Base-Shifting and Higher Elasticity of Taxable Income at the Bottom: The Curious Case of Brazil

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Abstract

Elevated elasticities in low-income brackets can emerge in tax systems that incentivize shifting the tax base from personal to corporate income due to substantial differentials between personal and corporate income tax rates. We examine the Brazilian case, which exemplifies this significant differential, by estimating the elasticity of taxable income (ETI) using longitudinal data (2011-2017) from Brazilian personal income tax returns and calculating optimal taxation levels. We assess behavioral responses via the natural experiment of bracket creep, which refers to an implicit increase in marginal tax rates resulting from inflation. Our estimates indicate an income-weighted elasticity of 0.64 and 0.62 for taxable and gross income, respectively, and unweighted elasticities of 0.76 for taxable income and 0.71 for gross income. We observe substantially higher income-weighted elasticities for the lower-income bracket (1.98 vs. 0.71 at the top) and attribute this to the insufficient integration between personal and corporate income tax systems. Low-taxable income declarants may not have low incomes when considering income exemptions, particularly dividends. We find significantly higher elasticities for self-employed individuals compared to wage earners, with deductions playing a minor role. Our findings underscore the importance of integrating personal and corporate income tax systems.

Keywords:Elasticity of taxable income; optimal tax rates; personal income tax; bracket creep.

JEL Classification: H24, H31, J22.

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1 Introduction

The elasticity of taxable income, or ETI, describes a taxpayer's responsiveness to changes in marginal tax rates, replacing compensated elasticity of labor supply as an indicator of their sensitivity to tax reforms. The aim of ETI is to capture all possible behavioral responses to income taxation in a single measure, without the need to specify the various mechanisms involved or consider the details of tax codes (Creedy, 2010; Feldstein, 1995*a*,*b*). The reduced-form approach to estimating the ETI has proven to be attractive, as it avoids complex structural models that encompass each possible behavior and – provided that certain assumptions are fulfilled – allows the researcher to easily measure the efficiency cost of taxation (Chetty, 2009; Feldstein, 1999).

The ETI literature has grown rapidly since its introduction in the early 1990s, with a focus on the United States and other developed countries.[1][2] However, different institutional settings produce completely different ETIs. Several elements such as the system of justice, corporate laws, the taxation of profits and dividends, the magnitude of labor market informality, the importance of public sector employment, education levels, and financial education, among other institutional arrangements, may affect a country's ETI. Specifically, the ability to transfer the tax base from personal to corporate income may significantly influence the average ETI, leading to an increase at the lower end and a decrease at the upper end. Taxpayers with increased flexibility in shifting their tax base between personal and corporate income tax are inclined to target the lowest taxable income range. This tendency is frequently motivated by the effects of inflation and nominal adjustments in taxable income, which can force taxpayers into higher tax brackets. Consequently, taxpayers strive to retain their position in the lowest tax bracket to reduce their personal income tax liability while exclusively paying corporate tax.

Brazil's tax system is distinctive in that it encourages the shifting of the tax base by maintaining a significant tax differential between liabilities faced by personal income tax (PIT) declarants and corporate declarants (one of the highest differences, if not the highest in the world according to Gobetti and Orair (2017)). Such a structure incentivizes taxpayers to strategically adjust their tax base in response to the differing rates. This effect is especially noticeable among those opting for the SIMPLES tax scheme[3], characterized by considerably

[1]Milligan and Smart (2015) and Sillamaa and Veall (2001) produce ETI estimates for Canada. Matikka (2018), estimates the ETI for Finland; Carey et al. (2015) estimates the same parameter for New Zealand and Hansson (2007) estimates the ETI for Sweden.

[2]Saez et al. (2012) conduct a complete survey of the literature regarding the main critiques, recent developments, and the agenda for future research.

[3]The SIMPLES Nacional (Sistema Integrado de Pagamento de Impostos e Contribuições das Microem-

lower corporate tax charges, thereby providing incentives for taxpayers to modify their tax base accordingly.

In order to investigate this phenomenon, we utilize panel data derived from the income tax returns of 5 million Brazilian taxpayers to produce our ETI estimates and understand how context-dependent they are.[4] We follow Saez (2003) and explore a natural experiment better known as "bracket creep" to estimate the ETI of personal income taxes before and after deductions. The natural experiment consists of the marginal tax rate variation produced by inflation in the absence of price adjustments in the income tax schedule. Two conditions must be met to correctly estimate behavioral responses with this design. First, marginal tax rates must change while the tax base and tax schedule remain constant. Second, changes in the marginal tax rates should produce different responses from taxpayers with similar incomes – as well as other economic characteristics (Saez, 2003).

The bracket creep due to inflation in Brazil between 2011 and 2017 meets the above conditions and provides a source of income tax rate variation to estimate the ETI. The Brazilian Federal Revenue Agency (Receita Federal do Brasil, or RFB in its Brazilian acronym) did not adjust the brackets of the income tax schedule to the Brazilian Consumer Price Index variation over that period. Therefore, a taxpayer near the upper end of a given bracket might "creep" into the next bracket if her real income does not change. On the other hand, taxpayers at the lower end of the same tax bracket are not expected to experience an increase in marginal rates. Thus, the bracket creep design uses panel data on tax reports and compares changes in the incomes of taxpayers near the upper end of a bracket to those at the lower end. This strategy allows comparisons between groups of taxpayers with similar incomes and economic characteristics, which makes the estimates robust to changes in the underlying distribution of income, especially underlying increases in inequality.

We estimate income-weighted ETIs of 0.64 for taxable income and 0.61 for gross income, and unweighted ETIs of 0.76 for taxable income and 0.71 for gross income. Our estimates are higher than the estimates (weighted by income) obtained by Gruber and Saez (2002) of 0.40 for taxable income and 0.12 for gross income. Heterogeneity analysis reveals that the elasticities are higher for low-taxable income declarants than for top-taxable income declarants (1.98 vs. 0.71 at the top). The ETI for the self-employed is much higher than

presas e Empresas de Pequeno Porte) is a simplified tax regime in Brazil designed for micro and small businesses. This system allows for a streamlined collection of federal, state, and municipal taxes, as well as social security contributions, with reduced rates and simplified procedures to reduce the tax burden for eligible businesses.

[4] Tax report information from the Brazilian Federal Revenue Agency is protected by privacy laws, requires special authorization for access, and must be processed on site.

that for wage earners. We provide explanations considering the Brazilian economic context. Besides, elasticities for nonitemizers are higher than for itemizers.

We also estimate an elasticity for overall deductions, equal to -0.15, notably lower– by a factor of three – than the income-unweighted ETI. For income-weighted regressions, this elasticity value approaches zero, thereby suggesting that deductions might not hold the same degree of importance in Brazil as they do in other nations.

Given that bracket creep constitutes an informal tax adjustment, it may pose challenges for taxpayers to discern changes in marginal tax rates. Consequently, ETI estimates derived from bracket creep should be regarded as a lower bound for behavioral responses. Nonetheless, despite its limitations, bracket creep offers a valuable approach to obtain this crucial parameter.

2 Overview of Personal Income Tax in Brazil

The Brazilian Personal Income Tax was initially established in 1924 through the annual budget law of 1923 (Law no 4.625, December 31, 1922) and subsequently recognized in the Constitution as a tax under the legislative competence of the federal government in 1934. The PIT has undergone numerous legislative amendments, culminating in the tax reporting structure of 1998, which bears a strong resemblance to the current system.

Brazilian law defines an income tax process that involves taxation throughout the calendar year and an annual adjustment upon the year's completion. PIT calculation is performed using the IRPF Annual Adjustment Statement (DIRPF), a report submitted by the last business day of April in the year following the receipt of income. The gross income comprises the sum of all taxable income of the taxpayer and their dependents, including income received from corporations, individuals, abroad, and positive results from rural activities.

The legislation permits various deductions from the gross taxable income, such as the simplified discount (20% of the gross income, replacing all other deductions but limited to a specific value that varies according to the base year), social contribution deductions for public and private pension funds, medical expenses (unlimited), and education expenses (limited to a fixed value), among others. After accounting for these deductions, the taxable income is obtained. The variables employed in our regression analyses are taxable income and gross income. A detailed calculation of PIT is provided in Appendix 11.

Economically, the average PIT collection in Brazil constituted 2.6% of GDP between

2011 and 2017. In contrast, Mexico, Argentina, and Chile averaged 2.9%, 2.3%, and 1.6%, respectively. The average for OECD countries was 8.0% of GDP, with Turkey presenting the lowest average at 3.6%. Regarding Brazil's total tax collection, the Brazilian PIT accounted for, on average, 7.9% of the total collected during the period 2011-2017, compared to the OECD average of 23.2% for the same period. In Latin America, Mexico had an average of 20.3%, Argentina 7.6%, and Chile 8.0%. Thus, the Brazilian context is comparable to middle-income Latin American countries and diverges from the higher-income OECD countries.

Two salient aspects of the Brazilian tax system include the dividend exemption since 1995 and the lower tax rates for financial investments compared to income from work. In 2014, new legislation permitted liberal professionals, such as doctors, dentists, accountants, engineers, and lawyers, to enter SIMPLES, a taxation scheme with lower rates than a standard legal entity.

This legislation engendered an asymmetry between the taxation of legal entities and individuals in Brazil. Consequently, numerous companies began hiring professionals as legal entities, exempting them from withholding tax on salary and labor charges. In turn, the contracted person also benefits from lower tax rates in the legal entity. Although two predominant corporate tax systems exist - the classical system and the imputation system (Ault and Arnold, 2010) - the dividend exemption has precipitated a gradual erosion of the PIT base. Brazil is among the few countries worldwide that exempt the distribution of profits.

To provide a sense of the magnitude of these favorably taxed incomes, Table 1 displays the evolution of exempt income from the distribution of profits and dividends, as well as income from financial investments (subject to taxation with income tax at source) for the entire universe of DIRPF declarants. Income from profit distribution represents 21.74% and financial income 4.41% of declared gross taxable income, considering the average percentage for the period 2011-2017. Furthermore, the table indicates that these two income types account for approximately 26% of gross income during the specified period.

The data highlights the proportion of income that circumvents the progressive taxation of the income tax table and signifies the percentage of income subject to base alteration in the PIT. In general, financial income is taxed at a rate of 15%, while income from dividends is taxed at an average rate of 20% by corporate income. This information allows us to compute a weighted rate of 19.1% for the entire set of incomes with preferential taxation.

In conclusion, the Brazilian PIT system demonstrates similarities to middle-income Latin American countries and deviates from the average of higher-income OECD countries. The exemption of dividends and lower tax rates on financial investments have created an asymmetry between the taxation of legal entities and individuals, leading to a gradual erosion of the PIT base. An examination of the distribution of profits and dividends, as well as financial investments, reveals the potential for substantial expansion of the PIT base through the taxation of such incomes.

3 The Elasticity of Taxable Income (ETI)

We follow Gruber and Saez (2002) and start from a labor supply model where the goal is to measure the impact of a tax change in the schedule faced by a taxpayer on her income. Thus, the agent maximizes a utility function $u(c, z)$, where c represents her consumption and z represents her pretax income (reported income). The budget constraint of the taxpayer on the linear part of the tax schedule is given by $c = z(1 - \tau) + R$, where τ is the marginal tax rate and R is the virtual income. Utility maximization produces an income supply function that depends on the slope of the budget line and virtual income, i.e., $z = z(1 - \tau, R)$, where $1 - \tau$ is the net-of-tax rate. Changes in τ and R affect reported income as follows:

$$dz = -\frac{\partial z}{\partial(1-\tau)}d\tau + \frac{\partial z}{\partial R}dR \tag{1}$$

Furthermore, the uncompensated elasticity of reported (taxable) income to the net-of-tax rate is:

$$e^u = \frac{(1-\tau)}{z}\frac{\partial z}{\partial(1-\tau)} \tag{2}$$

The income effect parameter is:

$$\eta = (1-\tau)\frac{\partial z}{\partial R} \tag{3}$$

Substituting equations (2) and (3) into equation (1) we obtain:

$$dz = -e^u z\frac{d\tau}{(1-\tau)} + \eta\frac{dR}{(1-\tau)} \tag{4}$$

Let $z^c = z^c(1 - \tau, R)$ be the compensated income supply function, which minimizes the costs to attain utility level $\overline{u}$ for a given tax rate τ. Thus, the compensated elasticity of income is defined as:

$$e^c = \frac{(1-\tau)}{z^c}\frac{\partial z^c}{\partial(1-\tau)} \tag{5}$$

The two elasticities and income effect parameter relate to each other through the Slutsky equation:

$$e^c = e^u - \eta \tag{6}$$

Substituting equation (6) into equation (4), after simple algebraic manipulation, we obtain:

$$\frac{dz}{z} = -e^c\frac{d\tau}{(1-\tau)} + \eta\frac{(dR - zd\tau)}{z(1-\tau)} \tag{7}$$

Note that $dR - zd\tau$ represents the change in after-tax income due to the tax change for a given before-tax income z, or the change in the tax liability for taxpayers with income z. Thus, equation (7) decomposes the change in reported income – in response to a change in the marginal tax rate – into a substitution effect (taxpayers' behavioral response) and an income effect. If we assume away income effects (i.e., $e^u = e^c = e$), the ETI with respect to the net-of-tax rate $(1-\tau)$ can be written as:

$$e = \frac{(1-\tau)}{z}\frac{\partial z}{\partial(1-\tau)} \tag{8}$$

The above equation yields the percent change in the reported income when the net-of-tax rate increases by 1%. This elasticity captures not only the labor market participation response but also all other responses to changes in marginal tax rates (Feldstein, 1999).

We assume that the income supply function z could shift randomly from year to year for reasons unrelated to tax changes, such as changes in work opportunities or preference shocks. Thus, equation (7) can be rewritten as:

$$\frac{dz}{z} = -e^c\frac{d\tau}{(1-\tau)} + \eta\frac{(dR - zd\tau)}{z(1-\tau)} + \varepsilon \tag{9}$$

4 ETI theoretical and empirical framework

We use data on individual income tax reports between 2011 and 2017, from the Brazilian Federal Revenue Agency. That information is protected by privacy laws, requires special authorization for access, and must be processed on-site.

We extracted a sample of 5 million individuals who filed tax reports in all years between 2011 and 2017. The panel contains reports filed using itemized deductions (known as the complete form), and nonitemized deductions (the simple form) and includes individuals who may have changed deduction types over time (and, consequently, types of forms), as reports can be amended. We removed reports with zero income from the dataset.

Our data include two types of income, *gross* and *taxable* income. The definitions of both incomes remain unchanged during the period. Gross income is the sum of wages, income received from other persons, income received from abroad, and the positive results from rural activities. We exclude capital gains and financial income from gross income due to the special tax treatment these incomes receive under Brazilian tax law. Taxable income is calculated by applying the deductions allowed by the Brazilian Tax Code to gross income.

Saez (2003) adopts an instrumental variable strategy to estimate the ETI around marginal tax kinks. The instrumental variable equals 1 if the taxpayer belongs to the treatment group, i.e., if her marginal tax rate changed while her pretax income remained unchanged in real terms. Otherwise, the taxpayer belongs to the control group, and the variable equals 0. Thus, the variable that separates taxpayers between treatment and control groups is the taxable income and the ETI estimation can be achieved through "differences-in-differences" estimation. We can use the same approach as in Gruber and Saez (2002) to estimate the ETI for the whole population, building an instrumental variable based on a synthetic tax rate that yields the same results as the binary variable.

Our empirical strategy relates changes in income between sets of years to changes in the marginal tax rate between the same sets of years. We follow Feldstein (1995*b*) in setting the time span equal to 3 years, which is standard in the ETI literature. Thus, we build a dataset of 20 million observations with sets of years: 2011–2014, 2012–2015, 2013–2016, and 2014–2017.

Equation (9) is the starting point for the empirical model; it represents the behavioral response of reported income induced by a small tax change $(d\tau, dR)$. According to Gruber and Saez (2002), equation (9) can be estimated replacing z with z_1 (first-period income), dz with $z_2 - z_1$ (change in income between the first and second time periods), $d\tau$ with

$T_2(z_2) - T_1(z_1)$ (change in marginal tax rates) and $dR - zd\tau$ with $[z_2 - T_2(z_2)] - [z_1 - T_1(z_1)]$ (change in after-tax income). However, for noninfinitesimal variations, it is better to use a log-log specification replacing dz/z with $log(z_2/z_1)$; $-d\tau/(1-\tau)$ with $log[(1-T_2)/(1-T_1)]$; and $(dR - zd\tau)/z(1-\tau)$ with $log[(z_2 - T_2(z_2))/(z_1 - T_1(z_1))]$. Using the approximation $z(1-\tau) \approx z - T(z)$, we obtain the following regression specification:

$$log\left(\frac{z_2}{z_1}\right) = e^c log\left[\frac{1-T_2}{1-T_1}\right] + \eta log\left[\frac{z_2 - T_2(z_2)}{z_1 - T_1(z_1)}\right] + \varepsilon \qquad (10)$$

where e^c is the compensated elasticity; η is the income effect parameter; z_i is income in year i; T_i is the marginal tax rate in year i; and $T_i(z_i)$ is the tax liability in year i. The elasticity parameter in equation (10) $log[(1-T_2)/(1-T_1)]$ is correlated with ε because, in the event of a positive shock to income (i.e., $\varepsilon > 0$), tax rates increase automatically due to progressivity. Therefore, OLS estimates of (10) produce biased estimates of the behavioral elasticity.

The instrumental variable proposed by Gruber and Saez (2002) to instrument the term capturing tax rate changes is T'_p, which is the marginal tax rate that an individual would face in year 2 if her real income did not change from period 1 to period 2. That is, $T'_p = T'(z_p)$ where z_p is a "projected" income in period 2 that expresses income in period 1 by its price-adjusted value in period 2. Thus, the instrument for $log[(1-T'_2)/(1-T'_1)]$ is $log[(1-T'_p)/(1-T'_1)]$, which is the predicted log net-of-tax-rate change if real income remains constant from period 1 to period 2.

The estimated parameters of the IV regression in (10) may also be biased – ε is correlated with z_1 – because of mean reversion or secular trends in the income distribution. Mean reversion is a consequence of transient income events leading to high (low) incomes in period 1 tending to be lower (higher) in period 2, which produces a negative (positive) correlation between ε and z_1. Secular trends in the income distribution, such as a change in the income distribution, also result in a correlation between ε and z_1. Even if these forces operate in opposite directions, they may not cancel each other out. In this case, many studies in the literature follow Auten and Carroll (1999) and Gruber and Saez (2002) and include lagged income as a covariate, entering the model either linearly or through polynomials or splines. Thus, a broad set of controls for income in period 1 could appear to be attractive, but in practice, with only two years of tax changes, a more sophisticated set of income controls could ruin identification, as highlighted by Gruber and Saez (2002). Recently, Weber (2014) proposed an exogenous instrument using a Sargan-type test, and Burns and Ziliak (2017) proposed an instrument based on cohorts of age and education.

The term $log[(z_2 - T_2(z_2))/(z_1 - T_1(z_1))]$ is also correlated with ε and needs to be instrumented, although in the present study, the income effect is considered to be null (i.e., $\eta = 0$). To analyze the income effect in equation (9), we examine the term $dR - zd\tau$, which is the change in after-tax income due to the tax change for a given before-tax income z . Because of bracket creep, this quantity is piecewise linear and continuously increasing in income, affecting treatments and controls alike. Intuitively, at any given kink in the tax schedule, the increase in tax liability due to bracket creep is approximately the same for both treatment and control groups, but the change in marginal tax rates is different, which makes the difference in behavioral response between the two groups mostly the result of substitution effects. Thus, the bracket creep phenomenon allows for the estimation of the compensated elasticity of income, e^c, our parameter of interest (Saez, 2003). The complete regression framework is the following:

$$\begin{aligned} Log\left(\frac{z_2}{z_1}\right) =& \alpha_0 + e^c log\left[\frac{1-T_2}{1-T_1}\right] + \alpha_1 log(z_1) + \alpha_2 f(taxinc_1) + \sum_{i=1}^{10} \alpha_{3i} Spline_i(z_1) \\ & + \sum_j \alpha_{4j} Year_j + \beta itemizer + \varepsilon \end{aligned} \tag{11}$$

where z_i is the income in year i (either taxable income, after deductions, or gross income, before deductions); T_i' is the marginal tax rate in year i ; e^c is the compensated elasticity of income; $itemizer$ is a dummy variable for deduction itemizer; $Year_j$ denotes base year dummies; $Spline_i$ is a ten-segment spline of base year income; and $f(taxinc_1)$ are polynomial functions of base year income. The panel is constructed by stacking differences in income across individuals and years. Equation (12) is then estimated by simple 2SLS, with the first stage being:

$$\begin{aligned} log\left[\frac{1-T_2}{1-T_1}\right] =& \theta_0 + e^c log\left[\frac{1-T_p}{1-T_1}\right] + \theta_1 log(z_1) + \theta_2 f(taxinc_1) + \sum_{i=1}^{10} \theta_{3i} Spline_i(z_1) \\ & + \sum_j \theta_{4j} Year_j + \delta itemizer + \varepsilon \end{aligned} \tag{12}$$

where $log[(1 - T_p')/(1 - T_1')]$ is used as instrument for $log[(1 - T_2')/(1 - T_1')]$. All standard errors are robust to intrapersonal correlation.

5 Data

Our dataset consists of 35 million observations, corresponding to a panel of 5 million individuals over seven years. The average annual salary is R$ 84,293, average gross income equals R$ 87,690, and average taxable income amounts to R$ 68,710. All income types have high standard deviations. Approximately 52% of the reports are nonitemizers, and 48% are itemizers (see Table 2).

During the 2011–2017 period, the personal income tax schedule was not fully adjusted for inflation, as shown in Table 3. Some income levels moved to the next bracket due to inflation. ETI estimations consider the differences in the following sets of years: 2011–2014, 2012–2015, 2013–2016, and 2014–2017. For each of those intervals, the differences between the consumer price index and the bracket adjustment were 6,53%, 10.30%, 14,04%, and 15.84%, respectively. Bracket creep is the only factor changing the tax schedule. No other change in marginal tax rates or in the tax base was implemented. Taxpayers, in general, were aware of the bracket creep effect on tax rates, as the nonadjustment of the personal income tax was widely publicized in the media.

Between 2011 and 2017, inflation remained at approximately 6% per year, with a peak at 10.67% in 2015 and a low at 2.95% in 2017. The average bracket adjustment was 4.50% between 2011 and 2015, only 1.50% in 2016 and zero in 2017, representing real increases in tax rates ranging from 1.34% to 5.79% per year. Accumulated increases in tax rates were high enough to induce changes in behavior. Figure 1 shows the effect of inflation on tax rates between 2014 and 2017 in 2014 values.

Descriptive statistics for variables utilized in the empirical models, compiled in a paired-year format, can be found in Tables 4, 5, 6, and 7. Tables 4 to 7 show that both the magnitude and sign of all variables are quite similar. Standard deviations are high, especially for income variables, as shown in Table 2. The instruments are negative for brackets 1 to 4 in all panels, which suggests an increase in marginal tax rates (by construction, the instrument is positive when tax rates increase and negative when tax rates decrease), and equal to zero for bracket 5, suggesting that those in the top bracket in year 1 remained in the same position in year 2. Note that many observations moved from bracket 2 to 5 during the 2011–2017 period, indicating the occurrence of bracket creep.

There is also positive income variation in the first bracket and negative variation in the top bracket, which is evidence of mean reversion.

6 ETI estimates

6.1 Average Elasticity of Taxable Income

Tables 8 and 9 report 2SLS estimates of equation (12). Both tables present four different specifications that address mean reversion and changes in the income distribution for both of our income measures. The first specifications (eq1/eq5) do not include income controls. The second specifications (eq 2/eq6) include controls for first-period income $log(z_1)$, as in Auten and Carroll (1999). The third specifications (eq3/eq7) include polynomials of base year income ($taxinc_1$ and $taxinc_1^2$) as additional controls, and the fourth specifications include 10-splines of income to allow for nonlinearities in changes in the income distribution (eq4/eq8) as in Gruber and Saez (2002). All specifications include dummies for each base year and itemized deductions (complete form). We present the results for gross income (before deductions) and taxable income (after deductions). Income excludes capital gains and returns to financial investments, and we removed taxpayers with gross income equal to zero from the dataset.

We present unweighted and weighted (by income) estimates in Tables 8 and 9, respectively. Weighted estimates feed into optimal tax and efficiency cost calculations since income responses to changes in marginal tax rates are proportional to the product of income elasticity and income level (Gruber and Saez, 2002). There is no censoring of major income changes in weighted estimates. We evaluate the effect of censoring some observations in Table A.1, in the appendix. Excluding tax filers with lower incomes does not result in substantial differences in the observed elasticities. There is higher variation in the gross income elasticity - especially for the unweighted regression – when low incomes are filtered out (columns 2, 3 and 8). This result supports the occurrence of strong mean reversion in the base of the income distribution.

Both the weighted and unweighted models are very sensitive to income controls and different specifications, as reported by Gruber and Saez (2002), Kopczuk (2005) and Neisser (2021). The elasticity coefficient for the unweighted estimates in Table 8 is positive for both taxable and gross income in the specifications without income controls (eq1/eq5). On the other hand, the elasticity for the weighted estimates in Table 8 is negative in the specification without income controls (eq1/eq5). The elasticities are positive when we add income controls for either weighted or unweighted estimates (see eq2 to eq4 and eq6 to eq8 in Tables 8 and 9).

The elasticity coefficients tend to be smaller but still statistically significant in all specifications in which we include income polynomials as controls (eq3/eq4 and eq7/eq8). Most splines' coefficients are significant, indicating nonlinearities in changes in the income distribution. For all estimates, itemization is associated with a higher reported taxable income.

Table 8 presents an unweighted ETI of 0.76 and an elasticity of gross income of 0.71. Table 9 shows weighted elasticities of 0.64 (taxable income) and 0.62 (gross income), respectively. The elasticities of gross income are smaller than the ETI because of the negative cross-elasticities between other components of total income and the PIT net-of-tax-rate, although the difference is not as large as in other studies (Gruber and Saez, 2002; Saez, 2003). Two explanations for such a difference exist: one is mechanical, as gross income has a larger base; the other is behavioral, as taxable income includes itemized deductions that respond to changes in tax rates. Additionally, elasticities weighted by the income – under both income concepts – are lower than unweighted elasticities, which is in accordance with other studies (Neisser, 2021). Finally, the first stages in the tables show that the instruments are highly significant.

Varying the time window

We can also define other time intervals to estimate that parameter, so we can test the sensitivity of our results to different time frames. The panel allows time intervals from one to six years. The corresponding ETI estimates are presented in Table 10 for the splines specification (eq4/eq8).

The ETI decreases as time intervals increase, although weighted regressions show that ETI is stable within a one-to-three-year period. The ETI for gross income is stable within one-to-five-year periods, decreasing for a six-year interval. Thus, in general, Brazilian taxpayers show more sensitivity to the net-of-tax rate in the short run, in line with the findings of Sammartino and Weiner (1997) and Goolsbee (2000).

ETI by itemization status

Brazilian taxpayers can choose between two types of deduction: the simplified deduction, which permits only a single, nonitemized deduction of 20% of gross income, limited to a value that is defined annually, and the itemized deduction. They are also known as the simplified form (nonitemizer) and complete form (itemizer). For high-income levels, the itemized deduction in the complete form is preferable since there are no limits for some deductions, such as health expenditures.

Table 11 shows elasticity estimates weighted or unweighted by income for both itemized and nonitemized reports. Both elasticities are basically the same for itemizers, suggesting that deductions do not play an important role in the Brazilian context. Surprisingly, the elasticities are much higher for nonitemizers than for itemizers, a result that contradicts the international literature. Furthermore, for nonitemizers, the elasticity of gross income is higher than of taxable income in regressions weighted by income, which is likely the result of the value that limits the use of the simplified deduction for high-income taxpayers defined by the RFB.

We discuss these results in detail after presenting the estimates by income range in the next section, since there is a strict correlation between the type of deduction and income.

6.2 Elasticities by income level

We estimate ETI by taxable and gross income levels. We order the taxpayers by taxable income, grouped into five categories defined by the income tax schedule of the Brazilian Personal Income Tax for the base year 2011: 0 to R$ 18,799.32; R$ 18,799.33 to R$ 28,174.20; R$ 28,174.21 to R$ 37,566.12; R$ 37,566.13 to R$ 46,939.56; and R$ 46,939.56 and above.

According to Gruber and Saez (2002), we should expect higher elasticities for top incomes, as high-income taxpayers have a greater capacity to reduce their taxable income through deductions, base shifting, and tax planning, among other means. Table 12 presents ETI estimates for the taxable income of the five groups. The first bracket with all the declarants has the highest elasticities, which is unexpected given the main results in the literature. Additionally, in the majority of income brackets, the elasticities for gross income surpass those for taxable income, leading to the inference that, in this context, deductions serve a less significant role in behavioral response compared to their importance in other nations.

Two important factors explain the high elasticities obtained for the first bracket: self-employed professionals represent 36% of statements on average for the period 2011-2017, and the percentage of declarations in the simplified (non-itemized) model is 63% of the declarations on average for the same period. Both percentages are the highest in relation to the other income brackets for both criteria. Table 12 outlines the elasticity estimates for the first bracket, excluding self-employed individuals. The exclusion leads to a decrease in the elasticity of taxable income of weighted regressions from 1.98 to 0.62. Similarly, the elasticity in unweighted regressions witnesses a drop from 2.98 to 1.09. Thus, the behavioral reaction is fundamentally linked to the control that self-employed professionals have over their gross income, as they can coexist both as individuals and as legal entities, transferring their income from one base to another according to the development of their tax situation in each year. In the year in which the revenue of the legal entity is high, the accountant transfers revenue to the individual and vice versa. Elevated inflation and nominal adjustments in taxpayers' earnings, absent a corresponding adjustment in personal income tax brackets, may propel taxpayers to categorize their earnings as corporate income. This observation crucially elucidates the high elasticity in a bracket subject to a relatively low marginal rate.

In Figure 2a, we compute a concentration curve for PIT-exempted income, highlighting the substantial concentration of such income in the first bracket, a contrast to the lower concentration indicated by the taxable income Lorenz Curve (depicted in green). Analogously, Figure 2b presents a concentration curve for Assets and Investments, demonstrating a higher concentration when compared to the Lorenz-type Curve for Taxable Income. This underscores that taxpayers within this range, while including several with genuinely low income, do not necessarily have low total income due to the practice of shifting their income base to a legal entity.

The analysis indicates that on average for 2011-2017, 54% of declarations in brackets two to four were from the simplified model, with self-employed professionals contributing 12% of declarations. The consistency in these figures may be linked to the closely estimated elasticities across these income ranges. For the fifth bracket, 36% of declarations came from the simplified model, with self-employed professionals accounting for 11%.

Notably, the highest income bracket in Table 12 showed high elasticities (0.52-1.25) compared to literature reports (Gruber and Saez, 2002; Kiss and Mosberger, 2015; Saez et al., 2012). This bracket is approximate to the top 5% of incomes. For context, the annual income for the top 1% corresponds to a gross income of R$189,200.00 (Medeiros et al., 2015), four times higher than the 2011 tax schedule's highest bracket. In this bracket, a shift to corporate income has been prevalent since 1996, likely due to the tax exemption on profit distribution (dividends). Although these taxpayers possess significant non-taxable income, many are wage earners from the public and private sectors (judges, public lawyers, executives) with high taxable incomes. Legal deductions, especially for education and medical expenses, are significant for this group, aligning with previous literature.

Lastly, base shifting can occur at other income levels. Some workers, in concert with their companies, may shift the base to avoid combined payroll taxes and personal income tax. This tactic might be less common in the second to fourth brackets, where public sector earners constitute 35% of declarants (2011-2017 average), coinciding with the brackets demonstrating the lowest elasticities.

6.3 Elasticities by types of job

The type of job can also influence behavior. We investigate the elasticities among wage earners in the private and public sectors and the self-employed. We exclude the other taxpayers not included in these groups from the estimation. Table 13 presents ETI estimates by type of job.

Self-employed elasticities are twice to seven times higher than those of wage earners, under either income concept. Such results align closely with those reported by Kleven and Schultz (2014) and Almunia and Lopez-Rodriguez (2019) and likely reflecting the increased ability of self-employed individuals to withhold information from the tax administration, a point noted by Kleven et al. (2011). Private sector wage-earners present slightly higher elasticities (than public sector employees), especially for gross income, since taxpayers have some freedom to shift their tax base to corporate tax. Finally, public sector employees have their salaries defined by a general policy, so that, as taxpayers, they do not have the flexibility to adjust their gross income, as demonstrated by the low elasticities obtained.

6.4 Elasticity of deductions

Deductions play an important role in most of personal income tax schedules, especially for high income individuals (Doerrenberg et al., 2017). We rely on the same framework defined by equation (11) to estimate the elasticity of deductions for gross income. Indeed, by replacing the logarithmic difference in income with the logarithmic difference in total deductions, or in a specific deduction, we obtain the elasticity of deductions. The sign of the elasticity should be negative since an increase in marginal tax rates tends to increase the deductions of gross income. Almunia and Lopez-Rodriguez (2019) use data from Spain and report elasticities for total deductions in the range -0.19 to -0.45, depending on the regression specification. They also find elasticities from -0.7 to -1.50 for private pension fund deductions.

Table 14 presents the elasticities for different gross income deductions. The elasticity of deductions is -0.15, three times lower than ETI unweighted by income. Estimates of the elasticity weighted by income approach zero. These results confirm the previous elasticities obtained for different types of deduction (itemization) – elasticities for the itemizers are lower than those for the nonitemizers who opt for the simplified deduction – and for various income ranges — elasticities of gross income are higher than those for taxable income – for most income brackets.

During the period we examined, deductions did not play an important role in Brazilian taxpayers' behavior. Deductions for high-income taxpayers have limited use in tax planning, and the typical behavioral response is a base shift to the corporate tax. The only unlimited deduction is medical expenses, and taxpayers are well aware of the electronic inspection made by Tax Administration using electronic tax invoices issued by clinics, hospitals, and doctors. The elasticity of medical deductions is -1.56, in the regression unweighted by income, and not statistically significant in the weighted regression. For private pension fund deductions, there is a limitation of 12% of gross taxable income. Its estimated elasticities are -0.25 (unweighted) and -0.16 (weighted), well below those reported in Spain.

7 Optimal Taxation

In the subsequent section, we detail the calculation of optimal tax rates, which includes a uniform rate that optimizes revenue and a specific rate that maximizes revenue from the highest earners. The formulas utilized in these computations, as per Saez et al. (2012), are elaborated in Appendix 11.]

Revenue-maximizing constant rate

Elasticity estimates from equation (14) weighted by income – obtained from Tables 7 and 8 and equal to $e_{TI} = 0.64$ (taxable income) and $e_{GI} = 0.62$, respectively – yield revenue-maximizing constant rates of $\tau_{TI} = 61.0\%$ and $\tau_{GI} = 61.7\%$.

Given that $a > 1$, the flat revenue-maximizing rate is always larger than the revenue-maximizing rate for top incomes only because increasing the top tax rate collects revenue only for the highest bracket but produces a behavioral response almost as large as an across-the-board increase in the marginal tax rate (Saez et al., 2012).

Revenue-maximizing rate for top income earners

Equation (13) yields the revenue-maximizing rate for the highest bracket and for the top 1% of income earners. We use the thresholds in Medeiros et al. (2015) – adjusted by a consumer price index (Índice de Preços ao Consumidor Amplo – IPCA) – to identify the top 1% of income earners. We calculate the Pareto parameter as an average for each year of the panel from 2011 to 2017. Table 15 shows the revenue-maximizing tax rates associated with different ETI and Pareto parameters.

The weighted (by taxable income) elasticity for the highest bracket in Table 12 is $e_{HB} = 0.71$. The average Pareto parameter for this bracket is $a = 1.77$, whereas that for the top 1%

bracket (fictitious) is $a = 2.66$, which yield optimal marginal tax rates equal to $\tau^* = 44.3\%$ (highest bracket) and $\tau^*(1\%) = 34.6\%$ (top 1%), respectively.

The reason that the top 1% tax rate is lower than the highest bracket tax rate is because we observe a higher Pareto parameter for the top 1% of income earners. This is expected since for most income distributions, this parameter converges to a value in the $1.5 - 2.5$ range as the average income grows. For example, Saez et al. (2012) report a value of 1.5 for the United States; Kiss (2013) finds a Pareto parameter of 2.5 for the top 1% of income earners in Hungary; and Kemp (2019) reports a 2.1 value for the top 1% of income earners in South Africa.

As Table 15 shows, the larger the ETI is, the smaller the tax rate, due to behavioral responses by taxpayers.

We rely on the following parameters for efficiency loss calculations: $e = 0.71$ (ETI for the highest bracket) and $a = 1.77$ (5^{th} PIT bracket); $a = 2.66$ (top 1% bracket – simulation) and $\tau = 27.5\%$ (Brazilian highest PIT tax rate). Equation (16) yields a marginal efficiency loss of -0.91 reais and -2.53 reais for each real of tax raised. Both values are considerably high.

Revenue-maximizing rate for top incomes, with base shift

The personal income tax base is affected by two major sources of erosion: exemptions and preferential rates. Profits and dividends have been exempt since 1996, capital gains in the stock market are taxed at 15%, and financial gains are usually taxed at 15%, with a maximum rate of 20%. Brazil adopted the strategy of taxing profits in the corporate income tax and exempting them from taxation in the personal income tax. However, although the tax rates for the corporate income tax may reach 34% for large companies, there are many small and medium-sized businesses taxed at maximum rates of 15%, without compensatory or pass-through mechanisms to the personal income tax. This opens a window for base shifting. Overall, there is a base shift of approximately 26% of gross taxable income, as mentioned in section 2. This shifted amount pays an average tax of 19%, assuming weighed division of the base between dividends (taxed at an average rate of 20% by the corporate income tax) and financial income (taxed at an average rate of 15%, which represents the rate for most operations in financial markets).

Considering $e = 0.71$ (ETI for higher bracket), $a = 1.77$ (5th PIT bracket), $a = 2.66$ (1% top bracket - simulation), $\tau = 27.5\%$ (Brazil's highest PIT tax rate), $s = 0.26$ and $t = 0.19$, we can use equations 23 (A3) and 24 (A4) to calculate efficiency losses and revenue-maximizing tax rates. The results are shown in Table 16.

The results show higher optimal tax rates ($\tau^* = 47.4\%$ and $\tau^*(1\%) = 38.2\%$) and smaller marginal efficiency losses (-0.64 reais and -1.43 reais, for each real of tax raised) due to base shifting. As a practical consequence, any tax reforms intended to increase progressivity, revenue, or both, must consider that base shifting due to preferential tax rates is an important characteristic of the Brazilian tax system. A reform that fails to establish mechanisms to control the shifting may ultimately increase top marginal rates for taxable incomes (mostly labor incomes), and this may induce ever further shifts to incomes receiving preferential treatment (mostly capital incomes).

8 Final Remarks

We estimate the behavioral response – measured by taxable income – to increases in marginal tax rates by using a natural experiment that originates from the lack of adjustment of the nominal tax schedule for inflation, known as bracket creep. We calculate the elasticity of taxable income (ETI) to the personal income tax (PIT) rate using a balanced sample of individual-level data from the Brazilian Federal Revenue Agency (RFB), in a total of five million tax fillers observed over the period 2011–2017.

We obtain estimates of the ETI weighted (by income) of 0.64 for taxable income and 0.61 for gross income, whereas ETI unweighted by income equal 0.76 for taxable income and 0.71 for gross income. Besides, estimates of elasticities decrease as time spans increase, suggesting that Brazilian taxpayers may overreact to tax changes in the short run.

Our main results indicate that the ETI estimates by income range (weighted by income) is very peculiar, with estimates of 1.98 for taxable income and 2.18 for gross income for the first tax bracket with all declarants– and much lower elasticities when excluding self-employed from the sample, equal to 0.62 and 0.92, respectively. In the highest bracket the elasticities equal 0.71 for taxable income and 1.25 for gross income. We pointed out that this fact occurs especially due to income base shift at the bottom of income distribution, where self-employed could change their gross income to his legal entity and vice versa (In fact, these declarants have a low taxable income but not a total low income if we consider income exemptions). This is a very particular phenomenon of Brazilian Tax System that demonstrates a lack of integration between personal and corporate income tax. Higher elasticities for gross income reinforce the conclusion regarding the limited importance of tax deductions.

Deductions do not seem central to the Brazilian PIT framework. The elasticity of all deductions (0.15) is four times lower than the ETI under any type of income and approaches zero (0.03) in estimates weighted by income. We find results that are very particular to Brazil. First, ETI (weighted by income) for the self-employed is 0.66 for taxable income and 0.79 for gross income, twice the elasticities of wage earners (0.29 for employees in the private sector and 0.34 for those in the public sector) for taxable income and more than twice the ETI for gross income (0.34 for the private sector and 0.25 for the public sector). Second, the ETI for those opting for simplified deductions (SD: nonitemizers using the simplified form) is higher than for those who choose itemized deductions (ID, using the complete form). The ETI (weighted by income) for SD is 0.66 for taxable income and 0.77 for gross income; for ID, it is 0.45 for taxable income and 0.42 for gross income.

We calculate revenue-maximizing tax rates and marginal efficiency costs based on our ETI estimates weighted by income. We calculate the revenue-maximizing constant rate to be 61% for taxable income and 61.7% for gross income, both as upper-bound limits. The revenue-maximizing top rate is 44.3% for the highest bracket of the Brazilian PIT, and we simulate that rate for the top 1% of the income distribution to be 34.6%. The associated marginal costs of efficiency are -0.91 reais and -2.53 reais, respectively. In the latter case, the efficiency cost would be greater than the tax revenue obtained by the tax increase.

We also simulate a base shift from the personal income tax base to the corporate income tax (dividends) and income from financial investments. In this case, the revenue-maximizing top rate is 47.1%, for the highest bracket of the Brazilian PIT, and we simulate that rate for the top 1% of the income distribution to be 37.8%, The associated marginal costs of efficiency are equal to -0.64 reais and -1.43 reais, respectively.

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9 Tables

Table 1: PIT-exempted income and income taxed at source (2011-2017)

	2011	2012	2013	2014	2015	2016	2017
Gross Taxable Income	1069.9	1196.8	1293.2	1437.5	1522.7	1620.1	1737.1
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)
Dividends and Profits from Small Businesses (SIMPLES) (=A+B)	229.6	255.5	287.3	320.2	334.0	350.3	370.2
	(21.5%)	(21.4%)	(22.2%)	(22.3%)	(21.9%)	(21.6%)	(21.3%)
A. Profits and Dividends	192.6	208.5	231.3	256.2	258.6	269.4	280.6
	(18.0%)	(17.4%)	(17.9%)	(17.8%)	(17.0%)	(16.6%)	(16.2%)
B. Income from Micro/Small Business Owners	37.0	47.0	56.0	64.1	75.4	80.9	89.7
	(3.5%)	(3.9%)	(4.3%)	(4.5%)	(4.9%)	(5.0%)	(5.2%)
Financial Investment Income - RTE	51.1	49.7	45.1	50.7	69.7	83.4	89.9
	(4.8%)	(4.2%)	(3.5%)	(3.5%)	(4.6%)	(5.1%)	(5.2%)

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata.
Note: Values in BRL R$ 2017 (prices adjusted by the IPCA index). The data consist of all tax filers.

Table 2: Summary statistics for the balanced panel of Brazilian tax filers (2011–2017)

Item	**Mean**	**Std. Dev.**
Income received from corporations (mostly wages)	84,293	124,173
Income received from other persons	2,775	62,911
Income received from abroad	92	16,945
Positive result from rural activities	474	36,543
Gross income	87,690	147,511
Exemptions or Simplified Deduction	18,980	45,500
Taxable Income	68,710	126,617
Calculated Tax	9,659	34,070
Share of non-itemizers (simplified form)	52%	
Share of itemizers (complete form)	48%	
N observations	35,000,000	

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata.
Note: Values in BRL R$ 2017 (prices adjusted by the IPCA index). The data consist of a balanced panel of 5,000,000 tax filers.

Table 3: Inflation and tax bracket adjustment in Brazil (2011–2017)

Year	**Consumer price index (IPCA)** (%) **(A)**	**Bracket adjustment** (%) **(B)**	**(A) - (B)**
2011	6.50	4.50	2.00
2012	5.84	4.50	1.34
2013	5.91	4.50	1.41
2014	6.41	4.50	1.91
2015	10.67	4.88	5.79
2016	6.29	1.50	4.79
2017	2.95	0.00	2.95

Source: Brazilian Institute of Geography and Statistics (IBGE) and Brazilian Federal Revenue Agency (RFB).

Table 4: Descriptive statistics for the set of years 2011–2014

Tax Bracket	**Instrument**	**Log** $[(1-T_2)/(1-T_1)]$	**Difference in log taxable income**	**Difference in log gross income**	**Difference in log wages**	**Number of observations**
1	-0.019	-0.057	0.275	0.267	0.309	1,290,969
	[0.033]	[0.082]	[0.853]	[0.819]	[0.861]	
2	-0.008	-0.047	0.115	0.107	0.119	1,312,217
	[0.025]	[0.088]	[0.458]	[0.422]	[0.473]	
3	-0.012	-0.035	0.056	0.055	0.063	728,046
	[0.031]	[0.095]	[0.458]	[0.416]	[0.460]	
4	-0.012	0.002	0.027	0.022	0.030	419,581
	[0.026]	[0.090]	[0.480]	[0.435]	[0.475]	
5	0	0.020	-0.059	-0.053	-0.050	1,249,187
	[0]	[0.064]	[0.524]	[0.465]	[0.496]	
Total	-0.010	-0.027	0.097	0.094	0.110	5,000,000
	[0.026]	[0.088]	[0.614]	[0.573]	[0.616]	

Source: RFB DIRPF (Microdata of Tax Reports) 2011–2017.
Notes:Taxpayers are grouped into tax brackets based on taxable income in the first period/year. Bracket 1 = Exemption, and Bracket 5 = maximum rate.
Standard deviations are in brackets.
Income values are in constant 2017 prices (in Brazilian reais, using the IPCA index).

Table 5: Descriptive statistics for the set of years 2012–2015

Tax Bracket	**Instrument**	**Log** $[(1-T_2)/(1-T_1)]$	**Difference in log taxable income**	**Difference in log gross income**	**Difference in log wages**	**Number of observations**
1	-0.027	-0.048	0.131	0.115	0.172	1,093,402
	[0.037]	[0.079]	[0.909]	[0.871]	[0.893]	
2	-0.019	-0.041	0.024	0.015	0.029	1,243,934
	[0.035]	[0.087]	[0.479]	[0.441]	[0.048]	
3	-0.029	-0.030	-0.024	-0.024	-0.015	801,698
	[0.042]	[0.095]	[0.479]	[0.439]	[0.471]	
4	-0.027	0.005	-0.048	-0.049	-0.041	475,629
	[0.033]	[0.091]	[0.491]	[0.447]	[0.481]	
5	0	0.021	-0.115	-0.107	-0.104	1,385,337
	[0]	[0.066]	[0.541]	[0.482]	[0.507]	
Total	-0.018	-0.019	-0.006	-0.009	-0.009	5,000,000
	[0.034]	[0.087]	[0.622]	[0.579]	[0.608]	

Source: RFB DIRPF (Microdata of Tax Reports) 2011–2017.
Notes:Taxpayers are grouped into tax brackets based on taxable income in the first period/year. Bracket 1 = Exemption, and Bracket 5 = maximum rate.
Standard deviations are in brackets.
Income values are in constant 2017 prices (in Brazilian reais, using the IPCA index).

Table 6: Descriptive statistics for the set of years 2013–2016

Tax Bracket	Instrument	Log $[(1-T_2)/(1-T_1)]$	Difference in log taxable income	Difference in log gross income	Difference in log wages	Number of observations
1	-0.031	-0.048	0.124	0.103	0.155	1,045,853
	[0.038]	[0.079]	[0.929]	[0.889]	[0.912]	
2	-0.027	-0,045	0.005	-0.006	0.007	1,175,865
	[0.039]	[0.875]	[0.492]	[0.453]	[0.494]	
3	-0.041	-0.037	-0.037	- 0.037	-0.029	806,537
	[0.046]	[0.095]	[0.479]	[0.437]	[0.473]	
4	-0.039	-0.003	-0.058	- 0.059	-0.052	510,442
	[0.033]	[0.090]	[0.493]	[0.449]	[0.478]	
5	0	0.020	-0.117	-0.111	-0.108	1,461,303
	[0]	[0.066]	[0.552]	[0.491]	[0.521]	
Total	-0.024	-0.021	-0.019	-0.024	-0.007	5,000,000
	[0.037]	[0.087]	[0.629]	[0.584]	[0.616]	

Source: RFB DIRPF (Microdata of Tax Reports) 2011–2017.
Notes:Taxpayers are grouped into tax brackets based on taxable income in the first period/year. Bracket 1 = Exemption, and Bracket 5 = maximum rate.
Standard deviations are in brackets.
Income values are in constant 2017 prices (in Brazilian reais, using the IPCA index).

Table 7: Descriptive statistics for the set of years 2014–2017

Tax Bracket	Instrument	Log $[(1-T_2)/(1-T_1)]$	Difference in log taxable income	Difference in log gross income	Difference in log wages	Number of observations
1	-0.031	-0.047	0.097	0.080	0.136	984,999
	[0.038]	[0.078]	[0.991]	[0.948]	[0.974]	
2	-0.031	-0.046	-0.019	-0.029	-0.015	1,078,140
	[0.041]	[0.089]	[0.546]	[0.505]	[0.548]	
3	-0.045	-0.038	-0.055	-0.053	-0.047	813,621
	[0.046]	[0.097]	[0.525]	[0.482]	[0.523]	
4	-0.042	-0.003	-0.072	-0.071	-0.065	530,487
	[0.032]	[0.092]	[0.533]	[0.486]	[0.519]	
5	0	0.023	- 0.130	- 0.121	- 0.120	1,592,753
	[0]	[0.070]	[0.610]	[0.546]	[0.577]	
Total	-0.025	-0.018	-0.043	-0.045	-0.029	5,000,000
	[0.038]	[0.089]	[0.677]	[0.628]	[0.663]	

Source: RFB DIRPF (Microdata of Tax Reports) 2011–2017.
Notes:Taxpayers are grouped into tax brackets based on taxable income in the first period/year. Bracket 1 = Exemption, and Bracket 5 = maximum rate.
Standard deviations are in brackets.
Income values are in constant 2017 prices (in Brazilian reais, using the IPCA index).

Table 8: (Unweighted) Elasticities of taxable and gross income in Brazil (2011–2017)

Control Variable	**Taxable Income**				**Gross Income**			
	eq1	**eq2**	**eq3**	**eq4**	**eq5**	**eq6**	**eq7**	**eq8**
Elasticity	1.0091***	2.2473***	1.9941***	0.7628***	0.8099***	1.8247***	1.6171***	0.7110***
	(0.0085)	(0.0118)	(0.0184)	(0.0102)	(0.0078)	(0.0106)	(0.0152)	(0.0098)
d_itemizer	0.0088***	0.1069***	0.1019***	0.0784***	0.0454***	0.1669***	0.1662***	0.1257***
	(0.0004)	(0.0005)	(0.0006)	(0.0004)	(0.0004)	(0.0006)	(0.0006)	(0.0004)
d_year== 2014	0.1337***	0.0734***	0.0715***	0.0938***	0.1316***	0.0744***	0.0729***	0.0941***
	(0.0005)	(0.0005)	(0.0005)	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0004)
d_year== 2015	0.0679***	0.0290***	0.0294***	0.0486***	0.0669***	0.0309***	0.0313***	0.0471***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0003)
d_year== 2016	0.0600***	0.0412***	0.0412***	0.0485***	0.0564***	0.0392***	0.0392***	0.0452***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
log(taxable income) - control		-0.2653***	-0.2989***					
		(0.0010)	(0.0023)					
log(gross income) - control						-0.2510***	-0.2769***	
						(0.0010)	(0.0020)	
Taxable Income - control (polyn.)			0.0724***				0.0552***	
			(0.0045)				(0.0034)	
Taxable Income2 - control (polyn.)			-0.0002***				-0.0001***	
			(0.00004)				(0.00003)	
Spline_1st decile control				-0.5367***				-0.5132***
				(0.0051)				(0.0053)
Spline_2nd decile control				-0.3222***				-0.1639***
				(0.0146)				(0.0134)
Spline_3rd decile control				0.2919***				0.3451***
				(0.0079)				(0.0065)
Spline_4th decile control				0.0714***				-0.2129***
				(0.0059)				(0.0046)
Spline_5th decile control				-0.3045***				-0.1194***
				(0.0054)				(0.0045)
Spline_6th decile control				-0.0892***				-0.1392***
				(0.0045)				(0.0043)
Spline_7th decile control				-0.2326***				-0.2098***
				(0.0047)				(0.0040)
Spline_8th decile control				-0.1328***				-0.1960***
				(0.0031)				(0.0031)
Spline_9th decile control				-0.0627***				-0.0637***
				(0.0023)				(0.0024)
Spline_10th decile control				-0.1806***				-0.1584***
				(0.0017)				(0.0016)
Constant	0.1625***	2.9471***	3.2579***	5.3922***	0.1386***	2.8267***	3.0727***	5.2519***
	(0.0005)	(0.0104)	(0.0219)	(0.0473)	(0.0004)	(0.0112)	(0.0195)	(0.0498)
1^{st} stage:**log** $[(1-T'_p)/(1-T'_1)]$	0.5678***	0.5121***	0.5172***	0.4881***	0.5678***	0.5244***	0.5223***	0.4752***
	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0007)	(0.0007)
N. observations	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000

Source: RFB DIRPF (Microdata of Tax Reports) 2011–2017.
Notes: 2SLS estimates for the balanced panel. All taxpayers have gross income different from zero in all years.
Three-year difference intervals are considered.
Standard errors are in brackets.
* p<0.10, ** p<0.05, *** p<0.01

Table 9: Weighted (by income) elasticities of taxable and gross income in Brazil (2011–2017)

Control Variable	**Taxable Income**				**Gross Income**			
	eq1	**eq2**	**eq3**	**eq4**	**eq5**	**eq6**	**eq7**	**eq8**
Elasticity	-1.7293***	1.3738***	1.2145***	0.6364***	-1.4950***	0.9258***	0.8168***	0.6247***
	(0.0172)	(0.0562)	(0.0465)	(0.0139)	(0.0142)	(0.0477)	(0.0367)	(0.0102)
d_Complete_Form	0.0431***	0.1635***	0.1583***	0.1481***	0.0856***	0.2049***	0.1998***	0.1937***
	(0.0013)	(0.0024)	(0.0020)	(0.0013)	(0.0011)	(0.0025)	(0.0021)	(0.0012)
d_year== 2014	0.0718***	0.0510***	0.0524***	0.0555***	0.0714***	0.0498***	0.0510***	0.0530***
	(0.0018)	(0.0017)	(0.0014)	(0.0016)	(0.0014)	(0.0014)	(0.0012)	(0.0013)
d_year== 2015	0.0550***	0.0362***	0.0373***	0.0408***	0.0537***	0.0353***	0.0361***	0.0376***
	(0.0014)	(0.0014)	(0.0012)	(0.0013)	(0.0011)	(0.0011)	(0.0009)	(0.0010)
d_year== 2016	0.0492***	0.0423***	0.0428***	0.0431***	0.0458***	0.0387***	0.0391***	0.0392***
	(0.0017)	(0.0015)	(0.0012)	(0.0014)	(0.0013)	(0.0012)	(0.0010)	(0.0011)
log(taxable income) - control		-0.1913***	-0.1770***					
		(0.0041)	(0.0053)					
log(gross income) - control						-0.1759***	-0.1645***	
						(0.0042)	(0.0047)	
Taxable Income - control (polyn.)			-0.0025				-0.0017	
			(0.0018)				(0.0016)	
Taxable Income2 - control (polyn.)			2 x 10 -6				2.7 x 10 -7	
			(2.5 x 10 -6)				(2.0 x 10-6)	
Spline_1st decile control				-0.4496***				-0.4416***
				(0.0016)				(0.0016)
Spline_2nd decile control				-0.5443***				-0.3221***
				(0.0052)				(0.0048)
Spline_3rd decile control				0.3407***				0.3090***
				(0.0068)				(0.0049)
Spline_4th decile control				0.0249***				-0.2304***
				(0.0062)				(0.0045)
Spline_5th decile control				-0.2772***				-0.1271***
				(0.0059)				(0.0045)
Spline_6th decile control				-0.1049***				-0.1507***
				(0.0046)				(0.0045)
Spline_7th decile control				-0.1854***				-0.1890***
				(0.0058)				(0.0050)
Spline_8th decile control				-0.1841***				-0.2296***
				(0.0091)				(0.0088)
Spline_9th decile control				-0.0235				-0.0505***
				(0.0168)				(0.0175)
Spline_10th decile control				-0.2406***				-0.2008***
				(0.0106)				(0.0106)
Constant	0.0202***	2.1263***	1.9726***	4.5705***	0.0118***	1.9815***	1.8550***	4.5662***
	(0.0012)	(0.0453)	(0.0560)	(0.0149)	(0.0010)	(0.0464)	(0.0512)	(0.0149)
1^{st} stage:**log** $[(1-T'_p)/(1-T'_1)]$	0.7112***	0.5805***	0.5546***	0.5235***	0.7207***	0.5974***	0.5740***	0.5128***
	(0.0008)	(0.0020)	(0.0015)	(0.0008)	(0.0008)	(0.0019)	(0.0014)	(0.0008)
N. observations	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000

Source: RFB DIRPF (Microdata of Tax Reports) 2011–2017.
Notes: 2SLS estimates for the balanced panel. All taxpayers have gross income different from zero in all years.
Three-year difference intervals are considered.
Standard errors are in brackets.
* p<0.10, ** p<0.05, *** p<0.01

Table 10: Elasticities of taxable income in Brazil: estimates for different time windows (2011–2017)

Income	1 year	2 years	3 years	4 years	5 years	6 years
Taxable Income - unweighted	0.93*** (0.01)	0.81*** (0.01)	0.76*** (0.01)	0.70*** (0.01)	0.56*** (0.02)	0.66*** (0.03)
Taxable Income - weighted	0.62*** (0.01)	0.64*** (0.01)	0.64*** (0.01)	0.51*** (0.01)	0.41 (0.02)	0.38*** (0.03)
Gross Income - unweighted	0.78*** (0.01)	0.71*** (0.01)	0.71*** (0.01)	0.73*** (0.01)	0.73*** (0.02)	0.62*** (0.02)
Gross Income - weighted	0.57*** (0.01)	0.59*** (0.01)	0.62*** (0.01)	0.58*** (0.01)	0.60*** (0.01)	0.49*** (0.03)
Observations	30,000,000	25,000,000	20,000,000	15,000,000	10,000,000	5,000,000

Source: 2SLS Estimates based on RFB DIRPF (Tax Reports) 2011–2017, microdata
Notes: 2SLS Estimates for the balanced panel. All taxpayers with gross income different from zero in all years.
* p<0.10, ** p<0.05, *** p<0.01

Table 11: Elasticities of taxable income in Brazil for nonitemized and itemized deductions (2011–2017)

Itemized Deductions (Complete form)		
	Taxable Income	**Gross Income**
unweighted	0.40*** (0.01)	0.42*** (0.01)
weighted	0.45*** (0.02)	0.42*** (0.01)
observations	9,742,093	9,742,093
Nonitemized Deductions (Simplified Form)		
	Taxable Income	**Gross Income**
unweighted	1.00*** (0.02)	0.97*** (0.02)
weighted	0.66*** (0.02)	0.77*** (0.01)
observations	10,257,907	10,257,907

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata
Notes: 2SLS estimates with balanced panel and taxpayers with both incomes different from zero in all years .
Three-year difference.
* p<0.10, ** p<0.05, *** p<0.01

Table 12: Elasticities of taxable income in Brazil: estimates for five taxable income brackets

	Taxable Income	**Gross Income**
	1st Bracket without the self-employed- R$ 0.00 to R$ 18799.32	
unweighted	1.0878***	1.0635***
	(0.0386)	(0.0291)
weighted	0.6167***	0.9225***
	(0.0319)	(0.0249)
observations	3,319,610	3,319,610
	1st Bracket -All- R$ 0.00 to R$ 18799.32	
unweighted	2.98***	3.10***
	(0.06)	(0.04)
weighted	1.98***	2.18***
	(0.04)	(0.03)
observations	5,163,876	5,163,876
	2nd Bracket -All- R$ 18799.33 to R$ 28174.20	
unweighted	0.06***	0.03**
	(0.01)	(0.01)
weighted	0.07***	0.007
	(0.01)	(0.01)
observations	5,248,868	5,248,868
	3rd Bracket -All- R$ 28174.21 to R$ 37566.12	
unweighted	0.07***	0.07***
	(0.02)	(0.01)
weighted	0.10***	0.03**
	(0.02)	(0.01)
observations	2,912,184	2,912,184
	4th Bracket -R$ 37566.13 to R$ 46939.56	
unweighted	0.10***	0.18***
	(0.02)	(0.02)
weighted	0.18***	0.22***
	(0.03)	(0.02)
observations	1,678,324	1,678,324
	5th Bracket -All- Above R$ 46939.56	
unweighted	0.52***	0.87***
	(0.04)	(0.03)
weighted	0.71***	1.25***
	(0.05)	(0.04)
observations	4,996,748	4,996,748

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata
Notes: Taxable income in 2011 (base year), values in BRL R$ 2011 (IPCA)
2SLS estimates with balanced panel and taxpayer with taxable income different from zero for all years
Three-year difference pattern
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 13: Elasticities of taxable income in Brazil, by type of job

	Taxable Income	**Gross Income**
	Wage earner (public sector)	
unweighted	0.19***	0.11**
	(0.01)	(0.01)
weighted	0.34***	0.25***
	(0.01)	(0.01)
observations	5,944,300	5,944,300
	Wage earner (private sector)	
unweighted	0.24***	0.24***
	(0.01)	(0.01)
weighted	0.29***	0.34***
	(0.02)	(0.02)
observations	5,834,678	5,834,678
	Self-Employed	
unweighted	1.28***	1.65***
	(0.04)	(0.04)
weighted	0.66***	0.79***
	(0.06)	(0.05)
observations	3,614,482	3,614,482

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata
Notes:Taxable income in 2011 (base year), values in BRL R$ 2011 (IPCA
2SLS estimates with balanced panel and taxpayer with taxable income different from zero for all years
Three-year difference pattern
* p<0.10, ** p<0.05, *** p<0.01

Table 14: Elasticities of taxable income for deductions of gross income

	All deductions
unweighted	-0.15***
	(0.03)
weighted	-0.03**
	(0.01)
observations	20,000,000
	Simplified Deduction
unweighted	-0.04**
	(0.02)
weighted	-0.10***
	(0.02)
observations	10,257,907
	Medical deductions
unweighted	-1.56***
	(0.09)
weighted	-0.05
	(0.10)
observations	9,742,093
	Private pension funds deduction
unweighted	-0.25***
	(0.06)
weighted	-0.16**
	(0.07)
observations	9,742,093

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata
Notes: 2SLS estimates with balanced panel and taxpayer with taxable income different from zero for all years
Three-year difference pattern
* p<0.10, ** p<0.05, *** p<0.01

Table 15: Revenue-Maximizing tax rates as a function of the elasticity of total income (e) and the Pareto coefficient (a)

$a \backslash e^{TI}$	**0.2**	**0.4**	**0.5**	**0.6**	**0.8**	**1**	**1.2**
1.75	74.1	58.8	53.3	48.8	41.7	36.4	32.3
2.00	71.4	55.6	50.0	45.5	38.5	33.3	29.4
2.25	69.0	52.6	47.1	42.6	35.7	30.8	27.0
2.50	66.7	50.0	44.4	40.0	33.3	28.6	25.0

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata.
Notes:(e) = ETI, (a) = Pareto coefficient

Table 16: Maximizing rates for the highest bracket and top incomes and marginal efficiency losses

Parameters	**Without base shift**		**With base shift** ($s = 0.3$; $t = 0.185$)	
	$a = 1.77$	$a = 2.66$	$a = 1.77$	$a = 2.66$
$e^{TI} = 0.71$	$\tau^* = 44.3\%$	$\tau^*(1\%) = 34.6\%$	$\tau^* = 47.4\%$	$\tau^*(1\%) = 38.2\%$
$\tau = 0.275$	$EC = -0.91$ reais	$EC = -2.53$ reais	$EC = -0.61$ reais	$EC = -1.34$ reais

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata.

10 Figures

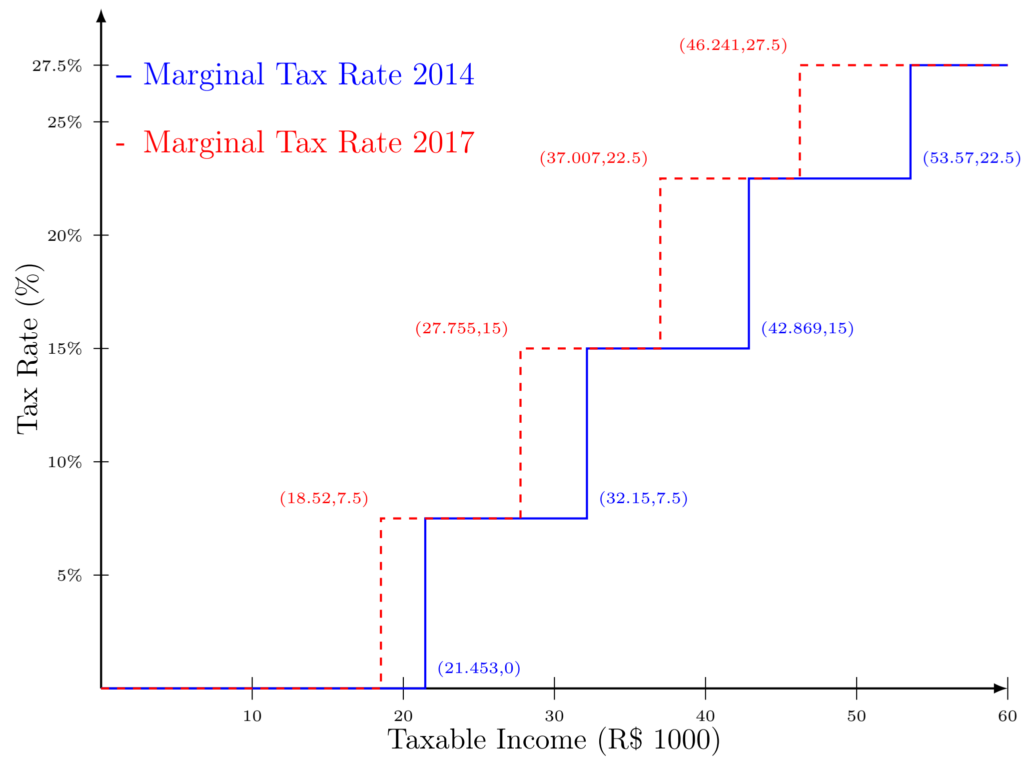
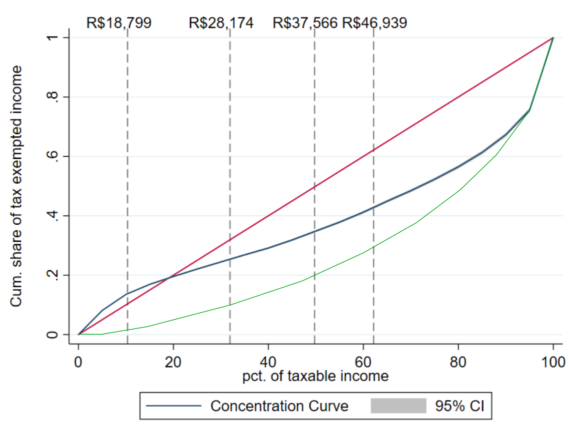
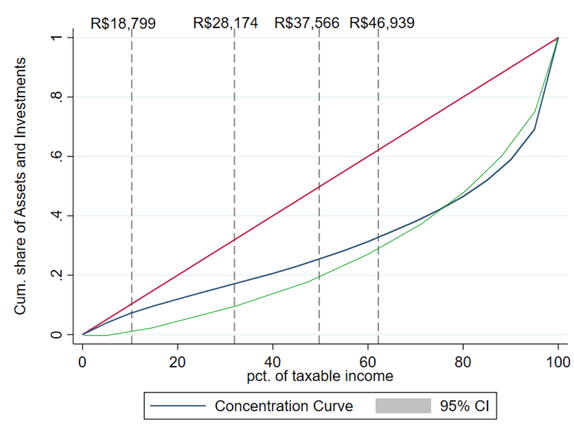


Figure 1: Bracket creep: effect of inflation on tax rates between 2014 and 2017

Note: The levels of the marginal tax rate represent the marginal tax rates outlined in the Brazilian Personal Income Tax (PIT) schedule throughout the period under examination. The taxable income levels in 2014 correspond to the official thresholds, while the thresholds for 2017 have been adjusted for inflation.



(a) PIT exempted income



(b) Assets and Investments

Figure 2: The Concentration Curves of PIT exempted income and assets and investments in 2011

Note: The lowermost green curve in the figures represent the Lorenz Curve of Taxable Income in 2011.

11 Appendix

Appendix 1 – The calculus of taxable income and income tax

The tax is calculated according to the following tax scheme:

(=) Gross Income (sum of the following components)

- (+) income received from corporations (for most part, wages)
- (+) income received from individuals
- (+) income received from abroad
- (+) positive result from the rural activity

(-) Deductions (or simplified discount)

- (-) Social Security Contribution for Public Pension Funds
- (-) Contribution to Private Pension Funds (limited to 12
- (-) Dependents deduction (fixed value per dependent)
- (-) Education Expenses (limited to a fixed value)
- (-) Medical Expenses
- (-) Judicial Alimony
- (-) Cash book (used by certain professional activities, such as medicine and notaries)

(=) Taxable Income

(×) Application of the annual progressive table on the taxable income

(=) Calculated Tax

(-) Deductions from calculated tax:

- (-) Incentives (charities, among others, limited to 6% of calculated tax)

(=) Tax liability

- (-) source withholding

(-) other payments obliged by law

(-) Tax paid abroad

(=) Balance of Tax, Payable or Refundable

Appendix 2 – Sensitivity tests to data censoring and interpolations

Data censoring

Table A.1 shows our estimates with censored data. It compares the original estimates with those considering different types of censoring, such as absolute income thresholds and combinations of absolute thresholds and variations in the logarithmic difference in income (in modulus), similar to the criteria adopted by Gruber and Saez (2002) to minimize mean reversion in their findings. The estimates are robust to subsetting.

Interpolations

We also verify the sensitivity to changes in the interpolation methods used to produce distributions of income by increasing the number of spline controls (deciles) and using cubic splines, rather than linear splines.

Table A.2 shows the results for two different spline configurations. In column (1), we show our original estimate. In column (2), we run regressions for a 15-segment spline. In column (3), we run regressions for a 10-segment cubic spline.

The estimates are invariant to changes in the specification of splines. The maximum variation was approximately 28%. An exception is the unweighted estimates of gross income, which show sensitivity to mean reversion in the base of the income distribution.

Table A.1: Robustness of elasticity of taxable income estimates to censoring

Taxable Income								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
unweighted	0.76***	0.78***	0.78***	0.65***	0.66***	0.73***	0.74***	0.79***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
weighted	0.64***	0.60***	0.59***	0.60***	0.60***	0.60***	0.59***	0.60***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Gross Income								
unweighted	0.71***	0.46***	0.45***	0.89***	0.88***	0.65***	0.62***	0.46***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
weighted	0.62***	0.60***	0.59***	0.59***	0.59***	0.60***	0.59***	0.59***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
observations	20,000,000	19,917,985	19,807,855	19,975,149	19,982,236	19,915,518	19,801,530	19,949,390

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata// Notes: Column (1): Original estimates (uncensored); Column (2): Estimates for fillers with taxable income > R$ 2500.00; Column (3): Estimates for fillers with taxable income $> R\$5000.00$; Column (4): Estimates for fillers with $|log(z1/z2)| < 5$; Column (5): Estimates for fillers with $|log(z1/z2)| < 7$; Column (6): Estimates for fillers with taxable income $> R\$2500.00$ and $|log(z1/z2)| < 7$; and Column (7): Estimates for fillers with taxable income $> R\$5000.00$ and $|log(z1/z2)| < 7$.
2SLS estimates with balanced panel and taxpayers with both incomes different from zero in all years.
Three-year difference. * p<0.10, ** p<0.05, *** p<0.01.

Table A.2: Robustness of elasticity of taxable income estimates to spline specifications

Weighting	**(1)**	**(2)**	**(3)**
		Taxable Income	
unweighted	0.76***	0.77***	0.79***
	(0.01)	(0.01)	(0.02)
weighted	0.64***	0.62***	0.50***
	(0.01)	(0.01)	(0.02)
		Gross Income	
unweighted	0.71***	0.71***	0.69***
	(0.01)	(0.01)	(0.01)
weighted	0.62***	0.59***	0.56***
	(0.01)	(0.01)	(0.01)
observations	20000000	20000000	20000000

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata
Notes: Column (1): Original Estimates – 10 piece splines of income logarithm; Column (2): Estimates with 15 piece splines of income logarithm; and Column (3): Estimates with 10 piece cubic splines of income logarithm.
2SLS estimates with balanced panel and taxpayers with both incomes different from zero for all years .
Three-year difference.// * p<0.10, ** p<0.05, *** p<0.01

Appendix 3 – Pareto parameters used to define thresholds for the higher bracket and the hypothetical top 1% bracket

Table A.3: Pareto parameters used to define thresholds for the higher bracket and the hypothetical top 1% bracket, Brazil, 2007–2011

Year	Threshold	z^m	a
Highest observed bracket			
2011	46,940	108,831	1.76
2012	49,052	112,454	1.77
2013	51,529	115,501	1.81
2014	53,566	120,769	1.80
2015	55,374	126,599	1.78
2016	55,976	129,003	1.77
2017	55,976	131,593	1.74
Average			1.77
Top 1% hypothetical bracket			
2011	189,200	307,069	2.61
2012	203,100	329,525	2.61
2013	215,103	340,988	2.71
2014	228,891	364,484	2.69
2015	253,314	407,512	2.64
2016	269,247	433,503	2.64
2017	277,190	437,139	2.73
Average			2.66

Source: RFB DIRPF (Tax Reports) 2011–2017, microdata.

Appendix 4 – Optimal taxation and marginal excess burden by monetary unit of extra taxes collected

Saez (2001) and Piketty and Saez (2013) describe the optimal taxation model framework using the elasticity in (8). We follow Saez et al. (2012) and use the formula

$$\tau^* = \frac{1}{1 + a \cdot e} \tag{13}$$

to obtain the revenue-maximizing tax rate for the top bracket is τ^*.

When the tax system has a single tax rate the tax-revenue maximizing rate becomes:

$$\tau^* = \frac{1}{1 + e} \tag{14}$$

When base shift occurs, the revenue-maximizing tax rate is:

$$\tau_s^* = \frac{1 + s \cdot t \cdot a \cdot e}{1 + a \cdot e} > \tau^* \tag{15}$$

if a fraction $s < 1$ of income disappears from the personal income tax base following a tax increase $d\tau$ and is shifted to other bases, to be taxed at average rate t.

We calculate marginal excess burden per monetary unit of extra taxes collected as:

$$-\frac{dB}{dT} = \frac{e \cdot a \cdot \tau}{(1 - \tau) - e \cdot a \cdot \tau} \tag{16}$$

And in case of base shift as:

$$-\frac{dB}{dT} = \frac{e \cdot a \cdot (\tau - s \cdot t)}{(1 - \tau) - e \cdot a \cdot (\tau - s \cdot t)} \tag{17}$$