Revista
Cadernos de Finanças Públicas

2025
Edição Especial

TesouroNacional

Indirect Tax Reform in Brazil: Firm Dynamics, Informality and Simples Nacional

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ABSTRACT

In this article, we analyze the impact of the tax reform recently approved in Brazil. We developed a general equilibrium model that incorporates sectoral heterogeneity, informality and a special tax regime for small businesses: Simples Nacional. Simulating the reform with a measure to simplify the tax system, we estimate an increase of up to 4.5% in GDP, with 2.7% due to the approximation of rates between sectors and up to 1.8% due to the simplification of the tax system. The results are significantly different in simulations in which informality and Simples are not present.

SUMMARY

1. INTRODUCTION

After 30 years of discussions, on December 20, 2023, the National Congress approved the proposed consumption tax reform (EC 132/2023). The approved text had significant changes compared to the one originally presented in 2019. The reform introduced a dual VAT, made up of the Contribution on Goods and Services (CBS), under the jurisdiction of the Federal Government, and the Tax on Goods and Services (IBS), under the shared jurisdiction of the states and municipalities. The original text recommended a single rate for all sectors of economic activity. The approved version included differentiated rates for some activities, such as health and education, among others. Approval of the reform would have been difficult without some differentiation of rates, due to political difficulties. However, due to the heterogeneity between sectors in terms of the productivity of firms, as well as the differences in the incidence of informality and Simples between sectors, there may be strictly economic reasons to justify the existence of differentiated rates.

In order to estimate the effects of the tax reform, we took into account important aspects of the Brazilian economy not considered in other recent studies. More specifically, we considered the informal sector and Simples Nacional in our modeling. These aspects are important to take into account, since companies may, in response to changes in their tax obligations, choose to operate under different tax regimes.

For example, a company in Simples Nacional may benefit from opting to operate in the general regime if its compliance costs decrease. Suppose this company was operating at a size below the optimum level consistent with its productivity, just to stay under the Simples revenue ceiling. If this is the case for a substantial portion of companies in Simples, the reform will promote an increase in the average size of relatively more productive firms, leading to an increase in the economy's productivity. On the other hand, a company in the general regime may benefit from opting for Simples or informality if, for example, the tax rate for the sector in which it operates increases too much, causing a negative impact on the economy's productivity.

The final result on the economy's productivity and GDP will depend on the composition of these effects. Under the approved reform, there will be a reduction in the average tax rate for the industrial sector, while most activities in the service sector will face higher rates. Companies in industry tend to be larger and more productive, while companies in the service sector can more easily escape into informality or Simples.

In this article, we develop a general equilibrium model to investigate the effects of the

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approved tax reform. The model is based on Ulyssea (2018), which considers the choice of companies between formality and informality. Like Alvarez et al. (2022), we will introduce Simples into the model as a third tax regime option. However, unlike these articles, we take into account different sectors of economic activity and intersectoral links, as in Cosar et al. (2016) and Dix-Carneiro et al. (2024). Companies can operate under three different regimes: the standard formal system[1], informality or Simples. In addition, our study analyzes the Brazilian Tax Reform, which is not the case in the articles mentioned.

Some studies have tried to estimate the impact of tax reform using general equilibrium models, all of which have found positive effects. Delalibera et al. (2024) use a model of company production networks and find that the unification of tax rates and the elimination of cumulative taxes lead to a 7.9% increase in GDP and a 1.8% increase in welfare. Oliveira (2023) develops a Ricardian model based on Caliendo, Dvorkin and Parro (2019), where each productive unit corresponds to a sector-region, which is useful for analyzing regional aspects of the reform. For the approved version of the reform, Oliveira (2023) finds a positive effect of 2.39% on GDP, considerably lower than the simulation for the first reform proposal, with a single rate, whose effect would be 5.75%. Domingues and Cardoso (2020) use a computable general equilibrium model and find a positive effect on GDP of 4.14%.

However, none of these studies consider the existence of informality or Simples Nacional in their modeling. In this paper, we will show that our choice to explicitly model these regimes is relevant, since the model captures important aspects of the Brazilian economy that were overlooked in these previous studies. It is worth noting that the impacts of the reform would be significantly different if we could exclude both Simples and informality. Our modeling allows us to "disconnect" these regimes from the economy. By carrying out these counterfactual exercises, we conclude that the impacts of the reform are overestimated by ignoring these regimes.

In addition, we simulated a range of possible gains from simplifying compliance costs for the main tax regime. Given the high complexity of the Brazilian tax system in place until then, the gains from simplifying the system are expected to be substantial. In this model, we present a quantification of the order of magnitude of these gains, which has not been done in previous studies based on models of which we are aware.

We found that the reform leads to an increase of up to 4.5% of GDP, of which 2.7% is due to the convergence of tax rates between sectors. The remaining 1.8% corresponds to the potential gain from simplifying the tax system. The manufacturing sector has seen a large in-

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1   We are not making a distinction between companies operating under Real Profit and Presumed Profit.

crease in its GDP (26.6%), while the services sector has seen a drop of 4.1%. In addition, the participation of the Simples and, to a lesser extent, the informal sector in GDP increases. The positive effects of the reform are considerably greater in a counterfactual analysis in which we do not admit the existence of both Simples and informality. In this case, GDP after the reform could increase by up to 21%, with 4.1% coming from changes in tax rates and the remaining 16.9% from simplifying the tax system.

This article is divided into five sections. After this introduction, the next section presents the institutional context and descriptive statistics on firm heterogeneity between sectors and tax regimes. Section 3 presents the theoretical model, including calibration. Section 4 presents the impact analysis of the reform and Section 5 concludes.

2. INSTITUTIONAL CONTEXT

2.1 The Brazilian tax system

The Brazilian tax system is often referred to as a "madhouse". According to the World Bank's Doing Business report (2020), Brazil ranks 184th out of 190 countries in terms of ease of paying taxes. The estimated time a company needs each year to comply with tax legislation is approximately 1,500 hours, which explains the complexity of the system. In comparison, Latin American countries spend five times less and OECD countries ten times less on average. Although companies often have an oversized tax department to ensure compliance, it is estimated that Brazilian tax litigation is equivalent to around 75% of GDP. In 2013, Brazilian tax litigation was estimated at 13.9% of GDP, while the median for Latin America and the OECD is 0.19% and 0.28%, respectively.

The complexity of the Brazilian tax system is largely attributable to indirect taxes. Brazil has five taxes on consumption: the federal ones (PIS, Cofins and IPI), the state ICMS and the municipal ISS, which have different characteristics and associated problems: the complexity of the legislation governing them is high, with a wide variation in rates for often similar products, different levies and calculation bases, difficulty in reimbursing tax credits and collection of ICMS at the origin instead of the destination, which generates a tax war between the states.

In addition to the high complexity of the tax system, Brazil stands out for having a high tax burden compared to countries of similar income and highly concentrated on consumption taxes. Figure 1 shows a comparison between Brazil's tax burden and some selected countries

for 2019.

We can see both the discrepancy between Brazil (33.1%) and the average for Latin American countries (22.9%) and the similarity with the average for developed OECD countries. Figure 2 shows, however, the difference in the share of indirect taxes in the tax burden between Brazil and various countries. There is a great discrepancy in the composition, with practically the majority of tax collection in Brazil coming from indirect taxes.

Figure 1: tax burden of selected countries.
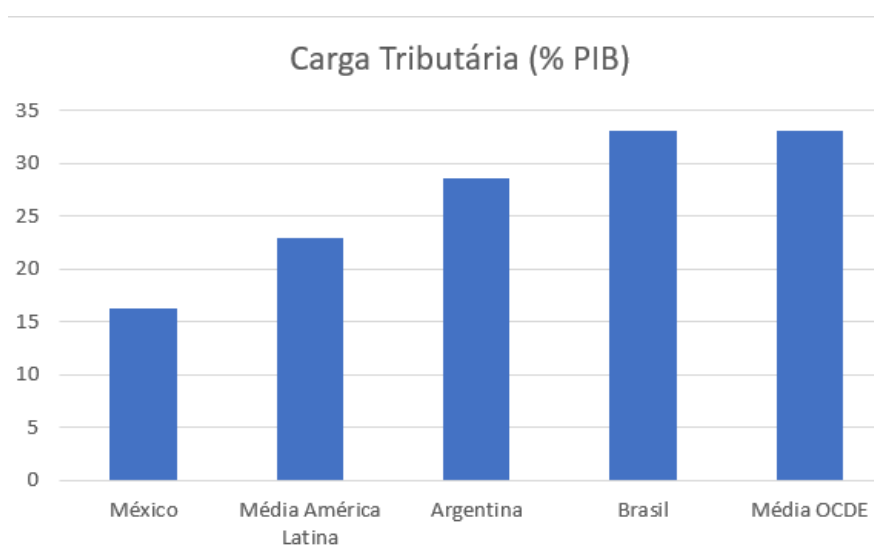
Source: OECD. Prepared by the authors.

Figure 2: share of indirect taxes for selected countries
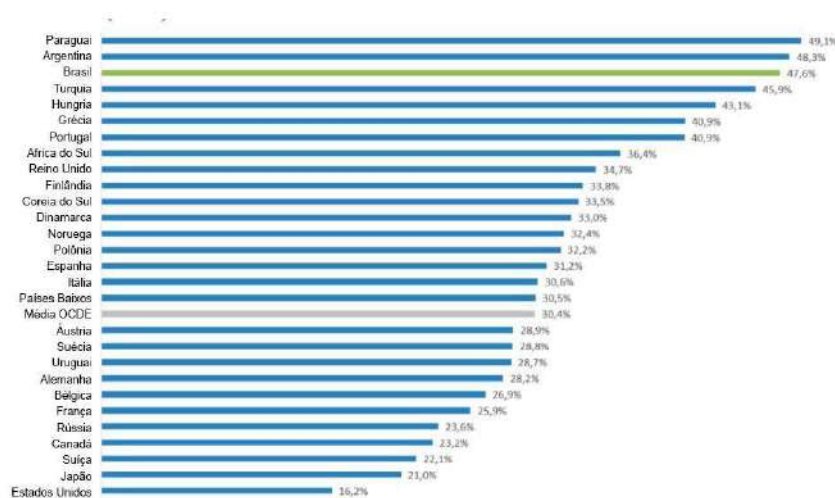
Source: OECD. Prepared by the authors.

2.2 Tax reform

A proposed consumption tax reform aimed at addressing these issues has been debated for decades, finally gaining approval in December 2023. Two recent attempts to pass a reform failed to take hold3, but approval has now been given by Congress (EC No. 132/2023) and the complementary laws regulating it are currently before the Federal Senate. This reform unifies five consumption taxes in a dual VAT system-one federal and one shared between states and municipalities-and shifts the taxation of goods and services from origin to destination, in line with countries that adopt a VAT.

The original proposal presented in 2019 recommended a single VAT rate for all economic activities, with no exceptions, estimating the rate at around 25%. However, significant changes were made before approval, including reductions in the rates for various products and economic sectors. The current standard rate has a lock recently approved by Congress, which allows a maximum rate of 26.5%. The differentiated 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. Also included among the sectors benefiting are: public transportation; national artistic, cultural, journalistic and audiovisual productions; sports activities; medicines, basic women's health products and personal hygiene products; agricultural products and inputs, among others.

Naturally, the greater the number of exceptions for certain products or sectors, the higher the standard rate will be, since the reform is fiscally neutral. A partial solution so that the standard rate is not too high is the adoption of the Selective Tax (IS), which was approved in the text of the law. This tax includes items harmful to health and the environment, such as cigarettes, alcohol and vehicles. Although the justification for adopting this tax was to reduce consumption of these items by reducing negative externalities, it was also instituted for revenue reasons. In 2019, government revenue for taxes similar to the proposed IS was around 0.9% of GDP, below the average for Latin America, which is estimated at around 2%.

2.3 Data

The main dataset we use to observe the characteristics of companies is the RAIS (Relação Anual de Informações Sociais), an annual administrative dataset with information on employers and employees and covering all formal companies in the Brazilian economy. The data contains information on workers and companies, such as education, salaries, number of employees and

whether the company opted for the Simples system in a given year. Although companies in Simples are formal (they have a taxpayer registration number - CNPJ), in this article we will classify companies into three groups:

• Formal: companies that have a CNPJ and are not in Simples (no distinction between Real Profit and Presumed Profit)

• Simples: companies that have a CNPJ and are in Simples

• Informal: companies that do not have a CNPJ.

We consider the following grouping of sectors:

• The "industry" sector includes manufacturing and other activities that typically operate on a large scale with low informality, such as extractive industries (mining, oil) and public services (water, gas, electricity).

• The "services" sector includes construction, which is similar to services in terms of its high degree of informality. We excluded the real estate sector from services, since imputed rents make up a large part of its GDP, and government activities (public administration, public education and health).

Figure 3 shows the distribution of company size (in logs) for Simples and Formal companies in the industry and services sectors. Formal companies have more employees on average than Simples companies and in all sectors, the dispersion of firm size is lower in Simples. Table 1 shows descriptive statistics.

Figure 3: distribution of the number of workers per firm
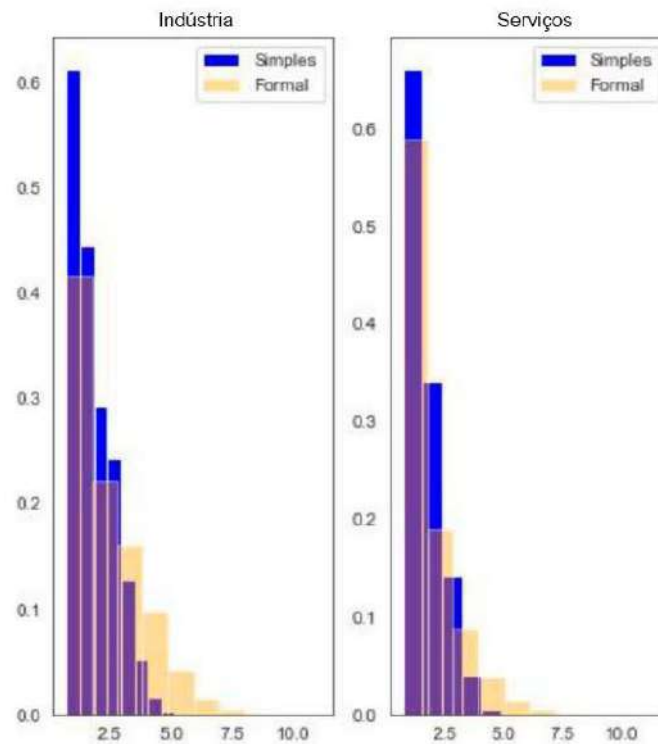
Source: RAIS microdata. Prepared by the authors. Note: the 'x' axis shows the log of the number of workers. The 'y' axis shows the relative frequency of the number of firms.

Other data sources used include the Input-Output Matrices, the Resources and Uses Tables and the study Business Demographics and Entrepreneurship Statistics (2016), all from the IBGE. In addition, we used data from the Federal Revenue Service (PIS/Cofins collection) broken down by economic activity and by tax regime (Presumed Profit, Real Profit and Simples Nacional). This data allows us to calculate the post-reform VAT rates for each sector, the parameters of the production function (share of intermediate goods and labor), company exit rates, and the share of Simples in tax collection. In section 3.2.1 we detail how the data was used to calculate the parameters.

Table 1: Descriptive statistics of firm size distribution

Tamanho da Empresa	Regime Tributário	Indústria	Serviços
média	Formal	52,72	24,69
	Simples	8,15	6,01
desvio padrão	Formal	404,68	315,45
	Simples	12,41	17,44
mediana	Formal	6,00	2,00
	Simples	4,00	3,00
p75	Formal	25,00	9,00
	Simples	9,00	7,00
p90	Formal	82,00	30,00
	Simples	19,00	13,00

Source: RAIS microdata. Prepared by the authors.

3. MODEL: THEORY AND CALIBRATION

3.1 Presentation

In this section, we describe the theoretical model used, as well as the calibration adopted to simulate the effects of the approved Tax Reform. Section 3.2 describes the model. In section 3.3 we explain how we used the data to calibrate the model's parameters, in order to reproduce characteristics found in the Brazilian economy.

3.2 Model

In this section, we describe the general equilibrium model used, similar to that of Ulyssea (2018), but expanded with more sectors of activity, intermediate goods and the Simples Nacional tax regime. There are J sectors of economic activity $j = 1, ..., J$. The first sector is made up of homogeneous representative firms, all operating under the formal regime. In the other sectors, $j = 2, ..., J$, the firms produce a homogeneous good, but are heterogeneous in their productivity

z. In addition, firms choose which tax regime s $\in$ {F, I, S} to operate in. They can opt for the formal regime (F), the informal regime (I) or the Simples regime (S). The labor and product markets are competitive, and firms in each sector, regardless of tax regime, face the same prices.

3.2.1 Production

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

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

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

with $0 < \alpha_j, \theta_j, \lambda_{jk} < 1$ and $\Sigma \lambda_{jk} = 1$. We assume $\alpha_j + \theta_j < 1$, according to the *span-of-control* model (Lucas, 1978).

Let p_j^{ι} be the index of intermediate inputs for sector j. Then, the optimal choice for the composition of intermediate inputs implies that:

$$\iota_{jk} = \lambda_{jk} \frac{p_j^{\iota} \iota_j}{p_k} \quad \text{e} \quad p_j^{\iota} = \prod_{k=1}^{J} \left(\frac{p_k}{\lambda_{jk}} \right)^{\lambda_{jk}}$$

and, conditional on prices, the optimal choice of ι_j defines the choices for ι_{jk}, for k = 1, . . . , *J*. Formal firms pay taxes, just like firms in Simples. However, the latter face reduced tax rates compared to formal firms. In addition, there is a maximum limit on the revenue allowed for firms operating under Simples.

Informal firms do not pay taxes, but face a ceiling on the number of employees. We follow the approach of De Paula and Scheinkman (2010), who adopt this limit on production in their model, rather than on the number of employees. This is a simplified way of modeling the costs of informality, considering that the probability of detection by the government is 100% for firms above this threshold and zero below it. The current profit function for a firm in sector j and tax regime s is given by

$$\pi_{js}(z) = \left\{\left(1 - \tau^{Y}_{js}\right)VA_{j}(z, l) - (1 + \tau^{W}_{s})wl\right\} \tag{3}$$

Subject to

$$l \leq \bar{l}^{I}, \text{ para } s = I$$

$$p_{j}q_{j}(z, l, \iota) \leq \bar{R}^{S}_{j}, \text{ para } s = S \tag{4}$$

Where τ^{Y}_{js} is the value added tax rate, τ^{W}_{js} is the payroll tax rate, and $VA_{j}(z, l)$ represents the value-added function, which is given by

$$VA_{j}(z, l) = \left\{p_{j}q_{j}\left(z, l, \iota_{j}\left(\iota_{j1}, ..., \iota_{jJ}\right)\right) - \sum_{k=1}^{J} p_{k}\iota_{jk}\right\} \tag{5}$$

If the firm is in the informal regime, we have $\tau^{Y}_{jI} = 0$ e $\tau^{W}_{jI} = 0$, while if the firm is in the formal or simple regime, both taxes are positive, $\tau^{Y}_{jF} > \tau^{Y}_{jS} > 0$ e $\tau^{W}_{jF} > \tau^{W}_{jS} > 0$. Job choices are limited by an upper limit in informal firms by the employment ceiling $\bar{l}^{I}$. In addition, if the firm operates under the Simples regime, it faces the constraint that its revenue must be limited by a revenue ceiling. $\bar{R}^{S}_{j}$.

3.2.2 Input

In each period and sector j, M_{j} companies are possible entrants. Before entry, companies observe only a signal $v_{j} \sim G_{j}$ of their real productivity z_{j} and pay an entry cost E_{js} to operate in the market. We assume that for each sector j, $E_{jF} > E_{jS} > E_{jI}$, reflecting that formal companies face higher costs to operate in the market, such as bureaucratic procedures. Similarly, Simples companies face legal restrictions to enter the market, but have a simplified tax system.

After entry takes place, the real productivity of companies is drawn from a distribution F_{j} $F_{j}(z_{j}|v_{j})$ which we assume to be continuous in z_{j} and j a v_{j} decreasing in j, v_{j} which means that j and v_{j} are positively correlated. Once productivity is realized, it remains constant and firms face an exogenous probability of exit κ_{js}. This formulation of the entry process produces an overlap in the distribution of productivities between different tax regimes, which is observed in the data. The value function is given by

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

Let $V_{js}^e(v)$ be the expected value of a firm with sign v_j, before the entry decision is made. Thus,

$$V_{js}^e\left(v_j\right) = \int V_{js}(z)dF(z|v_j)$$

The firm chooses the tax regime s if

$$V_{js}^e\left(v_j\right) - E_{js} \geq \{V_{js'}^e\left(v_j\right) - E_{js'}, 0\}$$

For example, a firm in sector j with signal v_j will choose to be formal if its expected net gains (after discounting compliance costs) are higher under the formal regime, i.e,

$$V_{jF}^e\left(v_j\right) - E_{jF} \geq \{V_{jI}^e\left(v_j\right) - E_{jI}, V_{jS}^e\left(v_j\right) - E_{jS}, 0\} \tag{6}$$

If the input in all three regimes is positive, then

$$V_{jI}^e\left(\overline{v_{jI}}\right) = E_{jI}$$

$$V_{jS}^e\left(\overline{v}_{jS}\right) - E_{jS} = V_{jI}^e\left(\overline{v}_{jS}\right) - E_{jI}$$

$$V_{jF}^e\left(\overline{v}_{jF}\right) - E_{jF} = V_{jS}^e\left(\overline{v}_{jF}\right) - E_{jS}$$

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

3.2.3 Productivity distribution

For the productivity stochastic process, we must specify the distribution of the signal G and the productivity shock F. Following Ulyssea (2018), we assume that G follows a Pareto distribution:

$$G_j(v \leq x) = \{1 - \left(\frac{x_m^j}{x}\right)^{\xi_j}, \quad se\ x \geq x_m^j\ 0, \qquad\qquad se\ x < x_m^j$$

After the firms receive the signal, there is a productivity shock ε, which we assume to be

log-normal i.i.d., with zero mean and variance σ_j^2. So productivity z is the product of ν and ε, forming a Pareto-Lognormal random variable. This distribution has three parameters for each sector, x_m^j, ξ_j e σ_j^2.

3.2.4 Balance

We assume that there is a representative agent who owns companies, supplies labor inelastically and derives utility from the consumption of final goods. The utility function is assumed to be a standard Cobb-Douglas $U(C1, \ldots, CJ) = c_1^{\zeta_1} \cdot \ldots \cdot c_J^{\zeta_J}$.

The government collects taxes from companies and transfers them directly to the household. We only consider stationary equilibria, so that prices and quantities remain constant over time. The household's income is then given by $I = w\bar{L} + \sum_{j=1}^{J} \Pi_j + T$, where $\bar{L}$ is the labor supply and T represents government transfers. Π_j represents the sector's total profits j net of input costs,

$M_{jI} E_{jI} + M_{jS} E_{jS} + M_{jF} E_{jF}$, where

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

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

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

where $F_z(\bar{z}_{js})$ is the unconditional probability that a company will go out of business in the sector j and tax regime s. The definition of equilibrium is as follows:

A stationary competitive equilibrium is a set of prices and allocations such that

A stationary competitive equilibrium is a set of prices and allocations such that

1. The labor and goods markets adjust.

2. The zero profit conditions are met: $z_{js} \geq \bar{z}_{js}$, where $\bar{z}_{js}$ is such that $\pi_{js}(\bar{z}_{js}) = 0$

3. For each sector, the size of the tax system is constant over time (equation 7).

3.3 Calibration

In this section we explain how we calibrated our model in order to reproduce the characteristics of the Brazilian economy present in the data. Firstly, we calibrated some parameters externally, i.e. directly from the available data sources or from the literature. We then calibrated the rest of the parameters by adjusting them to bring the model closer to the data.

We considered three production sectors in our model: agriculture, industry and services. Sector $j = 1$ is agriculture, including livestock, fishing and forest extraction. In order to reduce the number of parameters to be estimated and considering that the definition of formal and informal companies may be different for agriculture, we did not model the heterogeneity of companies and regime choices in this sector. We assume that productivity z is the same for all companies in this sector and that all companies are formal[2].

Sector $j=2$ corresponds to the activities grouped under the label "industry" described in Section 2.3, and is the model's numeraire asset. Similarly, sector $j=3$ corresponds to the activities grouped together as "services" described in Section 2.3. In these two sectors, firms are heterogeneous in terms of their productivity and their choice of tax regime.

3.3.1 External calibration

In this section, we show the parameters of the model that are calculated directly from the data or used from existing literature. First, we use the values of the payroll tax rates for the formal sector from Ulyssea (2018). For the payroll tax rate for Simples we used Alvarez et al. (2022). We assumed the same payroll taxes for all sectors.

To calculate Simples' share of indirect tax collection, we used data from the Federal Revenue Service, which details PIS and Cofins collection by sector and economic activity. Although this data only provides information on these two federal taxes, we hypothesized that the proportion of Simples tax collection would extend to other indirect taxes. This data should be viewed with caution, and serves as a proxy for what Simples' share of total indirect tax collection would be.

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2 In agriculture, landowners can legally hire many formal workers without setting up a company, which is the criterion for defining a formal company in other sectors. Our main database for formal companies, RAIS, only includes companies registered as legal entities, identified by a number, the CNPJ. However, employment data and other sources point to a high degree of informality in agriculture. We assume that the relationship between tax collection and value added is the tax rate on value added in this sector before the reform.

The parameters of the production function (share of intermediate goods, θ_j and share of labor, α_j), come directly from IBGE data, the 2015 Input-Output tables and the Resources and Uses tables. To calculate the rates after the tax reform, we also used the Input-Output Matrices and the Resources and Uses Tables. We used the proportions of the standard rates according to the law passed for each product and transformed them into a rate for each sector, using their *market shares*.

Matsumoto (2021) estimates that Simples companies pay around 50% of the cost of formal companies in the main regime to comply with tax obligations. We used this proportion as a reference to define the entry cost for Simples companies, considering that companies pay the present value of tax compliance costs when they enter the market. We assume that the cost of entry for companies in the Simples regime is half the cost of entry for companies in the formal regime.

Also from Matsumoto (2021), we used a ratio of around 65% for the estimated tax rates on production for Simples companies and Formal companies. We assume that the proportion of entry costs for informal companies in relation to formal companies is the same as in Ulyssea (2018).

For the revenue ceiling in Simples, we used the statutory value of R\$3,600,000 in terms of the average annual salary: according to IBGE, the average monthly salary in 2015 was R\$2480. We use the share of informal work (45%) and, following Gomes et al. (2020), we multiply informal wages by 12 and formal wages by 13.33 (additional thirteenth annual salary plus one third of a monthly salary as vacation bonus), which gives us an average annual salary of w = 31574 = 2480×(12×0.45+13.33×0.55). Thus, the income limit parameter is defined as R/w = 3,600,000 /31,574 = 114.

We defined the upper employment limit of five employees for informal businesses using the IBGE's ECINF (Economia Informal Urbana) survey as a reference. The latest edition of this survey on informal businesses, from 2003, focuses on informal production units with five or fewer employees.

For exit rates in the formal sector, we used data from the IBGE (Demografia das empresas e estatísticas de empreendedorismo, 2016), a study that uses data from the IBGE's Central Registry of Companies (Cadastro Central de Empresas - CEMPRE), as well as information from structural surveys by companies in the areas of Industry, Construction, Commerce and Services (PIA, PAIC, PAC and PAS). The study presents entry, exit and survival rates, according to the size and economic activity of the companies. It also provides information on the number of em-

ployees, by gender and education level, by type of demographic event, and aspects of company survival between 2011 and 2016. We used company exit rates by sector of economic activity. As the study presents exit rates with more disaggregated sectors than we are going to use, we aggregated the exit rates by a weighted average of the exit rates of the subsectors, using the gross production value of each subsector as a weight.

To take informality into account, we used the share of informal value added for each sector, as calculated in Torezani (2022). Table 2 shows the externally calibrated model parameters

Table 2: externally calibrated parameters

Parâmetro	Descrição	Valor	Fonte
τ_f^W	Imposto sobre folha de pagamento (formal)	0,375	Ulyssea (2018)
τ_s^W	Imposto sobre folha de pagamento (Simples)	0,175	Alvarez, Pessoa e Portela (2023)
θ_1	Participação de bens intermediários, agricultura	0,22	IBGE
θ_3	Participação de bens intermediários, manufatura	0,48	IBGE
θ_2	Participação de bens intermediários, serviços	0,26	IBGE
α_1	Participação do trabalho, agricultura	0,37	IBGE
α_2	Participação do trabalho, manufatura	0,34	IBGE
α_3	Participação do trabalho, serviços	0,47	IBGE
$\bar{\tau}_s^Y / \bar{\tau}_f^Y$	Média da alíquota Simples/Formal	0,65	Matsumoto (2021)
E_s/E_f	Razão de custo de compliance Simples/Formal	0,5	Matsumoto (2021)
E_i/E_f	Razão de custo de compliance Informal/Formal	0,47	Ulyssea (2018)
$\bar{R}^S/w$	Teto de receita do Simples	114	Estatutário
$\bar{\ell}^I$	Limite de emprego Informal	5	Pesquisa ECINF
$\kappa_{f,1}$	Taxa de saída, agricultura	0,15	IBGE
$\kappa_{f,2}$	Taxa de saída, manufatura	0,13	IBGE
$\kappa_{f,3}$	Taxa de saída, serviços	0,16	IBGE

Source: Own elaboration

3.3.2 Internal calibration

The remaining parameters are calibrated in such a way as to reproduce the model's data on the Brazilian economy. We use the following moments as targets: share of each sector in GDP, value added per worker, share of indirect taxes, share of informality in GDP and share of Simples in indirect tax collection.

Tabela 3: parâmetros calibrados internamente

Parâmetro	Descrição	Agricultura	Indústria	Serviços
$E_{f,j}$	Custo de *compliance* (formal)	-	9	6
$\kappa_{i,j}$	Taxa de saída informal	-	0,27	0,16
$\kappa_{s,j}$	Taxa de saída Simples	-	0,13	0,16
σ_j	Choque de produtividade pós-entrada	-	0,17	0,53
ξ_j	Parâmetro Pareto pré-entrada	-	4,8	4,34
ζ	Participação no consumo	0,05	0,40	0,55
τ_f^Y	Alíquota do imposto sobre valor adicionado (Formal)	-	0,48	0,14
τ_s^Y	Alíquota do imposto sobre valor adicionado (Simples)	-	0,20	0,10
A_1	PTF da Agricultura	950	-	-

Source: Own elaboration

We present the fit of the model to the data in Tables 4 and 5. Table 4 shows the fit for the data we used as a target. That is, the data we chose to approximate with the model. A good practice is to check that, with the parameters obtained, our model also reproduces well data that we don't use as a target. This fit is shown in Table 5.

Looking at the fit of the model in Table 4, we can see that we have a good approximation of each sector's share of value added, although the model slightly overestimates the share of industry and underestimates the share of services. With indirect taxes, the opposite is true: the model underestimates the share of industry and overestimates the share of services. Note that the difference between the model and the data is small. The share of informality in the GDP of each sector is well adjusted for both sectors, while there is a greater divergence in the share of Simples in taxes, especially in industry.

Table 4: model fit to data; moments used as *target*

Momento		Modelo		Dados
Participação no valor adicionado		*Agricultura*	*Indústria*	*Serviços*
	Modelo	7.5%	27%	66%
	Dados	7%	23%	70%
Valor adicionado por trabalhador (relativo à indústria)				
	Modelo	-	100%	66%
	Dados	-	100%	62.1%
Participação de impostos indiretos no valor adicionado				
	Modelo	4.9%	43%	12%
	Dados	4.9%	49%	9.4%
Participação da informalidade no valor adicionado				
	Modelo	-	3.7%	15%
	Dados	-	3.3%	15%
Participação do Simples nos impostos indiretos				
	Modelo	-	5.76%	11.3%
	Dados	-	1.8%	8.9%

Source: Own elaboration

Table 5, in turn, shows that the model performs well in approximating the data that was not used as a *target*. In particular, the model captures well the distribution of firm size (proportion of firms with 1 to 5 employees) and the size of each sector, in terms of the number of firms. The average number of employees is overestimated by the model. However, this is only an average value, sensitive to possible outliers. Other statistics in the distribution (such as the proportion of firms with up to 5 employees) are well adjusted, as are more important statistics for our purposes, such as the share of value added and the share of informality in value added.

Table 5: fitting the model to the data; *non-targeted* moments

Momento		Modelo	Dados
Tamanho médio de firmais, Formal e Simples		133	23

		Indústria	Serviços
Tamanho médio de firmas, Formal e Simples (relativo a serviços)			
	Modelo -	2.82	1
	Dados -	2.55	1
Proporção de firmas com 1 a 5 empregados (Formal e Simples)			
	Modelo -	50%	60%
	Dados -	45%	62%
Parâmetro Pareto Shape (6 ou mais empregados)			
	Modelo -	1.15	0.847
	Dados -	0.60	0.836
Tamanho do setor, Formal e Simples			
	Modelo -	9.5%	90.5%
	Dados -	11%	89%

Source: Own elaboration

4. TAX REFORM SIMULATIONS

In this section, we use the calibrated model to evaluate the effects of the tax reform. We simulate how rates would change between sectors and analyze the behavior of companies in steady-state equilibria under different sets of assumptions. We are not observing transition dynamics in our counterfactual exercises.

First, we calculated the neutral VAT rate, i.e. the rate that maintains the same proportion of indirect taxes on GDP as before the tax reform. Considering all the reduced rates for different economic activities according to the tax reform text, the estimated standard rate was 31.5%, which is higher than that found by other studies and the government's estimate. A cap on the maximum VAT rate of 26.5% was recently approved. We therefore decided to apply this rate in our simulations.

In our main specification, we assume that the entry costs of formal firms will decrease

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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, since the Brazilian tax system is very complex and the tax reform will simplify it. Matsumoto (2021) uses IBGE surveys to calculate compliance costs with the tax system, including accounting and legal costs for both regimes. He finds that these costs are around 50% lower in Simples. Thus, we assumed a 50% reduction in entry costs for firms in the main regime after the tax reform in our simulations with reduced compliance costs. This scenario may overestimate the reduction in entry costs after the tax reform. Therefore, we consider our simulation that maintains compliance costs as a lower bound for the effects of the tax reform and our simulation that reduces compliance costs as an upper bound for these effects.

Table 6: Aggregate effects of the Tax Reform

Reforma Tributária	Antes	Depois	
Variável		Reduzindo custo de compliance	Mantendo custo de compliance
Alíquota padrão	48.7%	26.5%	26.5%
PIB	100	104.5	102.7
Impostos indiretos / PIB	19.6%	17.2%	17.0%
PIB informal / PIB	11.1%	11.5%	11.9%
PIB do Simples / PIB	11.6%	13.2%	14.3%

Source: Own elaboration

We present our main results in Table 6. There was a 4.5% increase in GDP when we changed the tax structure and reduced the cost of entry for formal companies. In the last column, we only changed the tax rates of the sectors, keeping compliance costs unchanged before and after the reform. There is a 2.7% increase in GDP in this scenario. This means that if we break down the total gain of 4.5% in GDP from the tax reform, the change in tax rates between sectors represents an increase of 2.7% and the reduction in compliance costs represents the remaining 1.8%.

In addition, we see that in both scenarios there is a small increase in informality and a more significant increase in Simples, measured by its share of GDP. By keeping the compliance costs of formal companies constant, we see a greater increase in informality and in Simples. This is to be expected, as more companies will opt for the formal sector if they face a reduction in compliance costs for this regime.

Table 7 shows the new rates and the effects of the reform for each sector, in the main scenario with a reduction in compliance costs for the formal sector. We see an increase in the rate

for industry and a decrease for services, which means that the share of indirect taxes in industry decreases by 21.6 percentage points and in the services sector increases by 5.3 percentage points. There is a significant increase in the share of value added by Simples in the services sector, with a small increase in informality. In other words, in a scenario of an increase in the tax burden on services, companies that would no longer opt for the formal system would prefer Simples and informality.

In industry, the shares of value added from both informality and Simples fell, meaning that more companies preferred the formal system. As a result, we see an increase of 26.6% in the added value of industry and a reduction of 4.1% in the services sector. The aggregate effect is a 4.5% increase in GDP, in line with recent studies analyzing tax reform. Unlike other studies, our results indicate that not all economic activities benefit from the reform.

Table 7: Sectoral effects of the Tax Reform

Variável	Agricultura	Indústria	Serviços
Alíquota			
antes da reforma	4.88%	48.7%	14.3%
depois da reforma	2.7%	22.3%	23.2%
Impostos indiretos / PIB			
antes da reforma	4.9%	43.3%	11.7%
depois da reforma	2.7%	21.7%	17%
PIB informal /PIB			
antes da reforma	0%	3.72%	15.4%
depois da reforma	0%	2%	16.6%
Participação do Simples no PIB			
antes da reforma	0%	12.5%	12.6%
depois da reforma	0%	4.6%	18.2%
Participação do Simples na arrecadação			
antes da reforma	0%	5.76%	11.3%
depois da reforma	0%	4.2%	11.2%
Participação no PIB			
antes da reforma	7.5%	26.7%	65.8%
depois da reforma	7.5%	26.6%	65.9%
Variação do valor adicionado			
depois da reforma	-	26.6%	-4.1%

Source: Own elaboration

In a second set of counterfactuals, we first removed Simples from the model while maintaining informality, and then removed both Simples and informality. These scenarios were simulated keeping the standard rate of 26.5% after the reform, as before, and the same values for the remaining parameters in each scenario. The compliance costs of the formal regime are again

halved, which is the corresponding compliance cost for Simples companies.

We present the results in Table 8, and compare them with the results in Table 6. Firstly, if Simples didn't exist, more companies would choose informality directly, because before the reform, informality corresponded to 11.1% of GDP in the base scenario and 15.5% in the scenario without Simples. Furthermore, note that when only Simples is removed, the effects of the reform on GDP are greater (1.2 percentage points). However, we observe a small increase in informality in this version (1.3 percentage points) and a higher tax burden (compared to Table 6). In response to higher taxes, companies would be pushed further into informality.

Table 8: Aggregate effects of the reform, alternative scenarios: (a) without Simples and (b) without Simples and without informality.

Reforma Tributária	Antes	Depois	
Variável		Reduzindo custo de compliance	Mantendo custo de compliance
Alíquota padrão	48.7%	26.5%	26.5%
Sem Simples			
Impostos indiretos / PIB	19.9%	17.5%	17.2%
PIB informal / PIB	15.5%	16.8%	18.3%
PIB	100	105.7	102.7
Sem Simples e informalidade			
Impostos indiretos / PIB	22.8%	21.4%	21.4%
PIB	100	121	104.1

Source: Own elaboration

However, in the scenario without the reduction in tax compliance costs (last column), the GDP gains after the reform are equal to the gains with Simples. Therefore, the almost complete equalization of rates between industry and services produces the same GDP gains with or without Simples, because in the second case informality absorbs the service companies that don't enter the formal sector. However, the simplification effect of the tax system is much stronger in an environment without Simples.

Now, if both Simples and informality are not present, the results change significantly. In the scenario with no reduction in tax compliance costs, GDP increases by 4.1%, considerably more than the 2.7% increase in the model with Simples and informality. As there are no

alternative production regimes, more companies would choose the formal sector, boosting the economy's productivity.

In the scenario with reduced compliance costs, the increase in GDP is very high, at 21%, compared to 4.5% with Simples and informality. Both informality and Simples allow companies that wouldn't exist (in a world without these alternative production regimes) to exist and survive. In this case, the reduction in compliance costs would have a much stronger effect on GDP.

We also note that if we disregard Simples (or Simples and informality) in the model, the rates needed for a fiscally neutral reform in terms of revenue are lower than the base case.

5. CONCLUSION

We developed and quantified a model with heterogeneous sectors, an alternative tax regime (Simples Nacional) and informality. We apply the model to data to analyze the effects of the recent consumption tax reform passed in Brazil. By including informality and Simples as company choices, we gain new insights into the effects of the reform. Tax regimes and informality play an important role in understanding how companies will operate in response to changes in the tax structure.

In our simulations, we found that the reform leads to an increase in GDP of between 2.7% and 4.5%, depending on the assumption made about the magnitude of the reduction in compliance costs that companies will face in the main tax regime with the reform's approval. In the most conservative scenario, we assume that there is no simplification at all.

If we disregard the existence of such alternative tax regimes, the positive effects of the reform are amplified. If we consider only formal and informal companies (without Simples), the increase in GDP varies between 2.7% and 5.7%. If, in addition, we only consider formal companies (without Simples and without informality), this increase varies between 4.1% and 21%, which is much higher than the previous scenarios.

In addition, the share of Simples and informality in GDP responds positively to a change in the tax rate for a given sector. In other words, an increase in the rate for companies in the main tax regime makes them choose to operate in Simples or informality, rather than remaining in the main regime. This leads to important political implications. These responses must be taken into account when designing and changing the tax system. For example, by not considering that companies can opt for different tax regimes and informality, government revenues

can be significantly lower than expected. This becomes clear when we remove Simples and informality from the model, as the same main rate of 26.5% makes the indirect tax/GDP ratio 17% in the scenario with Simples and informality; 17.5% without Simples; and 21.4% without Simples and informality.

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