Brazilian Tax Reform: firm dynamics, informality and a special tax regime

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Abstract

We develop a general equilibrium model with sector heterogeneity, informality and a special tax regime for small firms. We bring the model to the data and analyze the effects of the consumption tax reform recently approved in Brazil. Simulating the reform with a measure of simplification of the tax system, we estimate an increase of up to 4.5% in GDP, with 2.7% due to changes in tax rates across sectors and 1.8% due to simplification of the tax system. The results can be significantly different in simulations where informality and the special tax regime are not present.

1 Introduction

After 30 years of discussion, the Brazilian National Congress approved a consumption tax reform in December 2023 (EC 132/2023). The approved legislation introduces a new VAT system, which significantly reduces the wide variation of tax rates across sectors that currently exist in the Brazilian economy. In order to estimate the effects of the tax reform, one should take into account that Brazil is a developing economy with a large informal sector and a special tax regime for small firms. These features play a crucial role as firms can, in response to changes in their tax obligations, choose to operate in different tax regimes.

In this paper, we develop a general equilibrium model to investigate the effects of consumption tax reforms under alternative tax regimes and sector heterogeneity. We model firms that are

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heterogeneous in terms of productivity, where in each sector they choose whether to enter the market and under which tax regime to operate. The tax regimes differ in their applicable rates, compliance costs, and firm size restrictions. Sectors differ by the parameters of the production function, entry costs, and the incidence of the alternative tax regimes.

Firms can operate in the formal standard system, informality, or in the simplified regime (*Simples*). Firms in the informal sector do not comply with taxes and regulations, but, similarly to De Paula and Scheinkman (2010), face an upper bound on their size, beyond which they are detected by the fiscal authority and close its activities. Firms in *Simples* face lower taxes and compliance costs but are constrained by revenue limits, which restrict their size.

We calibrate our model to simulate the effects of the tax reform recently approved in Brazil. The reform changes the main tax regime, reducing tax compliance costs and narrowing the differential in tax rates across sectors. Thus, it affects the composition of the economy across sectors and tax regimes.

Disregarding the existence of alternative tax regimes, there would be a clear predominance of positive effects on productivity and economic activity. The reform reduces tax rates for manufacturing activities, where firms tend to be larger and more productive. However, to maintain the overall tax burden, the reform raises rates in other activities, particularly in the service sector. Considering the existence of informality and the simplified tax regime, as well as the fact that the service sector has a larger share of GDP, the aggregate effect could be adverse. Then we should analyze the impact of the reform on the choice of the tax regime.

In sectors with a reduction in tax rates, there is an incentive for firms to formalize and migrate from the simplified tax regime to the main one. For example, consider a firm with intermediate productivity that initially limits its size to remain in the simplified tax regime. In the post-tax reform scenario, this firm may choose to operate under the general regime, with a larger size. If this is the case for a significant portion of firms, there will be an increase in the GDP share of firms that are more productive than average, raising the economy's productivity through a composition effect.

However, the opposite can occur in activities with tax rate increases, where the reform incentivizes informality and the migration of firms from the general tax regime to the simplified one, leading to a reduction in the average size of firms. Nonetheless, even in these activities, the reduction in tax compliance costs favors migration to the general regime. We simulate the effect on the economy as a whole, which is indeterminate a priori.

We find that the reform leads to an increase of up to 4.5% in GDP, of which 2.7% are due to changes in tax rates across sectors. The remaining 1.8% comes from the simplification of the tax system. The manufacturing sector has a large increase in its GDP (26.6%), while the service sector has a decrease of 4.1%. In addition, the informal sector and the simplified tax regime increase their shares in GDP. The positive effects of the reform are considerably higher in a counterfactual analysis in which we do not allow the existence of both the simplified tax regime and informality. In this case, GDP increases by 21%, with 4.1% coming from the changes in tax rates and the remaining 16.9% from the simplification of the tax system.

Our paper is closely related to two strands of the literature. First, it adds to the literature in quantitative general equilibrium models with firm heterogeneity, informality, and alternative tax regimes. In our model, we consider heterogeneous firms that choose between formal and informal regimes, following Ulyssea (2018). We also incorporate the Brazilian simplified tax regime Simples, as in Alvarez et al. (2023). However, unlike these authors, we take into account more than one sector of economic activity and input-output linkages, as in Coşar et al. (2016) and Dix-Carneiro et al. (2024). Additionally, none of these papers evaluate the Brazilian consumption tax reform.

Second, we contribute to the literature that simulate the impacts of the Brazilian consumption tax reform using general equilibrium models. Delalibera et al. (2024) use a firm production network model and find that unifying the tax rates and eliminating cumulative taxes lead to an increase of 7.9% in GDP and 1.8% in welfare. Oliveira (2023) develops a Ricardian model with region-sector units, which is useful to analyze regional aspects of the reform. The paper builds on Caliendo et al. (2019) and find a positive effect of 2.39% in GDP. When simulating the first proposal of the reform, with a unique tax rate, the effect increases to 5.75%. Domingues and Cardoso (2020) find a positive effect on GDP of 4.14%. None of this papers, however, consider informality or Simples, which is the main advantage of our model.

The next section presents the institutional background, Section 3 presents the data and some summary statistics. Section 4 presents the model, while Section 5 discuss the calibration. Section 6 presents the counterfactual analysis and Section 7 concludes.

2 Institutional Background

2.1 Tax Reform

The Brazilian tax system is often referred to as a "madhouse." According to the World Bank's 2020 Doing Business report, Brazil ranks 184 out of 190 countries for ease of paying taxes. The estimated time a business needs annually to comply with tax legislation is approximately 1,500 hours, highlighting the system's complexity. Despite firms often having an oversized tax division to ensure compliance, tax litigation amounts to about 75% of GDP[1].

A proposal for consumption tax reform aimed at addressing these issues has been under debate for a long time, finally gaining approval in December 2023. Two previous attempts in recent years failed to pass [2], but the third attempt was approved by Congress in December 2023 (EC nº132/2023). This reform consolidates five different consumption taxes into a dual VAT, composed by the Contribution on Goods and Services (*Contribuição sobre Bens e Serviços* - CBS), under the jurisdiction of the Federal Government, and the Tax on Goods and Services (*Imposto sobre Bens e Serviços* - IBS), under the jurisdiction of States and Municipalities. This change shifts the taxation of goods and services from the origin to the destination, in line with standard VAT systems.

The original proposal presented in 2019 recommended a single VAT rate across all economic activities, with no exceptions, estimating the tax rate to be around 25%. However, significant changes were made before approval, including reductions in tax rates for several economic sectors. The current maximum standard tax rate, stipulated by the congress, is 26.5%. The differentiated tax rates are proportional to the standard rate; for example, health and education services will pay 40% of the standard rate, while some food items are exempt. Recently, meats and other products were added to the exemptions list.

2.2 The Simples system

In order to increase formalization of micro and small firms, the first version of the Simples tax regime (Sistema Integrado de Pagamento de Impostos e Contribuições das Microempresas e Empresas de Pequeno Porte) was enacted in 1996. Aiming at reducing and simplifying the tax obligations for these firms, the system unified 6 federal taxes at reduced rates for eligible sectors

[1] see *Contencioso Tributário no Brasil* (2020)

[2] PEC nº 175/1995 and PEC nº 233/2008, both of which were not approved.

of economic activity. In this first version, states and municipalities had the option to adhere to the system. In 2006, a second version of the Simples (Simples Nacional) was approved. In this version, the main state and municipalities taxes (ICMS and ISS, respectively) were collected through the system by firms that chose to adhere to the system.

After Brazil's redemocratization, preferential treatment of small businesses was set in the Federal Constitution's article 179, "with the goal of incentivizing them through the simplification of their administrative, tax, pension and credit obligations, or through the elimination or reduction of such obligations by law". The reasons stated for the introduction of Simples in 1996 were to comply with Brazil's Constitution, and to reduce informality and unemployment by favoring small businesses.

The Simples initiative can expand tax revenues by helping small firms to become formal, as the tax rates for Simples are smaller than for firms in other tax regimes. On the other hand, tax incentives can generate large firm size distortions, worsening the misallocation of resources in the economy and leading to adverse effects on aggregate productivity. Monteiro and Assunção (2012) and Fajnzylber et al. (2011) use reduced form approaches to analyze the effects of the Simples. Piza et al. (2016) revisits both identification strategies, showing that the impacts of the Simples are ambiguous. Matsumoto (2021) also uses a reduced-form approach to study the effects of Simples on firm outcomes. Our primary goal is not to analyze the impact of Simples. Alvarez et al. (2023) used a structural model to estimate those effects.

We are interested in analyzing the effects of the consumption tax reform when explicitly modeling the Simples regime as a choice made by firms, as it is an important feature in response to changes in the tax structure. That is, changes both in the formal standard taxes and in Simples affect firm's decision on where to operate. It is not clear what the net effect of the tax reform is, and using our quantitative model helps to answer this question.

3 Data

In this section we describe the data sources we use, which are used to calibrate and estimate the model's parameters, as we explain with more detail in Sections 5.1 and 5.2.

The main dataset we use to observe firm's characteristics is RAIS (Relação Anual de Informações sociais), an annual matched employer-employee admnistrative dataset that covers all formal firms in the Brazilian economy. The data contains worker and firm's information, such

as education, wages, number of employees and if the firm chose the Simples system in a given year. Although firms in Simples are formal (they have a tax registry number - CNPJ), in this paper we will label firms in three groups:

- Formal: firms that have tax registry and are not in Simples system
- Simples: firms that have tax registry and are in Simples system
- Informal: firms that don't have tax registry.

Figure 1 displays the firm-size distribution (in log) for Simples and Formal firms in manufacturing and services. Manufacturing includes other typically large scale activities with low informality, such as extractive industries (mining, oil) and public utilities (water, gas, electricity). Services include construction, which is a non tradable activity with a higher degree of informality, as in other services activities. We exclude from services the real state sector, because imputed rents constitute a great part of their GDP, and governmental activities (public administration, public education and public healthcare). In all three sectors, the distribution of Formal firms is right-skewed relatively to Simples firms. Table 1 shows summary statistics. As expected, firms in Simples are smaller on average and there is a smaller dispersion in firm size. We don't observe in RAIS firms revenue or value added.

To compute after-tax reform tax rates we use IBGE Input-Otput tables and the Supply and Uses Tables. First, we apply the tax rates proportion of the standard rate as in the law approved for each product. Then we aggregate these taxes into a tax rate for each sector, by using the market shares of each product. In order to account for informality, we use the informal value-added share for each sector as computed in Torezani (2022). To compute the share of tax revenues coming from Simples we use data from the tax authority (PIS and Cofins revenues, by economic activity and fiscal regime).

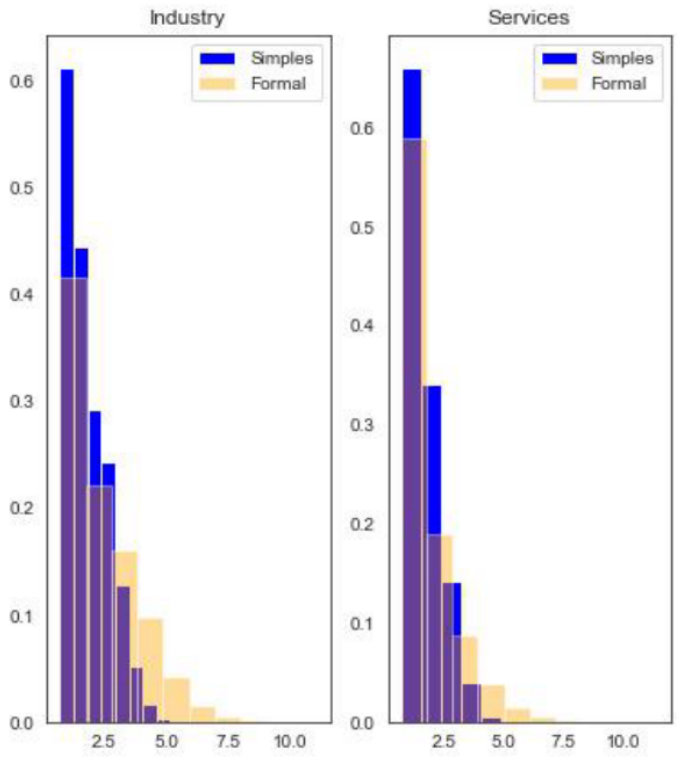

Figure 1: Distribution - log number of workers

Firm size	**Tax regime**	**Agriculture**	**Manufacturing**	**Services**
mean	Formal	5.68	52.72	24.69
	Simples	6.47	8.15	6.01
standard dev.	Formal	59.56	404.68	315.45
	Simples	15.89	12.41	17.44
median	Formal	2.00	6.00	2.00
	Simples	3.00	4.00	3.00
p75	Formal	4.00	25.00	9.00
	Simples	6.00	9.00	7.00
p90	Formal	8.00	82.00	30.00
	Simples	14.00	19.00	13.00

Table 1: Summary statistics for the firm size distribution

4 The model

In this section we develop a general equilibrium model, similar to Ulyssea (2018), but augmented with more sectors of activity, intermediate goods linkages, and the Simples tax regime. There are J sectors of economic activity $j = 1, \ldots, J$. The first sector is populated by homogeneous representative firms, all of them operating in the formal regime.

In the remaining sectors, $j = 2, \ldots, J$, firms produce a homogeneous good, but are heterogeneous in its productivity z. Additionally, firms chose in which fiscal regime $s \in \{F, I, S\}$ to operate. They can choose to be formal (F), informal (I) or in the Simples regime (S). Labor and product markets are competitive, and firms in each sector, independently of its fiscal regime, face the same prices.

4.1 Production

For each sector j, incumbent firms use the same production technology $q_j(z, \ell, \iota)$, where z is firm productivity, ℓ is the labor input, and ι is an aggregate of intermediate goods ι_{jk}, that represents intermediates goods that a firm in sector j buys from sector k. We assume Cobb-Douglas functional forms for the production function and intermediate inputs aggregate:

$$q_j(z, \ell, \iota) = z\ell^{\alpha_j}\iota^{\theta_j} \tag{1}$$

$$\iota_j(\iota_{j1}, \ldots, \iota_{jJ}) = \prod_{k=1}^{J} {\iota_{jk}}^{\lambda_{jk}} \tag{2}$$

with $0 < \alpha_j, \theta_j, \lambda_{jk} < 1$ and $\sum_{k=1}^{J} \lambda_{jk} = 1$. We assume $\alpha_j + \theta_j < 1$. This is as in the Lucas (1978) span-of-control model.

Let p_j^ι be the intermediate inputs index for sector j, defined as $p_j^\iota = \frac{\sum_{k=1}^{J} p_k \iota_{jk}}{\iota_j}$. Then the optimal choice for composition of intermediate inputs imply that:

$$i_{jk} = \lambda_{jk} \frac{p_j^\iota \iota_j}{p_k} \quad \text{and} \quad p_j^\iota = \prod_{k=1}^{J} \left(\frac{p_k}{\lambda_{jk}} \right)^{\lambda_{jk}} \tag{3}$$

and, conditional on prices, the optimal choice of ι_j defines the choices for ι_{jk}, for $k = 1, \ldots, J$.

Formal firms must comply with sector specific taxes and regulations. Firms in Simples must also comply with taxes, but face reduced tax rates compared with formal firms. Additionally, there is a maximum amount of revenues allowed to firms operating in the Simples regime.

Informal firms avoid taxes, but we assume that they face an upper bound for their number of employees. We follow De Paula and Scheinkman (2010), which assume such a bound for

output in their model. This is a simplified way of modelling informality costs, by considering that the probability of detection by government's officials is 100% for firms above this threshold and zero below it.[3]

Current profit function for a firm in sector j and fiscal regime s is given by

$$\pi_{js}(z) = \max_{\ell} \left\{ (1 - \tau_{js}^{Y}) \text{VA}_j(z, \ell) - (1 + \tau_s^{W}) w\ell \right\} \tag{4}$$

subject to

$$\begin{cases} \ell \leq \bar{\ell}^I, & \text{for} \quad s = I \\ p_j q_j(z, \ell, \iota) \leq \bar{R}_j^S, & \text{for} \quad s = S \end{cases} \tag{5}$$

where τ_{js}^{Y} is the value-added tax rate, τ_{js}^{W} is the payroll tax rate, and $\text{VA}_j(z, \ell)$ represents the value-added function, which is simply

$$\text{VA}_j(z, \ell) = \max_{\iota_{j1}, \ldots, \iota_{jJ}} \left\{ p_j q_j(z, \ell, \iota_j(\iota_{j1}, \ldots, \iota_{jJ})) - \sum_{k=1}^{J} p_k \iota_{jk} \right\} \tag{6}$$

If the firm is in the informal regime, we have that $\tau_{jI}^{Y} = 0$ and $\tau_I^{W} = 0$, while if the firm is in the formal or Simples regime, both taxes are positive, $\tau_{jF}^{Y} > \tau_{jS}^{Y} > 0$ and $\tau_{jF}^{W} > \tau_S^{W} > 0$. Labor choices are bounded from above in informal firms by an employment cap $\bar{\ell}^I$. Moreover, if the firm operates in the Simples regime, it faces the additional restriction that its revenue must be limited to a revenue cap $\bar{R}_j^S$.

4.2 Entry

In each period and sector j, M_j firms are possible entrants. Before entry, firms observe only a signal $\nu_j \sim G_j$ of its actual productivity, where G_j is a c.d.f. which has support in $(0, \infty)$, finite moments and i.i.d. Firms pay a cost in labor units, E_{js}, to enter the market. We assume that for each sector j, $E_{jF} > E_{jS} > E_{jI}$, which reflects that formal firms face higher costs to enter the market, such as bureaucratic procedures. Likewise, Simples firms face legal constraints to enter the market, but have a simplified tax system.

After entry occurs, firms actual productivity is drawn from a distribution $F_j(z_j|\nu_j)$, which we assume to be continuous in z_j and ν_j and decreasing in ν_j, which means that ν_j and z_j

[3] Ulyssea (2018) assumes informality costs that rise exponentially with firm size. His estimated parameters imply an informality cost function that is very close to a strict upper bound for firm size. We have experienced with a similar exponential function in the first version of our model also. However, imposing an employment upper bound from the beginning has improved substantially the numerical performance of our solution algorithm.

are positively correlated. After productivity is realized, it remains constant and firms face an exogenous exit probability κ_{js}. This formulation of the entry process produces an overlap in the distribution of productivities across different fiscal regimes, which is observed in the data. The value function is given by

$$V_{js}(z) = \frac{\pi_{js}(z)}{\kappa_{js}}$$

Let $V^e_{js}(\nu)$ the expected value of a firm with signal ν_j. That is, before entry decision is taken. Then

$$V^e_{js}(\nu_j) = \int V_{js}(z) dF(z|\nu)$$

The firm chooses its fiscal regime s if

$$V^e_{js}(\nu_j) - E_{js} \geq \max_{s' \neq s} \{V^e_{js'}(\nu_j) - E_{js'}, 0\}$$

For instance, a firm in sector j with signal ν_j will choose to be formal if its expected gains are higher in the formal regime, that is,

$$V^e_{jF}(\nu_j) - E_{jF} \geq \max\{V^e_{jS}(\nu_j) - E_{jS}, V^e_{jI}(\nu_j) - E_{jI}, 0\} \tag{7}$$

If entry in the three regimes is positive, then

$$V^e_{jI}(\bar{\nu}_{jI}) = E_{jI}$$

$$V^e_{jS}(\bar{\nu}_{jS}) - E_{jS} = V^e_{jI}(\bar{\nu}_{jS}) - E_{jI}$$

and

$$V^e_{jF}(\bar{\nu}_{jF}) - E_{jF} = V^e_{jS}(\bar{\nu}_{jF}) - E_{jS}$$

where $\bar{\nu}_{js}$ is the lowest level of the signal such that the firm in sector j and regime s enters the market.

4.3 Productivity distribution

For the stochastic process for the productivity, we must specify the distribution of the signal G and the produtivity shock F. As in Ulyssea, we assume G is a Pareto distribution:

$$G_j(\nu \leq x) = \begin{cases} 1 - \left(\frac{x^j_m}{x}\right)^{\xi_j}, & \text{if } x \geq x^j_m \\ 0, & \text{if } x < x^j_m \end{cases}$$

After firms receive the signal, there is a productivity shock ε, which we assume is an i.i.d. lognormal with mean zero and variance σ_j^2. Then, the productivity z is the product of ν and ε, which is a Pareto-Lognormal random variable. This distribution has three parameters, x_m^j, ξ_j and σ_j^2 for each setor.

4.4 Equilibrium

We assume there is a representative household that owns firms, supplies labor inelastically and derives utility from consuming the final goods. The utility function is assumed to be a standard Cobb-Douglas $U(C_1, \ldots, C_J) = C_1^{\zeta_1} \cdot \ldots \cdot C_J^{\zeta_J}$. The government collects taxes from firms and transfers it directly to the household. We consider only stationary equilibria, so that prices and quantities stay constant over time. Household income is then given by $I = w\bar{L} + \sum_j \Pi_j + T$, where $\bar{L}$ is labor supply and T represents government's transfers. Π_j represents total profits from sector j, net of entry costs, $M_{jI}E_{jI} + M_{jS}E_{jS} + M_{jF}E_{jF}$, where

$$M_{jI} = [G(\bar{\nu}_{jS}) - G(\bar{\nu}_{jI})]M_j$$

$$M_{jS} = [G(\bar{\nu}_{jF}) - G(\bar{\nu}_{jS})]M_j$$

and

$$M_{jF} = [1 - G(\bar{\nu}_{jF})]M_j$$

which represents the mass of entrants of sector j in each fiscal regime. If we denote by μ_{js} the mass of firms that survive in sector j and fiscal regime s, in a stationary equilibrium the size of each fiscal regime stays constant over time, which translates into

$$\mu_{js} = \frac{1 - F_z(\bar{z}_{js})}{\kappa_{js}} M_{js} \tag{8}$$

where $F_z(\bar{z}_j^s)$ is the unconditional probability that a firm dies in sector j and fiscal regime s. The definition of equilibrium is the following:

Definition 4.1. *A competitive stationary equilibrium is a set of prices and allocations such that*

1. *Labor and goods market clears.*
2. *Zero profit conditions holds: $z_{js} \geq \bar{z}_{js}$ where $\bar{z}_{js}$ is such that $\pi_{js}(\bar{z}_{js}) = 0$*
3. *For each sector, fiscal regime size is constant over time (equation 8)*

5 Calibration

In this section, in order to perform counterfactual analysis, we calibrate our model so that it reproduces features of the brazilian economy reflected in the data.

First we calibrate some parameters externally, i.e., directly from the data sources available or from the literature. Then, we calibrate internally the rest of the parameters to approximate some data moments.

We consider three production sectors in our model, agriculture, manufacturing, and services. Sector $j = 1$ is agriculture. In order to reduce the number of parameters to calibrate, and considering that the relevant definition of formal and informal firms may be different for this sector, we do not model firm heterogeneity and regime choices in agriculture. We assume that productivity z is the same for all firms in this sector, and all firms are formal.[4]

Sector $j = 2$ is manufacturing, including other typically large scale activities with low informality, such as extractive industries (mining, oil) and public utilities (water, gas, electricity). This is the numeraire good in the model, so that $p_2 = 1$.

Sector $j = 3$ is services, including construction. We exclude from services the real state sector, because imputed rents constitute a great part of their GDP, and governmental activities (public administration, public education and health).

5.1 External calibration

In this section, we describe the model's parameters that are computed directly from data or borrowed from the literature. First, we use the values for payroll tax rates of the formal sector from Ulyssea (2018). We take the value for the payroll tax rates for Simples used by Alvarez et al. (2023). We assume the same payroll taxes for all sectors.

The production function parameters α_j and θ_j come directly from IBGE data, the 2015 Input-Output tables and Supply and Use tables.

Matsumoto (2021) estimate that Simples firms pay about 50% of formal firms in order to comply with tax obligations. We use this ratio as reference for setting the entry cost for Simples

[4] In agriculture, land owners are allowed by the law to hire many formal workers without constituting a company, which is the criteria to define a formal firm in the other sectors. Our main database for formal firms, RAIS, only comprises firms registered as legal entities, that are identified by a number, the CNPJ. However, employment and other data sources point to a high degree of informality in agriculture. We assume that the ratio between tax collection and value added is the value added tax in this sector before the reform.

firms, considering that firms pay the present value of tax compliance costs when they enter the market. We assume that the entry cost for firms in the Simples regime is half of the entry costs for firms in the formal regime. We also impose that the ratio of the informal to formal entry costs are the same as in Ulyssea (2018). Matsumoto (2021) also estimated that, in average, firms in Simples pay approximately 65% of the taxes paid by firms in the main tax regime. We impose that this ratio should be generated by the model, in equilibrium.

For the revenue cap in Simples, we use the estatutory value of R$ 3,600,000 in terms of the mean annual wage. From IBGE, the mean monthly wage in 2015 was R$ 2,480. We use the informal labor share (45%) and, following Gomes et al. (2020), multiply informal wages by 12 and formal wages by 13.33[5], which gives us an annual mean wage of $w = 31,574 = 2,480 \times (12 \times 0.45 + 13.33 \times 0.55)$. So the Simples revenue limit parameter is set to $R/w = \frac{3,600,000}{31,574} = 114$.

We set the employment upper bound of five employees for informal firms using as reference the ECINF survey (Pesquisa de Economia Informal Urbana), form IBGE. The last edition of this survey of informal firms, from 2003, focus on informal production units with five or less employees.

For the exit rates in the formal sector, we use IBGE (*Demografia das empresas e estatísticas de empreendedorismo, 2016*), a study that uses data from the Central Business Register (CEMPRE) of IBGE, as well as information from the structural surveys conducted by companies in the areas of Industry, Construction, Trade, and Services (PIA, PAIC, PAC, and PAS). The study presents entry, exit, and survival rates according to the size and economic activity of companies. It also provides information on employed personnel by gender and education level, by type of demographic event, and aspects of company survival during the period from 2011 to 2016. We used the exit rates of companies by economic activity sector. Since the study presents exit rates with more disaggregated sectors than we will use, we aggregated the exit rates by taking a weighted average of the exit rates of the subsectors, using the gross production value of each subsector as a weight.

Table 2 shows the externally calibrated parameters of the model

[5]In Brazil, formal workers earn 13 months in salary every year plus one-third of a monthly salary as vacation allowance

Parameter	Description	Value	Source
τ_{jF}^{W}	Payroll tax (formal)	0.375	Ulyssea (2018)
τ_{jS}^{W}	Payroll tax (Simples)	0.175	Alvarez, Pessoa and Portela (2023)
θ_1	Intermediate goods share, agriculture	0.22	IBGE
θ_3	Intermediate goods share, manufacturing	0.48	IBGE
θ_2	Intermediate goods share, services	0.26	IBGE
α_1	Labor share, agriculture	0.37	IBGE
α_2	Labor share, manufacturing	0.34	IBGE
α_3	Labor share, services	0.47	IBGE
$\bar{\tau}_{jS}^{Y}/\bar{\tau}_{jF}^{Y}$	Simples/Formal mean production tax	0.65	Matsumoto (2021)
E_{jS}/E_{jF}	Simples/Formal compliance cost ratio	0.5	Matsumoto (2021)
E_{jI}/E_{jF}	Informal/Formal compliance cost ratio	0.47	Ulyssea(2018)
$\bar{R}^{S}/w$	Simples revenue cap	114	Statutory
$\bar{\ell}^{I}$	Informal employment cap	5	ECINF survey
$\kappa_{F,1}$	Exit rate, agriculture	0.15	IBGE
$\kappa_{F,2}$	Exit rate, manufacturing	0.13	IBGE
$\kappa_{F,3}$	Exit rate, services	0.16	IBGE

Table 2: External Calibration

5.2 Internal Calibration

The remaining parameters are calibrated by choosing their values in order to approximate the model's moments to data moment's. We use the value-added share of each sector, value-added per worker, share of indirect taxes, share of informality and Simples in GDP and share of Simples tax collections as data moments. The remaining parameters that we calibrate are the entry costs for formal firms, exit probabilities for informal and Simples firms, the parameters of the entry process, consumption shares for each sector, value-added tax rates for formal and Simples firms, and the agriculture TFP.

The parameters of the productivity process (more precisely, the shape of the Pareto distribution and the variance of the post-entry shock) and the formal entry costs are determined by the moments of firm size distribution in each fiscal regime. The tax rates for formal and Simples regimes are determined by the ratio of indirect taxes to value added by sector, and by the share of tax revenues from Simples in two federal taxes, PIS and COFINS. These parameters also

influence the size of each regime. The value-added share moment influence the consumption share parameter ζ_j. The informal share of GDP influences the informal exit probability.

Parameter	**Description**	**Agriculture**	**Manufacturing**	**Services**
E_{jF}	Compliance cost (formal)	-	9	6
κ_{jI}	Informal exit probability	-	0.27	0.16
κ_{jS}	Simples exit probability	-	0.13	0.16
σ_j	Post-entry productivity shock	-	0.17	0.53
ξ_j	Pre-entry Pareto shape parameter	-	4.8	4.34
ζ_j	Consumption share	0.05	0.40	0.55
τ^Y_{jF}	Value-added tax rate	-	0.48	0.14
τ^Y_{jS}	Simples value-added tax rate	-	0.20	0.10
A_1	Agriculture TFP	950	-	-

Table 3: *Sector-specific Parameters*

We display the parameter values and model fit in Tables 3 and 4, respectively. The model fits best the share of informal value added in each sector. The value-added share is slightly over-estimated in manufacturing and underestimated in services, as well as in the share of Simples tax colletions.

Table 5 shows the fit for the untargeted moments. Note that the model captures the relative size of each sector, when considering formal and Simples firms (last row of Table 5), and the share of firms with 1 to 5 employees. It also is able to reproduce the relative mean firm size, that is, the mean firm size of manufacturing relative to services (2.82 in the model *versus* 2.55 in the data), even though the absolute value is not well fited (133 in the model *versus* 23 in the data).

Moment				
Value-added share		***Agriculture***	***Manufacturing***	***Services***
	Model	*7.5%*	*27%*	*66%*
	Data	*7%*	*23%*	*70%*
Value added per worker (relative to manufacturing)				
	Model	*-*	*100%*	*66%*
	Data	*-*	*100%*	*62.1%*
Share of indirect taxes over value added				
	Model	*4.9%*	*43%*	*12%*
	Data	*4.9%*	*49%*	*9.4%*
Share of informality in value added				
	Model	*-*	*3.7%*	*15%*
	Data	*-*	*3.3%*	*15%*
Share of Simples in indirect taxes revenue				
	Model	*-*	*5.76%*	*11.3%*
	Data	*-*	*1.8%*	*8.9%*

Table 4: *Model fit - Targeted Moments*

Moment			***Model***	***Data***
Mean firm size, employees by firm, formal and Simples			133	23

			Manufacturing	***Services***
Mean firm size, formal and Simples (relative to services)				
	Model	-	*2.82*	*1*
	Data	-	*2.55*	*1*
Share of firms with 1 to 5 employees (formal and Simples)				
	Model	-	*50%*	*60%*
	Data	-	*45%*	*62%*
Firm Size Pareto Shape Parameter (6 or More Employees)				
	Model	-	*1.15*	*0.847*
	Data	-	*0.60*	*0.836*
Sector size (share of firms in formal and Simples)				
	Model	-	*9.5%*	*90.5%*
	Data	-	*11%*	*89%*

Table 5: *Model fit - Untargeted Moments*

6 Counterfactual Analysis

In this section, we use the calibrated model to assess the effects of the tax reform. We simulate how the tax rates would change across sectors and analyze firm's behaviour in a steady-state equilibrium under different sets of assumption. We are not observing transition dynamics.

We use the maximum tax rate allowed in the law, which is 26.5%, as the main tax rate after the tax reform. As a robustness exercise, we also compute the revenue-neutral main tax rate, which is 31.5%. This tax rate preserves the same indirect tax collections over GDP ratio observed before the tax reform. This value is above what other studies find and the congress approved as the maximum allowed tax rate. In our model this happens because GDP gains makes it possible reducing the consumption tax burden in GDP, maintaining the government's revenues. The robustness results concerning this tax rate are displayed in Appendix B.

In our main specification, we assume that the entry costs of the formal firms will decrease and become equal to the entry costs of Simples firms. This is a proxy for the reduction in compliance costs in the main tax regime, as Brazilian main tax system is very complicated and the tax reform will simplify it. Matsumoto (2021) use IBGE's surveys to compute compliance costs, including accounting and legal costs for both regimes. He finds that these costs are about 50% lower in Simples. Then we assume a 50% reduction in entry costs for firms in the main regime after the tax reform, in our simulations with lower compliance costs. This assumption may be overestimating the entry cost reduction after the tax reform. Thus, we see our simulation that keeps the compliance costs as a lower bound for the effects of the tax reform and our simulation that reduce the compliance costs as an upper bound for these effects.

Tax Reform	***Before***	***After***	
Variable		***Keep compliance* cost**	***Lower compliance cost***
Main tax rate	48.7%	26.5%	26.5%
GDP	100	102.7	104.5
Indirect taxes / GDP	19.6%	17.0%	17.2%
Informal GDP / GDP	11.1%	11.9%	11.5%
Simples GDP / GDP	11.6%	14.3%	13.2%

Table 6: Aggregate effects of the tax reform

We present our main results in Table 6. There is an increase of 4.5% in GDP when we

change the tax structure and reduce formal firm's tax compliance burden, which is expressed as a reduction in entry costs (third column). In the second column, we only change the sector's tax rates, but we keep the compliance cost constant. Note that there is a 2.7% increase in GDP in this scenario. This means that if we decompose the total GDP gain of 4.5% from the tax reform, changing the tax rates accounts for a 2.7% increase and reducing the tax compliance costs account for the remaining 1.8%.

In addition, we see that in both scenarios we observe an increase in informality and in Simples, as measured by its participation in GDP. By keeping the formal firm's compliance costs constant, we observe a larger increase both in Simples and in informality. This is expected, since reducing these costs for the formal firms makes it more profitable to operate in this regime.

Table 7 shows the new tax rates and the effects of the reform for each sector, for the main scenario with reduction in tax compliance costs. We see an increase in the tax rate for manufacturing and a decrease for services, which leads the share of indirect taxes in the manufacturing sector to decrease by 21.6 p.p. and in the service sector to increase by 5.3 p.p. Note that there is a large increase in the Simples value-added share for the service sector, with a small increase in informality. That is, in a scenario of increased tax burden in services, most firms that would no longer enter in the formal regime would prefer the Simples regime instead of informality.

In manufacturing, the value-added shares of both informality and Simples decrease, which means that more firms prefer the formal regime. As consequence, we see an increase in the value-added of manufacturing sector of 26.6% and a decrease of the service sector of 4.1%. The agregate effect is an increase of 4.5% of GDP, which goes in line with recent studies analyzing the tax reform. Our findings indicate, however, that not all economic activities benefit from the reform, even though our classification of economic activities is not too granular.

In a second set of counterfactuals, we first remove Simples from the model while maintaining informality, and then we remove both Simples and informality. These scenarios were simulated by keeping the main tax rate of 26.5% after reform, as before, and the same values for the remaining parameters in each scenario. The compliance costs of the formal regime are again reduced by half, equalizing it to the corresponding entry cost for Simples firms in the main scenario.

We display the results in Table 8, and we compare them to the results in Table 6. First of all, if the Simples tax system simply didn't exist, more firms would directly choose to be informal,

Variable	Agriculture	Manufacturing	Services
Tax rates			
before tax reform	4.88%	48.7%	14.3%
after tax reform	2.7%	22.3%	23.2%
Indirect taxes / VA			
before tax reform	4.9%	43.3%	11.7%
after tax reform	2.7%	21.7%	17%
Informal value-added share			
before tax reform	0%	3.72%	15.4%
after tax reform	0%	2%	16.6%
Simples value-added share			
before tax reform	0%	12.5%	12.6%
after tax reform	0%	4.6%	18.2%
Simples indirect taxes share			
before tax reform	0%	5.76%	11.3%
after tax reform	0%	4.2%	11.2%
Value-added share			
before tax reform	7.5%	26.7%	65.8%
after tax reform	7.5%	26.6%	65.9%
Change in value-added			
after tax reform	-	26.6%	-4.1%

Table 7: Sectoral effects of the tax reform, reducing formal compliance costs

since before the reform informality corresponds to 11.1% of GDP in the baseline scenario, compared to 15.5% in the scenario without Simples. Besides this, note that by only removing Simples, the effects of the reform on GDP are higher, with a increase of 5.7% (compared to 4.5%). We see, however, an increase in informality in this version of 1.3 percentage points, compared to 0.4 percentage points.

However, if we maintain the compliance costs for formal firms constant in the scenario without Simples, the GDP gains after reform are equal to gains with simples, of 2.7%, although informality grow 2.8 percentage points (from 15.5% to 18.3%), significantly higher than before (0.8 percentage points).Nonetheless, the tax system simplification effect is stronger in an

environment without Simples, of 3% compared to 1.8% when Simples is present.

Now, if both Simples and informality are not present, results change a lot. In the scenario without reduction in tax compliance entry costs, GDP rises 4.1%, 1.4 percentage points higher. In the scenario with reduction in compliance costs, the GDP increase is very high, 21%, *versus* 4.5% with Simples and informality. Both informality and Simples favors the operation of many firms that would not exist in a world without these alternative production regimes. In this case, reduction in tax compliance would have a much stronger effect on GDP.

Tax reform	***Before***	***After***	
Variable		***Lower compliance cost***	***Keep compliance cost***
Main tax rate	48.7%	26.5%	26.5%
Without Simples			
Indirect taxes / GDP	19.9%	17.5%	17.2%
Informal GDP / GDP	15.5%	16.8%	18.3%
GDP	100	105.7	102.7
Without Simples and informality			
Indirect taxes / GDP	22.8%	21.4%	21.4%
GDP	100	121	104.1

Table 8: Aggregate effects of the tax reform, without Simples and without Simples and informality, and reducing compliance costs

7 Conclusion

We developed and quantified a model with heterogeneous sectors, alternative tax regimes and informality. We applied the model to the data in order to analyze the effects of the recently approved consumption tax reform in Brazil. By bringing informality and the Simples tax regime in the set of choices that firms make, we have new insights on such effects. The tax regimes and informality play an important role in understanding how firms will operate in response to the changes in the tax structure.

In our simulations. we find that the reform leads to a GDP increase between 2.7% and

4.5%, depending on the assumption about the magnitude of reduction in compliance costs that firms will face in the main tax regime. This reduction on compliance costs work as a measure of simplification that will occur after the reform. In the more conservative scenario, we assume that there is no simplification at all.

If we disregard the existence of such alternative tax schemes, the positive effects of the reform are amplified. In the case where we consider only formal and informal firms (without Simples), GDP increase between 2.7% and 5.7%. If, beyond that, we consider only formal firms (without Simples and informality), this increase lies between 4.1% and 21%, which is much higher than the previous scenarios.

Furthermore, the Simples and informality share on GDP responds positively to the change in the tax rate of a given sector. That is, an increase in the tax rate for firms in the main tax regime makes firms choose to operate in Simples and informality, instead of the main tax regime. This fact lead to important policy implications. One should consider these responses when designing and altering the tax system. For instance, by not considering that firms may choose alternative tax regimes and informality, government's revenues can be significantly lower than is expected. That is clear when we shutdown the Simples and informality from the model, since the same main tax rate of 26.5% makes the indirect tax-to-GDP ratio be 17% in the scenario with Simples and informality, 17.5% without Simples and 21.4% without Simples and informality.

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Appendix

A Model Calibration

In this section we present a proposition used in the model calibration. For entrant firms of each sector j and tax regime s, there is a linear relation between productivity and labor choices, conditional on given prices and taxes. Then, we use the relation in Proposition A.1 for computing the lower bound of the productivity grid. That is, we ensure that the productivity value z correspondent to a firm that hires one worker in each tax regime lies on the grid.

Proposition A.1. *For any sector $j = 1, \ldots, J$ and tax regime $s = \{F, I, S\}$, productivity z, prices w, p_j, and employment choices $\ell_{js}(z)$ for incumbent firms are related by:*

$$\log \ell_{js}(z) = \frac{\log z + \Theta_{js}}{1 - \alpha_j - \theta_j}$$

for $\quad \mathbf{\Theta_s} = [\Theta_{js}]_{J\times 1}, \quad \log \mathbf{p} = [\log p_j]_{J\times 1} \quad$ *and*

$$\mathbf{\Theta_s} = \omega_\mathbf{s} + (\mathbf{I} - \mathbf{\Lambda}) \log \mathbf{p}$$

$$\omega_\mathbf{s} = \begin{bmatrix} (1-\theta_1)\left\{\log \alpha_1(1-\tau_{1s}^Y) - \log(1+\tau_s^W)w\right\} + \theta_1\left\{\log\theta_1 + \sum_k \lambda_{1k}\log\lambda_{1k}\right\} \\ \vdots \\ (1-\theta_J)\left\{\log \alpha_J(1-\tau_{Js}^Y) - \log(1+\tau_s^W)w\right\} + \theta_J\left\{\log\theta_J + \sum_k \lambda_{Jk}\log\lambda_{Jk}\right\} \end{bmatrix}_{J\times 1}$$

$$\mathbf{\Lambda} = \begin{bmatrix} \theta_1\lambda_{11} & \theta_1\lambda_{12} & \cdots & \theta_1\lambda_{1J} \\ \theta_2\lambda_{21} & \theta_2\lambda_{22} & \cdots & \theta_2\lambda_{2J} \\ \vdots & \vdots & \ddots & \vdots \\ \theta_J\lambda_{J1} & \theta_J\lambda_{J2} & \cdots & \theta_J\lambda_{JJ} \end{bmatrix}_{J\times J}$$

where $\mathbf{I}$ *is the* $J \times J$ *identity matrix.*

Then we compute the policy functions, that is, the labor and intermediate inputs demand function for each firm. In agriculture ($j = 1$) there is no heterogeneity, while in the remaining sectors the policy functions depend on productivity z.

The labor demand for formal and Simples firms is given by

$$\ell_j(\tau_s^W, \tau_{js}^Y, w) = \left[\left(\frac{\theta_j}{p_j^\iota}\right)^{\theta_j}\left(\frac{\alpha_j(1-\tau_{js}^Y)}{(1+\tau_s^W)\cdot w}\right)^{1-\theta_j} \cdot p_j \cdot z_j\right]^{\frac{1}{1-\alpha_j-\theta_j}}$$

For informal firms the labor demand is simply $\ell(0, 0, w)$. For both Simples and informal firms, this equation refers to labor demand for firms operating with under the upper bound size thresholds for each regime.

Intermediate inputs is given by

$$\iota = \left(\frac{p_j}{p_j^\iota} \cdot \theta_j \cdot z_j \cdot \ell_j^{\alpha_j} \right)^{\frac{1}{1-\theta_j}}$$

where p_ι is the intermediate input price index

With these quantities, we compute the profit and value functions for each firm. The firm's decision on which regime to enter is then made based on the highest expected value function.

B Additional Couterfactuals

We display the tables relative to the computed main tax rate that maintains the same tax burden before and after the reform. The value found is 31.5%, which is much higher than the maximum allowed in the law.

Tax Reform	***Before***	***After***	
Variable		***Lower compliance* cost**	***Keep compliance cost***
Main tax rate	48.7%	31.5%	31.5%
GDP	100	103.5	102.3
Indirect taxes / GDP	19.6%	19.6%	19.4%
Informal GDP / GDP	11.1%	10.5%	10.7%
Simples GDP / GDP	11.6%	19.4%	20.0%

Table 9: Aggregate effects of the tax reform

Variable	Agriculture	Manufacturing	Services
Tax rates			
before tax reform	4.88%	48.7%	14.3%
after tax reform	3.4%	27.2%	27.5%
Indirect taxes / VA			
before tax reform	4.9%	43.3%	11.7%
after tax reform	3.4%	26.2%	18.8%
Informal value-added share			
before tax reform	0%	3.72%	15.4%
after tax reform	0%	2.3%	14.9%
Simples value-added share			
before tax reform	0%	12.5%	12.6%
after tax reform	0%	5.9%	27.1%
Simples indirect taxes share			
before tax reform	0%	5.76%	11.3%
after tax reform	0%	4.5%	15.1%
Value-added share			
before tax reform	5.6%	26.7%	65.8%
after tax reform	5.6%	26.5%	66%
Change in value-added			
after tax reform	-	27%	-4.7%

Table 10: Sectoral effects of the tax reform, reducing formal compliance costs