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Taxation, credit constraints and the informal economy

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WORKING PAPER SERIES Nº 2015-43

DEPARTMENT OF ECONOMICS, FEA-USP
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This paper extends Evans and Jovanovic (1989)'s entrepreneurship model to incorporate the informal sector. Specifically, entrepreneurs can operate either in the formal sector – in which they have limited access to credit markets, but have to pay taxes – or in the informal sector – in which they can avoid paying taxes, but have no access to credit markets. In addition, technology in the informal sector is both less productive and more labor intensive than that in the formal sector. We calibrate the model to the Brazilian economy, and evaluate the impact of credit frictions and taxation on occupational choices, aggregate output and inequality. Removing all distortions can improve aggregate efficiency considerably, largely because this induces entrepreneurs to switch to the formal sector, where technology is superior. Most of this effect comes from removing credit market frictions, but taxes on formal businesses are also important. The elimination of distortions can also reduce inequality, but this comes from credit constraints and labor income taxation. Reducing taxes on formal businesses actually increases inequality in the model.

Keywords: Informal sector; credit frictions; taxation; entrepreneurship.

JEL Codes: E26; L26;O17.

Taxation, Credit Constraints and the Informal Economy

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Mauro Rodrigues[2]

July 2, 2015

Abstract
This paper extends Evans and Jovanovic (1989)'s entrepreneurship model to incorporate the informal sector. Specifically, entrepreneurs can operate either in the formal sector – in which they have limited access to credit markets, but have to pay taxes – or in the informal sector – in which they can avoid paying taxes, but have no access to credit markets. In addition, technology in the informal sector is both less productive and more labor intensive than that in the formal sector. We calibrate the model to the Brazilian economy, and evaluate the impact of credit frictions and taxation on occupational choices, aggregate output and inequality. Removing all distortions can improve aggregate efficiency considerably, largely because this induces entrepreneurs to switch to the formal sector, where technology is superior. Most of this effect comes from removing credit market frictions, but taxes on formal businesses are also important. The elimination of distortions can also reduce inequality, but this comes from credit constraints and labor income taxation. Reducing taxes on formal businesses actually increases inequality in the model.
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Resumo
Este trabalho busca incorporar a coexistência de um setor informal ao modelo de Evans e Jovanovic (1989). Empreendedores podem operar no setor formal – com acesso limitado ao mercado de crédito e sujeitos a cobrança de impostos – ou no setor informal – evitando a tributação, mas sem acesso a crédito. Adicionalmente, a tecnologia no setor informal é menos produtiva e mais intensiva em trabalho. O modelo é calibrado com base em dados da economia brasileira. Avaliam-se os efeitos de restrições no mercado de crédito e tributos sobre as escolhas ocupacionais, produção agregada e desigualdade. Remover todas as distorções melhora a eficiência agregada de maneira considerável, principalmente por conta da migração de agentes para o empreendedorismo formal, que opera com uma tecnologia superior. A restrição de crédito possui o maior efeito, mas os impostos sobre empresas formais também possuem papel importante. A eliminação de distorções também permite reduzir a desigualdade de renda, sendo que tal efeito advém da restrição de crédito e de impostos sobre a renda do trabalhado. Diminuir impostos sobre empreendimentos formais provoca elevação da desigualdade no modelo.
Palavras-chave: Setor informal, restrição de crédito, taxação, empreendedorismo.

Área 4 - Macroeconomia, Economia Monetária e Finanças
JEL classification: E26, L26, O17

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1 Introduction

Large informal sectors are a distinctive feature of developing economies.[1] Firms operate informally as a means of avoiding regulations and taxation. However, there are costs to this action, such as lack of access to formal credit markets and to the legal system. Moreover, there is evidence suggesting that firms in the informal sector are also less productive (De Paula and Scheinkman, 2006).

In the present paper, we explore some elements of this tradeoff by embedding a standard entrepreneurship model (Evans and Jovanovic, 1989) with an informal sector. Specifically, there are two sectors: the formal sector and the informal sector. In the formal sector, entrepreneurs have imperfect access to credit markets and have to pay taxes, while in the informal sector they can evade the payment of taxes but are barred from credit markets. Furthermore, technology is less efficient and more labor intensive in the informal sector.

Agents are heterogeneous in their entrepreneurial talent and wealth. Based on this, they decide between three occupations: wage working, entrepreneurship in the formal sector and entrepreneurship in the informal sector. Differently from Evans and Jovanovic, we also allow wages to be endogenous, which gives rise to nontrivial effects on income distribution.[2] We calibrate the model to approximate features of the Brazilian economy, and evaluate the effects of taxation and credit constraints on efficiency (aggregate output), formalization and inequality.

Taken together, the frictions included in the model are able to generate substantial inefficiency. Particularly, in our basic calibration, aggregate output is 30 percent below that of an undistorted economy. Most of this effect comes from credit constraints on formal entrepreneurs: removing this friction (holding taxes constant) reduces the level of inefficiency to less than 3 percent. Taxation on formal businesses also has an important impact on output: inefficiency is nearly halved when we equal such taxes to zero. These effects come largely from the migration of entrepreneurs from the informal to the formal sector, where productivity is higher.

We also evaluate how taxes on labor income (uniform across sectors) affect total output. Reducing such taxes can actually make the economy less efficient (although the effect is small in magnitude), since it lowers gross wages, thus making the informal sector (which is labor intensive) more attractive.

Removing all frictions also reduces income inequality in the model. This effect is attributed to relaxing borrowing constraints and lowering labor income taxes, which

[1] See, for instance, Schneider (2005).

[2] Gasperini (2010) also considers endogenous wages in Evans and Jovanovic's model.

contribute to raise wages (the effects on income inequality are basically driven by the behavior of wages, since most of the individuals in the model choose wage working). Eliminating taxes on formal businesses raises inequality, since it stimulates the migration of firms to the formal sector (less labor intensive), thus lowering labor demand.

Our work is related to a large literature that evaluates the effect of credit market frictions on entrepreneurship (see for instance Evans and Jovanovic, 1989; Blanchflower and Oswald, 1998; Paulson and Townsend, 2004; Buera, 2008). Our main contribution is to add two different sectors (formal and informal) to the classic model of Evans and Jovanovic. This allows us to analyze not only the effect of credit constraints, but also of taxation. Moreover, these effects can be larger than in a model with a single sector, since changes in parameters induce individuals to switch sectors that have different technologies.

The focus on efficiency is motivated by the literature on misallocation (Hsieh and Klenow, 2007; Restuccia and Rogerson, 2008), especially Jeong and Townsend (2007) and Banerjee and Moll (2010), which analyze the effect of credit market frictions on aggregate productivity. Regarding the effect on inequality, our work is particularly related to Cagetti and De Nardi (2006). Once more, considering the informal sector can amplify the effect of such frictions, since they influence the sector (and therefore technology) in which individuals choose to operate. The present study is also related to papers that model the informal sector, such as Rauch (1991), Amaral and Quintin (2006) and De Paula and Scheinkman (2009).

The rest of the paper is organized as follows. Section 2 describes the model. Section 3 explains how the model was calibrated to the Brazilian economy. Section 4 presents simulations regarding changes in credit frictions and taxation, and analyzes the effects on efficiency, occupational choice and inequality. Section 5 concludes.

2 Model

Our starting point is the model proposed by Evans and Jovanovic (1989). Specifically, there is a set of individuals, heterogeneous on their wealth and entrepreneurial talent. Each of them chooses either to be an entrepreneur or a wage worker. To become an entrepreneur, the individual may need to borrow resources. The presence of borrowing constraints then implies that occupational choice depends not only on entrepreneurial talent, but also on wealth.

We add to Evans and Jovanovic (1989) by introducing two different sectors in which the entrepreneur can operate: the formal sector and the informal sector. In the former,

the entrepreneur may borrow a limited amount of resources to finance her business but has to pay taxes, whereas in the informal sector the individual can evade the payment of taxes, but has to rely exclusively on her wealth (she has no access to credit markets). We consider a small open economy, so that the interest rate is exogenously fixed. Nonetheless, differently from Evans and Jovanovic (1989), wages are set according to a market clearing condition.

2.1 Technology

There is a continuum of mass 1 of individuals, which are heterogeneous in two dimensions: entrepreneurial talent – $\theta \in [0, \infty)$ – and wealth – $z \in [0, \infty)$. They are distributed in the population according to the pdf $f(\theta, z)$. Output is homogeneous and may be either produced in the formal sector or in the informal sector. An entrepreneur of talent θ operating in the formal sector combines capital (K_f) and labor (L_f) to generate output using the following technology:

$$Y_f = \theta \left(K_f^{\alpha} L_f^{1-\alpha} \right)^{\gamma}$$

where $\gamma \in (0, 1)$ is a span of control parameter, as in Lucas (1978). For this same entrepreneur, production in the informal sector is given by:

$$Y_i = \psi\theta \left(K_i^{\beta} L_i^{1-\beta} \right)^{\gamma}$$

where K_i and L_i stand for the amounts of capital and labor employed the entrepreneur in this sector, and ψ is a parameter that does not depend on θ. We assume $0 < \psi < 1$ and $\beta < \alpha$, that is, production in the informal sector is both less productive and more labor intensive.[3]

2.2 The formal sector

If a person decides to be an entrepreneur in the formal sector, she may need external funds to finance her capital. However, there are credit constraints: an agent can borrow up to a multiple of her wealth. Specifically, an individual with wealth z is able to borrow at most $(\lambda - 1)z$, where $\lambda \in [1, \infty)$ is a parameter that measures how lax is the borrowing constraint. The entrepreneur then has this amount plus her own wealth – that is, $(\lambda - 1)z + z = \lambda z$ – available for investment. This implies that the capital stock employed by her firm (K_f) cannot exceed λz.

[3] We follow Amaral and Quintin (2006) when assuming that the informal sector is labor intensive.

Net earnings of a formal entrepreneur with wealth z and talent θ are given by:

$$\pi_f(\theta, z) = \max_{K_f, L_f} \{(1-\tau_f)\theta \left(K_f^{\alpha} L_f^{1-\alpha}\right)^{\gamma} - wL_f - r(K_f - z) + T : \quad 0 \leq K_f \leq \lambda z\}$$

where τ_f is the tax rate on output (if produced in the formal sector), w is the wage rate, $r-1$ is the real interest rate and T is a lump-sum transfer. Tax revenues are distributed uniformly across the population in a lump-sum fashion. In other words, T depends neither on the person's characteristics, nor on her occupation. If the borrowing constraint does not bind (unconstrained entrepreneur), optimality conditions imply that:

$$\begin{aligned} K_{fu}^* &= \left[\frac{\gamma\theta(1-\tau_f)}{\left(\frac{r}{\alpha}\right)^{1-(1-\alpha)\gamma}\left(\frac{w}{1-\alpha}\right)^{(1-\alpha)\gamma}}\right]^{\frac{1}{1-\gamma}} \\ L_{fu}^* &= \left[\frac{\gamma\theta(1-\tau_f)}{\left(\frac{r}{\alpha}\right)^{\alpha\gamma}\left(\frac{w}{1-\alpha}\right)^{1-\alpha\gamma}}\right]^{\frac{1}{1-\gamma}} \end{aligned}$$

which are the amounts of capital and labor chosen by an unconstrained entrepreneur. In this case, the individual uses the efficient quantities of both inputs, and her choice does not depend on wealth. On the other hand, if the entrepreneur is constrained, we have that:

$$\begin{aligned} K_{fc}^* &= \lambda z \\ L_{fc}^* &= \left[\frac{\gamma\theta(1-\tau_f)(1-\alpha)(\lambda z)^{\alpha\gamma}}{w}\right]^{\frac{1}{1-\alpha(1-\gamma)}} \end{aligned}$$

Therefore, if the constraint binds, the entrepreneur's wealth affects the scale of her enterprise. The optimal choice of inputs by an entrepreneur in the formal sector can then be expressed as:

$$\begin{aligned} K_f^* &= \begin{cases} \lambda z, \text{ if } K_{fu}^* > \lambda z \\ K_{fu}^*, \text{ otherwise} \end{cases} \\ L_f^* &= \begin{cases} L_{fc}^*, \text{ if } K_{fu}^* > \lambda z \\ L_{fu}^*, \text{ otherwise} \end{cases} \end{aligned}$$

2.3 The informal sector

The entrepreneur in the informal sector has a problem analogous to that in the formal sector with two key differences: (i) she can evade the payment of taxes ($\tau_f = 0$), and (ii) she has no access to credit markets, having only her own wealth to use as capital ($\lambda = 1$). Net earnings are thus given by:

$$\pi_i(\theta, z) = \max_{K_i, L_i} \{\theta\psi \left(K_i^{\beta} L_i^{1-\beta}\right)^{\gamma} - wL_i - r(K_i - z) + T : \quad 0 \leq K_i \leq z\}$$

The optimal choice of inputs by an unconstrained entrepreneur is then:

$$\begin{aligned} K_{iu}^{*} &= \left[\frac{\gamma\psi\theta}{\left(\frac{r}{\beta}\right)^{1-(1-\beta)\gamma}\left(\frac{w}{1-\beta}\right)^{(1-\beta)\gamma}}\right]^{\frac{1}{1-\gamma}} \\ L_{iu}^{*} &= \left[\frac{\gamma\psi\theta}{\left(\frac{r}{\beta}\right)^{\beta\gamma}\left(\frac{w}{1-\beta}\right)^{1-\beta\gamma}}\right]^{\frac{1}{1-\gamma}} \end{aligned}$$

while a constrained entrepreneur chooses:

$$\begin{aligned} K_{ic}^{*} &= z \\ L_{ic}^{*} &= \left[\frac{\gamma\psi\theta(1-\alpha)z^{\beta\gamma}}{w}\right]^{\frac{1}{1-\beta(1-\gamma)}} \end{aligned}$$

The optimal decision of an entrepreneur in the informal sector is then summarized by:

$$\begin{aligned} K_{i}^{*} &= \begin{cases} z, \text{ if } K_{iu}^{*} > z \\ K_{iu}^{*}, \text{ otherwise} \end{cases} \\ L_{f}^{*} &= \begin{cases} L_{ic}^{*}, \text{ if } K_{iu}^{*} > z \\ L_{iu}^{*}, \text{ otherwise} \end{cases} \end{aligned}$$

2.4 Wage worker

A person who decides to be a wage worker receives the wage (net of taxes), the lump-sum transfer and interest on her wealth, which is lent to entrepreneurs that need external funds. Each wage worker supplies one unit of time inelastically. In other words, labor income does not depend on entrepreneurial talent. Following Amaral and Quintin (2006), we suppose no segmentation in the labor market, so that wages are equalized across sectors. Net earnings of a wage worker with wealth z are then:

$$\pi_w(z) = (1-\tau_n)w + rz + T$$

where τ_n is the tax rate on labor income.[4]

[4] In the model τ_f drives the wedge across sectors. We assume that the tax on labor income is uniform across sectors (that is, it has to be paid independently of the sector the worker chooses), so that τ_n does not capture this wedge as well.

2.5 Equilibrium

The decision of each agent is static. Given talent and wealth, she chooses the occupation which gives her the highest net income: wage worker, entrepreneur in the formal sector, or entrepreneur in the informal sector. Therefore, $\pi(\theta, z) = \max\{\pi_f(\theta, z), \pi_i(\theta, z), \pi_w(z)\}$ are the net earnings of an individual with wealth z and talent θ. The fraction of agents opting for each occupation $j \in \{f, i, w\}$ is:

$$O_j = \int\int 1\{\pi(\theta, z) = \pi_j(\theta, z)\} f(\theta, z) d\theta dz$$

where the subscripts f, i and w stand for entrepreneur in the formal sector, entrepreneur in informal sector and wage worker, respectively. The equilibrium wage is such that:

$$O_f + O_i + O_w = 1$$

and that the supply of labor from wage workers (left-hand side of the equation below) is equal to the demand for labor from formal and informal entrepreneurs (right-hand side):

$$O_w = \int\int 1\{\pi(\theta, z) = \pi_f(\theta, z)\} L_f^* f(\theta, z) d\theta dz + \int\int 1\{\pi(\theta, z) = \pi_i(\theta, z)\} L_i^* f(\theta, z) d\theta dz$$

Furthermore, since tax revenues are transferred back uniformly to the agents, we have that:

$$T = \int\int 1\{\pi(\theta, z) = \pi_f(\theta, z)\} \tau_f \theta \left(K_f^{*\alpha} L_f^{*1-\alpha}\right)^\gamma f(\theta, z) d\theta dz + O_w \tau_n w$$

where the terms on the right-hand side are the proceeds from taxation on formal entrepreneurs and on labor income, respectively.

3 Calibration

Our main objective is to understand the effects of taxation and borrowing constraints on occupation choice, aggregate efficiency and inequality, in an environment in which a significant fraction of output is produced in the informal sector. To do so, we calibrate the model to approximate some features of the Brazilian economy. Along with values for the model's parameters, we need functional forms for the distributions of wealth and entrepreneurial talent.

3.1 Parameter values

Table 1 presents our baseline calibration for the model's parameters. Some of these values were chosen in conformity with the literature, while others were set to replicate features of the Brazilian economy. Specifically, we choose $\lambda = 2$ for our borrowing constraint parameter, which means that the amount borrowed by a formal entrepreneur cannot be larger than the value of her own wealth. This value is in line with Paulson, Townsend and Karaivanov (2006)'s study on the Thai economy. Buera (2008) and Evans and Jovanovic (1989) use similar values for the U.S.

Table 1 – Parameter values

Parameter	Description	Value	Source
λ	Borrowing constraint parameter	2	Paulson et al (2006)
τ_n	Tax rate on labor income	0.176	Pereira and Ellery (2011)
τ_f	Tax rate on formal businesses	0.345	Pereira and Ellery (2011)
α	Formal sector technology parameter	0.35	Gollin (2002) and Buera (2008)
β	Informal sector technology parameter	0.25	Amaral and Quintin (2006)
ψ	Informal sector technology parameter	0.7	–
γ	Span of control parameter	0.65	Hsieh and Klenow (2007)
r	Real interest rate (plus 1)	1.0795	Average for Brazil (2003-2009)

As for the production parameters, we follow Gollin (2002) and Buera (2008) and set $\alpha = 0.35$. The analogous parameter for the informal sector is $\beta = 0.25$ (Amaral and Quintin, 2006; Pessoa and Pessoa, 2006). We choose $\gamma = 0.65$ for the span of control parameter, which is close to the value used by Hsieh and Klenow (2007). The parameter ψ is set at 0.7. This value guarantees that both sectors are active in our baseline calibration.

Tax rates on wages and formal output were set at $\tau_n = 0.176$ and $\tau_f = 0.345$. These values were estimated by Pereira and Ellery (2011) for the Brazilian economy. Finally, based on the average Brazilian real interest rate between 2003 and 2009, we set $r = 1.0795$.[5]

[5] To calculate the annual real interest rate, we use the short-term nominal interest rate (SELIC) in annual terms, targeted by Brazilian Central Bank for monetary policy purposes, minus the annual rate of CPI inflation (IPCA).

3.1.1 Distribution of wealth and entrepreneurial talent

We suppose that wealth and talent are independently distributed. Regarding wealth, we choose a log-normal distribution, i.e., $\log z \sim N(\mu_z, \sigma_z^2)$. The standard deviation σ_z can be mapped into the Gini index through the following formula:

$$Gini = 2\Phi(\sigma_z/\sqrt{2}) - 1$$

where $\Phi(\cdot)$ is the cdf of the normal distribution. To our knowledge there are no wealth surveys in Brazil, which could provide direct estimates of the wealth Gini index. Davies et al (2011) use data from countries with wealth surveys to project the wealth Gini of other countries. For Brazil, their estimate is 0.784. We use this value to calibrate $\sigma_z = 1.75$.

Entrepreneurial talent is an unobservable variable. Our strategy is to assume a uniform distribution – $\theta \sim U(0, A)$ – and calibrate the parameter A, along with the parameter μ_z from the wealth distribution, using statistics from the Brazilian economy. Specifically, for several combinations of A and μ_z, we simulate the model and compute the following objects: (i) share of informal output in GDP, (ii) share of wage workers in population, and (iii) share of wages in GDP. From the data, we approximate (i) using the Underground Economy Index (Índice de Economia Subterrânea), from the Getulio Vargas Foundation. The share of wage workers in the population comes from the Brazilian Household Survey and corresponds to the fraction of employees on total employment. Finally, the share of wages in GDP comes from the Brazilian National Accounts. Table 2 summarizes these statistics. We target averages between 2003 and 2009, since all three statistics are available in this period.

Table 2 – Statistics used to calibrate distributions of wealth and talent

	Value	**Source**
Share of informal sector in total output	19.89%	Índice de Economia Subterrânea Getulio Vargas Foundation
Share of wage workers in population	63.79%	Brazilian Household Survey (PNAD), IBGE Share of workers on total employment (people aged 10+)
Share of wages in total output	32.33%	Brazilian National Accounts, IBGE

For each pair (μ_z, A) we simulate the model and compute (i)-(iii), along with the squared difference between each of these objects and their corresponding values in the data, as displayed in Table 2. We choose the pair which minimizes the sum of such squared differences. This yields $A = 30$ and $\mu_z = 0.26$, and completes our calibration.

4 Simulations

Our simulations are based on a random draw of 100,000 individuals from the distributions of talent and wealth described above. Before turning to the quantitative implications of the model, we provide some intuition on its inner workings, particularly regarding the effects of credit constraints and taxation on occupational choice.

Figure 1(a) plots agents according to their characteristics and occupational choices, in an environment with no taxes ($\tau_f = \tau_n = 0$) and no credit constraints on formal entrepreneurs ($\lambda = \infty$). In this case, all entrepreneurs operate in the formal sector. Moreover, occupational choice depends only on talent: if θ is sufficiently high, the individual becomes an entrepreneur; otherwise, she chooses to be a wage worker. All Figures are in the Appendix.

Figure 1(b) introduces the borrowing constraint on formal entrepreneurs. We keep tax rates at zero, so that it is still not optimal to operate in the informal sector. This is the case studied by Evans and Jovanovic (the only difference here is that wages are endogenous). Now occupational choice depends on wealth as well as talent. In particular, there are two margins of inefficiency entailed by the borrowing constraint: (i) the intensive margin, that is, individuals with high θ and low z become constrained entrepreneurs and have to operate at scales lower than optimal, and (ii) the extensive margin, that is, some of these high-talent individuals prefer to become wage workers. These effects also reduce the demand for labor and, therefore, equilibrium wages.

Figure 2 introduces, in addition to credit constraints, the second source of friction in the model: taxes on formal entrepreneurs and on labor income. Now the informal sector becomes profitable for some individuals, since they can avoid paying taxes. In particular, for a given level of wealth, the least talented individuals opt for wage working. Increases in talent then induce individuals to become informal entrepreneurs: since their scale is relatively low, they prefer to operate informally in spite of not having access to credit markets. Further increases in θ (for the same level of z) are then related to larger scale: access to credit markets becomes essential, thus inducing such individuals to operate in the formal sector.

Table 3 presents some descriptive statistics about our calibrated economy. About 65

percent of all individuals are wage workers, and 18 percent are entrepreneurs operating in the formal sector. The informal sector employs the majority of workers (52.1%), but produces only 22 percent of the output in this economy. This is because such sector is both more labor intensive and less productive than the formal sector. Wage workers are the least talented individual of this economy, while formal entrepreneurs are slightly more talented than informal ones on average. Nonetheless, informal entrepreneurs are wealthier, especially those unconstrained: since these individuals do not need to borrow to operate at the optimal scale, they choose the informal sector in order to avoid paying taxes.

Table 3 – Occupational choices (%)

	Wage	**Formal entrepreneurs**			**Informal entrepreneurs**		
	workers	**All**	Constr.	Unconstr.	**All**	Constr.	Unconstr.
Share in population	**65.0**	**18.4**	17.4	1.0	**16.6**	7.3	9.3
Mean talent	**10.1**	**24.6**	20.7	23.5	**24.4**	26.1	22.9
Mean wealth	**5.4**	**1.6**	1.4	3.5	**13.3**	1.2	22.8
Share in output		**78.0**	67.9	10.1	**22.0**	8.6	13.4
Share in employment		**47.9**	44.7	3.2	**52.1**	17.3	34.8

4.1 Implications for efficiency

To measure efficiency, we compare our model's total output (formal and informal) to that of an economy with no distortions. Specifically, let $Y(\lambda, \tau_f, \tau_n)$ be the total output of an economy with parameters λ, τ_f and τ_n. Output in the absence of distortions is given by $Y(\infty, 0, 0)$. We define efficiency gap as $1 - Y(\lambda, \tau_f, \tau_n)/Y(\infty, 0, 0)$.

Table 4 displays the efficiency gap for selected combinations of tax rates and borrowing constraint parameters. In column (1), both tax rates are zero. Column (2) considers the case in which taxes on formal output are null, but the tax rate on labor income is positive. Column (3) does the opposite, i.e., allows taxes on formal output to be positive, but keeps taxes on labor income at zero. Finally, in column (4) both tax rates are positive. As for the borrowing constraint parameter, along with our calibrated value ($\lambda = 2$), we consider two extreme situations: $\lambda = \infty$ (that is, without such constraint) and $\lambda = 1$ (that is, no access to credit markets, even for formal entrepreneurs).[6]

[6] In all exercises, informal entreprenuers have no access to credit markets.

Table 4 – Effect of taxes and borrowing constraints on efficiency (%)

	(1)	(2)	(3)	(4)
	$\tau_n = 0$	$\tau_n = 0.176$	$\tau_n = 0$	$\tau_n = 0.176$
	$\tau_f = 0$	$\tau_f = 0$	$\tau_f = 0.345$	$\tau_f = 0.345$
$\lambda = \infty$	–	0.2	2.6	2.8
$\lambda = 2$	13.7	14.0	30.8	**30.0**
$\lambda = 1$	19.6	19.8	45.5	45.6

The efficiency gap of our calibrated economy is highlighted in bold. The combination of taxes and borrowing constraints generates an efficiency loss of 30 percent, relative to an economy with no distortions. Most of this effect is attributed to borrowing constraints: the efficiency loss is reduced to 2.8 percent, when we make such constraint unimportant (that is, when λ is increased from 2 to infinity), while keeping tax rates constant.

Though smaller in magnitude, the effect of taxes on total output is also substantial: the efficiency loss is nearly halved when one makes both tax rates equal to zero, but keeps $\lambda = 2$ (column (4) versus column (1)). This effect is basically driven by taxes on formal output (column (4) versus column (2)). When one reduces only the tax rate on labor income to zero (column (4) versus column (3)), the efficiency gap actually increases. This is because the fall in τ_n lowers gross wages, thus making the informal sector (which is labor intensive) more attractive. In other words, some entrepreneurs migrate to the informal sector, which is also less productive, leading to a fall in total output.

Notice that this negative effect of τ_n is absent in the extreme situations $\lambda = 1$ and $\lambda = \infty$. The reason is that, in these cases, the movement of entrepreneurs across sectors is severely reduced. For instance, when $\lambda = 1$, there is no incentive to operate formally, since entrepreneurs do not have access to credit markets in either sector (but in the informal sector they do not pay taxes). Therefore, changes in τ_n will not entail movements of individuals across sectors. Similarly, when $\lambda = \infty$, there is little incentive to operate informally, which reduces the mass of entrepreneurs reacting to an increase in τ_n.[7]

In what follows, we provide further detail on the mechanisms behind the effects tax rates and the borrowing constraint parameter on efficiency.

[7] In these cases, a high τ_n leads to inefficiency because it distorts the choice between wage working and entreprenuership.

4.1.1 Changes in λ

We now analyze the impacts of changing the borrowing constraint parameter on formalization and efficiency. Figure 3 displays percentage changes in total output, as well as formal and informal output (relative to our baseline calibration, i.e., $\lambda = 2$). Increasing λ implies that individuals in the formal sector have more access to credit. This sector, as a result, becomes more attractive, leading to a decrease in informal output. Total output rises because of two channels: (i) the intensive margin, that is, individuals that maintain their status of formal entrepreneurs (constrained) and can expand their scale since there is more credit available, and (ii) the extensive margin, that is, individuals that switch from the other two occupations and become formal entrepreneurs.

Table 4 decomposes the impact on total output into these two margins.[8] We also show the share of output produced in the informal sector, as well as the share of each occupation in the population. For instance, raising λ from 2 to 2.5 leads to a 20 percent increase in total output; the share of informal sector decreases from 22 to 15.4%. This effect comes mostly from the extensive margin, i.e., from individuals that become formal entrepreneurs as a result of an increase λ – specifically from entrepreneurs that leave the informal sector, since the share of wage workers is relatively constant across different values of λ.

Table 5 – Effects of changing the borrowing constraint parameter (%)

$\boldsymbol{\lambda}$	**1.0**	**1.25**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**
ΔTotal output	-37.0	-31.0	-24.1	–	20.0	29.3	32.9
Intensive margin	-2.3	-1.6	-1.1	–	2.6	5.7	8.0
Extensive margin	-34.7	-29.4	-23.0	–	17.4	23.9	25.0
Share of informal output	100.0	58.3	35.8	22.0	15.4	14.6	13.1
Occupational choices							
Wage workers	65.2	65.2	65.4	65.0	65.1	65.2	65.4
Formal entrepreneurs	0.0	3.0	11.3	18.4	20.3	22.1	24.3
Informal entrepreneurs	34.8	31.8	23.3	16.6	14.6	12.7	10.3

[8] To calculate the intensive margin, we add the change in output across entreprenuers that did not alter their occupational choices as a result of a different value for λ. The intensive margin is the change in production from entreprenuers that did alter their status.

4.1.2 Changes in τ_f

Table 5 and Figure 4 perform a similar exercise, but for changes in τ_f. As a result of increasing taxes on formal businesses, some individuals find more profitable to operate informally. Therefore, output in the informal sector rises at the expense of output in the formal sector. Moreover, nearly 100% of such effect comes from the extensive margin. Notice that the model is quite sensitive in this dimension. For instance, if τ_f rises by 0.5 percentage points, the informal sector share in total output jumps from 22 to 31.6%.[9] Total output falls as a result, as some entrepreneurs switch to a less productive technology when they move to the informal sector. The share of wage workers also increases in response to higher taxation on formal entrepreneurs. This is because the expansion of the informal sector (which is labor intensive) is associated with an increase in wages. As a result, some individuals switch to this occupation.

Table 6 – Effects of changing taxation on formal businesses (%)

$\boldsymbol{\tau_f}$ (%)	**32.0**	**33.0**	**34.0**	**34.5**	**35.0**	**36.0**	**37.0**
ΔTotal output	29.0	19.6	2.1	–	-3.5	-13.4	-19.3
Extensive margin	29.0	19.6	2.1	–	-3.5	-13.4	-19.3
Share of informal output	4.6	11.4	20.3	22.0	31.6	49.7	61.9
Occupational choices							
Wage workers	64.2	64.6	64.8	65.0	65.3	65.7	66.0
Formal entrepreneurs	26.0	21.7	20.4	18.4	11.9	7.5	4.1
Informal entrepreneurs	9.8	13.7	14.8	16.6	22.8	26.8	29.9

4.1.3 Changes in τ_n

Table 6 and Figure 5 exhibit results regarding changes in labor income taxation. As previously noted, an increase in τ_n raises efficiency, because it makes gross wages higher and, as a result, reduces relative profitability in the informal sector (which is more labor intensive). This induces some entrepreneurs to move to the formal sector, where the technology is more productive. This effect appears in the extensive margin, which is positive for increases in τ_n. The intensive margin, nonetheless, goes in the opposite

[9] For this reason, we chose values of τ_f very close to each other in Table 5.

direction, since entrepreneurs that do not switch sectors face higher costs, thus reducing their scale. Moreover, net wages fall, thus reducing the share of individuals that opt for wage working.

Table 7 – Effects of changing taxation on labor income (%)

τ_n (%)	**2.0**	**7.0**	**13.0**	**17.6**	**22.0**	**25.0**	**30.0**
ΔTotal output	-1.0	-0.7	-0.3	–	0.9	1.4	5.5
Extensive margin	0.4	0.6	0.3	–	-0.2	-0.6	-1.1
Intensive margin	-1.5	-1.3	-0.6		1.2	2.0	6.6
Share of informal output	24.7	24.1	23.4	22.0	21.0	18.3	17.2
Occupational choices							
Wage workers	67.3	66.9	65.7	65.0	64.8	63.8	62.0
Formal entrepreneurs	15.4	16.1	17.4	18.4	19.1	20.2	23.1
Informal entrepreneurs	17.3	17.0	16.9	16.6	16.1	16.0	14.9

In spite of the efficiency gains, increasing labor taxation worsens income inequality in the model, since most individuals are wage workers. In the following subsession, we discuss the distributional effects of changes in taxation and in the borrowing constraint parameter.

4.2 Implications for inequality

We measure inequality by the income Gini coefficient, which is equal to 0.469 in our baseline calibration. In other words, the model is able to generate considerable inequality, despite not featuring differences in labor productivity (in the data, the average Brazilian Gini index is equal to 0.562 during the 2003-2009 period). Table 7 is analogous to Table 4, but shows the impact of tax rates and the borrowing constraint parameter on income inequality in the model. As in the case of efficiency, the highest reduction in inequality occurs when one eliminates the credit market friction (that is, comparing $\lambda = 2$ and $\lambda = \infty$ in column (4)). Inequality also falls when we make the tax rate on labor income equal to zero (column (4) versus column (3)), but rises when we set the tax on formal enterprises at zero (column (4) versus column (2)).

Table 8 – Effect of taxes and borrowing constraints on inequality

	(1)	(2)	(3)	(4)
	$\tau_n = 0$	$\tau_n = 0.176$	$\tau_n = 0$	$\tau_n = 0.176$
	$\tau_f = 0$	$\tau_f = 0$	$\tau_f = 0.345$	$\tau_f = 0.345$
$\lambda = \infty$	0.399	0.475	0.375	0.439
$\lambda = 2$	0.451	0.499	0.446	**0.469**
$\lambda = 1$	0.423	0.489	0.413	0.456

Furthermore, notice that the parameter λ has a non-monotonic effect on the Gini coefficient: raising λ from 1 to 2 increases income inequality, but increasing λ further to infinity reduces this index. The relationship follows an inverted-U, where inequality peaks at λ roughly equal to 2.2.

This follows because λ has two contradicting effects on wages (and, therefore, inequality, since most individuals choose wage working in this economy). On the one hand, relaxing borrowing constraints boosts labor demand, as firms in the formal sector are able to reach larger scales of production. On the other hand, the increase in λ induces movements of entrepreneurs from the informal to the formal sector, which lowers labor demand since informal firms operate a labor-intensive technology. When λ is close to one (and all output is produced in the informal sector), the second effect dominates. As λ increases further, the first effect becomes more important.

A smaller tax rate on labor income lowers efficiency, but reduces inequality, since the net wage falls in response to higher τ_n. The opposite occurs for reductions in τ_f: this stimulates the migration from the informal to the formal sector, which increases total output but reduces the wage (since the informal sector is labor intensive).

5 Concluding remarks

This paper analyzed the effect of taxation and credit market frictions on occupational choice, aggregate efficiency and income inequality, in an environment where a large fraction of output is produced in the informal sector. In particular, we extended the model of Evans and Jovanovic (1989) to consider two sectors: the formal sector, in which entrepreneurs have limited access to credit markets, but have to pay taxes; and

the informal sector, in which entrepreneurs can evade the payment of taxes, but have to rely exclusively on their wealth to finance their capital. Individuals are heterogeneous on their wealth and entrepreneurial talent, and have to decide between three occupations: wage worker, entrepreneur in the formal and entrepreneur in the informal sector. In addition, the informal sector is both less productive and more labor intensive than the formal sector.

The model is calibrated to approximate features of the Brazilian economy in the 2000s. For our baseline parameters, the frictions included in the model are able to generate a considerable degree of inefficiency: total output is 30 percent below that of an economy with no distortions. This is largely attributed to credit frictions, but taxes on formal businesses are also important. Relaxing such frictions can the have a considerable impact on total output, mostly because it induces entrepreneurs to switch to the formal sector, which features a superior technology.

Regarding income distribution, removing all frictions also reduces inequality. This comes from relaxing borrowing constraints and lowering taxes on labor income. Lowering taxes on formal businesses improves aggregate efficiency, but worsens income inequality.

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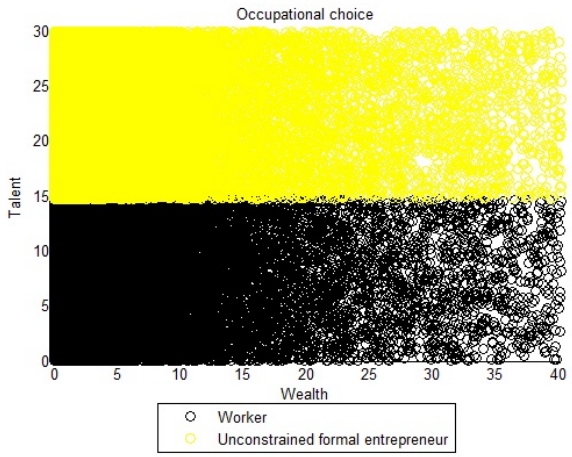
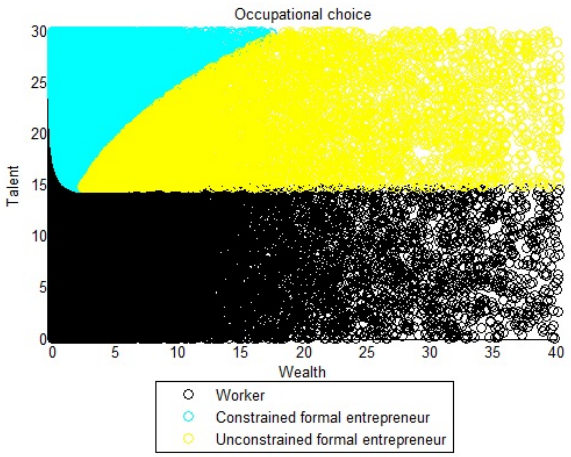
Appendix



(a) no distortions



(b) credit constraints on formal entrepreneurs

Figure 1: Occupational choices (without the informal sector)

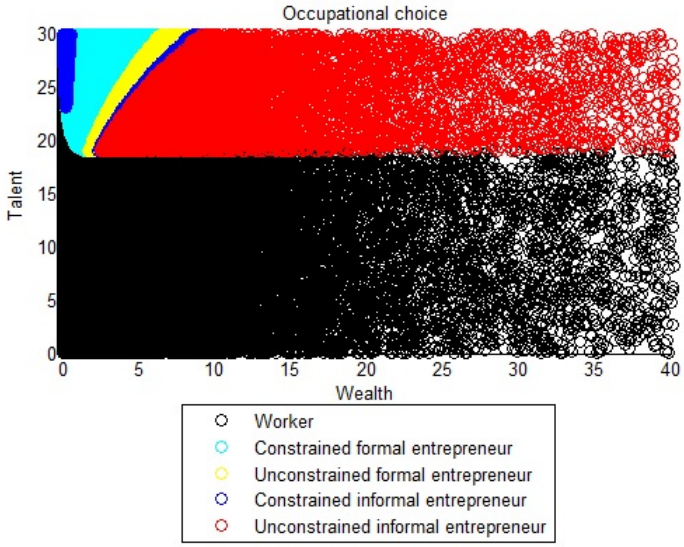


Figure 2: Occupational choices (introducing the informal sector)

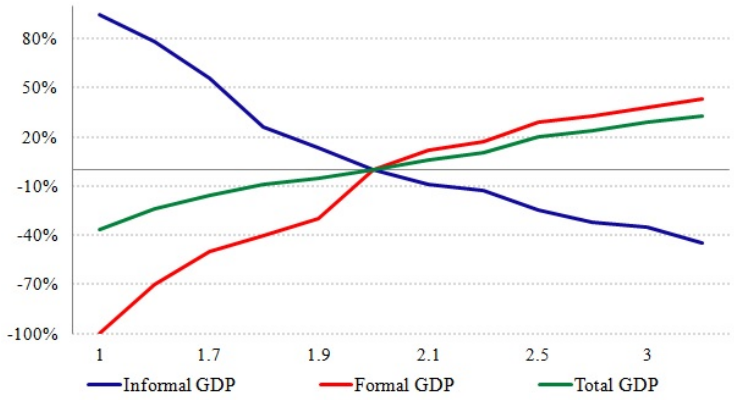


Figure 3: Effect of λ on output and formalization

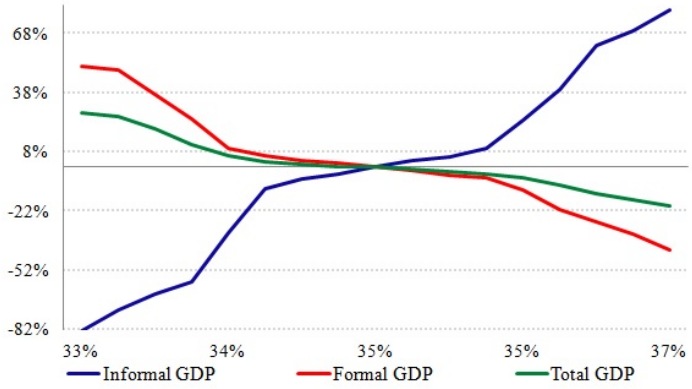


Figure 4: Effect of τ_f on output and formalization

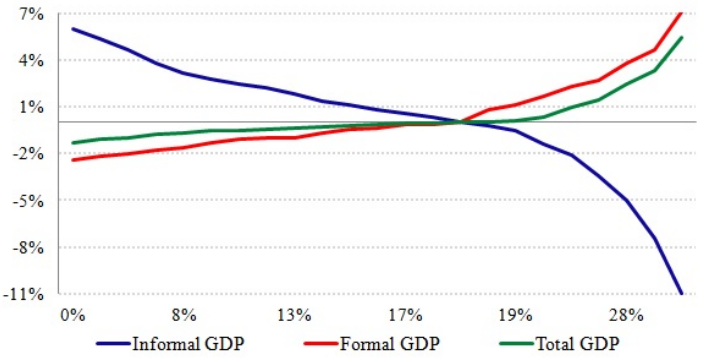


Figure 5: Effect of τ_n on output and formalization