Essays on Institutional Frictions and Misallocation

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Abstract

In the first chapter of my dissertation, I build a model of firm defaults to analyze effects of the differences in recovery rates and bankruptcy costs on total factor productivity (TFP), output per capita, and the size of credit markets across countries. I extend a standard firm dynamics model and incorporate financial markets. In the event of a default, the firm negotiates on its debt with the lender (reorganization) or is acquired by the lender (liquidation). Recovery rates under reorganization are endogenously determined. In countries with lower recovery rates, firms face higher interest rate schedules and a higher dispersion in interest rates which in turn causes misallocation in factor inputs and leads to lower TFP. The size of the credit markets, average level of capital, and average debt display a U-shaped pattern as the recovery rates decrease. The model generates up to a 9 percent decrease in TFP and average recovery rates that range from 72 percent to 6 percent. Higher bankruptcy costs lead to lower average recovery rates, higher dispersion in interest rates, and lower TFP. I also show that when recovery rates are modeled as a function of the firm characteristics, as opposed to constant recovery rates across firms, the effect of the differences in recovery rates on TFP is much lower.

The second chapter of my dissertation quantifies the role of formal sector institutions in shaping the demand of human capital and the level of informality. We propose a firm dynamics model where firms face capital market imperfections and costs of operating in the formal sector. Formal firms have a larger set of production opportunities and the ability to employ skilled workers, but informal firms can avoid the costs of formalization, entry costs, payroll taxes and the cost of tax compliance. These firm-level distortions give rise to endogenous formal and informal sectors and, more importantly, affect the demand for skilled workers. The model predicts that countries with a low degree of debt enforcement and high costs of formalization are characterized by relatively lower stocks of skilled workers, larger informal sectors, low allocative efficiency and measured TFP. Moreover, we find that the interaction between entry costs and financial frictions (as opposed to the sum of their individual effects) is the main driver of these differences. This complementarity effect derives from the introduction of skilled workers, which prevents firms from substituting labor for capital and in turn moves them closer to the financial constraint.

Keywords: Bankruptcy, Financial Structure, Informal Sector, Productivity, Policy Distortions, Human Capital, and Recovery Rates.

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

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Introduction

There are vast differences in output per capita across countries. The recent studies on misallocation have uncovered that micro-level distortions in an economy with heterogenous production units can affect total factor productivity (TFP), the biggest contributor of the cross- country differences in output per capita. Hence, misallocation of factor inputs further impact macroeconomic aggregates such as output per capita, capital per worker, and size of the credit markets. In my dissertation, I analyze the role of institutions in creating the cross-country differences in income per capita and other macroeconomic aggregates. More specifically, the first chapter evaluates how the differences in the debt enforcement procedures and bankruptcy costs affect TFP, the size of the credit markets and the recovery rates. The second chapter evaluates the effects of institutional frictions (entry costs, tax structure, and efficiency of debt enforcement) on total factor productivity, output per worker, the demand for human capital, and the size of the informal sector.

In the first chapter, I develop a general equilibrium model of firm dynamics with endogenous bankruptcy decisions to explain differences in TFP, recovery rates on debt upon default, and the size of the credit markets across countries as a response to the differences in the bankruptcy procedures and bankruptcy costs. I extend a standard firm dynamics model and incorporate financial markets. In the event of a default, the firm negotiates on the debt with the lender (reorganization) or the lenders acquire the capital of the firm (liquidation). I find that recovery rates are an increasing function of the firm's assets, and a decreasing function of debt levels. As the bargaining power of the firm increases, the dispersion in interest rates increases which in turn causes misallocation in capital and leads to lower TFP.

The size of the credit markets, average level of capital, and average debt display a U-shaped pattern as the bargaining power of the firm increases. As the bargaining power of the firm increases, the endogenous borrowing constraints become more binding because of lower recovery rates and the average size of the firm decreases. When the bargaining power of the firm increases further, only more productive firms can enter causing the average size of the firm to rise. The model generates up to a 9% decrease in TFP and average reorganization recovery rates that range from 72% to 6%. Higher bankruptcy costs lead to lower average recovery rates, higher dispersion in interest rates and lower TFP. Previous literature takes recovery rates to be constant across firms. If the recovery rates are taken constant across firms, then the effect of the changes in recovery rates on TFP is much larger.

In the second chapter we develop a general equilibrium model of firm dynamics with an endogenous demand for human capital and endogenous formal and informal sectors. Formal firms have a larger set of production opportunities and the ability to employ skilled workers, but they need to incur the cost of formalization, the entry costs and taxes, while the informal firms can avoid the costs of formalization. Formal sector firms face a lower cost of borrowing because they have access to credit markets with a higher degree of enforcement than in the informal sector. We introduce country-specific formal sector institutions entry costs, tax structure, and efficiency of debt enforcement, measured by the Doing Business database, to analyze their effects on human capital, TFP and informality. The interaction between entry costs and financial frictions when introduced together, as opposed to the sum of their individual effects when introduced separately, is the main driver of these differences across countries. This complementarity effect accounts for a large fraction of the differences between US and Lower Middle Income countries in terms of TFP, informal labor force and skilled workers, 27%, 64%, and 68% of the total differences respectively.

Chapter 1

Misallocation and Recovery Rates

1.1 Introduction

A better understanding of debt enforcement mechanisms is important in understanding the link between financial development and economic development. The design of bankruptcy procedures (creditor protection) affects financial market outcomes, such as recovery rates, the size of the credit markets, and interest rates.[1] Consequently, financial frictions under different debt enforcement environments affect the firm decisions on how much to invest, how much to borrow, whether to enter the market, and whether to exit the market, hence affect the firm distribution, aggregate output, and total factor productivity (TFP).

Recently many countries have incorporated reorganization procedures into their bankruptcy codes.[2] Although the popularity of the reorganization procedures has increased, an analysis of this bankruptcy mechanism has not been incorporated in the misallocation literature that studies the cross-country differences in TFP and income per capita. To understand the impact of the differences in debt enforcement procedures, more specifically the differences in recovery rates and bankruptcy costs on firm decisions, I build a model with reorganization and liquidation options. I analyze how differences in recovery rates and bankruptcy costs generate endogenous differences in TFP, output, and the financial market outcomes, the

[1] Recovery rates are defined as the percentage debt that is recouped by the lender upon default.

[2] Brazil, Germany, Czech Republic, Estonia, and Mexico are some of the examples where reorganization has been introduced as an option.

size of the credit markets, and the loan prices.

To explore the link between the differences in debt enforcement mechanisms, financial market outcomes, and TFP, I build a firm dynamics model with endogenous entry and exit in the spirit of Hopenhayn and Rogerson (1993) and incorporate capital markets similar to Cooley and Quadrini (2001). The model allows for firm default in equilibrium, and negotiation on debt between the lender and the borrower. At the beginning of each period firms draw their idiosyncratic productivity shocks and the fixed cost of operation. Then they decide whether to declare bankruptcy or not. Firms can declare bankruptcy in two ways, they can either negotiate on their debt, and agree on a decrease in their debt and continue with their operations (reorganization), or they can decide to declare liquidation. The recovery rates upon reorganization are determined by Nash bargaining. Due to equilibrium default and renegotiation on debt, interest rates differ across firms resulting in endogenous borrowing constraints and factor input misallocation.

For a given debt level a firm is more likely to choose reorganization over liquidation if it has a larger capital stock. A firm with higher productivity prefers to reorganize rather than liquidate. These results are consistent with Bris et. al.(2006) who show the existence of considerable heterogeneity between firms in terms of their assets and debt levels, that file for reorganization and liquidation, while the firms that file for reorganization are on average much larger. Recovery rates are an increasing function of the firm's capital. The recovery rates used by Bris et. al. (2006) increases monotonically as the firm size increases, but they find that firm size is insignificant as a determinant of the recovery rates. Altman et. al. (2005) find that firm size matters and a 100% increase in assets leads to a higher recovery rates by approximately 3%. Though, none of the empirical papers control for the productivity of the firm. Larger firms have a higher surplus so the lender has more to retrieve in the event of a default. For a given capital stock a firm with higher debt has lower recovery rates. The loan price schedules are increasing in the future capital stock and decreasing in the future debt level. The firms that default are more indebted compared to the operating firms. Consistent with Bris et. al. (2008) findings the recovery rates under liquidation are smaller than recovery rates under reorganization.

Using the benchmark economy, I implement two counterfactual exercises. First, I change the bargaining power of the firm to see how the differences in recovery rates affects economic outcomes. As the bargaining power of the firms increase, firms are able to extract more from the bargaining surplus at renegotiation and the recovery rates decrease. The decrease in the recovery rates causes the interest rate schedules faced by the firms to increase. Although the interest rate schedules increase, the mean equilibrium interest rates do not change much unless the firm has all the bargaining power. The effects on the average capital level and the debt level display a U-shaped pattern. As the financial frictions increase the firms become more constrained and that leads to decreases in capital and debt. As the bargaining power of the firms increases further, the firms that are able to enter are the ones with higher productivity levels which causes the average size of capital and debt to increase. The dispersion in interest rates increases significantly as the bargaining power of the firm increases. Higher dispersion in interest rates leads to capital misallocation and TFP decreases. The model produces up to a 9 percent decrease in TFP when the bargaining power of the firm is varied from 0 to 1 and generates average recovery rates that range from 72 percent to 6 percent. Total output decreases up to 16 percent.

In the second counterfactual exercise I increase the cost of bankruptcy proceedings. An increase in bankruptcy cost has direct effects on the recovery rates because of a direct decrease in the surplus. An increase of the bankruptcy costs from 7% to 15% and 30% leads to a 4% and 17% decrease in the average recovery rates, respectively. Lower recovery rates lead to higher interest rate schedules and higher dispersion in the interest rates, hence TFP decreases by 2% in spite of the rise in the entry productivity thresholds, when bankruptcy costs are increased to 30%.[3] The size of the firms increase due to a decrease in the wages and the rise in the entry productivity thresholds. The productivity threshold at the entry also increases as the interest rate schedules increase.

The link between financial frictions and TFP has been explored extensively in the recent

[3]The cost of bankruptcy proceedings range from 4% to 60% in the Doing Business Database. I experimented with 15% and 30% for the bankruptcy costs. The median recovery rate in the upper middle income and lower middle income countries is 15%. there are many lower income and low income countries with bankruptcy costs that are dispersed around 30%.

literature in different contexts. My paper relates to the work of Buera, Kaboski and Shin (2009), Erosa and Cabrilliana (2008), Antunes, Cavalcanti and Villamil (2008), Amaral and Quintin (2010), Moll (2012) and Midrigan and Xu (2012) who study the relationship between financial frictions and cross-country differences in TFP and output. In these papers, financial frictions are either modeled using a collateral constraint or an incentive compatibility constraint, so they do not model equilibrium default.[4] My work is also related to D'Erasmo and Moscoso Boedo (2012), D'Erasmo, Moscoso Boedo and Senkal (2013), Corbae and D'Erasmo (2014), and Steinberg (2013) in the way financial frictions are modeled. Although these models allow for equilibrium default, they assume recovery rates to be constant across firms. My work contributes to the literature on financial frictions by endogenizing the recovery rates and allowing for two different kinds of default: reorganization and liquidation. When recovery rates are a function of firm characteristics, consistent with the data, larger firms pay more of their debt, so the effects on TFP are moderate. These results are also consistent with the findings of Beck, Demirgüç-Kunt, and Maksimovic (2008), who find that small firms are financially more constrained.

The details of the financial market modeling are important for two reasons. First, the model results show that recovery rates differ across firms depending on the firm characteristics and the level of indebtedness, which is consistent with the empirical evidence. Bris et.al. (2006) find that the recovery rates for firms that are more indebted have lower recovery rates. They also find that the recovery rates are higher for the firms that have more secured debt. Additionally, Davydenko and Franks (2008) show that the creditor's rights across countries lead to adjustments in bank lending practices. Models that do not incorporate endogenous adjustments in the debt contracts overestimate the effects of credit market frictions. Second, the firms that enter bankruptcy do not necessarily exit the market. The availability of a reorganization process alters the firm distribution. In this regard, my paper contributes the literature by analyzing the effect of financial frictions controlling for the endogenous responses in loan contracts.

[4]For an extended review on micro-level distortions and misallocation see the recent paper by Restuccia and Rogerson (2012).

My paper also relates to the empirical literature on debt enforcement, creditor protection and financial development. Empirical literature in financial development shows that the legal origin of law is an important determinant of financial development. Although many countries modified their bankruptcy laws, the level of creditor protection does not change over time. Levine (1998) shows that countries that give a higher priority to creditors and enforce contracts promote financial development. Similarly, Djankov et. al. (2008) find that legal origins and per capita income are correlated with recovery rates. La Porta et. al. (1999) document that creditor protection differs significantly across countries, and even after the level of income is controlled for French civil law countries, considered as debtor friendly, still have lower recovery rates. I contribute to this literature by building the micro foundations behind the differences in recovery rates. My model produces consistent results with the empirical literature, where weaker levels of debt enforcement leads to lower recovery rates, smaller credit markets, and lower output, and are consistent with the data where countries with higher creditor protection do not necessarily end up with higher reorganization rates.

The remainder of my paper is organized as follows. Section 2 explains my model in detail. Section 3 characterizes the equilibrium. Section 4 describes calibration of the model. Section 5 elaborates the effects of creditor-friendliness on recovery rates, section 6 analyzes the causes of misallocation, and section 7 explains the effects of bankruptcy costs on recovery rates. Section 8 concludes.

1.2 Environment

I build a firm dynamics model in the spirit of Hopenhayn and Rogerson (1993), and incorporate financial markets as in Cooley and Quadrini (2001). Time is discrete, and the model period corresponds to one year. There are three kinds of entities in the economy, firms, lenders, and consumers. Firms produce the consumption and capital goods used in the economy, own all the capital and pay dividends to the consumers. Firms receive idiosyncratic productivity shocks, and cost shocks every period. Having received these shocks firms decide whether to default or not. Default leads to negotiation of debt (reorganization) with the lenders or the liquidation of the firm. Lenders make loans to firms given the capital, debt decisions and the productivity level of the firms. Consumers are the equity holders, supply labor to the firms and receive their profits net of entry costs. There are no aggregate shocks in the economy, hence I concentrate only on the steady-state of this economy.

1.2.1 Consumers

There is an infinitely lived representative consumer who maximizes her expected utility,

$$U = E\left[\sum_{t=0}^{\infty} \beta^t u(C_t)\right] \tag{1.1}$$

where E is the expectation operator, C_t is consumption and $\beta \in (0,1)$ is the discount factor. The household supplies one unit of labor inelastically at the market wage rate w. Because I concentrate on the stationary equilibrium, aggregates are assumed to be constant in the economy. Thus, the consumer maximizes her expected utility subject to the following budget constraint, and the non-negativity constraint

$$C = w + D - C_e + X, \tag{1.2}$$

$$C \geq 0, \tag{1.3}$$

where w is the equilibrium wage rate, D is the total dividends , C_e is the aggregate creation cost, and X is the value of the firms that exited. The consumer is responsible for the creation cost of new firms c_e that is introduced in the entrants problem, owns existing firms in the economy and receives dividends.

1.2.2 Firms

The output of each firm is given by the following Cobb-Douglas production function where k is the physical capital, n is labor and z is the idiosyncratic productivity shock. The production technology is given by

$$zk^{\alpha}n^{\gamma}, \tag{1.4}$$

with $\alpha, \gamma \in (0, 1)$ and $\alpha + \gamma < 1$. The idiosyncratic productivity shock z follows an AR(1) process

$$\ln(z_{t+1}) = (1 - \rho)\ln(\mu) + \rho\ln(z_t) + \epsilon_{t+1} \tag{1.5}$$

with $\epsilon_{t+1} \sim N(0, (1 - \rho^2)\sigma^2)$ where σ^2 is the variance of $\ln(z)$, μ is the mean, and ρ is the autocorrelation parameter. The conditional distribution of the future shock z_{t+1} is denoted by $F(z_{t+1}|z_t)$.

Firms maximize their expected discounted dividends d_t given by:

$$\max \sum_{t=0}^{\infty} \beta^t E_t d_t \tag{1.6}$$

where the discount rate is β.[5]

An incumbent firm starts the period with physical capital level k and one-period non-contingent debt level b. At the beginning of the period the firm draws the fixed operation cost c_f, and the productivity shock z. The value function of the firm at this stage is denoted by $V(k, b, z, c_f)$ and the firm has four choices. The firm can either pay its debt and continue operating ($V^O(k, b, z, c_f)$), decide to declare bankruptcy, reorganize and negotiate on its debt ($V^R(k, b, z, c_f)$), decide to declare bankruptcy, firesell its capital, pay its debt

[5]The stochastic part of the discount factor vanishes because I only concentrate on the steady-state of this economy.

and exit the market ($V^L(k,b,z,c_f)$), or decide to pay its debts and exit without default ($V^E(k,b,z,c_f)$). The value function of the firm is:

$$V(k,b,z,c_f) = \max\{V^O(k,b,z,c_f), V^R(k,b,z,c_f), V^L(k,b,z,c_f), V^E(k,b,z,c_f)\} \quad (1.7)$$

If the firm decides to operate without default at time t, it chooses current employment n, decides on the future capital stock k', borrowing b', and pays the fixed cost of operation c_f. If the firm decides to change its capital stock then it incurs the adjustment cost $g(k,k')$ and continues operating. Firms borrow at the price $q(k',b',z)$, the determination of this price is explained in the lender's problem.

$$V^O(k,b,z,c_f) = \max_{n,k',b'} \left\{ d(k,b,z,c_f) + \beta \int V(k',b',z',c'_f) dF(z'|z) d\xi(c'_f) \right\} \quad (1.8)$$

s.t.

$$d(k,b,z,c_f) = zk^\alpha n^\gamma - wn - c_f - k' + (1-\delta)k - g(k,k') + q(k',b',z)b' - b \geq 0 \quad (1.9)$$

If the firm decides to default and reorganize, then it negotiates on its debt with the lender. The firm is excluded from the credit markets within the period and its debt is reduced to λb after the negotiation with the lender. The determination of the recovery rate, λ, is explained in section 2.5. In the same period, the firm decides on its future capital k' and employment n. If the firm decides to change its capital stock, then it incurs the adjustment cost $g(k,k')$. The firm also incurs the bankruptcy cost proportional to its capital stock given by $c_R k$. The value function of the firm that decides to reorganize is

$$V^R(k,b,z,c_f) = \max_{n,k'} \left\{ d(k,b,z,c_f) + \beta \int V(k',0,z',c'_f) dF(z'|z) d\xi(c_f) \right\} \quad (1.10)$$

s.t.

$$d(k,b,z,c_f) = zk^\alpha n^\gamma - wn - c_f - k' - g(k,k') + (1-\delta)k - \lambda(k,b,z,c_f)b - c_R k \geq 0 \quad (1.11)$$

The third possible choice of the firm is to default and liquidate. The firm liquidates its assets, pays its debt and exits the market. The firm's payoff is the larger of the liquidation value of it capital net of its debt or 0, where $c_L k$ denotes the return from a fire sale of the firms capital.

$$V^L(k, b, z, c_f) = \max\{c_L k - b, 0\} \tag{1.12}$$

If the firm decides to exit without default, the firm sells all of its capital, pays its debt and leaves the market.

$$V^E(k, b, z, c_f) = k - b \tag{1.13}$$

The solution to the incumbent firm's problem provides the exit decision rule $\chi(k, b, z, c_f)$, which takes the value of 0 if the firm continues to operate, 1 if the firm decides to reorganize, 2 if the firm decides to declare bankruptcy and liquidates its capital, 3 if the firms exits without default. The optimal capital and debt decision rules are denoted by $g_k(k, b, z, c_f) = k'$ and $g_b(k, b, z, c_f) = b'$ respectively.

1.2.3 Entrants

Potential entrants pay a creation cost given by c_e to draw from the pool of ideas. After paying this cost they draw their productivity z' from the distribution $\eta(z)$ and decide whether to enter or not. If the firm decides to enter then it pays the entry cost κw. Draws from the unconditional distribution $nu(z)$ are assumed to be iid across firms. The value of a potential entrant net of entry costs W_e is given by

$$W_e = \int [V^O(0, 0, z_0, 0) - \kappa w]\nu(z_0) - c_e. \tag{1.14}$$

Free entry into this market implies

$$W_e = 0. \tag{1.15}$$

The new firms enter the market without any capital and debt and the fixed cost of operation in the first period is 0.

1.2.4 Lenders

Lenders are competitive and risk neutral. The lenders can borrow or lend at the exogenous world interest rate r. Asset markets are incomplete. In each period, firms borrow using only one period non-contingent debt $q(k', b', z)b'$ with a promise to pay b' next period, where $q(k', b', z)$ denotes the loan price. Prices depend on the firm characteristics given by the current technology z, the future level of capital k' and future level of borrowing b'. The following equation displays the expected profit of a lender for the contract written for a firm with characteristics and decisions z, k', b':

$$\begin{aligned} \pi(k', b', z) \quad &= \quad -q(k', b', z)b' + \frac{1 - p(k', b', z) - t(k', b', z)}{1+r} b' \\ &\quad + \frac{1}{1+r} t(k', b', z) \max\{0, \min(b', c_L k')\} \\ &\quad + \frac{1}{1+r} \int\int (I_{\chi(k', b', c_f', z')=1}) \lambda(k', b', z', c_f') b' \xi(c_f{}') dF(z'|z). \end{aligned} \tag{1.16}$$

The first expression in Equation (1.17) is what the lender gives out to the firm in the current period. Let $p(k', b', z)$ be the probability that the firm negotiates on its debt with the firm, and let $t(k', b', z)$ be the probability that the firm exits by liquidation. Then the second quantity is what the lender would retrieve if the firm does not default, and pays back all of its debt discounted by the risk-free interest rate. The third expression is what the lender would retrieve under liquidation in expectation. As mentioned before, the surplus of the lender in bounded below by 0 due to limited liability and b above. The fourth expression is what the lender would retrieve under reorganization where λ is the recovery rate in expectation. A competitive credit market ensures that $\pi(k', b', z) = 0$ and one can solve for the price function using this condition. Given everything else constant, equation (1.17) implies that a higher recovery rate leads to a lower interest rate.

1.2.5 Debt Renegotiation: Nash Bargaining

As discussed above, the bankrupt firm either files for reorganization or liquidation. If the firm decides to negotiate on its debt, then the lender and the borrower negotiate on the percentage of the debt that the firm is going to pay. In the case of a successful reorganization, value of the defaulted debt is reduced by a fraction $\lambda(z, k, b, c_f)$ of the unpaid debt b. The value for a debt-negotiating firm given the state variables (k, b, z, c_f) and recovery rate λ is given by

$$v^R(k, b, z, c_f; \lambda) = d(k, b, z, c_f; \lambda) + \beta \int V(k', 0, z', c_f')dF(z'|z)d\xi(c_f), \tag{1.17}$$

where

$$d(k, b, z, c_f) = zk^\alpha n^\gamma - wn - c_f - k' + (1 - \delta)k - \lambda b - c_R k \geq 0. \tag{1.18}$$

v^R is the expected life time value of repayment at state (z, k, b, c_f) when the recovery rate is λ. The threat point of the firm is the pay-off under liquidation is either 0 or the net liquidation value of the firm's capital after the debt payment. The surplus of this agreement for the borrower is given by the following equation;

$$\Delta^B(k, b, z, c_f; \lambda) = v^R(k, b, z, c_f; \lambda) - \max(0, c_L k - b). \tag{1.19}$$

The value to the lender is simple, it is the amount of debt the lender recovers and is equal to the λb. The threat point of the lender is the value that the lender would receive under liquidation and is equal to $\min(b, c_L k)$. The surplus agreement for lenders is given by the following equation;

$$\Delta^L(z, k, b, c_f; \lambda) = \lambda b - \min(b, c_L k). \tag{1.20}$$

The firm has the bargaining power (θ) and the lender has the power $(1 - \theta)$. λ that maximizes equation (1.21) gives the solution to the Nash-Bargaining problem.

$$\lambda \equiv \text{argmax}_{\tilde{\lambda}} (\Delta^B(k, b, z, c_f; \lambda))^\theta (\Delta^L(k, b, z, c_f; \lambda))^{(1-\theta)} \tag{1.21}$$

s.t $\Delta^B(k, b, z, c_f; \lambda) \geq 0$ and $\Delta^L(k, b, z, c_f; \lambda) \geq 0$.

The threat point of the lender ensures that the recovery rate under reorganization is greater than liquidation recovery rate as stated by the US bankruptcy rule. Chapter 11 bankruptcy rule in US ensures that the lender should receive a higher value under reorganization than liquidation, otherwise the case is converted to Chapter 7.

1.3 Equilibrium

I focus on the stationary equilibrium of the model. In this equilibrium the wage rates and the schedule of loan prices are constant.

1.3.1 Definition of the Equilibrium

A stationary competitive equilibrium is a set of value functions $V^*(k, b, z, c_f)$, $V^{*R}(k, b, z, c_f)$, $V^{*O}(k, b, z, c_f)$, W_e^*, loan prices $q(k', b', z)$, capital holdings $k'(k, b, z, c_f)$, debt holdings $b'(k, b, z, c_f)$ and default probabilities $p^*(k', b', z)$, $t^*(k', b', z)$, the wage rate w^*, the recovery rates $\lambda^*(k, b, z, c_f)$, aggregate distribution of firms $\nu^*(z, k, b; M)$ and a mass of entrants M such that

- Given prices, recovery rate functions and the value functions debt holdings, capital holdings and the default sets satisfy the firm's optimization problem.
- Given prices and the value functions the recovery rate $\lambda^*(k, b, z, c_f)$ solves the debt negotiation problem of the firms.
- The free entry condition is satisfied: $W_e^* = 0$.
- Lenders make zero expected profits on each contract.
- The distribution of firms $\nu^*(z, k, b; M)$ is stationary.
- Aggregate consumption is $C = w + \Omega - A + X$
- The labor market clears $\int n^*(z, k)\nu^*(z, k, b; M) = 1$

1.4 Calibration

In this section, I calibrate the model to the US business statistics. The results of this calibration are used as a benchmark to implement the counterfactual exercises. The model period corresponds to one year.

Table (1.1) presents a summary of all the parameters and the moments used for the calibration. The labor share and the capital share are based on the previous estimates of the degree of decreasing returns to scale at the firm level so that $\alpha+\gamma = 0.85$ as in Restuccia and Rogerson (2008). I let $\alpha = 0.21$, which implies $\gamma = 0.64$. The yearly risk free rate is set to 4% per year, and $\beta = \frac{1}{1+r}$. The depreciation rate δ is set to 7%. The value of sunk cost c_e is calibrated as in Hopenhayn and Rogerson (1993): the wage rate w is normalized to 1 and c_e is calculated through the free entry condition.

Table 1.1: Model Parameters

Parameter		Value	Moment(US Economy)
Discount Factor	β	0.9615	Avg. yearly return 5-year T-note
Depreciation Rate	δ	0.07	Manufacturing Sector
Labor Share	γ	0.64	Labor Share
Capital Share	α	0.21	Decreasing Returns to Scale
Std. Dev.	σ	0.2305	Manufacturing Sector
Autocorrelation	ρ	0.885	Manufacturing Sector
Adjustment cost	τ	0.0975	Manufacturing Sector
Fire sale loss	c_L	0.40	Aero Space Industry
Creation cost	c_e	16.08	Entry Condition
Mean of the productivity process	μ	1.693	Avg. Size of the Operating Firm
The bargaining power	θ	0.50	Recovery Rate US (Chapter 11)
Fixed cost of operation	c_f	0, 5.5, 40.5, ∞	Exit Rate Distr.
Distr. of c_f	$\xi(c_f)$	0.84, 0.08, 0.04, 0.04	Exit Rate Distr.
Reorganization cost	c_R	0.07	Doing Business
Entry cost	κ	0.264	Doing Business

The adjustment cost parameters and the volatility of the productivity process are set to values estimated by Cooper and Haltiwanger (2006) for the US Manufacturing industry. The adjustment cost takes the form $\tau k(i/k)^2$. The volatility of the productivity process σ is set to 0.2305, the autocorrelation parameter is set to 0.885 and the adjustment cost parameter τ is set to 0.0975. Cooper and Haltiwanger (2006) estimated an operating profit function of the form Ak^{θ} and calculated the variance of ln(A) as 0.4096. Though in this work, the production function is of the form $zk^{\alpha}n^{\gamma}$. To calculate the right variance for the productivity process, as in D'Erasmo and Moscoso Boedo (2012), I define operating profits as $zk^{\alpha}n^{\gamma} - wn$ and derive a profit function with a similar functional form of that of Cooper and Haltiwanger (2006) by substituting in the optimal labor decision rule. Using the fact that wages in the US are normalized to 1, following relation holds $Var(ln(A)) = \frac{\sigma^2}{1-\gamma^2}$, and the standard deviation is calculated to be 0.2305. The entry cost κ is taken directly from the Doing Business data base 2009 for the US Economy. The fire sale loss c_L is set to 0.40 as estimated by Ramey and Shapiro (2001). The reorganization cost is taken from the World Bank Doing Business database, and this value is 7% for the US economy. This value is also consistent with Bris et.al. (2006) who estimate that the bankruptcy costs are between 0% and 20% of the firms' assets.

I calibrate 10 parameters : the mean of the productivity process μ, fixed cost of operation c_f and its distribution, and the bargaining power of the firm θ. To obtain these values, I target the average size of the establishments in US, exit rate distribution in US, and the mean recovery rate under Chapter 11 respectively. The data on the establishment distribution and exit distribution is taken from the Statistics of US Businesses (SUSB) data set. The mean recovery rate under Chapter 11 is taken from Bris, Welch and Zhu (2006) and covers Arizona and New York bankruptcy courts.

Table (2.2) presents the target moments, and the model results. The overall bankruptcy frequency, the Chapter 11 frequencies out-of all bankruptcies are presented in Table (1.3). In general, the model does a good job of representing the bankruptcies in US when we look at the aggregate moments. The model overestimates the bankruptcy frequency and the reorganization rates. This result might be partially attributed the fact that the data doesn't include the out-of-court negotiations.[6] The model also underestimates the mean recovery rate for liquidation. The overall exit rate (including liquidations) is very close to the data.

The results in Table (2.3) show that the model produces a good representation of the US-industry in terms of the size distribution of employment. The model does a good job of matching the overall distribution of firms, but underestimates the number of very small firms, and overestimates the firms in the medium range. This result follows from the productivity shock parameters. Cooper and Haltiwanger (2006) estimate the productivity

[6]The data on US bankruptcy frequencies can be found at http://www.uscourts.gov/Statistics/BankruptcyStatistics/

Table 1.2: Target Moments

Moment	US Data	Model
Average Formal Est.	17.6	17.42
Mean RR (Chapter 11)	69.4%	69.28%
Exit Rate Distribution		
by Employment Size	%	%
1-4	14.88	16.34
5-9	6.72	9.78
10-19	5.57	8.74
20-49	4.91	6.46
50-99	4.58	4.22
100-249	4.16	4.22
250-499	3.9	4.22
500-	4.22	4.22

Table 1.3: Other Moments

Moment	US Data	Model
Mean RR (Chapter 7)	5.4%	2.29 %
Bankruptcy Frequency	0.83%	3.68%
Reorganization Frequency	37.39 %	53.74%

Note: Mean RR is taken from Bris et. al. (2006), and includes the firms in Arizona and State of New York. The bankruptcy frequency is calculated by dividing the number of bankruptcy filings divided by the number of firms in US from 2010-1997. The data is obtained from http://www.uscourts.gov/Statistics/BankruptcyStatistics/12-month-period-ending-december.aspx and the The Bankruptcy yearbook and almanac.

process using manufacturing industry where the average size of the establishments are much higher. That leads to a much lower percentage of small establishments in my model. The mismatch of the firms with small sizes are not particularly important, because small firms don't have important effects on the aggregates of the economy. However, the model does a good job of replicating the size distribution of firms with more than 50 employees.

I analyze whether the model is able to replicate the bankruptcy patterns observed in US, by comparing the characteristics of firm that file for liquidation and reorganization. Figure (1.1) presents the exit decision rule for low productivity firms and Figure (1.2) presents the exit decisions for high productivity firms over different capital and debt levels. In both figures, for a given level of productivity and debt level the firm is more likely to file for reorganization instead of liquidation if it has more capital. Not surprisingly, if the firm

Table 1.4: Distribution of US Establishments by Employment Size

Employment Size	Data %	Model %
1-4	48.6	25.5
5-9	21.8	24.46
10-19	14.2	24.32
20-49	9.6	18.04
50-99	3.2	5.71
100-249	1.8	1.81
250 +	0.01	0.15

Note: Data corresponds to the distribution of establishments by firm size for 2004 from Business Dynamics Statistics.

has enough capital to pay its debts then the firm chooses to operate without defaulting. Because of decreasing returns to scale and adjustment costs, firms with low debt levels and low productivity draws when they expand beyond their optimal size they exit without default. These results are similar to the findings of Corbae and D'Erasmo (2014) with a similar bankruptcy model of the US economy, who study how firm's investment decisions are affected by the bankruptcy options, the availability of reorganization and liquidation. Bris et. al. (2006) researching 300 cases from Arizona and New York federal bankruptcy courts find that Chapter 11 firms are larger on average. The mean Chapter 11 case is 39 times larger than the mean Chapter 7 case. In my model the mean reorganization case is 3 times larger than the mean liquidation case. The differences is due the fact that Bris et. al. (2006) data consists of extremely large Chapter 11 cases. Bris et. al. (2006) also state that although Chapter 11 cases are larger on average, there is a considerable overlap between the firms that file for Chapter 11 and Chapter 7.[7] When different levels of productivity are considered the model produces an overlap between the firms that file reorganization and liquidation. In short,the model generates reorganization for both small and large firms, while the reorganization is more likely for larger firms which is consistent with the empirical evidence.

The endogenous borrowing constraints (loan prices) shape the allocation of resources in the economy affecting the equilibrium distribution of firms through entry and exit decisions. A larger dispersion of loan prices can lead to significant distortions in the factor input

[7]See Figure 1 in Bris et. al. (2006)

allocation, so it is important to understand how loan prices are determined. Loan prices depend on the current productivity level, firm's decisions on future borrowing, and the firm's future capital stock. Figure (1.3) displays the loan price functions $q(k', b', z)$ for the benchmark economy along the future capital levels for a given productivity level. Similarly, Figure (1.4) displays the future debt levels for a given productivity level. The loan prices are higher (i.e. the interest rates are lower) when the future level of capital is higher. When a firm in default has a higher capital stock then the lender is able to recover more, so the loan prices are increasing in future capital stock. The changes in the slope are due to the presence of fixed cost of operation. When the the capital stock is very low, then any positive fixed cost of operation leads to either liquidation or exit. Once the firm has enough capital to cover the fixed cost of operation the prices increase faster. In the second panel, we see the loan prices along the future debt level b'. The figures show that the higher the level of future debt, the lower the loan prices (i.e. the interest rates are higher). Firms with different characteristics due to different default probabilities and different recovery rates face different interest rates.

Next, I analyze how the recovery rates change across different firms. The recovery rates are a function of the current productivity level, debt, capital stock, and the fixed cost of operation. Figure (1.5) shows recovery rates as a function of the capital stock for low and high levels of debt given the fixed cost of operation and the productivity level. The recovery rates are an increasing function of the current capital stock, because a higher current capital stock implies a higher threat point for the creditor and also a higher surplus in the Nash bargaining problem. Figure (1.6) displays the recovery rates as a function of the current debt for different levels of current capital stock. As seen on the graph, the higher the debt of the firm for a given level of capital stock, the less the creditor can recover. These facts are compatible with Bris et.al. (2006). Creditors recover less from the firms that are more indebted. Similarly, as the scale of the firm increases the recovery rates increase.

1.5 Bargaining Power of the Firm and the Recovery Rates

The bankruptcy codes and creditor rights differ across countries. Various studies show that the level of creditor protection depends on the origin of law, and even though many countries have altered their bankruptcy laws the level of creditor rights do not change over time.[8] Davydenko and Franks (2008) use a a sample of defaulted firms obtained from banks in UK, France, and Germany analyze if bankruptcy codes is a determinant of recovery rates. Analyzing the bankruptcy codes in these countries they conclude that France is the most creditor unfriendly UK is the most creditor friendly country in their sample. They find that France has the lowest recovery rates, and UK has the highest recovery rates in their sample. In their influential paper Djankov et. al. (2008) using a sample of 88 countries find similar results. They find that the average recovery rate is 68% for common law countries, 35% for French legal origin countries, 44% for German legal origin countries. The results of these studies show that the legal origin matters and has important effects on the efficiency of debt enforcement. Many developing economies such as Brazil, Turkey, Columbia, Uruguay and Argentina based their laws on French civil law.

Although debtor friendly business environments are designed to promote entrepreneurship, the ex post outcomes might not be favorable to the firms. Lower recovery rates can lead to higher interest rate schedules, a smaller demand for borrowing due to higher interest rates, resulting in smaller credit markets. The endogenous borrowing constraints can lead to factor misallocation, hence lower total factor productivity and lower output. To uncover the effects of the differences in debt enforcement mechanisms, i.e. differences in recovery rates, on TFP, output, and the size of the credit markets, I vary the bargaining power of the firm θ upon reorganization. In order to find the general equilibrium effects of creditor friendliness, I solve for the wage rate until the free entry condition is met, holding the entry cost c_e constant.

Table (1.5) presents the main aggregates of the model results along different levels of creditor friendliness. A higher value of θ implies a more debtor-friendly environment. When

[8]Djankov et. al. (2007) show that creditor rights are remarkably stable over time.

the bargaining power of the firm is changed from 0 to 0.2, the effects are negligible. Once θ increases further the changes in the aggregates increase in magnitude. The results show that small changes in the bargaining power of the firms that already have higher bargaining power for the creditors causes small changes in the loan price schedules, and the recovery rates hence in other important aggregates for the economy. However in economies that have a high θ, small changes in the bargaining power have large effects on the macro aggregates because of larger changes in loan price schedules and recovery rates.

The model produces a range of average recovery rates that change from 72% to 6%. In a more debtor-friendly country a slight change in θ causes bigger changes in the average recovery rates. Figures (1.7) and (1.8) show the recovery rate schedules for a given productivity level and a fixed cost of operation along different levels of capital and debt, respectively for $\theta = 0$ and $\theta = 0.7$. These results are consistent with the findings of Franks and Davydenko (2008). They show that although there are adjustments to lending practices the recovery rates are significantly lower in France compared to Germany and UK, which has lower creditor protection scores.[9]

Table 1.5: Model Results for Different Levels of Bargaining Power

Bargaining power (θ)	0.0	0.2	0.5	0.7	0.8	1.0
Avg. Recovery Rate under reorganization	0.72	0.72	0.69	0.66	0.63	0.06
Recovery Rates as in Doing Business	0.92	0.92	0.77	0.64	0.56	0.38
TFP (relative to benchmark)	1.00	1.00	1.00	0.99	0.98	0.91
Output (relative to benchmark)	1.01	1.01	1.00	0.98	0.95	0.86
Avg. Capital	43.83	43.40	41.97	40.52	45.65	70.15
Avg. Debt	22.67	22.21	19.27	16.41	17.37	46.85
Debt to Capital Ratio	0.60	0.60	0.58	0.58	0.50	4.13
Debt to Output ratio	0.94	0.93	0.88	0.87	0.76	6.13
Bankruptcy Frequency	4.50	4.40	3.68	4.53	4.87	8.75
Reorganization (%) to Bankruptcy	56.50	55.85	53.74	55.65	62.84	82.92
Avg. Recovery rate under Liquidation	3.48	3.41	2.30	1.17	1.22	2.58
Recovery rates Doing Business	0.92	0.92	0.77	0.64	0.56	0.38
Avg. Loan Prices	0.94	0.94	0.94	0.94	0.94	0.88
var(loan prices)	0.0019	0.0019	0.0024	0.0060	0.0116	0.0422

In addition to calculating the average recovery rate in the economy, I also calculate the

[9] Djankov et. al. (2008) also find that recovery rates are much lower in countries with lower creditor protection.

recovery rates that correspond to the World Bank Doing Business database recovery rates. The Doing Business database calculates the recovery rate for a hypothetical firm that has 201 employees and 100 units of capital and 100 units of debt across countries. As stated above, the average size of the firm in terms of employees in the economy are pinned down by the mean of the productivity process. In order to find the very same Doing Business firm in my model, I first find the firm that has 201 employees and the same recovery rate with the US economy, 77%. This pins down the capital level of the firm, and the debt level of the firm since they are equal.[10] Then I find the same firm in the other countries with different levels of θs, with the same capital and debt level and report the recovery rates in Table (1.5). The results are in line with the Doing Business dataset. In Doing Business recovery rates under reorganization range from 93% to 19.3%. The corresponding Doing Business recovery rates in my model range from 0.92% and 0.38% without the inclusion of different bankruptcy costs.[11]

As bargaining power of the firms decreases, recovery rates decrease and this leads to significant changes in the loan price schedules. Figure (1.9) plots the loan price schedules for different θ=0 and θ=0.7 as a function of future capital stock. As previously discussed the loan prices are an increasing function of the future capital level. The interest rates decrease when the firm has a higher capital stock as collateral in the next period. When the bargaining power is higher for the firm, the loan prices decrease, and the interest rates that firms face increase. Similar results hold when we plot the loan price schedules as a function of future debt levels as in Figure (1.10). The higher the bargaining power of a firm, the higher the interest rate schedules for a given the debt level of the firm. Although the interest rates functions change as I change the bargaining power of the firm, the average of the equilibrium interest rates do not change much unless θ is equal to 1. There are several factors behind the interest rates. As the recovery rates increase, the interest rate schedules become tighter that leads to lower borrowing and hence the average interest rates are not affected. As θ increases further, only more productive firms enter and the equilibrium interest rates do not

[10] This firm does not have to exist in equilibrium.

[11] When the bankruptcy costs rise, recovery rates decrease further.

increase in spite of the increase in borrowing. These results are consistent with the findings of Franks and Davydenko (2008). They find that the loan spreads charged by UK banks are similar to that of France.

The changes in the dispersion of interest rates has important consequences for misallocation and hence on measured total factor productivity. Although the average interest rates do not change as much, the dispersion in the loan prices increases significantly as the bargaining power of the firm increases. The increase in the variance of the loan prices shows that firms are affected by the endogenous borrowing constraints once the recovery rates decrease. This leads to a decrease in TFP. The model can generate up to a 9% decrease in TFP. As θ increases further the entry productivity threshold rises as the firms need to have higher productivity to be able borrow and operate. Although this effect counteracts the effect of factor misallocation, TFP still falls.[12]

Firm size displays a U-shaped pattern as the bargaining power of the firm rises. The average level of capital in the economy decreases at first. The increase in the interest rate schedules limits the borrowing opportunities of the firm and limits the size of the firm. As θ increases further the productivity thresholds at the entry increase. Because of higher productivities, the firms can borrow more and reach higher capital levels. The same mechanism applies to the average debt level in the economy.

In their study on private credit Djankov et. al. (2007) show that countries with stronger creditor protection have larger private credit to output ratios. My model produces similar results. When θ changes from 0 to 0.8 the debt to output ratio decreases by 24%. The magnitude of this change is also comparable to Djankov et. al (2007). They show that an increase in their creditor rights index by 1, where the index varies from 0 to 4, leads to a rise in the private credit to GDP by 6%. Similar to average capital and debt, debt to capital ratio and the debt to output ratio decreases at first and then increases when the bargaining power of the firm approaches 1.

The bankruptcy frequency and the reorganization percentage out of bankruptcy decreases at first as the level of creditor protection decreases with a corresponding increase

[12] I decompose the effects on TFP in the next section.

in the exit rate. As the environment becomes more debtor friendly bankruptcy rates start to increase, and the exit rates decrease. Figure (1.12) and (1.13) displays the exit decisions for the cases where $\theta = 0$ and $\theta = 0.8$ respectively. The figures show that when the bankruptcy system becomes more debtor friendly the reorganization region extends, and the exit without default shrinks. There is no clear pattern between creditor rights and bankruptcy frequencies. Claessens and Klapper (2005) in their empirical paper also find that the occurrence of the bankruptcies is not related to the creditor rights.

Average recovery rates under liquidation are very low compared to the reorganization process. This result is due to the fact there are many firms that have more debt than capital that file for liquidation so there are many liquidation cases with 0 recoveries. Similar to the capital levels, the recovery rates under liquidation display a U-shaped pattern. As the size of the firms increase, the lenders recover more under liquidation, although the recovery rates are much smaller compared to the reorganization process.

Table (1.9) presents the differences between firms that default and reorganize and the firms that continue operating without default. As expected the debt to capital ratio is higher for reorganizing countries. The firms that are reorganizing are much smaller on average in terms of capital compared to the firms that operate without default.

Table 1.6: Additional Model Results for Different Levels of Bargaining Power

Bargaining Power (θ)	0.0	0.2	0.5	0.7	0.8	1.0
Firms Operating without default						
Avg. Capital	43.83	43.40	41.97	40.52	46.74	75.42
Avg. Debt	22.70	22.24	19.35	16.66	17.61	19.72
Debt to Capital ratio	0.59	0.59	0.56	0.56	0.49	0.25
Firms that reorganize						
Avg. Capital	19.71	19.34	15.04	8.37	9.67	8.79
Avg. Debt	21.61	21.16	15.71	7.83	9.07	362.78
Debt to Capital Ratio	1.20	1.19	1.16	1.33	1.23	49.30

1.5.1 Misallocation and Bargaining Power

The changes in the prices, and the recovery rates alter entry and exit decisions, and hence the distribution of firms. The recent firm dynamics literature shows that the misallocation at the micro level has consequences at the aggregate level. Financial frictions that arise due to limited commitment lead to differential loan prices across firms, which lead to misallocation in factor inputs.

Under perfect capital markets the marginal product of capital (MPK) across firms will be equated across firms. In the presence of financial frictions, the optimal capital allocation will be distorted leading to different levels of MPK across firms. Table (1.7) displays the dispersion of the ln(MPK) as the level of creditor friendliness changes. The change in the variance of the ln(MPK) and loan prices are negligible when θ changes from 0 to 0.2. As θ increases further, the dispersion becomes much larger. The model generates a considerable dispersion in MPK. A change in θ from 0 to 0.8 causes a 40% change in the variance of the ln(MPK), and this difference is much bigger once θ increases to 1. The different interest rate schedules in countries with lower recovery rates lead to misallocation of resources.

Table 1.7: Dispersion of the log of Marginal Product of Capital

θ	var(ln(MPK))
0.0	0.18
0.2	0.18
0.5	0.20
0.7	0.23
0.8	0.25
1.0	0.32

To measure the extent of misallocation, I also calculate the optimal capital and labor ratios in the frictionless economy and the economies with different θs. In a frictionless economy with a Cobb-Douglas production function the optimal capital and labor ratio is constant. The following equation gives the optimal capital labor ratio for an economy with risk-free rate r, depreciation rate δ, and the wage rate ω:

$$\widetilde{\left(\frac{k}{n}\right)} = \frac{\alpha\omega}{\gamma(r+\delta)}. \tag{1.22}$$

In the presence of frictions the capital labor ratio will deviate from equation (1.22). One can calculate a measure of efficiency by decomposing the output weighted capital labor ratio $\widehat{\left(\frac{k}{n}\right)}$ into a mean effect $\overline{\left(\frac{k}{n}\right)}$ and a covariation effect $cov((k/n)_s, \phi_s)$, where ϕ_s is the output share of firm s.

$$\widehat{\left(\frac{k}{n}\right)} = \overline{\left(\frac{k}{n}\right)} + \operatorname{cov}\left(\left(\frac{k}{n}\right)_s, \phi_s\right).$$

An efficient allocation implies that the covariance term is 0. Table (1.8) presents the results for different levels of bargaining weights, θs. The output weighted capital to labor ratio decreases as we move to countries with lower recovery rates. The second column shows the average effect on the capital labor ratio decreases as θ increases. This result is due to the firm's switching from capital to labor because of lower wage rates. The fourth column displays the covariance term which decreases at first, but as θ becomes larger, it starts to increase. The decline in the covariance term is due to the switch from capital to labor, but as the firms grow larger in terms capital due to higher entry thresholds which leads to an increase in the covariance term. The last column shows the ratio of output weighted capital to the efficient level of capital to output ratio. This ratio declines as we move to more debtor friendly regimes.

Table 1.8: The Decomposition of the Capital Labor Ratio

θ	$\widehat{\frac{k}{n}}$	$\overline{\frac{k}{n}}$	$cov\left(\frac{k}{n}, \phi\right)$	$\widehat{\frac{k}{n}}/\widetilde{\frac{k}{n}}$
0.0	2.43	2.68	-0.24	0.81
0.2	2.43	2.68	-0.25	0.81
0.5	2.38	2.64	-0.26	0.80
0.7	2.30	2.44	-0.15	0.79
0.8	2.21	2.39	-0.18	0.78
1.0	1.98	2.09	-0.11	0.77

Note: $\widehat{\frac{k}{n}}$ corresponds to output weighted capital to labor ratio. $\overline{\frac{k}{n}}$ is the arithmetic mean of capital to labor ratio. $cov\left(\frac{k}{n}, \phi\right)$ is the covariance between the capital to labor ratio and output shares. $\widetilde{\frac{k}{n}}$ s the efficient level capital to output ratio (derived from the solution to a frictionless problem).

1.6 Bankruptcy Costs and Recovery Rates

The costs of debt enforcement have direct effects on the bankruptcy decision and the recovery rates. In this section, I analyze the effects of bankruptcy costs on TFP, recovery rates and other important aggregates for the economy. For the benchmark calibration the bankruptcy costs are obtained from the World Bank Doing Business database and are set to 7% of the capital stock of the firm. The bankruptcy costs range from 1% to 60% across countries in the Doing Business database. In order to understand the effects of the bankruptcy cost c_{11} is set to 0.15 and 0.30. I chose these two values because 15% is the median level of bankruptcy costs for upper middle income countries, and there are many lower middle and low income countries that have bankruptcy costs close to 30%. Table (1.9) and (1.10) present the benchmark results and the model results for higher bankruptcy costs.

Table 1.9: Model Results for Different Bankruptcy Costs

Bankruptcy Costs	Benchmark $c_R = 0.07$	$c_R = 0.15$	$c_R = 0.30$
Avg. Recovery Rate	0.69	0.66	0.57
TFP	1.00	1.00	0.98
Avg. Capital	41.39	42.02	48.40
Avg. Debt	19.27	19.89	23.57
Debt to Capital Ratio	0.58	0.58	0.56
Debt to Output ratio	0.88	0.88	0.86
Bankruptcy Frequency	3.68	3.91	2.87
Reorganization (%) to Bankruptcy	53.74	52.62	41.63
Loan prices	0.94	0.94	0.94
var(loan prices)	0.0019	0.0021	0.0022

Bankruptcy costs have direct effects on the recovery rates because a rise in the bankruptcy costs decrease the overall surplus that is negotiated by the firm and the lender. An increase in bankruptcy costs also leads to a decrease in the wages which counteracts the decrease in the surplus. An increase in the bankruptcy costs to 0.15 and 0.30 leads to decreases in the recovery rates by 4% and 6%, respectively . Figures (1.16) and (1.17) show how the recovery rates change when the bankruptcy cost increase along different capital and debt levels.

Total factor productivity doesn't change much when bankruptcy costs are increased from 7% to 15% due to the small changes in the interest rates schedules. The change from 7% to 30% causes a 2% drop in TFP. In addition to the misallocation caused by the interest rates, the higher capital levels cause the decreasing returns to take effect and TFP decreases. Figures (1.14) and (1.15) display how the loan price schedules change as a response to an increase in the bankruptcy costs. The average stock of capital rises as the bankruptcy costs increase. This is due to two factors. In countries with more costly enforcement, the wages go down. Similarly, the firms that can survive with high interest rates have to be more productive which raises the entry threshold of productivity. The same argument holds for the average debt levels in the economy. However, as the bankruptcy costs rise the debt to capital ratio and debt to output ratio falls. These results are consistent with the results of Djankov et. al. (2008), countries with higher costs of debt enforcement have smaller financial markets.

The rise in the bankruptcy costs leads to lower bankruptcy frequencies. Table (1.10) shows that as the cost of debt enforcement increases the difference between the reorganizing firms and the firms that operate without default becomes more stark. As the firms that operate without default increase in size, the ones that default become smaller.

Table 1.10: Additional Model Results for Different Levels of Bankruptcy Costs

Bankruptcy Costs	Benchmark $c_R = 0.07$	$c_R = 0.15$	$c_R = 0.30$
Firms Operating without default			
Avg. Capital	41.97	42.76	48.89
Avg. Debt	19.35	20.09	23.71
Debt to Capital ratio	0.56	0.56	0.55
Firms that reorganize			
Avg. Capital	19.71	19.34	15.04
Avg. Debt	21.61	21.16	15.71
Debt to Capital Ratio	1.20	1.19	1.16

1.7 Heterogenous Recovery Rates vs. Constant Recovery Rates

Previous studies either rely on incentive compatibility constraints and collateral constraints, or they assume constant recovery rates across firms to explain the effects of financial frictions on TFP.[13] I contribute to the literature by allowing for two types bankruptcy procedures, reorganization and liquidation, and by allowing for heterogenous recovery rates across firms. In my model, a bankrupt firm does not necessarily exit the market which might have an impact on the firm distribution. In addition, recovery rates are modeled as a function of the firm characteristics which is consistent with the data.Bris et. al. (2006) documents that recovery rates increase as the firms assets increase. Altman et.al (2005) shows that 100% increase in firm assets leads to higher recovery rates by approximately 3%. Assuming constant recovery rates across firms might overestimate the impact on TFP, because the larger firms are less constrained compared to the smaller firms when recovery rates are allowed to be different across firms.

To evaluate whether introducing heterogenous recovery rates across firms makes a difference in measured TFP, I implement another counterfactual exercise. Without recalibrating the model, I first set the recovery rate for the benchmark economy to be 0.77, the US recovery rate in the Doing Business database. Then I calculate the c_e that solves for the free entry condition with wage rate equal to 1. Using the resulting c_e, I iterate on the wage rate with the constant recovery rate of 92% (the Doing Business recovery rate I calculate by setting θ=0 in the benchmark model) and the constant recovery rate of 56% (the Doing Business recovery rate I calculate by setting θ=0.8 in the benchmark model). The results are displayed in Table (1.11). The first column corresponds to the case with recovery rates across firms set to 92%. The second column corresponds to recovery rates set to 77% (the Doing Business recovery rate for US), where the measured TFP in this case is normalized to 1. The third column correspond to the case with recovery rates equal to 56% for all firms.

When recovery rates are set at 92% across firms, almost no bankrupt firm declares

[13] Buera et. al. (2011), Midrigan and Xu(2012), D'Erasmo and Moscoso Boedo (2012) are among many papers in this vast literature. See Restuccia and Rogerson (2012) for an extended review of the literature.

Table 1.11: Model Results for Constant Recovery Rates vs. Heterogenous Recovery Rates

Recovery Rate	$\lambda = 0.92$	$\lambda = 0.77$	$\lambda = 0.56$
TFP	0.99	1.00	0.93
Total output	1.00	1.00	0.92
Avg. Loan prices	0.94	0.94	0.92

reorganization which leads to a drop in TFP. Corbae and D'Erasmo(2010) find similar results when they close the reorganization option in their model. When recovery rates are a function of the firm characteristics and differ across firms TFP declines by 2% (Table 1.5) compared to the case with constant recovery rates where TFP decreases by 7% when $\lambda = 0.56$. When recovery rates are constant across firms and interest rates increase. This result follows from the endogenous response of recovery to changes in the debt enforcement mechanisms. In the model with heterogenous recovery rates firms that are larger in terms of their capital stocks are less constrained compared to the model with constant recovery rates. Because larger firms are less constrained, the effects on TFP are much lower. The results show that assuming constant recovery rates produces larger differences in TFP and total output.

1.8 Conclusion

The positive relation between financial development and economic development is evident in the data. My work explores this relation by concentrating on differences in debt enforcement mechanisms across countries. Recently many economies adopted reorganization procedures in their bankruptcy procedures similar to the ones present in US. However an analysis of the reorganization procedure has not been incorporated in the misallocation literature that studies the cross-country differences in income. Previous literature either takes recovery rates upon default as constant across firms, or relies on incentive compatibility constraints with no-default models. I build a firm dynamics model with two different bankruptcy procedures, reorganization and liquidation to see how the differences in recovery rates and bankruptcy costs affect the important macroeconomic aggregates. The benchmark model results show that recovery rates are increasing in the firm's capital and decreasing in the firm's debt level. The counterfactual analysis shows that differences in recovery rates leads to changes in output, TFP, and the size of the credit markets. Differences in the bargaining power of the firm are able to explain up to a 9% decrease in TFP. The model also produces average recovery rates that range from 72% to 6%. Output per capita decreases up to 16% when the average recovery rates vary from 72% to 6%. Additionally when bankruptcy costs are increased from the US level of 7% to 30%, TFP decreases by 2% and recovery rates decrease by 12% points. As opposed to previous literature that studies the relationship between recovery rates and TFP, I allow recovery rates to be a function of the firm characteristics. If recovery rates are constrained to be constant across firms, the effect of changes in recovery rates on TFP is much larger.

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1.10 Appendix

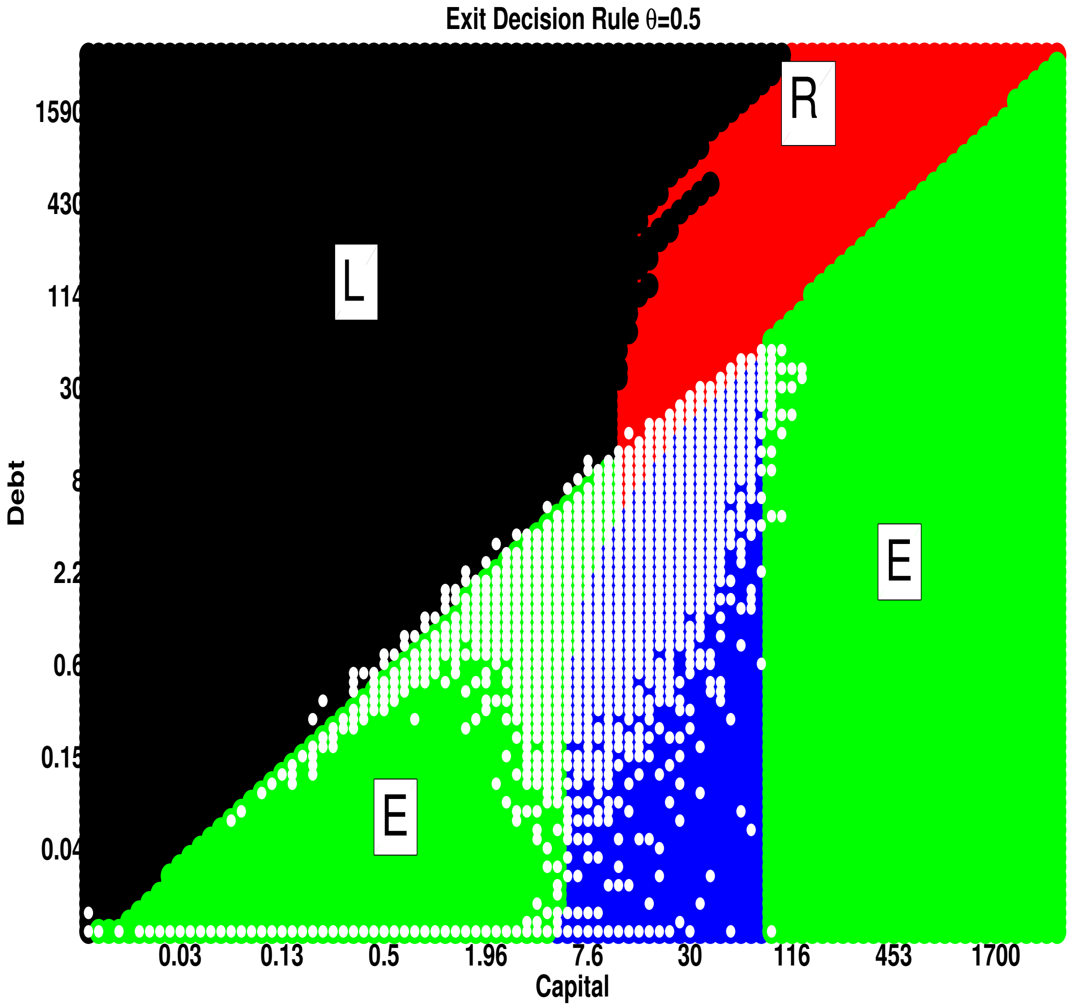

Figure 1.1: Exit decision rule for the benchmark economy for z_{low}

[14]The green region corresponds to the exit without default, black region corresponds to liquidation, red region corresponds to reorganization, blue region corresponds to reorganization. White dots represent the firm distribution.

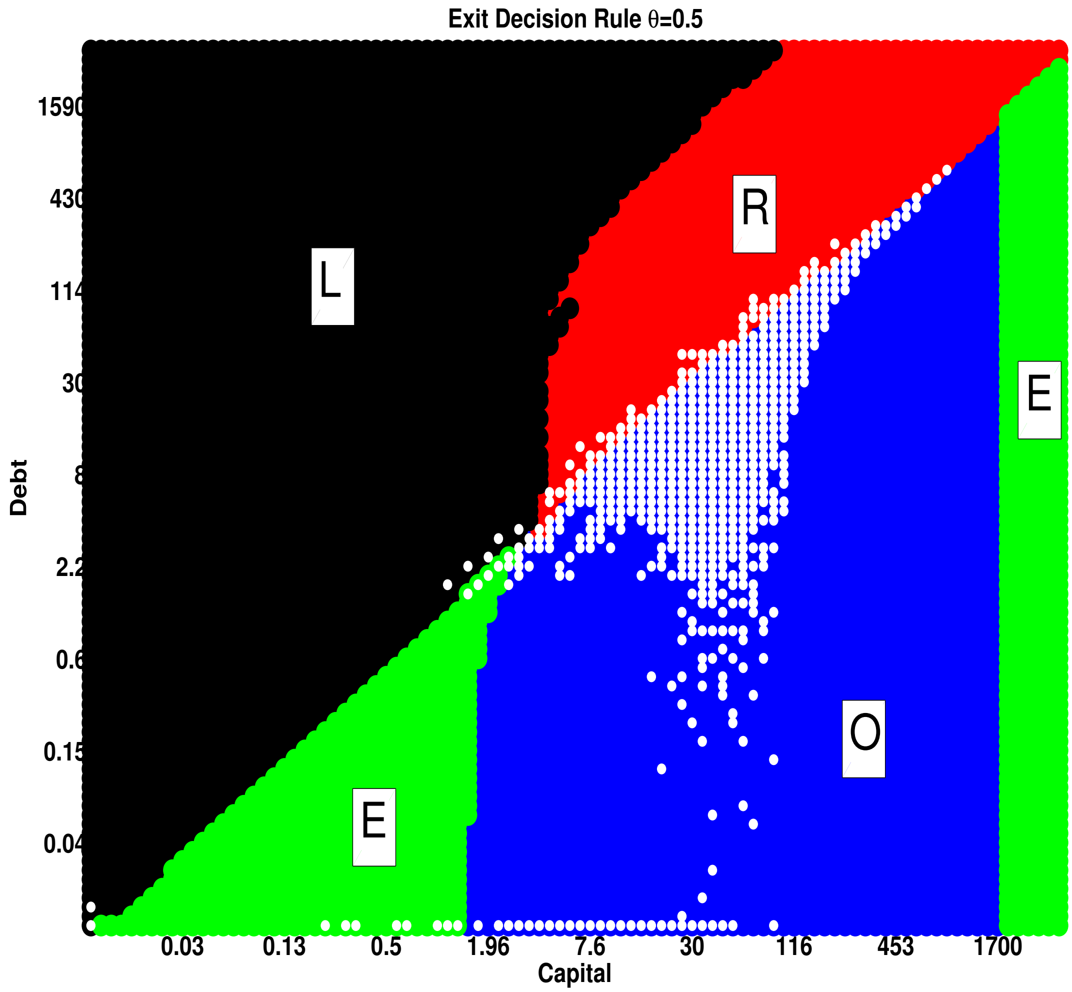

Figure 1.2: Exit decision rule for the benchmark economy for z_{high}

[15]The green region corresponds to the exit without default, black region corresponds to liquidation, red region corresponds to reorganization, blue region corresponds to reorganization. White dots represent the firm distribution.

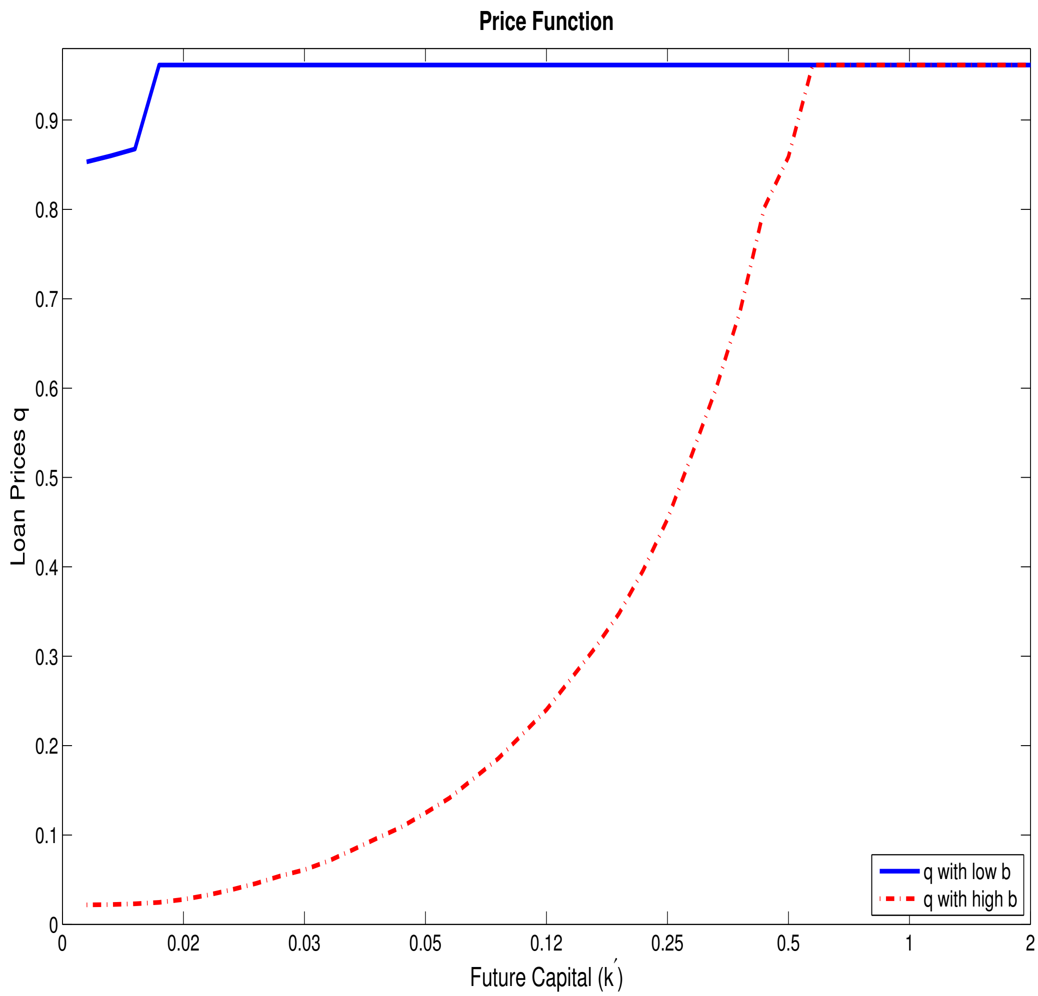

Figure 1.3: Price function for the benchmark economy

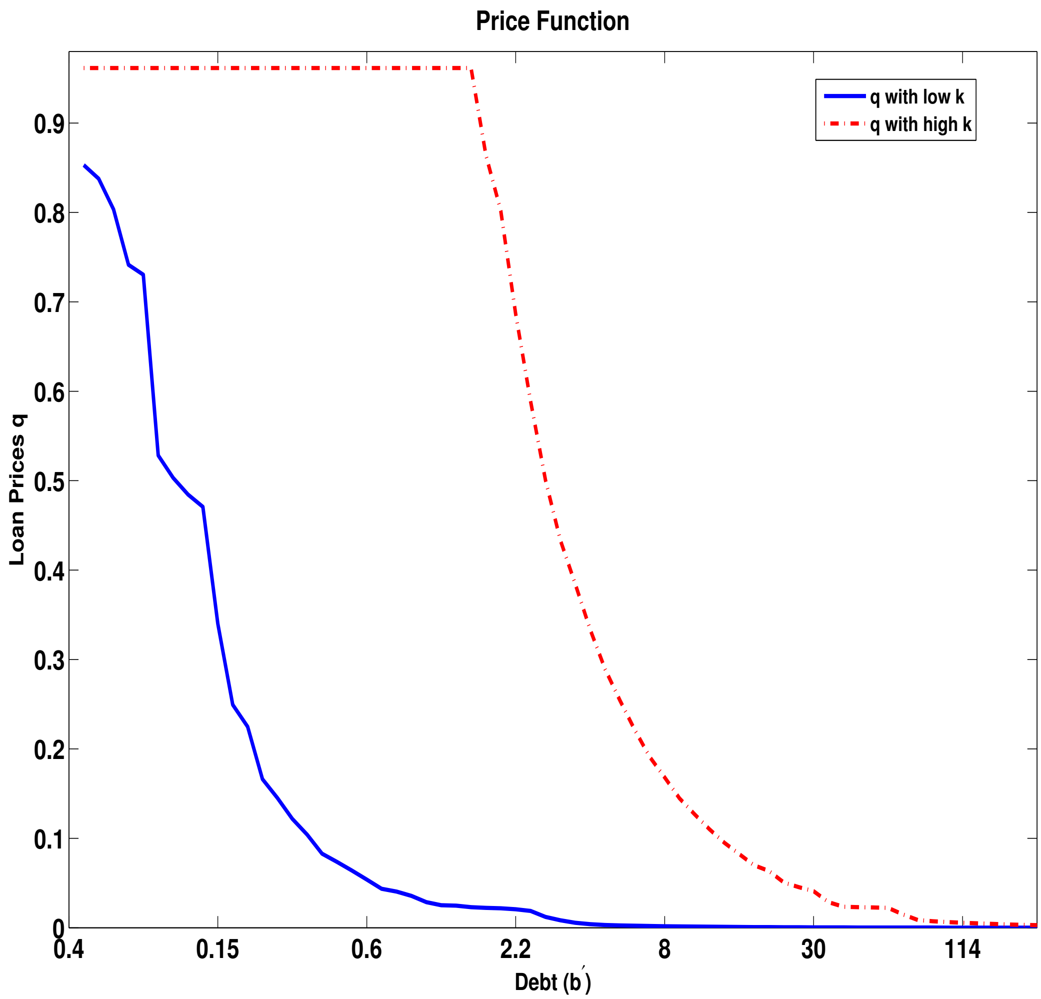

Figure 1.4: Price function for the benchmark economy

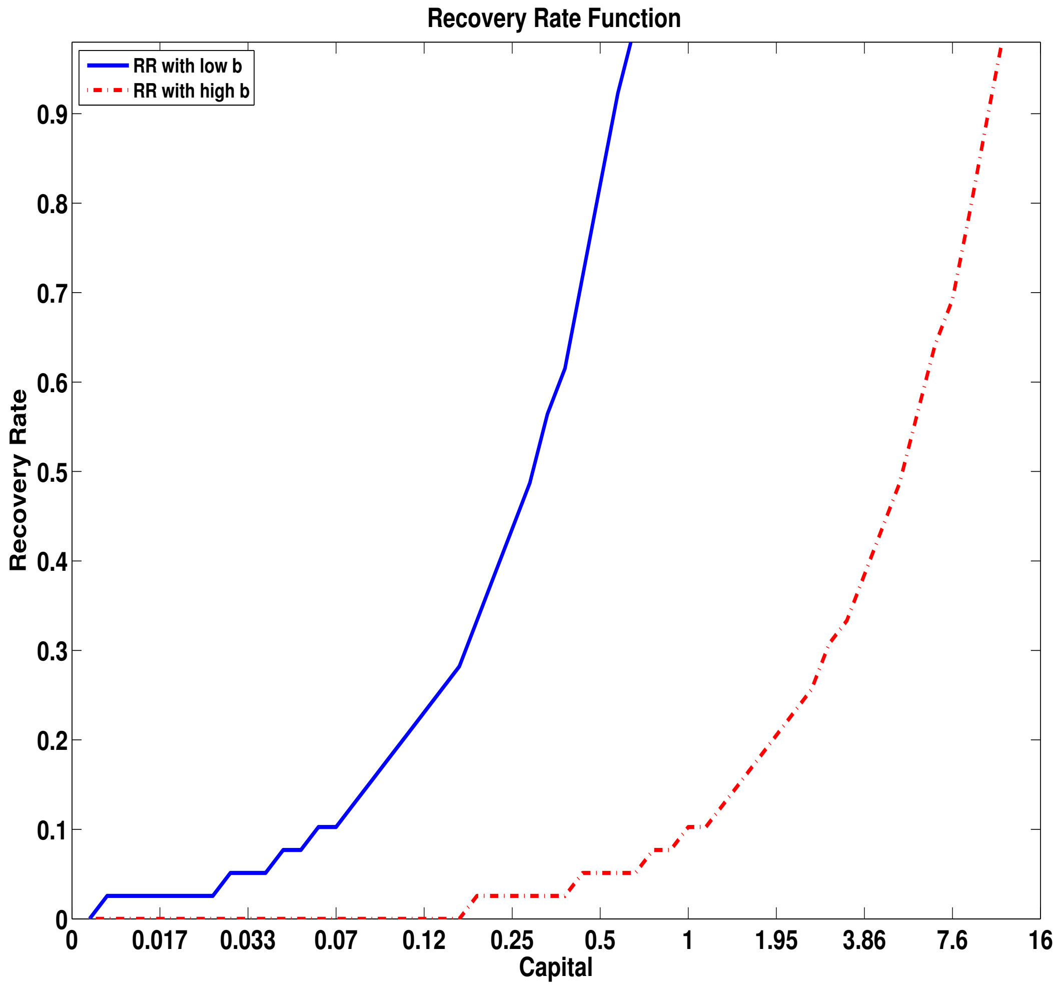

Figure 1.5: Recovery Rates for the benchmark economy

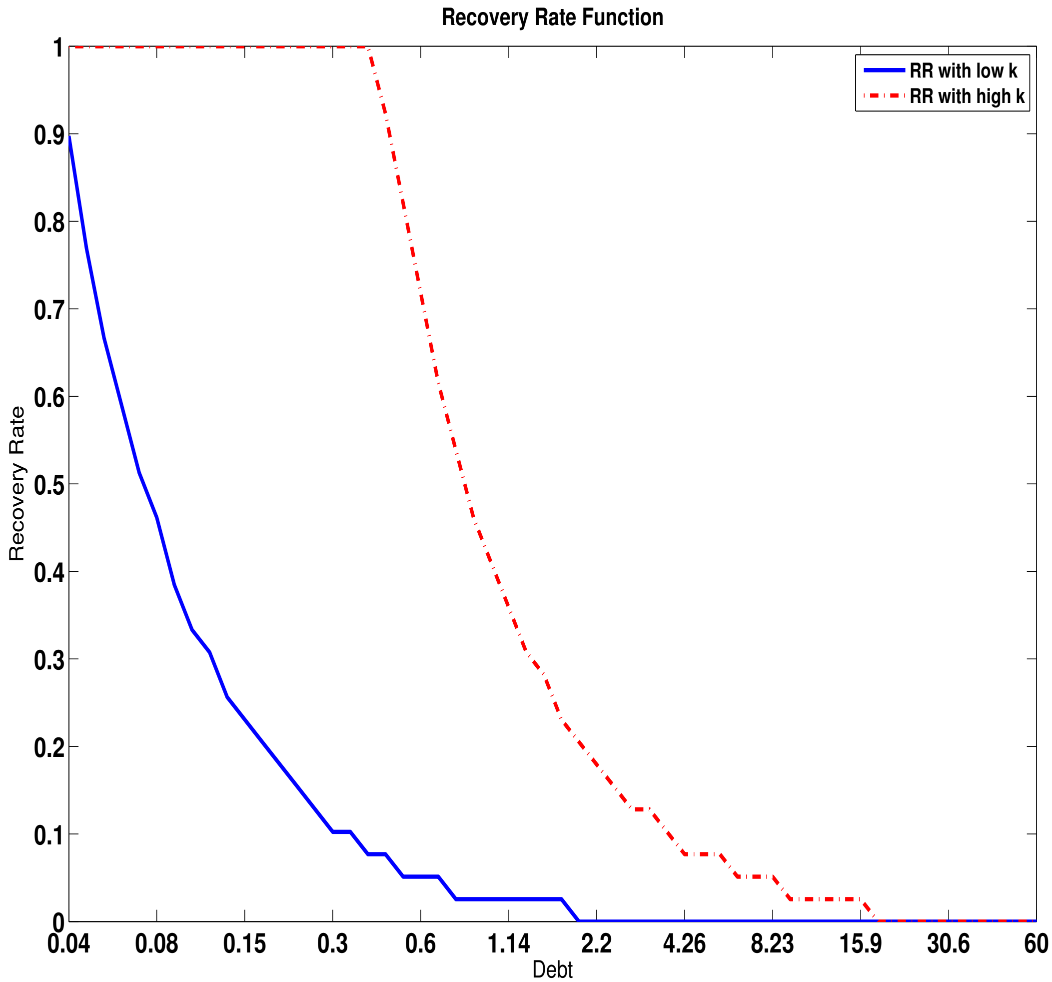

Figure 1.6: Recovery Rates for the benchmark economy

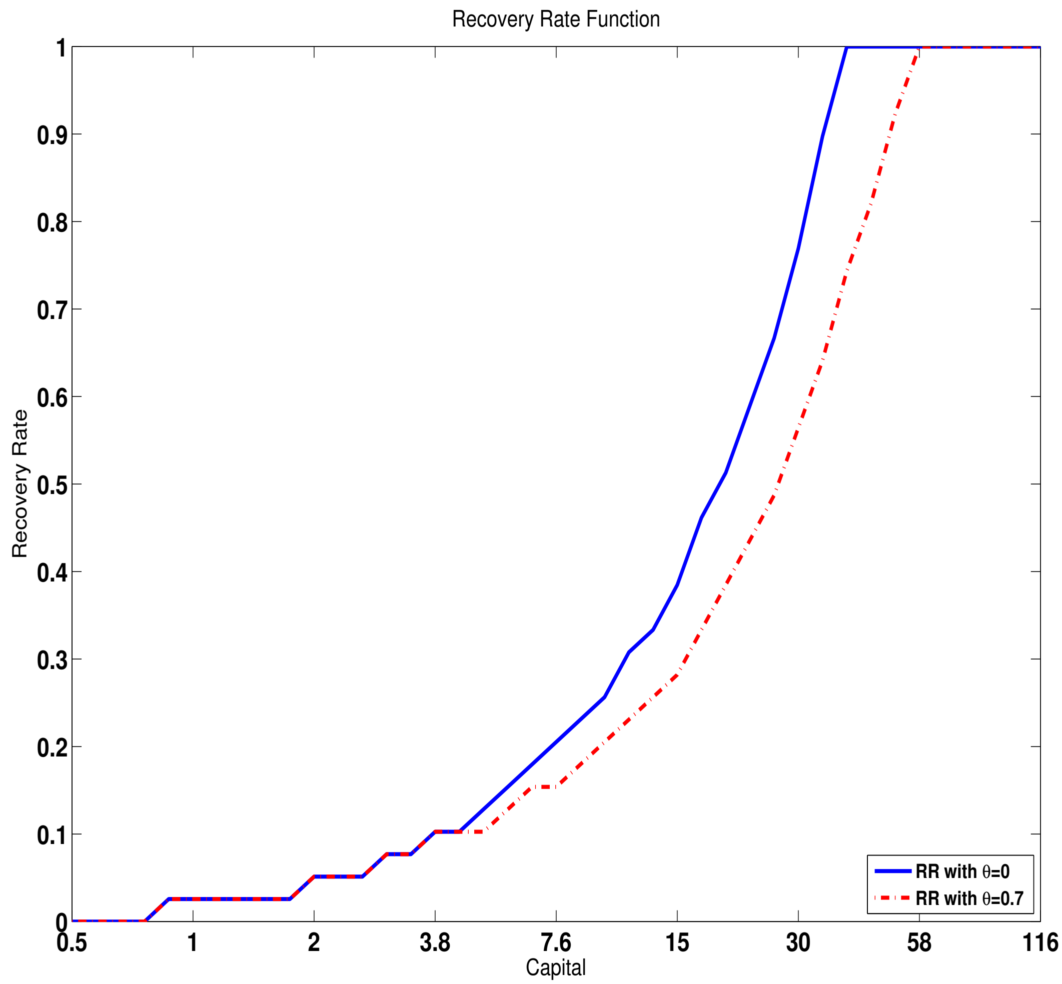

Figure 1.7: Recovery Rates for $\theta = 0$ and $\theta = 0.7$

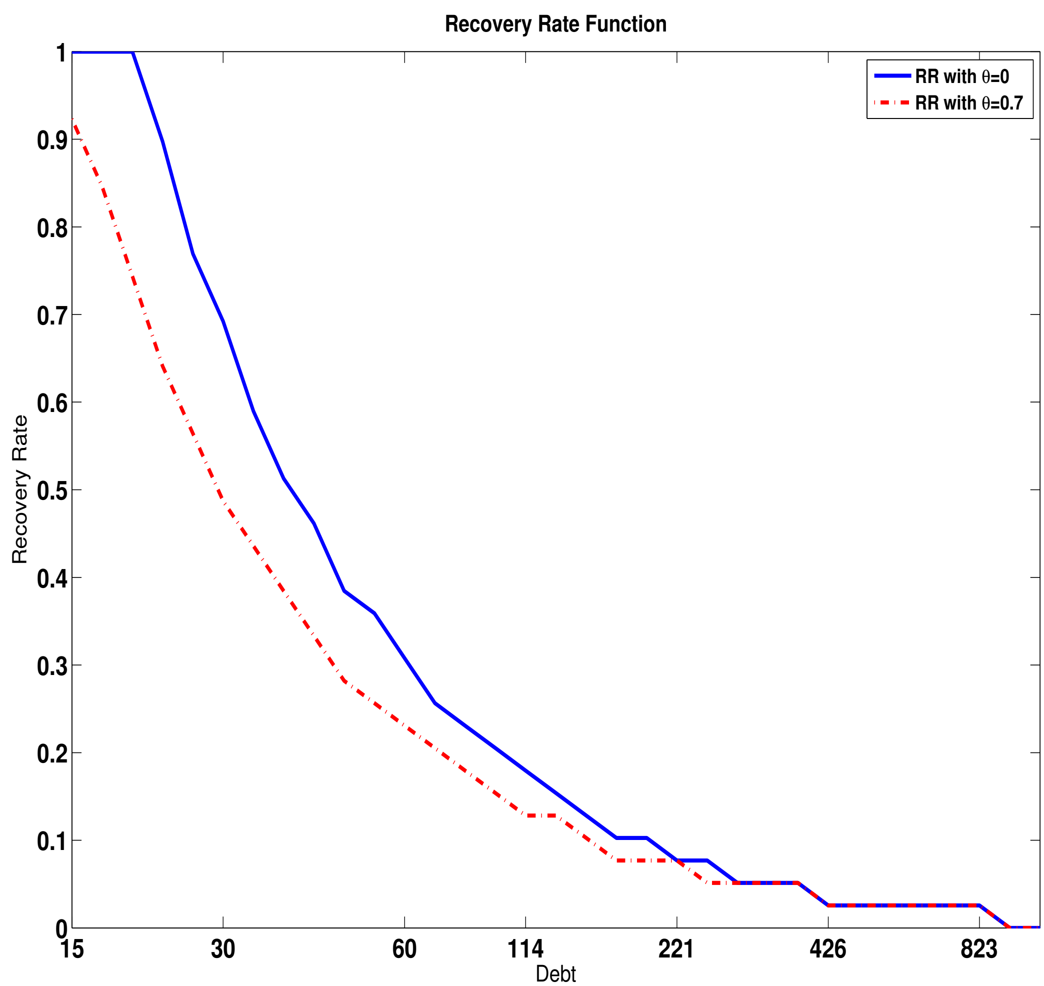

Figure 1.8: Recovery Rates for $\theta = 0$ and $\theta = 0.7$

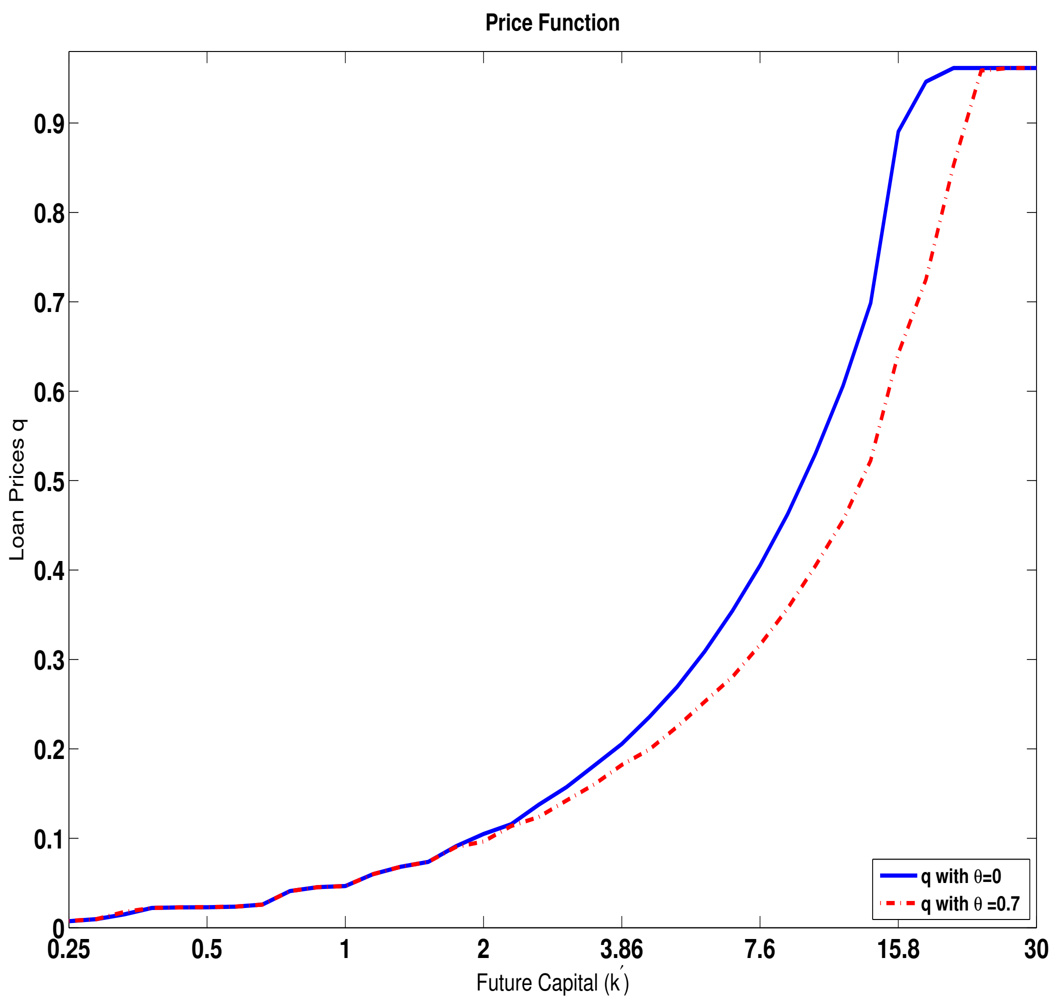

Figure 1.9: Price functions for $\theta = 0$ and $\theta = 0.7$

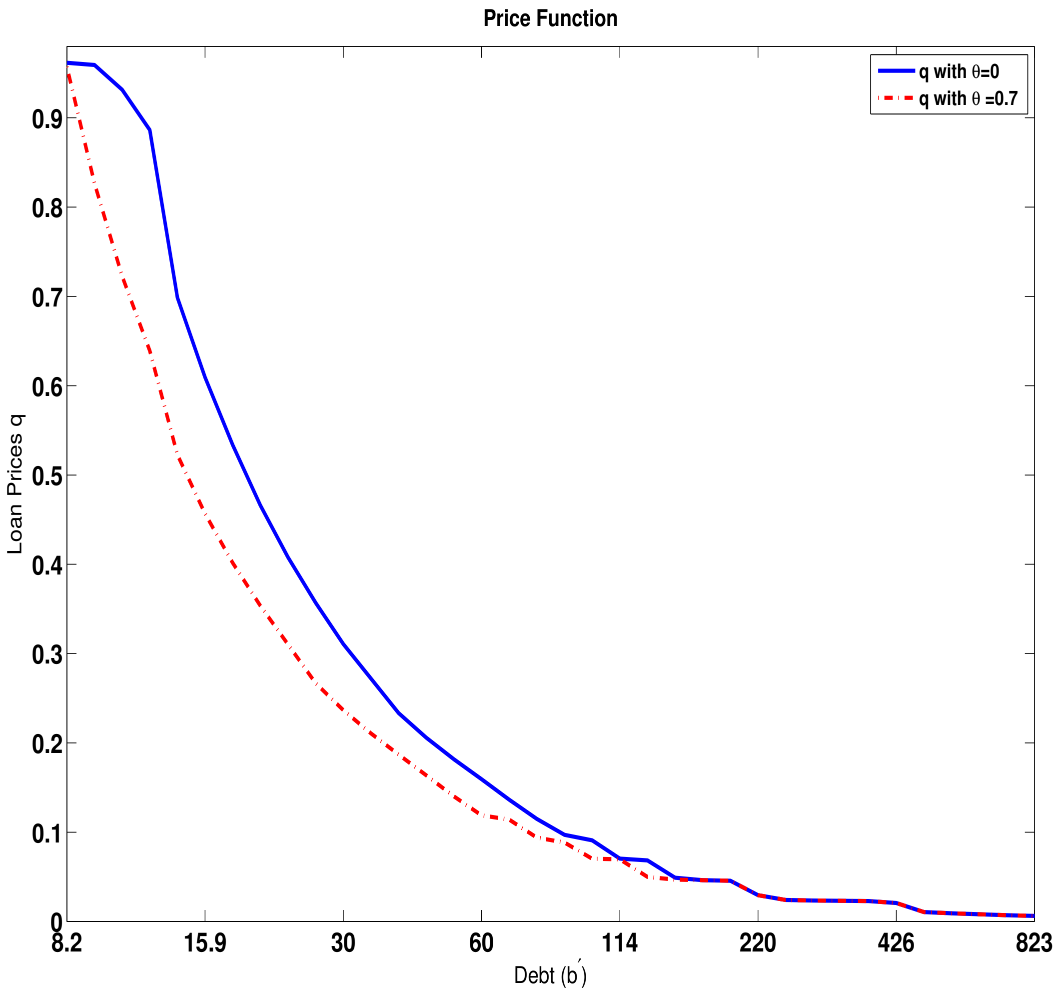

Figure 1.10: Price functions for $\theta = 0$ and $\theta = 0.7$

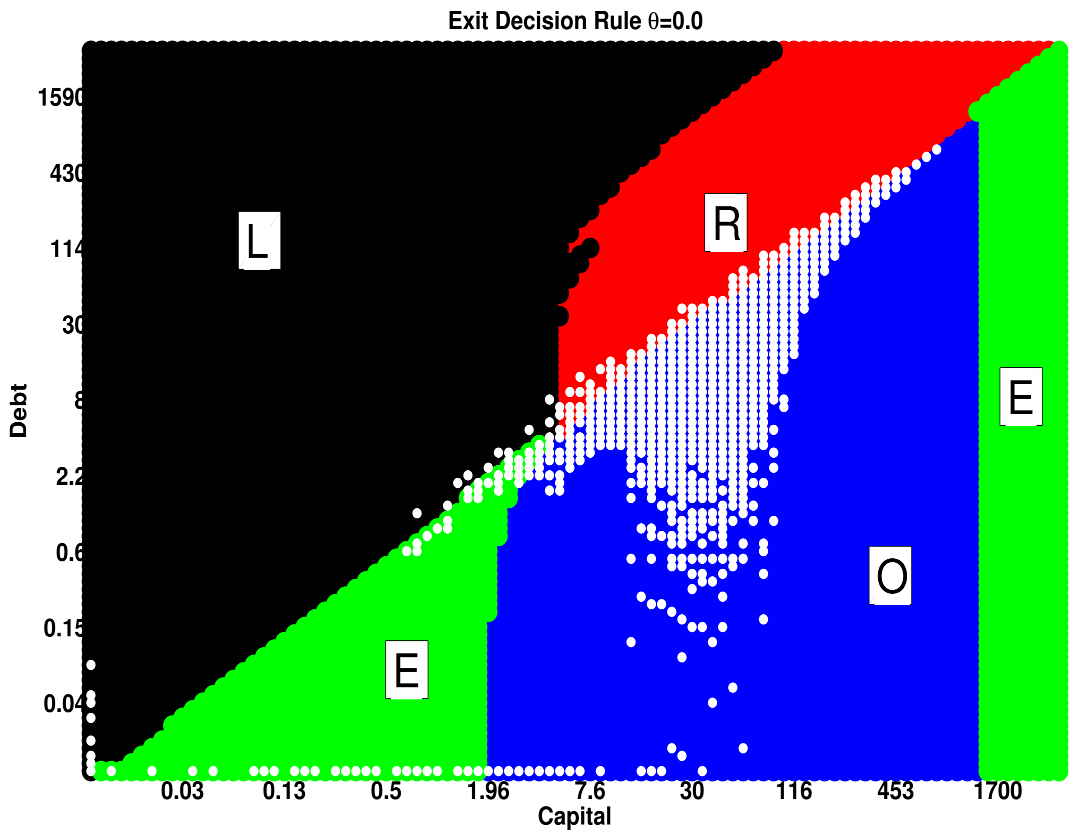

Figure 1.11: Exit decision rule for $\theta = 0$

[16]The green region corresponds to the exit without default, black region corresponds to liquidation, red region corresponds to reorganization, blue region corresponds to reorganization. White dots represent the firm distribution.

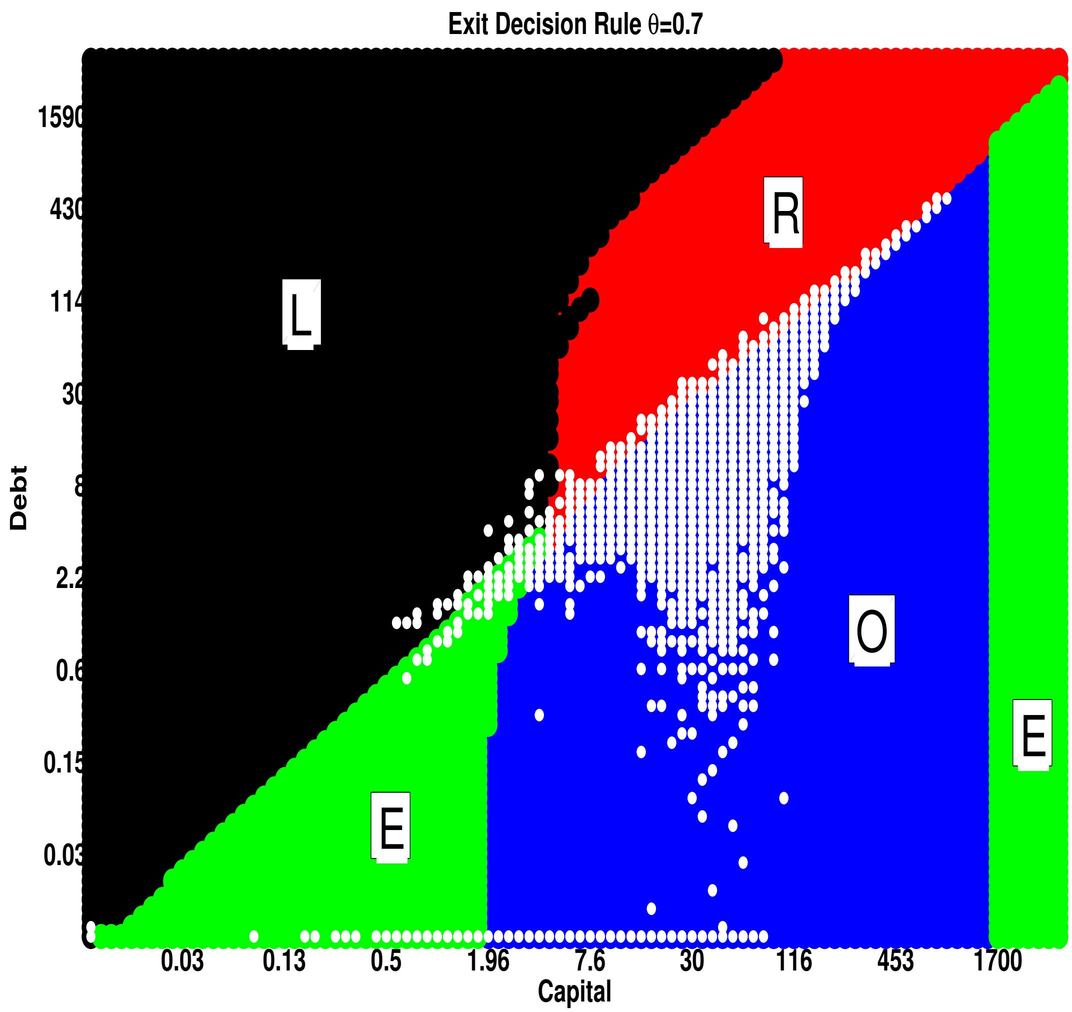

Figure 1.12: Exit decision rule for $\theta = 0$

[17]The green region corresponds to the exit without default, black region corresponds to liquidation, red region corresponds to reorganization, blue region corresponds to reorganization. White dots represent the firm distribution.

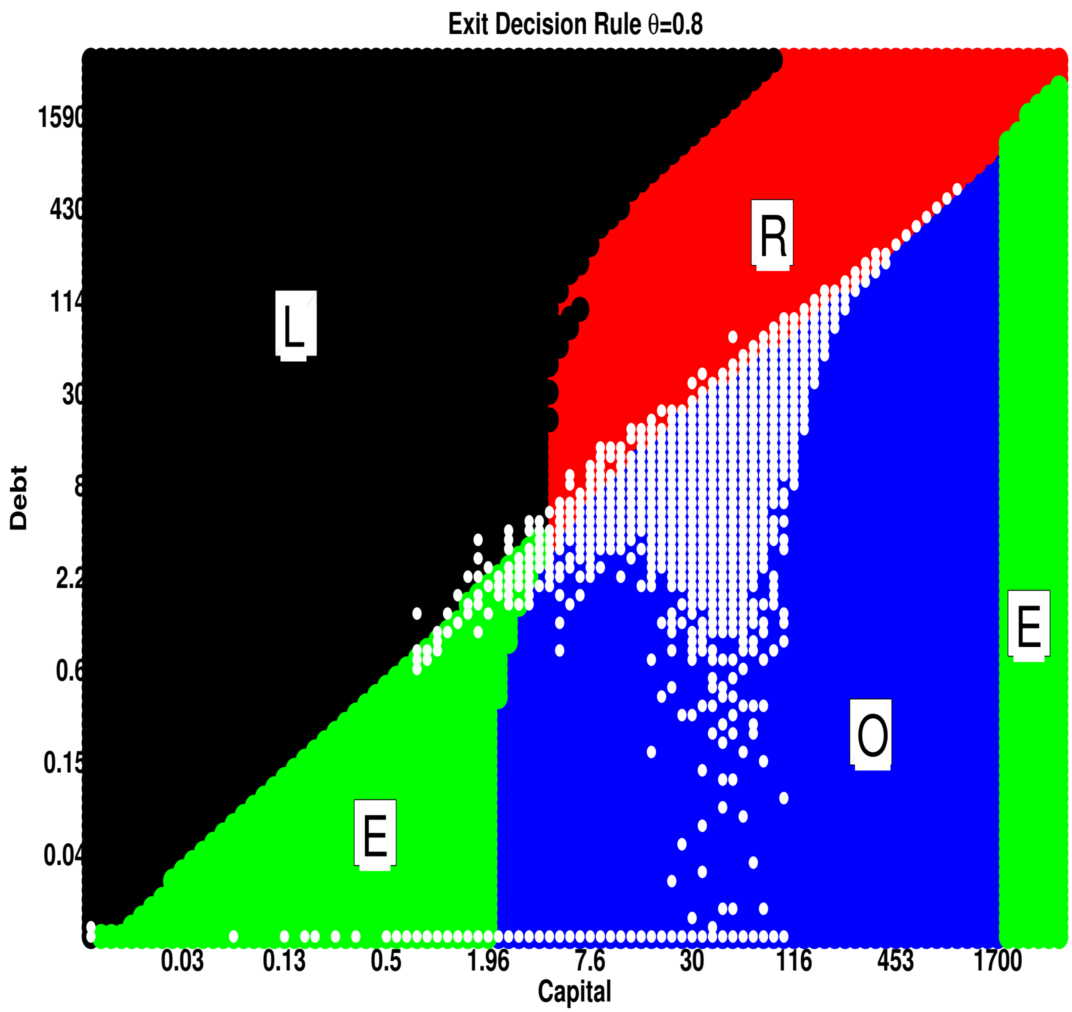

Figure 1.13: Exit decision rule for $\theta = 0.8$

[18]The green region corresponds to the exit without default, black region corresponds to liquidation, red region corresponds to reorganization, blue region corresponds to reorganization. White dots represent the firm distribution.

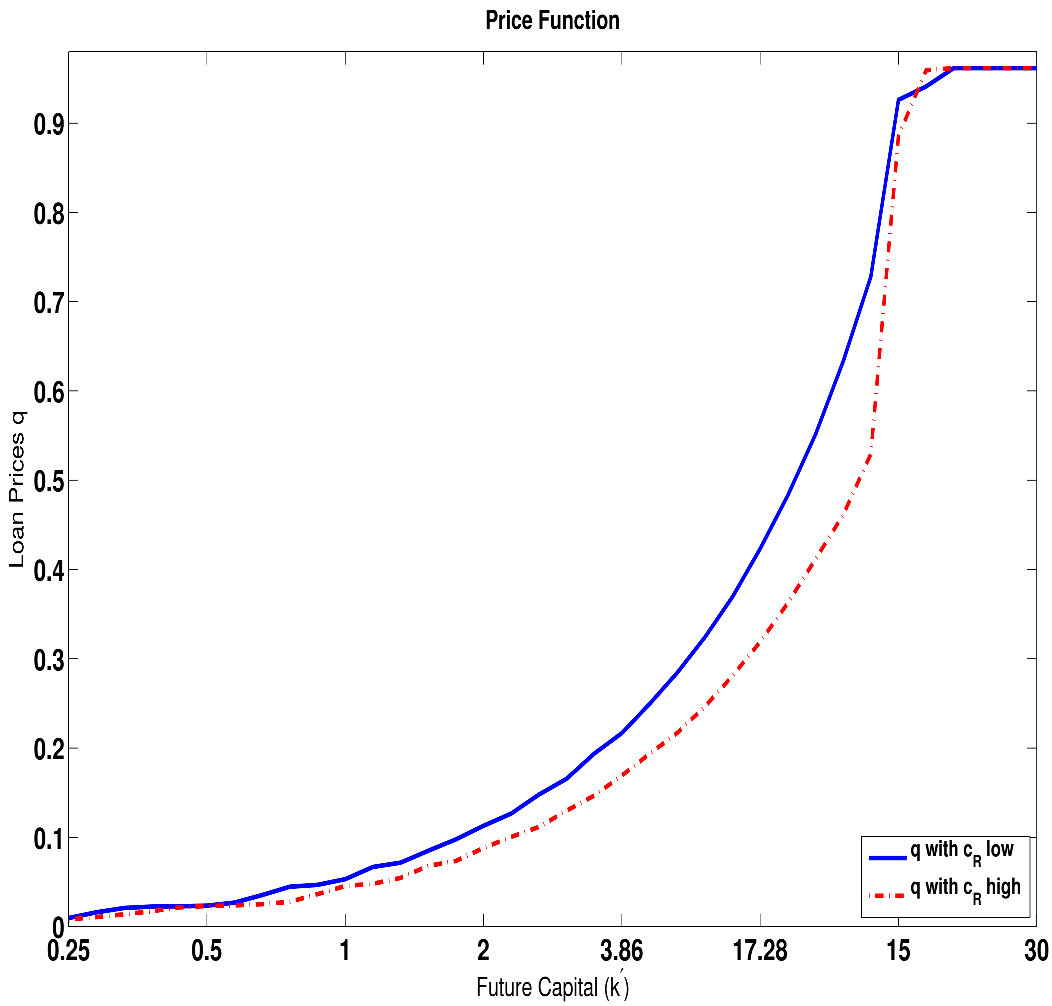

Figure 1.14: Price functions for $c_R = 0.07$ and $c_R = 0.30$

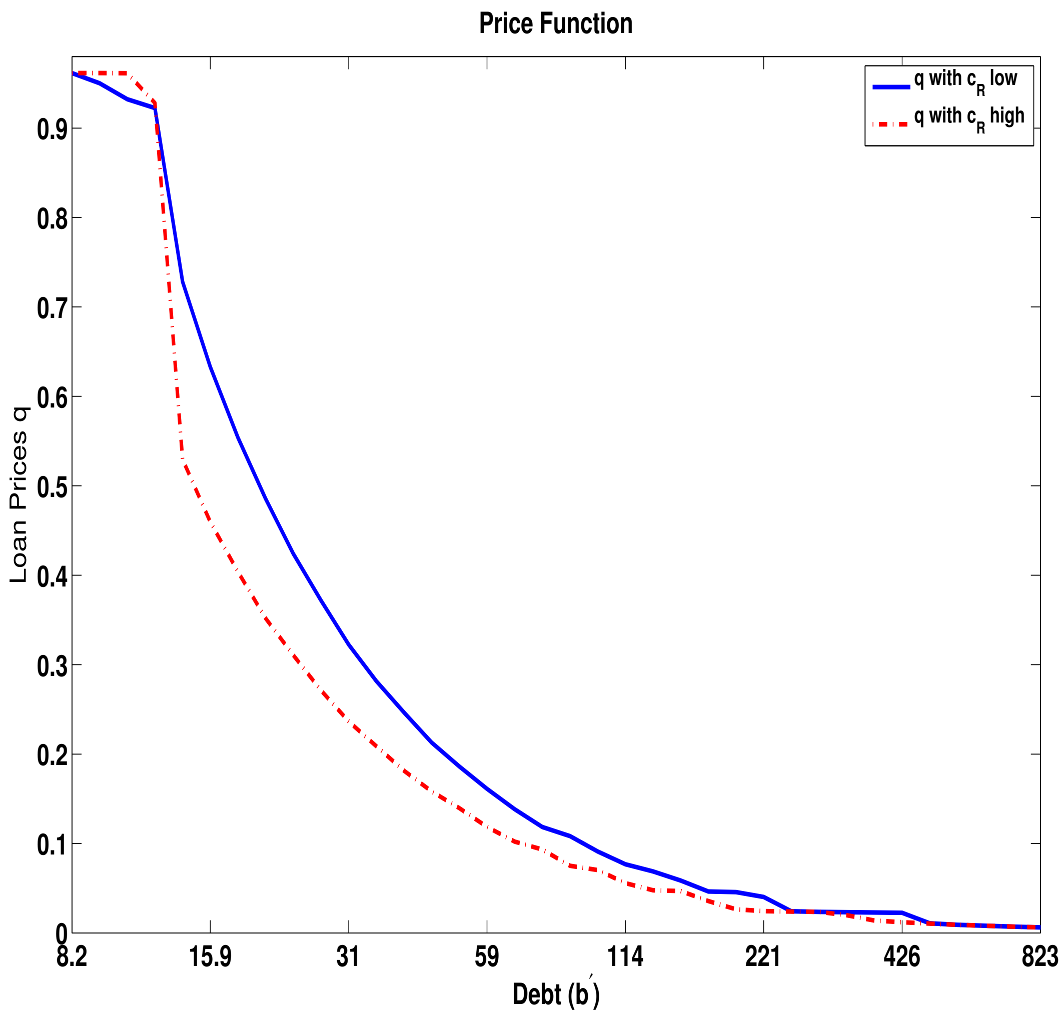

Figure 1.15: Price functions for $c_R = 0.07$ and $c_R = 0.30$

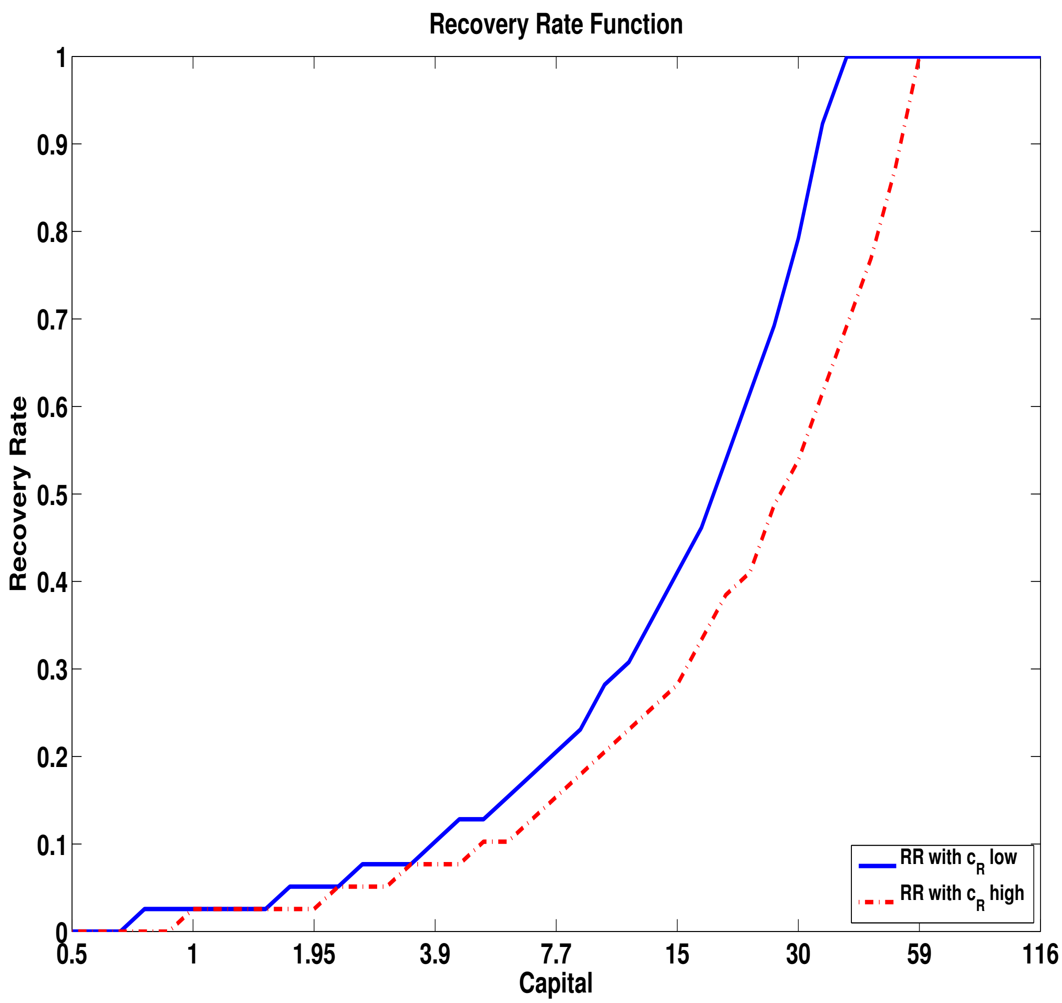

Figure 1.16: Recovery Rates for $c_R = 0.07$ and $c_R = 0.30$

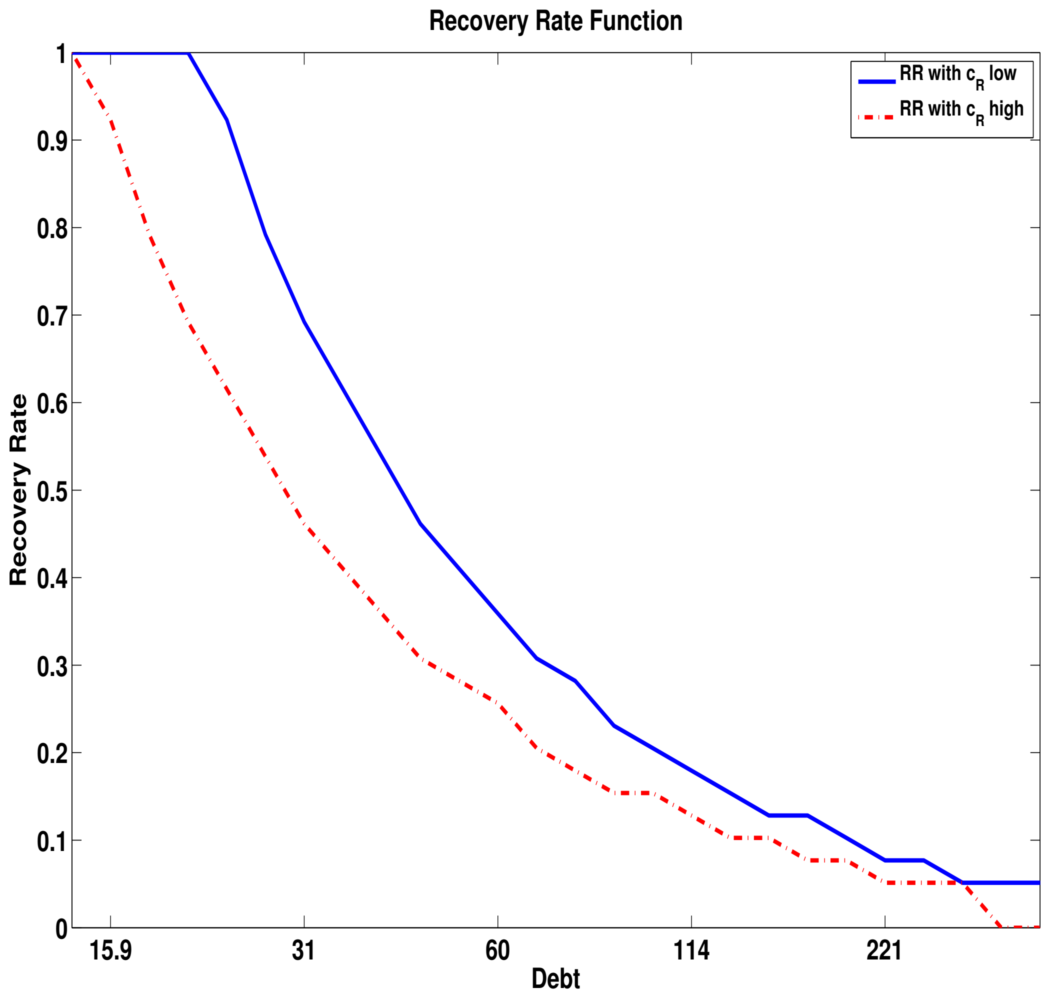

Figure 1.17: Recovery Rates for $c_R = 0.07$ and $c_R = 0.30$

Chapter 2

Misallocation, Informality and Human Capital: Understanding the Role of Institutions

2.1 Introduction

The question this paper addresses is: What is the role of formal sector institutions on the size of the informal sector, the stock of human capital and measured productivity? In particular, we explore how the demand of human capital interacts with formal sector institutions (entry costs to the formal sector, tax structure, and efficiency of debt enforcement). In summary, we find that formal sector entry costs, financial frictions, and taxes are complementary.

We develop a general equilibrium model of firm dynamics with an endogenous demand for human capital.[1] The model also displays endogenous physical capital financing and default decisions and allows for the existence of formal and informal sectors. Although entering and operating in the formal sector is costly, these firms have access to an expanded set of production possibilities and the ability to employ skilled workers. Formal sector firms

[1]Our intention is to highlight the role of the demand of human capital. For this reason, we simplify the skill-formation technology (i.e the supply side) as much as possible. Rich models that focus on the production of human capital include Mankiw, Romer and Weil (1992), Manuelli and Seshadri (2010) and Erosa, Koreshkova and Restuccia (2010).

face an endogenously lower cost of borrowing because they have access to credit markets with a higher degree of enforcement than in the informal sector. In our quantitative exercise, we calibrate the model to the US economy and then, we impose country-specific formal sector institutions, which are based on those measured by the World Bank as reported in its *Doing Business* database to analyze the effects that these have on informality, skill formation, and total factor productivity.[2]

Our focus is understanding the mechanics of each institution, therefore the main results are presented through a set of counterfactuals where we analyze the individual and joint changes in the costs of formality. We find that the complementary effect of entry costs and financial frictions is the key to understand the total effect on TFP, informality, and human capital when moving from the US to developing economies.[3] Individually, neither the entry cost nor the financial frictions generate significant changes in productivity, informality or human capital. However, when analyzed together, we find that the complementary effect (joint effect of entry costs and financial frictions net of their individual effect) explains a large fraction of the difference between the US and Low Middle Income countries in terms of TFP, informal labor force and skilled workers (27%, 64%, and 68% of the total difference respectively). We compute the same counterfactual in a model without human capital and show that there is no complementarity effect between frictions when human capital is absent.[4] The intuition is simple. The introduction of relatively expensive skilled workers increases the incentives to substitute away from labor and towards investment in physical capital. However, in the presence of financial frictions, this means that the firms move closer to the financial constraint and effectively pay higher interest rates. These results are in line with what Bergoeing, Loayza and Piguillem (2011) find in a model with technology adoption.

In order to quantify the role of human capital on measured total factor productivity and

[2] In order to isolate the effects of institutional differences, we assume that all countries have access to the same production possibilities.

[3] Relative to the US (which is our benchmark calibration), the model generates up to a 37% decrease in TFP, a 10 times larger informal sector and as large as a 60% decline in the stock of skilled workers when formal sector institutions are those of developing economies.

[4] The environment with no human capital is similar to that presented in D'Erasmo and Moscoso Boedo (2012).

informality, we run a counterfactual with no skilled workers. We find that the model with human capital generates a drop in measured TFP that is 48% larger than the model with no human capital. Moreover, we find that the increase in the size of the informal sector is more in line with the data when human capital is present. Finally, we study the role of informality and show that the introduction of the informal sector is quantitatively important as well. The counterfactual with no informal sector generates a reduction in measured TFP, relative to the US, that is 27% smaller than the drop produced by the benchmark model and generates a minimal change in the demand for human capital (as opposed to a 67% drop in our benchmark with informal sector and human capital). In short, when the three formal sector institutional frictions are introduced together they have a larger impact on TFP, human capital, and informality than the sum of the effects of these frictions when each one is introduced separately.[5]

Our work is motivated by the observed cross-country differences in TFP, human capital, and informality and their correlations with formal sector institutions. There are important differences in human capital in developed versus developing countries. Barro and Lee (2000) document that in the developing world, in the year 2000, 37% of the population over 25 years old have no formal schooling and only 27% have some secondary education. On the other hand, in advanced and transition economies, approximately two-thirds of the population over 25 years old have some secondary education. Panel (a) of Figure 1 shows the positive correlation between GDP per capita and skills.[6]

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 measured TFP (which effectively remains unexplained) is displayed in Panel (b) of Figure 1. The aim of this paper is to connect institutions in the formal sector across countries to resource misallocation and human capital formation and evaluate their effects on TFP.

[5]Because only firms in the formal sector are able to hire skilled workers and factor shares are unaffected, skilled workers as a fraction of the population (our measure of human capital) is almost unaffected.

[6]Skills are defined as the percentage of people that completed college as a percentage of the population over 25 years old, were taken from Barro and Lee (2000).

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.[7] Agents involved in the informal sector make explicit efforts not to be detected, which makes measuring this 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 cross-country differences in economic development. In a cross-country study of Latin America countries, Funkhouser (1996) shows that the mean education level in the formal sector is substantially higher than in the informal sector.

The model's predictions are consistent with the macro and micro facts of the informal sector described above. More specifically, at the calibrated parameters and measured institutions. We find a strong negative correlation between the level of informality, the stock of human capital, and income per capita. Moreover, the informal sector is characterized by very small, relatively unproductive, young firms, whereas the formal sector exhibits ever larger firms in countries with underdeveloped institutions. As we move along the development spectrum, poor countries display a bimodal distribution of firms, with many small and large ones, but not many middle sized firms. This feature has been described in the empirical literature as the "missing middle" and is one of the main determinants of the negative relationship between aggregate total factor productivity and income per capita.

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).[8] Amaral and Quintin (2008) model the informal sector as the endogenous response of managers who are heterogeneous in ability. Their model generates a formal sector that is endogenously

[7] Measured 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 for the US, the country we use for our benchmark calibration. However, this measure is highly correlated with most measures of the informal sector, either direct or indirect

[8] As in Rauch (1991) and Loayza (1996), we model the informal sector as an optimal response to the economic environment.

skill intensive. In this paper, we contribute to this literature by quantitatively measuring the effects of frictions on informality and the stock of human capital, while uncovering the mechanics of each friction.

Recent related literature on the distributional consequences of frictions follows two approaches in measuring 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 out 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 in the Doing Business data set, as in this paper. Papers in this group include Barseghyan and DiCecio (2010), Moscoso Boedo and D'Erasmo (2012), and Moscoso Boedo and Mukoyama (2012).

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 regarding the effects of each friction on the aggregates, and Section 7 concludes.

2.2 Data

2.2.1 Measured Institutions

We use data from the World Bank *Doing Business* project to set our institutional differences across countries. This data set 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.[9] 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.

The cost of entering the formal sector is constructed as in Moscoso Boedo and Mukoyama

[9] The construction permits category includes all procedures required for a business in the construction industry to build a standardized warehouse.

(2012). It includes the costs of registering a business and of dealing with licenses to operate a physical locale.[10] Both costs consists of 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 $\omega_n \kappa$), varies greatly across countries, with high levels of κ observed only at the very low end of the income distribution. Also, the correlation between the log of entry cost and log GNI per capita is very high at -0.7, significant at 1%.

In terms of the tax structure, we concentrate on payroll taxes, taxes on profits and the cost of tax compliance. The tax rates paid on profits, payroll taxes, and cost of tax compliance are respectively denoted by τ , τ_ω 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 who is devoted to the tasks related to tax compliance, and therefore translate time into costs as the worker's annual wages.

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 estate's value, includes court fees and the cost of insolvency practitioners, such as legal and accounting fees. 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. It displays a strong correlation of 0.78 with GNI per capita.

2.2.2 Human Capital and the Informal Sector

The main goal of our paper is to quantify the effects of institutions on the skill distribution, therefore the definition of "skills" is crucial. It is hard to find an accurate and comprehensive cross-country measure of skills, because schooling quality might differ significantly across countries. We follow the standard procedure in the literature and use data on education

[10] The 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. Some of the elements involved in construction permits, such as the cost of connection to basic services, are present when operating a physical locale.

from Barro and Lee (2000). This data set provides comprehensive coverage for cross-country education attainment up to 1995 and also construct projections up to the year 2000. They fill in the missing observations by the perpetual inventory method using the enrollment ratios. The data contains educational attainment data for primary, secondary, and higher levels of education (both completed and not completed) for the population over the age of 25, and the average years of schooling. We define skilled workers as those with completed higher education. According to this definition, skilled individuals account for 30.03 % of the population in the US, with the highest level stock of human capital. The lowest level of human capital is in Mozambique with 0.1%.

Informal labor force data is taken from the World Bank Development Indicators (WDI) database (2006), which measures the percentage of the labor force which is not covered by a pension scheme. The share of the labor force not covered by pension scheme provides a good direct measure of informality for the US, the benchmark country in the calibration and the only direct measure of informality we need for our quantitative exercise. In our sample, all of the countries do have a pension scheme, alleviating the potential drawback of having countries without formal pension schemes. Schneider and Enste (2000) report various alternative measures of the informal sector across countries (highly correlated with our measure), and is the most comprehensive study regarding informality in a cross country setting. They include indirect estimates of informal output from energy consumption or money demand or from discrepancies between official and actual employment in household surveys.

2.3 Environment

We build a firm dynamics model, augmenting D'Erasmo and Moscoso Boedo (2012) with human capital. The model is a version of Hopenhayn (1992) that incorporates capital investment 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. Each firm chooses to operate in either the formal or in the informal sector. Competitive risk-neutral lenders make loans to the corporate sector. Consumers supply both skilled and unskilled labor to the firms. Because our focus is on firm dynamics, we simplify the household problem and skill accumulation as much as possible. We focus on a stationary equilibrium.

2.3.1 Household Sector

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

$$U = \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(C_t)\right] \tag{2.1}$$

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 of a unit mass of labor divided between skilled (S_t) and unskilled workers. Skills can be 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 the only input in the production of skills, the household decides how to allocate unskilled labor between the production sector and schooling and the entire stock of skilled workers is allocated to the production sector. We denote the mass of unskilled labor allocated to production by N_t and the mass of unskilled labor allocated to schooling by A_t. Skilled labor depreciates at the rate δ_s. Thus, the law of motion for human capital is: $S_{t+1} = (1-\delta_s)S_t + (1/x)A_t$.

The wage rate for 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, i.e. $u(C_t) = C_t$. This assumption implies that the skill premium that would make the household indifferent between allocating resources to the production sector and the formation of new skills is independent of the wage level. Because we focus on a stationary equilibrium and there is no heterogeneity at the household level, this assumption can be imposed without loss of generality. Also, this implies that the skill premium is constant across countries. In Psacharopoulos and Patrinos (2004) one can see that the skill premium does not display a clear relationship with income, being the countries in the middle of the distribution the ones with a relatively larger premiums for skills.

The consumer is responsible for the creation cost of new firms c_e, and consequently owns existing firms in the economy and receives income from the firm's dividends. 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 equal to the total amount of taxes collected.

2.3.2 Firms and Technology

The unit of production is a single-establishment firm, also understood as a unique investment project. Each project is described by a production function. The production process displays decreasing returns to scale at the firm level. As mentioned earlier, empirical evidence shows that formal sector workers have more education and earn more as compared to the informal sector workers. We assume that the formal sector technology is:

$$f(z,k,s,n) = zk^{\alpha}s^{\epsilon_f}n^{\gamma_f}, \tag{2.2}$$

where z is the exogenous technology shock, k is physical capital, s is skilled labor and n is unskilled labor.[11] The informal sector technology is:

$$g(z,k,n) = zk^{\alpha}n^{\gamma_i}. \tag{2.3}$$

While consistent with the empirical evidence, the main reason for the assumed differences in the use of skilled workers across the formal and informal sector derives from the lack of data on the firm size distribution of informal firms. One alternative, not explored in this paper, is to consider a production technology in the informal sector that incorporates skilled labor with a potentially different factor share that its counterpart in the formal sector (i.e.

[11] This is the simplest production function that abstracts from the interesting implications of assuming different levels of capital-skill complementarity.

$g(z, k, s, n) = zk^{\alpha} s^{\epsilon_i} n^{\gamma_i})$.

There are two processes for z: *high* (h) and *low* (l). The *high* productivity process is given by

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

with $\epsilon_{t+1} \sim N(0, (1-\rho^2)\sigma^2)$, where σ^2 is the variance of $\ln(z)$, μ_h is the mean, and ρ the autocorrelation parameter of the process. The use of the *high* productivity process is restricted to the formal sector. To simplify the exposition of the model, we assume that the *low* productivity process is a constant given by μ_l. We also assume that the choice of technology process is irreversible, i.e. once a firm decides on *high* or *low* the firm will produce using this process until it exits.[12] These two processes are calibrated to match the size distribution of formal firms and the size of the informal sector. Their difference is one of the channels that allows the model to generate capital missallocation together with small informal establishments as observed in the data by Bartelsman et. al. (2008) and Perry et. al. (2007). Note that the fraction of firms operating under each process is an endogenous outcome of the model and a function of the country specific frictions. We denote the transition distribution function of z_t by $\eta_j(z_{t+1}, z_t)$ for $j = h, l$.

The assumption of different productivity processes is consistent with the evidence provided by La Porta and Shleifer (2008). They find that firms in the informal sector are fundamentally different than those in the formal sector. They document productivity differences at the firm level between informal firms and small formal firms that range from 100% to 300%. They also find that these differences are permanent and not the result of informal sector firms operating at a lower scale to avoid detection.[13,14] Moreover, Bruhn

[12]This is consistent with the evidence presented in Atkeson and Kehoe (2007) who argue that manufacturing plants needed to be completely redesigned in order to make good use of the new technologies.

[13]For example, differences in sales per worker are much higher (2 to 3 times) than the average entry cost, implying that is not just the barrier to entry the main factor affecting scale, productivity or the decision to operate informal. Related to this, they note that in a sample of developing economies, approximately 91% of registered firms at the time of the survey started as registered firms and do not come from the informal sector. Survey of microfirms in Brazil and Mexico also show that those that start informal never make any effort to become formal firms.

[14]Different microfoundations would be consistent with heterogeneous productivity across firms. As in Acemoglu et. at. (2007) and Song et. al. (2011) we can think of owners of formal firms delegating decision authority to its manager (while retaining control) and informal firms not being able to do so due to lack of contract enforcement. Since managers are able to make decisions based on superior information, firms that

(2011), Bertrand and Kramarz (2001) and McKenzie, David and Sakho (2007) present empirical evidence that shows that decreases in entry costs do not lead to the formalization of previously informal firms and only generate the creation of new business. Our assumption irreversible technology choice captures this feature. Finally, our assumption that the formal sector is relatively more skill intensive is based on the observations by Pratap and Quintin (2008), once we also include the education of the entrepreneur.

Firms maximize expected discounted dividends d_t:

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

at the rate R.[15] Firms can be created by paying a cost c_e. After paying this cost, firms learn their initial level of productivity z_0 for the h process. This initial level of productivity is drawn from the distribution $\nu(z_0)$. Draws from this distribution are assumed to be i.i.d across firms. With this knowledge of z_0 and μ_l at hand, firms decide to become formal, informal, or stay out of the market. If they become formal, firms choose between undertaking either of the two projects available, i.e. z_0 or μ_l. If they become informal, they can only undertake the project associated with the low process, i.e. μ_l. Informal firms can choose to formalize in the future. Unimplemented projects go back into the pool.

Formalizing a firm requires an entry cost κw_n. 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 skilled and unskilled labor.[16]

Operating firms in both the formal and informal sectors pay a random fixed cost of production c_f in every period, measured in units of output, which is iid across firms and over time with distribution $\xi(c_f)$. 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.

delegate attain a higher efficiency level.

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

[16] Most 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.

2.3.3 Financial Markets

A competitive credit industry makes loans to the formal and informal sector firms. Lenders are risk neutral, have unlimited access to a risk-free asset with return r_t. In each period, firms borrow using only one period non-contingent debt denoted by b (i.e. markets are incomplete). Loans of different sizes for different types of firms are treated as distinct financial assets. Because there is perfect information, the price of the non-contingent bond depends on firms' characteristics given by their choice of sector (formal or informal), future level of capital (k'), future level of borrowing (b'), and current technology (z). In particular, firms in the formal sector will borrow at price $q_j^f(k', b', z)$ $j = h, l$ and firms in the informal sector will borrow at price $q^i(k', b')$. 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 has an associated cost equal to a fraction ϕ of the firm's 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.

2.4 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.

2.4.1 Consumer Problem

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

$$C = \omega_n N + \omega_s S + \Pi + T - E + X \tag{2.4}$$

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 unit mass of labor is allocated between unskilled labor, skilled labor and schooling

$$1 = N + S + A.$$

The benefit to schooling is the discounted value of future skilled wages:

$$\beta^{x+1} \sum_{t=0}^{\infty} [\omega_s \beta^t (1 - \delta_s)^t] \tag{2.5}$$

The cost of schooling is the foregone unskilled wages during the x schooling years:

$$\sum_{t=0}^{x} \beta^t \omega_n. \tag{2.6}$$

In equilibrium, the household will invest in schooling until he is indifferent:

$$\frac{\omega_s}{\omega_n} = \left[\frac{1 - \beta(1 - \delta_s)}{1 - \beta} \right] \frac{1}{\beta^{x+1}}. \tag{2.7}$$

This equilibrium condition determines the skill premium. Finally, in the steady state equilibrium, the level of schooling is

$$\frac{A}{x} = \delta_s S.$$

Formal Sector Incumbent

An incumbent establishment in the formal sector with technology $j \in h, l$ starts the period with physical capital k, debt b, and previous productivity z_{-1}. Then, the firm draws the fixed cost of continuing the operation, c_f , and decides to operate the technology, exit after repayment of debts, or default and liquidate the firm. The value function of an establishment at this stage is denoted as $W_j^f(z_{-1}, k, b, c_f)$. The value function of a firm operating in the formal sector is denoted as $V_j^f(z, k, b, c_f)$.

The incumbent in the formal sector solves the Bellman equation

$$W_j^f(z_{-1}, k, b, c_f) = \max\left\{\int V_j^f(z, k, b, c_f)d\eta_j(z|z_{-1}),\ \max\{0, (1-\phi)k - \lambda b\}, k - b\right\} \tag{2.8}$$

and

$$V_j^f(z, k, b, c_f) = \max_{n,s,k',b'} d_j^f(z, k, b, c_f) + \beta \int W_j^f(z, k', b', c_f')d\xi(c_f) \tag{2.9}$$

s.t.

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

The solution to this problem provides the exit decision rule $\chi_j^f(z_{-1}, k, b, c_f)$, which 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.

Informal Sector Incumbent

An incumbent establishment in the informal sector, after observing the fixed 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;

$$W^i(k, b, c_f) = \max\left\{V^i(k, b, c_f), \tilde{V}_l^f(\mu_l, k, b, c_f), k\right\}, \tag{2.10}$$

where the value of staying in the informal sector is

$$V^i(k, b, c_f) = \max_{n,k',b'} \quad d^i(k, b, c_f) + \beta \int W^i(k', b', c_f')d\xi(c_f) \tag{2.11}$$

s.t.

$$d^i(k,b,c_f) = g(\mu_l,k,n) - c_f - \omega_n n - k' + (1-\delta)k + q^i(k',b')b' - b \geq 0 \tag{2.12}$$

The value of switching to the formal sector is[17]

$$\tilde{V}_j^f(z,k,b,c_f) = \max_{n,s,k',b'} \tilde{d}^f(z,k,b,c_f) + \beta \int W_j^f(z,k',b',c_f')d\xi(c_f) \tag{2.13}$$

s.t.

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

The solution to this problem provides the exit decision rule $\chi^i(k,b,c_f)$ which 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 $k'^i(k,b,c_f)$ and $b'^i(k,b,c_f)$ for a firm operating in the informal sector, and capital and debt decision rules $\tilde{k}_j'(z,k,b,c_f)$ and $\tilde{b}_j'(z,k,b,c_f)$ for a firm that switches from the informal sector to the formal sector.

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:

$$W_e = \int \max\{W^i(0,0,0), \tilde{V}_h^f(z_0,0,0,0)\}d\nu(z_0) - c_e. \tag{2.14}$$

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 *high* technology cannot be operated in the informal sector. The sector and technological decision

[17]Note that, at this stage, the relevant state is $z = \mu_l$ and $j = l$. We define this function in general form because we will use it as part as the definition of the entry problem.

are made after paying c_e and observing the productivity level z_0. Differences in the volatility of the process, together with differences in initial productivity,will generate differences in the decisions made 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 $\Xi(z_0)$.

2.4.2 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' is

$$\pi_j^f(k', b', z) = -q_j^f(k', b', z)b' + \frac{1 - p_j^f(k', b', z)}{1+r}b' + \frac{p_j^f(k', b', z)}{1+r}\min\{\lambda b', (1-\phi)k'\}, \quad (2.15)$$

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' is

$$\pi^i(k', b') = -q^i(k', b')b' + \frac{[1 - p^i(k', b')]}{1+r}b', \quad (2.16)$$

where $p^i(k', b')$ denotes the default probability of a firm operating in the informal sector. In equilibrium, the schedule of prices will adjust so that $\pi_j^f(k', b', z) = 0$ and $\pi^i(k', b') = 0$ for all (j, k', b', z).

2.4.3 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 and ω_n, a mass of entrants M, and aggregate distributions of firms in the formal $\vartheta(k, b, z, j; M)$ and informal $\hat{\vartheta}(k, b; M)$ sectors, 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. Distributions ϑ and $\tilde{\vartheta}$ are stationary.

5. Aggregate consumption: $C = \omega_n N + \omega_s S + \Pi + T - E + X$.

6. Bond market clears: $B = 0$.

7. The labor market clears

$$1 = A + N + S,$$

$$S = \sum_j \int s(z,k) d\vartheta(k,b,z,j;M),$$

$$N = \sum_j \int n(z,k) d\vartheta(k,b,z,j;M) + \int n(z,k) d\hat{\vartheta}(k,b;M).$$

2.5 Calibration

In this section, we calibrate the model to the US economy. The volatility of the high process σ is set to 0.2305 and the autocorrelation parameter ρ is set 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 $\eta(z'|z)$ following Tauchen (1986). From the transition matrix $\eta_h(z'|z)$ we can derive the unconditional probabilities $\eta^*(z)$. We set the distribution of initial shocks $\nu(z_0) = \eta_l^*(z)$.[18] We assume that the operating fixed cost can take values of $\{0, \hat{c_f}, +\infty\}$.

Following the literature, the risk free interest rate r is set to 4% per year, which implies that $\beta = 1/(1+r) = 0.9615$. The depreciation rate of skilled labor will be set to $\delta_s = 0.015$ to match an average yearly return to college education of 10.5%, as reported by Psacharopulos and Patrinos (2004). A skilled worker is defined as one with a college degree (16 years of education). By this definition, the fraction of skilled workers in the population in the

[18] To correctly identify the entry threshold for each sector and perform the quantitative experiment across countries we need to compute the model with a large number of points in the z dimension. We set the number of grid points for z to 100.

Table 2.1: Model Parameters

Parameter		Value	Moment (US economy)
Discount factor	β	0.9615	Avg. yearly return 5-yr. T-Note
Depr. rate for capital	δ	0.07	Manufacturing Sector U.S.
Depr. rate for skilled labor	δ_s	0.015	Avg. Return to Education
Years of schooling	x	6	Avg. years of schooling in U.S.
Capital Share	α	0.21	Capital share
Labor Share Informal	γ_i	0.64	Labor Share
Std. Dev.	σ	0.2305	Manufacturing Sector U.S.
Autocorrelation	ρ	0.885	Manufacturing Sector U.S.
Skilled Labor Share	ϵ_f	0.302	Skilled workers as % of labor force
Labor Share Formal	γ_f	0.338	Labor Share
Mean high process	μ_h	3.162	Avg. Operating Establishment
Mean low process	μ_l	0.6871	Size of Informal sector
Positive operating cost	$\hat{c}_f$	8.5	Exit Rate Distribution
Distribution Op. Costs	$\xi(\hat{c}_f)$	0.10	Exit Rate Distribution
	$\xi(\infty)$	0.042	Exit Rate Distribution
Creation Cost	c_e	0.103	Free Entry Condition

U.S. equals 30%. From Barro and Lee (2000), the average number of years of schooling in the U.S. is approximately equal to 12. This implies that the average number of years of schooling in the group of unskilled workers equals 10 (i.e. the number of years of education with which each agent in our economy is born). Then, we set x to 6 to match the number of years of education that are necessary in order to become skilled. The total labor share in each sector is set to 0.64 a standard value. That is $\gamma_f + \epsilon_f = \gamma_i = 0.64$. The value of ϵ_f is set to match the equilibrium fraction of skilled workers. The capital share is set such that the degree of decreasing returns to scale at the firm level in both sectors is consistent with the estimates presented in Restuccia and Rogerson (2008). In particular, we set $\alpha = 0.21$ so that $\alpha + \epsilon_f + \gamma_f = \alpha + \gamma_i = 0.85$. The physical capital depreciation rate δ is set to 7%, as in Cooper and Haltiwanger (2006). We normalize the unskilled wage rate to 1, and calculate the skilled labor wage rate using equation (2.7). The value of the entry cost c_e is calibrated as in Hopenhayn and Rogerson (1993), such that, in the benchmark equilibrium with $w = 1$, c_e satisfies the free entry condition with equality. 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 $\lambda = 0.77$ and $\phi = 0.07$.

We are left with 6 parameters to calibrate: the mean of the productivity process of the high and low projects μ_h and μ_l, respectively, the labor share of skilled workers ϵ_f (which, provided that the total labor share is 0.64, also determines γ_f), the intermediate operating cost $\hat{c_f}$, 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 US, the percentage of skilled workers in the labor force, and the exit rate distribution for US establishments. 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.

Table (2.2) shows the data and the corresponding model moments.

Table 2.2: Target Moments

Moment	US Data	Model
Average Formal Est.	17.6	17.5
Informal Sector (fraction of Labor Force)	7.8 %	7.8%
Skilled labor (fraction of population)	30.03 %	29.51 %
Exit Rate Distribution by Employment Size	%	%
1-4	14.88	12.75
5-9	6.72	5.88
10-19	5.57	5.71
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

The average size of a formal establishment is 17.6 in the U.S. data, and in our model this figure is 17.5. The model exit rate distribution is very close to what is observed in the data. The amount of skilled labor as a fraction of the population is 30.03% in the US data, and in our model this number is 29.5%. The model is right on target for the size of the informal sector at 7.8%.

Once calibrated, we test our model using the size distribution of US formal establishments as reported in Table 2.3. The model does a good job of generating the correct overall size and age distributions of operating establishments in the formal sector.

Table 2.3: Distribution of US Formal Establishments by Age and Employment Size

Age	Young		Middle		Old		**Total Size Dist.**	
Employment Size	Data %	Model %	Data %	Model %	Data %	Model %	**Data %**	**Model %**
1-4	13.6	0.01	20.6	7.33	14.4	22.99	**48.6**	**30.34**
5-9	2.5	2.43	9.8	9.87	9.5	10.42	**21.8**	**21.42**
10-19	1.2	4.26	6.2	12.24	6.8	5.93	**14.2**	**23.34**
20-49	0.7	0.82	3.9	13.11	5.0	2.97	**9.6**	**17.23**
50-99	0.2	0.09	1.2	4.65	1.8	0.59	**3.2**	**5.35**
100-249	0.1	0.02	0.6	1.86	1.0	0.15	**1.8**	**2.05**
250 +	0.0	0.0	0.2	0.20	0.23	0.01	**0.01**	**0.25**
Total Age Dist.	**18.4**	**7.6**	**42.6**	**49.3**	**39.0**	**42.7**	**100**	**100**

Note: Data corresponds to the distribution of establishments by firm size and age for 2004 from Business Dynamics Statistics. "Young" corresponds to 0-1 years in operation, "Middle" corresponds to 2-10 years, and "Old" corresponds to 11 years or more.

Regarding size, it generates the correct number of small establishments (with fewer than 19 employees), but misses at the very low end of the distribution (fewer than 5 employees). With respect to the age distribution of formal establishments, the model is on target when compared to the fraction of young, middle, and old establishments. A deeper look at the joint distribution shows that the model under-predicts the fraction of young establishments in the smallest size category. The reason for this is that the productivity threshold to enter the formal sector endogenously generates young establishments that are relatively more productive and therefore larger than what is observed in the data. On the other hand, the model yields a distribution of middle and old establishments across sizes that resembles the distribution observed in the data. By construction, the exit and the entry rates are the same in the model, and are found to be 7.5 %. The entry and exit rates in the data are 11.1% and 10.2%, respectively. Thus, the model average entry and exit rates are four and three percentage points lower than the US data, respectively.[19]

[19]This distance between the model and data in terms of size distribution of young firms, entry and exit rates is partly due to the way that the data is collected. In the data, establishments are observed at one point in time. Those establishments that are less than one year old are considered entrants. However, the model's counterpart for entrant establishments is defined as those establishments that are exactly one year

2.6 Quantitative Exercise: Country Specific Institutions

We analyze the impact of institutional frictions on the cross-country differences in measured TFP, informality, and the skill distribution. Our focus is on measured differences in the cost of entry to the formal sector, the tax structure, and the efficiency of debt enforcing mechanisms. The experiment has two parts. The first one can be interpreted as a counterfactual in which the effects of imposing country specific frictions onto the US economy are measured in the steady state, while the second part goes deeper into the mechanics of each friction, turning them on and off in a series of counterfactual exercises. Due to the high computational burden of the exercise, the number of observations is limited by grouping countries by income level following the World Bank's definition: High Income Countries (HIC) and Developing Countries, where Developing Countries are classified as Upper Middle Income Countries (UMIC), Lower Middle Income Countries (LMIC) and Low Income Countries (LIC).[20]

The first experiment can be described as follows. First, calibrate the model to the US economy by using $(\lambda, \phi, \tau, c_\tau, \tau_w, \kappa)_{US}$.[21] Next, for each income group $(\lambda, \phi, \tau, c_\tau, \tau_w, \kappa)_g$ are adjusted, where $g \in \{HIC, UMIC, LMIC, LIC\}$, and a new equilibrium is computed.[22] In order to implement it, the *Doing Business* database for 2009 is used to obtain the median $(\lambda, \phi, \tau, c_\tau, \tau_w, \kappa)$ for each income group. Table 2.4 shows parameter values for the US economy (used in the benchmark calibration) and those of High, Upper Middle, Lower Middle and Low Income countries.

We start our analysis by looking at the effects of country specific institutions on some important aggregates. These are the level of aggregate total factor productivity, the size of

old.

[20] Roughly, 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.

[21] In this case, the wage is normalized to one, and then the set of loan prices $q_j^f(k', b', z)$ and $q^i(k', b')$ are obtained through iteration, until lenders make zero profit on each contract. The mass of potential entrants M that clears the labor market is found together with the value of entry cost c_e that satisfies the zero entry condition.

[22] More specifically, the wage rate w and loan prices $q_j^f(k', b', z)$ and $q^i(k', b')$ are obtained through iteration until lenders make zero profits and the zero entry condition is satisfied (given the c_e obtained for the US). Finally, the mass of entrants M is adjusted in each case in order to clear the labor market.

Table 2.4: Frictions Across Income Groups

	λ	ϕ	τ	c_τ	τ_ω	κ
US	0.77	0.07	0.23	0.09	0.20	0.26
High (HIC)	0.72	0.08	0.18	0.07	0.28	1.08
Upper Middle (UMIC)	0.30	0.15	0.17	0.10	0.37	1.33
Lower Middle (LMIC)	0.25	0.15	0.17	0.14	0.31	5.08
Low(LIC)	0.15	0.09	0.20	0.13	0.23	7.03

Note: Countries are classified following the World Bank's income groups. Countries are 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. Median values for each group and friction are reported.

the informal labor force, output per worker and the fraction of skilled workers. Measured aggregate total factor productivity is computed, as is standard in the literature, by using an aggregate production function. In particular, we follow cross country studies such as Klenow and Rodriguez-Clare (1997) or Hall and Jones (1999) that compute the following equation:

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

where Y denotes aggregate output, K denotes aggregate capital, H denotes aggregate labor (adjusted for human capital), and $\hat{\alpha}$ is the capital share. In our model, 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 $1 - A$.We use the same capital share as in Hall and Jones (1999), which equals 1/3.[23] In the data, values of TFP and output per effective worker are obtained by updating Hall and Jones (1999) using Heston, Summers and Aten (2009) and Barro and Lee (2000). The model TFP is calculated as in Hall and Jones (1999), by calculating the value of human capital given the returns for every level of schooling. The informal labor force is reported by the WDI (2006), as the share of the labor force not covered by a pension scheme. Table 2.5 displays the main results for each income group and compares the model to the data for the median country in the income group.

Our model accounts for more than 2/3 of the TFP gap between the US and developing

[23]Including informal sector output in measures of GDP is line with National Accounts procedures. See D'Erasmo and Moscoso Boedo (2012) for an extensive discussion of issues regarding the measurement of aggregate output in the presence of an underground economy.

Table 2.5: Overall Effect of Changes in Institutions

	HIC		UMIC		LMIC		LIC	
	Data	Model	Data	Model	Data	Model	Data	Model
Informal Labor Force	8.8	11.76	45.0	52.33	71.7	69.22	95.0	62.73
Skilled workers % of population	11.00	28.27	9.00	15.57	5.70	10.03	1.40	12.12
TFP	0.91	0.89	0.70	0.72	0.44	0.63	0.31	0.64
Output per Worker	0.92	0.90	0.45	0.66	0.32	0.56	0.13	0.57

Note: TFP and Output per Effective Worker are reported relative to the US value. Data is from the 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 the population over age 25 who have completed college, from Barro and Lee (2000).

economies (a drop of up to 37%). We will extensively analyze the sources of observed productivity differences and the role of each friction in what follows. In short, we find that allocative inefficiencies, the distribution of human capital, and the share of output produced by firms in the informal sector play a crucial role.

The model accounts for a large fraction of the difference in terms of skilled workers across countries. As in the data, it generates a stock of human capital that is positively correlated with TFP, and income per capita and negatively related to the size of the informal sector. More specifically, it generates a stock of human capital that is only 52%, 33%, and 40% of the U.S. in UMIC, LMIC, and LIC, respectively. Differences in institutions and the resulting change in the size of the informal sector is one of the driving forces of this result. As the size of the informal sector increases, the demand for skilled workers is reduced. Moreover, as frictions increase, formal firms are also prevented from attaining their optimal level of capital and this in turn also affects the demand for skilled workers.

The model is successful in capturing the drop in human capital between the US and developing economies in the middle of the distribution (UMIC and LMIC). However, there is a discrepancy between the level of human capital generated by the model and the data for HIC (mostly Western Europe). This can be attributed to the fact that these countries are at the early stages of a transition to higher levels of human capital. Enrollment rates in recent years (the fraction of the population enrolled in college) are in line with the value of skilled workers that our model generates. At the very low end of the distribution (LIC), the model also over predicts the stock of human capital. There are many reasons for this difference.

First, we calibrated our model to the US and the calibration resulted in unskilled workers that are endowed with ten years of education (almost completed high school). Second, we simplified our model and assumed only two levels of skills and that the household has linear preferences resulting in a skill premium that is only a function of parameters and thus constant across countries. These assumptions allow us to isolate the role of institutions.

Another important result is that the model delivers an informal labor force comparable with the data. Informality in our model ranges from around 8% in the US to 69% at the low end of the income distribution. Although frictions generate a drop in output per effective worker, in the model output per effective worker in the Low Income Countries is up to four times higher than what is seen in the data. To understand this result, it is crucial to note that we assume no exogenous technological differences across countries, and that the steady state risk-free rate is also equal across countries generating a similar discrepancy in physical capital per worker ratios (see Table 2.6 below).

In Table 2.6, we present other important aggregate moments across income groups to test our model along different dimensions.

Table 2.6: Differences across Income Groups

	HIC		UMIC		LMIC		LIC	
	Data	Model	Data	Model	Data	Model	Data	Model
Avg Employment Formal	11.1	30.63	129.8	48.30	175	90.68	386.4	103.28
ln (Var employment formal)	10.5	7.1	12.7	8.02	12.7	9.08	13.6	8.71
Capital per worker	1.05	0.94	0.38	0.64	0.18	0.55	0.04	0.54
Formal Entry Rate	0.81	0.75	0.65	0.64	0.62	0.58	0.47	0.57
Business Density	1.62	0.33	0.93	0.28	0.31	0.25	0.03	0.25

Note: Capital per 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). 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 ratio of formal establishment to total population.

The model is on target both on average size, as reported by Alfaro et. al.(2009). Our model predicts that as frictions increase, the exit rate (and the entry rate, by construction) decreases. This implies that for Low Income Countries, firms choose to operate the limited technology, stay in business for much longer, preventing the natural process of churning of unproductive firms. Also, the model generates a relative business density, measured as the number of registered businesses as a percentage of the active population, that is in line with its observed counterpart. The business density drops to 25% of the US's for the Low Income Countries. High frictions generate low density, which generates low competitive pressures in the labor markets, which in turn generates low turnover in the formal sector (as observed by the low entry rate in developing economies), and lower average productivity.

2.6.1 The Role of Each Friction

In this section, we analyze the effects of each friction separately, as well as the joint effect of entry costs and financial frictions. To this end, we analyze changes in institutions from those of the U.S. to those of LMIC. The LMIC parameter values appear to be a natural benchmark for understanding the effect of institutional differences because they are noticeably different from those of the US (our calibrated economy) but are within the observed range. Panel (a) of Table 2.7 shows the impact of institutions on the economy with human capital (our benchmark). In order to understand the role of human capital, Panel (b) of Table 2.7 presents the same counterfactuals in a model without human capital.[24] To complete the analysis, Table 2.8 presents the fraction of the total effect that can be assigned to each friction for both models.

Entry cost: The third column of Table 2.7 reports the effects of changing the formal sector entry cost from the US level to LMIC level. Changes in entry costs affect the productivity threshold that makes firms indifferent between the formal and informal sectors. This change in the productivity threshold causes the informal labor force to increase to 11.7%, and TFP to fall to 0.80%. The percentage of skilled workers decreases by only 1%. The effects are more pronounced in the model with no human capital and they represent a larger fraction of the overall change in TFP and informality (as can be seen in the first column of Table 2.8).

Bankruptcy efficiency: The fourth column of Table 2.7 reports the effect of only changing

[24] The model with no human capital is calibrated to match the same targets that we use in our benchmark calibration. In particular, μ_h and μ_l are adjusted so that the average size of formal firms and the size of the informal sector in the model are consistent with the US values.

Table 2.7: The Role of Each Friction

Panel (a): Model with Human Capital (Benchmark)

	US	κ_{LMIC}	$\{\lambda, \phi\}_{LMIC}$	$\{\kappa, \lambda, \phi\}_{LMIC}$	$\{\tau, c_\tau, \tau_w\}_{LMIC}$	LMIC
Informal labor force (%)	7.80	11.70	10.12	53.28	9.85	69.22
Skilled workers	29.05	28.29	28.79	15.15	28.87	10.03
TFP	1.00	0.80	0.97	0.67	0.99	0.63
$var(\log(MPK))$	0.22	0.21	0.27	0.25	0.22	0.24

Panel (b): Model without Human Capital

	US	κ_{LMIC}	$\{\lambda, \phi\}_{LMIC}$	$\{\kappa, \lambda, \phi\}_{LMIC}$	$\{\tau, c_\tau, \tau_w\}_{LMIC}$	LMIC
Informal labor force (%)	7.80	78.40	27.10	94.28	17.90	95.8
Skilled workers	-	-	-	-	-	-
TFP	1.00	0.79	0.94	0.75	0.97	0.75
$var(\log(MPK))$	0.22	0.26	0.27	0.32	0.24	0.31

Note: US and LMIC denote economies where all parameters are set according to the given country. The following columns present the result from models where all the parameters are set to that of US, except the displayed parameters that are set to LMIC. TFP is reported relative to the US value. Model TFP is calculated as $TFP = \frac{Y}{K^{\hat{\alpha}}H^{1-\hat{\alpha}}}$ where $\hat{\alpha} = 1/3$ is taken from Hall and Jones (1999). See Table 2.4 for group specific parameters.

Table 2.8: Contribution of Each Friction to Overall Effect

	κ_{LMIC}		$\{\lambda, \phi\}_{LMIC}$		$\Delta\{\kappa, \lambda, \phi\}_{LMIC}$		$\{\tau, c_\tau, \tau_w\}_{LMIC}$	
% of Total Effect on	HK	no HK	HK	no HK	HK	no HK	HK	no HK
Informal labor force (%)	6.35	80.06	3.78	21.93	63.92	-3.86	3.34	11.48
Skilled Workers	4.00	-	1.37	-	67.72	-	0.95	-
TFP	54.05	84.00	8.11	24.00	27.03	-8.00	2.70	12.00

Note: "HK" corresponds to the results of the benchmark model with human capital; "No HK" corresponds to the results of a model with no human capital. Each column provides the fraction of the total effect (i.e the difference between LMIC and US) that can be assigned to each friction. The column $\Delta\{\kappa, \lambda, \phi\}_{LMIC}$ presents the complementary effect of $\{\kappa, \lambda, \phi\}_{LMIC}$ computed as the joint effect net of the individual effect of κ_{LMIC} and $\{\lambda, \phi\}_{LMIC}$.

the bankruptcy efficiency parameters in the formal sector from US to LMIC values. We change both the recovery rate λ and the cost of bankruptcy proceedings ϕ. In this case, TFP drops by only 3% and the percentage of skilled workers falls by less than 1%. These effects are partly due to an increase in informal activity, informal labor force increases to 10.7% from 7.8%, but is also due to an inefficient resource allocation within the formal sector. The variance of the log of the marginal product of capital increases by 23%. As in the case of the entry cost, the fraction of the overall change in TFP and informality explained by the individual effect of bankruptcy efficiency is larger in the model without human capital than in our benchmark.

Joint Effect of Entry Costs and Bankruptcy Efficiency: The fifth column of Table 2.7 reports the effects of changing both the formal sector entry costs and the formal sector's bankruptcy efficiency parameters for the formal sector from US to LMIC level (jointly changing κ, λ and ϕ). In our benchmark economy, together the change in entry costs and financial frictions cause the size of the informal sector to increase to 53%. This also causes a decline in TFP of 33%, and the stock of skilled workers as a percentage of the population falls to 15.15%. Interestingly, as can be seen from column $\Delta\{\kappa, \lambda, \phi\}_{LMIC}$ in Table 2.8, we find that in the model with human capital the complementary effect of entry costs and bankruptcy efficiency (i.e. the joint effect net of the sum of the individual effects) accounts for 27%, 64%, and 68% of the total effect in terms of TFP, informal labor force, and the stock of skilled workers respectively as opposed to a small (and even negative) effect in the case of the model with no human capital.[25] This complimentary effect is due to the change in the productivity threshold and the increase in the size of the the informal sector. Entry costs and bankruptcy efficiency frictions reinforce the effects. As the entry costs increase, entrants to the formal sector are more productive, and because productivity is not permanent they want to grow as quickly as possible. However, capital investment is costly due to the financial frictions and substituting capital with labor is also expensive due to the presence of skilled workers and the skill premium that they require. This induces them to move closer to a region of the state space where interest rates are high (i.e. the financial frictions become important). On the other hand, in the model with no human capital it is easier to substitute labor for capital. This is also reflected in the larger variance of the log of marginal product of capital. In short, when human capital is incorporated to the analysis, the joint effect is the main driver explaining TFP differences, the level of informality and

[25] More specifically, the pure complementary effect is taken as the joint effect (reported in column $\{\kappa, \lambda, \phi\}_{LMIC}$ of Table 2.7 minus the sum of the individual effects (reported in columns κ_{LMIC} and $\{\lambda, \phi\}_{LMIC}$) as a fraction of the overall effect (reported in column LMIC).

changes in the stock of skilled workers, and is almost as important as the individual effects of entry costs and bankruptcy efficiency. This is a key result of our paper and is in line with Bergoeing, Loayza, and Piguillem (2011), where they also find that entry costs and exit frictions jointly explain most of the effects of the frictions on output gaps. In their paper, this is due to a technology adoption mechanism, whereas in our paper it happens through the introduction of human capital.

Tax structure: The sixth column of Table 2.7 reports the effects of changing the tax structure parameters in the formal sector from US to LMIC levels (jointly changing τ, c_τ, τ_ω). Note that both with and without human capital, the effects are small in magnitude. From table 2.8 it can be noted that the individual effect of taxes is bigger in the case without human capital (representing around 12% of the total effect). However, the total impact of taxes is the sum of the individual effect plus the joint effect with the other frictions (represented by the complement of all impacts combined in table 2.8). In the case without human capital this effect is negligible and has to do with the fact that taxes on dividends are higher in the US than in the LMIC, but taxes on labor are higher in the LMIC than in the US. In the case with human capital the impact of taxes, while small individually, is higher through its joint effect with the other frictions. The total impact of taxes (individual plus joint) accounts for 10.81%, 25.95% and 26.91% of the gap between the US and LMIC in terms of TFP, informal labor force and skilled workers respectively. This change in the impact of taxes with and without human capital is connected with the mechanisms explained in the case of the joint effect of entry costs and bankruptcy efficiency. With human capital, firms substitute away labor with capital by getting closer to the financial constraint. Therefore, taxes that affect the relative price of labor to capital have a differential impact and the effects of higher labor taxes does not cancel out the one of lower dividend taxes.

In summary, we find that each friction operates through different channels. Entry costs generate a higher informal sector, whereas bankruptcy efficiency produces bigger changes in allocative efficiency. The most interesting result we obtain is that, in the model with human capital, when entry costs and bankruptcy efficiency are considered separately the effects on the informal sector, TFP and the stock of human capital are small. Once these frictions are combined, as shown in Tables 2.7 and 2.8, we get considerable changes in TFP, the size of the informal sector, and the stock of human capital. Institutions are highly complementary only in the presence of human capital. We can see that in the case without human capital the frictions are additive in their effects on TFP and informality (i.e. the combined effect is the same or smaller than the sum of the individual effects), while there is a high degree of complementarity in the case of an economy with human capital.

2.6.2 The Role of Human Capital

In this section, we analyze the contribution of human capital to changes in aggregate productivity and informality. We compare our benchmark economy with two models without human capital in the formal sector production function.[26] First, we present a model without human capital, calibrated to match the US targets: μ_h and μ_l are adjusted so that the average size of formal firms and the size of the informal sector in the model are consistent with the US values. This allows us to make a fair comparison with the benchmark because the starting point (i.e. the US economy) used to evaluate the effects of institutions is quantitatively similar. Second, a model without human capital was computed using the parameters that resulted from our benchmark calibration. This helps us disentangle the endogenous effects vs. the effects coming from differences in parameters.[27] Table 2.9 presents the most relevant statistics.

Table 2.9 shows that without skilled labor in the model, the productivity differences that are needed between the high and low process to match the targets are much smaller (note the different values in columns "No HK(1)" and "Benchmark"). Intuitively, labor is less expensive in the formal sector when firms are not required to hire skilled workers and therefore are not required to pay the skill premium, so the resulting productivity differences to sustain the observed level of informality are smaller.

[26] The parameter ϵ_f is set to zero and the unskilled labor factor share in the formal sector is adjusted so that the total degree of decreasing returns is the same across models.

[27] In all of the models, we first compute the equilibrium for the US and recompute the equilibrium using the institutions for LMIC.

Table 2.9: Counterfactual: No Human Capital

	Data	No HK (1)	No HK (2)	Benchmark
Mean Process μ_h		1.62	3.16	3.16
Mean Process μ_l		0.76	0.69	0.69
Moments U.S. Economy				
Avg. Formal Est.	17.6	17.6	216.28	17.5
Informal Labor Force (%)	7.8	7.8	0.0	7.8
Skilled Labor (%)	30.03	-	-	29.51
Main Results: LMIC				
TFP	0.44	0.75	0.93	0.63
Informal Labor Force	71.7	95.8	0.00	69.22
Output per worker	0.32	0.66	0.84	0.56
var(ln(MPK)) Formal Sector	-	0.27	0.27	0.24

Note: TFP and Output per worker in LMIC are reported relative to the US value. “No HK (1)” corresponds to the results of a model with no human capital that was calibrated to match the average size of formal establishments in the U.S. and the size of the informal sector; “No HK (2)” corresponds to the results of a model with no human capital computed using the parameters from our benchmark model; “Benchmark” corresponds to the results of the model with human capital.

The model without human capital (No HK (1)) generates a decline in TFP of 25% vs. 37% in our benchmark. Thus, incorporating human capital into the model generates a drop in TFP that is 48% larger than a model without human capital accumulation. The third column in the table (model No HK (2)) shows that differences in productivity are not the main driving force. A model with no human capital and large productivity differences generates only a drop in TFP of 7%. Note that this model generates no informal sector, so the drop in TFP is coming from the misallocation of resources in the formal sector, as evident from the value of the variance of the marginal product of capital.

Differences in TFP changes between the “No HK (1)” model and our benchmark are not the result of a larger informal sector. In fact, by adding human capital the model is more in line with the data (69.2% in the model vs.71.7% reported for the median LMIC) and generates a fraction of informal labor that is 28% lower than the “No HK (1)” model. At the calibrated productivity differences, a smaller change in the fraction of firms that ends in the informal sector, compared to the case with no human capital, generates a larger effect on measured TFP. Moreover, as presented in the previous section, in the benchmark economy there is a joint effect of entry costs and financial frictions that is not present when human capital is absent. The model with human capital accumulation generates a smaller dispersion of the marginal product of capital.

2.6.3 The Role of the Informal Sector

In this section, we analyze how the presence of an informal sector affects our results. In particular, we compare our benchmark economy with a model in which firms do not have the option to operate in the informal sector. As in Hopenhayn (1992), potential entrants choose between entering the formal sector or staying out of the market. Table 2.10 presents the results.

Table 2.10: Counterfactual: No Informal Sector Model

	LMIC Data	LMIC Benchmark	LMIC no informal
TFP	0.44	0.63	0.73
Informal Labor force (%)	71.7	69.22	-
Output per worker	0.32	0.56	0.71
Skilled workers (% of pop.)	5.70	10.03	31.93
var(ln(MPK)) Formal Sector	-	0.24	0.24

Note: TFP, Output per worker are reported relative to the US value. “LMIC Benchmark” corresponds to the results of the model with an informal sector (our benchmark results) and “LMIC no informal” corresponds to the results of a model with no informal sector.

The benchmark exercise leads to a 37% decrease in TFP, whereas it only falls by 27% when the informal sector is excluded from the model. Thus, the presence of an informal sector generates a drop in measured aggregate productivity that is 37% larger compared to the model without informality. Similarly, the output per worker falls by 46% in the model with an informal sector, whereas in the model without the informal sector this figure only falls by 29%. There are no quantitatively important differences in the var(ln(MPK)) of formal sector firms.

2.7 Conclusion

The stock of human capital has been related to a country’s level of development. In this paper, we built a firm dynamics model with imperfect capital markets, and measured institutional frictions in order understand the role each formal sector institution plays in generating the observed informal sector, 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 with access to credit markets with better commitment (given by observed recovery rates and associated costs), which leads to sorting into the informal or formal sectors.

We disentangle the effects of each friction (entry costs, taxes, and bankruptcy efficiency), and find that in a model with endogenous human capital, the main determinant of differences in the stock of skilled workers, informality and total factor productivity is the complementarity effect of entry costs and financial frictions. When human capital is absent there is no such complimentary effect. We also find that incorporating human capital into the production sector generates a drop in TFP that is 48% larger compared to the model without human capital. Finally, the introduction of an informal sector generates a drop in measured aggregate productivity of 37%.

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