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**CORRUPTION, CREDIT MARKET
IMPERFECTIONS, AND ECONOMIC
DEVELOPMENT**

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Corruption, Credit Market Imperfections, and Economic Development[*]

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Abstract

This paper studies the role of credit market imperfections and corruption on the process of economic development. We address the question of how much of the differences in output per capita across countries can be attributed to differences in credit market policies and corruption. In order to accomplish that, we construct and solve numerically a general equilibrium model with heterogeneous agents, contractual imperfections and occupational choices. The quantitative exercises suggest that a country in which debt contracts are not enforced and corruption corresponds to 10% of output will be roughly 1/3 to 1/2 as rich as the United States. Though this is an important effect, it is a small fraction of the huge differences in income per capita across countries.

1   Introduction

A persistent feature of the world economy is the wide inequality in per capita output across countries. According to the Penn World Tables 5.6, Mali's output per worker in 1990 was roughly 3% of the GDP per worker in the United States. This means that incomes per capita differ by a factor of 33.

Observers have pointed out several factors to explain differences in international incomes, such as geography,[1] religion,[2] colonial origins,[3] institutions,[4] and bad policies.[5] It is definitely a hard task to assess separately the role of each factor on the process of economic development. Surely, each one and their interactions contribute to the determinants of the long-run performance of economies.

In a recent book, De Soto (2000) argues that, as in the developed world, the streets of less developed countries are full of talented and enthusiastic entrepreneurs. However, while in developed countries agents create capital from capital, in developing countries the entrepreneurs' assets are "dead capital." This is what he calls the "Mystery of Capital," and what he points out as the major determinant of why capitalism triumphs in the West and fails everywhere else.

*"In this book (*The Mystery of Capital) *I intend to demonstrate that the major stumbling block that keeps the rest of the world from benefiting from capitalism is its inability to produce capital."* (De Soto (2000)[p. 5].)

Behind his idea are: i) the tremendous difficulties, in the form of regulation

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[1]Sachs and Warner (1995).

[2]Landes (1998).

[3]Acemoglu, Johnson and Robinson (2001).

[4]North (1990).

[5]Parente and Prescott (2000).

and corruption, for potential entrepreneurs in developing countries to open their businesses; and ii) the lack of a well functioning property rights system, which guarantees that agents can produce capital from their savings.

In this paper, we further study De Soto's hypothesis, i.e., we investigate the role of credit market imperfections and corruption on the process of economic development. We address the question of how much of the differences in output per capita across countries can be attributed to differences in credit market policies and corruption. In order to accomplish that, we construct and solve numerically a general equilibrium model with heterogenous agents, contractual imperfections and occupational choices. The quantitative exercises suggest that a country in which debt contracts are not enforced and corruption corresponds to 10% of output will be roughly 1/3 to 1/2 as rich as the United States. Though this is an important effect, it is a small fraction of the huge differences in income per capita across countries.

Our model clearly shares some features of a literature on the organization of production and on the process of economic development. Agents in our framework can choose to be either a worker or an entrepreneur. In this respect, this paper is related to Lucas' (1978) "span of control" model. Unlike this model, ours is built upon a dynamic framework and uses credit constraints in the analysis of occupational choice. Agents are differentiated by their entrepreneurial ability and their initial wealth. They care about their own consumption and the initial wealth of their offspring. In order to open a business, agents must buy in advance the capital to finance their project. However, capital markets are imperfect and not necessarily the best project will be undertaken. This interaction between wealth distribution and capital market imperfection is based on Banerjee and Newman (1993), which was also used by several authors, among whom Lloyd-Ellis and Bernhardt (2000) and Quintin (2001). However, the questions addressed by these authors are not the same as those studied in this paper. Lloyd-Ellis and Bernhardt (2000) study the macroeconomic and distributional

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dynamics associated with the process of economic development, while Quintin (2001) investigates how limited enforcement affects the size distribution of firms and productivity.

Notice also that our focus is on differences in income levels and not differences in growth rates. Authors have already studied the effects of enforcement and corruption on economic growth (see Mauro (1995), King and Levine (1993) and Marcet and Marimon (1992)). However, Easterly and Rebelo (1993) show that differences in growth rates across countries are mostly transitory and explaining differences in levels is the important problem in economic development (Parente and Prescott (2000)).

This paper is divided as follows: the next section describes the model economy. Section 3 describes the agents' optimal behavior, defines the competitive equilibrium allocations, and presents some analytical results. Section 4 solves the model numerically and conducts policy experiments. The last section provides some concluding remarks.

2 The model

2.1 Preferences, endowments and technology

2.1.1 Preferences

In each time period ($t = 0, 1, 2, ...$), the economy consists of a continuum of individuals in the unit interval. Each agent lives and is productive for one period, then reproduces another individual so that the population is constant. Agents care about their own consumption and leave bequest to their offspring. Let c_t^i and b_{t+1}^i denote consumption and bequest, respectively, by agent i at period t. Preferences are represented by

$$U^i = (c_t^i)^\gamma (b_{t+1}^i)^{1-\gamma}, \quad \gamma \in (0, 1). \tag{1}$$

This utility function implies that agents are risk-neutral with respect to income as the indirect utility function is linear in wealth. This implies that any additive punishment or reward in utility may be measured in terms of income. Notice that, for tractability, we assume that preferences are for the bequest and not the offspring's utility.[6]

2.1.2 Endowments

Each individual can be either a worker or an entrepreneur. Entrepreneurs create jobs and manage their labor force, n. As in Lucas' (1978) "span of control," each individual is endowed with a talent for managing, x^i, drawn from a continuous cumulative probability distribution function $\Gamma(x)$ with finite support $[\underline{x}, \overline{x}]$, where $\underline{x} \geq 0$. Therefore, in each period agents are distinguished by their initial wealth and ability as entrepreneurs, (b_t^i, x_t^i). We assume that the agent's talent for managing is not hereditary. (For notational convenience, we shall now, and for the remainder of this paper, drop superscript i to denote the agent.)

2.1.3 Production technologies

The technology that managers operate uses labor, n, and capital, k, to produce a single consumption good, y, and is represented by

$$y = xk^\alpha n^\beta, \;\; \alpha, \; \beta \; > 0, \;\; \text{and} \;\; \alpha + \beta < 1. \tag{2}$$

Capital fully depreciates during one period. Managers can operate only one project. In order to operate a technology, entrepreneurs must pay a start up cost, ς, in the form of regulations and corruption. This cost is assumed to be independent of the firm output since it is an *ex-ante* payment to the government. De Soto (1989, 2000) has shown that this cost varies across countries and is especially high in developing countries. Firms also pay an uniform payroll tax, τ.

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[6]See Banerjee and Newman (1993) and Lloyd-Ellis and Bernhardt (2000) for a similar formulation.

2.2 The capital market

Agents can borrow capital from a financial intermediary with access to perfect outside capital markets, in which a risk-free bond earns a gross return of $r \geq 1$. Let l be the amount of funds that an agent borrows from the financial intermediary. In order to finance their projects, constrained agents must put up their initial wealth, b, as collateral. Borrowers cannot commit *ex-ante* to their individual promises and can avoid the repayment obligation, rl, by defaulting on their debt and loosing rb. Those that renege on their debt loose the collateral and incur in a cost proportional to what was produced, ϕy. This is equivalent to an additive punishment in utility. This cost reflects the degree in which contracts are enforced in the economy. A higher ϕ means a better quality of the legal system or a stricter protection to investors. La Porta, Lopes-de-Silanes, Shleifer and Vishny (1998) show that countries differ enormously in the extend to which they provide legal protection to investors.[7] The point here is that, in contrast to Banerjee and Newman (1993), the quality of the project will be an important determinant of external debt.[8] Loans will be limited by the agents inheritance and the degree in which contracts are enforced.

2.3 Summing up

In order to characterize the optimal behavior and decisions of each agent, it is useful to describe the timing of events in the economy. In each period events occur sequentially. At the beginning of a period, each agent receives his bequest and the uncertainty about his ability is resolved. Next, each agent observes the endogenously determined wage and his credit limit, and decides his occupational

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[7]We do not model the Legal Code and the Credit Protection System. ϕ proxies for the degree in which investors are protected. See Krasa and Villamil (2002) for a model in which the characteristics of the judiciary system affect firm finance.

[8] Several studies have shown (see, in particular, Cohn and Coleman (2000)) that profitability of the firm is an important predictor of external debt, suggesting that lenders may use individual and business characteristics to evaluate projects.

choice. The acquisition of capital is then carried out if the agent decides to become entrepreneur. This step may involve borrowing, in which case his bequest is put as collateral. Production then takes place and the agent receives either the wage rate or profits. Then the agent decides whether to default or not. If he defaults, he looses the collateral and interest and must pay a cost proportional to what was produced. If he repays his loan and interest, he receives the collateral and interest. Finally, the agent consumes out of his holdings, leaves bequest to the next generation, and dies.

3   Optimal behavior and equilibrium

3.1   Entrepreneurs

Those who have enough resources and managerial ability to become entrepreneurs choose the level of capital and the number of employees to maximize profits subject the technological constraint. Since capital markets are imperfect, let us describe the problem of an entrepreneur for a given level of capital k. The problem of an entrepreneur with capital k is

$$\pi(k, x; w) = \max_{n} x k^{\alpha} n^{\beta} - (1 + \tau) w n, \tag{3}$$

where w is the wage rate. Equation (3) gives the labor demand of each entrepreneur:

$$n(k, x; w) = \left(\frac{\beta x k^{\alpha}}{w(1 + \tau)} \right)^{\frac{1}{1-\beta}}. \tag{4}$$

Substituting (4) into (3) yields the entrepreneur's profit function for a given level of capital,

$$\pi(k, x; w) = [(1 - \beta) x k^{\alpha}]^{\frac{1}{1-\beta}} \left(\frac{\beta}{w(1 + \tau)} \right)^{\frac{\beta}{1-\beta}}. \tag{5}$$

In an environment where managers do not default, they will solve the following problem

$$\max_{k \geq 0} \pi(k, x; w) - r(k + \varsigma). \tag{6}$$

This gives the optimal physical capital level:

$$k^*(x; w) = \left[\left(\frac{\beta}{w(1+\tau)} \right)^{\beta} \left(\frac{\alpha}{r} \right)^{1-\beta} x \right]^{\frac{1}{1-\alpha-\beta}}. \tag{7}$$

Since agents cannot commit to their promises, debt contracts must be self-enforcing. Let a be the amount of capital that is self-financed (or used as a collateral) and l be the amount of funds that is financed in the outside capital market. The income from running a project is:

$$V(b, x; w) = \max_{0 \leq a \leq b, \ l \geq 0} \pi(a + l, x; w) - r(a + l + \varsigma) \tag{8}$$

subject to

$$\pi(a + l, x; w) - r(a + l + \varsigma) \geq (1 - \phi)\pi(a + l, x; w) - ra.$$

This problem yields optimal policy functions $a(b, x; w)$ and $l(b, x; w)$. The total amount of capital used is $k(b, x; w) = a(b, x; w) + l(b, x; w)$. The last restriction is an incentive compatible constraint, which guarantees that individual promises will be fulfilled (see Kehoe and Levine (1993)). We can rewrite this constraint, such that

$$l(b, x; w) \leq \frac{\phi}{r} \pi(a(b, x; w) + l(b, x; w), x; w) - \varsigma.$$

It can be shown that constrained entrepreneurs put their entire wealth in the project as long as $b \leq k^*(x; w)$.[9] This implies that the size of a project of an entrepreneur (b, x) is limited above:

$$k(b, x; w) \leq b + \Delta(b, x; w), \tag{9}$$

where $\Delta(b, x; w) = \frac{\phi}{r} \pi(b + l(b, x; w), x; w) - \varsigma$. Therefore, projects are limited by the agents inheritance and the incompleteness of the capital market, represented by $\Delta(b, x; w)$. Notice that $\Delta(b, x; w)$ is increasing with the quality of the project. The idea behind this capital market is that financial intermediaries evaluate prospective entrepreneurs and choose the most promising projects (King and

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[9]Just solve the Kuhn-Tucker conditions of problem (8).

Levine (1993)). Therefore, a more developed capital market (ϕ close to one) fosters economic development by choosing higher quality projects.

The following lemma summarizes the value of undertaking each project:

Lemma 1 *For any $x \in [\underline{x}, \overline{x}]$, and $w > 0$, the value function $V(b, x; w)$, and the associated policy function $l(b, x; w)$, have the following properties:*

1. *$V(b, x; w)$ is continuous and differentiable in x and w. It is also strictly increasing in x and strictly decreasing in w.*

2. *For $b < k^*(x; w)$, $V(\cdot, x; w)$ is continuous, differentiable and strictly increasing. For $b > k^*(x; w)$, $V(\cdot, x; w)$ is constant.*

3. *$l(b, x; w)$ is strictly increasing for $b < k^*(w; w)$ and $l(b, x; w) = 0$ for $b > k^*(w; w)$.*

Proof. The proof is in the appendix. ∎

3.2 Occupational choice

The occupational choice of each agent defines his lifetime income. For any $w > 0$, an agent (b, x) will become an entrepreneur if $(b, x) \in E(w)$, where

$$E(w) = \{(b, x) \in [0, \infty) \times [\underline{x}, \overline{x}] : V(x, b; w) \geq w\}. \tag{10}$$

Let $E^c(w)$ denote the complement set of $E(w)$. Obviously, if $(b, x) \in E^c(w)$, then agents are workers.

The following lemma characterizes the occupational choice for a given bequest and entrepreneurial ability.

Lemma 2 *Define $b(x; w)$ such that $(b, x) \in [0, \infty) \times [\underline{x}, \overline{x}]$ and $V(b, x, w) = w$. Then there exists $x^*(w)$ such that $\frac{\partial b(x; w)}{\partial x} < 0$ for $x > x^*(w)$ and $\frac{\partial b(x; w)}{\partial x} = -\infty$ for $x = x^*(w)$. In addition, for each x*

1. *if $b < b(x; w)$, then $(b, x) \in E^c(w)$.*

2. if $b \geq b(x; w)$, then $(b, x) \in E(w)$.

Proof. The proof is in the appendix. ∎

Figure 1 illustrates this lemma. It shows the occupational choice in the (b, x) space for the baseline economy (see parameters on section 4). Lemma 2 and Figure 1 suggests that agents are workers when the quality of their project is low, i.e., $x < x^*(w)$ (the lightest shaded area). For $x \geq x^*(w)$, then agents might become entrepreneurs depending if they are credit constrained or not (notice that for very low bequests agents are workers even though their entrepreneurial ability is higher than $x^*(w)$). The negative association between $b(x; w)$ and x suggests that managers with better projects need a lower level of initial wealth to run a project. This is rather intuitive since profits are increasing in the quality of the project.
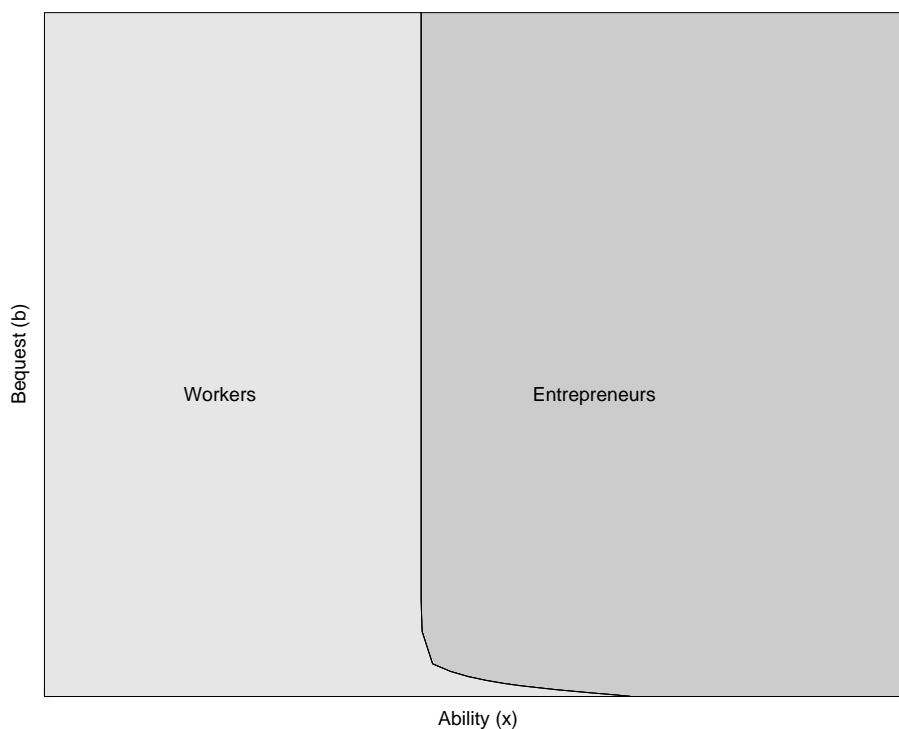
Figure 1: Firm size distribution in the formal and informal sectors.

3.3 Consumers

The lifetime wealth of agent (b, x) is given by

$$Y(b_t, x_t) = \max\{w_t, V(b_t, x_t; w_t)\} + rb_t, \tag{11}$$

Lifetime wealth is thus a function of agent-specific b_t and x_t, and economy-wide w_t, r, τ, ϕ, and ς. Given the lifetime wealth, (11), agents choose consumption and bequest to maximize preferences (1). This problem defines the optimal consumption, $c_t = c(Y_t)$, and bequest, $b_{t+1} = b(Y_t)$, policies. The functional form of (1) implies that agents leave a proportion $1 - \gamma$ of their lifetime wealth as a bequest. Notice that bequests cannot be negative because every agent is allowed to become a worker. Let u_t be a vector of all economy-wide variables and structural parameters, $u_t = (w_t, r, \tau, \phi, \varsigma)$, and let $z_t = (b_t, x_t)$. Define the measurable space $(Z, \mathcal{B})$, where $\mathcal{B}$ is the Borel algebra for the set $Z = \mathbb{R}_+ \times [\underline{x}, \overline{x}]$, and the bequest (or wealth) probability measure, $H_t : \mathcal{B} \to [0, 1]$, which specifies the probability of each event in $\mathcal{B}$. Since the distribution of ability is invariant and independent from the initial bequest distribution, there exist a probability measure $W_t : \mathcal{B}(\mathbb{R}_+) \to [0, 1]$ such that, for all $A \in \mathcal{B}$,[10]

$$H_t(A) = \iint_{z_t \in A} W_t(db_t) \Gamma(dx_t).$$

W_t is therefore the bequest distribution at period t.

3.4 Competitive equilibrium

Definition: Given $\lambda = (\tau, \phi, \varsigma)$, r, Γ, W_t, equilibrium at date t is a list w_t, $n_t = n(x; w_t)$, $l_t = l(b, x; w_t)$, $a_t = a(b, x; w_t)$, $V(b, x; w_t)$, $c_t = c(b, x; w_t)$, $b_{t+1} = b'(b, x; w_t)$, such that:

A. Given the wage rate and government policies, an agent of type (b, x) chooses his occupation to maximize his lifetime wealth, (11).

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[10] We make the abuse of notation of using the same letter to designate distribution functions and probability measures.

B. $l(b, x; w_t)$ and $a(b, x; w_t)$ solve (8).

C. Given the lifetime wealth, (11), $c(b, x; w_t)$ and $b'(b, x; w_t)$ maximize utility (1) for agent of type (b, x).

D. Given the wage rate, technology constraint, credit markets, and government policies, entrepreneurs select their labor force to maximize profits, (3).

E. The Labor Market clears:

$$\iint_{z \in E(w)} n(x_t; w_t) W_t(db_t) \Gamma(dx_t) = \iint_{z \in E^c(w)} W_t(db_t) \Gamma(dx_t). \qquad (12)$$

Notice that we just stated the labor market equilibrium condition. This is because interest rate is already determined, r, and Walras' law takes care of the goods market.

In the quantitative exercises it is important to evaluate policy experiments in "stable" economies, where, for instance, the real wage and income distribution are not changing significantly over time. Indeed, it is possible to show that when policies and institutions are stationary a unique steady-state equilibrium exists (i.e., an equilibrium with a constant real wage, w, and invariant distribution, $H = W\Gamma$) and from any initial condition the economy converges to this equilibrium.

Proposition 3 *There exists a unique stationary equilibrium with $0 < w < \infty$ and invariant distribution W. In addition, for any initial bequest distribution W_0 and stationary government policies and institutions λ, the bequest distribution converges to W.*

Proof. See appendix C. ∎

In the calibration and quantitative experiments we will study the economy in this particular equilibrium and therefore we will consider the long run impact of changes in policies and institutions.

4   Quantitative results

4.1   Parameterization

In order to solve out the model numerically we have to choose functional forms for the ability distribution and assign values to the parameters of the model, namely γ, α, β, r, τ, ς and ϕ. We parameterize the model such that, in the stationary equilibrium, we match some key empirical observations of the United States economy.

Parameter	Value
γ	0.8
β	0.55
α	0.35
r	2
τ	0.33
ς	0
ϕ	0.15
ϵ	12

Table 1: Parameter Values, Baseline Economy.

Table 1 summarizes the parameter values, which were determined as follows. We assumed that the entrepreneurial cumulative distribution function is $\Gamma(x) = Ax^{\frac{1}{\epsilon}}$, and we normalized the support of this distribution to interval $[0, 1]$, so that $A = 1$. We used parameter ϵ to match the income Gini coefficient of the US economy, which was 0.40 in 2000 (see World Bank (2000)). We assume the productive lifespan of the agents to be 35 years and we let $r = 2$, which implies a yearly real interest rate of roughly 2%. We set α and β such that about 55% of income is paid to labor, 35% is paid to the remuneration of capital, and 10% are profits (see Quintin (2001)). We chose a payroll tax of $\tau = 0.33$, which is consistent to the literature (Jones, Manuelli and Rossi (1993)). Since regulation costs are small in the United States,[11] we assumed that they are negligible relative to lifetime profits of entrepreneurs and we set $\varsigma = 0$. The

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[11] According to Loayza (1996) it takes about three to four hours to register a small factory in the United States at almost no income costs.

share of bequests in the instantaneous utility function, $1 - \gamma$, was taken to be 0.2, which is consistent to estimates by Laitner and Juster (1996). The variable that measures the degree in which debt contracts are enforced, ϕ, was chosen so that the ratio of entrepreneurs over the total population matches that of the real economy.[12] The value of ϕ was 0.15, which implies that entrepreneurs are 5.8% of total population

	US Economy	Baseline Economy
% of entrepreneurs	5.8	5.8
Income Gini (%)	40	40
% of business income	25	36
Business income Gini (%)	45	57

Table 2: Basic statistics, US and baseline economy. Sources: Cagetti and De Nardi (2002); all figures in percentage.

The baseline economy reproduces statistics consistent to those of the US economy. Table 2 also reports some other statistics. The first measure is income of entrepreneurs as a percentage of total income. Entrepreneurial income as a percentage of total income is around 25% in the United States and 36% in the model. The other statistic shown is the Gini coefficient of entrepreneurial income, which is around 45% in the PSID data and 57% in the model. These values indicate that the model compensates the lack of inequality in income wages (workers receive the same equilibrium wage) with a higher inequality among entrepreneurs, a question that we address later.

Figure 2 shows the entrepreneur's decision rule given his entrepreneurial ability and bequest. The horizontal area (when ability is low) corresponds to those agents that are workers. As the entrepreneurial ability increases, the size of the projects increases monotonically up to the point where entrepreneurs become financially constrained. This set of points corresponds to the change in the slope of the figure. For higher ability, agents can borrow part of the remaining value of the project.

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[12]We follow Cagetti and De Nardi (2002) to define entrepreneurs.
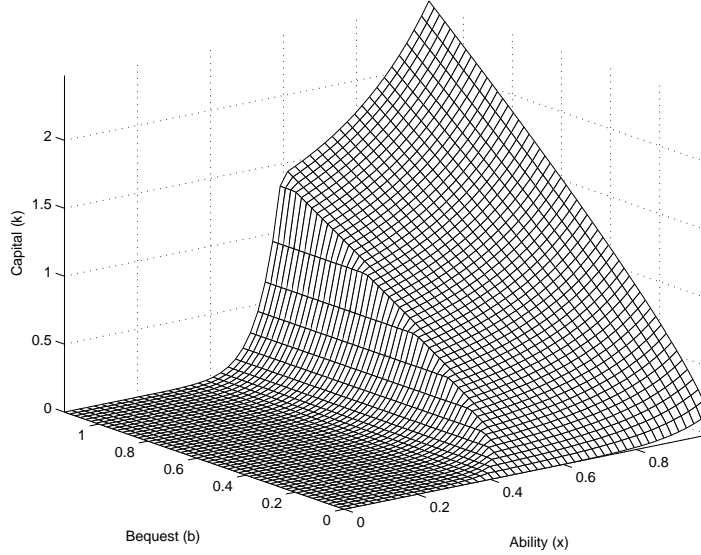
Figure 2: Firm size distribution in the baseline economy.

4.2 Policy experiments

With all parameters determined, we run some policy experiments to provide a numerical assessment of the long-run impact of corruption and enforcement on output per capita.

The results indicate a quantitatively sizeable impact of financial constraints on the structure of the economy. We can see this by looking at the rows of Table 3 labelled $\phi = 0$ and $\phi = 1$. These rows correspond to economies with no enforcement and full enforcement, respectively. In the first case, output falls to 47% of the baseline economy. This implies that improvements in the degree in which debt contracts are enforced would increase output per capita by a factor of 2. It suggests that a country in which debt contracts are not enforced will be roughly 1/2 as rich as the United States. We can also see in Table 2 that an economy with perfect enforcement would increase output by half compared to the baseline economy. Notice that ϕ goes from 0.15 to 1 in that case. This indicates that financial constraints have a higher impact on economies with poor

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enforcement.

	Output per capita	% of entrepreneurs	Income Gini (%)
US economy	100	5.8	40
Baseline	100	5.8	40
$\phi = 0$	47	8.6	36
$\phi = 1$	150	2.8	17
$\phi = 0$ and $\varsigma = 0.001$	46	8.4	36
$\phi = 0$ and $\varsigma = 0.0085$	43	7.2	35

Table 3: Basic statistics, baseline economy. Sources: Cagetti and De Nardi (2002) and Quadrini (1999); all figures in percentage.

The second important statistic is the number of entrepreneurs. When financial contracts are more enforced, the fraction of agents that are entrepreneurs in the economy decreases. The number of entrepreneurs decreases with higher enforcement, but the quality (size and productivity) of each entrepreneur's project increases. This is consistent to the empirical observations, which show that less developed countries tend to have more but less productive entrepreneurs (see Tybout (2000)).

Comparing with the baseline economy, income distribution becomes less unequal when there is perfect or no enforcement at all. There are two effects to explain this outcome. First, when enforceability increases, the average productivity tends to increase, since entrepreneurs become less constrained. This would tend to increase inequality. But this implies that wages also become higher, thus reducing inequality. This later effect dominates the former when ϕ goes to one. When ϕ goes to 0, the fall on the income Gini is moderate. The reduction of firms' average productivity is accompanied by a decrease in wages.

To assess the impact of firm start-up costs on the number of employees and on output per capita we change parameter ς (fifth and sixth rows of Table 3). Using data from the Peruvian economy (see De Soto (1989)), we set ς in terms of a markup of the monthly average wage, and ϕ to zero.[13] This start-up cost

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[13]We chose ς equal to 31 times the present value of a stream of a monthly wage rate whose present value equals the lifetime wage.

corresponds to roughly 1.2% of the present value of average business income. The results indicate that output and the number of entrepreneurs are not much affected relative to the case with no enforcement and no start-up costs. Since corruption and regulation are difficult to measure, we also run an experiment with ς equal to 10% of the present value of average business income. The results are in the sixth row of Table 3. Relative to the previous case, output and the number of entrepreneurs do not change significantly. Since ς increased by a factor of 8, this seems to indicate that corruption and regulation have a small impact on the long run output per capita.

We should highlight, however, that corruption and regulation might have a sizeable effect on the size of the informal (unregulated) sector. An unregulated sector would add another margin in which agents could substitute, and to avoid corruption and regulation agents could go underground. Depending on the characteristics of this sector, corruption could have an impact on output per capita (see Antunes and Cavalcanti (2003)) similar to those associated with credit market policies.

4.3   Sensitivity to parameters

As stated above, this model does not display wage inequality. This could be introduced by means of a "working ability" that would differentiate among workers. This inequality, however, would simply reflect the randomness of working productivity, which is not important to our purposes. The parameterization based on the income Gini suggests that the entrepreneurial distribution might be too uneven (see Table 2). In order to assess the impact of the distribution on output per capita, we calibrated the model by targeting the business income Gini coefficient instead of the income Gini. The parameters of Table 1 remain unchanged except for $\phi = 0.5$ and $\epsilon = 6.5$. For this parameterization, the results of changing ϕ from 0.5 to 0 and 1 are presented in Table 4.

When ϕ varies, the results are quantitatively close to those in Table 2 in

	Output per capita	% of entrepreneurs	% of business income	Business income Gini (%)
US economy	100	5.8	25	45
$\phi = 0.5$, $\epsilon = 6.5$	100	5.8	26	45
$\phi = 0$	43	12.4	37	42
$\phi = 1$	102	4.2	16	39

Table 4: Basic statistics, model economy. Parameterization with targeting of business income Gini coefficient; all figures in percentage.

terms of output variation, and number of entrepreneurs. For instance, when ϕ goes to 0, output per capita decreases to about 43% of the baseline income, and the percentage of entrepreneurs increases.

Table 5 shows the equilibrium results for output and the percentage of entrepreneurs when we change other parameters of the model. The second row shows the impact of increasing the lifespan to 45 years. The number of entrepreneurs does not change, whereas, as expected, output increases by 6%. The third row displays the case in which agents are not altruistic. The effect is sizeable on the percentage of entrepreneurs and on output per capita. Notice, however, that with $\gamma = 1$ and $\phi = 0$ the economy would collapse because everybody would be credit-constrained. In this case, financial constraints could explain any difference in output among countries. But this is a rather extreme case. The fourth row shows the results for a higher propensity to leave bequest. Output is much higher because agents are less credit constrained and as a consequence productivity increases. Notice that the existence of equilibrium requires that $\gamma > 1 - 1/r$. The model therefore displays some sensitivity to parameter γ, while for the other parameters the quantitative conclusions seem robust. There is no reason, however, to assume that the altruism degree varies across countries.

5 Concluding remarks

In this paper we investigate the role of credit market imperfections and corruption on the process of economic development. We address the question of how

	Output per capita	% of entrepreneurs
Baseline	100	5.8
$r = 2.58$	106	5.9
$\gamma = 1$	72	3.8
$\gamma = 0.7$	143	6.0

Table 5: Basic statistics, changes in parameters relative to the baseline; all figures in percentage.

much of the differences in output per capita across countries can be attributed to differences in credit market policies and corruption. For reasonable parameterizations, the quantitative exercises suggest that a country in which debt contracts are not enforced and corruption corresponds to 10% of output will be roughly 1/3 to 1/2 as rich as the United States. Though this is an sizeable effect, it is a small fraction of the huge differences in income per capita across countries.

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   D.C.

A Proof of Lemma 1

Continuity of $V(b, x; w)$ follows from the *Maximum Theorem* and differentiability from theorem 4.11 of Stokey and Lucas (1989).

   The Lagrangean associated with problem (8) is

$$L = \pi(a + l, x; w) - r(a + l + \varsigma) + \lambda[\phi\pi(a + l, x; w) - r(l + \varsigma)] + \chi[b - a_j].$$

The first order conditions are:

$$\frac{\partial L}{\partial l} = \pi_1(a + l, x; w) - r + \lambda[\phi\pi_1(a + l, x; w) - r] \leq 0, \tag{13}$$

$$l \geq 0, \ \frac{\partial L}{\partial l}l = 0,$$

$$\frac{\partial L}{\partial a} = \pi_1(a + l, x; w) - r + \lambda[\phi\pi_1(a + l, x; w)] - \chi \leq 0, \tag{14}$$

$$a \geq 0, \ \frac{\partial L}{\partial a}a = 0,$$

$$\lambda[\phi\pi(a + l, x; w) - r(l + \varsigma)] = 0, \tag{15}$$

$$\chi[b - a] = 0, \tag{16}$$

$$\frac{\partial L}{\partial \lambda} \geq 0, \frac{\partial L}{\partial \chi} \geq 0.$$

From (13), (14), and (16) it follows that $a(b, x; w) = b$.

   From the Envelope Theorem it can be shown that

$$V_x(b, x; w) = \pi_1(b + l(b, x; w), x; w)(1 + \lambda\phi) > 0,$$

$$V_w(b, x; w) = \pi_3(b + l(b, x; w), x; w)(1 + \lambda\phi) < 0,$$

If $b \leq k^*(x; w)$, then

$$V_b(b, x; w) = \pi_1(b + l(b, x; w), x; w)(1 + \lambda) > 0.$$

When $b > k^*(x; w)$, then by definition of $k^*(x; w)$, the net income from entrepreneurship cannot increase and $V_b(b, x; w) = 0$. For $b > k^*(x; w)$ it is also

obvious that $l(b, x; w) = 0$. When agents are credit constrained, the incentive compatible constraint holds with equality and

$$\phi\pi(b + l(b, x; w), x; w) = r(l(b, x; w) + \varsigma),$$

Thus,

$$\frac{\partial l(b, x; w)}{\partial b} = \frac{\phi\pi_1(b, x; w)}{r - \phi\pi_1(b, x; w)}.$$

By condition (13), we have that $r - \phi\pi_1(b, x; w) = \frac{\pi_1(b,x;w) - r}{\lambda}$. Since this is for constrained agents, the marginal increase of k on $\pi(b, x; w)$ is greater than r. Therefore,

$$\frac{\partial l(b, x; w)}{\partial b} = \lambda\frac{\phi\pi_1(b, x; w)}{\pi_1(b, x; w) - r} > 0.$$

B Proof of Lemma 2

For unconstrained agents, $b \geq k^*(x; w)$, and we have that

$$V(b, x; w) \geq w,$$

defines $x^*(w)$ such that for $x \leq x^*(w)$ agents prefer to be workers than managers, where

$$x^*(w) = \left(\frac{r}{\alpha}\right)^\alpha \left(\frac{w(1+\tau)}{\beta}\right)^\beta \left(\frac{w + r\varsigma}{1 - \alpha - \beta}\right)^{1-\alpha-\beta}.$$

$x^*(w)$ is independent of b. For constrained agents with $x \geq x^*(w)$, we have that $V(b, x; w) = w$ and $V_b(b, x; w) > 0$ define $b(x; w)$, such that

$$\frac{\partial b(x; w)}{\partial x} = -\frac{V_x(b, x; w)}{V_b(b, x; w)},$$

which is negative from lemma 1.

C Proof of Proposition 3

Here we provide the sketch of the proof. For a complete argument see Antunes and Cavalcanti (2003). This proof is an application of theorem 2 of Hopenhayn and Prescott (1992). The first step is to show compactness of the state space

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(b, x). Entrepreneurial ability is bounded by assumption. It can be shown that, from any initial bequest distribution with bounded support, the equilibrium wage rate $w \in [\underline{w}, \overline{w}]$, with $\underline{w} > 0$ and $\overline{w} < \infty$. This in turn implies that $b \in [\underline{b}, \overline{b}]$, with $\underline{b} > 0$ and $\overline{b} < \infty$. Then, $Z = [\underline{b}, \overline{b}] \times [\underline{x}, \overline{x}]$ is compact. The bequest distribution evolves according to

$$(T^* H_t)(A) = \int P_t(z_t, A) H_t(dz_t), \tag{17}$$

where P_t is the endogenous transition function and H_t is a probability measure. This operator is increasing. Intuitively, this means that, given the equilibrium wage rate w_t, an agent would never be worse off in terms of the expected value of b_{t+1} if, for any $\varepsilon > 0$, his state were $z_t + \varepsilon$ instead of z_t. Since the ability distribution is independent across generations, the model displays income mobility and the Monotonic Mixing Conditions are satisfied. Therefore, by Theorem 2 of Hopenhayn and Prescott (1992), there exists a unique time-invariant distribution W and associated equilibrium wage w, such that from any initial distribution W_0, the operator $T^* H_t$ converges to W.

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