Informal Sector Misallocation

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Abstract

I develop a quantitative framework of firm dynamics where the size of the informal sector is determined by financial constraints and the burden of government taxation in the formal sector. Informal sector firms do not pay taxes but have no access to external finance and face sector specific costs that limit their optimal scale of production. I then evaluate the impact of different policies for a calibrated model economy that resembles Mexico. I find that the aggregate effects of a complete elimination of formal sector registration costs are small (in contrast with quantitative models that ignore financial constraints and the informal sector). Improving the access to credit for formal sector firms increases wages, aggregate TFP and output per worker while reducing the size of the informal sector. An increment in the volume of credit relative to GDP to the levels of the US leads the informal sector to almost disappear. I evaluate the introduction of a stochastic tax-enforcement technology in a dynamic environment (work in progress): informal sector firms are detected by the government and forced to register (or exit) with a probability that depends on the scale of production. The model is extended to consider size-dependent taxes on firm output and labor.

JEL Classification: D24, E26, L11, O16, O17.

Keywords: informal sector, misallocation, aggregate productivity, financial constraints, economic development, government policy and enforcement, size-dependent taxes.

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1 Introduction

In many developing countries the informal economy accounts for over 30% of non-agricultural employment and well above 30% of GDP.[1] The informal sector has long been associated with financial underdevelopment and the excessive burden of taxes and regulation and has been attributed significant losses in terms of aggregate productivity, capital accumulation and output. This paper has two objectives: (1) to quantify the losses associated with the existence of a large informal sector, (2) to evaluate policies intended to ameliorate these losses.

We build a model of entrepreneurship and stochastic firm dynamics based upon the frameworks of occupational choice and industry equilibrium of Lucas (1978) and Hopenhayn (1992). Individuals differ in their ability to operate a decreasing returns to scale technology but are homogeneous as workers. More able entrepreneurs set-up firms and decide whether to belong to the formal or informal sector (an early example of self-selection in a static environment is Rauch, 1991). The trade-off is the following: firms in the informal sector avoid taxation and the costs of registration and face an additional cost of production that represents the costs of not having access to enforcement of commercial contracts, inferior access to public services and infrastructure, etc. (De Soto, 1989; Perry et al., 2007). This cost limits the optimal scale of firms in the informal sector. Across countries the size of the informal sector is determined by financial constraints and the burden of government taxation.

Financial constraints restrict the amount of capital used by entrepreneurs and have a leading role in the model. In equilibrium the size of the informal sector depends on the burden of taxes and access to credit in the formal sector. Intuitively, lower access to credit in the formal sector reduces the demand for labor and the wage level. This leads to individuals with lower entrepreneurial ability to set-up firms in the informal sector. Informal sector entrepreneurs have no access to external finance.[2] The entrepreneur may choose to start-off in the informal sector and later transition to the formal sector depending on his assets and ability.[3]

We first calibrate a quantitative model to match certain key statistics of a developing economy with large informal sectors (we consider the cases of Mexico, Egypt and Turkey). We find that the frictions considered go a long way in accounting for

[1] Statistics of informal sector employment are discussed in Section 2. Schneider and Enste (2000) describe nine widely applied methodologies of estimating the size of the *shadow economy*, highlighting their respective advantages and weaknesses. Data based on labor force and micro-business surveys (as the ones used here) are generally preferred. The *shadow economy* includes all market-based legal production of goods and services that are concealed from public authorities to avoid taxation, social security contributions and compliance with regulation in general, while pure household production, voluntary nonprofit (social) services and criminal activities are excluded.

[2] The difficulties for informal sector firms to collateralize their assets were already stressed in the work of De Soto (1989). In the same manner, Straub (2005), Catão et al. (2009) and Perry et al. (2007) emphasize the requirements of financial institutions such as credible documentation of physical location and pledgeable assets of the firms, their financial statements, etc. which, because of their nature, are not available for informal sector firms.

[3] Alternatively, Levenson and Maloney (1998) analyze the dynamic nature of informality in a model where entrepreneurial ability is initially unknown, surviving and more able entrepreneurs transition to the formal sector as they learn their ability.

the differences in aggregate total factor productivity (TFP), the average size of firms and output per capita relative to developed economies. Then we evaluate the impact of three different policies: (1) the complete elimination of the costs of registration and minimum capital requirements in the formal sector, (2) an improvement of access to credit in the formal sector, (3) the introduction of a tax-enforcement technology where informal sector firms may be detected with a probability that is increasing in the scale of production, and then are forced to either register and enter the formal sector or exit (the evaluation of this policy is work in progress). I find that the impact of a policy that eliminates registration costs is small. This is consistent with country level case studies that analyze this type of reforms. Improving the access to credit for formal sector firms increases wages, aggregate TFP and output per worker while reducing the size of the informal sector. An increment in the volume of credit relative to GDP to the levels of the US leads the informal sector to almost disappear.

The rest of the paper is organized as follows. In Section 2 we overview the related literature. In S.3 we document the key empirical facts that guide the construction and calibration of the quantitative framework: we compare the size distribution of firms, define the informal sector and provide estimates of its size in Mexico, Egypt and Turkey and exploit firm level data to document empirical regularities of informal sector firms compared to those in the formal sector. The model is presented in S.4. A brief characterization of the equilibrium and the sources of misallocation in the model are discussed in S.5. The calibration procedure and institutional parameters are discussed in S.6. In S.7 we present the main quantitative results and conduct and discuss policy experiments. Finally, we conclude with Section 9.

2 Relation to the Literature

This paper builds upon several recent strands of the macro-development literature. A brief overview follows.

The *misallocation* literature underscores the macroeconomic implications of distortions to the allocation of resources across firms, typically focusing on aggregate TFP and output losses, capital accumulation and the size and productivity distribution of firms. Hsieh and Klenow (2009) find that gaps in the marginal products of labor and capital across plants can explain a large part of the differences in TFP between China and India compared to the US. Busso et al. (2012) perform a similar empirical exercise for Mexico analyzing informal and formal sector firms. Restuccia and Rogerson (2008) analyze the potential quantitative effects of idiosyncratic tax schemes, suggesting the importance of evaluating specific distortions. Accordingly, Guner, Ventura and Xu (2008) and Garcia-Santana and Pijoan-Mas (2014) study policies that impose restrictions on the size of firms. Barseghyan and DiCecio (2011) asses the role of entry costs, including regulatory/legal fees for registering firms as well as non-regulatory sunken costs. Financial frictions have also been studied. For recent quantitative examples see Buera, Kaboski and Shin (2011) who analyze endogenous collateral constraints and Greenwood, Sanchez and Wang (2013) who focus

on the role of costly state verification, among many others.[4] Midrigan and Xu (2013) challenge the view that financial constraints can represent a quantitatively relevant source of aggregate productivity losses through the dispersion in the marginal product of capital.

There is a sizable literature that analyzes the determinants of the size of the informal sector. Many results are now standard:[5] the size of the informal sector decreases as credit availability improves in the formal sector (Straub, 2005; Antunes and Cavalcanti, 2007; Quintin, 2008; Catão et al., 2009; D'Erasmo and Moscoso-Boedo, 2012); the size of the informal sector increases with labor-market restrictions, heavier regulation of entry and the tax burden of the formal sector and decreases with enforcement of legal obligations (Djankov et al., 2002; Ihrig and Moe, 2004; Antunes and Cavalcanti, 2007; Perry et al., 2007; Prado, 2011; Leal-Ordoñez, 2014). At the firm level, compliance with regulation is associated with better access to external finance and informal sector firms are found to be less capital intensive, less productive, smaller and younger (Levenson and Maloney, 1998; Amaral and Quintin, 2006; Perry et al., 2007; La Porta and Shleifer, 2008; Pratap and Quintin, 2008; World Bank, 2010; de Paula and Scheinkman, 2011; Busso, Fazio and Levy, 2012).

These two strands of literature are linked. Several papers have analyzed the informal sector in models that incorporate firm dynamics. Amaral and Quintin (2006) and Antunes and Cavalcanti (2007) combine occupational choice with credit constraints to quantify the role of this friction taking into account the role of the informal sector. Quintin (2008) finds that lax tax enforcement alone does not suffice to generate a large informal sector and contractual imperfections are needed. The present paper is perhaps most closely related to D'Erasmo and Moscoso-Boedo (2012). They develop a model of firm dynamics with imperfect debt enforcement and also evaluate the impact on aggregate TFP, capital accumulation and the size distribution of firms. They find that these frictions can explain a drop in total factor productivity of up to 25%. The effect of each friction is analyzed and they find that entry costs account for 3/4 of TFP differences across countries.[6]

Different authors have considered the role of tax enforcement: Fortin, Marceau and Savard (1997), de Paula and Scheinkman (2011), Prado (2011), Leal-Ordoñez (2014). It is not surprising that this type of policy has received attention in policy and corporate circles (UK National Audit Office, 2008; McKinsey Global Institute,

[4]The growth of smaller firms is particulary constrained by the underdevelopment of the financial system. This mechanism has been found to be empirically more robust than other obstacles to firm-growth such as inefficient regulation and taxation, inadequate enforcement of property rights, political instability, poor provision of infrastructure, etc. (Beck and Demirgüç-Kunt, 2006).

[5]Schneider and Enste (2000), Tybout (2000) and Perry et al. (2007) offer extensive sets of references related to the informal sector. The literature also analyzes other issues of the informal sector related to inequality, labor market segmentation, human capital accumulation, the consequences of trade reform, optimal audit policies, corruption and rent-seeking bureaucracies. These topics are outside the scope of this project. De Soto (1989), a classic reference in the literature, already emphasized the impact of an overburdening regulatory system, weak property rights enforcements and lack of access to external finance in the informal sector.

[6]In my model, entrepreneurs may start their firm in the informal sector and, depending on their productivity, save to register in the formal sector.

2006). I extend the consideration of government tax enforcement to a setting with firm dynamics.

3 Empirical Analysis

In this section I document the key empirical facts that guide the construction and calibration of the quantitative framework. First I compare the distribution of employment and firms by size class for the US, with three developing economies: Mexico, Egypt and Turkey. In the developing economies a relatively large share of the non-agricultural private labor force belongs to small firms (less than 10 workers). Next, I define informal sector employment and provide measures of its size in these countries. Then, using micro-level databases for the three developing economies, I document how the formal/informal status and the capital-labor ratios of the firms are related to education and experience of the manager, size and age of the firm, revenue per worker and the ratio of skilled to total workers in the firm, while controlling for other variables that are standard in the literature.[7]

3.1 Distribution of Employment and Firms

In the US firms with less than 10 workers, represent 74.5% of the total number of firms and account for 12% of employment.[8] For Mexico, Egypt and Turkey the share of firms with less than 10 workers is approximately 95% and these firms account for over 67% of employment.

Table 1. Dist. of Employment and Firms by Size Class.

	dist. employment			dist. of firms		
size of firm:	<10	10-49	≥50	<10	10-49	≥50
US	11.8	19.1	69.1	74.5	20.5	5.0
Mexico	72.2	11.5	16.3	95.6	3.5	0.1
Turkey	67.0	16.0	17.0	95.0	3.2	1.8
Egypt	77.3	10.3	12.4	95.7	4.0	0.3

Recent work by Poschke (2014) documents the increase of average firm employment with income per capita (entrepreneurship and the importance of small firms fall with income per capita). Unsurprisingly, the preponderance of smaller firms in developing countries has been associated to the informal sector (see Tybout, 2000) and self-employment (Gollin, 2000).

[7]Examples in this literature are: Levenson and Maloney (1998) for Mexico, de Paula and Scheinkman (2011) for Brazil, World Bank (2010) for Turkey (same dataset for this country) and La Porta and Shleifer (2008) using cross-country firm level data.

[8]See the appendix for a description of the sources for Table 1.

3.2 The Informal Sector

In this section the concept of informal sector is defined and estimates of its size are provided for the countries of interest. As emphasized in the literature, informality encompasses different phenomena. In developed economies, informality is generally associated with tax evasion and undeclared labor in registered firms. In emerging economies it is typically associated with small unregistered firms that avoid all or most forms of taxation. We make an important distinction here, following ILO (2012):

> Employment in the informal sector is an enterprise-based concept and covers persons working in units that have *informal* characteristics in relation to, e.g., the legal status, registration, size, the registration of the employees, their bookkeeping practices, etc. Informal employment is a job-based concept and encompasses those persons whose main jobs lack basic social or legal protections or employment benefits and may be found in the formal sector, informal sector or households.

Informal employment can include workers in larger firms with relatively better access to finance that comply with most of their legal obligations.[9]

In Egypt, the share of informal wage workers in the private non-agricultural sector is 81.5% (Abdelhamid and El Mahdi, 2003). Wahba (2009) finds[10] that informal employment represented 76% of total private, non-agricultural waged employment in 2006 (80.5% in 1998). Of total micro and small enterprises, 82% are informal (El Mahdi, 2002; Ministry of Foreign Trade, 2003). Since small and micro enterprises contribute to 77% of the jobs in the non-agricultural private sector,[11] we can then estimate that informal sector employment represents approximately 63% of total non-agricultural private employment.

In Turkey, the informal sector accounts for approximately 25-39% of employment depending on different estimation criteria applied (Bulutay and Tasti, 2004). For Mexico, Leal-Ordoñez (2014) exploits data from the Economic Census and the micro-enterprize and household surveys to reach an estimate of 45% of employment

[9] See International Labour Office (2012) for a sample of countries where data for both informal employment and informal sector employment is available. For comparison, in India the figures are 83% and 67% respectively in non-agricultural activities. The informal sector is large in most developing economies such as, for example, Pakistan (73%), Philippines (72%), Colombia (52%), Peru (49%). An extension of the quantitative framework will take into account the possibility of informal employment in registered firms.

[10] Data from the Egypt Labor Market Surveys, carried out by the Economic Research Forum in cooperation with CAPMAS. An even more conservative estimate for informal sector employment can be computed considering only informal (no contract, no social security): self-employed, employers, unpaid family workers, casual workers. This results in approximately 40% of the labor force 1998.

[11] Before the reform described below, in Egypt the process to obtain a business license required 372 days and 127 administrative steps passed before 50 public entities. Dissolution and settlement procedures consisted of 25 bureaucratic steps during 244 days and a cost equivalent to over 20 monthly salaries of a worker. A bankruptcy process consisted of 53 bureaucratic steps, 653 days and the equivalent of well over 50 monthly salaries of a worker (Abdelhamid and El Mahdi, 2003).

in the informal sector. Estimates for the US are not available,[12] illegal foreign workers represent 3.5% of the workforce (OECD, 2004). However, illegal immigrant work is a different concept from informal sector employment.

3.3 Firm Level Data and Evidence

The ERF firm level data was collected by teams supervised by Dr. Alia El Mahdi (Egypt) and Dr. Semsa Ozar (Turkey), as part of the project: Promoting Competitiveness in Micro and Small Enterprises in the MENA Region (Middle East and Northern Africa). The database[13] includes, for each country, information on approximately 5,000 micro and small enterprises (less than 50 workers) in urban areas and covers all sectors except agriculture.

Among the main activities at the four digit level (ISIC, 3rd Revision) in Turkey we observe: maintenance and repair of motor vehicles (5020, 14.9% of observations), other retail in specialized stores (5239, 8.6%), restaurants, bars and canteens (5520, 7.7%), retail sale of textiles, clothing, footwear and leather goods (5232, 6.7%), retail sale in non-specialized stores with food, beverages or tobacco predominating (5211, 5.3%). Two manufacturing activities enter the top ten sectors at the four digit levels: manufacturing of wearing apparel, except fur apparel (1810, 2.6%) and manufacture of furniture (3610, 2.6%). In Egypt, retail sale of food, beverage and tobacco (5220, 26.9%) represents a larger share of total observations and the top manufacturing industry is that of other fabricated metal products (2899, 3.7%) at the seventh position, otherwise the group of top ten activities is unchanged.

The status of a business, formal/informal, is defined according to compliance with legal requirements: a formal firm has a licence, business registration and registration with tax authorities and social security subscription.[14] With this baseline definition the share of informal firms is 36% and 24% for Egypt and Turkey, respectively (in this database). Different (more lax) definitions of informality were used as a robustness check on the regressions below, with very similar results. The different definitions of informal status are highly correlated as firms decide simultaneously on the compliance with respect to different obligations (see for example Perry et al. Ch.

[12] Neither the BLS nor the ILO have data on informal employment for the US, where it is generally associated to work by illegal migrants (OECD, 2004). The share of the labor force without pension contributions was 7.8% in 2003 (World Development Indicators).

[13] A detailed description of the dataset and methodology for Turkey is found in Ozar (2006). In the case of Turkey, the survey was designed so that the weighted results capture the actual distribution of micro-small enterprises across sectors of activity, size, location and gender. The sampling was national in coverage and chosen by stratified, multi-stage systematic sampling method by TurkStat. On the basis of pre-test surveys and assessment of field experience, questions judged to be inaccurate were modified or excluded. Several questions were identified to ensure the consistency among the responses of the interviewees and participation in the survey was voluntary.

[14] For the ERF Egypt database, in particular, registration certificates were verified during the survey, the results are similar across countries in this database. In all cases surveys were voluntary, strictly confidential and conducted by non-government organizations. As would be expected, there is evidence of very high correlation between a firm's registration status, its tax and social security contributions compliance, as in Catão et al. (2009), for example.

5, 2007).

For Mexico, the micro-enterprize database ENAMIN is collected by the national statistics institute INEGI (see Leal-Ordoñez, 2014). The formal sector status is determined according to registration with the Ministry of Finance: for the year 2002, 56 percent of the firms in the sample were informal according to this definition. The main activities at the 3 digit level (CAE classification system) are: retail trade (621, 23.9%), repair services (721, 12.4%), construction (600, 9.6%), passenger transportation (641, 8.7%), food services (630, 6.9%) and domestic services (726, 3.7%).

Table 2. Probit Estimates of Informality.

database	Turkey	Egypt	Mexico
workers	-0.046***	-0.211***	-0.355***
working experience	-0.013***	-0.002	-0.004
years of educ. manager	-0.022***	-0.031***	-0.648***
age of firm	-0.027***	-0.086***	-0.030***
age of firm squared	0.001***	0.001***	0.001***
years current management	-0.008**	0.001	−−
revenue/workers (log)	-0.149***	-0.197***	-0.344***
skilled workers/total	-0.286***	-0.127	-0.513***
number of relatives at work	0.083***	0.039	−−
born rural	0.213***	0.272***	−−
industry controls	3 dig.	3 dig.	3 dig.
geographic controls	−	#8 gov.	#33 ent.
pseudo R2	0.13	0.22	0.33
n. observations	3803	4696	2007
Statistical significance: *** 1%, ** 5%, * 10%.			

Table 2 shows the probit estimates for informality (unavailable and statistically insignificant variables are excluded for Mexico). The probability of informality status is decreasing in education and work experience of the manager,[15] age of the firm, the number of workers, years of current management, the ratio of skilled to total number of workers and revenue per worker. The probability of informality status is increasing in the number of relatives of the manager working in the firm and whether the entrepreneur was born in a rural area.

[15]La Porta and Shleifer (2008), among others, emphasize the evidence on the substantial differences in terms of human capital of managers between the registered and the unregistered firms. For Mexico, the education variable consists of the following categories: no instruction, elementary education, secondary ed., vocational instruction, undergraduate degree, master's level education, doctorate.

Table 3. Regressions of Capital Labor Ratios (OLS).

database	Turkey	Egypt	Mexico
informal	-0.245***	-0.261***	-1.509***
years of educ. manager	0.059***	0.033***	0.658***
working experience	0.006**	0.005***	0.003
years current management	0.009***	0.002	−−
age of firm	0.013***	-0.006**	0.016**
skilled workers/total	0.383***	0.097	0.614***
revenue/workers (log)	0.423***	0.547***	0.477***
constant	11.053***	8.787***	5.131***
industry controls	3 dig.	3 dig.	3 dig.
geographic controls	−	#8 gov.	#33 ent.
R2	0.34	0.29	0.33
n. observations	3349	4755	2052
Statistical significance: *** 1%, ** 5%, * 10%.			

Table 3 shows the results of OLS regression with the log of capital-labor ratios as the dependent variable. Capital is defined as the book value of structures, buildings, tools, equipment and inventories. Again, different definitions of informality were used with similar results: for Egypt, for example, defining informality simply as firms not registered with the tax administration implied even larger coefficients of informality on the regressions of the capital labor ratios. Regressions on revenue per worker as the dependent variable also showed clear significant and negative coefficients of informality.[16]

4 The Model

The model builds upon the frameworks of occupational choice and industry equilibrium of Lucas (1978) and Hopenhayn (1992). There is a continuum of individuals that differ in their ability as entrepreneurs but are homogeneous in terms of their productivity as workers. Individuals are born as workers and, with some probability in every period, face the decision of becoming entrepreneurs.

Entrepreneurs have access to a decreasing returns to scale technology and have the option of conducting their business in the informal or formal sectors. The trade-off for this decision is as follows: firms in the informal sector do not pay taxes and avoid the fixed cost of registration and the initial minimum capital requirement.

[16]The general lack of book-keeping, recalling errors, volatility of production and fungibility of production inputs with household production make the estimation of productivity of informal sector firms a challenging task (La Porta and Shleifer, 2008). Regardless of this difficulty, basic measures of productivity, as well as other variables such as revenue per worker, are negatively correlated with informality. These differences across sectors can be due to self-selection in addition to intrinsic characteristics of informal and formal sector firms.

However, there is a convex cost specific to production in the informal sector, motivation for which is provided below. Formal sector entrepreneurs have better access to external finance as determined by collateral constraints. Additionally, we will consider government tax enforcement: the volume of output produced by informal sector firms determines the probability of detection by the authorities. If detected, informal sector entrepreneurs have to pay the fixed cost of registration and enter the formal sector, or lose their physical production capital and become workers.

Time is discrete and the problem of individuals is dynamic: they are able to accumulate financial assets and may find optimal to start their enterprize in the informal sector until they reach a certain level of financial wealth and then register to operate as a formal sector firm (a decision that will also depend on a transitory productivity shock and their permanent entrepreneurial ability). The analysis is restricted to the steady state of a small open economy[17] with no aggregate uncertainty.

4.1 Production Technology

Firms produce an homogeneous final good that serves as the numeraire. Firms in the formal sector have access to a standard production technology with decreasing returns to scale, but they differ in the entrepreneurial parameter φ, as given by the owner and manager of the firm:

$$q(s,f) \;=\; \varphi\, e^{a}\, f(k,l)^{\gamma} \quad \text{with} \quad f(k,l) \;=\; k^{\alpha}\,(l+\psi)^{1-\alpha} \tag{1}$$

where k is capital equipment, total labor input is the sum of hired labor $l \geq 0$ and the work of the entrepreneur[18] $\psi \in [0,1]$, $\gamma < 1$ is the span-of-control parameter of Lucas (1978), which determines the returns to scale. In addition to the differences in the permanent ability component, the firm is subject to productivity shocks a, which follow a discrete state Markov process with transition density $\Lambda(a' \,|\, a)$, where $e^{\bar{a}} = 1$ results from the unconditional mean of a. This matrix is constructed as a discrete representation of an AR(1) process. Individuals are indexed by state variables $s = \{\varphi, a, b\}$, where b are financial assets, and $z \in \{w, i, f\}$ denotes whether the individual is a worker or an entrepreneur in the informal or formal sectors, respectively. $M(s,z)$ is the mass of individuals over the state $\{s,z\}$.

4.2 Workers

Every period a mass of individuals is born and their permanent entrepreneurial ability is drawn from a density distribution $h(\varphi)$. At birth, individuals receive an en-

[17] Credit conditions in developing countries have been largely associated with exogenous factors such as policy-controlled interest rates, conditions in international financial markets and intermediation efficiency and market power in the financial sector (Catão et al., 2009). Higher interest rates typically observed in developing countries have been attributed to inefficient and uncompetitive financial markets (Greenwood, Sanchez and Wang, 2013). Note that Midrigan and Xu (2013) find larger misallocation losses for a closed economy relative to a small open economy in their model.

[18] This technology accounts for the labor input of managers in micro-firms, a segment that accommodates a large part of the labor force in developing economies (Gollin, 2008).

dowment of financial assets $\overline{b}$ (which can be thought of as bonds). The initial shock a is drawn from the unconditional distribution derived from $\Lambda(a' \mid a)$. Individuals value consumption of the final good through their lifetime[19] utility $\mathbb{E}_0 \sum_{t=0}^{\infty}(\beta\,(1-\delta))^t\, u(c_t)$, with period utility $u(c) = c^{1-\phi}/(1-\phi)$, discount factor β and probability δ that the individual dies in any period. An individual that dies is immediately replaced by a newly born so that the mass of individuals remains constant.

Individuals are born as workers and offer their labor services inelastically at a wage w. In every period, with some probability $P(x)$, they may receive a shock $x = 1$ which gives them the option to become entrepreneurs. As workers, they are homogeneous and free to move between the informal and formal sectors, thus there is a unique wage for all workers.[20] The problem of workers amounts to a savings decision, written as the policy function $b' = g_w(\varphi, a, b)$, and their occupation choice:

$$v_w(\varphi, a, b) = \max_{\{c, b' \geq 0\}} u(c) + \beta\,(1-\delta) \sum_{\{a',\, x'\}} P(x')\,\Lambda(a' \mid a)\, v(\varphi\, x', a', b') \qquad (2)$$

$$\text{s.t.} \quad c + b' = w + (1+r)\, b$$

The occupation choice is:

$$v(\varphi\, x, a, b) = \max\{\, v_w(\varphi\, x, a, b)\,,\; v_i(\varphi\, x, a, b)\,,\; v_f(\varphi\, x, a, b - c_e \mid b \geq \underline{b})\,\} \qquad (3)$$

where f and i refer to the formal and informal sectors respectively, c_e is the cost of entering the formal sector (there are no fixed costs of entering the informal sector). To register in the formal sector there is a minimum capital requirement condition, $b \geq \underline{b}$.[21] We turn next to the problem of the entrepreneurs in the formal and informal sectors.

4.3 Formal Sector Entrepreneurs

At the beginning of every period the entrepreneur relinquishes his financial wealth b to a financial intermediary. This deposit earns a net interest rate r. Within the period the entrepreneur is able to collateralize this deposit to obtain capital $k(s, f)$. A collateral constraint restricts the level of physical capital used in any given period by $k \leq \lambda_f\, b$, where λ_f determines the extent to which the formal sector entrepreneur is able to collateralize his financial wealth. At the end of the period the entrepreneur makes total factor payments $w\, l$ for hired labor input and $(r+\nu)\, k$ (which includes the physical capital depreciation rate ν) and receives $b\,(1+r)$ from his

[19] We follow a standard assumption in the literature in considering risk averse individuals. See, for example, Buera, Kaboski and Shin (2011) and references therein contained. Given the focus on occupational choice and the problem of small-firm entrepreneurs in developing countries this seems to be the relevant approach. In Egypt approximately 92% of all enterprises have only one proprietor and firms with less than 10 workers account for well over 70% of employment.

[20] The evidence on whether labor markets are segmented between informal and formal sector firms suggests mixed results at best. See the discussions in Maloney (2004), Pratap and Quintin (2008) and Perry et al. (2007, Ch. 3). Wage inequality is a topic outside the scope of this paper.

[21] In many countries it is possible to withdraw the minimum capital requirement immediately after registration and is therefore recoverable (Djankov, 2009; Barseghyan and DiCecio 2011).

deposit. We can define intratemporal debt as $d = k - b$, which determines net interest rate payments. The entrepreneur also faces an intertemporal decision to save, the solution to which is given by the optimal policy function $b' = g_f(\varphi, a, b) \geq 0$. The dynamic program of this type of entrepreneur is written as:

$$v_f(s) = \max_{\{c,l,k,b' \geq 0\}} u(c) + \beta\,(1-\delta) \sum_{\{a'\}} \Lambda(a' \,|\, a)\, \max\{\, v_f(s')\,,\, v_w(s')\,\} \tag{4}$$
$$\text{s.t.} \quad c + b' = (1-\tau)\,\pi(s,f) + (1+r)\,b \quad \text{and} \quad k \leq \lambda_f\, b$$

with firm profits as follows:

$$\pi(s,f) = q(s,f) - w\,l - (r+\nu)\,k \tag{5}$$

Entrepreneurs in the formal sector face taxes to profits τ.[22] An entrepreneur in the formal sector may choose to become a worker, registration status is lost, but cannot switch directly into the informal sector. The assumption $\beta\,(1-\delta)\,(1+r) < 1$ is required to allow the collateral constraints to be quantitatively relevant.

4.4 Informal Sector Entrepreneurs

In the informal sector, entrepreneurs face a collateral constraint with the same specification as in the formal sector, but the extent to which they are able to collateralize their financial wealth is lower and given by $\lambda_i < \lambda_f$ (as a benchmark λ_i equals one). The policy function $b' = g_i(\varphi, a, b) \geq 0$ is the optimal solution to their savings problem. The dynamic program for an informal sector entrepreneur is:

$$v_i(s) = \max_{\{c,l,k,b' \geq 0\}} u(c) + \beta\,(1-\delta) \sum_{\{a'\}} \Lambda(a' \,|\, a)\, \left(\, (1-\hat{\kappa})\, v(\varphi, a', b') + \hat{\kappa}\, \underline{v}(s') \,\right)$$
$$\text{s.t.} \quad c + b' = \pi(s,i) + (1+r)\,b \quad \text{and} \quad k \leq \lambda_i\, b \tag{6}$$

where $\hat{\kappa} = \min\{\kappa \cdot q(s,i), 1\}$ is the probability of being detected by the government which increases continuously with output,[23] $v(s)$ has been previously defined. When detected, the entrepreneur is given the option to pay c_e and register to the formal sector, or give up the physical capital used in production and start again as a worker. If financial assets b are not enough to cover registration costs, the entrepreneur has no choice but to be a worker once again (an entrepreneur with no financial assets is not able to rent capital for production):

$$\underline{v}(\varphi, a', b') = \max\{\, v_f(\varphi, a', b' - c_e)\,,\, v_w(\varphi, a', b' - k)\,\}$$

Profits for informal sector firms are:

$$\pi(s,i) = q(s,i) - w\,l - (r+\nu)\,k \tag{7}$$

[22] An alternative tax structure with size dependent taxes is specified below as a robustness exercise.

[23] Alternatively, de Paula and Scheinkman (2011) opt for a probability that depends on the capital stock of the firm, equal to zero below a particular threshold, with a discrete jump to one above this threshold (in a static framework). I assume that enforcement is costless.

where $q(s,i) = \varphi\, e^a\, f(k,l)^\gamma\, (1 - \xi\, (\varphi\, e^a\, f(k,l)^\gamma)^\omega)$ is the production technology in the informal sector. The specification of this production technology implies an additional cost relative to formal sector firms, which becomes increasingly important with size. This cost generates an incentive for informal sector firms to operate at an otherwise suboptimal scale and represents the inability to engage in legal contracts (increasing transaction costs), bribes to corrupt officials, the cost of enforcing their property rights when not protected by the government, worse access to infrastructure facilities and services, lack of a fixed location, etc. (De Soto, 1989; Fortin et al., 1997; Levenson and Maloney, 1998; Straub, 2005; Perry et al., 2007; World Bank, 2010).[24] Additionally, this cost does not imply a distortion for the optimal capital-labor ratios.

The timing is simple: the entrepreneur first makes production and savings decisions. At the end of the period the firm may be detected by the government, in this case the entrepreneur starts the following period in the formal sector, after paying the costs of registration, or goes back to being a worker. Informal sector firms have the option to register and operate in the formal sector at the beginning of every period after observing their shock a. This decision will depend on the productivity shock, permanent ability and assets of the entrepreneur.

4.5 Aggregation

The state space is given by $\{\varphi, a, b, z\} \in S_\varphi \times S_a \times S_b \times Z$, where $S_\varphi = [\underline{\varphi}, \infty)$, $S_b = [0, \infty)$, $Z = \{w, i, f\}$, $a \in S_a$ takes on a finite number of values. Let $M : \mathcal{S}_\varphi \times \mathcal{S}_a \times \mathcal{S}_b \times \mathcal{Z} \to \mathbb{R}_+$ denote the measure of individuals over the state space and $\overline{M}$ be the total measure of individuals. A mass of individuals is born every period (equal to the mass of individuals that die) and draw entrepreneurial ability φ from a density function $h(\varphi)$. The labor market clearing condition is given by:

$$\sum_{z \in \{i,f\}} \left(\int l(s,z)\, M(s,z)\, ds \right) = \int M(s,w)\, ds \tag{7}$$

Total output in this economy is:

$$Q = \sum_{z \in \{i,f\}} \left(\int q(s,z)\, M(s,z)\, ds \right) \tag{8}$$

Government revenues are destined to projects that do not affect the production technology or utility of individuals.

4.6 Equilibrium

Given government policies $\{\, \tau, c_e, \kappa, \underline{b} \,\}$ and interest rate r, a small-open economy stationary competitive equilibrium consists of:

[24] De Soto (1989) very graphically describes a number of practices followed by informal sector entrepreneurs in Peru to avoid detection and punishment by the authorities as well as other costs of informality: dispersion of employees among a number of smaller and less visible workplaces, lack of enforcement of commercial contracts, bribes to corrupt officials (10-15% of gross income compared to 1% paid by formal small business). See also Perry et al. Ch. 5 (2007) for further evidence.

- quantities $\{q(s,z)\}_{z\in\{i,f\}}$ and production inputs $\{l(s,z),k(s,z)\}_{z\in\{i,f\}}$,
- savings functions $\{g_z(s)\}_{z\in\{i,f,w\}}$,
- wage w, values $\{v(s),v_i(s),v_f(s),v_w(s)\}$, profits $\{\pi(s,z)\}_{z\in\{i,f\}}$,
- invariant measure $M(s,z)$,

such that:

- workers solve (2), formal sector entrepreneurs solve (4) and informal sector entrepreneurs solve (6),
- market clearing condition for labor (7) holds, the proceeds from taxation are dissipated,
- the measure $M(s,z)$ is consistent with workers and entrepreneurs' policy functions, optimal decision rules and detection probabilities.

5 Firm Dynamics and Misallocation

In an economy with an informal sector occupational choice is depicted as in Fig. 1, which graphs the occupation decision function for a worker:

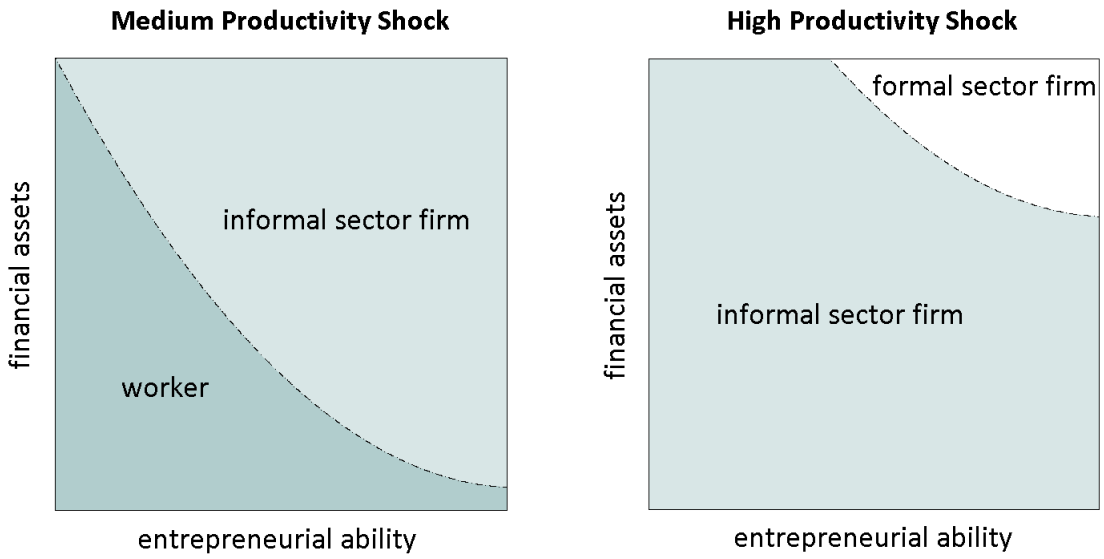
$$v(\varphi,a,b)=\max\{\, v_w(\varphi,a,b)\,,\, v_i(\varphi,a,b)\,,\, v_f(\varphi,a,b-c_e\,|\,b\geq\underline{b})\,\}$$

where the value of the idiosyncratic productivity shock is fixed in each panel. Individuals with relatively low entrepreneurial ability φ and little financial assets decide to become workers. Those with high enough entrepreneurial ability choose to run a firm depending on the level of assets and the productivity shock. Entrepreneurs may opt to start in the informal sector and eventually transition to the formal sector. On average more able entrepreneurs will move earlier to the formal sector. In the model, this is due to the nature of the informal sector specific costs, which is more costly (relative to the linear taxes of the formal sector) for the higher ability individuals. The result that more productive entrepreneurs are the ones likely to expand and benefit from a formal-status is intuitive (see Fajnzylber et al., 2011).

Additionally, given the levels of ability and productivity, entrepreneurs with more assets will transition to the formal sector. This result is derived from the combination of financial constraints and the informal sector specific marginal cost: for high entrepreneurial ability the after-tax profits of a formal firm becomes higher than profits for an informal firm at a lower level of financial assets (Fig. 2).[25]

[25]This property is inherited from the profit functions of the formal and informal sectors. This is in contrast with Antunes and Cavalcanti (2007) and Amaral and Quintin (2006) where wealthier agents are more likely to opt for the informal sector.

Figure 1. Occupational Choice



Productive efficiency requires equal marginal product of physical capital across firms. For firms in the formal sector the first order condition for physical capital is (abstracting from taxes):

$$q_k(s, f) = r + \nu + \mu(s, f)$$

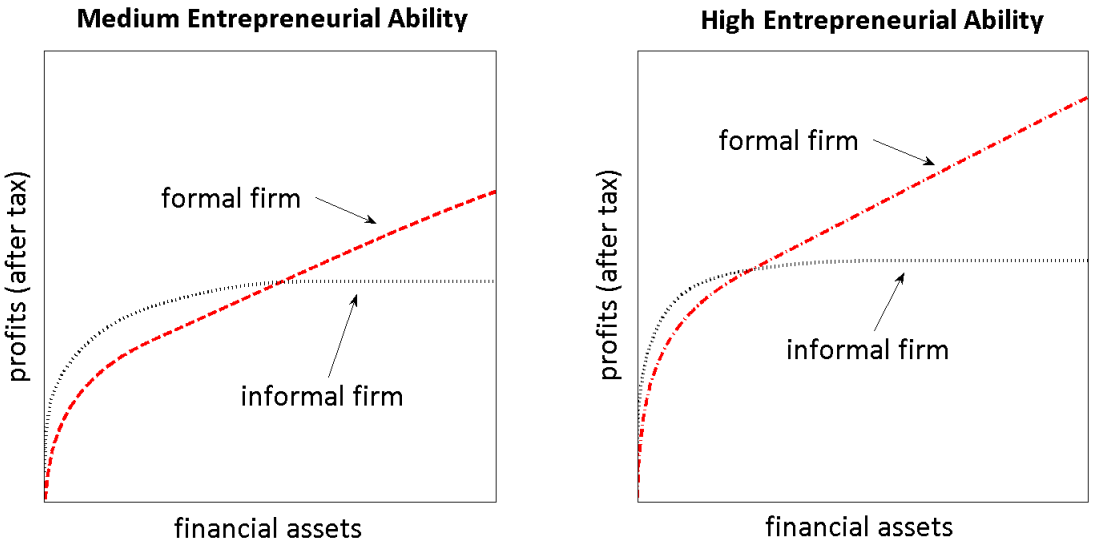
where $\mu(s, f)$ is the Lagrange multiplier on the borrowing constraint. Collateral constraints can generate dispersion in marginal productivity,[26] to the extent that the entrepreneurs are borrowing constrained and there is dispersion in $\mu(s, f)$ due to different idiosyncratic productivity levels and assets. Additionally, the lower bound of labor input for the firm $\psi \geq 0$, will also imply a deviation from equal marginal productivity for all firms, that may be quantitatively relevant in economies where a large share of the labor force is self-employed.

In the case of informal sector firms, input decisions are distorted by the sector-specific marginal cost of production as well as by the probability of being detected by the government (when considering tax enforcement). With government enforcement the choices of inputs are no longer static as can be seen in the dynamic problem of the informal sector entrepreneur. This implies an additional distortion: entrepreneurs limit their output to reduce the probability of detection by the authorities.

Finally, we need to consider a general equilibrium effect of financial constraints on productivity: in economies where λ_f is lower there will be lower wages due to the constraints faced by entrepreneurs and lower capital accumulation. As a result, more individuals in the economy will turn to entrepreneurship (or self-employment) and these marginal entrepreneurs will have lower managerial ability.

[26]The discussion of misallocation generated by financial frictions in this section borrows from Hsieh and Klenow (2009) and Midrigan and Xu (2013).

Fig. 2. Formal and Informal Sector Profits



6 Parameters and Taxes

The parameters of the model are divided into three sets. A first set of standard parameters is predetermined. Following the literature, a second set of parameters is calibrated to match key economic aspects of each economy. Finally, country specific institutional parameters (taxes, minimum capital requirements and registration costs) are specified.

6.1 Predetermined Parameters

The standard parameters taken from the literature are enumerated in Table 4. A period in the model represents a year, $\beta(1-\delta)$ is the effective discount factor (the exogenous exit rate δ is a calibrated parameter), r is the risk free interest rate, ϕ governs the intertemporal elasticity of substitution (Buera et al., 2011), ν is the capital depreciation rate (Barseghyan and DiCecio, 2011; Restuccia and Rogerson, 2008). Production parameters α and γ are also taken from Restuccia and Rogerson (2008). As a benchmark, ψ is set so that the entrepreneur can fully exploit his effective units of labor. In the baseline specification informal sector firms do not have access to credit (see, among many others, Amaral and Quintin, 2006; Perry et al., 2007).

Table 4. Predetermined Baseline Parameters.

description of parameter	parameter	value
income share of capital	α	1/3
span-of-control (returns to scale)	γ	0.85
labor input of entrepreneur	ψ	1.00
capital depreciation rate	ν	0.08
intertemporal elasticity of substitution	ϕ	1.50
effective discount factor	$\beta(1-\delta)$	0.92
risk free interest rate	r	0.04
autocorrelation coefficient	ρ	0.85
standard deviation of shocks	σ	0.38
informal sector collateral constraint	λ_i	1.00

The idiosyncratic shock a follows an AR(1) process with autocorrelation coefficient ρ with innovations that have a standard deviation of σ. Asker et al. (2012) estimate the productivity process of firms for a large set of emerging economies using different data sets. I take the median of the cross-country estimates for each parameter.

6.2 Model Calibration

We turn next to the calibrated parameters of the model in Table 5. The exogenous annual exit rate for firms, parameter δ, is set to match a total entry and exit rate of 0.15 (Bartelsman et al., 2009).[27] In the model, the total exit rate is determined by the endogenous exit of firms in addition to the stochastic exit shock given by probability δ.

Table 5. Baseline Calibrated Parameters: Mexico.

description of parameter	parameter	value
exogenous annual exit rate	δ	0.040
ability dist. mean (log-normal)	μ	-0.465
ability dist. std. dev. (log-normal)	ε	0.045
probability of entrepr. possibility	ϑ	0.170
informal sector technology	ω	7.750
informal sector technology	ξ	1.0e-07
collateral constraint (formal sector)	λ_f	1.680

[27] In the model, given our focus on the stationary equilibrium, total entry and exit rates are equivalent. The rate from Bartelsman et al. (2009) corresponds to the entry of firms for the total business sector, including firms with at least one employee. Given that the data is from the social security database, small informal sector firms may be underrepresented. For Brazil, a country with similar levels of financial development and size of the informal sector, D'Erasmo (2013) targets an exit rate of 0.129 for the formal sector.

The permanent entrepreneurial ability is drawn from a log-normal distribution with parameters μ and ε. The probability that a worker is given the option of becoming an entrepreneur is given by parameter ϑ. These three parameters mainly determine statistics related to the distribution of firms and employment according to firm size. The total average of firm size and the share of employment at firms with more than 50 workers is computed using data from the Economic Census and the National Survey of Employment and Occupation (based on Busso et al., 2012). Due to data availability, the shares of firms with different sizes are based on the Economic Census, while the share of employment according to firm age is from Hsieh and Klenow (2012) based on the Economic Census.[28] The median age and size statistics of informal sector firms and the average size of new firms is from ENAMIN.

Table 6. Baseline Model (Mexico): Target Statistics.

target statistics	data	model
total entry (and exit) rate of firms	0.150	0.150
share of employment at firms with 50+ workers	0.163	0.162
total average firm size (workers)	3.550	3.645
share of firms with less than 10 workers	0.956	0.946
size informal sector (employment share)	0.450	0.452
median size informal sector firms (workers)	1.000	1.070
credit/total output (ratio)	0.185	0.193
additional statistics	**data**	**model**
share of firms with 50+ workers	0.009	0.008
share of employment at firms with 15+ years	0.288	0.317
share of employment at firms with 5− years	0.336	0.249
std. dev. size informal sector firms (workers)	0.962	1.035
average size new firms (1 year or less)	1.295	1.203
median age informal sector firms	6.000	5.000
average formal/informal firm productivity	–	1.381
average formal/informal capital-labor ratio	–	1.294

Parameters ξ and ω correspond to the production technology of informal sector firms. These parameters determine the size of the informal sector in terms of total employment, and the size of these firms (computed from ENAMIN). The role of government enforcement is discussed as a policy exercise below, thus κ is set equal to zero in the baseline calibration.

The access to credit by formal firms in the economy is given by λ_f. The target for this parameter is the ratio of total credit to non-financial private sector firms

[28]The appendix describes and compares the size distribution of firms according to different sources.

relative to total output for the period 1996-2005, which equals 0.185.[29]

6.3 Institutional Parameters

Registration costs c_e are from Djankov et al. (2002). They compute the direct official costs of procedures plus the monetized value of the entrepreneur's time (as a fraction of GDP per capita in 1999) associated with meeting legal requirements that a start-up must bear in order to operate legally. Minimum capital requirements are from the World Bank's Doing Business Report (2004), also expressed in terms of GDP per capita.[30]

Table 7. Institutional Parameters.

description of parameter	parameter	US	Mexico	Turkey	Egypt
total tax rate as share of profits	τ	0.46	0.56	0.53	0.54
registration costs plus time value‡	c_e	0.02	0.83	0.37	1.17
minimum capital requirements‡	$\underline{b}$	0.00	0.88	0.13	7.88

‡expressed in terms of GDP per capita.

We first consider a simple tax structure where τ (computed by the World Bank Doing Business Survey, the earliest available data is for 2006) includes taxes paid by a standardized limited liability company expressed as a share of commercial profits (after accounting for allowable deductions and exemptions). The taxes are measured at all levels of government and include profit or corporate income tax, social security contributions and labor taxes paid by the employer, property taxes, dividend and capital gains tax, etc. Taxes withheld (sales tax or value added tax) but not paid by the company are excluded.

7 Quantitative Analysis

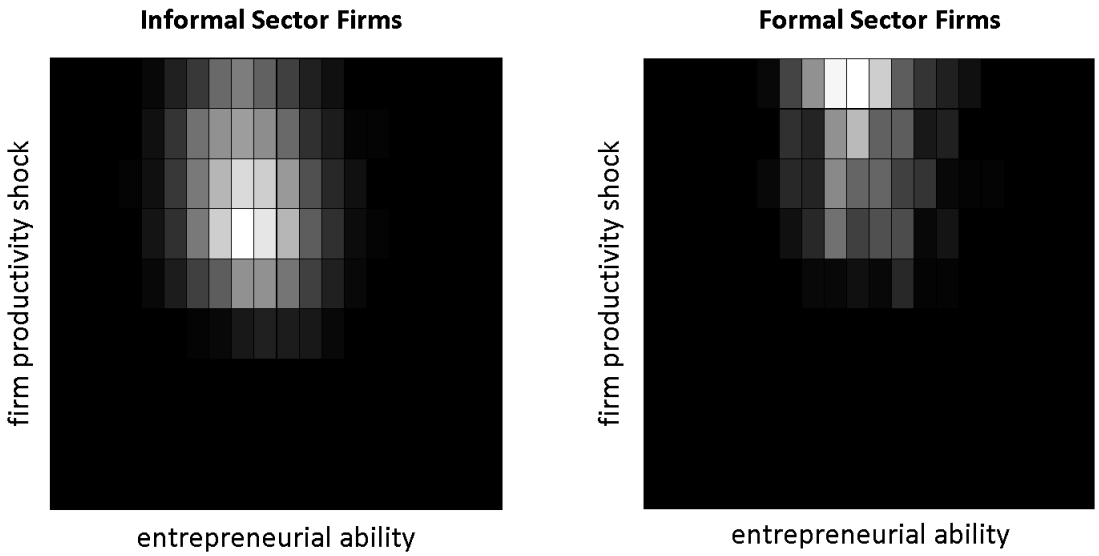
In this section we discuss three policy/reform experiments for a developing economy (we focus first on the case of Mexico): (1) the elimination of registration costs and minimum capital requirements, (2) improvements in access to credit for formal sector firms, (3) government enforcement of registration for informal sector

[29]These statistics are from the Bank of Mexico. For the period 2000-2005 this value is equal to 0.156.

[30]Barseghyan and DiCecio (2011) consider different broader definitions of entry barriers which include legal fees related to construction permits, utility connections and inspections associated with building a physical location in which to operate a firm as well as minimum capital requirements. In this sense, the figures used here may be considered a lower bound of these costs. In the model, these figures are expressed in terms of GDP per worker using labor force participation data from the World Bank.

firms. We also introduce an important extension to the model by considering size-dependent taxes for formal sector firms.

Fig. 3. Distribution of Entrepreneurs by Ability and Productivity Shock (Mexico)



7.1 Elimination of Registration Costs

The simplification of entry regulation has become a popular reform. According to the World Bank's Doing Business Project in the period 2003-2008 a total of 193 reforms took place in 116 countries (Djankov, 2009). These reforms include standardizing documents and reducing minimum capital requirements, registration costs or bureaucratic steps required to complete the registration process. Empirical cross-country studies suggest that reducing registrations costs can have a large impact on productivity (see the discussion in Djankov, 2009). In the theoretical literature, Antunes and Cavalcanti (2007) find that for a developing country with low financial enforcement, the size of the informal sector is equally accounted for by low financial contract enforcement and high regulation costs. Barseghyan and DiCecio (2011), in a model without financial frictions or the informal sector, find that countries in the lowest decile of the entry costs distribution have 1.32 to 1.45 times higher TFP and 1.52 to 1.75 times higher output per worker than countries in the highest decile. Empirical country-case studies, on the other hand, have found a modest impact resulting from reforms that reduce the cost of entering the formal sector.

Several studies have exploited micro-level data to analyze the impact of reducing registration costs for specific countries. Fajnzylber et al. (2011) and Monteiro et al. (2012) evaluate the impact of a program of bureaucracy simplification and tax reduction for micro-enterprises in Brazil, the SIMPLES program. Monteiro et al. (2013) document an increase of 13 percentage points in formal licensing among retail

firms created after the program. They find heterogeneous impact across industries, given that requirements to enter and operate in the formal sector differ according to economic activity. More specifically, they find no impact on construction, services and manufacturing sectors. Fajnzylber et al. (2011), in addition to a modest impact on registration, document that firms born under the SIMPLES program show higher levels of revenue and profits, suggesting the adoption of technologies and lines of business that are more permanent, capital intensive and of a larger scale, as measured by number of employees. Kaplan et al. (2011) estimate the effect of simplification of firm registration procedures on business start-ups in Mexico. They suggest that attention in business deregulation may have been overemphasized given the small increase in new start-ups and conclude that the small benefits of being formal may explain the low impact of the implemented reforms. Bruhn (2012) also examines the case of Mexico and estimates a small impact on registration.

For Mexico, we find that the complete elimination of formal sector registration costs and minimum capital requirements leads to a gain in aggregate TFP of 0.5 percentage points,[31] output per capita increases by 0.7 percentage points and the size of the informal sector as a share of total employment decreases from 0.452 to 0.440.[32]

The increase in wages is 1.2 percent while the increment in welfare (see below for definition of the consumption equivalence) is 0.9 percent. This is considerably smaller than estimates from models that ignore financial constraints. Prado (2011) estimates the welfare increase (in terms of consumption) of reducing registration costs so that the size of the informal sector equals that of Switzerland (8.6 percent in terms of output). For Mexico, he finds that this gain is equal to the equivalent of 5 percent of consumption.

7.2 Financial Sector Reform

We turn next to the impact of the improvement of access to credit for formal sector firms. Table 8 shows the baseline scenario for Mexico (as previously calibrated) and the impact on different aggregate variables as the volume of credit to GDP ranges from zero to two. We see that the informal sector practically disappears for the highest level of financial development.

[31] Following Midrigan and Xu (2013), TFP is computed from the expression $Y = A\,(K^{\alpha}\,L^{1-\alpha})^{\gamma}$. Similar results are obtained if we use $Y = A\,K^{\alpha\,\gamma}\,L^{1-\alpha\,\gamma}$ as in Guner et al. (2008) and Barseghyan and DiCecio (2011).

[32] We expect a larger impact for Egypt (forthcoming).

Table 8. Main Quantitative Results: Mexico.

variable	**base**	**#1**	**#2**	**#3**	**#4**	**#5**
private credit/total output	0.193	0.000	0.407	0.832	1.281	2.042
share informal sector employment	0.452	0.592	0.347	0.228	0.103	0.031
wage	1.000	0.909	1.088	1.231	1.389	1.658
TFP	1.000	0.966	1.025	1.049	1.089	1.142
output per person	1.000	0.941	1.062	1.179	1.330	1.604
capital per person	1.000	0.913	1.131	1.507	2.023	3.317
welfare (consumption equivalent)	1.000	0.930	1.070	1.185	1.319	1.577

We can compute the gains in welfare for newly born individuals (with the initial level of financial assets) in terms of the consumption equivalence $1+\Delta$, derived as follows:

$$1+\Delta = \left[\int_{\{\varphi,a\}} v_w^{new}(\varphi, a, \bar{b})\, dH(\varphi, a) \;/\; \int_{\{\varphi,a\}} v_w^{base}(\varphi, a, \bar{b})\, dH(\varphi, a) \right]^{1/(1-\phi)}$$

where $H(\varphi, a)$ is the distribution determined by the log-normal distribution for φ and the unconditional distribution derived from $\Lambda(a' \mid a)$ (φ and a are two independent random variables).

Table 9. Additional Quantitative Results: Mexico.

variable	**base**	**#1**	**#2**	**#3**	**#4**	**#5**
private credit/total output	0.193	0.000	0.407	0.832	1.281	2.042
average firm size (total)	3.645	3.117	4.242	5.374	7.466	13.083
share firms w/less than 10 workers	0.946	0.962	0.926	0.886	0.778	0.678
share empl. firms 50+ workers	0.162	0.093	0.202	0.273	0.318	0.278
avg. formal firm productivity	1.000	0.980	1.010	1.055	1.110	1.155
avg. informal firm productivity	1.000	0.958	1.037	1.087	1.100	1.099
weighted formal mg. product cap.	0.359	0.456	0.297	0.228	0.197	0.133
var. ln(mg. product cap.) formal	0.376	0.472	0.298	0.208	0.213	0.072
weight. capital-lab. ratio/optimal	0.420	0.353	0.494	0.610	0.703	0.934

For weighted statistics weights are given by output. Average formal and informal firm productivity are separately normalized to one for base scenario.

Table 9 presents different statistics related to the size distribution of firms, productivity and the marginal product of capital (for the weighted statistics, weights are given by output).

7.3 Size-Dependent Tax Structure (preliminary)

In this section we consider the possibility that taxes depend on the size of the firm. The tax structure consists of a tax $T(l)$ on labor and $T(q)$ on the output of firms.

Table 10. Size-Dependent Taxes (preliminary).

description of parameter	parameter	value
labor tax level parameter	λ_l	0.100
labor tax curvature parameter	τ_l	0.056
corp. income tax level parameter	λ_q	0.780
corp. income tax curvature parameter	τ_q	0.004
targets: *effective* tax rates	data	model
on labor: firms w/5-10 workers	0.110	0.113
on labor: firms w/70-80 workers	0.129	0.128
on corp. income: firms w/5-10 workers	0.195	0.228
on corp. income: firms w/70-80 workers	0.226	0.234

We follow one of the specifications described in Guner, Kaygusuz and Ventura (2008): the average tax rate on output is $T(q) = 1 - \lambda_q\, q^{-\tau_q}$. Under this specification the parameter λ_q controls the level of the tax rate, if τ_q equals zero then average and marginal tax rates are constant. The after-tax revenue of the firm is $(1 - T(q))\, q = \lambda_q\, q^{1-\tau_q}$.

The OECD Tax Database shows a corporate income tax rate of 0.28 for Mexico. This value is close to the level of the average tax-rate on firm output estimated by Leal-Ordoñez (2014): the total tax revenue from the formal sector amounted to 11 percent of GDP in 2008, while the value added associated to firms in this sector amounted to 44 percent of GDP, resulting in an average tax rate of 0.25.

For labor taxes we follow a similar specification $T(l) = \lambda_l\, l^{\tau_l}$. In this manner total labor costs for formal sector firms becomes $w\, l\, (1 + T(l))$. Note that this tax will affect the capital/labor ratio of formal sector firms. For Mexico, the average *total labor tax wedge* for the period 2001-2010 was 0.153.[33]

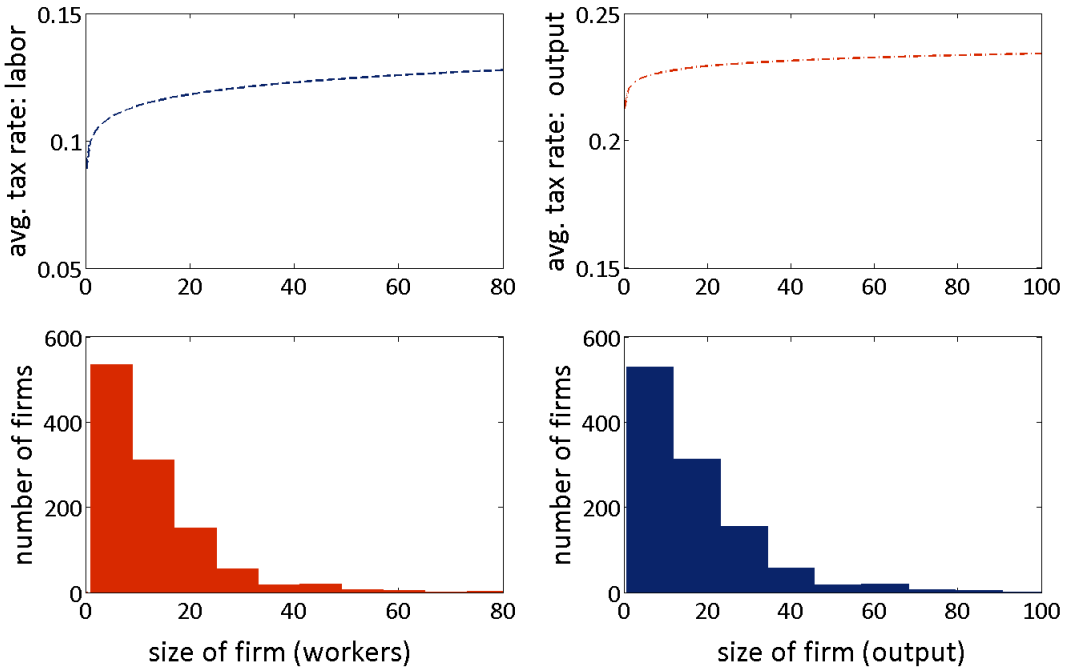
Next we exploit survey data from the World Business Environment Survey (WBES by the World Bank), which provides information on the percent of sales not reported to tax authorities.[34] In the case of Mexico this data suggests that firms

[33]The *total tax wedge* is taken from the OECD Tax Database and consists of the combined central and sub-central government income tax plus employee and employer social security contribution taxes, as a percentage of labour costs defined as gross average wage earnings plus employer social security contributions.

[34]Dabla-Norris et al. (2008) summarize the information contained in the firm level survey responses for over 4000 firms in 41 countries: the average percentage of sales reported to tax authorities is 80.8 for small firms (5-50 workers), 84.8 for medium sized firms (51-500 workers) and 88.1 percent for large firms (500 workers).

that have between 5 and 10 workers report on average 69.7 percent of their sales and declare 71.7 percent of their workforce. For firms that have between 70 and 80 workers, these numbers are 80.6 and 84.5 percent, respectively. We use these values to determine the parameters in Table 10.

Fig. 4 Size Dependent Taxes on Labor and Output



The impact of a complete elimination of registration costs and minimum capital requirements are also small in this version of the model, aggregate TFP increases by 1 percent and output per capita increases by 0.5 percent.

7.4 Government Enforcement of Registration (work in progress)

We now turn to government enforcement of registration. In many developed economies governments make use of data matching techniques: tax records are matched with external sources of information to identify taxpayers with income streams that have not been declared (UK National Audit Office, 2008). Physical inspections and audits are more direct methods of enforcement. In developed economies sanctions range from financial penalties and closure of business to criminal prosecution. There are also significant differences in the effectiveness and resources of the judicial systems across countries in terms of prosecuting evaders.[35]

[35]See Tax Administration in OECD and Selected Non-OECD Countries: Comparative Information Series. In the UK there are 1.6 tax employees per 1,000 of population, compared to less than 0.03 for countries like Turkey, India and Brazil.

The role of government enforcement is discussed in policy circles (World Bank, 2010) as well as in the private sector. A study by McKinsey Global Institute (2006) proposes that better enforcement of tax and business regulation would allow to reduce taxes encouraging more companies to join the formal economy in developing countries. There is, however, little work on understanding the impact of increased enforcement in developing economies. Almeida and Carneiro (2009) study firm level data for Brazil, and find that stricter enforcement of labor regulation constrains firm size and leads to higher unemployment.

In theoretical models it is not a general result that the optimum size of the informal sector is zero. Prado (2011) builds a model where the determinants of the size of the informal sector are taxation, government enforcement and formal sector entry costs. He finds that stricter enforcement does not always imply an economic improvement; under particular contexts countries can benefit from a larger informal sector. Leal-Ordoñez (2014) finds that better enforcement increases output when the informal sector is small but the opposite happens when it is large. I extend this exercise to an environment with firm dynamics and financial constraints.

In the exercise conducted here, we consider a probability of detection by the government that is increasing in output of the informal sector firm. In the case of detection, the entrepreneur is forced to pay the registration cost and enter the formal sector in the following period. If the entrepreneur does not have sufficient wealth to pay this registration cost, all financial assets are lost and enters the next period as a worker.

8 Conclusion

Significant aggregate productivity losses have been attributed to the existence of large informal sectors in developing economies. It is therefore not surprising the large effort dedicated to design policies intended to ameliorate these losses. The simplification of entry regulation has become a popular reform: in the period 2003-2008 193 reforms took place in 116 countries (Djankov, 2009). According to the World Bank's Doing Business Survey, Egypt was a top reformer for 2006-2007, this was the second time in 5 years that Egypt was among the top reformers in the world. The reforms included simplifications in the process of starting a business, easing of the tax burden and minimum capital requirements and registrations costs (the quantitative results for Egypt will be available soon).

For a model economy that resembles Mexico, I find that the impact of completely eliminating registration and minimum capital requirements costs is small. This is consistent with empirical country-case studies that exploit firm-level data to evaluate the consequences of these reforms. We also introduce a registration enforcement technology where informal sector firms are detected with a probability that depends on output (work in progress). Improving the access to credit for formal sector firms increases wages, aggregate TFP and output per worker while reducing the size of the informal sector. An increment in the volume of credit relative to GDP

to the levels of the US leads the informal sector to almost disappear.

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A Size Distribution of Firms

The data for the US distribution of firms is from Helfand et al. (2007), average 1990-2000. These statistics account for 97% of the total number of employees in private industries (code *USPRIV*, Federal Reserve Economic Data). The size distribution of firms data (establishment data is also available) can be compared to that of Rossi-Hansberg and Wright (2007), taking the average of the years 1990, 1992, 1994, 1995, 1997 and 2000 (includes firms with zero employees), see Table A1. OECD (2002) also provides information for the US on the distribution of enterprises by size class (Table A1).

For Turkey, the data is from World Bank (2010) and OECD (2002) (similar numbers are obtained from TurkStat, Household Labour Force Survey). Note that from OECD (2002) the size categories are different for US and Turkey. Data for registered workplaces is available from the Social Security Institution (see Kenar, 2009).

Table A1. Distribution of Enterprises and Employment by Size Class.

US % enterprises	*0-9*	*10-19*	*20-99*	*100-499*	*500+*
OECD	56.8	15.8	20.7	5.2	1.5
R. Hansberg and Wright (2007)	78.7	10.8	8.8	1.4	0.2
Helfand et al. (2007)	74.5	12.5	10.6	1.9	0.4
Turkey % enterp.	*0-9*	*10-49*	*50-99*	*100-499*	*500+*
OECD	95.0	3.2	0.8	0.9	0.2
Turkey % enterp. and empl.	*1-9*	*10-49*	*50-249*	*250-499*	*500+*
% of registered enterprises	85.5	12.5	1.7	0.2	0.1
% of registered workers	28.6	32.5	21.8	7.5	9.6
Egypt % estab. and empl.	*0-1*	*2-10*	*11-100*	*101-1,000*	*1,000+*
% of formal sector estab.	90.34	7.82	1.71	0.13	0.01
% of formal sector workers	51.94	22.35	11.19	9.34	5.18

For Egypt, data is from the Central Agency for Public Mobilization and Statistics (CAPMAS), the main statistical agency of the Egyptian government, Establishment Census 1996 (see Ministry of Foreign Trade, 2003). The Egyptian data, for non-agricultural activities, is divided in sizes 1-4, 5-14, 15-49 and 50+ workers (Ministry of Foreign Trade, 2003, Table 1 for establishments and Table 4 for employment). The dist. of firms by size is: 92.7, 6.12, 0.91, and 0.3% respectively. Figures obtained from the 2006 Economic Census are shown in Table A1.

For Mexico, the size distribution of firms is obtained from Busso et al. (2012), computed with data from INEGI, the national statistics institute. Considering multiplant firms does not alter the results (see Appendix Table 22). The distribution of

employment by firm size is based on Table 4 of Busso et al. (2012).

B Algorithm Outline

Given the interest rate and government policies, computing the equilibrium amounts to finding the wage w that clears the labor market. The grid for the ability variable φ consists of 20 points, with weights given by a discretized log-normal distribution. The Markov matrix $\Lambda(a' \mid a)$ is constructed following Tauchen (1986), with 9 possible state values. The grid for financial assets b has up to 750 points (as necessary depending on parameters and ability of the entrepreneur). The algorithm can be summarized as follows:

(1) Guess wage level w. Solve for quantities[36] $\{q(s,z)\}_{z\in\{i,f\}}$, production inputs $\{l(s,z), k(s,z)\}_{z\in\{i,f\}}$, profits $\{\pi(s,z)\}_{z\in\{i,f\}}$.

(2) Through value function iteration, until a desired level of precision is reached, obtain policy and value functions $\{g_z(s)\}_{z\in\{i,f,w\}}$, $\{v(s), v_i(s), v_f(s), v_w(s)\}$.

(3) Run 100 simulations of 25,000 individuals for 350 periods (this requires less memory than fewer simulations with more individuals, it is verified that increasing the number of simulations/individuals/periods does not change the results). An individual that dies is replaced by another individual with the same entrepreneurial ability.

(4) Compute the aggregates using the cross section of the last period of the simulations and check the market clearing condition for labor. Return to step (1) and adjust w and parameters as necessary.

[36] In the case of government enforcement (where the probability of detection depends on output), output decisions and value functions are solved jointly for informal sector firms, this makes the problem computationally more burdensome.