Why do workers of smaller firms bunch more at the kinks of the income tax schedule?

Armando Barros* Luciano Greco† Enlinson Mattos‡

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Abstract

We investigate the behavioral response of workers to the labor income tax schedule. Our contributions are threefold. First, we extend the theoretical framework *à la* Chetty et al. (2011) to show that, unless search costs are negligible, informality fosters bunching at kinks of the tax schedule, which brings to larger estimates of the elasticity of the formal labor income to tax changes. Second, we leverage administrative matched employer-employee data in a period of significant differences in tax rates across thresholds (larger potential tax savings) to test formal wage earners' elasticity of earnings for changes in marginal tax rates from the Brazilian federal income tax schedule. Third, we show that individuals bunched only at the second kink point of the tax schedule in years of large tax savings possibility (2006-2008), suggesting a sophisticated behavioral response. The smaller the firms are, the larger the estimated response-elasticity of workers, which corroborates our testable predictions. Moreover, the effect is significantly stronger for small firms under the Brazilian simplified tax regime, which highlights the importance of the degree of informality (e.g., of firms, sectors) to explain bunching at the kinks of income tax schedule.

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*São Paulo School of Economics (EESP FGV)
†University of Padua (dSEA and CRIEP)
‡São Paulo School of Economics (EESP FGV)

1 Introduction

Income tax is the main instrument for government financing and redistributive policy for most countries, with two key ingredients to determine the tax burden on individuals: the tax rates and the income thresholds (Atkinson and Stiglitz, 1976; Stiglitz, 1982). The empirical literature addressed the estimation of the taxpayer's responses to the income tax schedule (Saez, 2010; Bastani and Selin, 2014; Bosch et al., 2020; Doerrenberg et al., 2017; Kleven and Waseem, 2013; le Maire and Schjerning, 2013; Mavrokonstantis and Seibold, 2022; Saez et al., 2012), highlighting the importance of labor market frictions in the behavioral responses of taxpayers (Chetty et al., 2011; Best et al., 2014). Although, the literature has paid attention to the role of firms in determining the wage of formal workers (Kopczuk and Slemrod, 2006), most of the papers focus on firms' responses to size-dependent tax-policies (Saez et al., 2012; Best et al., 2015; Ulyssea, 2018; Monteiro and Assuncao, 2012; Piza, 2018) to identify firms' responses to taxes. This paper contributes to this agenda by focusing on how the interplay between formal and informal economies can affect the incentives of individuals and firms in the formal sector of the economy, which is less investigated in the literature.

The first part of the paper extends the model proposed by Chetty et al. (2011) to include both formal and informal labor markets. In our model, formal labor income is subject to a non-linear income tax, while informal labor income involves sheltering costs (Mayshar, 1991; Slemrod, 2001; Keen and Slemrod, 2017). Our main theoretical findings read as follows. In a framework without search costs in the formal labor market, the mix of formal and informal labor supply does not affect the theoretical measure of bunching. Hence, the estimation of labor elasticity converges to the theoretical parameter. Search costs deflate bunching and, hence, the estimation of labor elasticity (Chetty et al., 2011). However, this effect is influenced by the behavior of the informal labor supply. Particularly, the degree of informality of the activity of the considered firm (or sector of the economy) tends to inflate bunching and, thus, increase the estimated labor elasticity. Government policies, which typically affect searching costs or, more related to our main interest, sheltering costs, impact workers' (and firms') behavioral response to labor income tax. As highlighted in the literature, firms' size (in terms of number of formal employees) is likely to be a very good proxy of the degree of informality, given that smaller firms face smaller sheltering cost to informality and have larger flexibility to determine formal wages and fringe benefits. This second piece of the model suggests that the workers should present some level of sophistication to match the firms' labor contracts. Another approach to test our main theoretical predictions is to exploit the fact that small firms that participate simplified tax regimes are very likely to be more informal than other (similar) firms under the ordinary tax regimes.

The second part of the paper deals with our empirical strategy. We combine three data sets. First, we consider matched employer-employee administrative data from 2002 to 2018 to collect individual reported wages using all the universe of formal workers in Brazil, the Annual Social Information Survey (RAIS). Firms are responsible for withholding employee income taxes and monthly reporting to the tax authority values. Firms must also report detailed information about workers and plants via RAIS to the Brazilian Ministry of Labor. For workers, RAIS includes information about earnings, race, gender, education, and age. It also brings information about plant size, economic sector, location, and legal formation, with information on all formal jobs for the pair employee-employer for that survey year. We explore each individual's earnings reported by the firms in our period. Second, we also explore data on the representative Brazilian Survey PNAD (Survey on Current Population, Residence-based)[1] to capture workers out of the formal market and the self-employed ones[2]. Third, we compile the legislation on the Income tax in Brazil associated with aggregated data on income taxes collected and local government expenses to build a map with tax rates, exemption thresholds, income tax thresholds, and income tax collected. Our data reveals that (i) only 40 million (out of 120 million from the economically active population) individuals are in the formal sector; (ii) this figure is very different for each Brazilian state, going from as low as 42% (Maranhão) up to 88% (Santa Catarina) of formal workers, (iv) most of income taxes are collected from other-than-labor income, (v) while we observe a massive reduction in the lowest tax rate in 2009 (15% to 7.5%), there is no explicit policy on exemption threshold, other than inflation erosion due to the lack of nominal adjustment, and (vi) the living cost (as well as the level of publicly provided goods) is very different across Brazilian states. For instance, in São Paulo, the living cost is 80% larger than in Sergipe. The provision of goods and services by decentralized (i.e., State and local) governments follows this pattern but also presents idiosyncrasies related to population

[1] Pesquisa Nacional de Amostra Domiciar.

[2] Estimations for PNAD and PNADC can be found in the Appendix.

preferences.

Finally, our paper investigates taxpayers' responses to the federal income tax schedules using the bunching technique (Saez, 2010; Chetty et al., 2011). The results suggest that individuals bunch in the earnings level associated with changes in the marginal tax rates between the second and third income bracket. The first consistent results appeared in 2006, when the Simples Nacional presumptive tax regime was legally introduced, and firms were automatically assigned to it, culminating in 2008, when bunching achieved its maximum. Not only was increase in bunching masses observed in 2006-2008, but it was also monotonically correlated with firm size. In particular, the smaller the firms are, the more significant the evidence of bunching. This corroborates the idea presented in our theory that smaller firms are more subject to informality and, thus, are less constrained by frictions to manipulate employees' earnings, which in turn makes it less costly for them to bunch. We estimate an elasticity of taxable income 0.004 in 2008. The estimated elasticity jumps to 0.014 when we restrict the sample to the small firms. Firms under the special, simplified tax regime (Simples Nacional) perform almost twice larger bunching mass (0.027) compared to small firms. The mentioned evidence corroborates the mechanism highlighted by our theoretical analysis that informality relaxes labor market frictions thus bringing to larger bunching. Our results also suggest that bunching is virtually absent before 2006 and after 2008, and its size, statistical significance and pervasiveness at the second threshold of the federal income tax schedule using alternative sub-samples of the RAIS dataset peaks in 2008. While the drop in bunching in the period 2009-2018 is consistent with smaller tax savings, the absence of it before 2006 and its growth in the period 2006-2008 is likely to be driven by the importance of inflation uncertainty which reduces the ability of firms and workers to bunch and actually drops in the 2006-2008 period.

Our paper contributes to the literature on income tax elasticity in three directions. First, our theoretical model extends the analysis of the estimation of labor elasticity by bunching (Saez, 2010; Chetty et al., 2011; Slemrod, 2001; Saez et al., 2012) in two ways: it highlights the importance of the mix between formal and informal labor supply and of the sheltering costs, which in turn are likely to be driven by firms' size. Second, we explore matched employee-employer data on wage earnings reported by firms (total sample of third-part reporting) to document the response of exclusive formal workers, different from the literature that considers tax return of self-employed workers (Jales, 2018; Bastani and Selin, 2014; Doerrenberg et al., 2017; le Maire and Schjerning, 2013; Mavrokonstantis and Seibold, 2022). Third, we explore variation in time (2006 - 2009) across firms' size, workers' age and tenure to estimate the elasticity of taxable income for wage earners exploring the role of differences in proxies of the cost of tax avoidance and tax evasion in Brazil, a developing country with only 42% of the economically active population accountable to remit labor income taxes.

The paper is divided as follows. The next section describes the institutional background in Brazil, focusing on the changes in the income tax policy in our period of analysis. Section 3 presents a simple theoretical model. Section 4 presents our data and brings our empirical strategy. Section 5 discusses our main results and the final section concludes.

2 Institutional background

2.1 *Receita Federal* and taxes at the federal level

The Brazilian tax authority, *Receita Federal do Brasil*[3], is a federal autarky which was under the Ministry of Economy/Finance. It is responsible for managing the federal revenues from taxation, social security, and customs. It also manages tax policy formulation, customs control, smuggling, and other related activities.[4]

The federal taxes collected by *Receita Federal* account for about 65% of all public revenues in Brazil, the rest being mostly composed of social security contributions. One of these taxes is the income tax on individuals (IRPF, or IR), the main object of analysis here.

2.2 Individual income tax (IR)

The individual income tax (IR) was first introduced in Brazil in 1922, with the main objective to finance health, education, and urban development with rates varying between 8 and 20% progressively (da Nóbrega

[3]Short for *Secretaria Especial da Receita Federal do Brasil.*

[4]More detailed functions of *Receita Federal* with a complete list of public revenue sources from taxes and contributions is in the Appendix A.2.

and da Receita Federal, 2004). The Ministry of Finance was initially responsible for the collection, but with population and workforce growth, a new federal autarky, *Serviço Federal de Processamento de Dados* (Serpro), was created for tax collection in 1964. Finally, in 1968, the Serpro was substituted by the *Receita Federal*, which has remained responsible for tax matters since then.

Below, in Figure 1, we see how the IR brackets vary yearly, with their respective tax rates. Note that, in 2008, a tax reform adjusted the marginal rates from 15 - 27.5% to 7.5 - 15 - 22.5 - 27.5%. We can also check the marginal tax savings from staying right under each kink, computed as the rate above minus the rate below each kink. We interpret it as the marginal tax payment avoided by manipulating (e.g., by tax sheltering) the taxable income. For instance, in 2002-2008, the tax savings for staying in the second bracket instead of the third would be 12.5% (27.7% minus 15%). This kink provides the second-largest savings potential, behind only the first kink of 2008. The Appendix contains complete details on the individual IR tax schedule for 1998-2022. Additionally, Figure 2 displays the size of each group falling under a certain tax bracket. Note how, for the formal labor market administrative data, about 74.4% of the workers are tax-exempt; that is, they fall under the first bracket.

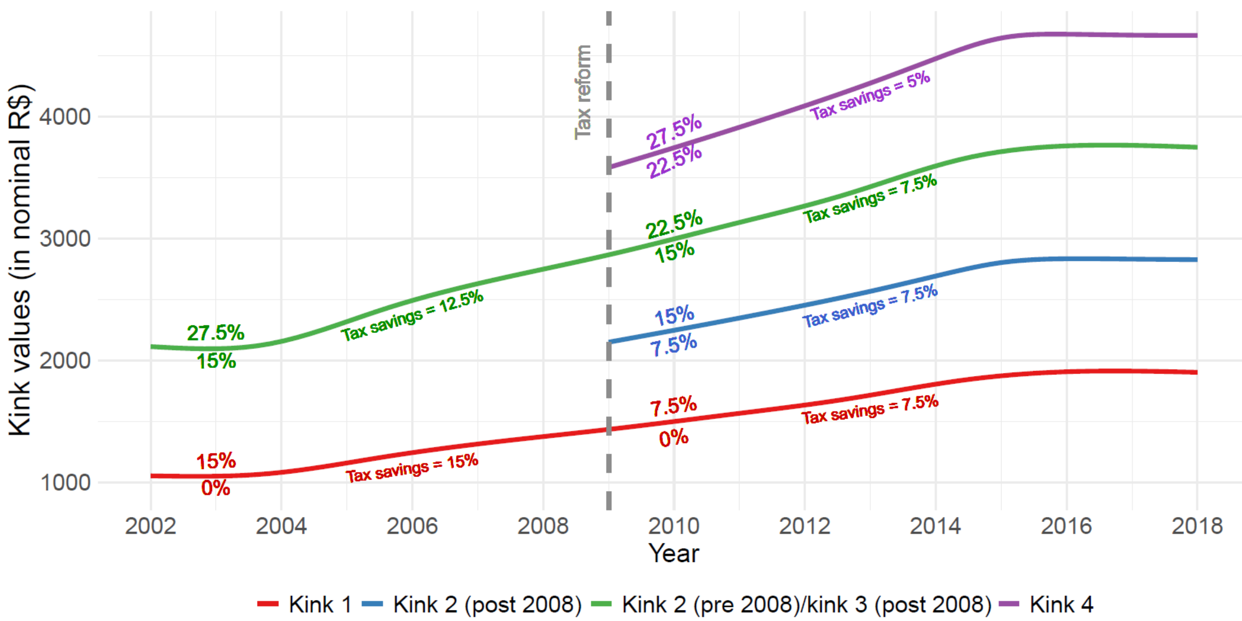
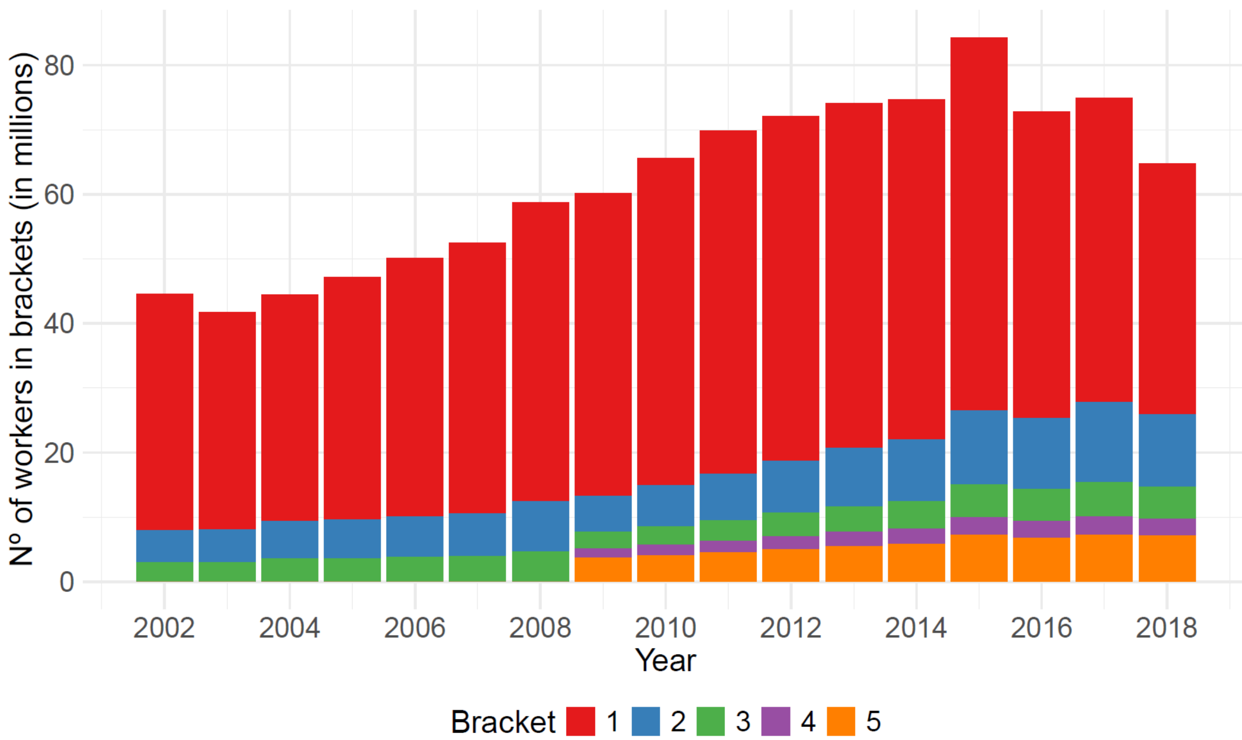


Figure 1: Brazilian income tax schedule, 2002-2018

Note: The figure describes the evolution of the income tax rates and brackets from 2002 to 2018. The y-axis refers to the taxable income from labor associated with each kink. The numbers below and above each line refer to the marginal tax rate under and above the kink, respectively. The "tax savings" labels refer to the marginal tax saved by receiving non-taxable payments (instead of wages) that would make earnings surpass the associated kink. It is computed by subtracting the rate above the kink from the one below.

Figure 2: Workers in each tax bracket, 2002-2018



Note: The figure describes the number of individuals in the formal labor market (data from employer-employee matched administrative data) under each tax bracket. Each bracket is defined as the taxable income that falls between two kinks, i.e., bracket two (2) refers to the income between the first and second kink values for a given year, while bracket 1 refers to the income under the first kink of that year.

Most of the individual tax is collected through the income taxes, or *Imposto de Renda Retido na Fonte* (IRPF), which follows a tax withholding mechanism: throughout the year, employers (and other income generators) act as third party collectors, directing taxes withheld to the *Receita Federal*, following the tax schedule associated with the respective year. The income tax withheld for a given worker is collected over wage net of social security contributions and tax credits from dependents as follows:

$$T = \tau(\tilde{w}) - nc$$

Where T are total taxes withheld for a given wage earner; $\tilde{w} = w - \text{INSS}(w)$ is wage net of social security (INSS), with $\text{INSS}(w)$ being the amount of contribution associated with gross wage w. $\tau(\tilde{w})$ is the income tax associated with $\tilde{w}$. In other words, formal workers pay taxes on their wages net of social security contributions. Finally, $n \in \mathbb{N}$ is the number of dependents, and c is the tax credit for each dependent, in R$.

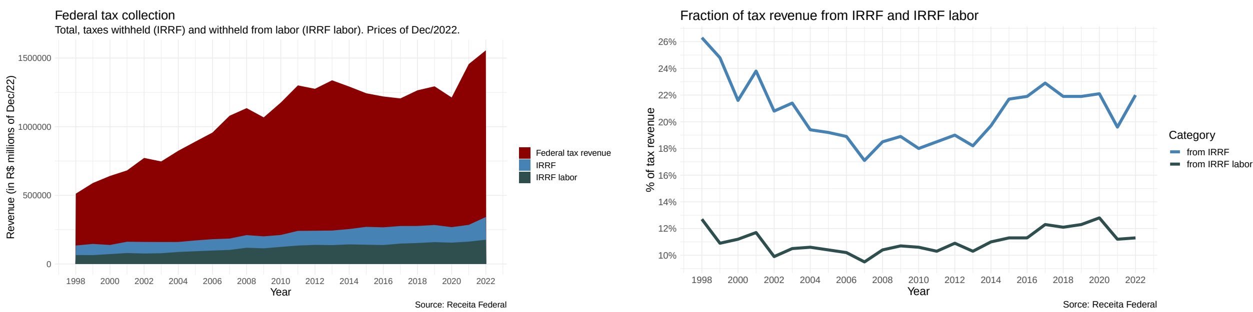
All individuals eligible for a positive marginal tax rate (say, those with monthly earnings net of social security over R$ 2014.12 in 2022) are subject to the IRPF[5]. At the beginning of the following year of a given IRPF collection period, individuals fill their income tax returns and pay (or collect) the remaining amount eligible to taxation not yet collected by the IRPF.

In Figure 3a, we have the total amount of federal tax revenue (no contributions included) and revenue from IRPF and labor IRPF for the period 1998 to 2022, in prices of December 2022. Note that revenues more than doubled from 1998 to 2011, slightly fell between 2012 and 2020, and spiked in 2021 and 2022, surpassing the R$ 1.5 trillion mark. In Figure 3b, we observe the share of IRPF and IRPF labor over total

[5] In particular, incomes subject to the IRPF are: from salaried work, non-salaried work paid by juridical persons, rents, brokerage services and royalties paid by juridical persons, and earnings from services between juridical persons, both within Brazil, or across borders.

taxes collected - an alternative way to represent the information in Figure 3a. The fraction of IRPF on labor does not change much throughout the period analyzed, remaining between 9% and 13% of total federal tax revenue. We focus on the reported wages net of social security contributions in the labor market in response to the tax rates of the income tax schedule.

Figure 3: Federal taxes and income taxes



(a) (b)

Notes: The figures describe federal tax collection, total income tax, and income tax from labor (left) and the fraction that the latter two represent from the total collected (right). Values are in R$ of 2022.

2.3 Simples Nacional

The Simples Nacional is presumptive taxation directed to a subset of small firms. It was introduced in 1996 in a decentralized way, where each state was responsible for managing its tax system. The national and more comprehensive version was implemented in 2006, which is part of the reasoning behind the first significant bunching estimates occurring in that year. This is also when the Simples entry was introduced in the RAIS survey.

This presumptive tax system unifies several state and municipal taxes to be paid over gross revenues in a single tax turnover. Beyond simplification, the Simples has a reduced tax burden compared to other usual business tax regimes.

To be eligible for Simples, firms must satisfy specific conditions, which include (i) being a small or micro-sized firm, following the official IBGE criteria; (ii) have annual gross revenues under R$ 4 800 000; and (iii) comply with the legal requirements. It is important to note that not all small and micro-sized firms are under presumptive taxation. They can opt-out even if they fulfill all the requisites.

3 Theoretical Model

In this section, we introduce a simple model *à la* Chetty et al. (2011) of the determination of wages and incomes of individuals who are employed in the formal sector, hence are subject to the federal taxation of labor income. Workers' earnings derive by wages in the formal sector, that are jointly determined by firms and workers by a simple job-search market, but potentially also by labor income in the informal sector. For the sake of simplicity, we rule out the possibility that further non-wage income may be earned in the formal sector.[6]

A typical worker i has a quasi-linear utility

$$u_i(x, l) = x - \alpha_i^{-\frac{1}{\varepsilon}} \frac{l^{1+\frac{1}{\varepsilon}}}{1+\frac{1}{\varepsilon}} \tag{1}$$

where x is individual consumption and $l = h + q$ the total amount of worked hours, that is the sum of hours worked in the formal sector h, and in the informal sector q. Workers are heterogeneous in the parameter that drives individual disutility of labor supply $\alpha_i > 0$, that has a smooth cumulative distribution function $F(\alpha)$.

[6]According to Furtado (2013) using PNAD, in Brazil less than 1% of individuals earn more than one formal income that is subject to the individual federal income tax.

As usual, we abstract from income effects for the sake of our empirical investigation that is to highlight the difference between estimated labor supply elasticity and the theoretical parameter ε (Saez, 2010).[7]

The firm j and the informal employees working for it share the same, linear production technology such that one worked hour is transformed in θ units of a good that is sold on the market at an exogenous, net-of-tax price p. The generic firm j posts a job offer $\{h_j, w(h_j)\}$, that requires h_j hours of work and pays an hourly wage equal to $w(h_j)$.[8] Assuming that the formal sector is characterized by free entry and that the generic firm j maximizes the (per-worker) profit:

$$\pi_j = p\theta h_j - w(h_j)h_j; \tag{2}$$

in equilibrium no firm offers an hourly wage that is higher or—because of free entry—lower than hourly productivity, i.e., $w(h_j) = w = p\theta$, for any number of hours h_j. Let the cumulative distribution function of aggregate hours required by firms in the formal labor market equilibrium be $G(h)$.[9]

The equilibrium in the formal labor market is determined by the following, simple matching game. The generic worker i randomly selects—from the aggregated distribution of firms' offers $G(h)$—an initial job offer characterized by the number of hours h_i^0. For the sake of simplicity, if the worker rejects the initial offer, she is able to select a job with her optimal number of hours h_i^*, though she incurs search costs $\phi \geq 0$. As we will see in Section 3.3, this setting can be handily be employed to study different sectors considering potential sources of heterogeneity such as technology or firms' size (Chetty et al., 2011). Moreover, our model can be also used to empirically analyze the impact of government programs that affect workers' productivity θ or searching costs ϕ.

We assume that firms fully report the formal income paid to a worker, $z = wh$. Each worker can also earn (from the same firm) an informal, free-of-tax labor income—that is produced with the same technology that the firm employs in the formal sector—$y = p\theta q = wq$, where q is the number of hours worked in the informal sector. However, the worker faces an *informality cost* (e.g., tax avoidance and tax sheltering, that are required to earn informal income, are costly) $s(m, y, \gamma) = \frac{a(m,y)}{\gamma}$, where: $m = z + y$ is the total earned income; $\gamma \geq 0$ is a parameter that measures the scope for informality in the business of firm j, which depends on idiosyncratic features, e.g. the firm's size, as well as common factors at sector or economy level and has the effect to reduce (amplify) the cost of tax avoidance as it grows (decrease); following a standard approach in the literature on tax evasion and tax avoidance (Slemrod, 2001; Slemrod and Yitzhaki, 2002), $a(m, y)$ is convex in both arguments and increasing in informal income $a'_y > 0$, though a larger total income reduces the marginal cost of tax avoidance $a''_{my} < 0$ (but $a''_{mm} + 2a''_{my} > 0$).[10] Without loss of generality, we also assume that the federal income tax has only two brackets with marginal tax rates τ_1, on formal labor income $z \leq K$, and $\tau_2 > \tau_1$, on formal labor income exceeding K. Thus, the consumption of the worker i is

$$x(h_i, q_i) = z_i - \tau_1 \min\{z_i, K\} - \tau_2 \max\{z_i - K, 0\} + y_i - s(z_i + y_i, y_i, \gamma). \tag{3}$$

3.1 Optimal labor supply without searching cost

In this case, the labor market equilibrium is driven by the optimization conditions of workers. As usual, the presence of a kink in the labor income tax implies that the optimal behavior of the generic worker i can be characterized in three possible cases.

[7] The main results can be obtained in a more general setting with income effects that determine non-constant theoretical labor supply elasticity (Chetty et al., 2011).

[8] As highlighted by Chetty et al. (2011), in this setting the number of hours cannot be changed by the worker or, after the contract is signed, also by the firm. Such an assumption represents the institutional and economic rigidity that affect firms' organization.

[9] Following Chetty et al. (2011), the market-clearing equilibrium requires that the distribution of jobs posted by firms coincides with the jobs selected by workers at the wage rate w after the job search process is complete—i.e., $G(h) = F(G(h), w)$.

[10] Considering the costs and benefits of tax evasion (and the links with tax sheltering), Cowell (1990) shows that the latter assumption can be motivated by decreasing absolute risk aversion of taxpayers. Throughout the paper we use the following notational convention: $\frac{\partial a(m,y)}{\partial y} = a'_y$, $\frac{\partial^2 a(m,y)}{\partial m \partial y} = a''_{my}$, and so on.

3.1.1 No bunching for low or high formal labor income

If the optimal supply of labor in the formal labor market is such that $z_i^* = wh_i^* \leq K$, by the optimization conditions of the worker who maximizes the utility function (1) under the budget constraint (3)

$$h: \quad w(1 - \tau_1 - \tfrac{a'_m}{\gamma}) - \big(\tfrac{h+q}{\alpha_i}\big)^{\frac{1}{\varepsilon}} = 0 \tag{4}$$

$$q: \quad w\big(1 - \tfrac{a'_m + a'_y}{\gamma}\big) - \big(\tfrac{h+q}{\alpha_i}\big)^{\frac{1}{\varepsilon}} = 0, \tag{5}$$

from (4) and (5), $\tau_1 = \frac{a'_y}{\gamma}$, hence the optimal informal labor income is $y_1 = y(\tau_1, \gamma, w) = wq_1$, with $q_1 = q(\tau_1, \gamma, w)$, where: $\frac{dq_1}{d\tau_1} = \frac{\gamma}{w(a''_{mm} + a''_{my})} > 0$, $\frac{dq_1}{d\gamma} = \frac{\tau_1}{w(a''_{mm} + a''_{my})} > 0$, $\frac{dq_1}{dw} = -(\frac{a''_{mm}}{a''_{mm} + a''_{my}} h + q_1) < 0$. The optimal formal sector labor supply is $h_i^* = \alpha_i [w(1-\tau_1)]^\varepsilon - q_1$.

If the optimal labor supply in the formal market is such that $z_i^* = wh_i^* \geq K$, by optimization conditions (4)—with the only difference that the marginal tax rate is τ_2 instead of τ_1—and (5), the optimal informal labor supply is $q_2 = q(\tau_2, \gamma, w)$ and the optimal informal labor income is $y_2 = y(\tau_2, \gamma, w) = wq_2$; hence, the optimal formal labor supply is $h_i^* = \alpha_i [w(1-\tau_2)]^\varepsilon - q_2$.

Let us remark that, for both low and high formal labor income, the amount of informal labor supply is independent of the parameter α_i that drives the disutility of labor supply, while it is driven by the shape of $a(m, y)$ and, particularly, by the level of the marginal tax rate and the degree of informality. It is worth to note that, in general, $q_2 > q_1$, while $q_2 = q_1 = 0$ when $\gamma = 0$ and all income is produced informally when $\gamma \to \infty$.

3.1.2 Bunching in the formal labor market

Given the market (equilibrium) wage rate, the formal labor income (of workers who do not bunch at the kink) is increasing in α_i. Thus, we can define $\underline{\alpha} = \frac{\frac{K}{w} + q_1}{[w(1-\tau_1)]^\varepsilon}$ as the maximum α_i of workers who optimally choose to produce a formal labor income equal to K, while facing the first-bracket marginal tax rate τ_1. Similarly, $\overline{\alpha} = \frac{\frac{K}{w} + q_2}{[w(1-\tau_2)]^\varepsilon}$ is the minimum α_i of workers who optimally choose to produce a formal labor income equal to K, while facing the second-bracket marginal tax rate τ_2. Let us first remark that, by $\tau_1 < \tau_2$, $\underline{\alpha} < \overline{\alpha}$. Hence, all workers with $\alpha_i \in [\underline{\alpha}, \overline{\alpha}]$ produce the same amount of formal labor income $z_i^* = wh_i^* = K$.

We also observe that the optimal informal labor supply of bunching workers is different with respect to the formula we worked out by the first order conditions (4) and (5), given that the marginal rate of substitution between c and z for these workers is not equal to the slope of the budget constraint. In other terms, the first order condition (4) does not hold for $\alpha_i \in (\underline{\alpha}, \overline{\alpha})$. Instead, for bunching workers the following condition holds:

$$w(1-\tau_1) > \left(\frac{\frac{K}{w} + q}{\alpha_i}\right)^{\frac{1}{\varepsilon}} > w(1-\tau_2). \tag{6}$$

However, the informal labor supply is still determined by the first order condition (5) with $h_i^* = \frac{K}{w}$. By comparative statics, we obtain that, for bunching workers, the informal labor income depends also on parameters driving individual preferences $q_i^* = q(K, \gamma, w; \varepsilon, \alpha_i)$, particularly $\frac{dq_i^*}{dh_i^*} \in (-1, 0)$, $\frac{dq_i^*}{d\gamma} > 0$, and $\frac{dq_i^*}{d\alpha_i} > 0$.[11]

Finally, we remark that the (theoretical) mass of bunching workers is

$$B = F(\overline{\alpha}) - F(\underline{\alpha}). \tag{7}$$

3.1.3 Estimation of the elasticity using bunching

Relying on the first order condition (4) for workers with taste parameter $\overline{\alpha}$, both with the actual marginal tax rate τ_2 and with the counterfactual marginal tax rate τ_1, we can retrieve the extension of the equation (3) of Saez (2010, p. 186) to include the informal labor income:

$$\Delta z = (K + y_2)\Big[\Big(\frac{1-\tau_1}{1-\tau_2}\Big)^{\varepsilon} - 1\Big] + y_2 - y_1, \tag{8}$$

where Δz is the growth of the formal labor income if the worker with utility characterized by $\overline{\alpha}$ faces the (counterfactual) marginal tax rate τ_1 (instead of τ_2). Following Saez (2010), the mass of bunching workers in the formal sector is:

$$B = \int_{\frac{K}{w}}^{\frac{K+\Delta z}{w}} g_1(h)dh \simeq \frac{\Delta z}{w} \frac{g_1(\frac{K}{w}) + g_1(\frac{K+\Delta z}{w})}{2}, \tag{9}$$

where $g_1(h)$ is the (counterfactual) density distribution when there is no change in the marginal tax rate at the kink K. Given that in the labor market equilibrium (without frictions) $G_1(h) = F(\alpha_i \leq \frac{h+q_1}{[w(1-\tau_1)]^{\varepsilon}})$, then $g_1(h) = f(\frac{h+q_1}{[w(1-\tau_1)]^{\varepsilon}})\frac{1}{[w(1-\tau_1)]^{\varepsilon}}$. Under the approximation that $g_1(h)$ is uniform around the kink K, $\frac{B}{g_1(\frac{K}{w})} w \simeq \Delta z$ (Chetty et al., 2011, p. 761).[12] Thus, by the expression (8), we obtain the formula of the elasticity in an environment with formal and informal labor supply:

$$\varepsilon \simeq \frac{\frac{B}{g_1(\frac{K}{w})} w - (y_2 - y_1)}{(K + y_2) ln(\frac{1-\tau_1}{1-\tau_2})} \tag{10}$$

The formula that we may employ to empirically estimate the labor supply elasticity (10) depends on the size of both formal and informal labor supply. Particularly, a larger difference between τ_2 and τ_1, widens the gap between y_2 and y_1 and hence inflates $B = F(\overline{\alpha}) - F(\underline{\alpha})$. However, in the measure of the elasticity (10), the latter effect is counterbalanced by the term $y_2 - y_1$ at numerator and y_2 at denominator.

Considering that the informal labor supply is quite hard to measure, this may be a major limitation of the technique of estimating ε via bunching. However, the next result shows that the formal/informal labor supply mix—that is clearly influenced by the marginal tax rates—does not affect the measure of elasticity:

[11] By the comparative statics on the first order condition (5):

$$\frac{dq_i^*}{dh_i^*} = -\frac{\big(\frac{h_i^*+q_i^*}{\alpha_i}\big)^{\frac{1}{\varepsilon}-1}\frac{1}{\varepsilon\alpha_i}}{w^2\frac{a''_{mm}+2a''_{my}}{\gamma} + \big(\frac{h_i^*+q_i^*}{\alpha_i}\big)^{\frac{1}{\varepsilon}-1}\frac{1}{\varepsilon\alpha_i}} \in (-1, 0)$$

$$\frac{dq_i^*}{d\gamma} = \frac{\frac{a'_m+a'_y}{\gamma^2}}{w^2\frac{a''_{mm}+2a''_{my}}{\gamma} + \big(\frac{h_i^*+q_i^*}{\alpha_i}\big)^{\frac{1}{\varepsilon}-1}\frac{1}{\varepsilon\alpha_i}} > 0$$

$$\frac{dq_i^*}{d\alpha_i} = \frac{\big(\frac{h_i^*+q_i^*}{\alpha_i}\big)^{\frac{1}{\varepsilon}-1}\frac{1}{\varepsilon\alpha_i^2}}{w^2\frac{a''_{mm}+2a''_{my}}{\gamma} + \big(\frac{h_i^*+q_i^*}{\alpha_i}\big)^{\frac{1}{\varepsilon}-1}\frac{1}{\varepsilon\alpha_i}} > 0$$

$$\frac{dq_i^*}{dw} = \frac{1 - \frac{a'_m+a'_y}{\gamma} - \frac{(a''_{mm}+a''_{my})z_i^*+(a''_{mm}+2a'_{my}+a''_{yy})y_i^*}{\gamma}}{w^2\frac{a''_{mm}+2a''_{my}}{\gamma} + \big(\frac{h_i^*+q_i^*}{\alpha_i}\big)^{\frac{1}{\varepsilon}-1}\frac{1}{\varepsilon\alpha_i}}.$$

We remark that for low formal and informal incomes, z_i^* and y_i^*, $\frac{dq_i^*}{dw} > 0$ while as incomes increase we may have that $\frac{dq_i^*}{dw} < 0$. In Appendix A.1, we also show that the marginal rate of substitution between consumption and gross-of-tax (formal) income is always decreasing in α_i also for bunching workers.

[12] Taking the first-order Taylor expansion of $g_1(\frac{K+\Delta z}{w})$ around $g_1(\frac{K}{w})$, we observe that the local uniformity assumption holds for $g'_1(\frac{K}{w}) = f'(\underline{\alpha}) \simeq 0$.

Proposition 1 *The expression (10) depends only on the marginal tax rates. Particularly, it does not depend on the parameter driving the relative size of formal and informal labor supply.*

Proof. By the assumption of uniformity of $g_1(\frac{K}{w}) = f(\underline{\alpha})\frac{1}{[w(1-\tau_1)]^{\varepsilon}}$ around the kink, $f'(\underline{\alpha})$ is negligible. Thus, we also have that $B = F(\overline{\alpha}) - F(\underline{\alpha}) \simeq f(\underline{\alpha})(\overline{\alpha} - \underline{\alpha})$. Substituting these formulas into the expression (10), we obtain:

$$\varepsilon \simeq \frac{(\frac{1-\tau_1}{1-\tau_2})^{\varepsilon} - 1}{ln(\frac{1-\tau_1}{1-\tau_2})}. \tag{11}$$

■

By the expression (11) we see that the two effects of informal labor income—the inflating effect on bunching and the direct effect of informality that tends to reduce the elasticity—perfectly compensate each other. Thus, absent any friction in the labor market we can employ the formula of Saez (2010) and Chetty et al. (2011),

$$\varepsilon \simeq \frac{\frac{B}{g_1(\frac{K}{w})}w}{Kln(\frac{1-\tau_1}{1-\tau_2})}, \tag{12}$$

to estimate the elasticity, given that informal labor income (whatever the degree of informality of the firm, sector or economy) does not affect the estimator of ε.

3.2 Estimation of elasticity in a model with searching costs

Following Chetty et al. (2011), we now introduce search costs in the determination of the labor market equilibrium. If the worker i receives a job offer featuring h_i^0 and refuses it, she is able to find a job featuring her optimal number of hours of formal labor h_i^*, but she has to face search costs equal to ϕ. Particularly, for any bunching worker i—i.e., with $\alpha_i \in [\underline{\alpha}, \overline{\alpha}]$—we may define an *inaction region* $[\underline{h}_i, \overline{h}_i]$, the boundaries of which are defined by the following conditions:

$$u_i\Big(x\Big(\frac{K}{w}\Big), \frac{K}{w}\Big) - \phi = u_i(x(\underline{h}_i), \underline{h}_i) \quad for \quad \underline{h}_i < \frac{K}{w}; \tag{13}$$

$$u_i\Big(x\Big(\frac{K}{w}\Big), \frac{K}{w}\Big) - \phi = u_i(x(\overline{h}_i), \overline{h}_i) \quad for \quad \overline{h}_i > \frac{K}{w}. \tag{14}$$

If a worker with $\alpha_i \in [\underline{\alpha}, \overline{\alpha}]$—who would bunch at the kink without search costs—receives an offer $h_i^0 \notin [\underline{h}_i, \overline{h}_i]$, she prefers to drop it and search for her optimal job—with $h_i^* = \frac{K}{w}$—though this implies bearing search costs ϕ. In turn, this worker continues to bunch at the kink even with search costs. Conversely, a worker with $\alpha_i \in [\underline{\alpha}, \overline{\alpha}]$ who receives a job offer $h_i^0 \in [\underline{h}_i, \overline{h}_i]$ accepts it even if $h_i^0 \neq \frac{K}{w}$, because of search costs. Thus, this type of workers do not bunch anymore at the kink because of search costs. As highlighted by Chetty et al. (2011), the existence of the inaction region $[\underline{h}_i, \overline{h}_i]$ deflates the mass of bunching workers and, thus, brings to under-estimate the labor supply elasticity. In turn, any policy which shrinks (widens) the inaction region implies a growth (reduction) of the estimated elasticity and a convergence to (divergence from) the structural parameter ε.

An important difference between our setting and Chetty et al. (2011) is that we consider the interaction between formal and informal labor supply. Proposition 1 highlights that, absent search costs, bunching behaviors and the estimated elasticity are not affected by the size of informal labor supply. With search costs, this result changes. To understand this point we first investigate the way key parameters—i.e., the degree of informality γ, search costs ϕ, and workers' average productivity w—affect the size of the inaction region.

Remark that both for (almost all) bunching and for all non-bunching workers with $\alpha_i \in (\underline{\alpha}, \overline{\alpha})$, the first order condition (4) does not bind given that either they bunch at the kink $h_i^* = \frac{K}{w}$ or they stick to the initial job offer $h_i^0 \in [\underline{h}_i, \overline{h}_i]$ which does not correspond to the kink, i.e., $z_i^0 = wh_i^0 \neq K$. In the following, we denote by $q_i^0 = q(z_i^0, \gamma, w; \varepsilon, \alpha_i)$ the optimal informal labor supply of the worker that decided to accept the initial job offer h_i^0, hence the total income is $m_i^0 = z_i^0 + y_i^0 = w(h_i^0 + q_i^0)$, while $q_i^* = q(K, \gamma, w; \varepsilon, \alpha_i)$ is the optimal informal labor supply of the worker who decided to drop the initial offer and choose her best job h_i^*, hence the total income is $m_i^* = K + y_i^*$ (with $y_i^* = wq_i^*$). By the comparative statics on condition (5) that we discussed at the end of Section 3.1.2, we know that $\frac{dq_i^0}{dh_i^0} \in (-1, 0)$, which brings to: 1) $q_i^0 > q_i^*$ ($q_i^0 < q_i^*$) if $h_i^0 < \frac{K}{w}$ ($h_i^0 > \frac{K}{w}$); $\frac{dm_i^0}{dh_i^0} = \frac{d(z_i^0 + y_i^0)}{dh_i^0} = w(1 + \frac{dq_i^0}{dh_i^0}) > 0$.

We can state the following result:

Proposition 2 (Testable predictions on the estimated elasticity) *The bunching mass and, hence, the elasticity of (formal) labor supply increases in the degree of informality and decreases in search costs.*

Proof. The estimated elasticity is lower than ε because of the existence of the inaction region. Hence, any change that shrinks (widens) such a region—i.e., increases (decreases) $\underline{h}_i$ and decreases (increases) $\overline{h}_i$, for i with $\alpha_i \in [\underline{\alpha}, \overline{\alpha}]$—also increases (decreases) the bunching mass and, hence, the estimated elasticity. Let us remark that, by the Envelope Theorem, any change of q_i^*, $\underline{q}_i = q(\underline{z}_i, \gamma, w; \varepsilon, \alpha_i)$ (with $\underline{z}_i = w\underline{h}_i$) and $\overline{q}_i = q(\overline{z}_i, \gamma, w; \varepsilon, \alpha_i)$ (with $\overline{z}_i = w\overline{h}_i$) does not affect the conditions (13) and (14) that characterize $\underline{h}_i$ and $\overline{h}_i$, respectively. Putting the total differential of equation (13) with respect to $\underline{h}_i$, γ and ϕ equal to zero, we obtain:

$$\frac{d\underline{h}_i}{d\gamma} = \frac{a(K + y_i^*, y_i^*) - a(\underline{z}_i + \underline{y}_i, \underline{y}_i)}{w(1-\tau_1) - \left(\frac{\underline{h}_i + \underline{q}_i}{\alpha_i}\right)^{\frac{1}{\varepsilon}}} \frac{1}{\gamma^2} \tag{15}$$

$$\frac{d\underline{h}_i}{d\phi} = -\frac{1}{w(1-\tau_1) - \left(\frac{\underline{h}_i + \underline{q}_i}{\alpha_i}\right)^{\frac{1}{\varepsilon}}} \tag{16}$$

where $\underline{y}_i = w\underline{q}_i$. The denominator of expressions (15) and (16) is strictly positive, given that $\alpha_i \in [\underline{\alpha}, \overline{\alpha}]$ and $\underline{h}_i < \frac{K}{w}$. Therefore, $\frac{d\underline{h}_i}{d\phi} < 0$. To assess the sign of expression (15), let us remark that

$$a(m_i, y_i) = \int_0^{\hat{m}_i} \int_0^{\hat{y}_i} a''_{my}(m, y) dm dy \tag{17}$$

for any vector $(\hat{m}_i, \hat{y}_i)$. Thus,

$$a(K + y_i^*, y_i^*) - a(\underline{z}_i + \underline{y}_i, \underline{y}_i) = \int_{\underline{z}_i + \underline{y}_i}^{K + y_i^*} \int_{\underline{y}_i}^{y_i^*} a''_{my}(m, y) dm dy > 0 \tag{18}$$

given that $K + y_i^* > \underline{z}_i + \underline{y}_i$ and $y_i^* < \underline{y}_i$ when $\underline{h}_i < \frac{K}{w}$, and $a''_{my} < 0$, which implies that $\frac{d\underline{h}_i}{d\gamma} > 0$. By the same procedure, we show that

$$\frac{d\overline{h}_i}{d\gamma} = \frac{a(K + y_i^*, y_i^*) - a(\overline{z}_i + \overline{y}_i, \overline{y}_i)}{w(1-\tau_2) - \left(\frac{\overline{h}_i + \overline{q}_i}{\alpha_i}\right)^{\frac{1}{\varepsilon}}} \frac{1}{\gamma^2} < 0 \tag{19}$$

$$\frac{d\overline{h}_i}{d\phi} = -\frac{1}{w(1-\tau_2) - \left(\frac{\overline{h}_i + \overline{q}_i}{\alpha_i}\right)^{\frac{1}{\varepsilon}}} > 0 \tag{20}$$

where $\overline{y}_i = w\overline{q}_i$, given that: the denominator of expressions (19) and (20) is strictly negative for $\alpha_i \in [\underline{\alpha}, \overline{\alpha}]$ and $\overline{h}_i > \frac{K}{w}$; and the numerator of (19) is still positive by $K + y_i^* < \overline{z}_i + \overline{y}_i$ and $y_i^* > \overline{y}_i$ when $\overline{h}_i > \frac{K}{w}$ and $a''_{my} < 0$. ■

Proposition 2 shows that policies that affect γ or ϕ indirectly influence the estimated elasticity of (formal) labor supply by the bunching technique. Particularly, tax policies that reduce (increase) the cost of tax avoidance are likely to foster (hamper) workers' bunching and the estimated elasticity.

3.3 Bunching under simplified tax regimes

Our model allows us to draw insights and testable predictions about the effect of simplified tax regimes on bunching at the kink of the income tax schedule of (formal) employees of firms that are subject to these regimes, as compared to firms that are not treated by the simplified tax regime. The stylized facts about simplified tax regimes is that they provide typically to small firms (e.g., in terms of turnover)—sometimes also in specific sectors—a tax reduction (e.g., lower actual tax rates) and simplified bureaucratic procedures (e.g., declaration filings, computation of tax liabilities, etc.). Simplified tax regimes are widespread in the world and aim at multiple purposes, including the reduction of the incentive to tax avoidance and tax evasion in highly informal sectors or economies. For example, in the case of Brazil the tax code has been amended in 2006 to introduce the "Simples" (explained in detail in Section 2.3) tax regime at the national level, which was designed to reduce the tax burden and bureaucracy for small firms, consolidating various federal, state, and municipal taxes into a single payment, making it easier and cheaper for businesses to comply with tax obligations.

The described stylized facts can be translated into the terms of our model as follows. A firm may decide to enter a simplified tax regime if some features are satisfied, part of them are linked to the fact the involved firms, and hence their employees, are quite likely to be exposed to higher degree of informality (i.e., larger γ). A second effect is that such regimes may influence the functioning (i.e., total factor productivity) of involved firms, which may influence the wages they pay to employees. If productivity θ increases (decreases), w increases (decreases) for firms under simplified regimes with respect to the same firms paying taxes under the regular tax regime.

As regards the stronger informality effect, from Proposition 2 we know that, other things equal, a larger γ implies larger bunching and estimated elasticity. However, the second effect on productivity and wages may go in either direction of curbing or pushing up bunching behaviors. To understand why, we put the total differential of equation (13) with respect to $\underline{h}_i$ and w equal to zero and we obtain:

$$\frac{d\underline{h}_i}{dw} = \frac{(K+y_i^*)\Big(\frac{\frac{K}{w}+q_i^*}{\alpha_i}\Big)^{\frac{1}{\varepsilon}} - (\underline{z}_i+\underline{y}_i)\Big(\frac{\underline{h}_i+\underline{q}_i}{\alpha_i}\Big)^{\frac{1}{\varepsilon}} - \Big[w(1-\tau_1) - \Big(\frac{\underline{h}_i+\underline{q}_i}{\alpha_i}\Big)^{\frac{1}{\varepsilon}}\Big]\underline{z}_i}{w(1-\tau_1) - \big(\frac{\underline{h}_i+\underline{q}_i}{\alpha_i}\big)^{\frac{1}{\varepsilon}}}\frac{1}{w^2}. \tag{21}$$

As showed in the proof of Proposition 2, the denominator of (21) is positive; also,

$$(K+y_i^*)\Big(\frac{\frac{K}{w}+q_i^*}{\alpha_i}\Big)^{\frac{1}{\varepsilon}} - (\underline{z}_i+\underline{y}_i)\Big(\frac{\underline{h}_i+\underline{q}_i}{\alpha_i}\Big)^{\frac{1}{\varepsilon}} > 0, \tag{22}$$

given that we also showed $\frac{K}{w}+q_i^* > \underline{h}_i+\underline{q}_i$, which implies $K+y_i^* > \underline{z}_i+\underline{y}_i$. Thus, $\frac{d\underline{h}_i}{dw} > 0$ ($\frac{d\underline{h}_i}{dw} < 0$) if the expression (22) is larger (smaller) than the last term of the numerator of (21). Following the same procedure, by the expression (14), we obtain:

$$\frac{d\overline{h}_i}{dw} = \frac{(K+y_i^*)\Big(\frac{\frac{K}{w}+q_i^*}{\alpha_i}\Big)^{\frac{1}{\varepsilon}} - (\overline{z}_i+\overline{y}_i)\Big(\frac{\overline{h}_i+\overline{q}_i}{\alpha_i}\Big)^{\frac{1}{\varepsilon}} - \Big[w(1-\tau_2) - \Big(\frac{\overline{h}_i+\overline{q}_i}{\alpha_i}\Big)^{\frac{1}{\varepsilon}}\Big]\overline{z}_i}{w(1-\tau_2) - \big(\frac{\overline{h}_i+\overline{q}_i}{\alpha_i}\big)^{\frac{1}{\varepsilon}}}\frac{1}{w^2}. \tag{23}$$

Again, by the results of Proposition 2, the denominator of (23) is negative and, given that $\frac{K}{w}+q_i^* < \overline{h}_i+\overline{q}_i$, $\frac{d\overline{h}_i}{dw} > 0$ ($\frac{d\overline{h}_i}{dw} < 0$) if

$$(K+y_i^*)\Big(\frac{\frac{K}{w}+q_i^*}{\alpha_i}\Big)^{\frac{1}{\varepsilon}} - (\overline{z}_i+\overline{y}_i)\Big(\frac{\overline{h}_i+\overline{q}_i}{\alpha_i}\Big)^{\frac{1}{\varepsilon}} < 0, \tag{24}$$

is, in absolute term, larger (smaller) than the last term of the numerator of (23). In turn, the effect of larger wage on bunching is ambiguous.

4 Data and Empirical Strategy

This paper investigates individuals in the formal sector in detail. For the main analyses, we leverage the RAIS: administrative employer-employee matched data on the formal sector provided by the Brazilian Ministry of

Work and Labor (*Ministério do Trabalho e do Emprego, MTE*). We want to investigate whether (*i*) formal workers respond to the kinks in the tax schedule stressing the role of firm size that these individuals are employed (*ii*) those employed in firms that are more likely to be informal—specifically, high earners—are also more likely to exhibit behavioral responses near the tax kinks. We proxy the degree of informality by firm (employment) size and by the participation in the Simples regime. We first describe the data and then present the empirical strategy.

4.1 Data

For the labor market, we use the *Relação Anual de Informações Sociais* (RAIS) employer-employee matched data. The RAIS is provided by the *Ministério do Trabalho e da Previdência* (MTE)—the Brazilian Ministry of Labor and Social Security—since 1975, and contains yearly information about firms and formal workers, filled by employers up to 2018. Some of its variables include municipality of residence, type of activity by the National Classification of Economic Activities (CNAE) code, labor market earnings, age, gender, indicator if the worker/firm is under the *Simples* regime, taxpayer's registry (CPF, an individual identifier), and registry of corporate taxpayers (CNPJ, a firm identifier).

Table 1 describes the fraction of each group included in the bunching analysis over all the employed individuals from the formal labor market data described above. That is, it gives us a notion of the size of each group included in the analysis. Additionally, Table 2 shows the individual descriptive statistics for the periods of interest and each bracket. The periods of interest are separated as follows. (*i*) 2002-2005: Pre-introduction of Simples Nacional. (*ii*) 2006-2008: Introduction of Simples Nacional, but pre-tax schedule reform (from three to five brackets; refer to Figures 1 and 2). (*iii*) 2009-2018: Introduction of tax reform, in which the opportunity for tax savings is lower at the kinks (again, refer to Figure 1).

Table 1: Groups' shares

Group	**2002-2005**	**2006-2008**	**2009-2018**
First-timers	0.27	0.26	0.23
New-comers	0.54	0.57	0.56
Simples	-	0.21	0.24
Simples, firms with 19 employees or less	-	0.12	0.13
Simples, firms with over 19 employees	-	0.10	0.11
Micro-sized firms	0.15	0.14	0.13
Small-sized firms	0.37	0.36	0.35
Medium-sized firms	0.49	0.47	0.48
Bracket 1	0.83	0.82	0.74
Bracket 2	0.11	0.11	0.11
Bracket 3	0.06	0.07	0.05
Bracket 4	-	-	0.04
Bracket 5	-	-	0.06

Notes: The table describes the shares of each group included in the analysis. Each numeric entry is defined as (n of individuals in group)/(n of formally employed individuals). First-timers refers to individuals between the ages of 18 and 25. New-comers refer to those with a tenure of one year or less. Simples refer to those employed in firms under the presumptive tax regime. We also included rows for those employed in firms under Simples with 19 employees or less and over 19 employees – with 19 being the median number of workers of Simples' firms. Micro-sized firms refer to the individuals employed in firms of that size, following the official IBGE criteria. The same is true for Small-sized (includes those in Micro-sized) and Medium-sized firms (includes those in Small-sized). The Brackets refer to the individuals whose labor market earnings fall in each bracket (between two kinks) of the income tax schedule. The Simples Nacional was introduced by law in 2006, hence the missing data from 2002-2005. Also, the statistic for the fifth bracket only began in 2009 because of the tax reform that took place that year.

Table 2: Descriptive Statistics by period and bracket

	2002-2005			2006-2008			2009-2018				
Brackets	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**4**	**5**
Wage (R$ of Dec/2022)	1 432	4 549	13 736	1 553	4 650	14 237	1 720	3 648	5 209	6 693	15 162
	(671)	(953)	(9 629)	(635)	(956)	(10 398)	(550)	(532)	(639)	(719)	(10 956)
Male	0.61	0.64	0.69	0.60	0.64	0.67	0.57	0.66	0.63	0.61	0.65
	0.49	0.48	0.46	0.49	0.48	0.47	0.49	0.47	0.48	0.49	0.48
Age	32.95	38.54	40.97	32.93	38.53	41.75	33.60	38.59	39.67	40.82	42.97
	(10.89)	(10.23)	(9.83)	(10.91)	(10.41)	(10.12)	(11.35)	(10.70)	(10.40)	(10.48)	(10.46)
Tenure	2.88	7.52	9.40	2.64	7.17	9.77	2.36	5.07	6.98	8.56	10.16
	(4.86)	(8.04)	(9.11)	(4.73)	(8.00)	(9.15)	(3.86)	(6.80)	(8.86)	(10.33)	(10.37)
Education years	9.49	12.46	14.51	10.11	12.73	14.87	10.81	12.45	14.06	14.07	15.45
	(3.64)	(3.92)	(3.38)	(3.46)	(3.70)	(3.23)	(3.14)	(3.54)	(3.49)	(3.33)	(2.96)

Notes: The table contains the descriptive statistics for individuals within each bracket and each period of interest. 2002-2005 represents years before the introduction of Simples Nacional. 2006-2008 represents the period when Simples Nacional was introduced, and there was still no reform in the income tax schedule. 2009-2018 is the period covering the modified tax schedule (which explains the five brackets instead of the three from the other periods). For each variable in the first column, the means are above and standard deviation (in parenthesis) are below.

4.2 Empirical model

4.2.1 Canonical bunching and elasticity estimation

As highlighted in Section 3, abstracting from search costs (or other informational frictions), a good estimator of the elasticity of the formal labor supply is given by the expression (12), which can also be written as

$$\varepsilon = \frac{B/\tilde{g}_1(z^*)z^*}{\Delta\tau/(1-\tau_2)}, \tag{25}$$

where $\tilde{g}_1(z) = g_1(\frac{z}{w})\frac{1}{w}$ is the counterfactual probability density of earnings in the absence of kink, which is worked out under the assumption of local uniformity of the density function, as discussed in Section 3. Therefore,

$$B = \int_{z^*}^{z^*+\Delta z^*} \tilde{g}_1(z) \approx \tilde{g}_1(z)\Delta z^*$$

with $z^* = \frac{K}{w}$. Note that both $\tilde{g}_1(z^*)$ and B on the right hand side of the expression (25) are estimable. To do so, we use the approach introduced by Chetty et al. (2011). The canonical procedure is as follows. For the probability distribution of earnings, we estimate the counterfactual distribution, using bin counts c indexed by j, following the polynomial model:[13]

$$c_k = \underbrace{\sum_{m=0}^{n} \beta_m \cdot (z_k)^m}_{\text{Polynomial}} + \underbrace{\eta \cdot \mathbb{1}[z_k = z^*]}_{\text{Threshold control}} + \nu_k \tag{26}$$

Where η is the threshold coefficient dummy, which we need to control for in order to not bias the counterfactual bin count upwards. Additionally, n is the polynomial order for the fit, and ν_k is the error term. With conventional OLS estimation, we get the fitted bin count values $\hat{c}_k$ as

$$\hat{c}_k = \sum_{m=0}^{n} \hat{\beta}_m \cdot (z_k)^m + \hat{\eta} \cdot \mathbb{1}[z_k = z^*] \tag{27}$$

To estimate $g_1(z^*)$, we plug z^* above, and extrapolate the estimated expression by excluding the threshold dummy. This gives us the counterfactual bin count (density) at the threshold:

$$\hat{c}_{z^*} = \sum_{m=0}^{n} \hat{\beta}_m \cdot (z^*)^m \tag{28}$$

[13] Following Mavrokonstantis (2019), we correct each bin count by the integration constraint, i.e., we correct the counterfactual distribution considering that all individuals above $z^*+\Delta z^*$ reduce their earnings proportionally. This, in turn, shifts the observed distribution inwards, meaning that the polynomial would not be sufficient to estimate the counterfactual without bias, absent of this correction.

The excess number of observations locating at z^*, that is, the bunching mass B, is then estimated as the difference between the observed and counterfactual bin counts at the threshold:

$$\hat{B} = c_{z^*} - \hat{c}_{z^*}$$

With these estimations, the elasticity in the expression (25) is identified. To compare bunching across different rates and thresholds, we adopt the normalization $\hat{b} = \hat{B}/\hat{c}_{z^*}$, which, along with ε, represents a parameter of interest. Again, following Chetty et al. (2011), standard errors are residual-based bootstrapped, with 100 samples.

4.2.2 Estimation with diffuse bunching

In some instances, bunching does not occur precisely at the threshold. Agents and firms may face frictions and, thus, might not be able to fine-tune their earnings so to stay exactly at z^*. As a result, we also observe exceeding masses in bins around the threshold.[14] To account for this, we estimate the following model using the same methodology described above:

$$c_k = \sum_{m=0}^{n} \beta_m \, (z_k)^m + \sum_{i=z_L}^{z^*} \eta_i \, \mathbb{1}[z_k = i] + \nu_k \tag{29}$$

Note how we now consider a bunching zone, defined by the interval $[z_L, z^*]$. Thus, we include several dummies to encompass this region. The fitted bin count values $\hat{c}_k$, $k \in [z_L, z^*]$, for the bunching region are obtained as in the canonical case, while the exceeding mass will be given by

$$\hat{B} = \sum_{k=z_L}^{z^*} (c_k - \hat{c}_k) \tag{30}$$

The normalized excess mass also is as in the canonical case: $\hat{b} = \hat{B}/\hat{c}_{z^*}$.

5 Results

Following the empirical model described in the last section, we run many estimations to look for evidence of bunching.[15] Particularly, we applied the estimation technique to different sub-samples of the RAIS dataset for each year between 2002 and 2018. First, we filtered our dataset by geographical area: Brazil and regions (Northeast, North, Midwest, Southeast, South). Then, we used information about employees, particularly their age and occupational conditions, to construct sub-samples. Finally, we focused on firms' features, particularly the economic sector, and size (i.e., the number of employees).

We document evidence of bunching for several of the mentioned filters (or sub-samples) only at the second threshold of the federal income tax schedule before the 2008 reform, which corresponds to the third threshold of the post-reform tax schedule that was enforced from 2009 on (see Figure 1). The number of sub-samples that generate statistically significant results, as well as the size of bunching and the implied elasticity of taxable income in those cases, peaks in 2008. In 2007, fewer filters generated statistically significant results, featuring lower confidence levels and smaller exceeding masses compared to 2008. Results for 2006 show a few cases of (significant) exceeding masses, while in the period 2002-2005, we do not find any of it. As highlighted by Figure 1 in Section 2, the 2008 reform split the second and the third brackets of the federal income tax schedule to create a new five-bracket schedule. After that reform, we again document only scant and weak evidence of exceeding masses with some filters in specific years (e.g., micro firms in 2016). Thus we can conclude that in most parts of the period 2009 to 2018, for all filters, there is no significant evidence of bunching.

The literature on bunching has extensively documented the lack of exceeding masses that we should observe according to theoretical models of workers' choices in the absence of any behavioral bias. Myopic

[14] In our case, we exclusively observe diffuse bunching at the left side of z^*. Hence, we consider the case where the bunching region is defined by the interval $[z_L, z^*]$, where z_L is the earnings value where we have the first indication of bunching.

[15] All results are available from the Authors upon request and will soon be part of an Online Appendix.

choices, informational frictions and search costs on the labor market—to mention just few, main sources of behavioral biases—may explain the divergence between empirical analyses and baseline theoretical predictions (Saez, 2010; Chetty et al., 2011). Thus, larger tax savings, which characterized the 2002-2008 federal tax schedule in Brazil (see Figure 1), are more conducive to bunching, which provides an intuitive explanation for the drop in significance and size of exceeding masses across all sub-samples after 2008. In the same way, economic and social conditions that widen the importance of behavioral biases—such as lower education (hence financial literacy) of individuals, larger uncertainty about the specific features of the tax code, stronger institutional constraints in wage determination (e.g., collective bargaining), etc.—tend to curb the significance and size of exceeding masses. Inflation and collective wage setting may have widened the relevance of behavioral biases in 2002-2006. Inflation brings to bracket creeping, which, in the Brazilian case, motivated frequent changes to the tax code to adapt tax thresholds (that are set in nominal terms), as we may observe from Figure 1. Unpredictable inflation and imperfect corrections of tax thresholds to counter bracket creeping may reduce the ability of workers and firms to effectively implement bunching behaviors.[16]

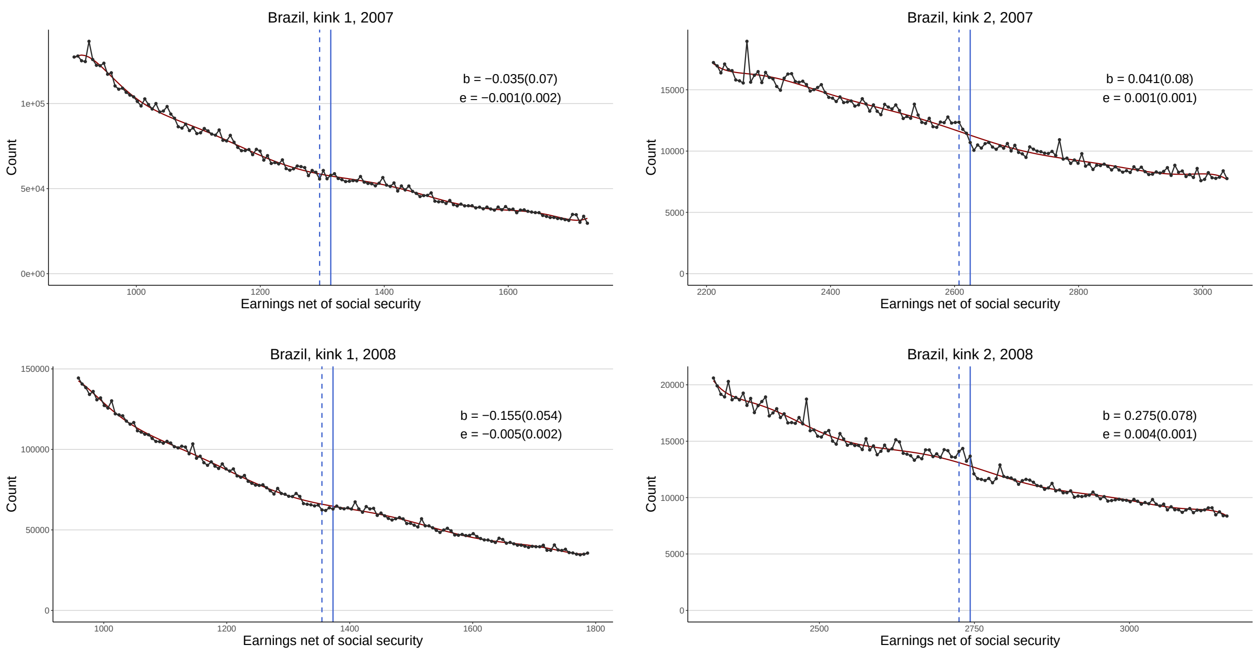


Figure 4: Elasticity and bunching mass estimations, Brazil, RAIS

Note: Bunching excess mass (b) and elasticity of taxable income (e) estimations, as described in Section 4.2, and corresponding standard deviations (in parenthesis), estimated via bootstrap, with 100 resamples. The vertical axis represents the bin counts c_j, with a width of R$ 6 each. The horizontal represents the monthly normalized labor market earnings (wages) net of social security. The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. z^* and z^L are four bins apart. The counterfactual density (in red) is estimated using a 9^{th} degree polynomial.

In Figure 4 the results for Brazil, first and second threshold of the federal tax schedule, in years 2007-2008 are plotted. As anticipated, only in 2008, at the second threshold, we find evidence of a significant exceeding mass. As usual, Figure 4 also reports the implied point-estimate of the elasticity of the taxable labor income which—though very small ($e = 0.004$) given the relative size of the exceeding mass ($b = 0.275$)—is different from zero with very high confidence. The size and significance of exceeding masses vary a lot across different filters and years. Table 3 summarizes a selection of results for years 2007 and 2008 considering different filters, which allows us to detect possible regularities.[17] The latter may, in turn, indicate potential sources

[16] In the Appendix A.4, we report extensive evidence of the negative correlation between the number of filters/years bringing to significant exceeding masses and the volatility of inflation.

[17] Figures corresponding to the results summarized in Table 3 are reported in Appendix A.3).

of the variability of estimated bunching across filters and years and, ultimately, may shed some light on the importance of the informality channel we are interested in.

Table 3: RAIS results, 2007 and 2008

Panel A. RAIS estimates around the second kink - Brazil and macro-regions

Years	Estimates	Brazil	Northeast	North	Midwest	Southeast	South
2007	Bunching	0.041 (0.08)	0.342 (0.417)	-0.496 (0.504)	0.028 (0.43)	0.175 (0.16)	0.406 (0.132)
	Elasticity	0.001 (0.001)	0.005 (0.006)	-0.007 (0.007)	0 (0.006)	0.002 (0.002)	0.006 (0.002)
2008	Bunching	0.275 (0.078)	0.707 (0.296)	0.499 (0.539)	1.479 (0.623)	0.47 (0.182)	0.68 (0.131)
	Elasticity	0.004 (0.001)	0.01 (0.004)	0.007 (0.007)	0.02 (0.008)	0.006 (0.002)	0.009 (0.002)

Panel B. RAIS estimates around the second kink - selected sectors

Years	Estimates	Public	Real estate	Retail	Industry
2007	Bunching	-0.094 (0.262)	0.151 (0.264)	0.546 (0.3)	0.438 (0.109)
	Elasticity	-0.001 (0.004)	0.002 (0.004)	0.007 (0.004)	0.006 (0.001)
2008	Bunching	0.372 (0.392)	1.161 (0.297)	1.585 (0.303)	0.572 (0.094)
	Elasticity	0.005 (0.005)	0.016 (0.004)	0.022 (0.004)	0.008 (0.001)

Panel C. RAIS estimates around second kink - selected filters

Years	Estimates	First-timers	New-comers	Small firms
2007	Bunching	-0.216 (0.182)	0.246 (0.175)	0.166 (0.164)
	Elasticity	-0.003 (0.003)	0.004 (0.003)	0.003 (0.003)
2008	Bunching	0.604 (0.141)	0.684 (0.111)	0.964 (0.182)
	Elasticity	0.009 (0.002)	0.01 (0.002)	0.014 (0.003)

Filters by geographical area (Panel A of Table 3) show that the five regions of Brazil perform different bunching masses and confidence of estimates. Particularly, estimates for Brazil and all regions but South are not significant in 2007, while estimates for Brazil and all regions but North are significant in 2008. Point estimates are larger in 2008 than in 2007 for Brazil and all regions and significance increases also for South between 2007 and 2008. Several economic and social feature may drive this results, particularly the structural features of regional economies such as the composition by sector of activity and the firms' dimension by number of employees. As regards the role of the informal sector, relying on PNAD survey data for the considered years, we estimate that the share of formal workers was the highest among Brazilian regions in the South (75% in 2008) and the lowest in the North (49%) and Northeast (43%). The largest bunching ($b = 1.479$ and $e = 0.02$) is measured in Midwest, where the share of formal workers in 2008 was 65% (slightly smaller than the average for Brazil). The latter observations suggest a correlation between the degree of informality (of the regional economy) and the size and confidence of estimates of bunching.

Moving to firms' characteristics, Panel B of Table 3 reports results for the second threshold of tax schedule, years 2007-2008, and four sector filters: Public, which includes Public administration, defense and social security; Real estate; Retail, which includes Retail and auto-services; and Industry, which includes Transformation industry. The sectors are selected to consider different types of activity and occupational conditions. Public is the sector where we expect to find no room for bunching because of the institutional setting of the public employment. Particularly, there is no scope for informal work in governmental agencies. On the contrary, we expect to have tax savings incentives at play in the other sectors, with different specific features. Again the results show substantial variation across filters and years. As expected, there is never bunching in Public administration, defense and social security (see also Figure 9 in Appendix A.3). The dynamics of results for other selected (private) sectors is interesting. In 2007, Real estate does not show significant exceeding masses, while to different extents Retail and Industry do. Compared to 2007, exceeding masses jump in 2008 for Real estate (point estimates $b = 1.161$ and $e = 0, 016$) and Retail ($b = 1.585$ and $e = 0.022$), while it does not change a lot in the case of Industry ($b = 0.572$ and $e = 0.008$); also statistical significance of estimates increases. Real estate is a highly commissioned sector, where workers receive bonuses that may be hidden from the tax authorities. While this may explain the size and significance of bunching in 2008, it cannot easily explain why we do not observe it in this sector in 2007. A similar mechanism is at play in Retail and auto-services where transactions are mostly in person and in cash (at least in the considered period), which suggests a considerable degree of mix between formal and informal economic activity. In line with our theoretical predictions, in this case, we observe bunching both in 2007 and 2008, though the mentioned features of the sector cannot explain the remarkable increase in size that we measure. The results for Transformation industry, though affected by similar dynamics, are more stable and smaller (in relative size).

Other features of firms (and/or employees) seem relevant to understanding the determinants of bunching behavior. To highlight the role of such non-sector sources of heterogeneity, Panel C of Table 3 reports another set of filters dealing with occupational characteristics of workers and firms' size. The results for the sub-sample of "First-timers", which include individuals aged between 18 and 25, investigates bunching behavior of workers who are new in labor market. In this case employers and employees have more discretionary power over wages (particularly, at relatively high levels of wages), compared to more senior employees, and they can choose earnings so that they can save on tax liability. Moreover, the opportunity cost for moving to informality is low for younger workers, since they are just beginning their careers. The bunching and elasticity estimations are $b = 0.604$ and $e = 0.009$, respectively, and both significant at 99%, for the second bracket of 2008. However, there is no evidence of bunching for this filter in 2007. Results are a little stronger for a similar group, which we call "New-comers", that includes employees for less than one year in their current job. Those individuals mostly do not have their wages corrected by institutional mechanisms (e.g., inflation-related wage correction) and, probably more than First-timers, they may have some margin to negotiate earnings, thus implementing tax planning. Consistently, we find highly significant estimates for 2008, second threshold of the income tax schedule: $b = 0.684$ and $e = 0.01$.

Anecdotal evidence links results for First-timers and New-comers to the mix between formal and informal employment. Looking for a more reliable proxy of the role of informality in the relationship between the employee and the employer, the most natural candidate is the firm's size in terms of the number of employees. Small firms and their employees are likely to face lower tax avoidance and tax evasion costs essentially because of the lower coordination costs between the employer and the employees, due to small numbers of people involved, relational contracts (which complement the formal labor contract), low degrees of unionization, and lower chance of detection by the tax authority. Hence, individual earnings can more easily be fine-tuned to set the formal and informal mix and remain within the bunching zone. Indeed, empirical evidence from Brazil points to this relationship between tax evasion, firm size, and informality, such as in Ulyssea (2018). In particular, the latter study suggests that informality is not only associated with a binary decision at the extensive margin (informal or not informal) but also with an intensive margin, which relates to the degree of informality adopted by each firm, via "off the books" payments, for instance. That is why the results in the last column of Panel C of Table 3 show the estimates for the sub-sample of "Small firms", which, according to the IBGE's official definition, includes firms with less than 100 employees for industry sectors, and below 50 employees for the remaining sectors. The bunching mass, which is small and not significant in 2007, jumps to $b = 0.964$ (with implied elasticity of taxable income $e = 0.014$), which is highly significant.

To focus on the role of firms' (employment) dimension, Figure 5 compares bunching behavior in 2007 (left panels) and 2008 (right panels) of four different sub-samples of firms: Micro firms (panels a and b, firms with under 20 employees in industrial sectors, or 10 employees in non-industrial sectors), which include firms; Small firms (panels c and d, firms with under 100 employees in industry, or 50 employees in non-industry sectors); Medium firms (panels e f, firms with under 500 employees in industry, or 100 employees in non-industry sector); Large firms (panels g and h, firms with over 500 employees in industry, or 100 employees in non-industry sector). Though bunching is significant for all such filters, there is a clear monotonic trend whereby smaller firms perform larger estimated exceeding masses and, hence, the elasticity of taxable labor income: bunching is maximum for Micro firms ($b = 1.897$ and $e = 0.0.28$ and minimum—though significantly different form zero—for Large firms ($b = 0.129$ and $e = 0.002$). Of course, the sample size varies across these filters: it is minimum for Micro firms and maximum for Large firms (though it does not increase monotonically with firms' size). However, the results for all sub-samples in 2008 are highly significant.

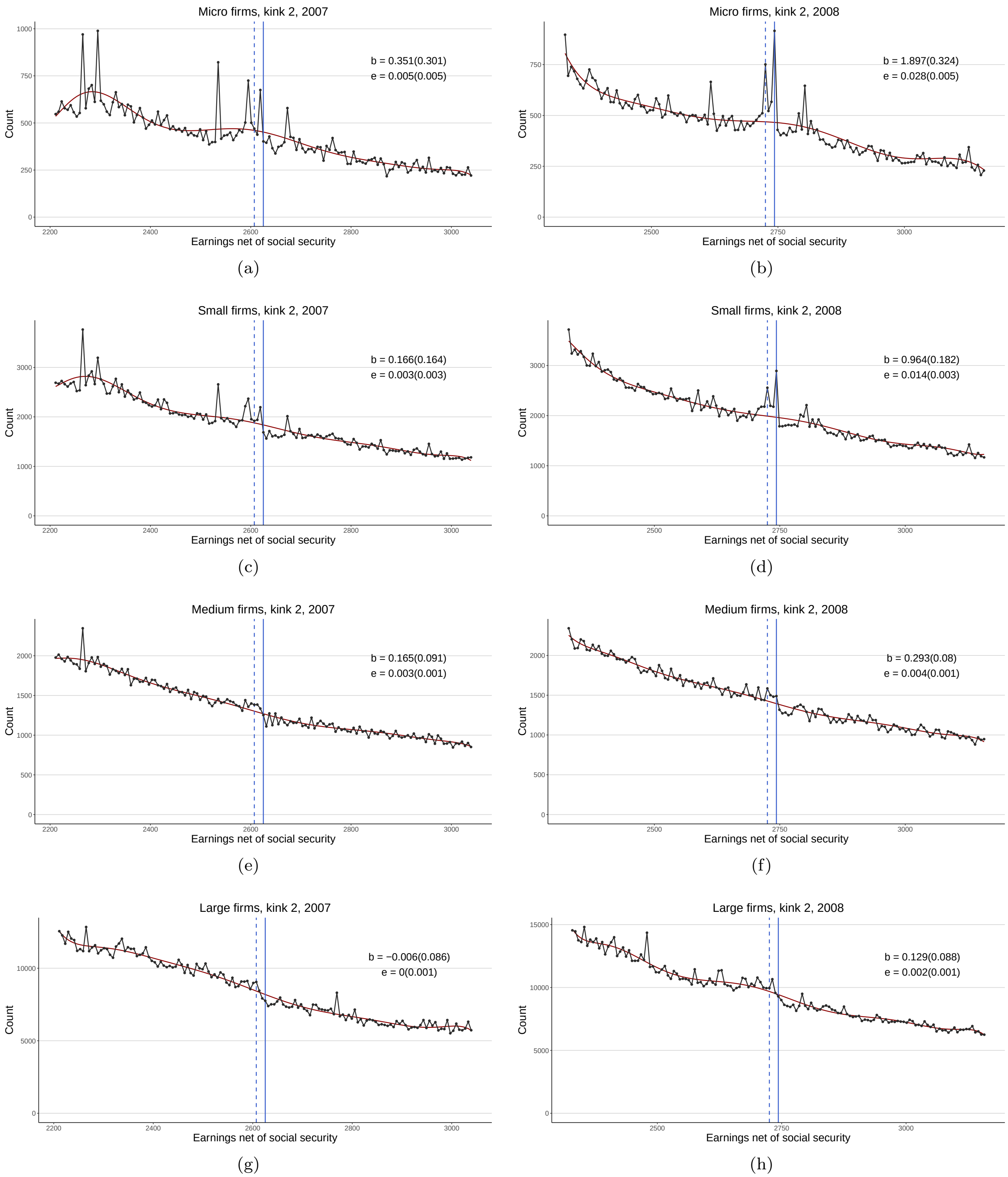


Figure 5: Elasticity and bunching mass estimations, firms by size, RAIS

Note: Bunching excess mass (b) and elasticity of taxable income (e) estimations, as described in Section 4.2, and corresponding standard deviations (in parenthesis), estimated via bootstrap, with 100 resamples. The vertical axis represents the bin counts c_j, with a width of R$ 6 each. The horizontal represents the monthly normalized labor market earnings (wages) net of social security. The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. z^* and z^L are four bins apart. The counterfactual density (in red) is estimated using a 9^{th} degree polynomial.

Though the most likely mechanism that explains the monotonic relationship between firms' size is the mix between formal and informal economic activity, the existence of a simplified tax regime for Brazilian firms, the Simples Nacional (see Section 2.3), allows us to add a crucial piece of evidence, in line with our theoretical predictions. As discussed in Section 3.3, though simplified tax regimes can have impacts on economic activity of firms—e.g. improving (or reducing) total factor productivity, or widening (or restricting) firms' capacity to avoid or evade taxes—the most useful feature of these regimes is that we can exploit the (voluntary) participation in them as an interesting proxy of lower cost of tax avoidance, other things equal, i.e., of a larger γ. From Section 3.3, the theoretical prediction is that firms under the Simples Nacional regime should peform larger bunching. To test this prediction, we split the sample of Small firms in two. Figure 6 compares the results for Small firms under Simples regime (panels a and b) and Small firms that do not participate in the Simples regime (panels c and d). The theoretical prediction is corroborated by the results. Simples firms bunch both in 2007 and 2008. Particularly, in 2008, the exceeding mass that we estimate for Simples firms ($b = 1.785$, with implied elasticity $e = 0.027$) is very large compared to the set of Small firms (see panel d of Figure 5) and much larger than Small firms that do not participate to the Simples regime ($b = 0.646$ and $e = 0.01$).

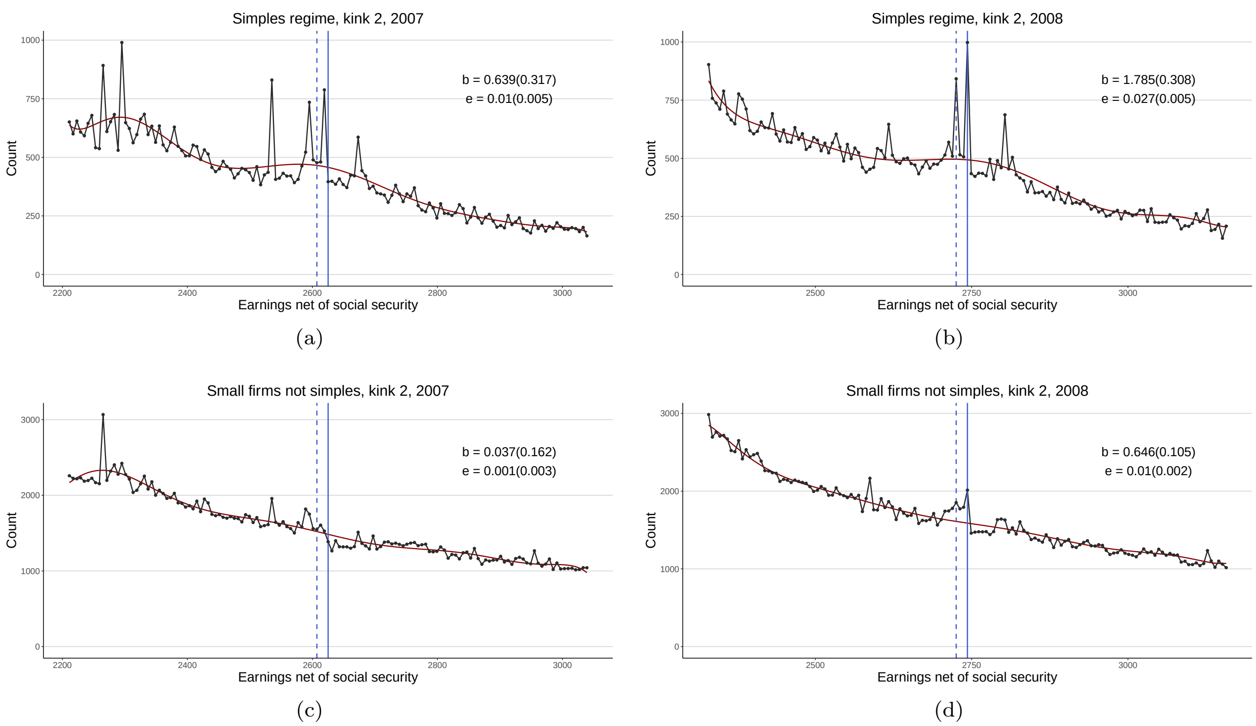


Figure 6: Elasticity and bunching mass estimations, Simples vs. Non-simples firms, RAIS

Note: Bunching excess mass (b) and elasticity of taxable income (e) estimations, as described in Section 4.2, and corresponding standard deviations (in parenthesis), estimated via bootstrap, with 100 resamples. The vertical axis represents the bin counts c_j, with a width of R\$ 6 each. The horizontal represents the monthly normalized labor market earnings (wages) net of social security. The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. z^* and z^L are four bins apart. The counterfactual density (in red) is estimated using a 9^{th} degree polynomial.

6 Conclusion

We produce a model that stresses the role of the informal sector in alleviating search costs on the elasticity of taxable income measured by labor responses to tax rates.

We take the model to the data to investigate taxpayers' response to income tax rates using matched employer-employee data on reported firms' wages for 2006-2009. However, about 42% of the Brazilian workforce is in the informal market, and most the formal workers earn wages close to the minimum wage (much lower than the minimum tax liability), which leads us to work with a very specific set of workers potentially affected by the income tax rate.

Our results show taxpayers' behavioral response in our data. We have evidence of exceeding mass at kinks of the income tax schedule—in particular, at the second kink for the year 2008 (smaller in 2006-2007)—but it disappeared with the change in the number of tax rates and thresholds in 2009. Bunching is larger for smaller firms and even larger for firms under the simplified tax regime. These findings strongly corroborate our theoretical predictions about the role of informality in the presence of search cost in formal labor market.

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A Appendix

A.1 Theoretical Results

Lemma 3 (Single crossing property) *At the worker's optimum,* $\frac{dx}{dz}|_u$ *is decreasing in* α_i*. Particularly, it is decreasing for any* $\alpha_i \in (\underline{\alpha}, \overline{\alpha})$*.*

Proof. For any α_i, $\frac{dx}{dz} = \left(\frac{\frac{z}{w}+q}{\alpha_i}\right)^{\frac{1}{\varepsilon}} \frac{1}{w}$, where we used $h = \frac{z}{w}$. Considering that q_i^* is independent of α_i for workers who optimally choose h_i—i.e., $\alpha_i \notin (\underline{\alpha}, \overline{\alpha})$, $\frac{\partial}{\partial \alpha_i}\left(\frac{dx}{dz}\right) = -\left(\frac{\frac{z}{w}+q}{\alpha_i}\right)^{\frac{1}{\varepsilon}-1} \frac{1}{w\alpha_i^2} < 0$. For workers with $\alpha_i \in (\underline{\alpha}, \overline{\alpha})$, $h_i^* = \frac{K}{w}$. Hence, by the first order condition (5)—i.e., $w\left(1 - \frac{s'}{\gamma}\right) = \left(\frac{\frac{K}{w}+q}{\alpha_i}\right)^{\frac{1}{\varepsilon}}$—we can write $\frac{dx}{dz} = \left(\frac{\frac{K}{w}+q_i^*}{\alpha_i}\right)^{\frac{1}{\varepsilon}} \frac{1}{w} = 1 - \frac{s'}{\gamma}$. Thus, $\frac{\partial}{\partial \alpha_i}\left(\frac{dx}{dz}\right) = -\frac{s''}{\gamma} w \frac{dq_i^*}{d\alpha_i} < 0$, given that, by the comparative statics on the first order condition (5), $\frac{dq_i^*}{d\alpha_i} > 0$ for all $\alpha_i \in (\underline{\alpha}, \overline{\alpha})$. ■

A.2 Institutional Setting

A.2.1 Functions of *Receita Federal*

Some of the main functions of the *Receita Federal* are[18]:

- Handling of domestic and international trade taxes;
- Management and execution of tax collection activities, research and tax investigation;
- Interpretation, application and elaboration of proposals for improvement of the federal tax legislation;
- Support for the formulation of tax and customs policies;
- Support for the elaboration of the federal annual budget's revenues;
- Participation in international cooperation and negotiation and implementation of international accords relating to taxation and customs.

A.2.2 Federal taxes and contributions

The Brazilian federal taxes are:

- **Tax over imports (II)**: collected from importers (either juridical persons or individuals), for imported goods;
- **Tax over financial operations (IOF)**: for loans, stocks and other financial products;
- **Taxes over industrialized goods (IPI)**: collected immediately after an industrialized good exits the firm;
- **Income tax over individuals (IRPF, or IR)**: income tax for individuals, divided into four categories (income from work, capital, residents from abroad, and others);
- **Income tax over juridical persons (IRPJ)**: income tax for juridical persons.

The contributions are mainly destined to social security:

- **Contribution for social security maintenance (Cofins)**: collected from all juridical persons, with the exception of those under the *Simples Nacional*[19] tax regime. Calculated over gross revenue. Confins' objective is to finance part of the Brazilian social security, such as public heath and retirements;

[18] https://www.gov.br/receitafederal/pt-br/acesso-a-informacao/institucional/competencias-1

[19] The *Simples Nacional* is a simplified tax regime, exclusive for micro and small juridical persons (with annual revenue up to R$ 4.8 million, for 2022). Businesses under this scheme are eligible for a simplified tax schedule and structure, with lower rates.

- **Social Integration Program (PIS/PASEP)**: collected from juridical persons, for social benefits for workers, such as unemployment insurance and wage allowances. The PIS/PASEP's objective is to finance workers' and employees' benefits, such as wage allowances and unemployment insurance, for both private (PIS) and private (PASEP) sectors;
- **Contribution over net profits (CSLL)**: collected from juridical persons, with same rules as the IRPJ. CSLL's objective is to finance social security;
- **Contribution for social security (INSS)**: collected from juridical persons. INSS's objective is to finance social security.

A.2.3 Brazilian tax schedule over the years

Figures 7 and 8 show the details about the Brazilian individual income tax (IRPF) throughout 1998-2022, in values of Dec/2022 and nominal values, respectively. In particular, we observe the trajectory of the monthly tax base (wages net of social security contributions) and marginal rates associated with each bracket. For instance, in 1998, the marginal tax rate for real monthly incomes up to R$ 4062 is 0%; from R$ 4062.05 to R$ 8124 is 15%; and over R$ 8124.05 is 25%. It is worth noting that the (nominal) tax rate schedule changes once, between 2009 and 2010, throughout the period analyzed, from 0 - 15 - 27.5% to 0 - 7.5 - 15 - 22.5 - 27.5%. The tax base remains constant in nominal values throughout the periods 1998-2002, 2003-2005, and 2015-2022.

1998		
Tax base		Rate
From	to	
R$ -	R$ 4.062,00	0,0%
R$ 4.062,05	R$ 8.124,00	15,0%
R$ 8.124,05	R$ -	25,0%

1999		
Tax base		Rate
From	to	
R$ -	R$ 3.995,85	0,0%
R$ 3.995,89	R$ 7.991,69	15,0%
R$ 7.991,73	R$ -	27,5%

2000		
Tax base		Rate
From	to	
R$ -	R$ 3.667,93	0,0%
R$ 3.667,97	R$ 7.335,87	15,0%
R$ 7.335,91	R$ -	27,5%

2001		
Tax base		Rate
From	to	
R$ -	R$ 3.461,15	0,0%
R$ 3.461,19	R$ 6.922,31	15,0%
R$ 6.922,34	R$ -	27,5%

2002		
Tax base		Rate
From	to	
R$ -	R$ 3.778,82	0,0%
R$ 3.778,85	R$ 7.554,07	15,0%
R$ 7.554,10	R$ -	27,5%

2003		
Tax base		Rate
From	to	
R$ -	R$ 3.358,04	0,0%
R$ 3.358,08	R$ 6.712,92	15,0%
R$ 6.712,95	R$ -	27,5%

2004		
Tax base		Rate
From	to	
R$ -	R$ 3.072,32	0,0%
R$ 3.072,35	R$ 6.141,74	15,0%
R$ 6.141,77	R$ -	27,5%

2005		
Tax base		Rate
From	to	
R$ -	R$ 3.141,37	0,0%
R$ 3.141,40	R$ 6.277,34	15,0%
R$ 6.277,37	R$ -	27,5%

2006		
Tax base		Rate
From	to	
R$ -	R$ 3.210,04	0,0%
R$ 3.210,06	R$ 6.414,56	15,0%
R$ 6.414,58	R$ -	27,5%

2007		
Tax base		Rate
From	to	
R$ -	R$ 3.252,31	0,0%
R$ 3.252,33	R$ 6.499,02	15,0%
R$ 6.499,04	R$ -	27,5%

2008		
Tax base		Rate
From	to	
R$ -	R$ 3.253,64	0,0%
R$ 3.253,67	R$ 6.501,67	15,0%
R$ 6.501,70	R$ -	27,5%

2009		
Tax base		Rate
From	to	
R$ -	R$ 3.210,59	0,0%
R$ 3.210,61	R$ 4.811,63	7,5%
R$ 4.811,66	R$ 6.415,59	15,0%
R$ 6.415,61	R$ 8.016,41	22,5%
R$ 8.016,43	R$ -	27,5%

2010		
Tax base		Rate
From	to	
R$ -	R$ 3.216,34	0,0%
R$ 3.216,38	R$ 4.820,31	7,5%
R$ 4.820,33	R$ 6.427,15	15,0%
R$ 6.427,17	R$ 8.030,85	22,5%
R$ 8.030,87	R$ -	27,5%

2011		
Tax base		Rate
From	to	
R$ -	R$ 3.173,57	0,0%
R$ 3.173,59	R$ 4.756,17	7,5%
R$ 4.756,19	R$ 6.341,64	15,0%
R$ 6.341,66	R$ 7.924,00	22,5%
R$ 7.924,02	R$ -	27,5%

2012		
Tax base		Rate
From	to	
R$ -	R$ 3.113,88	0,0%
R$ 3.113,90	R$ 4.666,71	7,5%
R$ 4.666,72	R$ 6.222,36	15,0%
R$ 6.222,38	R$ 7.774,96	22,5%
R$ 7.774,98	R$ -	27,5%

2013		
Tax base		Rate
From	to	
R$ -	R$ 3.074,50	0,0%
R$ 3.074,52	R$ 4.607,69	7,5%
R$ 4.607,71	R$ 6.143,66	15,0%
R$ 6.143,68	R$ 7.676,62	22,5%
R$ 7.676,64	R$ -	27,5%

2014		
Tax base		Rate
From	to	
R$ -	R$ 3.033,55	0,0%
R$ 3.033,57	R$ 4.546,32	7,5%
R$ 4.546,34	R$ 6.061,83	15,0%
R$ 6.061,85	R$ 7.574,36	22,5%
R$ 7.574,37	R$ -	27,5%

2015		
Tax base		Rate
From	to	
R$ -	R$ 3.036,20	0,0%
R$ 3.036,21	R$ 4.507,54	7,5%
R$ 4.507,55	R$ 5.981,64	15,0%
R$ 5.981,66	R$ 7.438,57	22,5%
R$ 7.438,58	R$ -	27,5%

2016		
Tax base		Rate
From	to	
R$ -	R$ 2.743,38	0,0%
R$ 2.743,40	R$ 4.072,83	7,5%
R$ 4.072,84	R$ 5.404,76	15,0%
R$ 5.404,78	R$ 6.721,18	22,5%
R$ 6.721,20	R$ -	27,5%

2017		
Tax base		Rate
From	to	
R$ -	R$ 2.581,08	0,0%
R$ 2.581,09	R$ 3.831,87	7,5%
R$ 3.831,89	R$ 5.085,01	15,0%
R$ 5.085,03	R$ 6.323,55	22,5%
R$ 6.323,57	R$ -	27,5%

2018		
Tax base		Rate
From	to	
R$ -	R$ 2.507,19	0,0%
R$ 2.507,20	R$ 3.722,17	7,5%
R$ 3.722,18	R$ 4.939,43	15,0%
R$ 4.939,44	R$ 6.142,51	22,5%
R$ 6.142,52	R$ -	27,5%

2019		
Tax base		Rate
From	to	
R$ -	R$ 2.416,67	0,0%
R$ 2.416,68	R$ 3.587,79	7,5%
R$ 3.587,80	R$ 4.761,11	15,0%
R$ 4.761,12	R$ 5.920,75	22,5%
R$ 5.920,76	R$ -	27,5%

2020		
Tax base		Rate
From	to	
R$ -	R$ 2.316,90	0,0%
R$ 2.316,92	R$ 3.439,68	7,5%
R$ 3.439,69	R$ 4.564,55	15,0%
R$ 4.564,57	R$ 5.676,33	22,5%
R$ 5.676,34	R$ -	27,5%

2021		
Tax base		Rate
From	to	
R$ -	R$ 2.216,76	0,0%
R$ 2.216,78	R$ 3.291,01	7,5%
R$ 3.291,02	R$ 4.367,27	15,0%
R$ 4.367,28	R$ 5.430,99	22,5%
R$ 5.431,00	R$ -	27,5%

2022		
Tax base		Rate
From	to	
R$ -	R$ 2.014,12	0,0%
R$ 2.014,13	R$ 2.990,17	7,5%
R$ 2.990,18	R$ 3.968,04	15,0%
R$ 3.968,05	R$ 4.934,52	22,5%
R$ 4.934,53	R$ -	27,5%

Figure 7: Brazilian income tax schedule 1998-2022 (in prices of Dec/2022)

1998		
Tax base		Rate
From	to	
R$ -	R$ 900,00	0,0%
R$ 900,01	R$ 1.800,00	15,0%
R$ 1.800,01	R$ -	25,0%

1999		
Tax base		Rate
From	to	
R$ -	R$ 900,00	0,0%
R$ 900,01	R$ 1.800,00	15,0%
R$ 1.800,01	R$ -	27,5%

2000		
Tax base		Rate
From	to	
R$ -	R$ 900,00	0,0%
R$ 900,01	R$ 1.800,00	15,0%
R$ 1.800,01	R$ -	27,5%

2001		
Tax base		Rate
From	to	
R$ -	R$ 900,00	0,0%
R$ 900,01	R$ 1.800,00	15,0%
R$ 1.800,01	R$ -	27,5%

2002		
Tax base		Rate
From	to	
R$ -	R$ 1.058,00	0,0%
R$ 1.058,01	R$ 2.115,00	15,0%
R$ 2.115,01	R$ -	27,5%

2003		
Tax base		Rate
From	to	
R$ -	R$ 1.058,00	0,0%
R$ 1.058,01	R$ 2.115,00	15,0%
R$ 2.115,01	R$ -	27,5%

2004		
Tax base		Rate
From	to	
R$ -	R$ 1.058,00	0,0%
R$ 1.058,01	R$ 2.115,00	15,0%
R$ 2.115,01	R$ -	27,5%

2005		
Tax base		Rate
From	to	
R$ -	R$ 1.164,00	0,0%
R$ 1.164,01	R$ 2.326,00	15,0%
R$ 2.326,01	R$ -	27,5%

2006		
Tax base		Rate
From	to	
R$ -	R$ 1.257,12	0,0%
R$ 1.257,13	R$ 2.512,08	15,0%
R$ 2.512,09	R$ -	27,5%

2007		
Tax base		Rate
From	to	
R$ -	R$ 1.313,69	0,0%
R$ 1.313,70	R$ 2.625,12	15,0%
R$ 2.625,13	R$ -	27,5%

2008		
Tax base		Rate
From	to	
R$ -	R$ 1.372,81	0,0%
R$ 1.372,82	R$ 2.743,25	15,0%
R$ 2.743,26	R$ -	27,5%

2009		
Tax base		Rate
From	to	
R$ -	R$ 1.434,60	0,0%
R$ 1.434,61	R$ 2.150,00	7,5%
R$ 2.150,01	R$ 2.866,70	15,0%
R$ 2.866,71	R$ 3.582,00	22,5%
R$ 3.582,01	R$ -	27,5%

2010		
Tax base		Rate
From	to	
R$ -	R$ 1.499,14	0,0%
R$ 1.499,16	R$ 2.246,75	7,5%
R$ 2.246,76	R$ 2.995,70	15,0%
R$ 2.995,71	R$ 3.743,19	22,5%
R$ 3.743,20	R$ -	27,5%

2011		
Tax base		Rate
From	to	
R$ -	R$ 1.566,61	0,0%
R$ 1.566,62	R$ 2.347,85	7,5%
R$ 2.347,86	R$ 3.130,51	15,0%
R$ 3.130,52	R$ 3.911,63	22,5%
R$ 3.911,64	R$ -	27,5%

2012		
Tax base		Rate
From	to	
R$ -	R$ 1.637,11	0,0%
R$ 1.637,12	R$ 2.453,50	7,5%
R$ 2.453,51	R$ 3.271,38	15,0%
R$ 3.271,39	R$ 4.087,65	22,5%
R$ 4.087,66	R$ -	27,5%

2013		
Tax base		Rate
From	to	
R$ -	R$ 1.710,78	0,0%
R$ 1.710,79	R$ 2.563,91	7,5%
R$ 2.563,92	R$ 3.418,59	15,0%
R$ 3.418,60	R$ 4.271,59	22,5%
R$ 4.271,60	R$ -	27,5%

2014		
Tax base		Rate
From	to	
R$ -	R$ 1.787,77	0,0%
R$ 1.787,78	R$ 2.679,29	7,5%
R$ 2.679,30	R$ 3.572,43	15,0%
R$ 3.572,44	R$ 4.463,81	22,5%
R$ 4.463,82	R$ -	27,5%

2015		
Tax base		Rate
From	to	
R$ -	R$ 1.903,98	0,0%
R$ 1.903,99	R$ 2.826,65	7,5%
R$ 2.826,66	R$ 3.751,05	15,0%
R$ 3.751,06	R$ 4.664,68	22,5%
R$ 4.664,69	R$ -	27,5%

2016		
Tax base		Rate
From	to	
R$ -	R$ 1.903,98	0,0%
R$ 1.903,99	R$ 2.826,65	7,5%
R$ 2.826,66	R$ 3.751,05	15,0%
R$ 3.751,06	R$ 4.664,68	22,5%
R$ 4.664,69	R$ -	27,5%

2017		
Tax base		Rate
From	to	
R$ -	R$ 1.903,98	0,0%
R$ 1.903,99	R$ 2.826,65	7,5%
R$ 2.826,66	R$ 3.751,05	15,0%
R$ 3.751,06	R$ 4.664,68	22,5%
R$ 4.664,69	R$ -	27,5%

2018		
Tax base		Rate
From	to	
R$ -	R$ 1.903,98	0,0%
R$ 1.903,99	R$ 2.826,65	7,5%
R$ 2.826,66	R$ 3.751,05	15,0%
R$ 3.751,06	R$ 4.664,68	22,5%
R$ 4.664,69	R$ -	27,5%

2019		
Tax base		Rate
From	to	
R$ -	R$ 1.903,98	0,0%
R$ 1.903,99	R$ 2.826,65	7,5%
R$ 2.826,66	R$ 3.751,05	15,0%
R$ 3.751,06	R$ 4.664,68	22,5%
R$ 4.664,69	R$ -	27,5%

2020		
Tax base		Rate
From	to	
R$ -	R$ 1.903,98	0,0%
R$ 1.903,99	R$ 2.826,65	7,5%
R$ 2.826,66	R$ 3.751,05	15,0%
R$ 3.751,06	R$ 4.664,68	22,5%
R$ 4.664,69	R$ -	27,5%

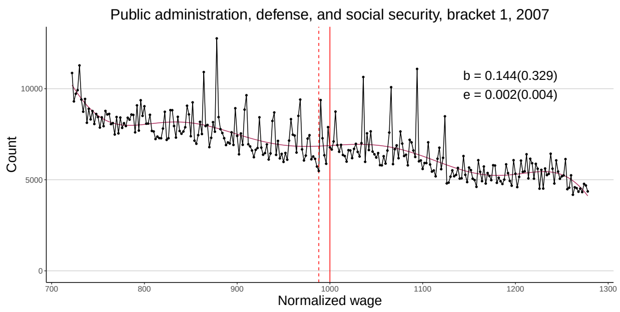
2021		
Tax base		Rate
From	to	
R$ -	R$ 1.903,98	0,0%
R$ 1.903,99	R$ 2.826,65	7,5%
R$ 2.826,66	R$ 3.751,05	15,0%
R$ 3.751,06	R$ 4.664,68	22,5%
R$ 4.664,69	R$ -	27,5%

2022		
Tax base		Rate
From	to	
R$ -	R$ 1.903,98	0,0%
R$ 1.903,99	R$ 2.826,65	7,5%
R$ 2.826,66	R$ 3.751,05	15,0%
R$ 3.751,06	R$ 4.664,68	22,5%
R$ 4.664,69	R$ -	27,5%

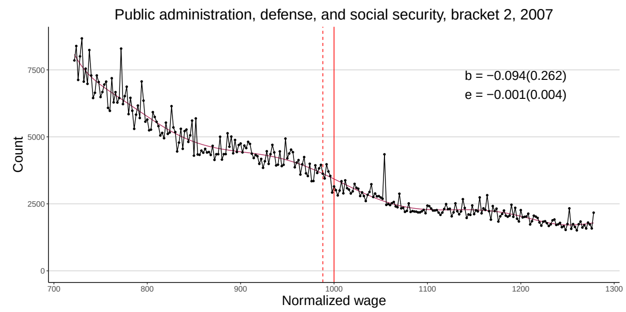
Figure 8: Brazilian income tax schedule 1998-2022 (nominal values)

A.3 Bunching results underlying Table 3

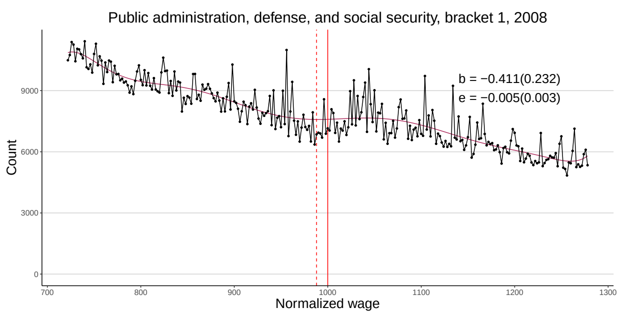
We report in this section the Figures that correspond to results summarized in Table 3.



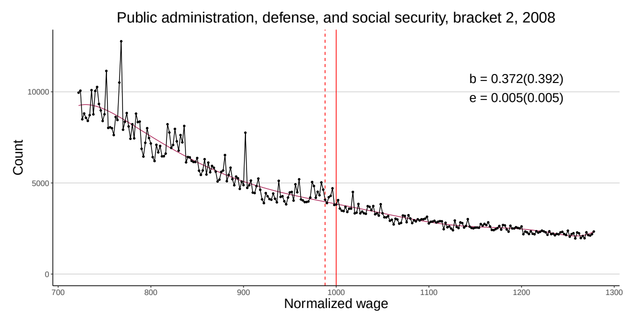
(a)



(b)



(c)



(d)

Figure 9: Elasticity and bunching mass estimations, public sector, RAIS

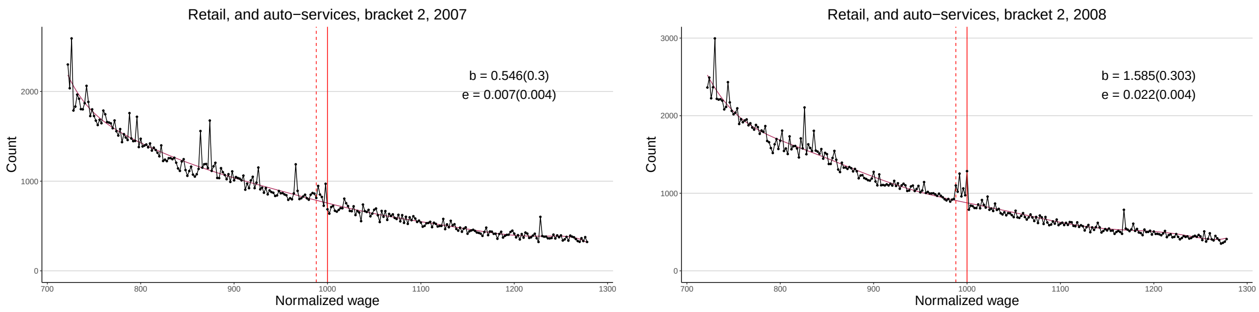
Note: Bunching and elasticity estimations, as described in Section 4.2. The vertical axis represents the bin counts c_j, the horizontal represents the normalized December wage net of social security, in terms of the associated earnings threshold ($z = z^* \iff$ Normalized wage $= 1000$). The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. The bin widths are set to 2, with 140 bins to the right and left. The counterfactual density is estimated using a 9^{th} degree polynomial. standard errors (in parenthesis) are estimated via bootstrap, with 100 resamples.

(a)

(b)

Figure 10: Elasticity and bunching mass estimations, real estate, RAIS

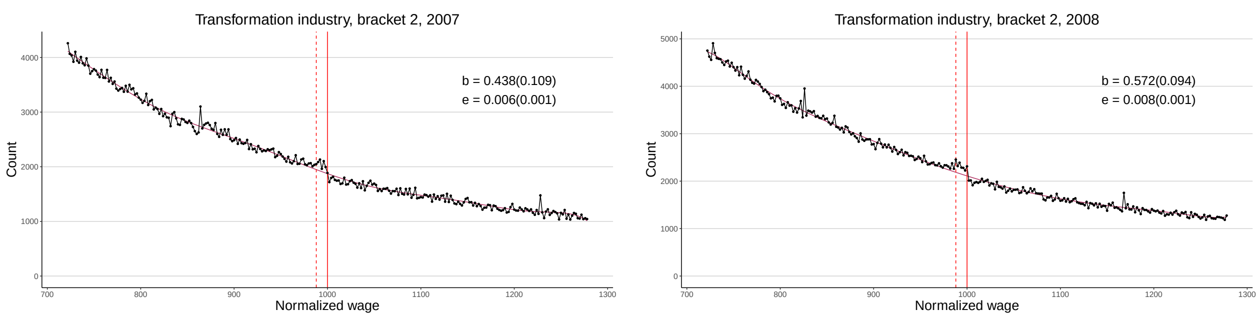
Note: Bunching and elasticity estimations, as described in Section 4.2. The vertical axis represents the bin counts c_j, the horizontal represents the normalized December wage net of social security, in terms of the associated earnings threshold ($z = z^* \iff$ Normalized wage $= 1000$). The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. The bin widths are set to 2, with 140 bins to the right and left. The counterfactual density is estimated using a 9^{th} degree polynomial. standard errors (in parenthesis) are estimated via bootstrap, with 100 resamples.



(a) (b)

Figure 11: Elasticity and bunching mass estimations, retail, RAIS

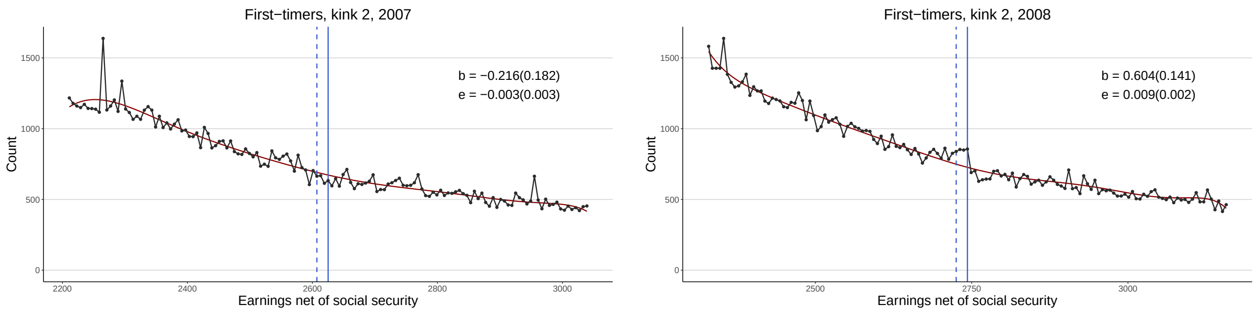
Note: Bunching and elasticity estimations, as described in Section 4.2. The vertical axis represents the bin counts c_j, the horizontal represents the normalized December wage net of social security, in terms of the associated earnings threshold ($z = z^* \iff$ Normalized wage $= 1000$). The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. The bin widths are set to 2, with 140 bins to the right and left. The counterfactual density is estimated using a 9^{th} degree polynomial. standard errors (in parenthesis) are estimated via bootstrap, with 100 resamples.



(a) (b)

Figure 12: Elasticity and bunching mass estimations, transformation industry, RAIS

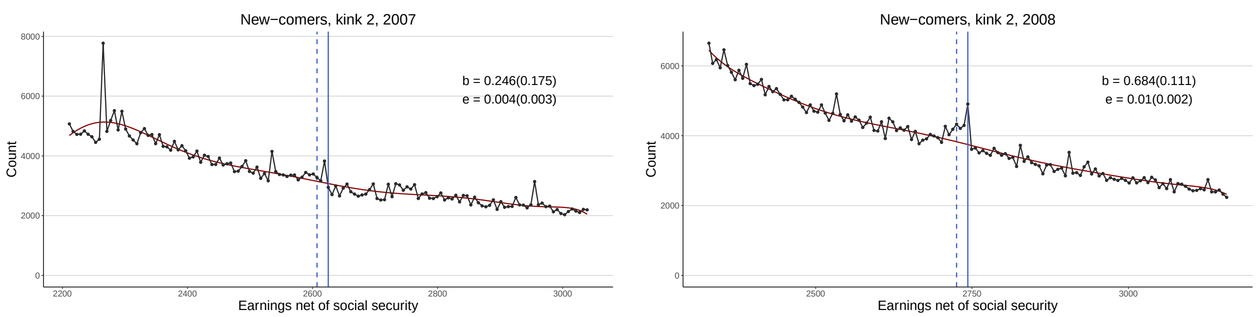
Note: Bunching and elasticity estimations, as described in Section 4.2. The vertical axis represents the bin counts c_j, the horizontal represents the normalized December wage net of social security, in terms of the associated earnings threshold ($z = z^* \iff$ Normalized wage $= 1000$). The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. The bin widths are set to 2, with 140 bins to the right and left. The counterfactual density is estimated using a 9^{th} degree polynomial. standard errors (in parenthesis) are estimated via bootstrap, with 100 resamples.



(a) (b)

Figure 13: Elasticity and bunching mass estimations, first-timers, RAIS

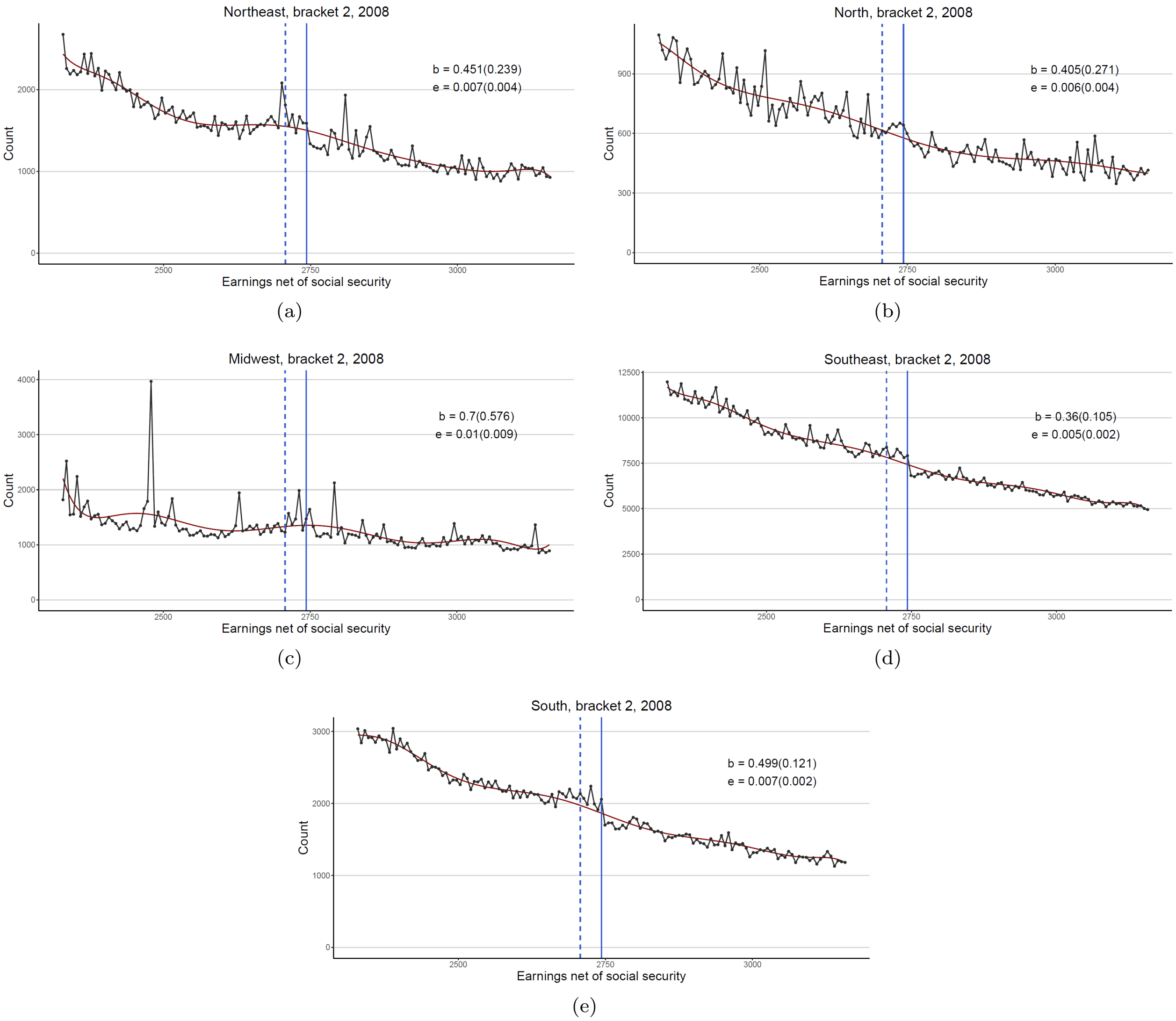
Note: Bunching and elasticity estimations, as described in Section 4.2. The vertical axis represents the bin counts c_j, the horizontal represents the normalized December wage net of social security, in terms of the associated earnings threshold ($z = z^* \iff$ Normalized wage = 1000). The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. The bin widths are set to 2, with 140 bins to the right and left. The counterfactual density is estimated using a 9^{th} degree polynomial. standard errors (in parenthesis) are estimated via bootstrap, with 100 resamples.



(a) (b)

Figure 14: Elasticity and bunching mass estimations, new-comers, RAIS

Note: Bunching and elasticity estimations, as described in Section 4.2. The vertical axis represents the bin counts c_j, the horizontal represents the normalized December wage net of social security, in terms of the associated earnings threshold ($z = z^* \iff$ Normalized wage = 1000). The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. The bin widths are set to 2, with 140 bins to the right and left. The counterfactual density is estimated using a 9^{th} degree polynomial. standard errors (in parenthesis) are estimated via bootstrap, with 100 resamples.



(a) (b) (c) (d) (e)

Figure 15: Elasticity and bunching mass estimations, regions, RAIS

Note: Bunching excess mass (b) and elasticity of taxable income (e) estimations, as described in Section 4.2, and corresponding standard deviations (in parenthesis), estimated via bootstrap, with 100 resamples. The vertical axis represents the bin counts c_j, with a width of R$ 6 each. The horizontal represents the monthly normalized labor market earnings (wages) net of social security. The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for the first kink, and $\tau_1 = 15\%$ and $\tau_2 = 27.5\%$ for the second kink. The solid line represents the earnings threshold z^*, and the dashed line represents the lower limit z_L for diffuse bunching. z^* and z^L are four bins apart. The counterfactual density (in red) is estimated using a 9^{th} degree polynomial.

A.4 Inflation, adjustment and bunching

Here, we discuss about the potential reasons behind bunching heterogeneity across years: why do we observe greater bunching mass in some years, for a given filter? For this preliminary analysis, we restrict our results to the second threshold, for the period 2002-2008. This is because the bunching estimates are more salient for this threshold (see the Results section), and because the tax schedule's 0-15-27.5% structure remains constant throughout this period. Moreover, we use a fixed-effects specification to account for individual characteristics of individual type filters. Hence, the unit of observation refers to the pair (i, t), where i is the filter type, and t is the year. For instance, $(Southeast, 2004)$, or $(Transformation\,Industry, 2007)$ are two observations included in the data.

A possible explanation for the heterogeneity would be related to inflation which, we argue, makes the adjustment of individuals in the earnings distribution harder. Here are some preliminary regression results that corroborate with this argument. First, we provide the regression results of $\ln(1+b)$ (truncated at zero when $1+b \leq 0$) on inflation volatility and its lags, measured by the standard deviation of quarterly inflation (IPCA index). The hypothesis is that inflation volatility makes it harder for individuals do adjust their nominal earnings to match the threshold because of monetary illusion. The argument of monetary illusion can also be made for inflation itself (results below), measured by the IPCA and INPC indexes (the INPC is more granular, can be separated by regions). Note how estimations, in general, suggest a negative relationship between bunching mass and inflation and volatility – robust across specifications and lags.

Dependent Variable:		ln_b	
Model:	(1)	(2)	(3)
Variables			
log(ipca_sd)	0.0363	0.0005	0.0362
	(0.0324)	(0.0306)	(0.0329)
log(ipca_sd_l1)	-0.0718**	-0.0710**	-0.0944***
	(0.0318)	(0.0290)	(0.0309)
log(ipca_sd_l2)		-0.1516***	-0.1455***
		(0.0296)	(0.0283)
log(ipca_sd_l3)			-0.0854**
			(0.0338)
Fixed-effects			
type	Yes	Yes	Yes
Fit statistics			
Observations	182	182	182
R^2	0.24515	0.34730	0.37313
Within R^2	0.03989	0.16982	0.20267

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Dependent Variable:		ln_b	
Model:	(1)	(2)	(3)
Variables			
log(ipca_yr)	-0.0154	-0.2216***	-0.2217***
	(0.0636)	(0.0750)	(0.0755)
log(ipca_yr_l1)	-0.2434***	0.1328	0.1194
	(0.0789)	(0.1048)	(0.1151)
log(ipca_yr_l2)		-0.4463***	-0.4202***
		(0.0948)	(0.1254)
log(ipca_yr_l3)			-0.0564
			(0.1232)
Fixed-effects			
type	Yes	Yes	Yes
Fit statistics			
Observations	182	182	182
R^2	0.29142	0.39600	0.39685
Within R^2	0.09875	0.23176	0.23284

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Dependent Variable:		ln_b	
Model:	(1)	(2)	(3)
Variables			
log(inpc_yr)	0.0522	0.0184	-0.0906
	(0.0594)	(0.0570)	(0.0686)
log(inpc_yr_l1)	-0.1965***	0.0303	0.1012
	(0.0682)	(0.0711)	(0.0821)
log(inpc_yr_l2)		-0.3127***	-0.3817***
		(0.0549)	(0.0846)
log(inpc_yr_l3)			0.0127
			(0.0963)
Fixed-effects			
type	Yes	Yes	Yes
Fit statistics			
Observations	182	182	161
R^2	0.26576	0.38522	0.43819
Within R^2	0.06611	0.21805	0.26122

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

We can also make a point relating not to inflation itself, but also to inflation of the threshold analyzed (second, from 2002-2008). Again, when the threshold greatly varies from year to year, individuals might not be able to fine tune their earnings to the threshold.

Dependent Variable:	ln_b	
Model:	(1)	(2)
Variables		
log(z_star_infl)	-0.2010***	0.2247
	(0.0554)	(0.2083)
log(z_star_infl_l1)		-0.3440**
		(0.1580)
Fixed-effects		
type	Yes	Yes
Fit statistics		
Observations	130	78
R^2	0.39461	0.50967
Within R^2	0.11206	0.09043

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Finally, since the IRRF's tax base is earnings net of social security (INSS), we can also argue that, when the INSS schedule changes with high frequency, individuals might lose some capacity to adjust earnings. The results below corroborate with this hypothesis. In particular, the result is significant for the first lag of number of changes of social security, in a given year.

Dependent Variable:		ln_b	
Model:	(1)	(2)	(3)
Variables			
changes_inss	0.0542	0.0230	-0.1129
	(0.0605)	(0.0608)	(0.1179)
changes_inss_l1		-0.1562***	-0.2543***
		(0.0380)	(0.0816)
changes_inss_l2			0.1056
			(0.0756)
Fixed-effects			
type	Yes	Yes	Yes
Fit statistics			
Observations	182	182	182
R^2	0.21770	0.28153	0.29492
Within R^2	0.00498	0.08616	0.10320

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

A.5 Results with PNAD and PNADC datasets

This section discusses both PNADs (survey) data sets. All the results are fuzzy and do not indicate bunching whatsoever. We ponder that the reason behind these is that we are using a methodology that demands high sample size and low measurement error, less compatible with survey data. In particular, counterfactual fit is not satisfactory, given that the large number of empty bins which contaminates the polynomial fits, even with large bin-widths. In this subsection, we provide representative results, while the remaining ones can be found in the Online Appendix. The outputs can be summarized in Table 4. Bootstrap standard errors are in parenthesis.

Table 4: PNAD and PNADC results

Panel A. PNAD estimates around first income tax kinks (1998-2015)

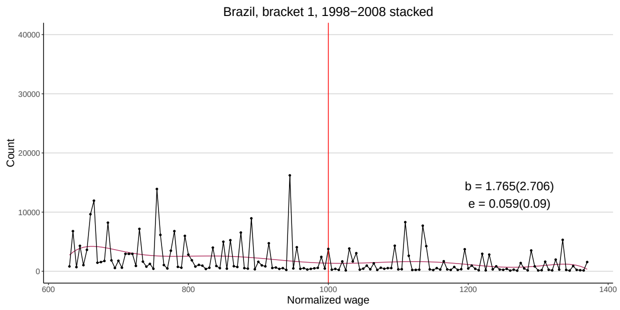
Years	Estimates	Full sample	Self-employed	Informal workers
Large kink (1998-2008)	Bunching mass	1.765 (2.706)	1.682 (5.293)	1.688 (17.287)
	Elasticity	0.059 (0.09)	0.056 (0.176)	0.056 (0.576)
Small kink (2009-2015)	Bunching mass	-0.904 (3.082)	-0.918 (33.119)	-0.836 (7.168)
	Elasticity	-0.06 (0.205)	-0.061 (2.208)	-0.056 (0.478)

Panel B. PNADC estimates around first income tax kinks (2012-2022)

Years	Estimates	Full sample	Self-employed	Informal workers
Small kink (2012-2022)	Bunching mass	0.541 (3.624)	-0.376 (6.568)	0.277 (9.833)
	Elasticity	0.036 (0.242)	-0.025 (0.438)	0.018 (0.656)

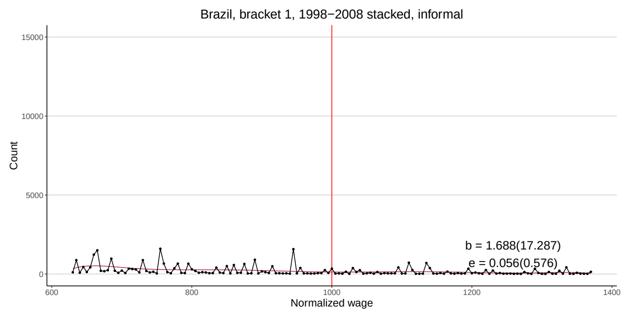
Notes: Bootstrap standard errors are in parenthesis. Bunching and elasticity estimations, as described in Section 4.2, for unfiltered data (Brazil), self-employed, and informal workers (PNAD). The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for 1998-2008 and $\tau_1 = 0\%$and $\tau_2 = 7.5\%$ for 2009-2018.

Figures 16, 17, and 18 bring results for the sample three periods considered (the first two from PNAD, and the last from PNADC), respectively, at the tax exemption ceiling, using bin-widths of 5. For each time range, we have the estimations for the full sample, and for both self employed and informal workers. Note the distribution of earnings is not "smooth", and more data granularity may be necessary.



(a) Brazil

(b) Self-employed

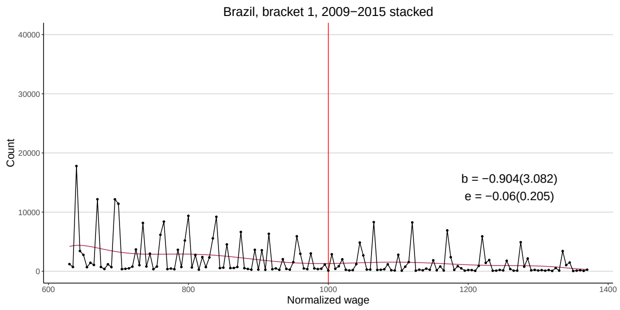


(c) Informal

Figure 16: Elasticity and bunching mass estimations, 1998-2008 (PNAD)

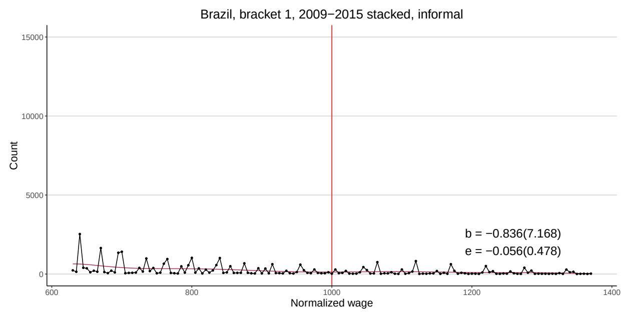
Note: Bunching and elasticity estimations, as described in Section 4.2, for unfiltered data (Brazil), self-employed, and informal workers (PNAD). The vertical axis represents the bin counts c_j, the horizontal represents the normalized December wage $\omega = 1000 \times z/z^*(t, \rho)$, with $\rho = 1$. By construction, $z^* = 1000$. The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 15\%$ for 1998-2008. The bin widths are set to 2, with 140 bins to the right and left. The counterfactual density is estimated using a 9^{th} degree polynomial. standard errors (in parenthesis) are estimated via bootstrap, with 100 resamples.

For the period 1998-2008, even though the elasticity is different from zero, there is some bunching mass at the thresholds analyzed, which could be originating from the round number bunching present for years 1998-2001 (check Section 4.2 to recall the details). We can develop a falsification test for the hypothesis of round number bunching presence, which fails to be rejected: had we had no round number effects, we could expect to see similar exceeding mass for the 2009-2015 data period, assuming that everything else is constant, except the fact that z^* falls over a round number. From the results in Figure 17 below, we note the absence of such phenomenon, with statistically insignificant estimations. Hence, we fail to reject the null and, thus, have evidence of round number bunching for the period 1998-2008.



(a) Brazil

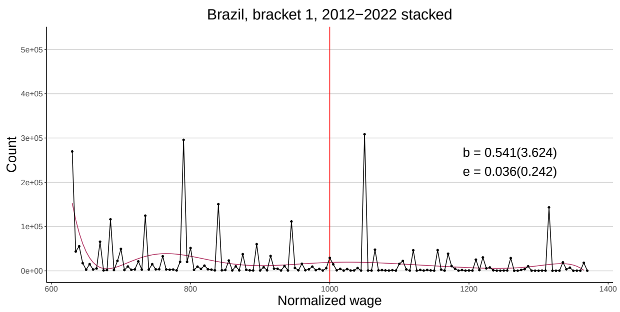
(b) Self-employed



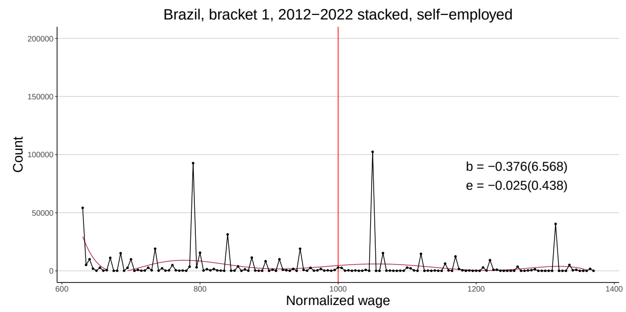
(c) Informal

Figure 17: Elasticity and bunching mass estimations, 2009-2015 (PNAD)

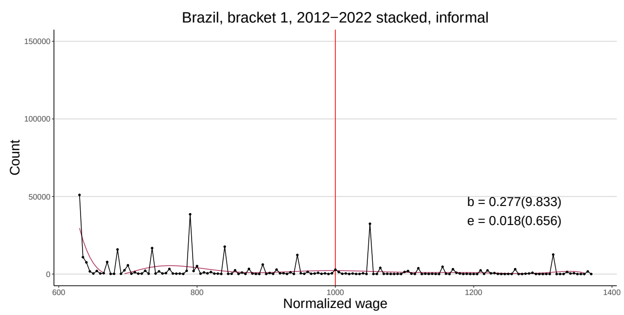
Note: Bunching and elasticity estimations, as described in Section 4.2, for unfiltered data (Brazil), self-employed, and informal workers (PNAD). The vertical axis represents the bin counts c_j, the horizontal represents the normalized December wage $\omega = 1000 \times z/z^*(t, \rho)$, with $\rho = 1$. By construction, $z^* = 1000$. The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 7.5\%$ for 2009-2015. The bin widths are set to 2, with 140 bins to the right and left. The counterfactual density is estimated using a 9^{th} degree polynomial. standard errors (in parenthesis) are estimated via bootstrap, with 100 resamples.



(a) Brazil



(b) Self-employed



(c) Informal

Figure 18: Elasticity and bunching mass estimations, 2012-2022 (PNADC)

Note: Bunching and elasticity estimations, as described in Section 4.2, for unfiltered data (Brazil), self-employed, and informal workers (PNADC). The vertical axis represents the bin counts c_j, the horizontal represents the normalized December wage $\omega = 1000 \times z/z^*(t, \rho)$, with $\rho = 1$. By construction, $z^* = 1000$. The tax rates are $\tau_1 = 0\%$ and $\tau_2 = 7.5\%$ for 2012-2022. The bin widths are set to 2, with 140 bins to the right and left. The counterfactual density is estimated using a 9^{th} degree polynomial. standard errors (in parenthesis) are estimated via bootstrap, with 100 resamples.