

Misallocation, Informality and Human Capital

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Abstract

We develop a theory of total factor productivity with heterogeneous firms to explain differences in human capital across countries. In our model, firms face capital markets imperfections and costs of creating and operating in the formal sector. These distortions give rise to endogenous formal and informal sectors. Formal firms have a larger set of production opportunities but informal firms can avoid the costs of formalization. The model predicts that countries with a low degree of debt enforcement and high costs of formality are characterized by low allocative efficiency and a larger informal sector, lower TFP and lower human capital accumulation. We find that this mechanism is important in generating the skill distribution observed in developing countries.

Keywords: Financial Structure, Informal Sector, Productivity, Policy Distortions, Human Capital.

JEL Classifications: D24, E26, J24, L11, O16, O17

1 Introduction

In this paper, we quantify the effects of formal sector institutions on human capital formation and total factor productivity differences across countries. We build a general equilibrium firm

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dynamics model that incorporates endogenous capital financing and bankruptcy decisions. We allow for the existence of a formal and informal sector. While entering and operating in the formal sector is costly, firms have an expanded set of production possibilities and the ability to employ skilled workers. Formal sector firms face a lower cost of borrowing since they have access to credit markets with a higher degree of enforcement than the informal sector.

For our quantitative exercise, we calibrate the model to the US economy and then impose country specific measures of formal sector institutions (entry costs, taxes and bankruptcy efficiency) and evaluate the effects that these have on total factor productivity, informality and skill formation. We find that, by generating resource misallocation and sizable informal sectors, the model generates differences in the stock of human capital and total factor productivity in line with what is observed across countries.

There are important differences in human capital stocks between the developed and the developing countries. Barro and Lee (2001) document that for the year 2000, 37% of the population aged over 25 and over have no formal schooling and only 27% have some secondary education in the developing world. On the other hand, in advanced and transition economies about two-thirds of the population aged over 25 have some secondary education. Figure 1.a shows the positive correlation between GDP per capita and skills.¹

Jones and Romer (2009) document that differences in measured inputs explain less than half of the cross country differences in per capita GDP. The strong positive relationship between GDP per capita and TFP (what effectively remains unexplained) is displayed in Figure 1.b. The aim in this paper is to connect measured institutions in the formal sector across countries to resource misallocation and human capital formation and evaluate their effects on TFP.

As Figure 1 shows, informal activity is correlated with aggregate productivity and the stock of human capital. Our measure of informality corresponds to the fraction of the labor force that participates in the underground economy.² Agents involved in the informal sector make explicit

¹Skills are defined as the percentage of people that completed college as a percentage of the population over age 25, taken from Barro and Lee (2001).

²Measured as the fraction of the labor force not covered by a pension scheme, WDI (2006). We focus on the the share of labor force not covered by pension schemes because it provides a better direct measure of informality

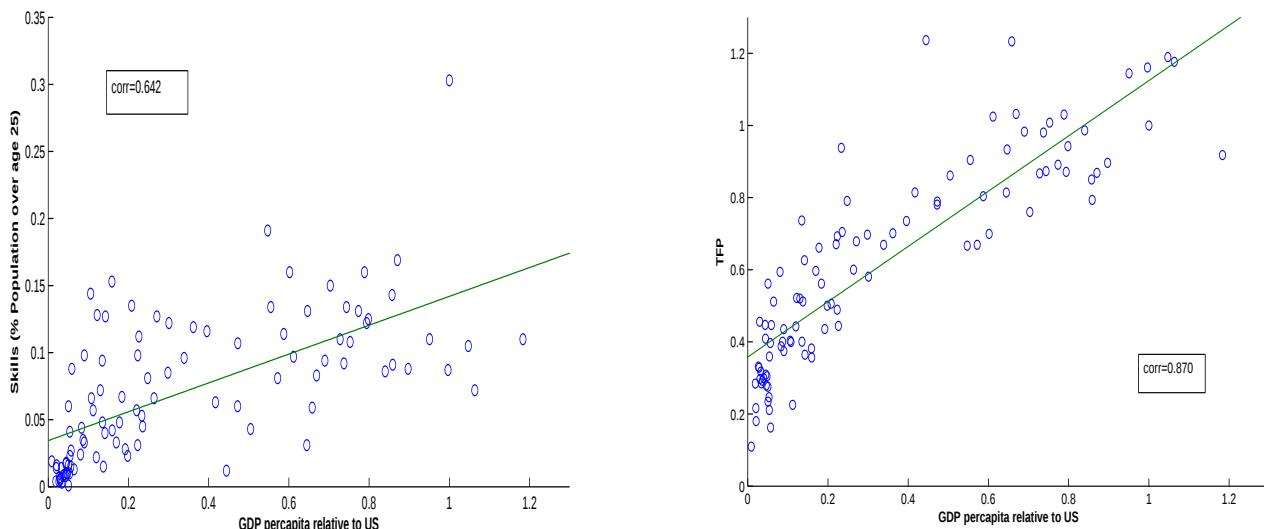


Figure 1: Skills, Total factor productivity and GDP per capita

Note: Skills are defined as the percentage of people that completed college as a percentage of the population over age 25, taken from Barro and Lee (2001). Total factor productivity and output per effective worker are authors calculations based on Hall and Jones (1999). See appendix for details. Solid lines indicate OLS regression.

efforts not to be detected, which makes measuring the informal sector extremely challenging. The fraction of the labor force that is engaged in production outside of the formal sector ranges from around 10% in developed countries to almost 100% at the low end of the income distribution. Although the measures of informality are extremely noisy, such a large sector of the economy cannot be ignored when analyzing the differences in economic development around the world. Figure 2.a relates the human capital stock to the informal labor force.³ This relation is supported by firm level data. Pratap and Quintin (2008) report that informal sector is characterized by small scale, unskilled and self-financed activities. Furthermore, Funkhouser (1996), in a cross-country study of Latin America countries, shows that mean education level in the formal sector is substantially higher than the mean education level in the informal sector.

As in Rauch (1991) and Loayza (1996), we model the informal sector is an optimal response to the economic environment. Similarly, Amaral and Quintin (2008) model the informal sector for the US, the country we use for our benchmark calibration.

³The size of the informal activity varies according to the measure used but the empirical correlations presented in Figure 2 remain. See Schneider and Enste (2000) for direct and indirect approaches in calculating informal activity.

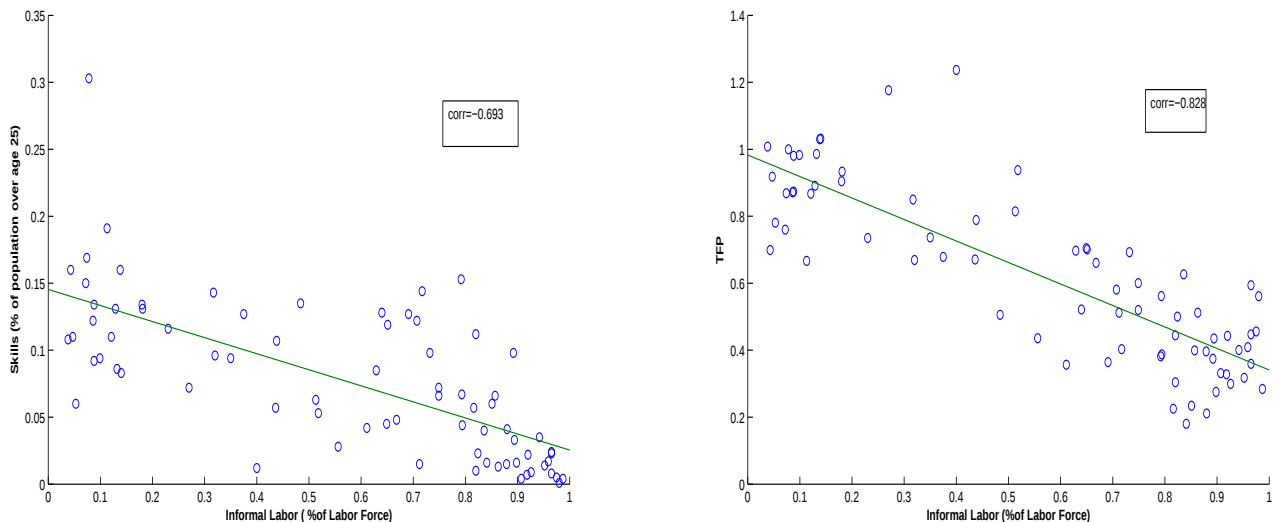


Figure 2: Skills, Informal labor force and TFP

Note: The share of informal labor force corresponds to the share of the labor force not covered by a pension scheme as reported by the World Development Indicators 2006. Solid lines indicate OLS regression.

as the endogenous response of managers that are heterogeneous in ability. In their model the formal sector ends up being skill intensive as well. In this paper, we contribute to this literature by quantitatively measuring the effects of frictions and informality on the stock of human capital.

Our approach to firm dynamics originates with Hopenhayn (1992) and Hopenhayn and Rogerson (1993), and we add capital markets as in Cooley and Quadrini (2001) to our model. Recent related literature on the distributional consequences of frictions follows two approaches in measuring the institutional and financial frictions. Hsieh and Klenow (2009), Restuccia and Rogerson (2008), Guner, Ventura, and Xu (2008), Arellano, Bai, and Zhang (2009) and Buera, Kaboski and Shin (2009) back up the implied frictions that firms face to generate the observed distribution of the firms. The second strand of the literature uses the measured frictions documented by the Doing Business data set as in this paper. Papers in this group include Barseghyan and DiCecio (2010), Moscoso Boedo and D’Erasmus (2010) and Moscoso Boedo and Mukoyama (2010).

The remainder of the paper is organized as follows, section 2 describes the data, section 3 presents the model, section 4 presents the equilibrium, section 5 explains the calibration for

the benchmark case without frictions, section 6 presents the results with frictions for the high income, middle income and low income countries and section 7 concludes.

2 Data

We use the World Bank Doing Business data set to measure the institutional frictions, which provides a quantitative measure of regulations for starting a business, dealing with construction permits, employing workers, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts and closing a business both in terms of time and resources.⁴ In this paper, we will focus on the cost of entering the formal sector, the tax rate and the level of tax compliance difficulty (while operating in the formal sector), and the efficiency of the debt enforcing mechanisms if the firm decides to default on its debt. Figure (3) provides the data on these frictions across countries.

The cost of entering the formal sector is constructed as in Moscoso Boedo and Mukoyama (2010). It includes the costs of registering a business and of dealing with licenses to operate a physical locale.⁵ Both costs have a monetary cost and a time cost (which is translated to monetary units by assuming that one worker has to be employed full time in order for the firm to go through the entry process). The cost of entering the formal sector as a fraction of the wage (denoted by $\omega\kappa$) varies greatly across countries, with high levels of κ observed only at the low end of the income distribution. For example, registering a business in the developed countries like US and UK costs only 0.7% of GNI per capita, while in Argentina and Turkey this cost is 9.0 % and 14.9 % respectively, whereas in Zimbabwe it is 500% of GNI per capita. In terms of time, starting a formal business takes more than 4 years in Zimbabwe, more than 1.5 years in Brazil and only 46 days in US. Dealing with licenses also displays great variation

⁴Construction permits includes all procedures required for a business in the construction industry to build a standardized warehouse.

⁵The data used to generate the cost of dealing with licenses to operate a physical local is obtained from the World Bank Doing Business database as Dealing with Construction Permits. Part of the elements involved in construction permits, such as the cost of connection to basic services, are present when operating a physical locale.

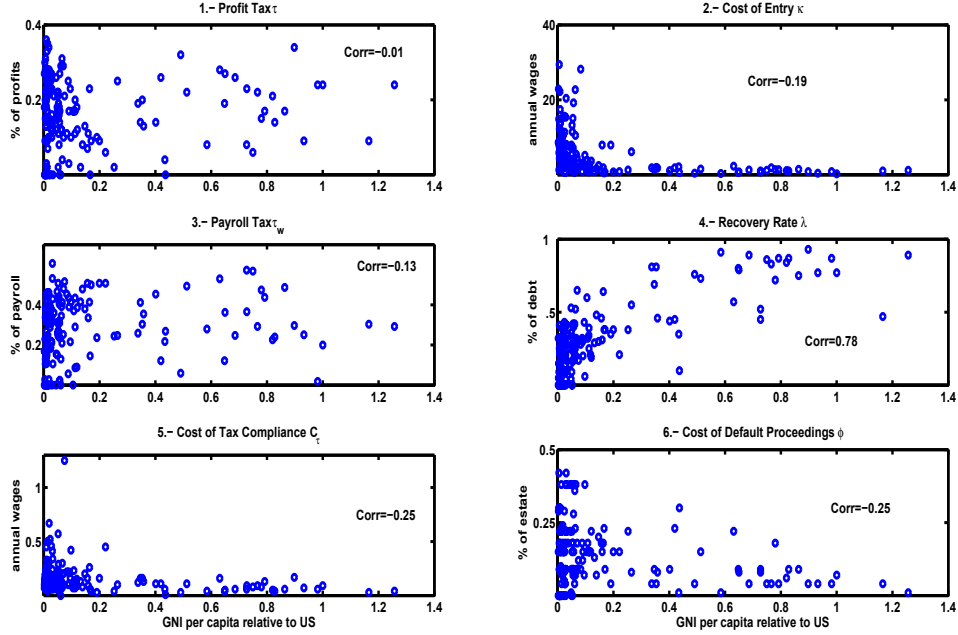


Figure 3: Cost to entry, income tax rate, cost of tax compliance, recovery rate, and cost of default proceedings from the Doing Business Database in 2009.

across countries. The cost is 13% of GNI per capita in the US and 600 times per capita income in Liberia and 100 times in Zimbabwe. In terms of time, it takes 40 days to obtain a license in the US and up to 1000 days in Haiti.

In terms of the tax structure we concentrate on payroll taxes, profit taxes and the cost of tax compliance. The tax rate paid on profits, pay roll taxes and cost of tax compliance are respectively denoted by τ , τ_w and $\omega_n c_\tau$. Cost of tax compliance reflects the time that it takes to pay taxes in each country. We assume that there is a full time unskilled worker during this time devoted to the tasks related to tax compliance, and therefore translate time into costs as the workers annual wages. The cost of paying taxes only displays levels above 10 weeks for countries below 20% of the US GNI per capita. Paying taxes takes no time in the Maldives, 12 hours in the UAE, 187 hours in the US, and more than 1000 hours in Vietnam, Bolivia, Belarus, Cameroon and Brazil.

The efficiency of the system in the event of default has two components, a cost component

and a recovery rate. The cost of the system ϕ , reported as a percentage of the estates value, includes court fees and the cost of insolvency practitioners, such as legal and accounting fees. It ranges from 1% of the estates value in countries like Norway and Singapore to more than 40% in Sierra Leone, Liberia, and the Ukraine and above 70% in the Central African Republic. The recovery rate λ refers to what external lenders obtain once the firm decides to default on its debt. It is effectively zero for many extremely poor countries in sub-Saharan Africa, and over 75 % in most of the developed economies. For example in US this rate is 76.7 %, whereas in Turkey it is 20.2 %, 29.8 % in Argentina, and 0.0 % in Zimbabwe.

Our main goal is to match the cross country skill distribution in this paper, so the definition of skills is crucial. It is hard to find an accurate and comprehensive cross country distribution of skills, since schooling quality might differ significantly across countries. Data on education is taken from Barro and Lee (2001). This data set provides the largest coverage for cross country education attainment up to 1995 and also construct projections to 2000. They fill the missing observations by the perpetual inventory method using the enrollment ratios. The data contains educational attainment data for primary, secondary and higher level of education for both completed and not completed for the population over age 25, and the average years of schooling. We assume that every agent is born with primary school education. An agent becomes skilled after college completion, which takes 6 years. The skilled individuals as a fraction of the total population is 30.03 % in US according to our definition of skills, with the highest level stock of human capital. The lowest level of human capital is at Mozambique with 0.1%. Informal labor force data is taken from World Bank Development Indicators (WDI) database (2006), which measures the percentage of the labor force which is not covered by the pension scheme.

3 Environment

We build a firm dynamics model augmenting D’Erasmus and Moscoso Boedo (2011) with human capital. The model is a version of Hopenhayn (1992) that incorporates capital and financial

frictions as in Cooley and Quadrini (2001). Time is discrete, and we set one period to be one year. There are three kinds of entities in the economy: firms, lenders and consumers. Firms produce the consumption and capital goods. They are the capital owners and pay dividends to the consumers. The firm chooses to operate between the formal and the informal sector. Competitive risk neutral lenders make loans to the corporate sector. Consumers supply both skilled and unskilled labor to the firms. We focus on a stationary equilibrium.

3.1 Households

There is an infinitely lived representative household that maximizes expected utility. Preferences are:

$$U = \mathbb{E} \left[\sum_{t=0}^{\infty} \beta^t u(C_t) \right] \quad (1)$$

where $\mathbb{E}$ is the expectation operator, C_t is aggregate consumption and $\beta \in (0, 1)$ is the discount factor.

The household is composed by a unit mass of labor. The household starts the period with a given (by past investments) stock of skilled workers. It then decides how to allocate unskilled labor between the production sector and the production of future skilled labor. We assume that skills are acquired through home schooling. In order to become skilled, an unskilled worker must remain outside the market for x years. Given that unskilled labor is our only input in the production of skills, then all the stock of skilled workers is allocated to the production sector. The wage rate for the skilled workers is denoted by ω_s and the wage rate for the unskilled worker is ω_n . In order to keep the problem as simple as possible, we assume a linear utility function. This makes the skill premium required to make the household indifferent between allocating resources to the production sector and the formation of new skills independent of the wage level.

The consumer is responsible for the creation cost of new firms c_e , consequently owns existing firms in the economy and receives income from the dividends they pay. Moreover, the household

has access to a risk free bond B_{t+1} that is in zero net supply and pays r_t units of the consumption good in the following period. Finally, the household receives a lump sum transfer for the total amount of taxes collected.

3.2 Firms

The unit of production is a single establishment firm, also understood as a unique investment project. Each project is described by a production function that combines physical capital k , skilled labor s and unskilled labor n . The production process displays decreasing returns to scale. As mentioned earlier, empirical evidence shows that formal sector workers have higher education and earn more compared to the informal sector workers. We assume that the formal sector technology is given by:

$$f(z, k, s, n) = zk^\alpha s^\epsilon n^{\gamma_f}, \quad (2)$$

where z is the exogenous technology shock. The informal sector technology is given by

$$g(z, k, n) = zk^\alpha n^{\gamma_i} \quad (3)$$

There are two processes for z : one whose used is limited to the formal sector (l), and one unlimited with regards to sectors (u). The limited productivity process is given by,

$$\ln(z_{t+1}) = (1 - \rho)\ln(\mu_l) + \rho\ln(z_t) + \epsilon_{t+1} \quad (4)$$

with $\epsilon_{t+1} \sim N(0, (1 - \rho^2)\sigma^2)$ where σ^2 is the variance of $\ln(z)$, μ_l is the mean and ρ is the autocorrelation parameter of the process. The conditional distribution of z_{t+1} is denoted as $\eta_l(z_{t+1}, z_t)$. The unlimited productivity process is assumed to be a constant given by μ_u . These two processes are calibrated to match the size distribution of formal firms and the size of the informal sector. Firms maximize expected discounted dividends d:

$$E \sum_{t=0}^{\infty} R^t d_t \tag{5}$$

at the rate R .⁶

Firms can be created by paying a cost c_e either formal or informal. After paying this cost, firms learn their initial level of productivity $z_{0,j}$ for each technology. Their initial level of productivity $z_{0,j}$ is drawn from the distribution $\nu_l(z_0)$. Draws from this distribution are assumed to be i.i.d across firms and technologies. After observing their productivity, firms choose between staying out of the market or operating one of the technologies as a formal or an informal firm.

There is a random fixed cost of production c_f , measured in units of output, that is iid. across firms and over time with distribution $\xi(c_f)$ paid every period both in the formal and the informal sector. Establishments own their capital and can borrow from financial intermediaries in the form of non-contingent debt $b \geq 0$. They finance investment with either debt or internal funds.

3.3 Financial Markets

A competitive credit industry makes loans to the formal and informal sector firms. Creditors are risk neutral and have access to the risk-free bond with return r . Asset markets are incomplete. In each period, firms borrow using only one period non-contingent debt denoted by b . Since there is perfect information, prices depend on firms characteristics given by their choice of sector (formal or informal), their future level of capital (k'), their level of borrowing (b'), and their current technology (z). In particular, firms in the formal sector will borrow at price $q_j^f(k', b', z)$ and firms in the informal sector will borrow at price $q^i(k', b', z)$ default on their debt. A default triggers a bankruptcy procedure that liquidates the firm. If a firm defaults in the formal sector, creditors can recover up to a fraction λ of the original loan. The formal bankruptcy procedure

⁶We only discuss the stationary equilibrium, so without loss of generality we assume that the firms' discount factor is constant.

has an associated cost equal to a fraction ϕ of the firm capital. The values of the recovery rate λ and the bankruptcy cost ϕ are obtained from the Doing Business database. Because the capital of the informal firm is not legally registered, the recovery rate of a loan to an informal sector firm that defaults is assumed to be zero.

4 Equilibrium

We focus on the stationary equilibrium of the model. In this equilibrium the wage rates and the schedule of loan prices are constant. Once the wage ω_n is solved for, the skill premium equation will determine ω_s . Every equilibrium function depends on the set of loan prices and the wage rates.

4.1 Consumer Problem

Since we concentrate on the stationary equilibrium, aggregates in the economy are constant. Hence, household maximization implies that the consumer supplies its unit of labor inelastically, $\beta = R = \frac{1}{1+r}$ and that aggregate consumption is:

$$C = \omega_n n + \omega_s s + \Pi + T - E + X \quad (6)$$

where Π is the total profit, T is the lump-sum transfer from the income and payroll taxes, E is the aggregate creation cost, and X is the exit value of firms.

The benefit to schooling is;

$$\beta^{x+1} \sum_{t=0}^{\infty} [\omega_s \beta^t (1 - \delta_s)^t] \quad (7)$$

where δ_s is the depreciation rate of skilled labor. The cost of schooling is the foregone wages for x years

$$\sum_{t=0}^x \beta^t \omega_n \quad (8)$$

which gives the following equilibrium condition for the skill premium.

$$\frac{\omega_s}{\omega_n} = \left[\frac{1 - \beta(1 - \delta_s)}{1 - \beta} \right] \frac{1}{\beta^{x+1}} \quad (9)$$

Finally, the law of motion for human capital is:

$$s_{t+1} = (1 - \delta_s)s_t + (1/x)a_t$$

where a_t is the number of students.

4.1.1 Formal Sector Incumbent

An incumbent establishment in the formal sector with technology $j \in l, u$ starts the period with physical capital k , debt b , and previous productivity z_{-1} . Then, the firm draws the fixed cost that is required for continuing the operation, c_f , and decides to operate the technology, exit after repayment of debts, or default and liquidate the firm. If the firm decides to exit after repayment, it receives $k - b$, if it decides to default and liquidate the firm, it receives the maximum of the remainder of the capital $(1 - \phi)k$ after paying the recovery rate λ (net of the costs associated with default proceedings) to the outside investors and zero. The value function of an establishment at this stage is denoted as $W_j^f(z_{-1}, k, b, c_f)$. If it decides to remain in business, it pays c_f and observes the current period's productivity z . The value function of a firm operating in the formal sector is denoted as $V_j^f(z, k, b, c_f)$. If the firm decides to operate, it decides the amount of skilled and unskilled labor in the current period, s and n respectively, capital and assets for the following period, k' and b' , and produces. The formal sector incumbent is subject to a proportional tax on profits τ , a cost in unskilled labor units of filing those taxes $c_\tau \omega_n$, and a payroll tax $\tau \omega_n$ for both the skilled and the unskilled labor. ⁷

⁷Most countries apply progressive taxes, the tax rates on the skilled and unskilled labor might differ. Evaluating the costs as a percentage of the unskilled wage might underestimate the frictions prevailing in the economy.

The incumbent solves the Bellman equation

$$W_j^f(z_{-1}, k, b, c_f) = \max \left\{ \int V_j^f(z, k, b, c_f) d\eta_j(z|z_{-1}), \max\{0, (1 - \phi)k - \lambda b\}, k - b \right\} \quad (10)$$

and

$$V_j^f(z, k, b, c_f) = \max_{n, s, k', b'} d_j^f(z, k, b, c_f) + \beta \int W_j^f(z, k', b', c_f) d\xi(c_f) \quad (11)$$

s.t.

$$\begin{aligned} d_j^f(z, k, b, c_f) &= (1 - \tau)[f(z, k, s, n) - c_f - \omega_n(1 + \tau_\omega)(n + c_\tau) \\ &\quad - \omega_s(1 + \tau_\omega)s] - k' + (1 - \delta)k + q_j^f(k', b')b' - b \geq 0 \end{aligned}$$

The solution to this problem provides the exit decision rule $\chi_j^f(z_{-1}, k, b, c_f)$ that takes the value of 0 if the firm continues to operate, 1 if the firm decides to default, and 2 if the firm decides to exit after repayment. We also obtain the optimal capital and debt decision rules $k_j^f(z, k, b, c_f)$ and $b_j^f(z, k, b, c_f)$, respectively, for a firm in the formal sector.

4.1.2 Informal Sector Incumbent

An incumbent establishment in the informal sector, after observing the fix operating cost c_f , can choose to stay informal, to pay the formal entry cost $\kappa\omega_n$ and switch operations to the formal sector, or to exit the market after a default. More specifically, the informal incumbent establishment solves the following Bellman equation;

$$W^i(k, b, c_f) = \max \left\{ V^i(k, b, c_f), \tilde{V}_u^f(\mu_u, k, b, c_f), k \right\}, \quad (12)$$

where the value of staying in the informal sector is

$$V^i(k, b, c_f) = \max_{n, k', b', s} d^i(k, b, c_f) + \beta \int W^i(k', b', c_f) d\xi(c_f) \quad (13)$$

s.t.

$$d^i(k, b, c_f) = g(z, k, n) - c_f - \omega_n n - \omega_s s - k' + (1 - \delta)k + q^i(k', b', z)b' - b \geq 0 \quad (14)$$

The value of switching to the formal sector is

$$\tilde{V}_j^f(z, k, b, c_f) = \max_{n, s, k', b'} \tilde{d}_j^f(z, k, b, c_f) + \beta \int W_j^f(z, k', b', c_f) d\xi(c_f) \quad (15)$$

s.t.

$$\begin{aligned} \tilde{d}_j^f &= (1 - \tau)[f(z, k, s, n) - c_f - \omega_n(1 + \tau_\omega)(n + c_\tau + \kappa)) \\ &\quad - \omega_s(1 + \tau_\omega)s] - k' + (1 - \delta)k + q_s^f(k', b', z)b' - b \geq 0 \end{aligned}$$

The solution to this problem provides the exit decision rule $\chi_j^i(z_{-1}, k, b, c_f)$ that takes the value of 0 if the firm continues to operate in the informal sector, 1 if the firm decides to default, and 2 if it decides to switch its operations to the formal sector. We also obtain the optimal capital and debt decision rules $k_j^i(z_{-1}, k, b, c_f)$ and $b_j^i(z_{-1}, k, b, c_f)$ for a firm operating in the informal sector, and capital and debt decision rules $\tilde{k}_s^i(z, k, b, c_f)$ and $\tilde{b}_s^i(z, k, b, c_f)$ for a firm that switches from the informal to the formal sector.

4.1.3 Entrants

To draw from the pool of ideas, potential entrants pay a creation cost given by c_e . The value of a potential entrant W_e is given by:

$$W_e = \int \int \max_{j=s, l} \{W^i(0, 0, 0), \tilde{V}_l^f(z_{0, l}, 0, 0, 0)\} d\nu_s(z_0) d\nu_l(z_0) - c_e \quad (16)$$

Effectively, an entrant has no capital, no debt, and the cost of production c_f equals zero. The entrant chooses between technologies, conditional on the restriction that the limited technology cannot be operated in the informal sector. The sector and technological decision are made after paying c_e and observing the productivity level $z_{0, l}$ $j \in l, u$, which affects the conditional distri-

bution from which the first productivity parameter will be drawn. Differences in the volatility of the process together with differences in initial productivity are going to generate differences in the decisions by the entrants and by the potential lenders. That introduces differences in behavior as a function of volatility and contract enforceability. In equilibrium, $W_e = 0$ will hold. The solution to this problem provides the entry decision rule $\Xi(z_{0,u}, z_{0,l})$.

4.2 Lenders' Problem

Lenders make loans to formal and informal establishments and take prices as given. Profit for a loan b' to a firm in the formal sector with future capital k'

$$\pi_j^f(k', b', z) = -q_j^f(k', b', z)b' + \frac{1 - p_j^f(k', b', z)}{1 + r}b' + \frac{p_j^f(k', b', z)}{1 + r} \min\{\lambda b', (1 - \phi)k'\} \quad (17)$$

where $p_j^f(k', b')$ denotes the default probability of this borrower.

Profit for a loan b' to a firm in the informal sector with future capital k' ,

$$\pi_i^f(k', b') = -q_i^f(k', b')b' + \frac{[1 - p_i^f(k', b')]}{1 + r}b' \quad (18)$$

where $p_i^f(k', b')$ denotes the default probability of the informal borrower. In equilibrium, the schedule of prices will adjust so that $\pi_j^f(k', b', z) = 0$ and $\pi_i^f(k', b') = 0$ for all (j, k', b', z) .

4.3 Definition of equilibrium

A stationary competitive equilibrium is a set of value functions $W_j^f, W^i, V_j^f, \tilde{V}$, decision rules (physical capital, human capital, debt, default, exit and sector), the wage rates ω_s, ω_n aggregate distributions of firms in the formal $\vartheta(k, b, z, s, j; M)$ and informal $\hat{\vartheta}(k, b, s; M)$ sectors, and a mass of entrants M such that:

1. Given prices, the value function of the firms and the decision rules are consistent with firms optimization.

2. The free entry condition is satisfied: $W_e = 0$.
3. Lenders make zero profit for every type of loan.
4. Invariant distributions ϑ and $\tilde{\vartheta}$ are stationary.
5. Aggregate consumption $C = \omega_n n + \omega_s s + \Pi + T - E + X$.
6. The labor market clears

$$1 = \int (n(z, k) + s(z, k)) d\nu(k, b, z, j; M) + \int (n(z, k) + s(z, k)) d\hat{\nu}(k, b; M) + a_t$$

where $a_t = s_t \delta_s x$

5 Calibration

In this section we calibrate the model to the US economy. The basis for this calibration can be found in Moscoso Boedo and Mukoyama (2008) and D’Erasmus (2009). The productivity process for the limited technology is given by

$$\ln(z_{t+1}) = (1 - \rho)\ln\mu_l + \rho\ln(z_t) + \epsilon_{t+1} \quad (19)$$

with $\epsilon_{t+1} \sim N(0, (1 - \rho^2)\sigma_l^2)$ where ρ is the autocorrelation parameter and σ_l^2 is the variance of the process. The volatility of the limited process σ_l is set to 0.2305 and the autocorrelation parameter ρ to 0.885 as estimated for the U.S. manufacturing sector by Cooper and Haltiwanger (2006). The process is discretized to obtain the grid for z and the transition probabilities $\eta_x(z'|z)$ following Tauchen (1986). From the transition matrix $\eta_l(z'|z)$ we can derive the unconditional probabilities $\eta_l^*(z)$. We set the distribution of initial shocks $\nu_l(z_0) = \eta_l^*(z)$. As a benchmark, given the lack of information about the distribution of establishments in the informal sector, we set $\sigma_s = 0$ so productivity of the simple projects is constant.

Table 1: Model Parameters

Parameter		Value	Moment (US economy)
Discount factor	β	0.9615	Average yearly return 5-yr. T-bill
Depr. rate for capital	δ_k	0.07	Manufacturing Sector
Depr. rate for skilled labor	δ_s	0.015	Annual Return to Education
Years of schooling	x	6	Avg years of school in US labor force
Skilled Labor Share	ϵ	0.286	Skilled workers as % of population
Labor Share Formal	γ_f	0.354	Labor Share
Capital Share	α	0.21	Capital share
Labor Share Informal	γ_i	0.64	Labor Share
Std. Dev.	σ	0.2305	Manufacturing Sector
Autocorrelation	ρ	0.885	Manufacturing Sector
Creation Cost	c_e	0.095	Entry Condition
Mean limited process	μ_l	2.77	Avg. Operating Establishment
Mean unlimited process	μ_u	0.664	Size of Informal sector
Positive operating cost	$\hat{c}_f$	9.5	Exit Rate Distribution
Distribution Op. Costs	$\xi(\hat{c}_f)$	.100	Exit Rate Distribution
	$\xi(\infty)$	.042	

A skilled worker is defines as one with a college degree (16 years of education). We set x to 6 to match the average years of schooling for the US labor force as in Barro and Lee (1999).⁸ The skilled labor share ϵ_f is set to 0.286 to match the percentage of skilled workers a fraction of the population, $\gamma_f + \epsilon_f$ is set to 0.64 a standard value, and the capital share is based on previous estimates of the degree of decreasing returns to scale at the firm level as in Restuccia and Rogerson(2008). In particular, in the formal sector, we set $\alpha + \epsilon_f + \gamma_f = 0.85$, and in the informal sector we set $\alpha + \gamma_i = 0.85$. The risk free interest rate r is set to 4% per year to match the average real return on a 5 year T-Note over the last 30 years that implies that $\beta = 1/(1 + r) = 0.9615$. The depreciation rate δ_k is set to 7%, and the depreciation rate of skilled labor will be set to $\delta_s = 0.015$ to match the average yearly return to college education reported by Psacharopulos and Patrinos(2004). We normalize the unskilled wage rate to 1, and calculate the skilled labor wage rate through equation (9) given 6 years of schooling. The value of the entry cost c_e is calibrated as in Hopenhayn and Rogerson (1993), we find the value of

⁸Given our definition of skills (college education completed), and the fraction of skilled workers in the US, we can compute the years of schooling implicit in our unskilled workers. That is equal to 10. Therefore we set the difference to be 6.

c_e that, in equilibrium, satisfies the free entry condition with equality. We assume that the operating fixed cost can take values of $\{0, \hat{c}_f, +\infty\}$. The parameters $\{\tau, c_\tau, \tau_\omega, \kappa, \lambda, \phi\}$ are taken directly from the values reported in the World Bank Doing Business database (2009) for the U.S. economy. We set the tax rates $\tau = 0.23$, $c_\tau = 0.09$ and $\tau_\omega = 0.20$; the entry cost $\kappa = 0.26$; and the bankruptcy parameters to $\lambda = 0.77$ and $\phi = 0.07$.

We are left with 5 more parameters to calibrate: the mean of the productivity process of the large scale and small scale projects μ_l and μ_u respectively, the operating cost c_f , and the associated probabilities $\xi(\hat{c}_f)$ and $\xi(\infty)$. To obtain values for these parameters, we target the size of the informal labor force, measured as those workers not covered by a pension scheme (as reported by World Development Indicators 2006), the average size of formal establishments in the U.S. and the exit rates distribution across the size of firms, the percentage of the skilled labor to labor force and the capital-labor ratio. The data regarding the size distribution of establishments (in the formal sector) and exit rates in the US comes from the Statistics of US Business (SUBS) data set for the years 2003-2004. It is the same data used in Moscoso Boedo and Mukoyama (2008).

Table (2) shows the data moments and the corresponding model moments. The average size of a formal establishment is 17.6 % in the US data, in our model this figure is 14.08. The size of the informal sector is 7.8 % in the data, and in our model it is 8.28 %.

Table 2: Target Moments

Moment	Us Data	Model
Average Formal Est.	17.6	14.08
Informal Sector(fraction of Labor Force)	7.8 %	8.28%
Skilled labor (fraction of the Labor Force)	30.03 %	32.68 %
Exit Rate Distribution by Employment Size	%	%
1-4	14.88	12.56
5-9	6.72	7.81
10-19	5.57	4.64
20-49	4.91	4.20
50-99	4.58	4.20
100-249	4.16	4.20
250-499	3.9	4.20
500-	4.22	4.20

We test our model using the distribution of US formal establishments by size (Table (3)). The model does a good job generating the right distribution of operating establishments in the formal sector by size. Regarding size, it generates the right number of small establishments (with less than 19 employees), but misses at the very low end of the distribution (less than 5 employees).

Table 3: Distribution of US Formal Establishment by Employment Size

Total Size Distribution	Data %	Model %
1-4	48.6	32.68
5-9	21.8	26.44
10-19	14.2	20.58
20-49	9.6	14.88
50-99	3.2	3.95
100-249	1.8	1.41
250 +	0.7	0.04

By construction the exit and the entry rates are the same in the model, which is found to be 7.8 %. The entry and exit rates in the data are 11.1% and 10.2% respectively. Thus, compared to the US data, the model average entry and exit rates are three and two percentage points lower respectively.

6 The Effects of Country Specific Institutions

In this paper, we analyze whether the institutional frictions explain the differences in TFP, and ask if these TFP differences lead to differences in the skill distribution across countries. Since the model is computationally intensive we limit our analysis to 4 country income groups, high income countries (HIC), upper middle income countries (UMIC), lower middle income countries (LMIC) and low income countries(LIC).⁹ We use the Doing Business 2009 data set to obtain the median $(\lambda, \phi, \tau, c_\tau, \tau_\omega, \kappa)$ for each income group. Table (4) shows the parameter values for the US economy and for these income groups. We then compare the benchmark case (US) with the equilibrium across income groups. Our experiment can be described as follows. We first calibrate the model to the US economy by using $(\lambda, \phi, \tau, c_\tau, \tau_\omega, \kappa)_{US}$. In the benchmark case, we set $\omega_n = 1$, and then iterate on the set of loan prices $q_j^f(k', b', z)$ and $q^i(k', b')$ until the lenders make zero profit on each contract and find the mass of entrants M that clears the labor market. Then for each income group, we set the group parameters to their values, and we iterate on the unskilled labor wage rate ω , and loan prices $q_j^f(k', b', z)$ and $q^i(k', b')$ until lenders make zero profits, and labor markets clear (given M obtained for US). Finally we adjust the creation cost for each income group c_e until the free entry condition is met.

Table 4: Frictions Across Income Groups

	λ	ϕ	τ	C_τ	κ	τ_ω
US	0.77	0.07	0.23	0.09	0.20	0.20
High (HIC)	0.77	0.07	0.19	0.07	1.13	0.30
Upper Middle (UMIC)	0.30	0.15	0.15	0.15	1.86	0.39
Lower Middle (LMIC)	0.28	0.15	0.20	0.16	4.82	0.28
Low(LIC)	0.16	0.18	0.20	0.13	8.49	0.23

In order to understand the effects of country specific frictions on firms productivity, we compute total factor productivity using an aggregate production function both in the data and the model to compare it across equilibria associated with different frictions. In order to compute

⁹Roughly, countries are classified as HIC if their GNI per capita is higher than 25% of the US, UMIC if their GNI per capita falls between 8% and 25% of the US, LMIC if their GNI per capita falls between 2% and 8% of the US and LIC if their GNI per capita is below 2% of the US.

total factor productivity in the model and the data, we follow the cross country studies such as Klenow and Rodriguez-Clare (1997) or Hall and Jones (1999). They compute the following equation.

$$TFP = \frac{Y}{K^\alpha H^{1-\alpha}}$$

where Y denotes aggregate output, K denotes aggregate capital, H denotes some aggregate for labor (usually adjusted for human capital) and α is the capital share. We follow the same procedure in our the model, where aggregate output is the sum across both formal and informal firms, aggregate capital is the sum of capital across establishments in both sectors and our aggregate measure of labor equals one. We use the same parameter share as in Hall and Jones (1999). which equals 1/3. Table (5) displays the main results for each income group and compares the model to the data for the median country in the income group. Values of TFP and output per effective worker are taken from Hall and Jones (1999). The model TFP is calculated as in Hall and Jones (1999), by calculating the value of the human capital given the returns for every level of schooling. The informal labor force is reported by 2006 WDI as the share of labor force not covered by the pension scheme. Our model accounts for more than 2/3

Table 5: Main Results

	HIC		UMIC		LMIC		LIC	
	Data	Model	Data	Model	Data	Model	Data	Model
TFP	0.93	0.89	0.61	0.68	0.54	0.58	0.37	0.58
Informal Labor Force	8.80	12.25	44.40	59.21	74.90	84.07	92.60	81.41
Output per eff. Worker	0.92	0.91	0.45	0.64	0.32	0.52	0.13	0.52
Skilled workers % of LF	11.00	31.26	9.00	14.54	5.70	6.12	1.40	6.12

Note: TFP and Output per effective worker are reported relative to the US value. Data is from authors calculations based on Hall and Jones (1999). The size of the informal labor force is taken from the World Development Indicators(2006) as the share of the labor force not covered by a pension scheme. Skilled workers are proxied by the percentage of college completed as a percentage of the population over age 25 from Barro and Lee (2000).

of the TFP differences between US and the developing economies. Our model is consistent with the pattern of skill distribution across countries. The model generates a stock of human capital that is positively correlated with TFP as observed in the data. It ranges from 14.54 percent

in upper middle countries to 6.12 percent in the low income countries. In terms of informal activity, the model performs a decent job in generating an informal labor force comparable with the data. Informality in our model ranges from around 8% in the US to 81% at the low end of the income distribution. The model output per effective worker values are up to four times higher than what is seen in the data, in the case of the Low Income Countries. The model does a decent job in terms of matching output per effective worker for the other country income groups.

Table 6: Differences across Income Groups

	HIC		UMIC		LMIC		LIC	
	Data	Model	Data	Model	Data	Model	Data	Model
Avg Employment Formal	11.1	23.21	129.8	39.01	175	73.71	386.4	84.98
Capital per effective worker	1.05	0.95	0.38	0.56	0.18	0.42	0.04	0.42
Formal Entry Rate	0.81	0.75	0.65	0.59	0.62	0.54	0.47	0.54
Business Density	1.62	0.61	0.93	0.36	0.31	0.19	0.03	0.17

Note: Capital per effective worker, Formal Entry Rate, Business Density are reported relative to the US value. Data on average employment and variance of employment is taken from Alfaro et. al. (2009). Capital per effective worker is from author's calculations based on Hall and Jones (1999). One unit of effective worker equals one unit of human capital. Data on the Formal Entry Rate and Business Density are taken from the 2008 World Bank Group *Entrepreneurship Survey and Database*. The model counterpart is obtained as total formal labor force over the average size of formal establishments which equals the measure of formal establishment to total population.

In Table (6), we present other important moments across income groups to test our model in different dimensions. In terms of the average size distribution the model is on target both on average size as reported by Alfaro et. al.(2009).

Our model predicts as frictions increase, the exit rate (and the entry rate, by construction) decreases. This implies that for Low Income Countries countries operate the limited technology, firms stay in business for much longer, preventing the natural process of churning of unproductive firms. Also, the model generates a relative business density that is in line with the observed one (measured as the number of registered businesses as a percentage of the active population). The business density drops to 17% of the US's for the Low Income Countries. High frictions generate low density, which generates low competitive pressures in the labor markets, generating low turnover in the formal sector (as observed by the low entry rate in developing economies), and lower average productivity.

6.1 Firm Level Productivity Decomposition

To be done.

6.2 How important is each friction

To be done.

7 Conclusion

The level of human capital has been considered as an important sign of development for a country. But there still remains an important gap between the human capital stocks of the developed and the developing world. In this paper, we built a firm dynamics model with imperfect capital markets, and measured institutional frictions to explain the cross country differences in stock of human capital and total factor productivity. In our model, entering and operating in the formal sector is costly, but allows firms to choose from an unrestricted set of technologies, while providing firms access to credit markets with better commitment (given by observed recovery rates and associated costs), which leads to sorting into informal or the formal sector. We find that a low degree of debt enforcement and high costs of formality leads to low allocative efficiency, a lower stock of human capital and a larger informal sector characterized by low productivity firms. We find that the using the measured frictions documented by the World Bank Doing Business database, our the model explains more than two-thirds of the productivity differences between the US and developing economies and is consistent with the cross country skill distribution. Consistent with the data, we find a negative correlation between income per-worker, stock of human capital and a sizable informal sectors that are comparable to the data.

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