Borradores de ECONOMÍA

Informality, Saving and Wealth Inequality[*]

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Abstract

The informal sector is an extensive phenomenon in developing countries. While some of its implications have drawn considerable attention in the literature, one relatively unexplored aspect has to do with the saving patterns of workers and firms and how these might influence aggregate savings and wealth inequality. In this paper, we aim to fill that gap by examining both entrepreneurs' and workers' choices regarding whether to perform informally and regarding asset accumulation. Specifically, we build an occupational choice model wherein saving is primarily motivated by precautionary considerations. The model features labor and capital market segmentation, and is calibrated to replicate the saving rates, wealth inequality and composition of occupations across the formal and informal sectors of Colombia. Computational experiments further allow us to analyze the effects of highly debated formalization policies on wealth redistribution and promotion of saving and entrepreneurship. Alternative frameworks are finally considered.

Keywords: informality, wealth inequality, saving, occupational choice models
JEL codes: E21, E26, O17

1 Introduction

Many countries experience both firm and labor informality as prominent realities. Firms operating in the informal sector usually do not pay taxes and social security contributions, nor do they comply with state regulations. Moreover, some of these firms are not even registered, and workers do not pay income taxes on their wage income. This is an extensive phenomenon worldwide, but especially in developing economies. Indeed, Schneider, Buehn, and Montenegro (2010) report average sizes of over 40% of GDP for Sub-Saharan Africa and Latin America and the Caribbean, which contrast with rates of about 17% in high-income OECD countries.

Informality has implications for fiscal sustainability, for total factor productivity and growth, and ultimately for macroeconomic outcomes. While some of these implications have occupied a fair amount of attention in the literature, one relatively unexplored aspect has to do with the saving patterns of workers and firms in the informal sector and how these might influence a country's overall savings and wealth distribution. This paper aims to contribute in this regard by examining both entrepreneurs' and workers' choices regarding sector of operation and asset accumulation, as well as their potential impact on aggregate savings and wealth inequality.

To this end, we build a dynamic general equilibrium model wherein heterogeneous agents choose whether to perform their activities formally or informally. These decisions are the result of analyzing the costs and benefits associated to such occupational choices and take account of several policy instruments (taxes, minimum wage, firms' creation costs) and access to external finance. In the model, there are imperfections in both labor and capital markets that translate into segmentation, meaning that some individuals are excluded from the advantages of formality. Such imperfections, particularly those pertaining to credit markets, in turn result in agents' inability to insure against idiosyncratic uncertainty, thus inducing them to save for precautionary reasons.

The model is calibrated to replicate the saving rates and the distributions of wealth and occupations in Colombia, a country with extensive informality at the firm level and in the labor market. This procedure allows assessing the impact of several formalization policies on the patterns of asset accumulation and the extent of informality in this developing country. That way, we provide support for highly debated policy measures like payroll tax cuts and reform of the prevailing minimum wage scheme, as they are potentially redistributive and contribute to promoting saving and entrepreneurship. Moreover, programs aiming at reducing entry costs and enhancing productivity in the

formal sector, such as education and better rule of law, might be similarly beneficial.

The paper is organized as follows. Section 2 reviews the related literature. The main aspects of the model economy are described in Section 3, whereas some empirical regularities pertaining to informality and saving in Colombia and an assessment of the quantitative performance of the model are left to Sections 4 and 5. In Section 6, we examine how the informal sector and asset accumulation behave in the face of changes in the policy parameters mentioned above. A somewhat similar approach is undertaken in Section 7, where we analyze the implications of some assumptions and alternative settings. Section 8 concludes.

2   Related literature

Few efforts have been made to rationalize saving behavior as related to informality. Most of the available approaches to saving revolve around the life cycle model of consumption (for a survey, see Attanasio & Weber, 2010). Furthermore, the poor have taken center stage in recent years with some studies examining the strategies and instruments they use to cope with idiosyncratic risk and financial constraints (Karlan, Lakshmi Ratan, & Zinman, 2014; Collins, Murdoch, Rutherford, & Ruthven, 2009; Banerjee & Duflo, 2007). Yet the literature has barely addressed the saving patterns of individuals performing economic activities in the informal sector, let alone a distinction between labor and entrepreneurial saving behavior.

Several studies document the existence of capital market segmentation between the formal and the informal sectors. This characteristic feature has often been associated with imperfect information, limited enforceability and other frictions that translate into exclusion from formal financial markets and heavy reliance on informal intermediation mechanisms (Batini, Levine, Kim, & Lotti, 2010). In this regard, Gatti and Honorati (2008) and Dabla-Norris and Koeda (2008) find evidence that informality is significantly and robustly associated with lower access to formal credit, with a higher dependence on informal sources of financing, and with firms' propensity to report availability of finance as an obstacle to their operations. Such findings are certainly in line with Catão, Pagés, and Rosales (2009), who show that financial deepening fosters overall formalization especially in those sectors that rely more on external funds.

While capital markets are segmented between the formal and the informal sector, there is no unambiguous evidence regarding labor market segmentation in developing

countries (Batini et al., 2010; Pratap & Quintin, 2008). Empirical studies generally indicate that formal wages are higher than informal ones, but this average earnings differential might reflect that formal workers tend to be more educated and experienced than their informally employed counterparts. Many of these studies claim that a formal sector premium remains after controlling for observable employer and employee characteristics; however, Pratap and Quintin (2006) show that standard segmentation tests are weak and produce results that are sensitive to the choice of econometric techniques. This paper and those of Magnac (1991) and Maloney (1999) overall conclude that compelling evidence that labor markets are dualistic has yet to be produced.

In spite of the relatively abundant literature characterizing informal activities and markets, few theoretical efforts have addressed the mentioned features in a somewhat comprehensive manner. Most of the existing endeavors are focused on replicating specific characteristics of either workers or firms in the informal sector (e.g., labor market segmentation, the missing middle), with no explicit attempts at integrating financial exclusion and other dimensions inherent to informality. This highlights, as Batini et al. (2010) argue, the need for dynamic general equilibrium approaches for a full understanding of the costs, benefits and policy implications of informal activities.

With the aim to fill this gap, the setting developed herein expands Hamann and Mejía's (2013) model of firm informality to account for workers' decisions regarding labor supply and asset accumulation in a general equilibrium framework. In the model, individuals choose either to become entrepreneurs or work for a wage formally or informally based on the analysis of the costs and benefits associated with such occupational choices. Formality specifically entails compliance with taxes and regulations, including a minimum wage policy and firm creation fees, whereas informal agents can only access outside financing at a higher interest rate. Given this environment, saving behavior is primarily driven by precautionary motives.

To our knowledge, this is the first study analyzing the patterns of saving and asset accumulation in the informal sector from both an empirical and a theoretical perspective. Pratap and Quintin (2008) document that informal economic activities tend to be self-financed, yet estimates of the size of assets in this sector are rare and imprecise. As for theoretical approaches, Galiani and Weinschelbaum (2012) develop an occupational choice model in which heterogeneous firms and workers choose optimally whether to operate formally or informally. Their model, however, yields no labor market segmentation. Such a result is rather an assumption in De Paula and Scheinkman (2011), where informal firms additionally face a higher cost of capital and enforcement-induced

limitations on scale. Likewise, Amaral and Quintin (2006) generate differences in access to finance by assuming that contracts are easier to enforce in the formal sector. All these papers consider labor informality and feature scale dualism at the firm level, but do not address how the existence of informal activities influences the distribution of wealth across sectors and agents.

Furthermore, this paper is related to a number of recent studies that quantitatively examine the impact of capital market imperfections and costs of creating and operating formal sector firms on economic development. D'Erasmo and Moscoso Boedo (2012), in this regard, propose a general equilibrium model of firm dynamics predicting that countries with low degrees of debt enforcement and high costs of formality are characterized by low allocative efficiency and a large share of output produced by low-productivity informal firms. Somewhat similarly, Antunes and Cavalcanti (2007) construct a general equilibrium model with three occupational choices (worker, formal entrepreneur or informal entrepreneur) and inequality in wealth and entrepreneurial ideas to assess how much of the cross-country variation in the size of the informal sector and per capita income can be attributed to entry barriers and limited enforcement of financial contracts. They find, among other results, that contract enforcement and regulation costs interact in non-linear ways and cannot account for much of the output differences across countries.

While these models allow for endogenous firm-level informality, other studies in the misallocation literature resort to slightly similar frameworks such as dual productive structures and introduce capital market imperfections in the form of constraints on the amount of debt and/or equity producers can issue (see Buera, Kaboski, & Shin, 2011; Midrigan & Xu, 2010, 2014). The study of Midrigan and Xu (2010) is particularly noteworthy in this regard, since their benchmark economy enables interpretation of the smaller total factor productivity losses predicted for Colombia in spite of its very low external finance to GDP ratio as reflecting a strong precautionary saving motive that induces productive establishments to quickly accumulate internal funds. Though the present paper does not tackle the role of financial frictions in total factor productivity, it contributes to gaining insight about the implications of informal activities for capital accumulation, and to a thorough assessment of the effects of formalization policies in developing countries.

3 The model

We propose a model of occupational choice featuring taxation, entry costs, and labor and capital market segmentation. The economy consists of two sectors: a formal sector encompassing everything produced strictly following all the regulations in place, and an informal sector comprising production unreported to the tax authorities or conducted with workers that are not hired under a regular contract. In this context, individuals choose either to operate a business or to work for a wage each period. Hence they are heterogeneous with respect to their productivity, their occupation, and their wealth. The economy is small and open and financial markets are incomplete, but individuals use a risk-free asset to insure against idiosyncratic uncertainty. Time is discrete and measured in years.

3.1 Heterogeneity and demographics

The economy is populated by a continuum of infinitely-lived individuals. In each period, they choose whether to work for a wage or to operate a business in one of the two sectors. Their choices are based on the comparative advantages associated with each occupational status—formal entrepreneur, informal entrepreneur, formal worker, informal worker—as described below.

Individuals are heterogeneous with respect to their productivity z, their occupation o, and their wealth a. While the latter two are chosen endogenously by forward-looking decisions, the former is an exogenous stochastic process that takes three possible states $z \in \{z_L, z_M, z_H\}$ (denoting low, medium and high) and evolves over time according to the Markov transition probabilities $p(z', z) = \Pr(z_{t+1}|z_t)$. Depending on an individual's occupation, z can be regarded as entrepreneurial ability or units of labor efficiency.

At the beginning of each period, individuals are either entrepreneurs or workers in either the formal or informal sector,

$o \in \mathcal{O} = \{\text{formal entrepreneur, informal entrepreneur, formal worker, informal worker}\},$

and hold some level of a risk-free asset, denoted by $a \in \mathcal{A} = \{a_0 < a_1 < \cdots < a_{n_a}\}$ such that $a_0 \geq 0$.

3.2 Preferences

Individuals discount their future utility using the discount factor $\beta \in (0, 1)$. Their problem is to maximize lifetime utility as described by

$$U = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t),$$

where per-period utility exhibits constant relative risk aversion:

$$u(c_t) = \frac{c_t^{1-\sigma} - 1}{1 - \sigma}.$$

To this end, individuals face two types of decisions: a *static* one, whereby entrepreneurs choose the optimal factor demands, and a *dynamic* one, which involves an agent's occupation o' and asset holdings a' next period.

3.3 Technologies

An entrepreneur with ability z uses capital and labor to produce a homogeneous consumption good. At the beginning of each period, he is operating the technology $f^s(\cdot)$ in either of the two sectors, $s = \{f, i\}$. His production technology is of the form

$$f^s(z_t, k_t^s, n_t^s) = z_t (k_t^s)^\kappa (n_t^s)^\mu,$$

where k_t^s and n_t^s are the levels of capital and labor used in period t. It is further assumed that $0 < \kappa + \mu < 1$, meaning that production exhibits decreasing returns to scale. For simplicity, capital is assumed to fully depreciate. Total production is defined as $y_t^{tot} = \sum_s y_t^s$.[1]

3.4 Labor and capital markets

Individuals decide how much to hold of the risk-free asset next period a', whose gross rate of return is R^*. In addition, they have access to financial intermediaries, who receive deposits a, rent capital k^s to entrepreneurs, and loan funds at the rate R^s. While formal agents can resort to formal financial intermediaries (i.e., banks) and are charged

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[1]Note that since both formally- and informally-produced goods are identical, they must have the same price in equilibrium, $q_t^s \equiv q_t \; \forall s$. For simplicity, this price is imposed along the solution and normalized to unity.

the competitive interest rate R^*, those operating informally are left with the option of borrowing from informal intermediaries (i.e., moneylenders) at typically higher interest rates, $R^i > R^f = R^*$. Consequently, there is an interest rate differential between intermediaries reflecting capital market segmentation.

While the reasons underlying this market segmentation are not modeled here, one might think of a simple way to rationalize it in the context of a small open economy. Accordingly, we assume that formal individuals can finance their excess supply or demand for capital at the international capital markets at the rate R^*, but, in contrast, individuals operating informally are excluded from such a possibility. Thus, capital demand in the informal sector is limited by the available supply in the domestic market, which implies that the informal return on capital is higher than the formal one.

Labor markets also are assumed to be segmented with the prevalence of a minimum wage policy and non-wage costs on formal employment. The minimum wage is binding; hence, entrepreneurial demand and workers' supply cannot adjust via lower wages, thereby determining the informal sector workforce by exclusion. Non-wage costs comprise taxes on payroll and labor income, which must be paid by individuals operating formally as described below. Overall, these labor market rigidities and wedges secure protection of formal workers at the expense of forcing those who do not manage to procure a job in the formal sector to join the informal sector.

3.5 Incentives

The incentives individuals face depend on whether they decide to remain as workers in either of the two sectors or switch to formality as entrepreneurs. In particular, if an individual chooses to become a formal entrepreneur, he must pay a creation cost for his business η, which is denominated in units of the consumption good.

Also, a formal entrepreneur hires each labor unit at a wage w^f and pays constant tax rates on profits, $\tau^c > 0$, and payroll, $\tau_f^w > 0$. An entrepreneur operating in the informal sector, in contrast, must pay a wage per unit of labor of w^i and no taxes $(\tau_i^w = 0)$.

Likewise, an individual who decides to be a formal worker earns a minimum wage $w^f = w_{\min}$ and pays a fixed tax rate on labor income, $\tau^y > 0$. If the individual instead chooses to work informally, she is paid a wage per unit of labor efficiency of w^i and charged no taxes.

There are no switching costs on labor supply. Moreover, irrespective of their sector

of operation, entrepreneurs choosing to liquidate their formal businesses and move to another occupation face no exit costs. All revenue collection from taxes and entry fees is rebated to individuals in the form of a lump-sum transfer denoted by b.[2]

Accordingly, an individual's earnings depend on her current occupation and can be summarized in the following reward function:[3]

$$r\left(z, a, o\right) = \begin{cases} (1 - \tau^c)\pi^f(z, a) + b, & o = \text{formal entrepreneur} \\ \pi^i(z, a) + b, & o = \text{informal entrepreneur} \\ (1 - \tau^y)w^f + b, & o = \text{formal worker} \\ w^i z + b, & o = \text{informal worker} \end{cases},$$

where π^s is the profit from running a business in sector s. This indirect profit function is defined as

$$\pi^s(z; w^s, R^s) = \max_{k^s, n^s}\left\{f^s(z, k^s, n^s) - (1 - \tau_s^w)w^s n^s - R^s k^s\right\},$$

and the associated factor demands are $k^s(z; w^s, R^s)$ and $n^s(z; w^s, R^s)$, with $k^s, n^s \geq 0$.

Note that earnings from all occupations are stochastic, except for those obtained by working formally. In other words, the minimum wage policy makes the formal worker status serve as an avenue of insurance from the downside risk of the stochastic productivity associated with entrepreneurship and informality. Such is the main benefit from formal sector labor, even though informal workers may be earning more.

3.6 Individuals' problem

We formulate the individual's problem as a discrete dynamic program with three state variables: productivity, $z \in \mathcal{Z}$, net wealth, $a \in \mathcal{A}$, and occupation, $o \in \mathcal{O}$. The decision variables are current consumption, c, and net asset holdings and occupation next period, $a' \in \mathcal{A}$ and $o' \in \mathcal{O}$.

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[2]Such a transfer can be thought of as comprising all-inclusive social security benefits. It also amounts to assuming that the government cannot distinguish an individual's occupation, and hence informal activities are neither monitored nor punished.

[3]Time-t subscripts are omitted hereafter, with the prime symbol ($'$) denoting a variable next period.

The state transition function is defined as

$$g\left(z,a,o\right) = \begin{cases} r(z,a,o) - c + R^*a - \eta 1_{\neg o'}, & o' = \text{formal entrepreneur} \\ r(z,a,o) - c + R^*a, & o' = \text{any other occupation} \end{cases},$$

where $1_{\neg o'}$ is an indicator variable which equals one if an individual starts a formal enterprise (and she is not a formal entrepreneur at the beginning of the period); otherwise, the indicator variable takes on zero value.

The recursive representation of an individual's problem is given by the following Bellman equation:

$$v(z,a,o) = \max_{c \geq 0, a' \in \mathcal{A}, o' \in \mathcal{O}} \left\{ u(c) + \beta \sum_{z'} p(z',z) v(g\left(z,a,o\right)) \right\}, \tag{1}$$

where v is the value function of the individual. Associated with this function, there is an optimal policy for the decision variables. Letting ω be the vector of state variables, $\omega = (z,a,o)$, such a policy function can be denoted by $x\left(\omega\right) = \{c(\omega), a'(\omega), o'(\omega)\}$. The controlled-state process of the just described individual program accordingly is a Markov chain with transition probability matrix $\mathcal{P}$ and ergodic distribution h.

This framework implies that, with segmented labor and capital markets, individuals with a given productivity save for consumption smoothing purposes. Yet those individuals who manage to accumulate enough assets are eventually able to overcome financial imperfections in the informal sector and run their businesses at a profit. Labor market rigidities and wedges secure flat income flows and determine how many workers join labor formality, in turn affecting the decision to engage in informal activities.

3.7 Equilibrium

Note that the solution to the discrete dynamic program described in Equation (1) depends on the values of the formal and informal wages, (w^f, w^i), and the interest rates, (R^f, R^i). In this regard, recall that our setting assumes that the interest rate is given to formal agents, who can borrow or lend in financial markets through zero-profit competitive intermediaries. Informal agents, in contrast, are excluded from these markets and thus have to resort to other sources of funding. Since these sources are limited, the informal interest rate is higher than the formal one. Consequently, while the interest rate is exogenous in the formal credit market, supply of savings and demand

for capital in the informal sector endogenously determine the informal rate.

As regards wages, the assumption that the minimum wage is binding in the formal sector implies that the wage is given to formal agents. Since workers can move freely across sectors, the informal wage is on the contrary determined in an endogenous manner by the mass of individuals willing to work in the informal sector at wage w^i and the labor demand by informal entrepreneurs at that wage. Summarizing, whereas w^f and R^f are taken as parameters, w^i and R^i constitute an equilibrium outcome.

Let $\mathcal{O}_f$ and $\mathcal{O}_i$ be the sets of agents who optimally choose to be formal and informal, respectively. A stationary equilibrium for this economy consists of an invariant distribution h of the state variables ω; a set of policy functions $x(\omega)$, and labor and capital decisions by entrepreneurs $\{n^s(z), k^s(z)\}$ such that, given wages (w^f, w^i), interest rates (R^f, R^i), tax and benefit rates $(\tau^c, \tau^w, \tau^y, b)$, and the cost of creating a formal firm η,

- individuals solve their optimization problem, the Bellman equation (1);

- the distribution h is stationary: $h = \mathcal{P}'h$;

- the formal capital net supply at the deposit interest rate, $R^f = R^*$, is

$$A^f \equiv \sum_{z \in \mathcal{Z}} \sum_{j \in \mathcal{O}_f} h_j a(\omega) - \arg\max_{k^f} \pi^f(z; w^f, w^i, R^f, R^i);$$

- the informal capital market clears at the interest rate R^i:

$$A^i \equiv \sum_{z \in \mathcal{Z}} \sum_{j \in \mathcal{O}_i} h_j a(\omega) = \arg\max_{k^i} \pi^i(z; w^f, w^i, R^f, R^i);$$

- the formal labor net supply at the binding minimum wage, $w^f = w_{\min}$, is

$$N^f \equiv \sum_{z \in \mathcal{Z}} \sum_{j \in \mathcal{O}_f} h_j o(\omega) - \arg\max_{n^f} \pi^f(z; w^f, w^i, R^f, R^i);$$

- the informal labor market clears at the market wage w^i:

$$N^i \equiv \sum_{z \in \mathcal{Z}} \sum_{j \in \mathcal{O}_i} h_j o(\omega) = \arg\max_{n^i} \pi^i(z; w^f, w^i, R^f, R^i);$$

11

- and the government satisfies the budget constraint:

$$\tau^c \Pi^f + \tau^w w^f N^f + \tau^y w^f N^f + \sum_{j \in \mathcal{O}_f} \eta = \sum_j h_j b,$$

where Π^f denotes the aggregate profits of formal entrepreneurs.

Notice that formal capital and labor markets do not necessarily clear. Excess capital supply is exported abroad, with no effect on the formal interest rate, in this small open economy. Further, as noted above, excess labor supply is shifted to the informal market.

4   An application to Colombia

In this section, we apply the proposed model to Colombia with the aim to elucidate its observed patterns of saving as displayed by occupations along the formal-informal dimension. We first provide, as a matter of context, some factual evidence regarding informality and saving in line with the intuition of the model economy outlined in the literature review. Then we present the model parameterization.

4.1   Facts

The Colombian economy exhibits substantial informality at the firm level and in the labor market. Some estimates indeed suggest that the informal sector comprised about 37% of GDP and 74% of the labor force in the early to mid 2000s (see, respectively, Schneider et al., 2010; Bernal, 2009). Yet the issue of labor market segmentation is moot. For the 1980s, Magnac (1991) finds compelling evidence favoring the hypothesis that formal and informal labor markets were competitive; but changes in Colombia's labor legislation and its social security scheme in the past two decades have erected high minimum wage and non-wage costs of formal employment—i.e., payroll taxes and employers' contributions—as important segmenting forces (see, in this regard, World Bank, 2010; Mondragón-Vélez, Peña, & Wills, 2010; Kugler & Kugler, 2009).

In contrast, several recent studies provide evidence of borrowing constraints and segmentation between formal and informal capital markets. Data from the first nationally representative survey on financial capability and the Colombian Longitudinal Survey, in particular, coincide in suggesting that informal sector workers are frequent users of informal credit entities and commonly resort to family, friends and moneylenders to

ease financial strain (Reddy, Bruhn, & Tan, 2013; ELCA, 2012). Further, Cárdenas and Rozo (2009) show using commercial registration series and other data sources that informal entrepreneurs in Colombia typically face obstacles to accessing external funding and make less use of bank loans. Lastly, Caro, Galindo, and Melendez (2012) find that banking credit availability increases labor formalization in formal firms.

In this context, saving appears to be one of the main means by which individuals in the informal sector deal with their inherently unsteady income flows. Table 1 shows some patterns of earnings volatility and individual and aggregate saving using data from the 2010 wave of the ELCA survey. It can be seen that the earnings of informal workers and entrepreneurs jointly considered are slightly more volatile (with respect to the mean) than those of formal ones. Moreover, the saving rates of the informally employed people are higher than those of the formals, meaning individuals performing informal activities tend to save a higher proportion of their earnings. These patterns overall suggest that exclusion from formal financial markets and earnings variability might boost the incentive for individuals in informality to save.

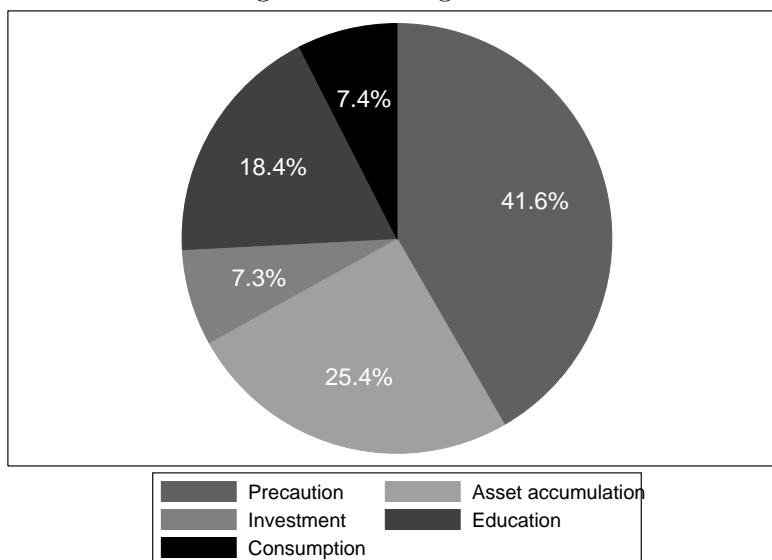Table 1: Earnings volatility and saving patterns by sector

| | Earnings volatility | Saving rate | |
		Individual	Aggregate
Formal	0.919	8.41%	5.70%
Informal	1.099	18.63%	6.43%
Ratio	0.837	0.45	0.89

Note: Informality is defined by making no contributions to the social security system (health or pensions). Earnings volatility is measured by coefficients of variation. Individual saving rates correspond to medians. Both individual and aggregate saving rates are fractions of earnings. See Appendix B for details.
Source: Authors' calculations based on the 2010 wave of the ELCA survey.

Such a contention is certainly reinforced in Figure 1, which shows the saving motives reported by ELCA-surveyed individuals. According to the Figure, approximately 41.6% of those surveyed save for precautionary reasons. While buffering future and old age or unexpected events seems to be the main purpose of saving, other important motivations are asset accumulation (25.4%), business investment (18.4%), and payment of consumption and educational expenses (7.3% both). This ranking highlights the role played by saving in providing a response to shocks or adverse events individuals face irrespective of their occupation and/or sector of operation.

Figure 1: Saving motives

Yet there are few efforts seeking comprehensive rationalization of these facts. Most of the available studies analyze the determinants of saving, with a focus on testing the life cycle hypothesis at the household level (see Daza, 2013; Melo, Téllez, & Zárate, 2006). Interestingly, little attention has been paid to the saving behavior of individuals according to whether they perform their economic activities in the informal sector and/or their occupational status. Except for ELCA (2012), which reports that formality in the use of saving mechanisms and the banking system are correlated with formal employment, no other works can be found in this regard for the Colombian economy.

4.2 Calibration

The model is calibrated to replicate the cross-sectoral distributions of wealth and occupations in the Colombian economy. Since the period is set to one year, the discount factor is equal to 0.972. This is a common value in studies on emerging market economies. Also, the value of the risk aversion coefficient is taken from Prada and Rojas (2010), who estimate this parameter and the Frisch elasticity of labor supply using quarterly data on hours by skilled and non-skilled workers in Colombia during 2001 and 2006.

As for the technology parameters, Zuleta, Parada, García, and Campo (2010) apply several methodologies to estimate the factor shares during the period 1984-2005. We

take averages of some of the obtained time series for the shares of physical and human capital such that κ is set to 0.374 and μ to 0.465. Note that these values fulfill the technology specification of decreasing returns to scale, $\kappa + \mu = 0.839$. Also recall the production technologies are assumed identical across the two sectors.

Moving on to the policy parameters, the tax and regulatory rates to which formal firms are subject are taken from The World Bank's *Doing Business* database. This project currently reports a tax burden on firms consisting of a profit tax of 18.7%, as well as social security contributions and payroll taxes paid by employers amounting to 28.8%. Yet the entry fee has been set at 10%, a low value compared to the average cost of registering a business in Colombia during 2004-2014 (16.5% of per capita income).

Furthermore, the labor income tax rate has been made equal to the top statutory marginal income tax rate prevailing in Colombia since 2008. The formal sector wage has been assigned a value of 0.12, thus guaranteeing the bindingness of the minimum wage policy. All the mentioned parameter values imply an equilibrium government transfer of about 0.023 and are summarized in Table 2.

Table 2: Benchmark parameterization

Parameter	Value	Description	Source
β	0.972	Discount factor	DGE literature
σ	2.35	Risk aversion coefficient	Prada and Rojas (2010)
κ	0.374	Capital share	Zuleta et al. (2010)
μ	0.465	Labor share	Zuleta et al. (2010)
R^f	1.018	Formal sector interest rate	International macro literature
η	0.1	Formal firm creation cost	Doing Business Database, 2004-14
τ^c	0.187	Profit tax rate	Doing Business Database, 2014
τ^w	0.288	Payroll tax rate	Doing Business Database, 2014
τ^y	0.33	Labor income tax rate	Colombian labor income tax laws

The process for individual productivity is discretized into the mentioned three states using the Rouwenhorst method (see Appendix A). We assume that the probability of staying in the lowest state and the probability of remaining in the highest state are both equal to 0.7. Further, the unconditional variance of the underlying autoregressive process is assigned a value of 0.4.

It is worth noting that the present parameterization is consistent with the interest rate structure observed in empirical studies. In this regard, we assume the interest rate at which capital is financed in the formal sector is equivalent to the international interest rate, which is set to 1.8% following the relevant literature. Given that $R^f = R^* = 1.018$,

our calibration implies that informal agents finance their capital needs at an interest rate of 1.719 in equilibrium. Such a rate is within the available estimates for Colombia and other Latin American countries.[4]

5 Quantitative performance

5.1 Model assessment

To evaluate the performance of the model economy, Table 3 displays some distributional statistics allowing for comparison with data from the ELCA survey.[5] For the computations, firm informality is defined by an establishment's lack of commercial registration (Definition E.1.); in turn, a worker is considered informal when she has not contributed to the social security system, be it health or a pension scheme (Definition W.5.). See Appendix B for details.

In the first panel, we report some statistics for occupations. It can be seen that the model does a good job in replicating the observed composition of workers and entrepreneurs across the formal and the informal sectors. Also, the benchmark economy captures the trend in the occupational distribution between workers and entrepreneurs. Although the numbers do not match those of the ELCA, they are consistent with studies contending that entrepreneurs represent a small fraction of the Colombian workforce.[6]

The second panel presents some statistics concerning aggregate savings. In particular, saving rates are computed as proportions of earnings for each occupation and sector.[7] The ratios of rates between formal and informal occupations also are calculated, with a ratio greater than one meaning that formal agents save relatively more of their income. Given that saving theories often associate the act of saving with asset accumulation, aggregate assets in the stationary equilibrium account for model savings.

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[4]According to data from the ELCA survey, interest rates charged by moneylenders are about 2.3 times higher than those of formal financial institutions in Colombia (ELCA, 2012). Also, using a survey of 48,000+ small entrepreneurs in Brazil, De Paula and Scheinkman (2011) estimate that informal firms face at least 1.3 times the cost of capital faced by formal firms.

[5]We also compute statistics pertaining to occupations and the asset distribution using two surveys conducted by the National Department of Statistics: the National Household Survey (GEIH, for its initials in Spanish) and the Microenterprise Survey. The obtained statistics, which are available upon request, turn out to be rather close to those of the ELCA.

[6]Mejía (2009), in particular, presents evidence from the National Household Survey suggesting that entrepreneurs, defined as business owners, comprised around five percent of the total workforce during the period 1996-2004.

[7]Likewise, Table 7 in Appendix C reports the savings of each occupational status as percentages of aggregate savings.

Table 3: Distributional statistics

	Model	Data
OCCUPATIONS		
Workers	90.4%	56.9%
Formal	75.1%	76.2%
Informal	24.9%	23.8%
Entrepreneurs	9.6%	43.1%
Formal	30.9%	29.8%
Informal	69.1%	70.2%
SAVING RATES		
Workers	19.61%	5.11%
Formal	20.44%	4.93%
Informal	18.46%	5.71%
Ratio	1.11	0.86
Entrepreneurs	31.67%	5.75%
Formal	32.04%	6.02%
Informal	31.10%	5.22%
Ratio	1.03	1.15
WEALTH DISTRIBUTION		
Gini coefficient	0.61	0.71
Coefficient of variation	0.58	6.51
Mean-to-median ratio	1.00	-55.08

Note: Data corresponds to statistics from the 2010 wave of the ELCA survey. Informal occupational statuses lump actual informals and non-respondents together. See Appendix B for further details.

Unlike the first panel, the model overstates the saving rates of both entrepreneurs and workers. There are a number of reasons for such an overstatement. Among these, it is worth noting that the ELCA restricts its sample to low- and middle-income households, in which saving capacity is not precisely concentrated (see, in this regard, Tovar, 2008). Yet the benchmark economy slightly matches data on gross national saving rates,[8] and certainly resembles the cross-sectoral ratios as shown.

Finally, the third panel displays the asset distribution. One can see that the model generates trends in wealth inequality that are at odds with the data. To be specific, net wealth tends to be less concentrated in the benchmark economy than in the actual statistics. That individuals are assumed unable to hold negative assets seems to play a role in explaining these divergences, as the values of the mean-to-median ratio suggest. This finding is robust to variations in the model parameters as shown below.

5.2 Sensitivity analysis

The results are sensitive to changes in some model parameters. This is particularly evident concerning values of the preference parameters and the individual productivity process as shown in Tables 4 and 5. It can be observed that, for certain parameterizations that differ from the benchmark economy, the composition of occupations and savings and the Gini coefficient of wealth exhibit substantial variations.[9] Moreover, most of these variations are consistent with the proposed mechanism.

Note that the saving rates of both workers and entrepreneurs rise with increases in the discount factor, the risk aversion coefficient, the volatility of the productivity process, and the formal interest rate. Also, the cross-sectoral ratios of entrepreneurial saving rates exhibit an increasing trend as values taken by the mentioned parameters go up. These patterns of asset accumulation underscore consumption smoothing and formal firm creation as drivers of saving. While labor formalization suggests the latter motive prevails concerning the degree of patience and skills variability, slightly less formal sector workers support the former as regards the remaining coefficients.

Also note that changes in the distributional properties of individual productivity and the factor shares appear to give rise to monotonic variations in saving behavior and the occupations composition. Small increments in the capital income share are

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[8]National accounts data yield an average estimate of 18.8% for 2000-2012. As for households, gross savings have been about 7 percent of GDP during the same period (DANE, 2014).

[9]The savings held by individuals in each occupation as a percentage of aggregate savings also feature significant changes, as displayed in Tables 8 and 9 in Appendix C.

Table 4: Sensitivity to preference and technology parameters

	β				σ				κ			
	0.961	0.967	0.971	0.974	1.50	2.17	2.83	3.50	0.361	0.366	0.371	0.376
WEALTH DISTRIBUTION												
Gini coefficient	0.587	0.581	0.590	0.567	0.584	0.616	0.589	0.581	0.534	0.557	0.613	0.592
Coefficient of variation	0.584	0.583	0.583	0.585	0.586	0.584	0.584	0.585	0.582	0.584	0.584	0.584
Mean-to-median ratio	1.004	1.000	1.002	1.002	1.006	1.001	0.994	1.006	1.004	1.002	0.997	0.998
SAVING RATES												
Workers	0.4%	0.6%	21.1%	33.5%	12.9%	19%	26.6%	46.4%	1%	20.1%	18.7%	24.3%
Formal	0.2%	0.4%	22.4%	40.4%	14.4%	20%	30.9%	54.1%	0.4%	12.4%	18.1%	28.9%
Informal	12.6%	16.2%	18.9%	24.4%	10.8%	17.6%	20.8%	36.1%	41.6%	37.6%	19.6%	17.8%
Ratio	0.02	0.02	1.18	1.66	1.33	1.13	1.49	1.50	0.01	0.33	0.92	1.62
Entrepreneurs	18%	20.5%	29.2%	59.7%	31.7%	30%	46.2%	66%	34.5%	32%	28.3%	39.2%
Formal	0%	0%	14.7%	69.6%	31%	29.2%	50.9%	75.4%	0%	5.1%	22.9%	39.1%
Informal	44.9%	51.4%	51.4%	43.2%	32.7%	31.1%	38.8%	51.3%	84.8%	71.9%	36.5%	39.5%
Ratio	0.00	0.00	0.28	1.61	0.95	0.94	1.31	1.47	0.00	0.07	0.63	0.99
OCCUPATIONS												
Workers	89.2%	88.7%	88.9%	84.2%	87.2%	90.6%	87.2%	86.5%	84.9%	87.4%	90.8%	87.8%
Formal	77.7%	76.4%	78.4%	79.8%	78.3%	75.2%	78.8%	77.9%	65.2%	63.5%	74.6%	79.1%
Informal	22.3%	23.6%	21.6%	20.2%	21.7%	24.8%	21.2%	22.1%	34.8%	36.5%	25.4%	20.9%
Entrepreneurs	10.8%	11.3%	11.1%	15.8%	12.8%	9.4%	12.8%	13.5%	15.1%	12.6%	9.2%	12.2%
Formal	0%	0%	10.8%	38.5%	26.9%	29.2%	34.2%	35.5%	0%	2.3%	21%	30%
Informal	100%	100%	89.2%	61.5%	73.1%	70.8%	65.8%	64.5%	100%	97.7%	79%	70%
R^i	1.59	1.58	1.61	1.62	1.63	1.72	1.65	1.65	1.56	1.59	1.71	1.64

Table 5: Sensitivity to productivity process and formal interest rate

	unconditional variance				p				R^*			
	0.38	0.41	0.43	0.45	0.68	0.70	0.72	0.75	1.0138	1.0152	1.0165	1.0178
WEALTH DISTRIBUTION												
Gini coefficient	0.549	0.611	0.598	0.586	0.552	0.610	0.623	0.651	0.584	0.619	0.592	0.592
Coefficient of variation	0.582	0.584	0.584	0.584	0.585	0.584	0.582	0.583	0.584	0.584	0.584	0.584
Mean-to-median ratio	1.003	0.998	1.003	1.003	1.000	0.998	1.001	0.996	0.997	0.999	1.001	1.002
SAVING RATES												
Workers	3%	21.4%	25.9%	30.2%	25.3%	20.9%	0%	0%	13.6%	17.6%	22%	23.8%
Formal	1.4%	23.7%	37.8%	47.4%	28.5%	22%	0%	0%	14.6%	18.8%	25.3%	28.3%
Informal	43%	18.2%	10.5%	6.7%	21.3%	19.2%	19.9%	15%	12.2%	15.9%	16.8%	17.6%
Ratio	0.03	1.30	3.61	7.11	1.34	1.14	0.00	0.00	1.20	1.19	1.50	1.60
Entrepreneurs	32.6%	33.5%	43.1%	46.1%	65.2%	31.1%	19.2%	18.1%	30.2%	25.6%	32.2%	38.6%
Formal	0%	34.1%	49.7%	46.9%	88%	27.6%	0%	0%	27.3%	22.3%	24.2%	38.1%
Informal	81.2%	32.6%	32.9%	44.7%	30.8%	36.4%	48.9%	46%	34.5%	30.6%	44.3%	39.4%
Ratio	0.00	1.05	1.51	1.05	2.85	0.76	0.00	0.00	0.79	0.73	0.55	0.97
OCCUPATIONS												
Workers	86.8%	89.9%	87.3%	86.3%	81.1%	90.2%	92.3%	93.8%	87.4%	91.1%	88.6%	87.9%
Formal	61.9%	76.5%	81.4%	84.4%	77.7%	76.2%	77.3%	81.5%	78%	75.5%	79%	79%
Informal	38.1%	23.5%	18.6%	15.6%	22.3%	23.8%	22.7%	18.5%	22%	24.5%	21%	21%
Entrepreneurs	13.2%	10.1%	12.7%	13.7%	18.9%	9.8%	7.7%	6.2%	12.6%	8.9%	11.4%	12.1%
Formal	0%	31.4%	40.5%	33.3%	48.4%	24.8%	0%	0%	24.4%	25.2%	19.2%	29.4%
Informal	100%	68.6%	59.5%	66.7%	51.6%	75.2%	100%	100%	75.6%	74.8%	80.8%	70.6%
R^i	1.56	1.70	1.64	1.56	1.65	1.69	1.64	1.66	1.62	1.71	1.63	1.65

conducive to increases in the saving rates of those formally employed. Likewise, a trend towards labor formalization is observed as both the unconditional variance and ability persistence increase. Such a concentration around formal workers highlights the insurance role that the minimum wage policy grants to this occupational status in environments characterized by widely dispersed skills and low social mobility.

6   Policy experiments

In this section, we analyze the results of experiments assessing the effects on the benchmark economy of different policy measures. These policies traditionally have been proposed to foster formalization and take the form of reductions in firm and labor taxes, the minimum wage and the entry cost into formality. Although we focus our attention on the impact on occupational choices across the formal and informal sectors, the incomplete-market nature of the model also allows us to examine which policies might enhance aggregate saving and favor wealth redistribution.

6.1   Firm taxation cuts

The first set of experiments we consider pertain to the effects of firm taxation, which are represented by reductions in taxes on payroll and profits. Figures 2 and 3, in this regard, show that these tax cuts trigger significant increases in saving rates, especially by formal agents.[10] These policies also lead to decreases in the percentage of population devoted to informal activities. Wealth inequality experiences small but non-negligible reductions, as does the share of total output informally produced.

Of these policy experiments, payroll tax cuts are particularly noteworthy due to the sizeable variations in savings and occupational choices generated by small changes in this component of non-wage labor costs. This policy, in an environment characterized by a binding minimum wage, contributes to lessening the burden of taxation born by formal firms and thereby drives a substantial increase in asset accumulation. Accordingly, this policy promotes the hiring of formal workers and encourages formal entrepreneurship.

Profit tax cuts increase earnings at the disposal of formal firms and hence favor entrepreneurial saving in the formal sector. Its impact on occupational choices is similar to that of payroll tax cuts, even though the latter is apparently of a greater extent. Interestingly, these two tax policies affect the coefficient of variation of wealth negligibly.

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[10]Complementary, yet detailed results can be found in Table 10 in Appendix C.
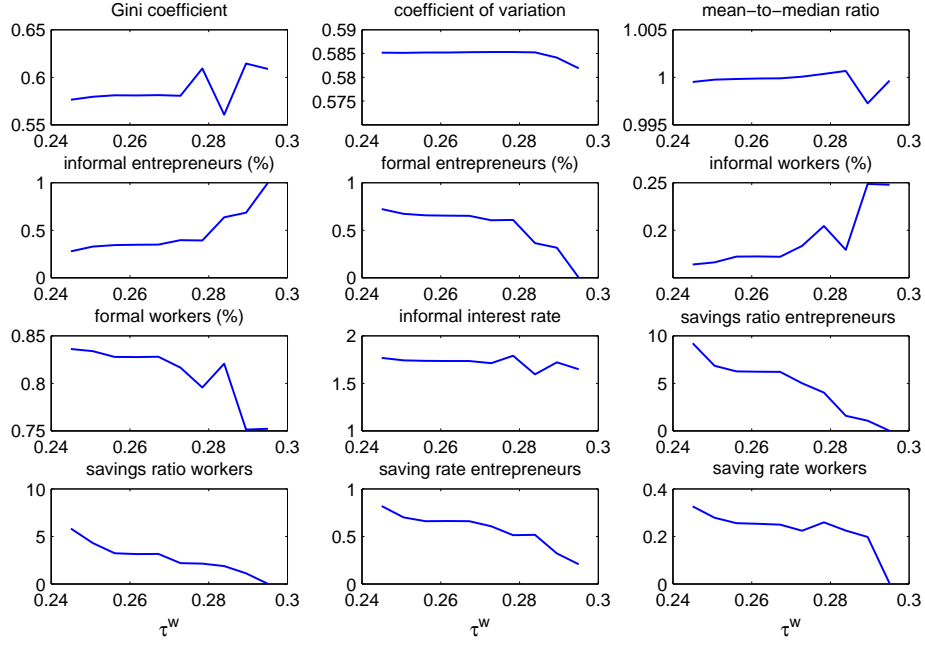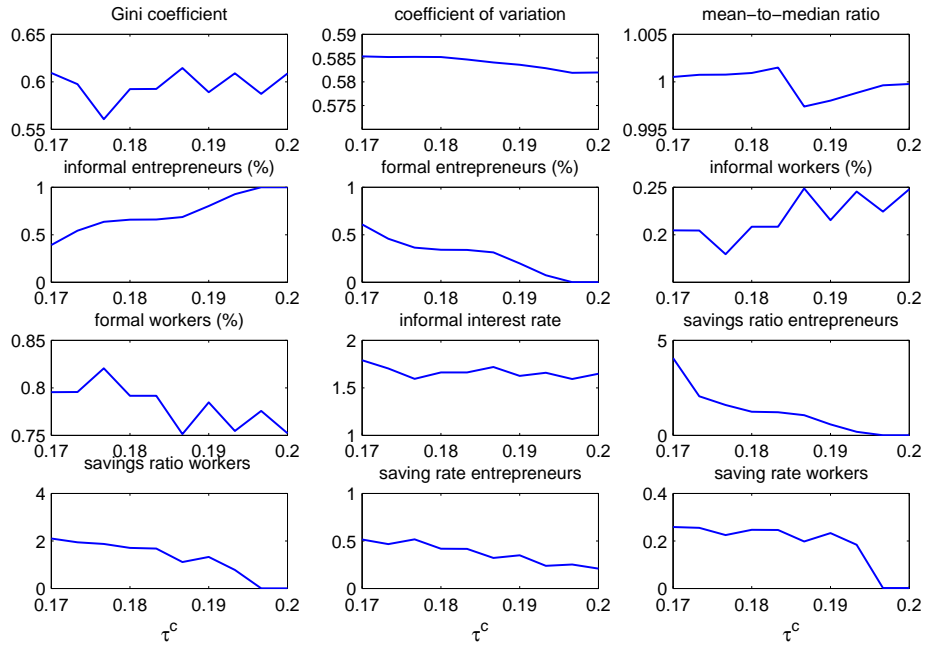
Figure 2: Effects of payroll taxation


Figure 3: Effects of profit taxation

These results overall highlight the potential role of payroll taxation as a tool to foster not only labor formalization, but also saving and entrepreneurship.

The analysis above suggests that the lion's share of the benefits from the mentioned tax reductions is held by formal entrepreneurs. In this sense, the results presented here are certainly in line with those of Rozo (2008), who finds that the effects of payroll tax cuts are greater on firms in the formal sector. The seeming connection between this policy and the recent abolition of the so-called *aportes parafiscales* enacted in the Colombian Tax Reform Act of 2012 is therefore not surprising.

6.2 Labor taxation cuts

We now consider the effects of reductions in the labor income tax rate. It can be seen from Figure 4 that this policy encourages individuals to join the formal labor force. Also, given the government budget constraint, smaller tax rebates go hand in hand with greater inequality in the distribution of assets. These patterns are in line with the intuition on the effects of labor taxation in the present economic environment. In contrast, both saving rates and entrepreneurship perform in a non-monotonic fashion, suggesting an ambiguous impact of income taxation on firm formalization.

Figure 4: Effects of income taxation

23
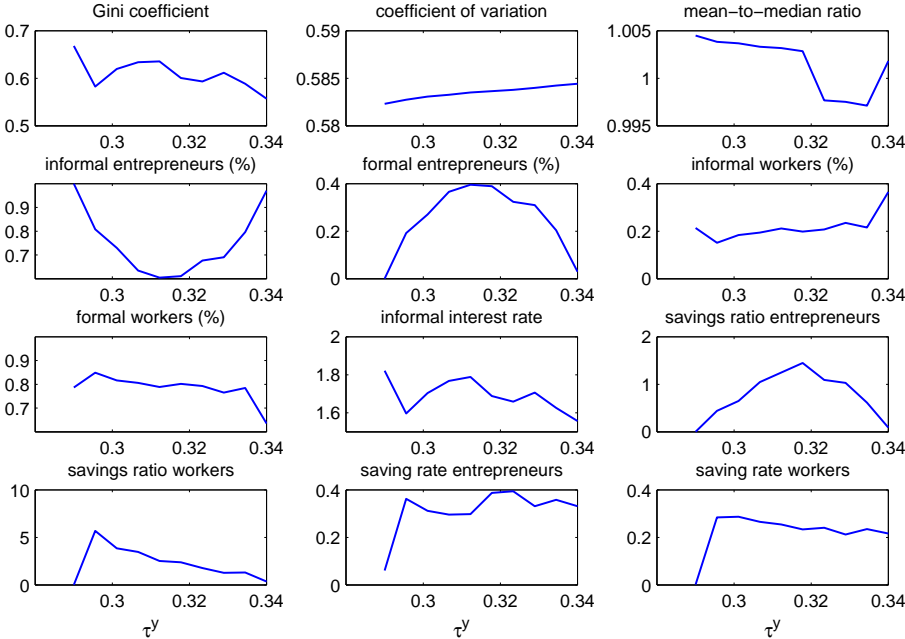
6.3 Minimum wage reduction

Reducing the minimum wage is somewhat similar in its effects to a payroll tax cut. Indeed, Figure 5 shows that small decreases in this policy parameter give rise to non-negligible increases in saving rates. The population composition also exhibits changes, with a significant fraction of individuals becoming formal entrepreneurs. This pattern of entrepreneurial behavior contrasts the one observed on the labor side, where the informal status interestingly tends to intensify. Last but not least, wealth inequality experiences a steady reduction.

Figure 5: Effects of minimum wage policy
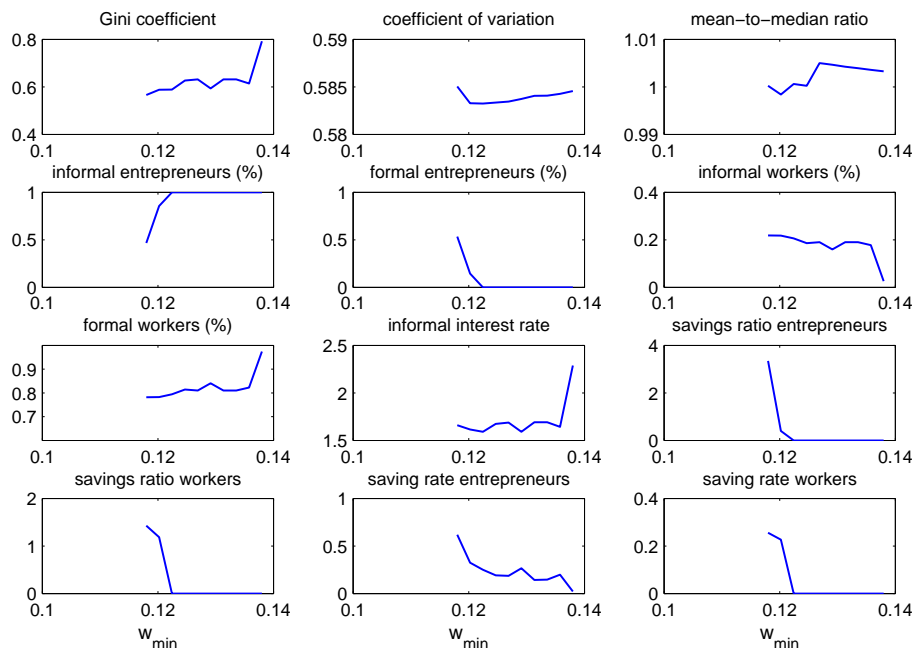
To some extent, the results described above are a reflection of the insurance character granted by the minimum wage policy to formal labor. Such a secure status certainly enables risk-averse individuals to accumulate assets and, in a context of stochastic productivity, it discourages them from choosing occupations associated with entrepreneurship and informality. Under these circumstances, minimum wage cuts lessen the attractiveness of working formally and spurs the choice of otherwise riskier activities. This, in turn, leads to a more even distribution of asset holdings and thereby of net wealth.

Granted that minimum wage reductions do not compromise the very existence of this policy, an interesting experiment would consist of making income earned in formal

jobs contingent on an individual's skills. This experiment amounts to a full removal of the minimum wage, and hence of the causes for labor market segmentation characterizing the model economy. Understanding the consequences of such a policy change on informality incidence, saving and wealth distribution would be of value for debates regarding reforming the currently binding minimum wage scheme in Colombia.

6.4   Reduction of entry costs

Finally, we consider the effects of reducing the cost faced by individuals when deciding to start a formal business. This policy change, as expected, makes entrepreneurship in the formal sector a more attractive occupational choice while affecting labor supply like manner. Consequently, savings as a fraction of income increase for all occupations and sectors, but agents performing in formal statuses do save relatively more. This certainly explains why wealth inequality varies in a non-monotonic fashion.

Figure 6: Effects of entry costs
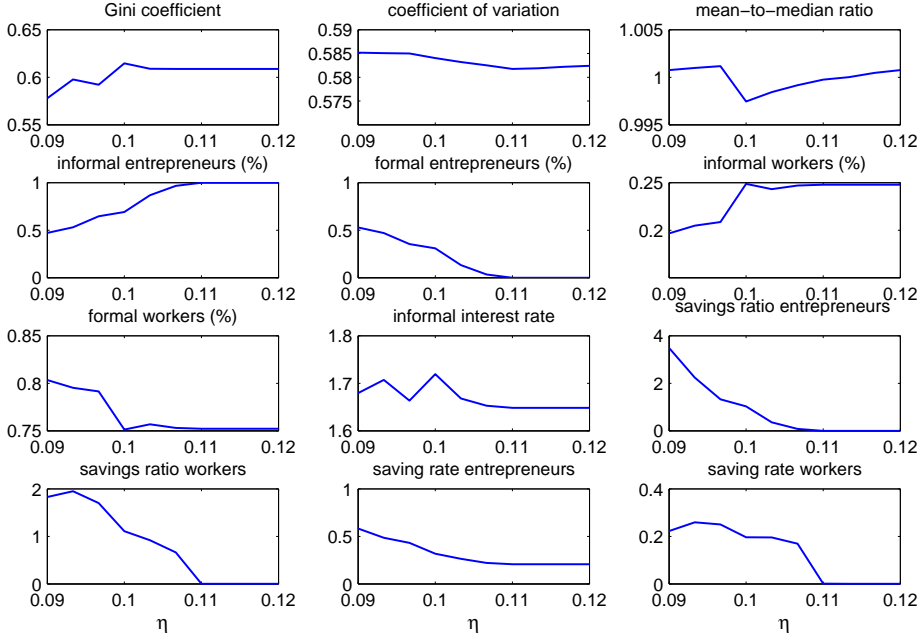
7 Alternative settings

The previous section displays the results of experiments addressing changes in policy parameters while keeping the core structure of the model intact. Yet consideration of alternative economic environments could yield further insight into how the benchmark economy works and the implications of its underlying assumptions. This section analyzes deviations from two of these assumptions, namely, lump-sum redistribution and the absence of a productivity advantage in the formal sector. We discuss the motivations for their introduction and the outcomes of the computational exercises as follows.

7.1 Formal productivity advantage

Our benchmark economy is built on the grounds that, even though individual productivity follows a finite-state stochastic process, none of the occupational statuses holds a productivity advantage over any another. This assumption is certainly at odds with the informality literature, in which the notion of extremely inefficient firms run by managers with low levels of human capital stands as a stylized fact (see La Porta & Shleifer, 2014).[11] In view of this potential criticism, we propose an alternative environment by introducing a shift factor to the production technology in the formal sector, thus implicitly characterizing the concerned entrepreneurs as higher skilled.

Let us denote such a shift factor by Z. Figure 7 shows how the choice of occupations and asset holdings, as well as inequality in the distribution of wealth, are affected by its introduction. It can be seen that the productivity advantage attracts individuals to join the lines of formal entrepreneurship while discouraging informal economic activities as a whole. Saving rates, in turn, experience a substantial increase, especially for those agents performing in the formal sector. Accordingly, the Gini index of wealth decreases in a non-negligible manner, although the coefficient of variation and the mean-to-median ratio remain roughly as constant.

The described patterns suggest that policies aimed at enhancing entrepreneurial ability and the overall organizational environment in the formal sector, such as technology improvements and education, may also yield rewards in terms of promoting saving and reducing gaps in wealth distribution. This policy implication cannot be highlighted

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[11]Admittedly, our modeling of the productivity process is aimed to portray the informal sector as one in which both highly and poorly educated managers co-exist. We deem such a representation as better reflective of informal entrepreneurship in Colombia, where it is not uncommon to see highly skilled individuals running firms that do not comply with taxes and regulations.

Figure 7: Effects of formal productivity advantage
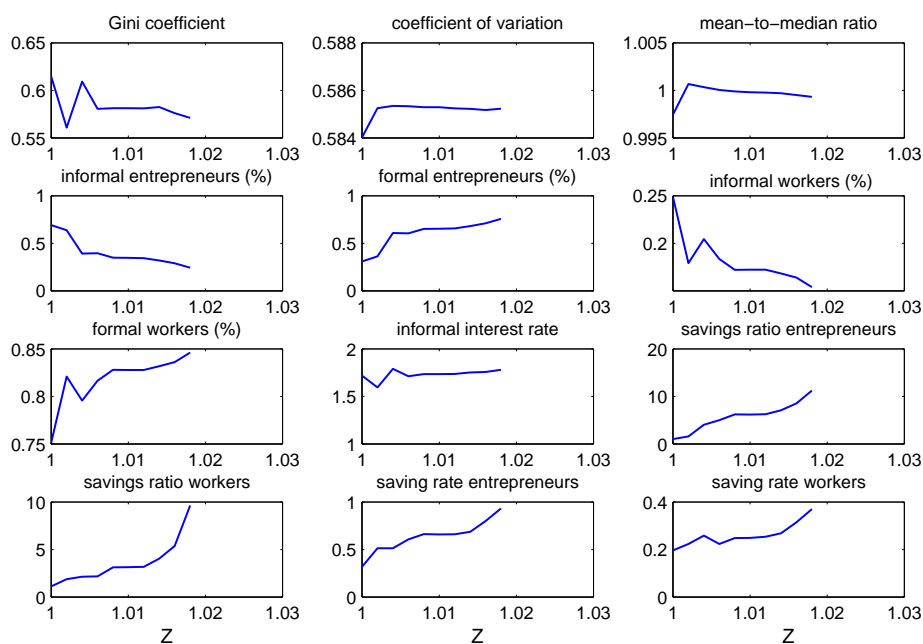
more given recent efforts led by governments in many developing countries to support small and medium enterprises with vocational and managerial training. Programs furthering institutional capabilities (i.e., so-called governance and rule of law) and financial inclusion can be regarded as pointing in the same direction.

7.2 Taxation without redistribution

The following exercise presents an economic environment wherein government revenue is not redistributed among individuals. Such a policy of "taxation without redistribution" contrasts with that of the benchmark economy in that taxes and fees paid by formal agents are not rebated in a lump-sum fashion, thus constituting wasted resources that do not contribute to enhancing welfare.

Table 6 presents the results of simulations for the settings with and without rebates. It can be seen that the Gini coefficient of wealth is lower in the alternative setup. This apparently surprising finding suggests that the income effect associated to lack of government transfers affects agents differently altogether. Furthermore, no redistribution strengthens precautionary motivations, which explains the higher saving rates displayed by individuals in all occupational statuses.

Table 6: Comparing model setups

	Benchmark	No rebate
OCCUPATIONS		
Workers	90.4%	87.6%
Formal	75.1%	78.5%
Informal	24.9%	21.5%
Entrepreneurs	9.6%	12.4%
Formal	30.9%	27.5%
Informal	69.1%	72.4%
SAVING RATES		
Workers	19.6%	26.2%
Formal	20.4%	29.4%
Informal	18.5%	21.6%
Ratio	1.11	1.36
Entrepreneurs	31.7%	43.1%
Formal	32.0%	42.2%
Informal	31.1%	44.2%
Ratio	1.03	0.96
WEALTH DISTRIBUTION		
Gini coefficient	0.61	0.59
Coefficient of variation	0.58	0.58
Mean-to-median ratio	1.00	0.99

Moreover, the absence of government-provided social insurance and its individual-specific income effects trigger a recomposition of occupations, which is why both formal labor and informal entrepreneurship increase. These patterns of asset accumulation and occupational statuses, as pointed out above, are all certainly consistent with consumption smoothing motives.

Since the comparison above involves two admittedly extreme cases, it would be interesting to examine the implications of other fiscal frameworks for occupational choices and asset accumulation in the formal and informal sectors. In this regard, alternative specifications of the role of the government and its budget constraint allowing for different forms of taxation (e.g., revenue-neutral tax policies) and redistribution (provision of public goods) represent not only worthy avenues for future research, but also ones potentially leading to more realistic policy prescriptions.

8   Concluding remarks

This paper examines how extensive informality at the firm level and in the labor market affects the patterns of asset accumulation and wealth distribution. To this end, we develop an occupational choice model with labor and capital market segmentation in which formality entails compliance with taxes, a minimum wage policy and firm entry costs, whereas informal agents can only access finance at a higher interest rate. Saving, in this framework, is primarily driven by precautionary motives and as a means to start formal businesses. The model is calibrated to replicate data on saving rates, wealth inequality and informal sector incidence in Colombia, further allowing for the assessment of several policies and alternative specifications.

By and large, our model does a good job in replicating the distribution of workers and entrepreneurs across the formal and informal sectors; but it is not as successful regarding the patterns of asset accumulation and wealth inequality. As for government interventions, reductions in firm taxation and the minimum wage emerge as potentially beneficial policies in terms of wealth redistribution and promotion of saving and entrepreneurship. A similar conclusion can be reached in regard to entry costs into formality and productivity-enhancing measures such as education and better rule of law. The relevance of these potential benefits is all the more prominent given present concerns about the levels of financial inclusion and literacy, as well as recent debates on removing certain payroll contributions and reform of the minimum wage scheme.

Our approach, however, is not without limitations. Noticeable among them is the mentioned misstatement of wealth accumulation and concentration. To improve our proposed model, an interesting possibility would be the introduction of government enforcement of restrictions on informal activities. Another worthwhile specification would involve financial market incompleteness in the form of collateral constraints. These two extensions, alongside those mentioned throughout the paper, would certainly make for a richer economic environment, thus allowing us to shed further light on issues that are at the heart of current academic and policy discussions.

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A   Solution method

The model is solved by a combination of several numerical procedures. The computational implementation of the solution is based in part on some codes contained in the CompEcon toolbox (see Miranda & Fackler, 2002), the inequality package developed by Pozzi (2008) and Franz Hamann's (2013) macro toolbox.

First, we proceed by applying state space discretization. The process for individual productivity $z \in \mathcal{Z}$ thus is discretized into three states following the method proposed by Rouwenhorst (1995). In the same vein, we construct a grid of 200 points for the asset level $a \in \mathcal{A}$. Likewise, there are four occupations $o \in \mathcal{O}$ in the model. Hence the state space comprises $\mathcal{Z} \times \mathcal{A} \times \mathcal{O}$.

The general equilibrium solution involves finding out informal factor prices. This is accomplished, as for the wage, by implementing the bisection method to an algorithm solving the dynamic programming problem. Such an algorithm takes a given informal wage to solve the entrepreneurs' static problem, compute individual utility, solve Equation (1) through policy function iteration, and calculate the excess demand for labor under the resulting stationary occupations. The bisection technique permits ascertaining the wage rate that nullifies the excess demand.

At the end of each informal wage trial, taxes and fees due by formal agents are computed so as to estimate the lump-sum transfers (i.e., total government revenue). If convergence has not been verified, these transfers are incorporated into the individuals' budget constraints at the subsequent trial.

Once general equilibrium convergence is reached, the ergodic distribution of com-

bined assets and occupations is obtained. Then we compute the stationary values of the endogenous variables, including the informal interest rate. The wealth Gini index, the coefficient of variation and the mean-to-median ratio are also calculated.

B   An empirical assessment of informality

The informal sector includes a range of heterogeneous activities and individuals, all of which makes defining it and appropriately measuring its performance a challenging task. With this in mind, we employ data from the Colombian Longitudinal Survey to obtain estimates of the occupational composition across workers and entrepreneurs and along formal-informal lines. Based on these estimates, we calculate the distributional statistics for a number of relevant variables providing a test of the model and supporting empirical material.

The Colombian Longitudinal Survey of Wealth, Income, Labor and Land (henceforth ELCA) is a follow up of a group of both rural and urban households in Colombia. It is carried out by the Universidad de Los Andes every three years and is intended for a period of at least 10 years. The survey sample is made up of 10,800 households, 6,000 urban and 4,800 rural, representing national socio-economic strata 1 to 4 as well as five geographical regions.

Our analysis focuses on the first wave, which was conducted in 2010, due to data availability. Also, we only consider the urban subsample so as to obtain measures comparable to those of surveys conducted by the National Department of Statistics (DANE), namely, the National Household Survey and the Microenterprise Survey. Because households may be composed of individuals with different occupational statuses,[12] we estimate incidence on an individual basis but restrict the unit of analysis to the household head when it comes to classifying a household's assets.

In order to measure the degree of establishment-level informality, we consider two criteria that a firm operating in the formal sector must satisfy. These criteria are the following: carrying of a book-keeping system (BKS),[13] and commercial registration (CR). Thus, we posit two different definitions of informality as follows:[14]

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[12]Given the longitudinal nature of the ELCA, the follow up is conducted on the head of the household, his/her spouse and offspring under 10 years of age.

[13]This criterion encompasses establishments who record operations using a ledger, a profit and loss statement or any other sort of accounting record (e.g., a notebook or spreadsheet).

[14]Another important criterion pertains to compliance with social security and payroll contributions (SSC). Hamann and Mejía (2013) form combinations of these criteria (BKS, CN and SSC) in order to

E.1. Partial informality due to the lack of commercial registration (no CR), and

E.2. Partial informality due to the lack of a book-keeping system (no BKS).

As for labor informality, we consider six defining criteria as follows:

W.1. DANE (10 workers): The DANE defines as informal those individuals who fall into the following categories:

  (i) workers in firms with up to 10 employees;

  (ii) unpaid family aids;

  (iii) unpaid workers in other households' firms or businesses;

  (iv) domestic housekeepers;

  (v) day laborers or pawns;

  (vi) own-account workers in establishments with up to 10 employees (exception made for independent professionals and technicians), or

  (vii) business owners of firms with up to 10 employees.

W.2. DANE (5 workers): This criterion is similar to the previous one, but switches the firm size from 10 to 5 employees.

W.3. Health: This criterion defines as informal those workers who are not affiliated with the health care system, nor pay contributions thereto. It also includes those workers belonging to the subsidized health care regime and/or who are beneficiaries from their spouses or families.

W.4. Pension: This criterion encompasses as informal those workers who do not contribute to a pension fund at the time of the survey.

W.5. Health or pension: This criterion classifies as informal those workers who are informal either health-wise or pension-wise according to the former two criteria.

W.6. Health and pension: This criterion is similar to the previous one, but switches from the either-or to the both-and connection.

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obtain estimates of firm informality using data from the Microenterprise Survey. The ELCA, however, does not elicit information regarding payments to the social security system, and hence we cannot allow for this definition or combinations based thereon.

With all these definitions, we compute several distributional statistics pertaining to earnings, savings and wealth in the formal and informal sectors. Wealth, in particular, is assessed based on the following variables:

- Gross assets: It is the sum of the value of physical assets (vehicles, land plots, buildings, machinery and equipment, office equipment, transportation equipment, livestock, and other physical goods) and financial assets (cash; money deposited in banks, corporations, employee funds, and cooperatives; contributions to voluntary pension and severance funds; government bonds; shares of companies on stock markets; bonds or investments on companies; money deposited in groups or saving chains; lent money) that the household owns.

- Debt: It is the sum of all debt reported by the household. This debt is owed to banks or financial institutions, employee or cooperative funds, chain stores or hypermarkets, compensation funds, guilds or associations, relatives, friends, moneylenders, armed groups, banks and financial institutions abroad, among others.

- Net assets: Gross assets - Debt.

For these variables, we calculate the mean, median, minimum, maximum, quintiles 1 to 4, coefficient of variation and Gini coefficient. We also compute these distributional statistics for earnings.

In addition to income and wealth statistics, we obtain estimates of savings, defined as gross financial assets, at the individual and aggregate level for each occupation and the entire sample following the mentioned informality definitions. Then we calculate the saving rates with respect to earnings and income. For individual savings, both totals and rates, we compute the mean, median, minimum, maximum, quintiles 1 to 4, and coefficient of variation.

Furthermore, we determine the number of savers corresponding to each occupational status. With these data and the mean savings mentioned above, we can estimate total financial assets per occupation and, by adding them up, obtain aggregate savings. Computing the percentage of these savings held by each of the four occupations is possible through simple division.

Lastly, the ELCA elicits information from individuals over 10 years of age concerning their reasons for saving. We arrange the responses and categorize them into five motives as follows:

i. Precaution: Individuals who save for future and old age, or for unexpected events.

ii. Asset accumulation: Individuals who save to buy a house, a car, or other assets.

iii. Investment: Individuals who save in order to start up or invest in a business.

iv. Education: Individuals who save to pay for their own education or that of their children.

v. Consumption: Individuals who save for entertainment and recreational purposes.

We subsequently obtain the total number of respondents claiming such motives and, using the defining criteria above, estimate the fractions corresponding to formal and informal occupations and individuals.

C   Savings weights by occupation and sector

Table 7: Savings weights

	Model	Data
Workers		
Formal	36.97%	51.24%
Informal	23.93%	14.43%
Entrepreneurs		
Formal	23.93%	19.35%
Informal	15.18%	14.99%

Table 8: Preference and technology parameters

	β				σ				κ			
	0.961	0.967	0.971	0.974	1.50	2.17	2.83	3.50	0.361	0.366	0.371	0.376
AGGREGATE ASSETS	0.064	0.072	0.115	0.183	0.085	0.105	0.147	0.236	0.136	0.131	0.105	0.131
WEIGHTS												
Workers												
Formal	36.55%	32.13%	44.31%	38.79%	32.60%	37.90%	38.79%	41.85%	24.28%	28.60%	36.98%	41.65%
Informal	25.38%	29.28%	21.64%	17.74%	17.01%	23.68%	19.23%	20.77%	39.66%	37.64%	26.42%	18.25%
Entrepreneurs												
Formal	00.00%	00.00%	10.32%	30.91%	29.81%	22.60%	28.09%	26.00%	0.00%	3.22%	17.87%	24.19%
Informal	38.07%	38.59%	23.73%	12.56%	20.58%	15.82%	13.89%	11.39%	36.06%	30.54%	18.73%	15.91%

38

Table 9: Productivity process and formal interest rate

	unconditional variance				p				R^*			
	0.38	0.41	0.43	0.45	0.68	0.70	0.72	0.75	1.0138	1.0152	1.0165	1.0178
AGGREGATE ASSETS	0.137	0.116	0.138	0.152	0.170	0.109	0.092	0.106	0.086	0.096	0.118	0.130
WEIGHTS												
Workers												
Formal	27.67%	39.52%	48.10%	54.60%	27.90%	36.97%	45.16%	61.31%	33.37%	40.50%	44.20%	41.61%
Informal	39.81%	21.90%	10.35%	5.63%	16.83%	23.93%	29.01%	19.25%	18.96%	23.35%	18.99%	18.38%
Entrepreneurs												
Formal	0.00%	23.78%	29.24%	24.61%	44.84%	23.93%	00.00%	00.00%	26.18%	19.06%	16.71%	23.87%
Informal	32.52%	14.80%	12.31%	15.16%	10.42%	15.18%	25.83%	19.44%	21.49%	17.09%	20.10%	16.14%

Table 10: Firm taxation and entry costs

	τ^w					τ^c				η			
	0.251	0.262	0.273	0.284	0.295	0.17	0.18	0.19	0.20	0.09	0.10	0.11	0.12
Aggregate Assets	0.182	0.168	0.150	0.139	0.099	0.151	0.136	0.125	0.099	0.146	0.109	0.099	0.099
Weights													
Workers													
Formal	36.70%	34.39%	31.58%	35.35%	41.55%	37.80%	40.83%	42.11%	41.55%	31.75%	36.97%	41.55%	41.55%
Informal	8.02%	10.08%	12.76%	14.05%	30.54%	15.80%	17.53%	20.63%	30.54%	14.45%	23.93%	30.54%	30.54%
Entrepreneurs													
Formal	50.71%	50.46%	49.37%	35.92%	00.00%	40.04%	27.25%	17.39%	0.00%	45.26%	23.93%	00.00%	00.00%
Informal	4.57%	5.07%	6.29%	14.69%	27.91%	6.36%	14.39%	19.86%	27.91%	8.54%	15.18%	27.91%	27.91%

Table 11: Formal labor costs and firms' productivity advantage

	$w_{\min}$					τ^y					Z				
	0.120	0.125	0.129	0.134	0.138	0.290	0.301	0.312	0.323	0.334	1.000	1.004	1.008	1.012	1.016
AGGREGATE ASSETS	0.122	0.124	0.154	0.142	0.023	0.105	0.140	0.126	0.131	0.127	0.109	0.151	0.166	0.169	0.208
WEIGHTS															
Workers															
Formal	42.63%	65.75%	67.23%	68.16%	68.78%	66.99%	59.32%	52.45%	42.31%	41.45%	36.97%	37.91%	34.46%	34.58%	37.64%
Informal	22.01%	14.79%	12.23%	20.18%	21.07%	25.24%	10.73%	15.96%	17.24%	20.75%	23.93%	15.69%	9.99%	9.92%	6.62%
Entrepreneurs															
Formal	13.29%	0.00%	0.00%	0.00%	0.00%	0.00%	14.95%	20.79%	25.32%	18.25%	23.93%	40.03%	50.41%	50.49%	51.98%
Informal	22.07%	19.46%	20.54%	11.65%	10.15%	7.78%	15.00%	10.80%	15.12%	19.55%	15.18%	6.37%	5.14%	5.00%	3.76%