Universidad del Rosario | Facultad de Economía

SERIE DOCUMENTOS DE TRABAJO

No. 321

Enero de 2025

The Impact of Tax Asymmetries on Labor and Business Informality: The Case of Colombia

Cristina Fernández Mejía

Universidad del Rosario, Facultad de Economía
Cl. 12c #4-59. Bogotá, D. C., Colombia
PBX: (031) 2970200 ext. 4163

facultadeconomia@urosario.edu.co
https://www.urosario.edu.co/Facultad-de-Economia/Inicio/
https://repository.urosario.edu.co/handle/10336/20291

The Impact of Tax Asymmetries on Labor and Business Informality: The Case of Colombia

Cristina Fernández*

Abstract

This paper illustrates how two well-indented policies to reduce informality, such as the income tax waiver for small firms and the income tax deduction of labor cost, end up generating a large number of small firms hiring workers, most likely unskilled, without a formal contract. This paper also shows the difficulties in reducing informality in the complex regulatory environment of Colombia. Policies oriented to reduce labor informality have a limited impact and are costly from the fiscal point of view; policies oriented to reduce business informality are more effective, but do not necessarily reduce labor informality if they are directed towards low-productivity firms. The methodology used to illustrate these facts was the estimation of Ulyssea (2018) for the case of Colombia, in an environment of asymmetric tax and social security regulations.

Keywords: Informality, Firm informality, Business informality, Informal labor market, Taxonomy of informality, Policy recommendations for informality.
JEL codes: D22, D58, E24, J21, J46, O17.

*Economics Ph.D. student at Universidad del Rosario and researcher of Fedesarrollo. I would like to the invaluable help of Andres García-Suaza, Fernando Jaramillo, and Juan Miguel Gallego in developing this paper. Comments by Gabriel Ulyssea, Luis Eduardo Arango, and Luis Fernando Mejía were also very helpful. This working paper was funded by the Colombia Científica-Alianza EFI Research Program, with code 60185 and contract number FP44842-220-2018, funded by The World Bank through the call Scientific Ecosystems, managed by the Colombian Ministry of Science, Technology, and Innovation. I also would also like to thank the Departamento Nacional de Planeación (DNP) for financing a previous version of this paper.

1 Introduction

One of the first questions asked when approaching the analysis of the Colombian productive sector and the labor market is why there are so many small, low-productivity firms hiring informal workers. One usual explanation is the stronger enforcement on larger firms, but this explanation falls short when considering the weak enforcement institutions in Colombia. An alternative hypothesis is the existence of regulations that incentive this behavior. The research question of this paper is how the complex set of tax, social security, and labor policies in Colombia shapes business and worker informality throughout the size distribution of firms.

The main hypothesis of this article is that two main features of the institutional framework are causing this firm behavior: First, there is an income threshold under which firms are exempted from paying taxes. In Colombia, businesses are not required to pay income taxes if they earn a yearly gross income lower than COP$46 million (nearly US$14,000 of 2019)[1]. There is another threshold for exempted VAT at COP$100 million (nearly US$26,000). Second, there is the possibility of deducting formal labor costs, including wages and payroll taxes, from the income tax base. Due to this deduction, income tax payers are almost indifferent between hiring workers formally and informally (the effective rate after this deduction is nearly 4.7%), while exempt firms face higher incentives to hire informally because they do not get the tax exemption (the effective rate is nearly 47%, ten times higher).[2] This incentive, which has been relatively ignored in the literature, proves to be an efficient policy to promote formal hiring among taxpayers.

Table 1 summarizes the labor contributions after receiving the tax deduction faced by businesses paying or not income tax and assuming a 28.8% income tax rate (τ_y), and a 19% VAT tax rate (τ_{vat}). According to this table, taxpayers face VAT and income taxes, but lower employer contributions; whereas smaller firms do not pay VAT and income taxes but face a higher relative cost of hiring formally vs. informally[3].

Although the COP$46 million tax threshold seems low, it covers an important percentage of micro-businesses in Colombia, which in turn accounts for around 93% of all firms in the country, excluding agriculture and self-employment. As shown in Table 2, and according to the Colombian Micro-Business Survey (EMICRON), 77% of the micro businesses are below the income and VAT thresholds; 10% above the income tax threshold but below the VAT threshold, and 13% above both thresholds. Table 2 also shows that 86% of small formal micro-businesses are registered as 'natural persons' and, therefore, suitable to be exempted from income tax.

Table 1. Taxes and contributions faced by businesses (2019)

Gross income Yearly $COP millions	VAT τ_{vat}	Income tax τ_y	Social security τ_w	Tax deduction $(1+\tau_w)\tau_y$	Relative cost of hiring informally: social security and tax deductions $\tau_w - (1+\tau_w)\tau_y$
< 46	0%	0%	47%	0%	47%
> 46 & < 100	0%	29%	47%	$147\% \times 29\% = 42\%$	$47\% - 42\% = 4.7\%$
> 100	14.5%	29%	47%	$147\% \times 29\% = 42\%$	$47\% - 42\% = 4.7\%$

Source: Own calculations. *Note:* VAT includes income tax deductions.

[1] The threshold to pay income taxes is not fixed and depends upon the percentage of expenditures reported by the entrepreneur. This threshold exists only for businesses registered as natural persons, but most businesses do not have incentives to register as legal entities. Also, for simplicity, other income deductions are ignored. This assumption is supported by the fact that a firm must meet a series of requirements to validate these deductions

[2] In 2023 the same arguments continue to be valid but differences are larger because the tax rate increased to 35%. Also, a single tax scheme was implemented that allow deductions of social security payments

[3] It might be easier to understand the problem with an example: A formal firm with an income of COP$1000 and a wage bill of COP$500. This firm should pay a payroll bill of COP$237 ($\tau_w = 47\%$) and having a tax base of $235 (income wage bill payroll) and should pay an income tax of COP$76 ($\tau_y = 28.8\%$). Without formal deduction for labor costs, the tax base will be (COP$1000) and the tax, is COP$288. The value the firm saves in taxes for hiring workers formally is (COP$288-COP$76=COP$212), and the value of the payroll bill net of tax deductions is equal to (COP$237-COP$212=COP$23), that is equivalent to a tax rate of 4.8%

Table 2. Number of firms above and below the income thresholds and those registered as "natural persons"

	Total	%	Informal	%	Formal	%	Formal firms registered as "natural person" (%)
Microbusiness	1,411,670	100%	1,370,133	100%	41,536	100%	73%
<46	1,087,547	77%	1,077,821	79%	9,725	23%	86%
>46 & <100	145,088	10%	137,608	10%	7,480	18%	87%
>100	179,033	13%	154,704	11%	24,329	59%	63%

Source: EMICRON and own calculations. Excludes firms with one worker. Informal: not registered recently or not formal accounts.

Table 3 summarizes the hypothesis on how these two institutional characteristics (tax waivers and tax exemptions) interact with the minimum wage and enforcement policies to encourage or constrain extensive and intensive informality margins. Larger firms tend to show a lower intensive margin since they can deduct formal labor costs and face high enforcement policies, and a lower extensive margin, resulting from both high enforcement policies and taxes. On the other hand, smaller firms face high incentives to both be informal and hire informally, because of the high formal labor cost. They are also more affected by the minimum wage because small firms don't get the incentive to deduct costs, and because they also tend to hire more unskilled workers. These mechanisms shape not only the distribution of informality but also the distribution of firms, productivity, and labor through different firm sizes.

Table 3. Forces affecting the formality decisions across firm sizes

Gross Income	**Intensive margin** Labor informality	**Extensive margin** Business informality
Below the threshold	• Low control and enforcement • High labor costs *High incentives to informal hiring*	• Low control and enforcement • No taxes
Above the threshold	• High control and enforcement • Low labor cost *High incentives to formal hiring*	• High control and enforcement • Income tax and VAT

Source: Own hypothesis.

The methodology used to test this hypothesis is to estimate Ulyssea (2018), a model that has been shown to accurately replicate the Brazilian informality case, with and without these three institutional constraints. According to the results, both models well replicate the distribution of the number of firms, the intensive and extensive margin, and the share of skilled workers in different firms for the case of Colombia. However, the unconstrained model accommodates a higher informality in the country by assuming a lower enforcement on business formality, and the constrained model by assuming a lower enforcement on both business and labor informality. The lower role of the enforcement mechanism in the new model suits well the case of developing countries, where enforcement institutions tend to be rather weak.

This contribution has important policy implications because it moves the focus of recommendations from payroll taxes and enforcement to a holistic analysis of the tax, labor, and social security institutions. This shift is welcomed, since payroll taxes policies have shown positive but limited effects on informality; and enforcement policies applied to small businesses can be ineffective, and even harmful for employment and welfare. Comparative statics also allows us to observe the impact of fiscal and labor policies on informality. Policies oriented to reduce labor informality have a limited impact and are costly from the fiscal point of view, and policies oriented to reduce business informality are more effective, but do not necessarily reduce labor informality if they are directed towards small firms.

Although the model is estimated for the Colombian case, the main conclusions of this paper can be applied to a variety of developing countries, which typically face high informality and have institutional constraints in the form of minimum wages, formal labor cost tax deductions, and tax brackets for low-income firms (Paturot, Mellbye, & Brys, 2013).

Self-employment continues to be an unfilled gap in explaining informality and a pending item on the agenda. In fact, I have realized that this topic, although tremendously important for the Colombian case, should be analyzed with

an occupational choice model ax explained by Fernández (2023a)), rather than with a firm's perspective model as Ulyssea (2018), and therefore is left for future research.

This paper is structured as follows. Section 2 briefly reviews the existing literature, Section 3 shows the main facts of informality in Colombia, Section 4 presents the theoretical model that results from introducing institutional arrangements to the model of Ulyssea (2018), sections 5 and 6 estimates the model and shows the fitting for the Colombian case, Section 7 illustrates some comparative static exercises and Section 8 concludes.

2 Literature review

Historically, the analysis of informality has debated between the segmented and integrated view. The segmented view, led by Lewis (1954) and Harris and Todaro (1970), advocates for two different markets with few transitions between them: one including low-educated and low-productivity firms and the other high-educated and high-productivity firms. The integrated view led by Maloney (2004) stand up for a sole market where firms and workers freely transit between formality and informality. However, some others, such as De Soto (1989) and De Soto (2000) support a third view, where firms and workers transitions are limited by excessive regulation. Recently, informality has been understood as a phenomenon that encompasses the three different types of informality mentioned above, depending on the size and distribution of productivity of firms (Fernández, Villar, & Gómez, 2017; Loayza, 2016; Perry et al., 2007; Ulyssea, 2018).

According to Perry et al. (2007), informal firms include small subsistence firms, regulations-restricted firms, and firms of a larger size that do not comply with regulations. They argue that some firms can benefit from lowering the costs of informality and react to an increase in the costs of being informal, but they also understand that small firms require policies such as access to formal credit, training, and business development services. Loayza (2016) reinforced this framework and policy recommendations with a model calibrated for Latin American countries, where the type and amount of informality is closely related to the cost of formality, which, in turn, harms productivity.

Although these models and analysis stress the importance of lowering the cost of formality, most empirical analysis has found a limited and sometimes non-existent impact of policies such as payroll taxes and registration cost cuts. A positive example is the reduction in payroll taxes from 29,5% to 16% that occurred in Colombia, 2012. This measure reduced the informality rate of dependent workers by 4.8 pp., which is consistent with a 2.4 pp. reduction in the informality rate of the economy (Fernández & Villar, 2016). Similarly, Kugler, Kugler, and Herrera-Prada (2017) found that this reduction increased formal employment in more than 3% and reduced informal employment in 2.9%. However, the reduction in Peru's labor cost of micro-businesses from 54% to 17% of mean wages did not generate a significant reduction in informality when controlling for growth (Chacaltana, 2016). According to M. Jaramillo (2013), this could be related to lack of enforcement.

Ulyssea (2018) shifted the focus of the analysis from the cost of formality to the cost of informality. He developed a model that departs from Melitz (2003) but includes an internal and external margin of informality. When applying this model to the Brazilian case, the author found that while reducing payroll taxes can be an effective policy recommendation, enforcement is the main driver of the shape of informality in the size distribution of firms and the most effective variable to reduce informality. This emphasis on enforcement could have been inspired by the Brazilian case. According to 'Haanwinckel and Soares (2021), Brazil increased the percentage of workers supervised by labor inspectors by 34% between 2003 and 2012, along with a new incentive scheme. Impact analyses of this increase in enforcement are mixed: Fairris and Jonasson (2016) found a positive impact and Almeida and Carneiro (2012) did not find an impact on formality.

Another possible explanation for the limited impact of reducing informality costs is the interaction of these policies with tax and labor regulations. Antón and Rasteletti (2018) included a more detailed structure of the tax institutions in their model for the case of Mexico, but their analysis was more focused on the fiscal impact of formalization policies. Dix-Carneiro, Goldberg, Meghir, and Ulyssea (2021) formulated a model with tax and minimum wage frictions, but in this case the model was oriented to analyze the impact of trade. Acosta-Henao (2020) analyzed the relationship between tax rates and an enforcement rate, whose effectiveness depends on the size of the informal sector (measured by its assets) and government expenditure. According to his findings, this enforcement perspective creates a Laffer curve, where an increase in taxes can reduce informality under specific circumstances.

The single-tax schemes literature tends to consider a richer institutional framework, particularly in the cases of Brazil and Uruguay, where the single-tax includes social security contributions. Alaimo, Bosch, Kaplan, Pagés, and Ripani (2015) estimated that these schemes formalized about half a million Brazilian micro-businesses and two million jobs between 2000 and 2005; and together with Fajnzylber, Maloney, and Montes-Rojas (2011), found that the firms that opted for the single-tax scheme have shown higher levels of income, profits, hire more workers, and are more capital intensive. According to Amarante and Perazzo (2013), the single tax policies in Uruguay increased the number of formal self-employed workers from 6% to 23% between 2006 and 2010.

In the case of Colombia, Hamann-Salcedo and Mejía (2013) and Mejía and Posada (2007), through a general equilibrium model, found that regulation institutions act as a legal barrier to the entrance of formal firms into the market. TSimilarly, the recent Employment Mission by Levy and Maldonado (2021) suggested that the behavior of employment and informality in Colombia was mainly due to the complicated labor and social security systems, but did not elaborate much on their interaction with the tax system . This paper aims to fill this gap.

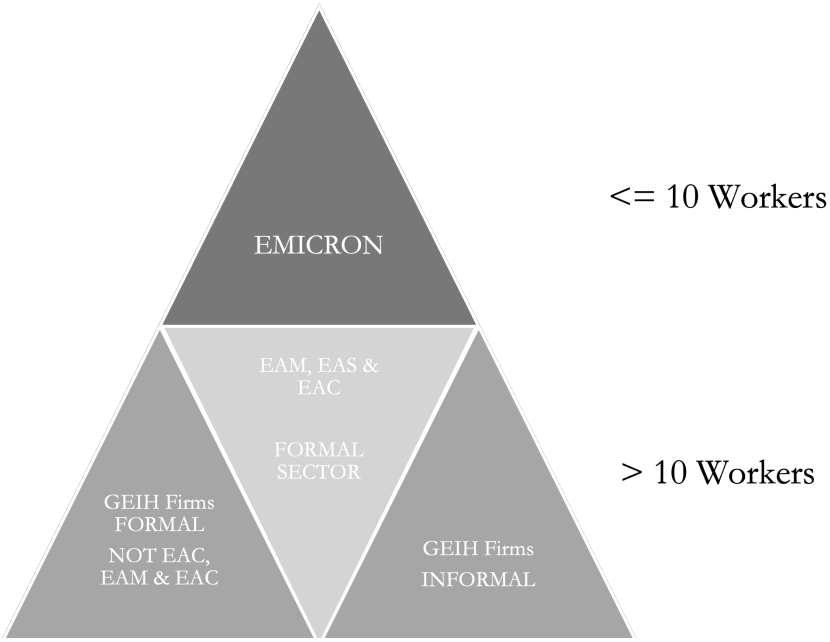
3 A panorama of informality in Colombia

One of the limitations in analyzing informality in Colombia, and particularly business informality, is the lack of a business census or a representative survey to simultaneously analyze the entire universe of firm, including informal and informal firms , and micro-business and larger firms. The last economic census was conducted in 1990. Fernández (2023b) filled this gap by compiling information on nearly half million firms from EMICRON (employer-employee microbusiness survey), the structural surveys of manufacturing, services, and trade (EAM, EAS, and EAC), and the section of the household survey (GEIH) that asks questions to entrepreneurs[4].

Figure 1 shows the procedure used to build this new database (EEG: EMICRON, structural and GEIH surveys): information of firms with ten workers or fewer is taken from EMICRON; firms with more than 10 workers are represented by the structural surveys (EAM, EAS, and EAC) and by the GEIH if they are informal or belong or are not covered by the structural surveys. The set of variables collected through this procedure is rather wide and allows generating a good characterization of informality in Colombia. A representativeness analysis of this survey, as well as other features, can be found in the original article.

[4]This paper uses the version of EEG (2019) that includes self-employment, because otherwise the size distribution of firms would be biased.

Figure 1. Sources of information of the EEG



Source: Fernández (2021).

The EEG allows the identification of the following stilized facts that should be considered when modelling informality for the case of Colombia.

1. Extensive margin of informality. Business informality in Colombia is high and more continuous than binary, in the sense that there are firms that represent a larger or smaller portion of the regulations. This is unlike the case of Brazil, where the single tax scheme embodies a large part of the legislation, generating a more discrete business informality variable.

Although it is difficult to estimate and model a continuous variable of business informality, it makes sense to use different informality scenarios in the analysis. Figure 2 shows the extensive margin, according to three different definitions of business informality. As shown in the figure, informality is widely spread among small firms and across all informality definitions, even after excluding one-worker firms. The informality of business is also of considerable size for companies with more than 10 workers (42% among firms with 10 to 40 workers). Therefore, assuming that these firms are formal, as in Ulyssea (2018), is not realistic for the Colombian case. Under this criteria the business informality rate in Colombia is 88% but is can be as low as 30% if we consider a lighter criteria.

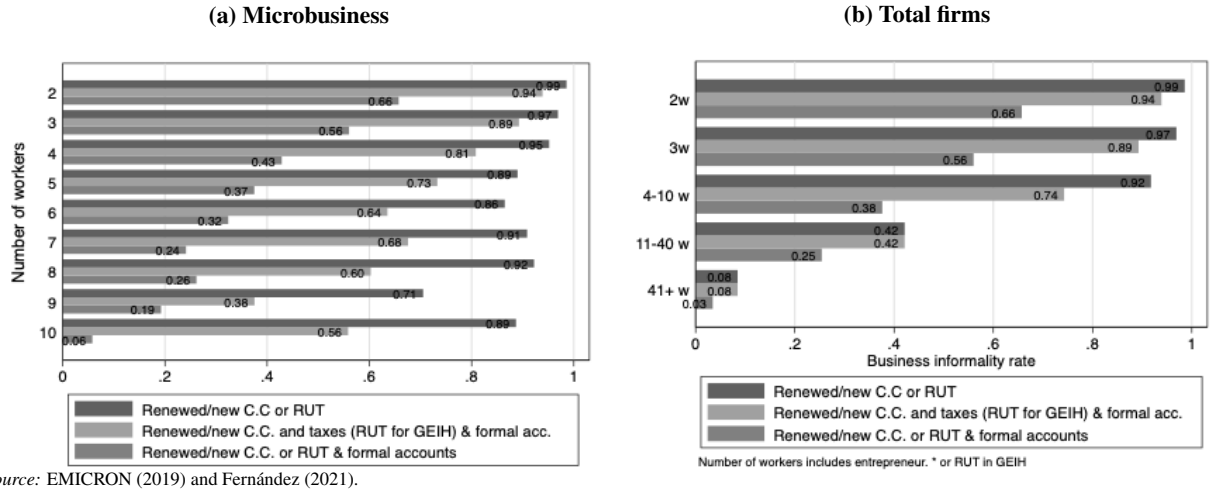
It is very important to have the perspective of business informality for several definitions of the variable, but for the specific purpose of this paper, formal firms are restricted to those that pay taxes or are exempted and, therefore, it is more accurate to have a strict definition of informality considering three criteria: Renewed or new registration with the Chamber of Commerce[5], formal accounts[6], and being tax contributors or exempted[7] (lighter bar in the graph).

[5]The question in the GEIH also includes RUT registration (income tax registration).

[6]General Balance or Profit and Losses Statement or with a daily register book

[7]In the case of micro-business, it also includes as formal firms that not supposed to pay taxes. Firms with more than 10 workers (GEIH) are assumed to pay taxes.

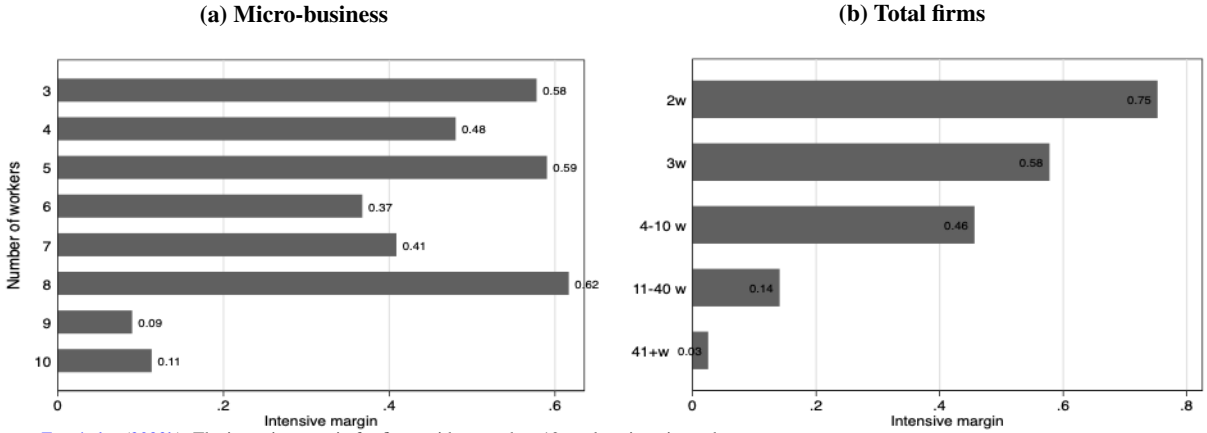
Figure 2. Extensive margin of informality according to 3 definitions of informality



Source: EMICRON (2019) and Fernández (2021).

2. Intensive margin of informality The intensive margin of informality is defined as the percentage of workers who do not contribute to health or pensions and are hired by formal companies with at least 2 dependents (3 workers). Figure 3 shows this statistic for microbusiness (EMICRON, 2019) and for all firms (EEG, 2019)[8]. The intensive margin for micro-business does not show a smoothly decreasing behavior, probably due to the number of observations available, but arranging the information by ranges generates a decreasing intensive margin. However, it is important that the intensive margin remains significant for relatively large firms (14% among formal firms with 10 to 40 workers). Therefore, we do not assume a null intensive margin for firms with more than 10 workers, as literature often do. The labor informality rate among EEG(2019) firms is 71%.

Figure 3. Intensive margin of informality



Source: Fernández (2023b). The intensive margin for firms with more than 10 workers is estimated.

3. Value-added distributions. EEG (2019) also allows for the comparison of per-worker value-added distributions between formal and informal firms [9]. According to Ulyssea (2018), the overlap of the formal and informal per-worker value added distributions, with formal firms having a higher mean, is consistent with heterogeneous firms that take the formality/informality decision with limited information. As shown in Figure 4, the Colombian case shows a high overlap between formal and informal distributions, suggesting a high uncertainty. The perfect conditions foreseen in his model would predict totally independent distributions.

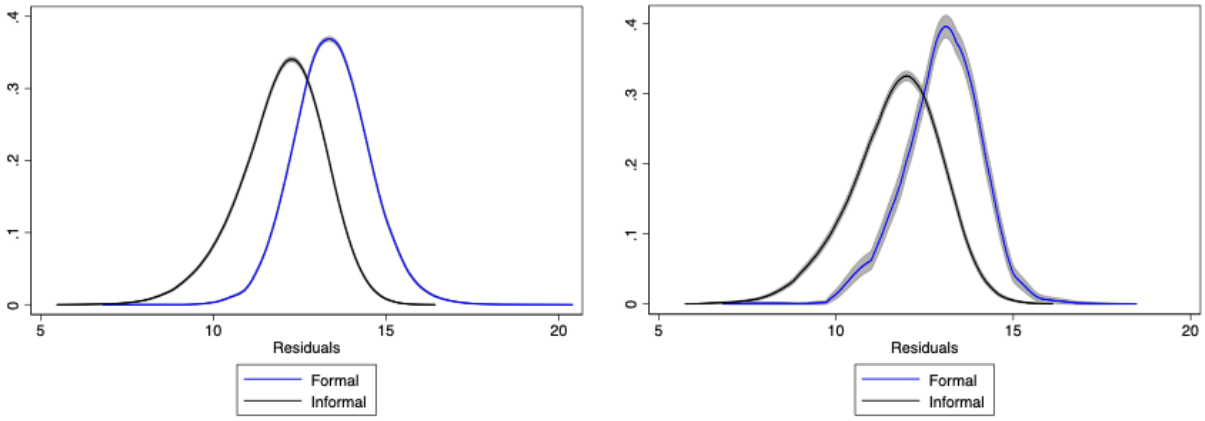
[8]The informality rate is observed for firms with less than 10 workers (EMICRON). Informality for larger firms (bigger than 10 workers) outside of these structural surveys is estimated through a random forest procedure feed with the same GEIH survey but regarding questions asked to workers and the GEIH (2021) that asks workers about the registration status of their place of work, as shown in Fernández (2023b) . Non-remunerated workers, partners, and entrepreneurs are also classified according to their informality status and therefore are included in the denominator.

[9]The EMICRON and the structural surveys provide this information for micro business and firms in the services, trade, and manufacturing sector. The value added of other firms is estimated using factor remunerations. The complete methodology can be found in Fernández (2023b)

According to this panorama, Ulyssea (2018) is a good model to understand informality in Colombia for four reasons: includes micro-business and larger companies simultaneously in the analysis, contemplates the two margins of informality, considers some firms and worker heterogeneity, and allows modifications to obtain a detailed institutional framework, as shown in the next section.

Figure 4. Intensive margin of informality

(a) Total **(b) New firms**



Source: Fernández (2023b).

4 A model to understand informality with institutional frictions

To show the importance of institutions in shaping informality, this article estimates Ulyssea (2018) for the case of Colombia. The idea of this model is that, based on an economic assessment, firms decide to comply or not with labor, tax regulations subject to waivers, and tax-free brackets.

This model assumes the same production function and prices (normalized to 1) for formal and informal firms, one factor of production (labor), and a single good. The concave production function for each sector is $y_s(\theta) = \theta l_s^{\alpha}$ with $\alpha < 1$ and $s = I, F$, where the subscript S refers to whether the workers are hired by a formal or informal firm. The model considers two levels of qualification (skilled (1) and unskilled (2)) aggregated through a CES function with shares of skilled workers η_i and η_f and an elasticity of substitution $\frac{1}{1-\rho}$. Therefore, $l_F = (\eta_i l_{F1}^{\rho} + (1-\eta_f) l_{F2}^{\rho})^{\frac{1}{\rho}}$.

In addition to regulation, informal firms face fixed and variable production costs, and an enforcement cost applied to the extensive margin that increases in size, and of the following form $T(l_I) = (1 + \frac{l_I}{b_I})$, where b_I is an exogenous parameter. Since informal firms are assumed to only hire informal workers, the earnings of informal firms (I) can be expressed as follows:

$$\max_{l_{i1}, l_{i2}} \pi = \theta l_I^{\alpha} - \left(1 + \frac{l_{I1}}{b_I}\right) w_1 l_{I1} - FC_I$$
$$s.t.\ l_I = (\eta_I l_{I1}^{\rho} + (1-\eta_I) l_{I2}^{\rho})^{\frac{1}{\rho}},\ l_I > 0,\ \alpha < 1,\ w_1 > w_2$$

On the other hand, formal firms F must pay income taxes (τ_y) charged over the value added net of formal costs and vat taxes charged on revenues (τ_{vat}). τ_y is equal to zero if income is lower than the income tax threshold (Y_y) and τ_{vat} is equal to zero if income is lower than the VAT threshold (Y_{vat}). Formal firms can hire formal workers, paying social security contributions (τ_w) and a minimum wage, if binding, on unskilled wages[10]; and / or informal workers, who are affected by enforcement costs, like those faced by informal firms $F(l_{Fs}) = (1 + \frac{l_{Fis}}{bs}),\ \ s = 1, 2.$

[10] According to Loayza, Ulyssea, and Utsumi (2018). Whether the minimum wage is binding or not can be written as $\max(wage_{unskilled}, w_{min})$ then $t_{wmin} = \frac{\max(wage_{unskilled}, w_{min})}{w_{min}}$.

Workers are assumed to perform the same activities within the formal firm, subject to their level of qualification. They are hired according to their relative costs, but there is a critical threshold $\tilde{l}$ above which only informal workers are hired. $\tilde{l}$ can be seen as an endowment of informal workers for all firms, even large formal ones[11]. Skilled workers are assumed to face a higher enforcement on skilled workers; therefore, the threshold for this type of labor is lower. This feature generates three types of formal firms: i) Firms that hire only informal workers ($l_{F1} < \tilde{l}_1$ & $l_{F2} < \tilde{l}_2$), ii) Firms that hire some formal skilled workers ($l_{F1} > \tilde{l}_1$ & $l_{F2} < \tilde{l}_2$) and iii) Firms that hire some formal skilled and unskilled workers ($l_{F1} > \tilde{l}_1$ & $l_{F2} > \tilde{l}_2$). The profits of formal firms (F) can be expressed as follows:

$$
\begin{aligned}
\pi_f =& \max_{l} \Big\{ (1-\tau_y-\tau_{vat})\theta l_F^{\alpha} - C(l) \Big\} \\
C(l) =& \Big(1+\frac{l_{Fi1}}{b_s}\Big) l_{Fi1} w_1 + \Big(1+\frac{l_{Fi2}}{b_s}\Big) l_{Fi2} w_2 + \lambda_1 (1+\tau_w)(1-\tau_y) l_{Ff1} \\
&+ \lambda_2 (1+\tau_w)(1-\tau_y)(1+\tau_{wmin}) l_{Ff2} \\
s.t.\ & l_F = (\eta_i l_{F1}^{\rho} + (1-\eta_f) l_{F2}^{\rho})^{\frac{1}{\rho}},\ l_F > 0,\ \alpha < 1, w_1 > w_2\ \&\ b_2 > b_1 > 0, \\
& l_{Ffs} = l_{Fs} - \tilde{l}_s\ s = 1,2,\ \lambda_s = 1\ \ if\ \ l_{Ffs} > \tilde{l}_s\ \ and\ \ 0\ \ otherwise, \\
& \tau_y = 0\ \ if\ \ \theta l_F^{\alpha} < Y_y,\ \tau_{vat} = 0\ \ if\ \ \theta l_F^{\alpha} < Y_{vat},\ \tau_{wmin} = \frac{\max(w_2, w_{min})}{w_{min}}.
\end{aligned}
$$

More clearly, the maximization problem according to size of the firm is the following:

1. Firms that hire only informal ($l_{F1} < \tilde{l}_1$ & $l_{F2} < \tilde{l}_2$)

$$
\begin{aligned}
\max_{l_{i1}, l_{i2}} \pi =& (1-\tau_y-\tau_{vat})\theta l_F^{\alpha} - \Big(1+\frac{l_{Ii1}}{b_1}\Big) w_1 l_{Ii1} + \Big(1+\frac{l_{Ii2}}{b_2}\Big) w_2 l_{Ii2} - FC_I \\
s.t.\ & l_I = (\eta_i l_{FI}^{\rho} + (1-\eta_f) l_{I2}^{\rho})^{\frac{1}{\rho}},\ l_I > 0,\ \alpha < 1, w_1 > w_2\ \&\ b_2 > b_1 > 0
\end{aligned}
$$

2. Firms that hire some formal skilled workers ($l_{F1} > \tilde{l}_1$ & $l_{F2} < \tilde{l}_2$)

$$
\begin{aligned}
\max_{l_{i1}, l_{i2}} \pi =& (1-\tau_y-\tau_{vat})\theta l_F^{\alpha} - \Big(1+\frac{\tilde{l}_1}{b_1}\Big) w_1 \tilde{l}_1 + \Big(1+\frac{l_{Fi2}}{b_2}\Big) w_2 l_{Fi2} - FC_F \\
&- (1+\tau_w)(1+\tau_y) w_1 l_{Ff1} \\
s.t.\ & l_F = (\eta_i l_{F1}^{\rho} + (1-\eta_f) l_{F2}^{\rho})^{\frac{1}{\rho}},\ l_F > 0,\ \alpha < 1, w_1 > w_2\ \&\ b_2 > b_1 > 0, \\
& l_{Ffs} = l_{Fs} - \tilde{l}_s,\ \ s = 1,2,\ tau_y = 0\ if\ \theta l_F^{\alpha} < Y_y,\ \tau_{vat} = 0\ if\ \theta l_F^{\alpha} < Y_{vat}, \\
& \tau_{wmin} = \frac{\max(w_2, w_{min})}{w_{min}}.
\end{aligned}
$$

3. Firms that hire some formal skilled and unskilled workers ($l_{F1} > \tilde{l}_1$ & $l_{F2} > \tilde{l}_2$)

$$
\begin{aligned}
\max_{l_{i1}, l_{i2}} \pi =& (1-\tau_y-\tau_{vat})\theta l_F^{\alpha} - \Big(1+\frac{\tilde{l}_1}{b_1}\Big) w_1 \tilde{l}_1 + \Big(1+\frac{\tilde{l}_2}{b_2}\Big) w_2 \tilde{l}_2 - FC_F \\
&- (1+\tau_w)(1+\tau_y)(w_1 l_{Ff1} + \max(w_2, w_{min}) l_{Ff2}) \\
s.t.\ & l_F = (\eta_i l_{F1}^{\rho} + (1-\eta_f) l_{F2}^{\rho})^{\frac{1}{\rho}},\ l_F > 0,\ \alpha < 1, w_1 > w_2\ \&\ b_2 > b_1 > 0, \\
& l_{Ffs} = l_{Fs} - \tilde{l}_s,\ \ s = 1,2,\ tau_y = 0\ if\ \theta l_F^{\alpha} < Y_y,\ \tau_{vat} = 0\ if\ \theta l_F^{\alpha} < Y_{vat}, \\
& \tau_{wmin} = \frac{\max(w_2, w_{min})}{w_{min}}.
\end{aligned}
$$

[11] A way to understand this, is the existence of some activities within the firm subject to be performed by independent workers, that pay social security on their own.

The informal worker thresholds ($\tilde{l}_s, \quad s = 1, 2$) can be derived by equalizing the marginal cost of hiring informally ($w_2 + \frac{2w_2 l_{F2}}{b_2}$) and formally $\{(1+\tau_w)(1+\tau_y)\max(w_2, w_{min})\}$. The threshold for unskilled workers can be derived as follows: $\tilde{l}_2 = \frac{(1+\tau_w)(1+\tau_y)b_2 \frac{w_2^*}{w_2}}{2}, \quad w_2^* = \max(w_2, 2_{min})$. Similarly, the threshold for skilled workers that do not face the minimum wage restriction can be written as: $\tilde{l}_1 = \frac{(1+\tau_w)(1-\tau_y)b_1}{2}$.

Each period, a potential number of M firms enters the market. These firms only observe a vague production function υ, which is a parameter that distorts true productivity. υ is identically distributed among all participants. This uncertainty is key, since it allows us to have formal and informal firms at the same level of productivity. To enter the formal sector, firms must pay a fixed cost, denominated in units of production, $E_f > E_i$. Once companies enter the market, they obtain their true productivity from the function $F(\theta/\upsilon)$, which remains constant once companies enter the market. There is a positive relationship between υ and θ. This ex ante uncertainty mechanism explains why formal and informal firms coexist in the same productivity ranges. If firms face unexpectedly low productivity, they exit the market before they start producing. Firms face the possibility of exiting the market κ_i or κ_f, depending on whether they are formal or informal. Since prices and productivity remain constant, the firm value function can be expressed as $V_s(\theta, w) = \max\left\{0, \frac{\pi_s(\theta,w)}{\kappa_s}\right\}, \quad s = I, F$ and the respective expected value as: $V_s^e(\theta, w) = \int V_s(\theta, w) dF(\frac{\theta}{\upsilon}), \quad s = I, F$.

5 Estimation of the model

To observe the impact of tax, labor, and social security institutions on the behavior of informality, the model detailed above was estimated for the case of Colombia with and without institutional constraints. Following Ulyssea (2018), the model was estimated using a two-stage minimum distance (SMD) estimator. This estimator uses the value of some structural parameters and the guess values of estimated parameters, wages for skilled and unskilled workers, productivity shocks, and the distribution functions of some key variables of the economy. Some moments of these distributions are compared with the same moments obtained from the distributions of the real data, and the estimated parameters are adjusted until the model converges[12]. Therefore, the initial and final values for the estimated parameters might diverge.

The estimation of the model involves gathering information of the structural parameters in the economy, as well as giving an accurate guess for the initial values of the estimated parameters, which is important given that the SMD is a procedure to find local rather than global minimums. The sources of the structural parameters and the initial values of the estimated parameters for the unconstrained and institutional-constrained models are detailed in Annex 1.

Table 4. Structural parameters used in the estimation

		Brazil	Mexico	Colombia unconstrained	Colombia constrained
w_1	Equilibrium wage of skilled informal workers	844	2.35	985	973
w_2	Equilibrium wage of unskilled informal workers	591			688
w_2	Equilibrium wage of unskilled workers			820	
τ_w	Payroll/Payroll Contributions	0.37	0.35	0.34	0.47
τ_y	Income taxes	0.29	0.00	0.14	0.29
V_0	Pareto parameter, ex ante productivity	7.00	7.08	7.30	7.30
κ_f	Exit probability of formal firms	0.13	0.08	0.16	0.16
γ_f	Cost of operating in the formal sector / unskilled wage	0.45	0.45		
γ_i	Cost of operating in the informal sector / unskilled wage			0.05	0.05
τ_{vat}	VAT tax (net of income tax deduction)				0.145
y_{ty}	Monthly threshold for paying income tax (40% deductions)				5597
y_{tvat}	Monthly threshold for paying VAT				9995

Sources: Ulyssea (2018), Alvarez and Ruane (2019) and those referred above in the text.

[12] To give robustness to the results, again following Ulyssea (2018) I simulated 300,000 observations and 20 databases

Table 4 summarizes the parameters used by Ulyssea (2018) and Alvarez and Ruane (2019) to analyze the cases of Brazil and Mexico; and the parameters resulting from the calibration in the case of Colombia. Table 5 shows the initial and final values of the estimated parameters in the Colombian case, and the final parameters of the Brazilian and Mexican parameters. There are five important differences in the final version of the Colombia case with respect to the values registered in other countries. First, the cost of enforcement is lower in the case of Colombia. As explained in the introduction, the weakness of Colombia's enforcement authorities is consistent with this results.

Another important difference from the case of Brazil is the higher ex post variance in productivity, which is consistent with the productivity of formal and informal firms having a greater overlap section in the case of Colombia (Fernández, 2023b); and the lower entry cost to the formal sector is probably related to Colombia which has periodic rather than upfront registration costs.

Table 5. Estimated parameters

		Brazil	Mexico	Colombia		
				Initial	Without constraints	With institutional constraints
b_f	Intensive margin cost, skilled workers	2.61	2.35	2.61	5.71	24.2
b_f	Intensive margin cost, unskilled workers	4.94		4.94	4.72	41.3
b_i	Cost of extensive margin	5.01	4.58	5.01	29.1	8.92
δ_i	Exit probability of informal firms	0.38	0.27	0.24	0.25	0.27
γ_i	Cost of operating in the informal sector / w2	0.25	0.19			
γ_f	Cost of operating in the formal sector / w2			0.33	0.36	0.36
x_i	Pareto shape parameter	3.08	1.57	2.99	3.01	2.44
E_f	Cost of entering the formal sector	4282	93193	3214	3077	2946
E_i	Cost of entering the informal sector	2023	8	457	799	765
α	Cobb Douglas function parameter	0.6	0.32	0.50	0.65	0.57
σ	Productivity variance ex post	0.24	0.27	0.24	0.33	0.54
ρ	CES elasticity parameter	0.29		0.29	0.37	0.30
η_I	Skilled worker CES share. Informal firms	0.48		0.59	0.58	0.63
η_F	Skilled worker CES share. Formal firms	0.59		0.88	0.77	0.78

Sources: Ulyssea (2018), Alvarez and Ruane (2019) and those referred above in the text.

6 Fitness of the model

Table 6 shows the moments of the distributions of the main variables estimated with the model and with the data, which serves as support for the calibration process. These moments were specifically selected for the Colombian case, and for this reason they are not compared with the Brazilian ones. As can be seen in the results, it replicates remarkably well all parameters, except for the case of business informality among large firms.

In addition to estimating the similarity of the models in terms of means, the distributions by size of some of the key variables were compared. Figure 5 shows the formal distribution of companies for Brazil and Colombia (constrained and unconstrained).

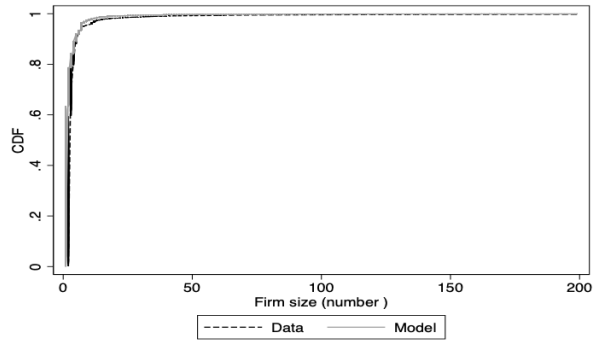
Table 6. Estimated moments (observed & simulated data)

	EEG and GEIH	Model with institutional constrains
Moment 1. Formal workers among dependents (GEIH, workers)	37%	37%
Moment 2. Informal workers among the unskilled (GEIH, workers)	61%	61%
Moment 3. Informal workers among the qualified (GEIH, workers)	28%	28%
Moment 4. Business informality rate	93%	96%
Moment 5. Business informality rate in firms with 1/3 dependents (2/4 workers)	97%	96%
Moment 6. Business informality rate in firms with 4/9 dependents (5/10 workers)	83%	86%
Moment 7. Business informality rate in firms with 10+ dependents (11+ workers)	22%	24%
Moment 8: Intensive margin in firms with 2/4 dependents (3/5 workers)	55%	55%
Moment 9: Intensive margin in firms with 5/19 dependents (6/20 workers)	24%	21%
Moment 10: Intensive margin in firms with 20+ dependents (21+ workers)	3%	4%
Moment 11: % of informal firms with 1/4 dependents (2/5 workers) in total informal firms	95%	95%
Moment 12: % of informal firms with 1/9 dependents (1/10 workers) in total informal firms	99%	99%
Moment 13: % of formal firms with 1/9 dependents (2/10 workers) in total formal firms	54%	51%
Moment 14: % of formal firms with 10/19 dependents (11/20 workers) in total formal firms	18%	18%
Moment 15: % of formal firms with 20/39 dependents (21/40 workers) in total formal firms	13%	14%
Moment 16: % of formal firms with 40+ dependents (41+ workers) in total formal firms	15%	18%

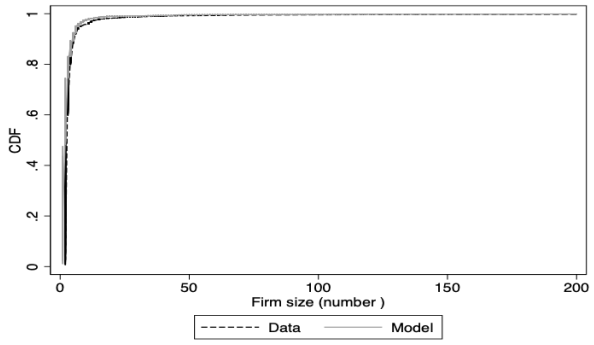
Sources: EEG and model estimates under the strict informality scenario.

Figure 5. Firm size distribution (Formal firms)

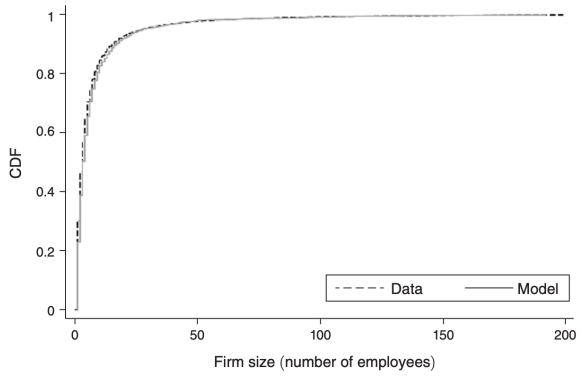
(a) Colombia unconstrained



(b) Colombia constrained



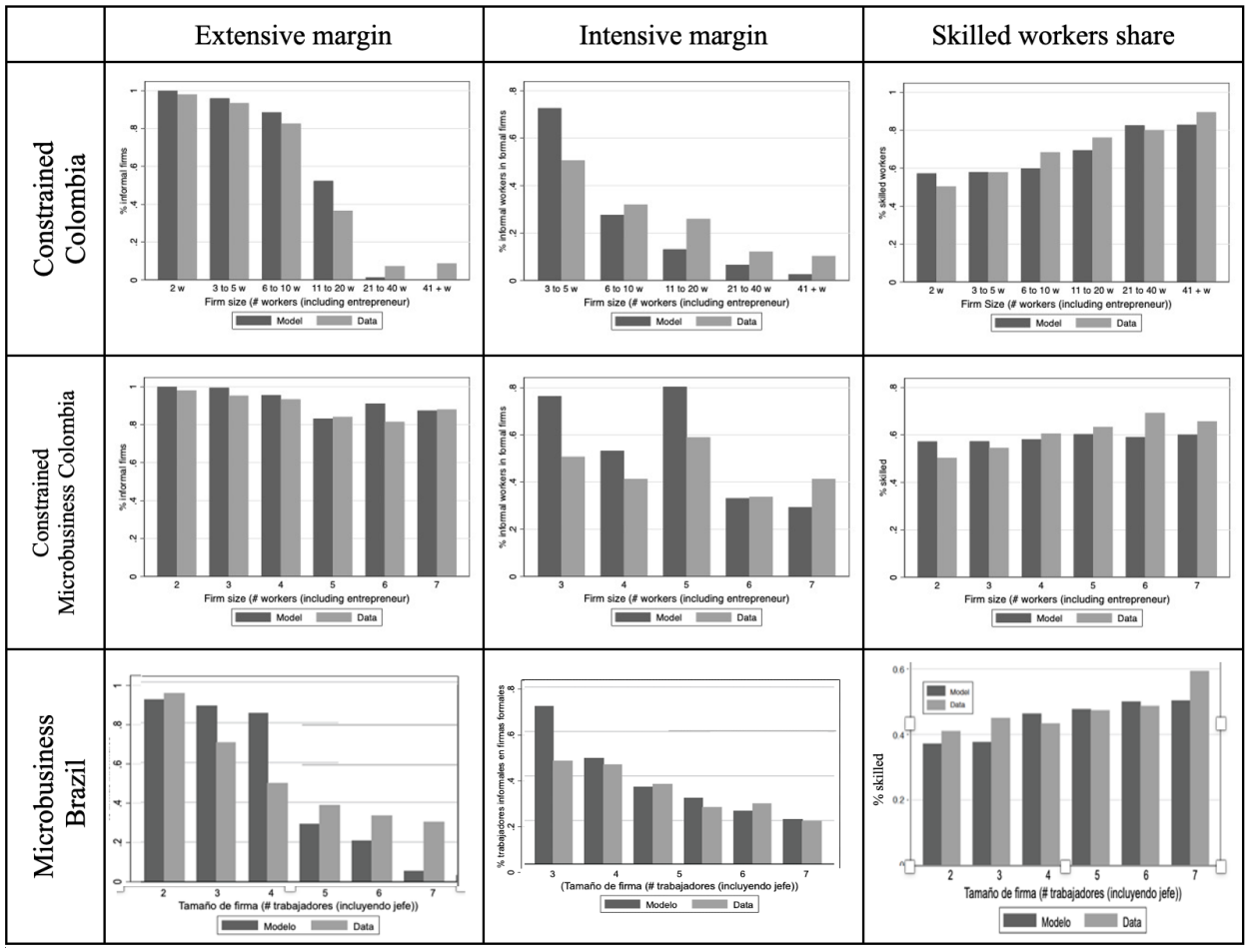
(c) Brazil



Source: Author's calculations EEG (2019), GEIH (2019) and Ulyssea (2018).

Figure 6 shows the extensive and intensive margin of informality and the share of skilled workers in formal and informal firms, for unconstrained Colombia, for constrained Colombia, constrained microbusiness (which is more comparable to Ulyssea (2018)) and Brazil. As shown in the figure, the prediction of the model fits the data very well, considering the erratic behavior of the indicator for firms between 5 and 10 workers.

Figure 6. Firm size distribution of extensive margin, intensive margin and share of skilled workers

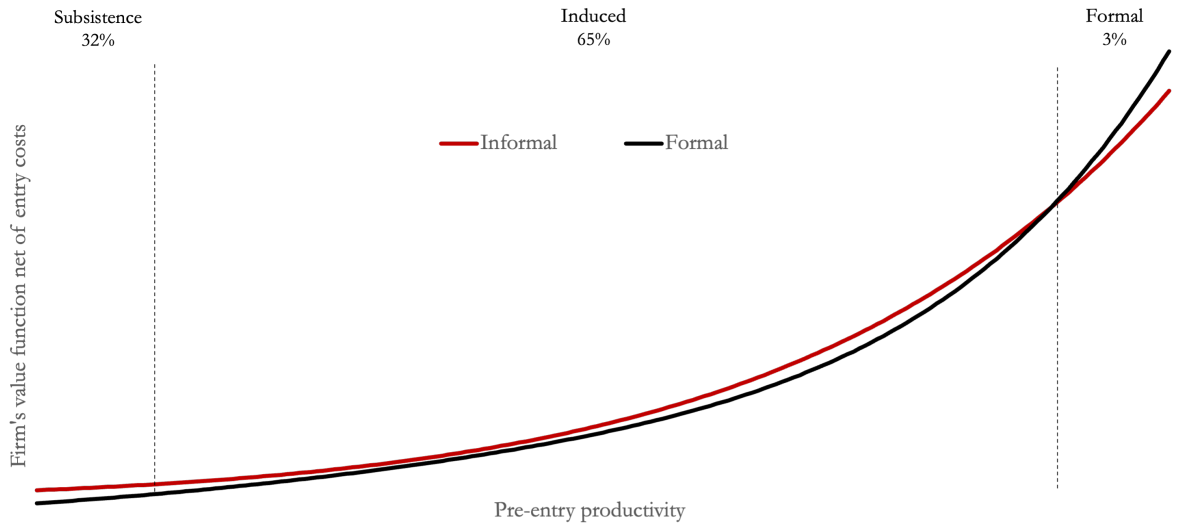


Source: Author's calculations EEG (2019), GEIH (2019) and Ulyssea (2018).

One of the most important features of this model is that it allows one to identify three types of firms: the Subsistence firms that are the ones that cannot operate formally; the Induced, which are those that could operate as formal but prefer to be informal because it is more profitable, and the Formal Firms. According to Figure 7, the Subsistence Informality is relatively small in Colombia, which makes sense since the fixed entrance cost of the formality is relatively small. Also, it is important to consider that unipersonal companies are excluded from this exercise. On the other hand, Induced firms represent quite a large portion of informality, and the informal and formal firm values are similar, implying that policies that change the relative variable cost of operating formally might be effective[13].

[13] Ulyssea (2018) proposed a much complex taxonomy which depends on a scenario in which entry barriers were eliminated. I prefer the one used here, not only because it is easier to implement but also because in the Colombian case the scenario without entry cost is affected by non-linearities and becomes difficult to use to formulate a taxonomy.

Figure 7. Taxonomy of informality

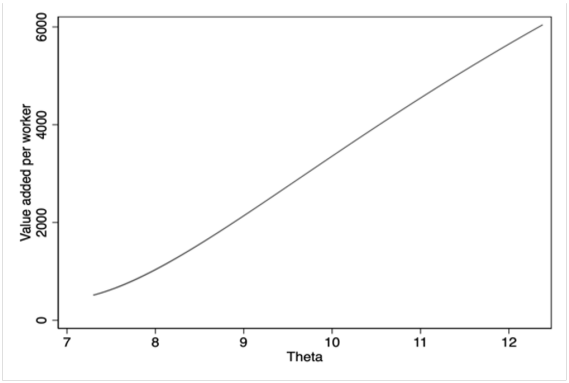


Source: Model simulations.

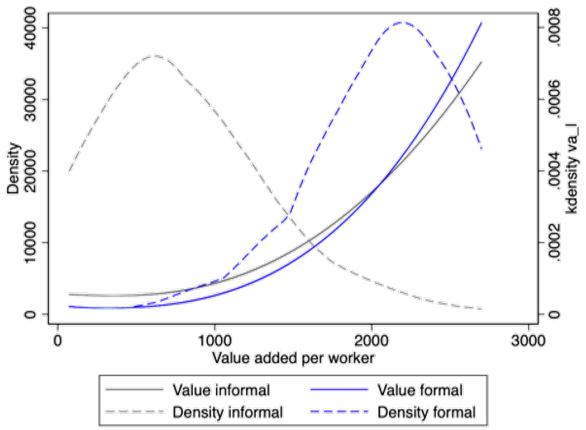
This taxonomy is interesting because it considers the heterogeneity of informality in Latin America and is very useful to understand the impact of different policies. However, one inconvenience is that θ is the parameter that allows one to identify the different types of informality. An alternative is to build a taxonomy based on the value added per worker. As shown in Figure 8a, there is a lineal relationship between this variable and θ, and it can be corroborated in Figure 8b that the taxonomy is similar to that based on θ. Figure 8b also shows that the density of formal and informal firms, along their size, responds to incentives to be formal and informal. This finding allows policy targeting to be more efficient. However, it is important to note that the intersection between the formal- and informal-sector curves occurs later in the value added than in the preproductivity taxonomy.

Figure 8. θ, value added per worker and a taxonomy based on the latter

(a) Theta and value added per worker (Simulated data)



(b) Taxonomy of informality (VA per worker vs. value function)



Source: Simulated data.

7 Comparative statics

To analyze the impact of policies on a set-up with a complex institutional arrangement as in the Colombian case, on top of the traditional policies to reduce informality, some tax scenarios were added. The objective of introducing these scenarios is not to suggest that tax policies should be implemented to reduce informality, but rather as informality being a side effect of these policies.

The exercises were divided into two groups: policies to reduce business informality and policies to reduce labor informality in formal firms, understanding that these two objectives can be strongly related. To observe changes clearly, the level of changes in parameters tried to resemble extreme cases, but in some exercises, this was not possible without generating a corner solution, and softer versions of the change were analyzed instead. The best example of this limitation is the reduction in payroll taxes that, as F. Jaramillo (2020) pointed out, should follow the following rule $\tau_w > \tau_y + \tau_{w^*}\tau_y$ to be able to find an internal solution of the model.

As in Ulyssea (2018), the impact of these policies was analyzed on the lifetime value of the firm net of entry costs, for each percentile of the productivity distributions (which is positively related to size) and for each of the following groups: i) "always formal": firms that are formal in the base case and in the counterfactual; ii) "always informal": firms that are informal in the base case and in the counterfactual; iii) "switchers": informal firms in the base case becoming formal in the counterfactual. The macroeconomic implications of the policies were also included in the analysis.

7.1 Policies on the extensive margin or business informality

Four policies were considered to reduce business informality: a 50% reduction in formal entry costs to a level that is almost equal to informal entry costs, 45% more enforcement of informality ($b_i = 1$) and the elimination of income and vat taxes ($\tau_y = 0$ and $\tau_{vat} = 0$). As shown in Figure 9, in the enforcement scenario, the value of "always informal" firms decreases because they reduce their size inefficiently to avoid being caught; and because it becomes more costly to operate informally, at the point that some firms decide to formalize ("switchers"). Although the most affected informal firms are the large ones, considering enforcement is increasing in size, most of the firms that decide to formalize are the smaller ones, because they are exempted from income tax, so it is relatively less expensive to become formal. Similarly, in the scenario of a reduction in formal entry costs, the 'switchers' tend to be small firms since their fixed costs are a larger share of total costs. The increase in the number of formal firms in both scenarios increases the skilled wage hurting "always formal" firms.

Regarding tax policies, the decrease in VAT and income tax is positive for formal firms and negative for informal firms because of competition in the labor market. It also led firms to formalize, particularly the larger ones, which are subject to pay taxes. The set of "switchers" that opt to formalize is more restricted in the VAT scenario, since the VAT threshold is higher.

This is consistent with the macro impacts of the policies illustrated in Table 7. In fact, these policies induce the entry of new companies, the formalization of others, and a consequent reduction in the informality of the business. As formal firms hire a higher proportion of skilled workers, the skilled wage increases. Meanwhile, the unskilled wage substantially decreases in the enforcement scenario, where informal firms get severely hurt; and marginally decreases in the entry cost scenario, because of general equilibrium means.

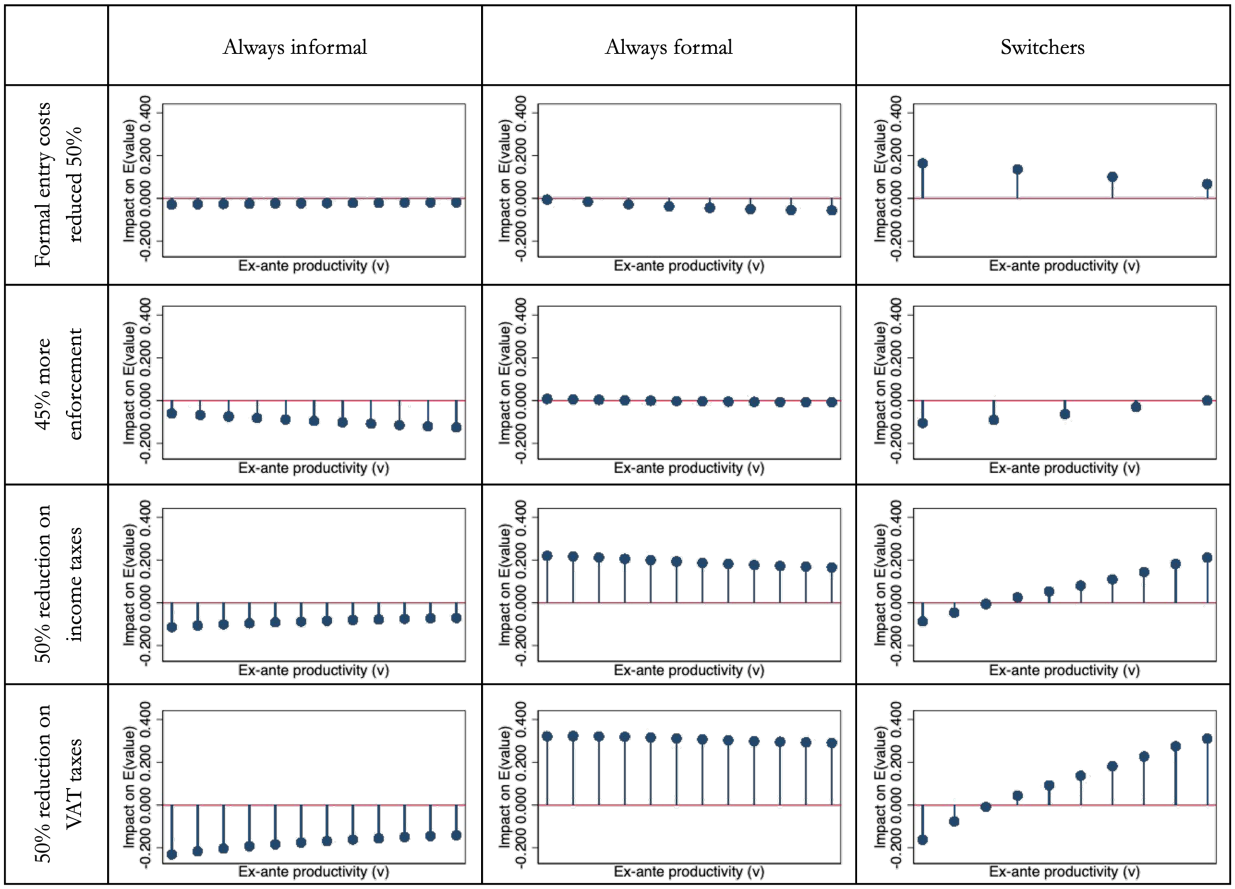
The reduction in entry costs scenario, where the firms that formalize are mostly small, causes the percentage of firms that hire informally to increase, augmenting the informality rate of skill workers. Meanwhile, in the enforcement and VAT scenario, a reduction on the informality rate of skilled workers is observed, because larger firms are the ones that hire formally. Interestingly, labor informality increases when the income tax is eliminated because the labor cost deduction disappears.

Taxes revenues are mostly driven by social security contributions, and consequently decrease in the scenarios with larger labor informality. Meanwhile, as the reduction of entrance costs is biased towards small firms, this scenario is characterized by a smaller reduction of the informal GDP and a lower output. Finally, whereas in the entry cost and enforcement scenarios welfare decreases along with the unskilled wage; the increase in welfare is impressive in the

tax scenarios, probably due to an unrealistic assumption of a perfectly efficient zero-cost government.

In sum, extensive margin policies are successful in reducing business informality. This would naturally reduce the informality of labor, as in the VAT scenario. However, if the firms that formalize are the smaller ones, as in the enforcement or the entry-cost scenario, labor informality remains unchanged and can even increase due to firms entering the market. In the income tax scenario, the informality of labor increases because the tax deduction disappears. One key question is the importance of formalizing firms if they do not pay taxes and do not hire workers formally.

Figure 9. Microeconomic impact of policies oriented to the extensive margin



Source: Simulated data.

Table 7. Macroeconomic impact of policies oriented to the extensive margin (policy/baseline, constrained model)

	Lower entry cost	Higher enforcement	Lower income tax	No VAT tax
Informal firms	0.62	0.94	0.76	0.74
Informal GDP	0.62	0.77	0.55	0.48
Informal workers	1.08	0.87	1.17	1.07
Skilled informal workers	1.12	0.79	1.24	1.14
Unskilled informal workers	1.03	0.98	1.08	0.97
Skilled premium	1.11	1.15	1.08	1.07
Skilled wage	1.06	1.01	1.12	1.23
Unskilled wage	0.96	0.88	1.04	1.14
Mass of firms	1.13	1.03	1.09	1.08
Output	1.01	1.06	1.03	1.04
Tax revenues	0.96	1.08	0.90	0.96

Sources: Simulated data.

7.2 Policies on the intensive margin or labor informality in formal firms

Figure 10 shows the impact of decreasing payroll taxes in 4.5 pp, double the enforcement on informal hiring by formal firms ($b_1 = 2$ and $b_2 = 0.5$), and an elimination of the income tax waiver on small firms (threshold for income taxes = 0), which, as shown before, generates a tax deduction on payroll taxes for small firms.

As shown in the Introduction, payroll costs are higher for small firms that do not take advantage of the tax deduction; but these firms do not hire many workers formally. Therefore, the reduction of payroll taxes is mostly beneficial to productive "always formal" firms, which are large formal workers employers, increasing labor demand, wages, and hurting informal firms, by general equilibrium means.

In contrast, the increase in enforcement hurts small "always formal" firms that hire more workers without a formal contract. This lowers unskilled wages and benefits large "always formal" and "always informal" firms. The impact of eliminating the tax waiver on small firms is very similar to the impact of reducing payroll taxes, but large "always formal" firms get relatively more benefits, and small "always formal" firms end up being hurt.

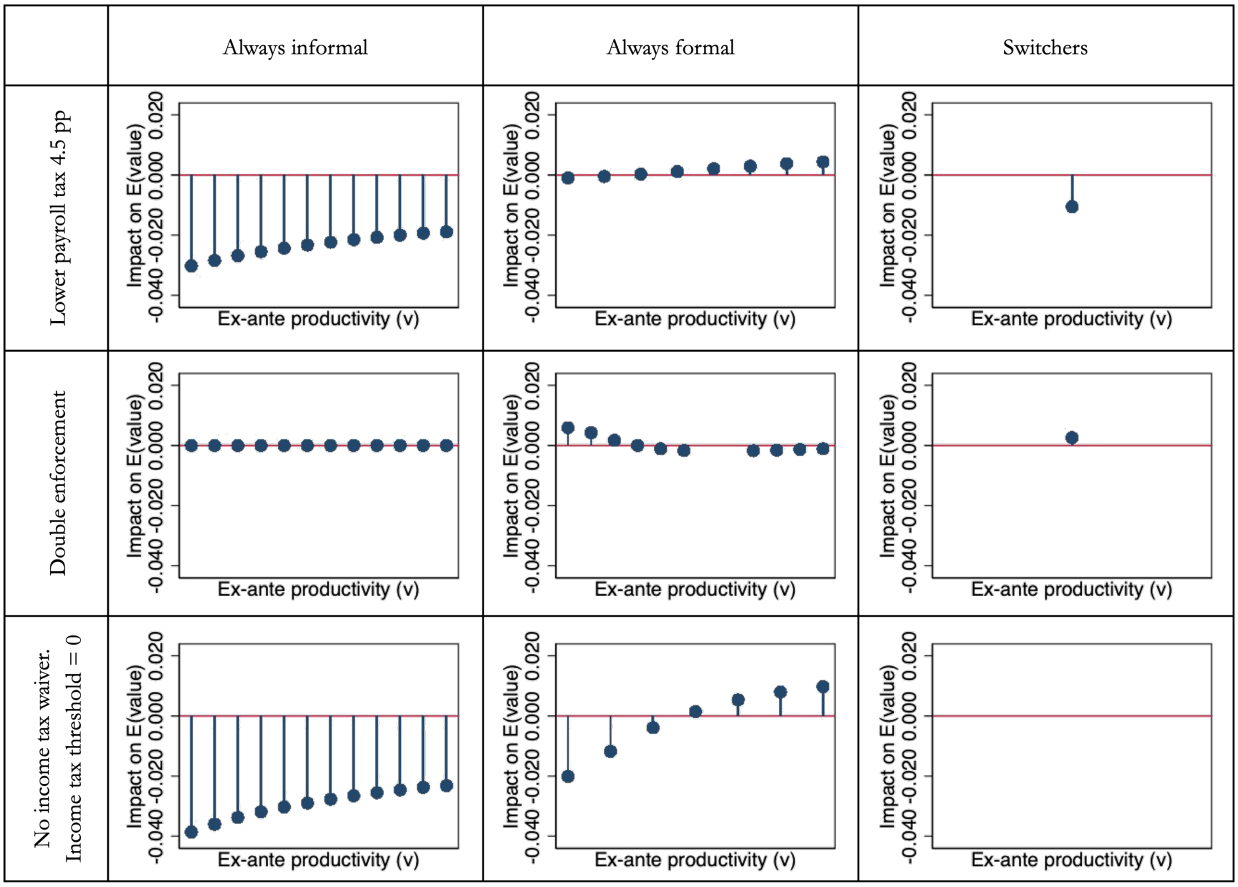
Consistently, Table 8 illustrates that intensive margin policies reduce labor informality to some extent. However, the impact varies according to the policies. In the reduction of payroll taxes, labor informality gets lower among skilled workers, since larger firms are the ones that get more benefits, whereas in the elimination of income tax deduction scenario, labor informality gets lower among unskilled workers. Consequently, skilled wages increase relatively more in the payroll scenario, whereas unskilled wages increase relatively more in the income tax scenario. Enforcement in the intensive margin scenario has a lower impact on labor informality (-1pp), since the formalization effect is controlled by the fact that it becomes more profitable for new firms to operate fully informal than to operate formally and face a high enforcement on the hiring process.

Similarly, as the payroll policy is more favorable for larger firms, production increases more than in other scenarios. From a fiscal point of view, as expected, the reduction on payroll taxes reduces tax revenues and the elimination of the tax waiver increases them. Welfare moves accordingly to changes in taxes.

Reducing the tax waiver in small firms and adopting a flat profit tax, or simply enforcing firms to register as a business, can be an effective way to reduce labor informality, because it solves the asymmetry of tax deductions. However this policy is difficult to implement because of social, political and enforcing reasons.

In sum, labor informality policies have a consistent but limited impact on labor informality and few impacts on business informality. However, it is important to consider that strong enforcement on the intensive margin can make it more profitable for small firms to become informal 100%. Another drawback of policies oriented to reduce labor informality is the fiscal cost. This result is in line with the evaluations of the 2012 reduction of payroll taxes in Colombia.

Figure 10. Microeconomic impact of policies oriented to the intensive margin



Source: Simulated data.

Table 8. Macroeconomic impact of policies oriented to the intensive margin (policy/baseline, constrained model)

	Lower payroll tax	Higher labor enforcement	No income tax waiver
Informal firms	1.00	1.00	1.00
Informal GDP	0.95	0.99	0.97
Informal workers	0.93	0.98	0.94
Skilled informal workers	0.93	0.98	0.99
Unskilled informal workers	0.93	0.97	0.88
Skilled premium	1.01	1.00	0.93
Skilled wage	1.03	1.00	1.00
Unskilled wage	1.02	1.00	1.08
Mass of firms	1.00	1.00	1.00
Output	1.02	1.01	1.02
Tax revenues	1.02	1.01	1.00

Sources: Simulated data.

8 Final remarks

The recent Colombian Employment Mission (Levy & Maldonado, 2021) recommended an integral reform of the regulatory system to reduce unemployment; and warned against partial equilibrium solutions to the employment

problem, which can generate wrong incentives and unwanted results. This paper presents a clear example of this situation. The waiver of income tax for small firms is an adequate policy to reduce informality in small firms, and the formal cost deductions from the income tax is an effective, thought barely analyzed policy, to reduce business informality. However, the combination of both policies with nonlinear parameters ends up generating a large share of small firms hiring workers informally, and therefore with low possibilities of hiring skilled workers, which is essential to enhance productivity.

A possible solution to this problem is to generate vouchers of social security payments, accountable for firms below the income tax threshold that hire workers through a formal contract, that can be used once the firm gets bigger. This recommendation, in addition to generating incentives to formalize, generates incentives to grow. Other policies to address this problem include a single-tax scheme that includes social security or at least one in which taxes are estimated after deducting formal labor costs. More aggressive policies as a new social security scheme or a flat income tax can also be analyzed.

This paper also makes evident that the reduction of labor informality does not have an easy way out, and this explains many decades of unsuccessful efforts to reduce the problem. Consistent with the evaluations of the 2012 reduction on payroll taxes in Colombia, the estimated model shows that the reduction in payroll taxes, amidst a complicated regulatory environment, has a moderate impact on informality and ties the fiscal accounts. The model simulations also show that tighter enforcement on the intensive margin could push formal firms towards informality, where all workers are hired informally, but the enforcement tends to be softer. Policies on an extensive margin are more effective, but do not necessarily increase labor formality. In fact, if policies are oriented towards small firms, the informality of labor might remain unchanged because small formal firms hire as many informal workers as an informal firm. This leads to the question of the importance of formalizing small businesses if formal small firms do not pay taxes and do not hire with a formal contract.

In sum, there is not a single policy that can magically reduce informality by itself. A combination of different policies focused on different types of informality and trying to avoid non-linealities and having in mind general equilibrium effects might be a better approach to solve the problem in the future.

This article makes an important contribution to understanding the interaction between informality of business and informality of labor in Colombia. However, is important to complete the informality panorama in Colombia with the self-employment analysis, which is one of the highest in Latin America.

References

Acosta-Henao, M. (2020). *Law Enforcement and the Size of the Informal Sector.* Retrieved from https://ssrn.com/abstract=3588010 (Draft Paper)

Alaimo, V., Bosch, M., Kaplan, D. S., Pagés, C., & Ripani, L. (2015). *Empleos para Crecer*. Washington, D.C.: Inter-American Development Bank.

Almeida, R., & Carneiro, P. (2012). Enforcement of Labor Regulation and Informality. *American Economic Journal: Applied Economics*, *4*(3), 64–89.

Alvarez, J., & Ruane, M. C. (2019). *Informality and Aggregate Productivity: The Case of Mexico*. International Monetary Fund.

Amarante, V., & Perazzo, I. (2013). Trabajo por Cuenta Propia y Monotributo en el Uruguay. *Revista internacional del trabajo*, *132*(3-4), 623–641.

Antón, A., & Rasteletti, A. (2018). *Imposición al Trabajo en Contextos de Alta Informalidad Laboral: Un Marco Teórico para la Simulación de Reformas Tributarias y de Seguridad Social* (Documento para Discusión No. 646). Washington, D.C.: Inter-American Development Bank.

Chacaltana, J. (2016). Peru, 2002-2012: Growth, Structural Change and Formalization. *Revista CEPAL*.

De Soto, H. (1989). *The Other Path: The Economic Answer to Terrorism*. New York, NY: Harper & Row.

De Soto, H. (2000). *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else*. Basic Books.

Dix-Carneiro, R., Goldberg, P. K., Meghir, C., & Ulyssea, G. (2021). *Trade and Informality in the Presence of Labor Market Frictions and Regulations* (Working Paper No. 28391). Cambridge, MA: National Bureau of Economic

Research.
Fairris, D., & Jonasson, E. (2016, February). *Determinants of Changing Informal Employment in Brazil, 2000–2010* (MPRA Paper No. 71475). Munich, Germany: University Library of Munich, Germany.
Fajnzylber, P., Maloney, W. F., & Montes-Rojas, G. V. (2011). Does formality improve micro-firm performance? evidence from the brazilian simples program. *Journal of Development Economics*, *94*(2), 262–276.
Fernández, C., Villar, L., & Gómez, N. (2017). Taxonomía de la Informalidad en América Latina. *Coyuntura Económica*, *47*(1 y 2), 137-167.
Fernández, C. (2023a). *Informality, Productivity & Inequality: An Analysis from the Point of View of Firms and Workers.* (PNUD)
Fernández, C. (2023b). MSMEs and informality: A new employer-employee database for Colombia. *Forthcomming*.
Fernández, C., & Villar, L. (2016). *The Impact of Lowering the Payroll Tax on Informality in Colombia* (Working Paper No. 015212). Bogotá, Colombia: Fedesarrollo.
'Haanwinckel, D., & Soares, R. R. (2021). 'workforce composition, productivity, and labour regulations in a compensating differentials theory of informality'. *The Review of Economic Studies*, *88*(6), 2970-3010.
Hamann-Salcedo, F. A., & Mejía, L. F. (2013). *Formalizando la Informalidad Empresarial en Colombia* (Vol. Capítulo 10. Pág.:399-427). Banco de la República de Colombia.
Harris, J. R., & Todaro, M. P. (1970). Migration, Unemployment and Development: A Two-Sector Analysis. *American Economic Review*, *60*(1), 126.
Jaramillo, F. (2020). *Informalidad – Margen Intensivo. Mimeo, note=Universidad del Rosario.*
Jaramillo, M. (2013). *Employment Growth and Segmentation in Peru, 2001-2011: Country Case Study on Labour Market Segmentation* (Employment Working Paper No. 151). Geneva, Switzerland: International Labour Organization.
Jenkins, S. P., & Kerm, P. V. (2007). *PARETOFIT: Stata module to fit a Type 1 Pareto distribution.* Statistical Software Components, Boston College Department of Economics.
Kugler, A. D., Kugler, M. D., & Herrera-Prada, L. O. (2017). Do Payroll Tax Breaks Stimulate Formality? Evidence from Colombia's Reform. *Economía*, *18*(1), 3–40.
Levy, S., & Maldonado, D. (2021). *Misión del Empleo. Reporte Resumen.*
Lewis, W. A. (1954). Economic Development with Unlimited Supplies of Labour. *The Manchester School*, *22*(2), 139-191.
Loayza, N. V. (2016). Informality in the Process of Development and Growth. *The World Economy*, *39*(12), 1856–1916.
Loayza, N. V., Ulyssea, G., & Utsumi, T. (2018). Informality and the Labor Market Effects of Mass Migration: Theory and Evidence from Syrian Refugees in Turkey. In *7th turkey labor market network meeting* (Vol. 9, p. 2020).
Maloney, W. F. (2004). Informality Revisited. *World Development*, *32*(7), 1159–1178.
Medina, C., & Posso, C. (2010). *Technical Change and Polarization of the Labor Market: Evidence for Brazil, Colombia and Mexico* (Borradores de Economía No. 614). Bogotá, Colombia: Banco de la República.
Mejía, D., & Posada, C. E. (2007). *Informalidad: Teoría e Implicaciones de Política* (Borradores de Economía No. 455). Bogotá, Colombia: Banco de la República.
Melitz, M. J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, *71*(6), 1695–1725.
Paturot, D., Mellbye, K., & Brys, B. (2013). *Average Personal Income Tax Rate and Tax Wedge Progression in OECD Countries* (OECD Taxation Working Papers No. 15). Paris, France: OECD Publishing.
Perry, G. E., Maloney, W. F., Arias, O. S., Fajnzylber, P., Mason, A. D., & Saavedra-Chanduvi, J. (2007). *Informality : Exit and Exclusion* (No. 6730). The World Bank Group.
Ulyssea, G. (2018). Firms, Informality, and Development: Theory and Evidence from Brazil. *American Economic Review*, *108*(8), 2015–2047.

9 Sources of structural parameters and first guesses of estimated parameters

Equilibrium wages for skilled and unskilled workers: To estimate wages that are not affected by the composition of the labor force or the sector composition in the GEIH, a logarithmic regression of the wage was estimated with an adjusted variable for highly qualified workers and other control variables of the business and worker. To further minimize measurement error, the sample is restricted to employees who are between 18 and 69 years old and who have worked at least 20 hours in the reference week, but at most 84 hours (which is the 99th percentile). The lower limit of 20 hours is intended to exclude interns who are still in school and workers with very little connection to the labor market. The estimated regression is used to calculate the adjusted wage for high-skilled workers (COP$973,097), unskilled workers (COP$821,430) and unskilled informal workers (COP 688,978).

Function parameters of the distributions: The production function follows a Cobb-Douglas distribution, the firm distribution follows a Pareto distribution, and the mix of skilled and unskilled labor, a CES distribution. Medina and Posso (2010) estimated the substitution elasticity for unskilled / skilled labor in Colombia at $\sigma = 1.47$ and $\sigma = 1.31$, if controlling for unemployment and minimum wage. This implies CES parameters of $\rho = 0.32$, $\rho = 0.24$, respectively, given $\sigma = 1/(1-\rho)$. Simple shares of skill workers in formal and informal firms (0.713 and 0.451, respectively) were used as initial values to estimate the CES shares. Workers with secondary education are considered skilled workers. The structural parameter of the Pareto location is calibrated at 7.3; and the initial shape parameter is 3, according to the fitting of the data for a firm of minimum size of 2, according to Jenkins and Kerm (2007). The initial parameter used for the Cobb-Douglas coefficient was $\alpha = 0.4952$, according to the Penn World tables.

Exit probability of formal and informal firms: The Colombian Central Bank estimates the exit rate of formal firms at 19%, using administrative data, which is the parameter that we use in the estimates for the case of formal firms. For informal firms, I calculated the parameter at 24.8% (respectively) as the monthly average of the change in the number of entrepreneurs in the GEIH (as a proxy for the change in the number of firms), discounting the number of entrepreneurs who have been in business for less than 12 months for the period 2019/2018. It is important to bear in mind that in any case, these parameters not only contain the effect of entry and exit of the firm but also involve the effect of transitions between formality and informality.

Taxes and contributions: The income tax (τ_y) was estimated as the relationship between companies' taxes and gross profits (income minus direct or material inputs), according to the Colombian Corporate Supervisory Authority database. The resulting income tax is 28.8%. The VAT tax (τ_{vat}) used is the statutory rate (19%) net of income tax deductions (14.5%). The effective payroll tax rate is estimated using the statutory rates on wages observed in the GEIH for 2019 of formal workers in firms with 2 or more workers and includes: transportation subsidy, severance, interest on severance, additional annual wages (prima), vacations, employer's health, social security and 'Caja de compensacion,' ICBF and SENA contributions (when applicable), and occupational risk insurance. The total contribution amounts to 47.2%. The income tax threshold is established as the monthly equivalent of an annual income of COP 46 million (assuming no deductions[14]), and the threshold of the τ_{vat} at COP$100 millions, assuming no deductions.

Cost of entry or minimum scale required to participate in the formal and informal sector, denominated in units of production. This cost is estimated as the total monthly costs, other than materials, of a new firm (less than 1 year) with 2 workers (minimum size), including an entrepreneur (minimum size) at COP$1'760,000 and COP$378,000 for formal and informal firms, respectively.

Annual fix cost: Assuming that property costs are flexible, the annual fix cost is limited to the formalization cost, which is 0.34% as a percentage of unskilled wage for formal firms and close to 0.4% for informal firms (EMICRON, 2019). The estimation of the model for the Colombian case sets the informal costs as a structural parameter and the formal cost as the flexible, because the estimate for informal firms is more reliable and to avoid negative solutions, without setting additional restrictions.

[14]This is an upper limit for the threshold. However, given that to obtain a deduction firms should use an " electronic bill", use electronic transactions, and prove that contractors pay their own social security, it is reasonable to assume this upper limit in the model.

Other initial parameters: Other initial parameters such as the enforcement parameters and the variance of the pre-productivity shocks, and structural parameters such as the mean productivity shocks used Ulyssea (2018) values. Also, individual company productivity is estimated using a grid θ that affects income. This grid was created to save computational time and a non-binding high range was used so as not to limit the results. Additionally, a vector of transition probabilities is created for each point on the grid to calculate the expected post-entry values in each sector for each possible participant.