive role and a reduction in the final income Gini index by 15.9%, positioning Brazil as a reference case among Latin American countries in the early 21st century. However, to continue on its path towards becoming a more equitable society, Brazil must liberate itself from the constraints of a regressive tax system. This could be achieved by reducing the burden of indirect taxes and increasing taxation on the wealthiest, who currently pay proportionately less taxes than the bottom 10% of the population.

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Appendix A

A.1   The decomposition of the Gini index

The Gini index can be decomposed by income source (Rao, 1969; Pyatt, Chen and Fei, 1980; Lerman and Yitzhaki, 1985). Considerer income x_i - after the benefit or tax, or more broadly *ex post* income - to be ordered in such a way that:

$$x_1 \leq x_2 \leq \ldots \leq x_n$$

So, the Gini index of this distribution can be calculated using the expression:

$$G_x = \frac{2}{n^2 \mu} \sum_{i=1}^{n} i \, x_i - \left(1 + \frac{1}{n}\right) \tag{2}$$

or

$$G_x = \frac{2}{n\mu} \text{cov}(i, x_i) \tag{3}$$

with $\mu = \frac{1}{n}\sum_{l=1}^{n} x_i$

It is assumed that income x_i is made up of k sources, considering taxes as negative sources:

$$x_i = \sum_{h=1}^{k} x_{hi} \tag{4}$$

The average of the h-th component is

$$\mu_h = \frac{1}{n}\sum_{i=1}^{n} x_{hi} \tag{5}$$

and the respective share in total income is

$$\varphi_h = \frac{\mu_h}{\mu} = \frac{\sum_{i=1}^{n} x_{hi}}{\sum_{i=1}^{n} x_i} \tag{6}$$

being, for the taxes, negative income shares.

By replacing (4) in (3), it is possible to obtain

$$G_x = \frac{2}{n\mu}\sum_{i=1}^{k} \text{cov}(i, x_{hi})$$

or

$$G_x = \frac{2}{n}\sum_{h=1}^{k} \varphi_h \frac{1}{\mu_h} \text{cov}(i, x_{hi}) \tag{7}$$

Similar to (3), the concentration coefficients of the h-th component can be defined as

$$C_h = \frac{2}{n\mu_h} \text{cov}(i, x_{hi}) = \frac{2}{n} \text{cov}\left(i, \frac{x_{hi}}{\mu_h}\right) \tag{8}$$

It should be kept in mind, as stated, that the concentration coefficients are defined based on the final income rank.

As a result of (7) and (8),

$$G_x = \sum_{h=1}^{k} \varphi_h C_h \tag{9}$$

As can be seen, the concentration coefficient is proportional to the covariance between the positions of order i and the relative rents μ_{hi}/μ_h. Thus, the concentration coefficient is not affected by the exchange of sign of the source since the relative rents will remain the same. It can be verified that

$$-1 + \frac{1}{n} \leq C_h \leq 1 - \frac{1}{n} \tag{10}$$

A.2   The marginal effects of cash transfers, taxes, and in-kind benefits on income inequality

Following Hoffmann (2013), let b be the benefit and t the tax and considering that x is the *ex post* income, the gross being for transfers and disposable for taxes. Therefore, the ratio between the value of the benefits and the value of the previous income – in this case, the market income – is

$$\beta = \frac{\Sigma \, b}{\Sigma \, (x - b)} \tag{11}$$

And the ratio between the value of taxes and the previous income – in this case, the gross income – is

$$\gamma = \frac{\Sigma \, t}{\Sigma \, (x + t)} \tag{12}$$

Remembering (9) $G_x = \sum_{h=1}^{k} \varphi_h C_h$, the Gini index of *ex post* rents (x) after granting benefits and taxation are, respectively:

$$G_x = \frac{1}{1 + \beta} C_{x-b} + \frac{\beta}{1 + \beta} C_b \tag{13}$$

$$G_x = \frac{1}{1 - \gamma} C_{x+t} - \frac{\gamma}{1 - \gamma} C_t \tag{14}$$

The following presentation uses the example of benefits, being similar in the case of taxes. Assuming a proportional change in the value of the benefits, the new value can be described as

$$b_d = \theta b \tag{15}$$

with $\theta = 1 + \delta$, where δ is positive and arbitrarily small, to the point that it does not cause the *ex post* rents to be reordered, which implies the concentration ratios C_{x-b} and C_b remain the same.

The new value of β is

$$\beta_D = \theta \beta \tag{16}$$

Thus, the new *ex post* income Gini index is

$$\frac{1}{1 + \theta \beta} C_{x-b} + \frac{\theta \beta}{1 + \theta \beta} C_b$$

And the G_x variation is

$$\Delta G_x = \left(\frac{1}{1 + \theta \beta} - \frac{1}{1 + \beta} \right) C_{x-b} + \left(\frac{\theta \beta}{1 + \theta \beta} - \frac{1}{1 + \beta} \right) C_b \tag{17}$$

After some algebraic manipulation, using (12), we obtain

$$\frac{\Delta G_x}{\theta - 1} = \frac{\Delta G_x}{\delta} = \frac{\beta}{1 + \theta \beta} (C_b - G_x) \tag{18}$$

Following Lerman and Yitzhaki (1985), it is possible to define the level of variation of the Gini index arising from the marginal increment as

$$\lim_{\delta \to 0} \frac{\Delta G_x}{\delta} = \frac{\beta}{1 + \beta} (C_b - G_x) \tag{19}$$

Based on (11):

$$\frac{\beta}{1+\beta} = \frac{\Sigma \, b}{\Sigma \, x} \tag{20}$$

Returning to the initial presentation of the section, regarding the decomposition of the Gini index, where it was seen that, when the final income x_i is formed by k

components – expression (4) –, the Gini index can be decomposed into k components - expression (9) -, which can be expressed as follows:
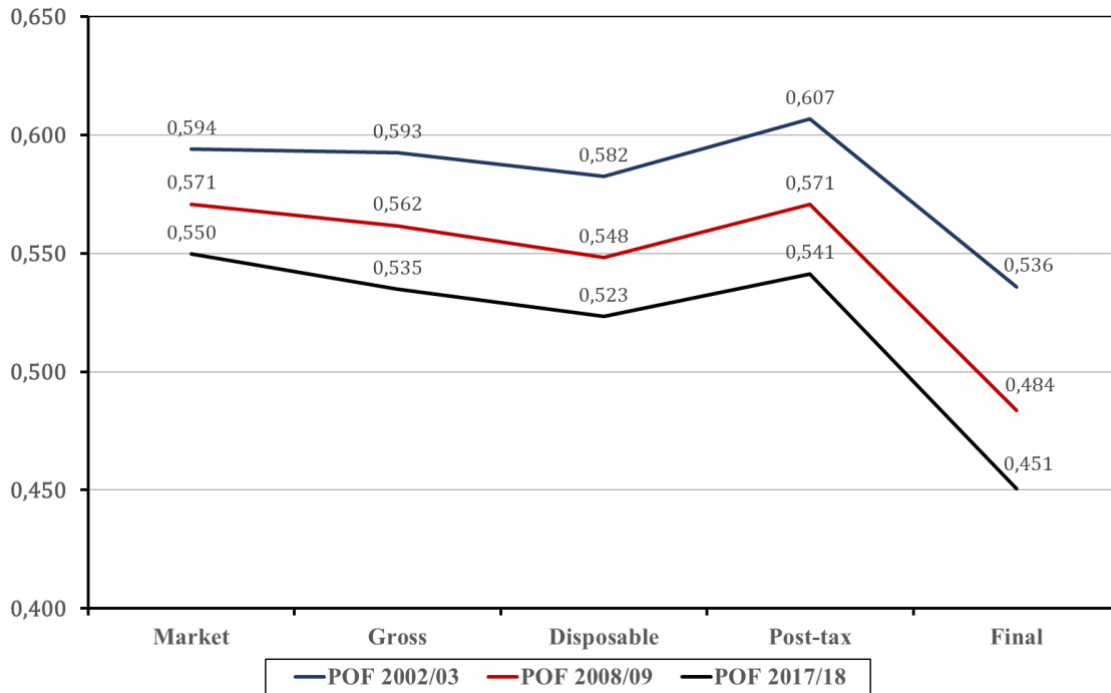
$$\sum_{h=1}^{h} \varphi_h (C_b - G_x) = 0 \tag{21}$$

As in (18), the intensity of the G_x variation resulting from a small proportional increase in the x_{hi} portion is given by $\varphi_h (C_h - G_x)$, summarizing the potential of each component to collaborate in changing inequality.

Appendix B

Figure B1

Evolution of the Gini Index by income stages, with pensions included in market income. Brazil 2002/03, 2008/09, and 2017/18

Source: own elaboration based on POFs 2002/03, 2008/09, and 2017/18 microdata for cash transfers and direct taxes; Silveira (2012) and Silveira et al. (2022) for indirect taxes; Inep for public education expenses; and PNS, SHA, SIOPS and other administrative records of the Ministry of Health for public health expenditures.