Intermediation Costs, Investor Protection and Economic Development*

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Abstract

This paper studies the effect of financial repression and contract enforcement on entrepreneurship and economic development. We construct and solve a general equilibrium model with heterogeneous agents, occupational choice and two financial frictions: intermediation costs and financial contract enforcement. Occupational choice and firm size are determined endogenously, and depend on agent type (wealth and ability) and credit market frictions. The model shows that differences across countries in intermediation costs and enforcement generate differences in occupational choice, firm size, credit, output and inequality. Counterfactual experiments are performed for Latin American, European, transition and high growth Asian countries. We use empirical estimates of each country's financial frictions, and United States values for all other parameters. The results allow us to isolate the quantitative effect of these financial frictions in explaining the performance gap between each country and the United States. The results depend critically on whether a general equilibrium factor price effect is operative.

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1 Introduction

Financial intermediation costs and contract enforcement vary considerably across countries and with the level of economic development. For example, Demirgüç-Kunt, Leaven and Levine (2004) document that the net interest margin, which reflects explicit and implicit financial sector taxes (e.g., taxes on financial transactions, intermediary profits or inflation) and bank regulation (e.g., barriers to entry and non-interest-bearing reserve requirements), is over 10% in Belarus, Burundi and Ghana, but less than 2% in the Netherlands and Switzerland.[1] Similarly, data from The World Bank (2005*a*) shows that collateral and bankruptcy laws vary considerably across countries, as does the quality of the judicial system in which the laws are enforced. Seminal research by La Porta, Lopes-de-Silanes, Shleifer and Vishny (1998) shows that institutions that affect contract enforcement are correlated with the level of economic development (see figure 2). We study the quantitative effects of these financial frictions on three measures of macroeconomic development: output per capita, total credit and income inequality.

We construct a general equilibrium model with heterogeneous agents and two financial frictions – limited enforcement and intermediation costs. Agents choose to be either workers or entrepreneurs, as in the Lucas (1978) "span of control" model. We make a key modification by assuming that firms use capital in addition to labor; see Antunes and Cavalcanti (2007). Heterogeneous ability is exogenous, in the sense that the ability to manage a firm productively is drawn from a fixed distribution and is independent within and across generations. Agents choose consumption and capital bequests to maximize preferences subject to lifetime wealth. Bequests thus connect generations across time and the bequest distribution evolves endogenously. We study two capital market frictions: a deadweight cost to intermediate loans and an incentive constraint to ensure loan repayment. The capital of each entrepreneur depends on the profitability of the project and the entrepreneur's net worth. Thus, the most able individuals will not necessarily become entrepreneurs or operate firms of the unconstrained optimal size. Rather, occupational choice and firm size are determined endogenously by an agent's type (ability and bequest) and the credit market frictions.[2]

We calibrate the model economy so that the long run equilibrium matches key statistics of the United States economy. We then explore how the equilibrium properties of the model change with variations in the two policy variables, intermediation costs and the level of contract enforcement. First, we consider benchmark changes in the policy parameters. Next, we use independent estimates of intermediation costs and contract enforcement for Brazil, France, Russia and Singapore, keeping the other parameters at the U.S. level. Through this counterfactual exercise, we evaluate what U.S. output per capita and credit would be if financial contract enforcement and intermediation costs were the same as in, for instance, Brazil.

The effects of these financial market imperfections depend on two opposing forces: a *demand effect* and a *general equilibrium effect.* When intermediation costs increase or enforcement weakens, the demand for loans by entrepreneurs decreases for a given interest rate. This is the demand effect. When the interest rate is exogenous, this is the only effect in the loan market. Consequently, less productive and smaller firms operate because a larger number of these firms is required to clear the labor market. When the interest rate is endogenous, a fall in the demand for loans decreases the

[1] The net interest margin is a measure of the wedge between borrowing and lending rates. See figure 2.

[2] Antunes, Cavalcanti and Villamil (2007) prove the existence of a unique stationary equilibrium that is fully characterized by a time invariant bequest distribution and associated equilibrium factor prices. From any initial bequest distribution and any interest rate, convergence to this unique invariant bequest distribution occurs. They also describe a direct, non-parametric approach to compute the stationary solution.

interest rate. A lower interest rate implies higher capital, productivity, and firm size. This is the general equilibrium effect, and the overall effect of a change depends on the two opposing forces.

Our simulations show that the quantitative effect of financial reform depends critically on the interest rate. For instance, when financial contract enforcement and intermediation costs change from the U.S. to the Brazilian level, output per capita decreases by roughly 43 percentage points when the interest rate is fixed (this is about half of the difference in output per capita between Brazil and the United States),[3] but by only 6.3 percentage points when the interest rate is determined endogenously. The general equilibrium factor price effect is quantitatively significant. The effect of financial reform on entrepreneurs' income inequality is also striking. When the interest rate is fixed, financial reform decreases borrowing costs. Fewer but more able managers become entrepreneurs, and this is more efficient. Inequality increases because more able managers operate firms. When the interest rate is endogenous it increases after an identical financial market reform. This offsets the loan demand effect, especially for able but capital constrained entrepreneurs at the upper tail of the entrepreneurial income distribution. Finally, we check the robustness of our results by assuming that a significant fraction of output is produced by non-financially constrained firms, which form a 'corporate sector' (see Quadrini, 2000). Interestingly, adding this unconstrained sector augments the capital market distortions because the frictions increase the amount of capital used by this sector, but not necessarily more productively than by some credit constrained entrepreneurs.

The paper proceeds as follows. Section 2 describes the model. Section 3 considers the occupational choice problem. Section 4 describes the model calibration. Section 5 contains policy experiments designed to evaluate the effects of benchmark changes in the two financial frictions. Section 6 performs counterfactual experiments for selected countries. Section 7 analyzes the economy with a financially unconstrained corporate sector and compares it with the baseline model. Finally, section 8 concludes.

2 The model

Consider an economy with a continuum of measure one individuals. Each individual lives for one period and reproduces another such that population is constant. Time is discrete and infinite ($t = 0, 1, 2, ...$). There is one good that can be used for consumption or production, or left to the next generation as a bequest.

2.1 Preferences, endowments and technology

Preferences: Agents care about their own consumption and leave a bequest to their offspring. Let c_t^i and z_{t+1}^i denote consumption and bequests, respectively, by agent i in period t, with

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

The utility function implies that agents are risk-neutral with respect to income as the indirect utility function is linear in wealth. This implies that any additive punishment or reward in utility may be measured in terms of income. For tractability, we assume that preferences are for the bequest and not the offspring's utility.[4]

[3] Interestingly, intermediation costs and contract enforcement can explain most of the difference in output per capita and total private credit as a share of output between France and the United States.

[4] For a similar formulation, see Banerjee and Newman (1993) and Lloyd-Ellis and Bernhardt (2000).

Endowments: Each agent is endowed with an initial wealth, b_t, inherited from the previous generation. An individual can be either a worker or an entrepreneur. Entrepreneurs create jobs and manage their labor force, n. As in Lucas (1978), each individual is endowed with a talent for managing, x^i, drawn from a continuous cumulative probability distribution function $\Gamma(x)$ where $x \in [0,1]$. Thus, in each period agents are distinguished by their initial bequest and ability as entrepreneurs, (b_t^i, x_t^i). We assume that an agent's talent for managing is not hereditary and (b_t^i, x_t^i) is public information. In the remainder of the paper we drop agent superscript i.

Production sector: Managers operate a technology that uses labor, n, and capital, k, to produce a single consumption good, y, that is represented by

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

Capital fully depreciates between periods. Managers can operate only one project.

The capital market: Agents have two options in which to invest their initial wealth:

- Financial Intermediaries: Agents can competitively rent capital to financial intermediaries (banks) and earn an endogenously determined interest rate, r.
- Private Equity: Agents can use their own capital as part of the amount required to start a business. They borrow the remaining capital they require from a bank at interest rate r_B.

Competition among banks implies that the effective interest rate on borrowing is $r_B = r + \tau$, where τ reflects transaction costs such as explicit and implicit financial sector taxes (e.g., taxes on financial transactions, bank profits or inflation), or bank regulations (e.g., reserve and liquidity requirements). For expositional and computational purposes, we use the equivalent setting where all agents deposit their initial wealth in a bank and earn return r. The banks lend these resources to entrepreneurs, who use their initial wealth as collateral for the loan. The interest rate on the part of the loan that is fully collateralized is r, while the rate on the remainder is r_B.

We assume that borrowers cannot commit *ex-ante* to repay. Those that default on their debt incur a cost equal to percentage ϕ of output net of wages. This is equivalent to an additive utility punishment. This penalty reflects the strength of contract enforcement in the economy.[5]

3 Optimal behavior and equilibrium

3.1 Entrepreneurs

Agents who have sufficient resources and managerial ability to become entrepreneurs choose the level of capital and the number of employees to maximize profit subject to a technological constraint and (possibly) a credit market incentive constraint. Let us first consider the problem of an entrepreneur for a given level of capital k and wages w:

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

which yields the labor demand of each entrepreneur:

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

[5] A proportional punishment is standard. See Krasa and Villamil (2000) and Krasa, Sharma and Villamil (2007).

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

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

Let a be the amount of self-financed capital (or, equivalently, the part of the loan that is fully collateralized by the agent's personal assets), and l be the amount of funds borrowed from a bank (or, equivalently, the amount of the loan that is not collateralized).

Unconstrained Problem. When initial wealth is sufficient for the agent to start her own business without resorting to credit finance (i.e., $b > a$ and $l = 0$), entrepreneurs solve the problem

$$\max_{k \geq 0} \pi(k, x; w) - (1+r)k. \tag{6}$$

This gives the optimal physical capital level:

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

There is no credit market incentive constraint because when the firm is entirely self-financed, no repayment problem exists.

Constrained Problem. Now consider the case where the entrepreneur's initial wealth may not be sufficient to finance the firm (i.e., $b \leq a$ and $l \geq 0$); the entrepreneur may wish to obtain loans from the credit market. Since agents cannot commit to repay, loan contracts must be self-enforcing.

The entrepreneur now maximizes the net income from running the project

$$V(b, x; w, r) = \max_{a \geq 0,\ l \geq 0} \pi(a+l, x; w) - (1+r)a - (1+r+\tau)l \tag{8}$$

subject to the credit market incentive constraint and feasibility

$$\phi\pi(a+l, x; w) \geq (1+r+\tau)l \tag{9}$$

$$b \geq a. \tag{10}$$

Incentive compatibility constraint (9) guarantees that *ex-ante* repayment promises are honored (the percentage of profits the financial intermediary seizes in default is at least as high as the repayment obligation). See Kehoe and Levine (1993). We can rewrite this constraint as

$$l(b, x; w, r) \leq \frac{\phi}{1+r+\tau} \pi(k(b, x; w, r), x; w).$$

The policy parameters affect loan size: Penalty ϕ has a direct effect; better enforcement ($\phi \to 1$) increases loan size.[6] Intermediation cost τ has an indirect effect via the interest rate wedge.

Feasibility constraint (10) states that the amount of self finance, a, cannot exceed bequest, b.

The constrained problem yields optimal policy functions $a(b, x; w, r)$ and $l(b, x; w, r)$ that define the size of each firm,

$$k(b, x; w, r) = a(b, x; w, r) + l(b, x; w, r).$$

There are four types of solutions to the entrepreneur's problem:

[6] See Quintin (2001) and Guner, Ventura and Yi (2004) for the effect of policies on firm size distributions.

Case 1. No constraint binds. The entrepreneur self-finances and does not borrow ($b > a > 0$, $l = 0$).

Case 2. (10) binds ($a = b > 0$), (9) does not, but $l = 0$. The entrepreneur uses all wealth to self-finance and does not borrow.

Case 3. (10) binds ($a = b > 0$), (9) does not, and $l > 0$. The entrepreneur uses all wealth to self-finance and borrows additional funds from the bank.

Case 4. Both constraints bind. The entrepreneur uses all wealth to self-finance ($a = b$) and borrows ($l > 0$) from the bank, but is credit constrained, $\phi\pi(a + l, x; w) = (1 + r + \tau)l$.

Entrepreneurs invest their entire wealth in their firm as long as $b \leq k^*(x; w, r)$. This follows immediately from the fact that the cost of self-finance is lower than using a financial intermediary. This implies that firm size k of an entrepreneur (b, x) is such that

$$k \leq b + \frac{\phi}{1 + r + \tau}\pi(b + l, x; w). \tag{11}$$

We omit the arguments of k and l for readability. Thus, firm size is limited by an agent's inheritance, b, and the capital market frictions, τ and ϕ.

3.2 Occupational choice

The occupational choice of each agent defines his lifetime income. Define $\Omega = [0, \infty) \times [\underline{x}, \overline{x}]$. For any $w, r > 0$, an agent (b, x) will become an entrepreneur if $(b, x) \in E(w, r)$, where

$$E(w, r) = \{(b, x) \in \Omega : V(b, x; w, r) \geq w\}. \tag{12}$$

The complement of $E(w, r)$ in Ω is $E^c(w, r)$. If $(b, x) \in E^c(w, r)$, then agents are workers. The following lemma characterizes occupational choice for a given bequest and entrepreneurial ability.

Lemma 1 *Define $b_e(x; w, r)$ as the curve in set Ω such that $V(b, x; w, r) = w$. Then there exists an $x^*(w, r)$ such that $\frac{\partial b_e(x;w,r)}{\partial x} < 0$ for $x > x^*(w, r)$ and $\frac{\partial b_e(x;w,r)}{\partial x} = -\infty$ for $x = x^*(w, r)$.*

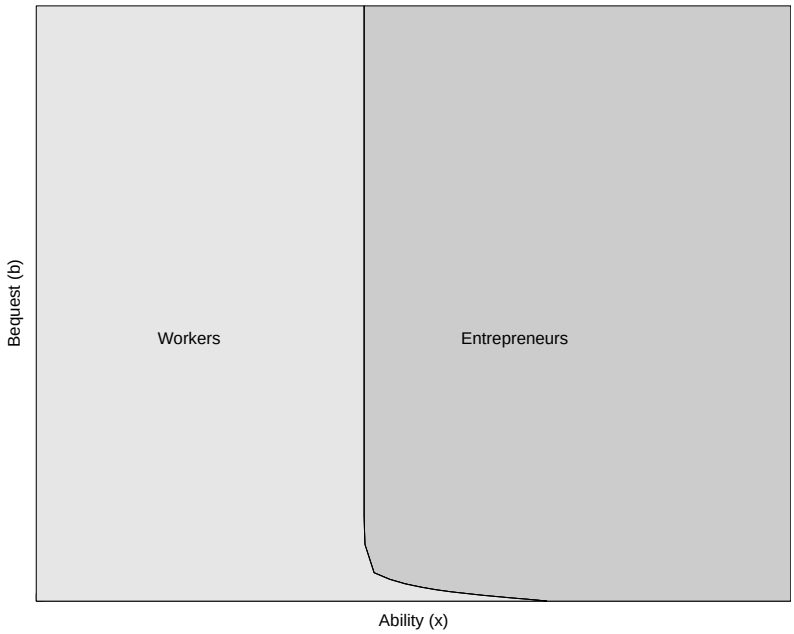
1. *For all x, if $b < b_e(x; w, r)$, then $(b, x) \in E^c(w, r)$.*

2. *For all x, if $b \geq b_e(x; w, r)$, then $(b, x) \in E(w, r)$.*

Proof. See lemma 2 of Antunes et al. (2007). ■

Figure 1 shows occupational choice in (b, x) space for the baseline economy in section 4. Lemma 1 and figure 1 indicate that agents are workers when the quality of their project is low, i.e., $x < x^*(w, r)$ (the lightest shaded area). For $x \geq x^*(w, r)$ agents may become entrepreneurs, depending on whether or not they are credit constrained. If bequests are very low, agents are workers even though their entrepreneurial ability is higher than $x^*(w, r)$. The negative association between $b_e(x; w, r)$ and x suggests that managers with better managerial ability need a lower level of initial wealth to run a firm. This is intuitive since profits are increasing in managerial ability.

Figure 1: Occupational choice.



3.3 Consumers

In period t, the lifetime wealth of an agent characterized by (b_t, x_t) is given by

$$Y_t = Y(b_t, x_t; w_t, r_t) = \max\{w_t, V(b_t, x_t; w_t, r_t)\} + (1 + r_t)b_t. \tag{13}$$

Lifetime wealth is thus a function of agent-specific b_t and x_t, and economy-wide w_t and r_t. Given lifetime wealth, (13), agents choose consumption and bequests to maximize preferences (1). This problem defines optimal consumption, $c_t = c(Y_t)$, and bequest, $z_{t+1} = b(Y_t)$, policies. The functional form of (1) implies that agents leave a proportion $1-\gamma$ of their lifetime wealth as a bequest. Bequests cannot be negative because every agent can become a worker.

3.4 Competitive equilibrium

Let Υ_t be the bequest distribution at period t, which evolves endogenously across periods. The initial bequest distribution, Υ_0, is exogenously given. In a competitive equilibrium, agents optimally solve their problems and all markets clear. The agents' optimal behavior was previously described in detail. It remains, therefore, to characterize the market equilibrium conditions.[7] Since the consumption good is the numeraire we need two market clearing conditions to determine the wage rate and the interest rate. The labor and capital market equilibrium equations are:

$$\iint\limits_{z \in E(w_t, r_t)} n(x; w_t, r_t)\Upsilon_t(db)\Gamma(dx) = \iint\limits_{z \in E^c(w_t, r_t)} \Upsilon_t(db)\Gamma(dx) \tag{14}$$

$$\iint\limits_{z \in E(w_t, r_t)} k(b, x; w_t, r_t)\Upsilon_t(db)\Gamma(dx) = \iint b\Upsilon_t(db)\Gamma(dx). \tag{15}$$

[7] See Antunes et al. (2007) for a formal definition of the competitive equilibrium.

Table 1: Parameter values, baseline economy.

Parameters	Values	Comment/Observations
β	0.55	Labor share based on Gollin (2002)
α	0.35	Capital share based on Gollin (2002)
τ	0.005	Intermediation cost based on Demirgüç-Kunt and Huizinga (1999)
γ	0.94	Calibrated to match the U.S. historical Post-War return on government bonds (about 2%, International Financial Statistics)
ϕ	0.26	Calibrated to match the percent of entrepreneurs over the total population (about 9%) based on Quadrini (1999)
ϵ	4.422	Calibrated to match the entrepreneurial earnings Gini index of 45% (see Quadrini (1999))

Given that the only connection between periods is the bequest, it is essential to provide the law of motion for the distribution of bequests to fully characterize the competitive equilibrium. Define $P_t(b_t, A) = \Pr\{z_{t+1} \in A | b_t\}$ as a non-stationary transition probability function, which assigns a probability for a bequest in $t+1$ for the descendant of an agent that has bequest b_t. The law of motion of the bequest distribution is

$$\Upsilon_{t+1} = \int P_t(b, A)\Upsilon_t(db). \tag{16}$$

In the quantitative exercises it is important to evaluate policy experiments in "stable" economies, where the real wage, interest rate and income distribution do not change significantly over time. Antunes et al. (2007) show that when policies and institutions are stationary a unique steady-state equilibrium exists (i.e., an equilibrium with a constant real wage and interest rate, w and r, and invariant distribution, $H = \Upsilon\Gamma$); from any initial condition the economy converges to this equilibrium.

Proposition 2 *There exists a unique stationary equilibrium with $w > 0$, $r - 1 < \infty$ and invariant distribution Υ. In addition, for any initial bequest distribution Υ_0, interest rate $0 < r - 1 < \infty$, and stationary credit market frictions (τ, ϕ), the bequest distribution converges to Υ.*

Proof. See Proposition 2 in Antunes et al. (2007). ■

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

4 Measurement

In order to study the quantitative effect of financial repression and contract enforcement on entrepreneurship and economic development, we must assign values to the model parameters and specify a functional form for the distribution of managerial ability. Our strategy is to calibrate the model economy such that the long run equilibrium matches some key statistics of the U.S. economy. We assume that the cumulative distribution of managerial ability is given by $\Gamma(x) = x^{\frac{1}{\epsilon}}$.[8]

[8]Chaterjee, Corbae, Nakajima and Ríos-Rull (2002) have shown that this functional form can generate an earnings distribution that is similar to the U.S. distribution.

Table 2: Basic statistics, U.S. and baseline economy. Sources: International Financial Statistics database, Demirgüç-Kunt and Huizinga (1999), Quadrini (1999), Maddison (1995), and World Development Indicators database.

	U.S. economy	Baseline economy
Yearly real interest rate (%)	2.0	2.0
Tax as a percentage of total bank assets (%)	0.50	0.50
% of entrepreneurs (%)	9.0	8.8
Entrepreneurs' income Gini (%)	45	45.35
Capital to output ratio	2.5	2.24
Private credit as a share of GDP	1.98	2.02

When ϵ is equal to one, entrepreneurial talent is uniformly distributed in the population. When ϵ is greater than one the talent distribution is concentrated among low talent agents. We define the model period to be 35 years. Table 1 lists the value of each parameter and includes a comment on how each was selected.[9] We set α and β such that about 55% of income is paid to labor, 35% is paid to the remuneration of capital, and 10% are profits.[10] We use tax as a percentage of total bank assets to measure intermediation costs, which in the United States is 0.5%.[11]

We must determine the value of three remaining parameters: The fraction of total income that is left to the next generation, $1-\gamma$, the strength of financial contract enforcement, ϕ, and the curvature of the entrepreneurial ability distribution, ϵ. We choose these three parameters such that in the baseline model the real interest rate is 2%,[12] the percent of entrepreneurs over the total population is about 9%, and the Gini index of entrepreneurial earnings is about 45%, see Quadrini (1999). The calibrated value of γ that matches the historical risk-free rate of return on government bonds in the United States is 0.94. This value suggests that agents in general leave about 6% of lifetime wealth as inheritance to the next generation. Gokhale and Kotlikoff (2000) estimate that bequests account for 4 to 8% of labor compensation. In the steady state of our model the ratio of bequests to labor earnings is $\frac{1-\gamma}{1-(1-\gamma)(1+r)} = 0.065$, which is in the interval estimated by Gokhale and Kotlikoff (2000). The value of ϕ in the baseline economy is 0.26. Cagetti and De Nardi (2006) calibrate an enforcement parameter $1-f$ that is conceptually identical to ϕ using a different model and U.S. data. They find that $1-f=0.25$, which is similar to our calibrated measure.

The model matches the U.S. economy fairly well along a number of dimensions that were calibrated (the first four statistics in table 2), as well as some statistics that were not calibrated,

[9] Appendix A contains sensitivity analysis for each parameter. The results are robust to all parameters except utility parameter γ, which determines bequests.

[10] Gollin (2002) argues that it is important to adjust factor income shares by entrepreneurial income, which is often treated incorrectly as the capital income share. If we include entrepreneurial profits as labor income as suggested by Gollin, the effective labor and capital income shares will be 0.65 and 0.35, respectively. These income shares are those that map our model to those observed in the U.S. national accounts. If we use another adjustment suggested by Gollin, which assumes that entrepreneurial income is the same mix of labor and capital income as in the rest of the economy, the effective labor and capital income shares will be roughly 0.61 and 0.39, respectively. In any case, the effective labor income share will be in the range estimated by Gollin, 0.60 to 0.80.

[11] See Demirgüç-Kunt and Huizinga (1999). A model period corresponds to 35 years, thus the target intermediation cost in our model is $\tau_{\text{model}} = (1+0.005)^{35} - 1 = 0.1907$.

[12] We define the real interest rate by the nominal U.S. T-Bill rate minus the realized inflation rate. The average yearly real rate from 1960 to 2000 in the International Financial Statistics (IFS) database is 2%. Since the model period is 35 years, the model interest rate is $(1+0.02)^{35} - 1 = 1$.

Table 3: Policy Experiments: Intermediation cost. ϕ_{base} and τ_{base} denote the baseline parameter values.

	Output per capita, % baseline	Wage, % baseline	% of entrepreneurs	Credit to output ratio	Entrepreneurs' income Gini	Interest rate
Part (a): Exogenous interest rate, r. Enforcement parameter, $\phi_{\text{base}} = 0.26$						
Baseline	100.00	100.00	8.80	2.02	45.35	1
$\tau = 2 \times \tau_{\text{base}}$	95.14	95.35	8.94	1.82	45.20	1
$\tau = 4 \times \tau_{\text{base}}$	85.24	85.90	9.34	1.46	44.83	1
Part (b): Endogenous interest rate, r. Enforcement parameter, $\phi_{\text{base}} = 0.26$						
$\tau = 2 \times \tau_{\text{base}}$	98.06	99.25	8.85	2.01	45.51	0.80
$\tau = 4 \times \tau_{\text{base}}$	93.70	96.70	9.08	1.98	46.10	0.33

such as the capital to output ratio and total private credit as a share of output. According to Maddison (1995) the capital to output ratio in the U.S. is roughly 2.5, while in the model it is 2.24. Data from the World Bank Development Indicators show that over the last 15 years the average total private credit as a share of income in the U.S. was about 1.98, while in the model it is 2.02. The model does not match the income Gini: the model income Gini is roughly 33%, while in the data it is 40-44%. However, since every worker receives the same equilibrium wage rate in the model economy, it follows that it should underestimate its real world counterpart.[13]

5 Quantitative Experiments

We now explore how the equilibrium properties of the model change with benchmark variations in intermediation costs and contract enforcement. We vary the parameters separately, and then run experiments in which we change both simultaneously. In all cases we examine the model's predictions along six dimensions: output per capita as a fraction of U.S. output per capita, the wage rate as a fraction of the baseline value, the percentage of the population that are entrepreneurs, private credit as a share of output, the entrepreneurs' income Gini coefficient, and the interest rate. All statistics correspond to the steady-state equilibrium of the model.

5.1 Intermediation Costs: τ

Table 3 describes the model's predictions as the value of the intermediation cost parameter is changed. A rise in τ has two effects: First, entrepreneurs decrease the demand for loans for a given interest rate, since the cost of borrowing has increased. This is the *demand effect*. When the interest rate is exogenous, this is the only effect on the loan market. The decrease in loan size lowers the capital input, and a greater number of small firms is required to clear the labor market. More people choose to become entrepreneurs and self-finance their projects, but these additional projects are generally less productive and smaller because they are run by less able managers with smaller bequests. Second, when the interest rate is endogenous, a fall in the demand for outside finance decreases the interest rate. A lower interest rate implies higher capital, higher productivity

[13] We could have added labor income shocks to increase the income Gini. This would increase the complexity of the model without adding any new insights to the results.

Table 4: Policy Experiments: Enforcement. ϕ_{base} and τ_{base} denote the baseline parameter values.

	Output per capita, % baseline	Wage, % baseline	% of entrepreneurs	Credit to output ratio	Entrepreneurs' income Gini	Interest rate
	Part (a): Exogenous interest rate, r. Intermediation cost parameter, $\tau_{\text{base}} = 0.005$					
Baseline	100.00	100.00	8.80	2.02	45.35	1
$\phi = \frac{1}{2} \times \phi_{\text{base}}$	75.53	72.71	10.84	0.94	45.30	1
$\phi = \frac{1}{4} \times \phi_{\text{base}}$	57.57	55.32	12.88	0.46	43.29	1
$\phi = \frac{1}{20} \times \phi_{\text{base}}$	39.03	38.23	15.94	0.09	38.46	1
$\phi = 1$	132.52	169.41	4.85	7.99	33.01	1
	Part (b): Endogenous interest rate, r. Intermediation cost, $\tau_{\text{base}} = 0.005$					
$\phi = \frac{1}{2} \times \phi_{\text{base}}$	98.16	99.25	9.75	1.96	48.24	-0.07
$\phi = \frac{1}{4} \times \phi_{\text{base}}$	96.90	98.65	10.24	1.94	49.68	-0.61
$\phi = \frac{1}{20} \times \phi_{\text{base}}$	74.10	61.2	11.8	1.12	49.7	-1
$\phi = 1$	103.29	100.00	4.84	2.13	29.86	4.69

and larger firm size. This is the *general equilibrium effect*. When the interest rate is endogenous, the overall effect on the economy of a rise in τ depends on these two opposing forces.

Quantitatively, when the interest rate is exogenous and τ is quadrupled relative to the baseline, entrepreneurs rise to 9.34%, output per capita falls to 85.24% of the baseline value, and the outside credit to output ratio falls from 2.02 to 1.46. When the interest rate is endogenous, there is a sharp decrease in r due to the general equilibrium effect. Output per capita falls to 93.70% of its baseline value and the change in the credit to output ratio is small, decreasing by only 2% while in the exogenous case it decreases by 28%. When r is fixed, all the adjustment is done by the loan quantity, as the credit to output ratio shows. When r is endogenous, the quantity adjustment in the loan market is much smaller due to factor price movement. The difference in entrepreneurial income inequality is also striking. When r is exogenous there are more but less productive entrepreneurs, leading to a decrease in income inequality. When r is endogenous, a falling interest rate increases the size of projects that can be financed, increasing the income of entrepreneurs at the upper tail of the income distribution. However, higher intermediation costs increase the cost of borrowing and therefore have a negative impact on the income of credit constrained entrepreneurs, who in general are in the lower tail of the income distribution.

5.2 Investor Protection: ϕ

Table 4 shows that as the level of enforcement decreases ($\phi \to 0$), output per capita and the credit to output ratio decrease. There are more entrepreneurs in the economy, but they are less productive. The effects are again stronger when the interest rate is exogenous than when it is endogenous. Weaker contract enforcement means that the demand for loans will fall for a given interest rate; see equation (9). Therefore, entrepreneurs decrease working capital and firm size shrinks. For the labor market to clear, more but less productive entrepreneurs enter. This is the demand effect, and it is the only effect in the economy when the interest rate is exogenous. When the interest rate is endogenous, the general equilibrium effect is also operative: a decrease in the demand for borrowing decreases the interest rate, which in turn implies a higher demand for loans. Higher ability entrepreneurs can be funded at lower cost, increasing productivity and firm size.

Table 5: Policy Experiments: Intermediation cost & Enforcement. ϕ_{base}, τ_{base} are baseline parameters.

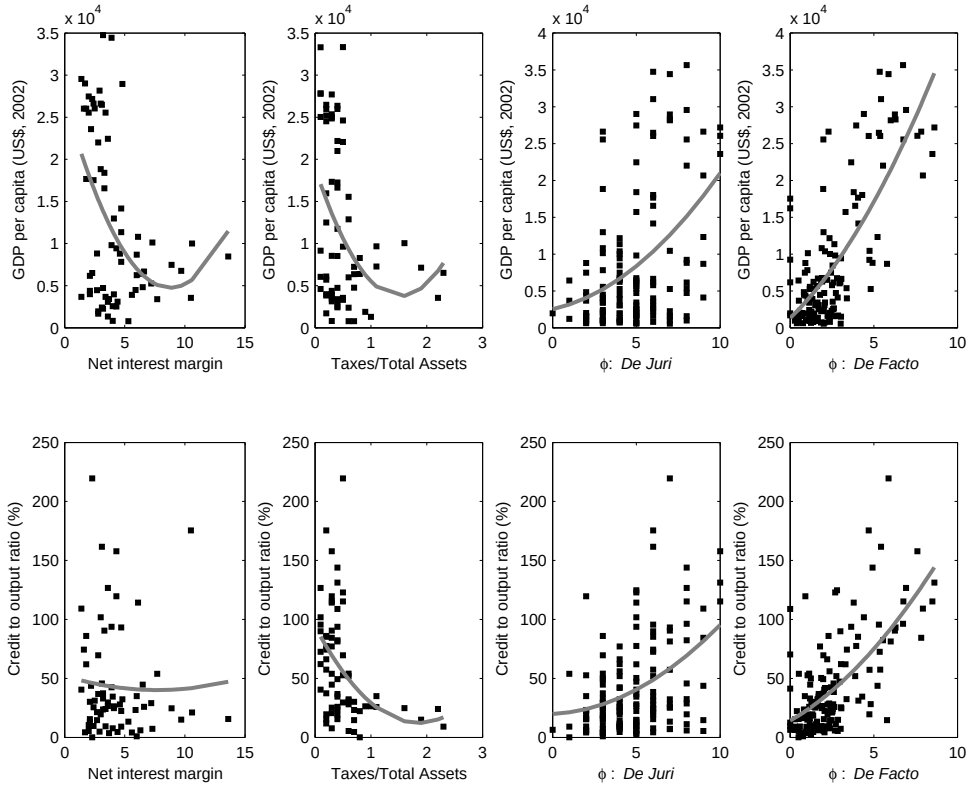
	Output per capita, % baseline	Wage, % baseline	% of entrepreneurs	Credit to output ratio	Entrepreneurs' income Gini	Interest rate
Part (a): Exogenous interest rate, r.						
Baseline	100.00	100.00	8.80	2.02	45.35	1
$\tau = 2 \times \tau_{\text{base}}$, $\phi = \frac{1}{2} \times \phi_{\text{base}}$	72.13	69.71	11.05	0.86	45.05	1
$\tau = 4 \times \tau_{\text{base}}$, $\phi = \frac{1}{4} \times \phi_{\text{base}}$	51.36	49.77	13.59	0.21	41.81	1
Part (b): Endogenous interest rate, r.						
$\tau = 2 \times \tau_{\text{base}}$, $\phi = \frac{1}{2} \times \phi_{\text{base}}$,	96.22	98.50	9.84	1.91	48.49	-0.27
$\tau = 4 \times \tau_{\text{base}}$, $\phi = \frac{1}{4} \times \phi_{\text{base}}$	71.51	75.75	11.55	1.88	49.00	-1

We also investigate two limiting cases, $\phi = \frac{1}{20} \times \phi_{\text{base}}$ (virtually no enforcement) and $\phi = 1$ (perfect enforcement). When the interest rate is exogenous, output per capita is roughly 39% and 132% of the baseline economy value with virtually no enforcement and perfect enforcement, respectively. Therefore, a typical agent in an economy with full enforcement is about 4.5 times richer than a typical agent in an economy with virtually no enforcement of financial contracts. The difference in output per capita is much smaller (a factor of about 1.3) when the interest rate is endogenous. We can conclude that although financial contract enforcement, ϕ, can generate important variations in output per capita, it alone cannot account for the fact that incomes in the richest countries are 30 times higher than in the poorest; see Parente and Prescott (2000).

5.3 Intermediation Costs and Investor Protection: τ, ϕ

Table 5 reports results of experiments in which both enforcement and intermediation costs are changed. When ϕ and τ both worsen by a factor of four, output per capita decreases by about 49% when the interest rate is exogenous and 29% when it is endogenous. This result is consistent with our previous finding that the demand effect is significant, but it is offset by factor price movements associated with the general equilibrium effect when the interest rate is endogenous. Our model predicts that negative real interest rates can occur when the interest rate is endogenous, a result that may seem odd (see the last columns of tables 4 and 5). This result is consistent with the negative interest rates observed in repressed financial markets (i.e., closed economies with low investor protection and high intermediation costs). Calomiris and Beim (2000) document that Latin America, North Africa and the Middle East had real interest rates ranging from -10% to 0% until the burst of financial liberalization in the 1990s. Real interest rates in these regions then increased to the level observed in industrialized countries and East Asia. Similarly, the average real interest rate in transition countries reached -35% in 1993, and has increased to the level observed in industrialized countries. When financial reform decreases the cost of outside finance, talented entrepreneurs are able to start firms and operate them at higher, more productive scales. There are fewer, but more productive, entrepreneurs. As a result, output and inequality increase.

Figure 2: Financial repression, legal enforcement, GDP per capita, and private credit to output ratio. Net interest margin and intermediary taxes over total assets are from Demirgüç-Kunt and Huizinga (1999). *De juris* ϕ is the Legal Rights Index from The World Bank (2005*a*) data. *De facto* ϕ is the Legal Rights Index times the Rule of Law (see Kaufmann et al. (2003)). GDP per capita and private credit over output are from The World Bank (2005*b*). GDP per capita is in 2002 US$ adjusted for PPP. Countries were selected based on data availability. The solid line is the best second order polynomial fit.



6 Counterfactual Analysis

The previous experiments describe quantitative properties of the model for systematic variations in financial contract enforcement and intermediation costs. We now use independent estimates of intermediation costs and contract enforcement for several representative countries, keeping the other parameters at the U.S. level. The purpose of this counterfactual exercise is to investigate what the level of U.S. output per worker would be if financial contract enforcement and intermediation costs were the same as in, for instance, Russia.[14] This gives an estimate of how much of the difference in output per worker between Russia and the U.S. can be accounted for by differences in financial market imperfections. We discuss Brazil, France, Russia and Singapore in detail, as representatives of Latin America, Europe, a transition country and a high growth Asian country. In the Appendix, we report detailed results for Argentina, Chile, Germany, Hong Kong, Italy, South Korea, Poland and the U.K., and in figures 3 and 4 we summarize results for 25 countries.

For each country, we feed in independent estimates of intermediation costs and contract enforcement and compare the model's predictions with the relevant country data. Intermediation

[14]We do not assume that the other parameters in Russia are the same as those observed in the U.S. Our goal is to isolate the effects of intermediation costs and enforcement. As our sensitivity analysis shows, the results might be different if, for instance, the share of bequests over earnings, $1-\gamma$ is very different in Russia than in the U.S.

costs are measured as intermediary taxes over banks' total assets: 1.1% in Brazil, 0.2% in France, 1.9% in Russia and 0.5% in Singapore.[15] Figure 2 shows that the relationship between per capita output and either the net interest margin or intermediary taxes is similar. The relationship between the credit to output ratio and intermediary taxes is stronger than the net interest margin relationship. Because we model τ as a deadweight loss, figure 2 verifies that intermediary taxes is the appropriate measure in our model. Estimates of the contract enforcement parameter are based on Djankov, McLiesh and Shleifer (2005) and The World Bank (2005*a*). We use two methods to assess enforcement parameter ϕ: a *de juris* measure based on the written laws of a country and a *de facto* measure to account for how laws are likely to be enforced. Figure 2 shows that these two measures are qualitatively similar, but we now consider their quantitative significance.

6.1 *De juris* ϕ

For the *de juris* measure we use a legal rights index which indicates the degree to which collateral and bankruptcy laws facilitate lending. This index follows previous work by La Porta et al. (1998), and includes seven aspects of collateral law and three aspects of bankruptcy law.[16] The index ranges from 0 to 10, with higher scores indicating that collateral and bankruptcy laws are better designed to promote access to credit. To determine the parameter estimate for ϕ, we multiply the ratio of the legal rights index of a country to the U.S. value by the baseline $\phi = 0.26$. For Brazil, the corresponding value is $\phi = 0.074$. France and Russia have the same value of $\phi = 0.11$, while in Singapore the estimated value is $\phi = 0.37$.

Table 6 shows that when the interest rate is exogenous, contract enforcement and intermediation costs alone explain roughly half of the difference in output per capita between Brazil and the U.S., and almost the whole difference in total private credit as a share of GDP. When the interest rate is endogenous, financial market imperfections explain only a small part of the difference in output per capita, but a large part of the difference in the credit to output ratio. Simulations using Russian data yield similar results. Interestingly, when the interest rate is exogenous, intermediation costs and financial contract enforcement explain all the difference in output per capita and the credit to output ratio between France and the U.S.

Singapore is particularly interesting because measured enforcement of financial contracts is higher than in the U.S., but output per capita is 32% lower. When the interest rate is exogenous our model indicates that output per worker would be 13% higher in the U.S. if contract enforcement were similar to Singapore. Two alternatives may account for the discrepancy between the model predictions and data for Singapore: i) Other factors (e.g., total factor productivity or differences in bequests in Singapore and the U.S., as measured by parameter $1-\gamma$) may explain why Singapore has higher contract enforcement, but lower output per capita and credit over output than the U.S. ii) Creditor protection and total credit (productivity) may not have a monotonic relation as assumed in Kehoe and Levine (1993) type models, where borrowers have an incentive to default if the punishment is less than the debt repayment obligation. Lenders know this, and rationally limit the supply of credit. Higher creditor protection leads to a higher credit supply; there is no default

[15] Intermediation costs can also be measured by the net interest margin, which Demirgüç-Kunt and Huizinga (1999) decompose into its constituent parts: non-interest income, overhead costs, taxes, loan loss provision, and after tax bank profits. Since τ is a deadweight loss in our model, and some of these components need not be, we use Taxes/Total Assets. Figure 5 in appendix A shows that the net interest margin of country j relative to the net interest margin in the U.S. has a strong positive correlation with the intermediary taxes of country j relative to the intermediary taxes of the U.S. Quantitative simulations are therefore similar for both cost measures.

[16] The index contains data on the duration of time to enforce a contract and costs (court and attorney fees) across countries. The legal rights index is: Brazil 2, France and Russia 3, Singapore 10 and U.S. 7.

Table 6: *De juris* ϕ. Empirical Data and Model Predictions for Reference Economies.

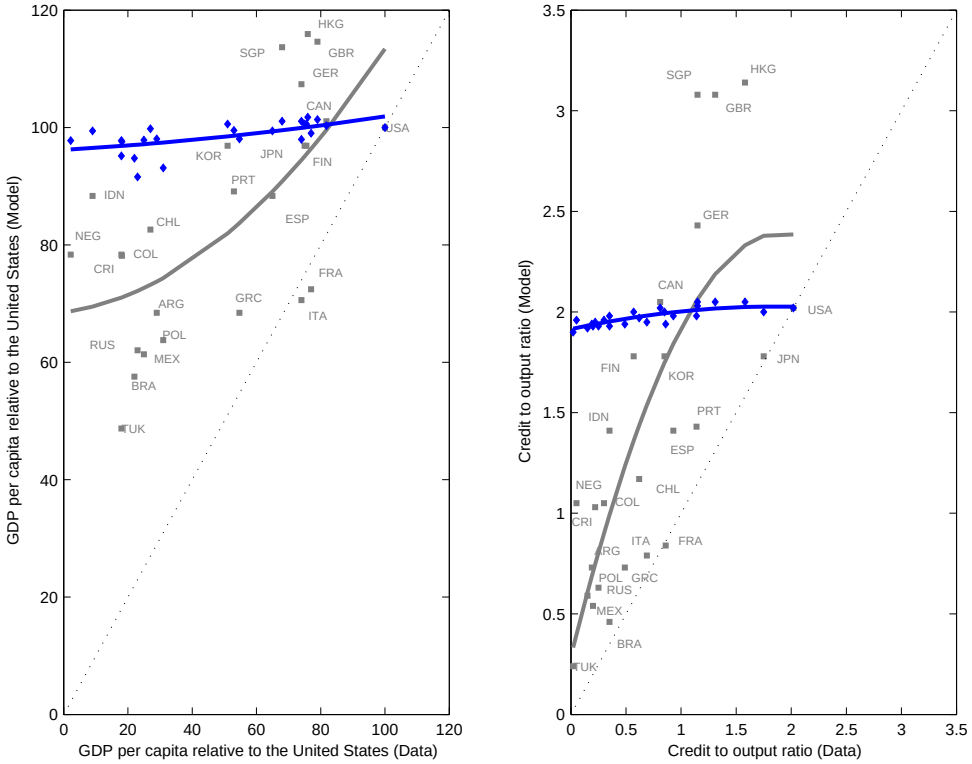
			Exogenous interest rate		**Endogenous interest rate**	
	ϕ	τ	Output per capita, % baseline	Credit to output ratio	Output per capita % baseline	Credit to output ratio
Baseline case	**0.26**	**0.5%**	**100**	**2.02**	**100**	**2.02**
Brazil (data)	**0.074**	**1.1%**	**22**	**0.35**	**22**	**0.35**
Model's predictions						
1) Intermed. costs	0.26	1.1%	94.17	1.78	97.77	2.00
2) Enforcement	0.074	0.5%	60.38	0.52	97.20	1.94
3) Intermed. costs & enforcement	0.074	1.1%	57.57	0.46	94.76	1.92
France (data)	**0.11**	**0.2%**	**77**	**0.86**	**77**	**0.86**
Model's predictions						
1) Intermed. costs	0.26	0.2%	103.01	2.12	97.77	2.03
2) Enforcement	0.11	0.5%	70.58	0.79	97.96	1.95
3) Intermed. costs & enforcement	0.11	0.2%	72.43	0.84	99.03	1.96
Russia (data)	**0.11**	**1.9%**	**23**	**0.15**	**23**	**0.15**
Model's predictions						
1) Intermed. costs	0.26	1.9%	86.31	1.45	93.89	1.99
2) Enforcement	0.11	0.5%	70.58	0.79	97.96	1.95
3) Intermed. costs & enforcement	0.11	1.9%	62.04	0.59	91.57	1.92
Singapore (data)	**0.37**	**0.5%**	**68**	**1.15**	**68**	**1.15**
Model's predictions						
1) Intermed. costs	0.26	0.5%	**100**	**2.02**	**100**	**2.02**
2) Enforcement	0.37	0.5%	113.67	3.02	101.06	2.05
3) Intermed. costs & enforcement	0.37	0.5%	113.67	3.02	101.06	2.05

in equilibrium, thus increasing the punishment is welfare improving. In contrast, recent work by Dubey, Geanakoplos and Shubik (2005) shows that when some agents default in equilibrium there may be an optimum level of creditor protection. Increasing the punishment for default beyond this level is not welfare enhancing because borrowers might decrease the demand for outside financing, decreasing capital and output.[17] This is clearly an important issue for future research.

Figure 3 reports the performance of our model for 25 countries. The figure shows the predicted output per capita (and the credit to output ratio) relative to the U.S. level of relative output per capita observed in the data. If imperfections in the financial sector explained all the difference in output per capita between a particular country and the U.S., then the point would lie on the 45^0 line. We observe: i) when the interest rate is exogenous, there is a strong positive correlation between model predictions and observed data; ii) the model tends to predict values that are higher than those observed in the data, but this is not surprising given that we focus on only two capital market frictions and abstract from all other differences among countries (i.e., TFP, labor market institutions, government policies, etc.); iii) when the interest rate is endogenous, there is a sharp difference between the predictions of the model and the data for most countries. On (iii), we note

[17]For the U.S., recent work by Grant (2003) shows that increasing the punishment for default increases debt held as suggested by Kehoe and Levine (1993). However, consumption is smoother in high exemption states.

Figure 3: *De juris* ϕ. Data and Model Predictions for Selected Economies. Gray squares: Model predictions with exogenous r; solid line is the best second order polynomial fit. Blue diamonds: Model predictions with endogenous r; solid line is the best second order polynomial fit. Dashed line: 45^0 line.



that recent waves of financial reforms have occurred in many countries. Interestingly, for some European countries, such as France, Italy and Greece, our model indicates that financial frictions account for the whole difference in income levels between these countries and the United States.

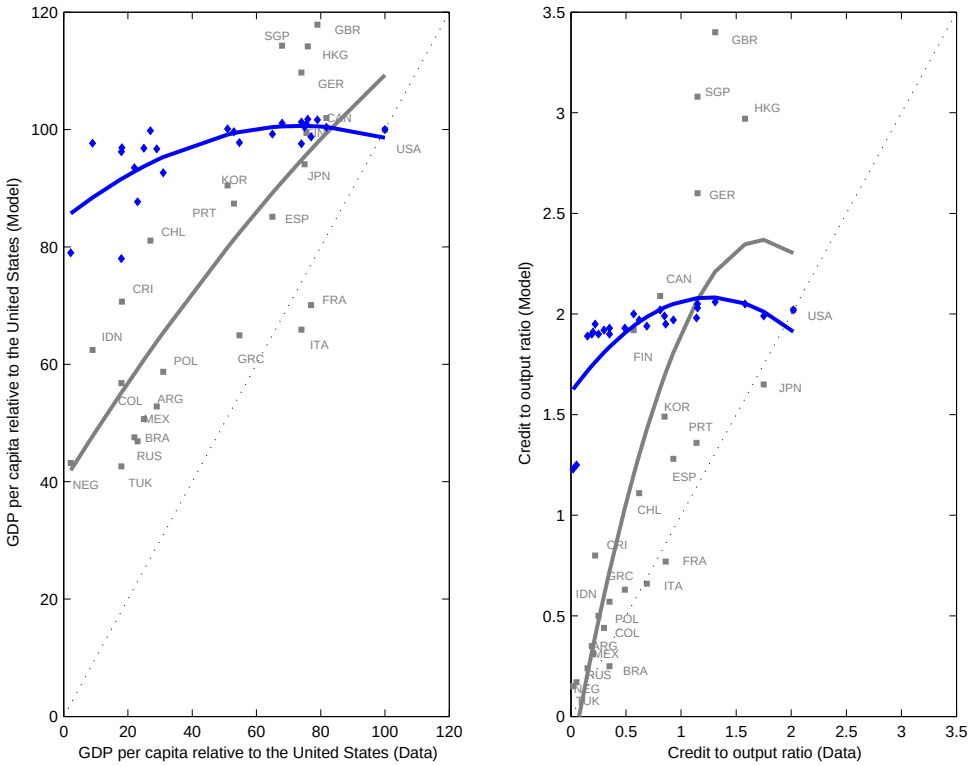
6.2 *De facto* ϕ

In the previous counterfactual exercises we used a legal rights index as a proxy for investor protection parameter ϕ, which measures the degree to which *de juris* collateral and bankruptcy laws facilitate lending. However, the written law is only part of investors' legal protection. Another part is the overall quality of the rule of law in the country, as this determines how the written law is enforced in practice. Following Araújo and Funchal (2005), we now define investor protection by the previous legal rights index times a rule of law indicator. The rule of law index, which is computed by Kaufmann et al. (2003), measures the degree to which laws are enforced in society.[18] According to this index, the U.S. has a score of 5.588 while Brazil has a score of 0.88.[19] This measure of *de facto* enforcement results in higher variation in investor protection than does the legal rights index alone. Investor protection between the U.S. and Brazil now varies by a factor of 6.35,

[18]We use the 2002 rule of law index, which varies from -2.5 to 2.5. Higher scores indicate that agents have higher confidence in the rules of society. We normalize it to a 0 to 10 interval.

[19]The investor protection index for France, Russia and Singapore is 2.298, 1.032, and 8.5, respectively. As before, we multiply the ratio of our measure of investor protection for a country to the U.S. value by the value of ϕ used in the benchmark calibration.

Figure 4: *De facto* ϕ. Data and Model Predictions for Selected Economies. Gray squares: Model predictions with exogenous r; solid line is the best second order polynomial fit. Blue diamonds: Model predictions with endogenous r; solid line is the best second order polynomial fit. Dashed line: 45^0 line.



almost twice the alternative measure. Interestingly, figure 4 shows that the correlation between the model and the data is even better for the de facto measure. Most countries are closer to the 45^0 line. Notice that for an exogenous interest rate, financial market imperfections explain almost the whole difference in output per capita for some European countries (France, Italy and Greece), and a significant part of the gap for some Latin American countries (Brazil, Mexico and Argentina) and Transition Economies (Russia and Poland). The pattern for exogenous and endogenous interest rates is also similar to figure 3, for reasons explained previously.

Table 7 reports quantitative results for the *de facto* measure of enforcement for the four reference countries. See the Appendix for eight additional countries. The alternative enforcement measure does not change significantly for France and Singapore, therefore the quantitative counterfactual exercises for these countries are similar to those reported for the *de juris* measure. The results, however, are quite different for Brazil and Russia, since these countries have a much lower level of investor protection when the rule of law is introduced. When investor protection falls from the U.S. to the Brazilian level, output per capita falls by 50% and the credit to output ratio falls to 0.28. This implies that *de facto* enforcement alone accounts for roughly 64% of the difference in output per capita between the U.S. and Brazil. It also accounts for the whole difference in the credit to output ratio. Results for Russia are quantitatively similar to those observed in Brazil, except that in Russia intermediation costs play a larger role than in Brazil.

Table 7: *De facto* ϕ. Data and Model Predictions for Reference Economies.

			Exogenous interest rate		**Endogenous interest rate**	
	ϕ	τ	Output per capita, % baseline	Credit to output ratio	Output per capita % baseline	Credit to output ratio
Baseline case	**0.26**	**0.5%**	**100**	**2.02**	**100**	**2.02**
Brazil (data)	**0.039**	**1.1%**	**22**	**0.35**	**22**	**0.35**
Model's predictions						
1) Intermed. costs	0.26	1.1%	94.17	1.78	97.77	2.00
2) Enforcement	0.039	0.5%	49.22	0.28	93.79	1.91
3) Intermed. costs & enforcement	0.039	1.1%	47.57	0.25	93.50	1.90
France (data)	**0.10**	**0.2%**	**77**	**0.86**	**77**	**0.86**
Model's predictions						
1) Intermed. costs	0.26	0.2%	103.01	2.12	97.77	2.03
2) Enforcement	0.101	0.5%	68.35	0.73	97.67	1.94
3) Intermed. costs & enforcement	0.101	0.2%	70.09	0.77	98.74	1.95
Russia (data)	**0.05**	**1.9%**	**23**	**0.15**	**23**	**0.15**
Model's predictions						
1) Intermed. costs	0.26	1.9%	86.31	1.45	93.89	1.99
2) Enforcement	0.045	0.5%	51.16	0.32	96.51	1.90
3) Intermed. costs & enforcement	0.045	1.9%	46.89	0.24	87.69	1.89
Singapore (data)	**0.38**	**0.5%**	**68**	**1.15**	**68**	**1.15**
Model's predictions						
1) Intermed. costs	0.26	0.5%	**100**	**2.02**	**100**	**2.02**
2) Enforcement	0.37	0.5%	114.27	3.08	101.06	2.05
3) Intermed. costs & enforcement	0.37	0.5%	114.27	3.08	101.06	2.05

7 Constrained Firms

In our baseline economy about 10% of firms fully self-finance and the remainder seek loans at some point during the 35 year model period. This raises the question: How would our results change if entrepreneurs were less credit constrained? In order to answer this question we use the Quadrini (2000) two sector model of production which adds an unconstrained "corporate sector" to the constrained entrepreneurial sector. This provides a robustness check on our results.[20] The corporate sector has a representative firm with a standard constant returns-to-scale production function: K_c and N_c denote capital and labor, respectively, and A_c is a total factor productivity (TFP) parameter. The corporate firm's output of consumption good, Y_c, is given by:

$$Y_{ct} = A_c K_{ct}^{\theta} N_{ct}^{1-\theta}, \quad \theta \in (0,1), \quad A_c > 0. \tag{17}$$

The representative firm in the corporate sector takes factor prices (w, r) as given and chooses labor and capital to maximize profits. The first order conditions of this problem are:

$$w_t = (1-\theta) A_c \left(\frac{K_{ct}}{N_{ct}}\right)^{\theta}, \tag{18}$$

$$(1+r_t) = \theta A_c \left(\frac{K_{ct}}{N_{ct}}\right)^{\theta-1}. \tag{19}$$

The only other equations of our original model economy that are modified by the introduction of this corporate sector are the two market clearing conditions (14) and (15) which become:

$$\iint\limits_{z \in E(w_t, r_t)} n(x; w_t, r_t) \Upsilon_t(db)\Gamma(dx) + N_c(w_t, r_t) = \iint\limits_{z \in E^c(w_t, r_t)} \Upsilon_t(db)\Gamma(dx) \tag{20}$$

$$\iint\limits_{z \in E(w_t, r_t)} k(b, x; w_t, r_t) \Upsilon_t(db)\Gamma(dx) + K_c(w_t, r_t) = \iint b \Upsilon_t(db)\Gamma(dx). \tag{21}$$

We wish to perform quantitative exercises, and must now calibrate two additional parameters: the capital share in the corporate technology, θ, and TFP parameter, A_c. Consistent with Gollin (2002), we assume that the capital share in the corporate sector is $\theta = 0.40$. We calibrate A_c such that 60 percent of aggregate capital is employed in the corporate sector (see Quadrini, 2000), giving $A_c = 0.375$. Parameters α, β and τ are the same as in table 1. We use the same targets to calibrate ϕ, γ and ϵ, but their values change with the introduction of the corporate sector to:[21] $\gamma = 0.953$, $\phi = 0.086$ and $\epsilon = 5.649$. The new γ and ϵ are close to the baseline values in table 1, but ϕ is three times lower than our baseline value of 0.26 and Cagetti and De Nardi (2006). Table 8 reports key statistics of the U.S. economy and those generated by the calibrated model with a corporate sector. The model matches well all target estimates (lines 1 to 5), but now underestimates the capital to output ratio (1.72 versus 2.5). The ratio of credit to entrepreneurs over output is 0.51; if we also assume that capital in the corporate sector is borrowed, then the ratio of private credit to output is higher (1.54). Both values are considerably lower than the U.S. economy estimate of 1.98.[22]

We now conduct policy experiments in the corporate model identical to those in table 5: fix all other parameters, and analyze benchmark variations in intermediation costs and contract

[20] See also Wynne (2005).

[21] As before, parameters γ, ϕ and ϵ are calibrated to set the yearly real interest rate in the model to 2 percent, the

Table 8: Basic statistics, U.S. and economy with a corporate sector. Sources: International Financial Statistics database, Demirgüç-Kunt and Huizinga (1999), Quadrini (1999), Quadrini (2000), Maddison (1995), and World Development Indicators database.

	U.S. economy	Baseline economy
Yearly real interest rate (%)	2.00	2.00
Tax as a percentage of total bank assets (%)	0.50	0.50
% of entrepreneurs (%)	9.00	9.01
Entrepreneurs' income Gini (%)	45	45
Capital employed in the corporate sector (%)	60	60
Capital to output ratio	2.5	1.72
Private credit as a share of GDP	1.98	0.51–1.54

enforcement. Table 9 shows that when the interest rate is exogenously determined the results are similar to what we found previously, but the output effect is stronger. When the enforcement parameter decreases by a factor of 2 and intermediation costs double, output decreases by 61% in table 9 but by only 28% in table 5. The reason for this difference in magnitude is the absence of wage changes in the model with a corporate sector. An exogenous interest rate implies an exogenously determined wage rate – see equations (18) and (19). Therefore, higher credit market imperfections imply, for given factor prices, lower demand for loans by each entrepreneur which decreases capital input and therefore labor demand. Previously, lower labor demand implied a decrease in the wage rate, which increased labor input and output. Now, the wage rate is constant and potential entrepreneurs become workers in the corporate sector. The fraction of total capital used by the corporate sector increases sharply with higher credit market imperfections, but the sector is not necessarily more productive than some of the credit constrained entrepreneurs, which accounts for the output loss.

When the interest rate is endogenous, the results are sharply different than in the case without a corporate sector. Now when the enforcement parameter decreases by a factor of 2 and intermediation costs double, output decreases by 50% in table 9; it decreased by only 3.8% in table 5. Nonetheless, there is still a sizeable general equilibrium effect on output, as the 50% decrease is smaller than in the exogenous interest rate case, 61%. Lower enforcement and/or higher intermediation costs imply a lower demand for capital by each entrepreneur and therefore a lower demand for labor. However, for each entrepreneur the policy effects are stronger on capital demand than on labor demand.[23] Capital and labor are then used by the corporate sector with a higher capital labor ratio and the interest rises. The wage rate decreases, counterbalancing some of the negative effects on output. In both cases inequality decreases sharply as credit market imperfections worsen. There are more workers in this economy receiving the same (low) labor income.

Table 9 shows that adding a corporate sector deepens the effects on output of the policy experiments in table 5. This may seem surprising since the goal of adding an unconstrained corporate sector was to relax the credit constraint. Output drops because the share of capital

number of entrepreneurs over the total population to 9 percent, and the entrepreneurial income Gini to 45 percent.

[22]This might seem at odds with, for instance, Quadrini's (2000) calibration, but in his model a time period is one year while in ours a period covers the entire time that agents engage in productive activities (35 years). The introduction of a corporate sector in a yearly model is intuitive since, in any given year, a considerable fraction of firms may not be credit constrained. In a model with longer periods, more firms are likely to be credit constrained at their inception. The different timing assumptions might justify different perspectives on when a corporate sector is appropriate.

[23]From equation (4) observe that $\frac{\partial n}{\partial \phi} / \frac{\partial k}{\partial \phi} = \alpha/(1-\beta)$, which is less than one as long as $\alpha < \beta$, as we assume.

Table 9: Policy Experiments: Intermediation cost & Enforcement. ϕ_{base}, τ_{base} are baseline parameters

	Output per capita, % baseline	% of Capital employed in the corporate sector	% of entrepreneurs	Credit to output ratio	Entrepreneurs' income Gini	Interest rate
Part (a): Exogenous interest rate, r: $\tau_{\text{base}} = 0.005$, $\phi_{\text{base}} = 0.086$, $A_c = 0.375$						
Baseline	100.00	60	9.01	0.51	45	1
$\tau = 2 \times \tau_{\text{base}}$, $\phi = \frac{1}{2} \times \phi_{\text{base}}$	38.58	94	7.36	0.10	25.40	1
$\tau = 4 \times \tau_{\text{base}}$, $\phi = \frac{1}{4} \times \phi_{\text{base}}$	26.59	97	6.37	0.03	17.31	1
Part (b): Endogenous interest rate, r: $\tau_{\text{base}} = 0.005$, $\phi_{\text{base}} = 0.086$, $A_c = 0.375$						
$\tau = 2 \times \tau_{\text{base}}$, $\phi = \frac{1}{2} \times \phi_{\text{base}}$	49.68	84	8.95	0.11	30.50	1.64
$\tau = 4 \times \tau_{\text{base}}$, $\phi = \frac{1}{4} \times \phi_{\text{base}}$	38.12	89	8.59	0.02	23.82	1.83

used by the corporate sector increases from 60% to at least 84% (in the endogenous interest rate case) when enforcement decreases by a factor of 2 and intermediation costs double. First, this illustrates that it is important to channel capital to the most productive users when agents are heterogeneous, not simply relax the percentage of constrained agents. Second, Ayyagari, Beck and Demirgüç-Kunt (2003) show that the share of the entrepreneurial sector in total output (based on firms with less than 250 employees) increases with the level of development, but this relationship is not as strong as our numerical experiments suggest. For instance, the contribution of the corporate sector to total output is roughly similar in Argentina, Peru, Japan, and the United States, despite differences in their levels of economic development. Just as higher frictions decrease productivity in the entrepreneurial sector, TFP may also fall in the corporate sector through a mechanism that we do not explicitly model. For instance, low enforcement might affect the ability of large firms to mitigate operational risk, which typically is an increasing function of the firm scale.[24]

8 Concluding remarks and policy implications

This paper developed a framework to study qualitatively and quantitatively the effects of two financial frictions, intermediation costs and financial contract enforcement, on three measures of development: output per capita, total credit and inequality. We used data on intermediation costs and enforcement to map observed cross country differences in financial frictions into our model economy. We found that:

- Using independent measures of intermediation costs and enforcement, we show that financial frictions account for part of the differences in international income levels. Our counterfactual exercises using ϕ *de facto* show that financial market imperfections explain almost the whole difference in output per capita for some European countries (France, Italy and Greece), and a significant fraction for some Latin American countries (Brazil, Mexico and Argentina) and transition economies (Russia and Poland).

[24]We also did experiments keeping the share of the capital in the corporate sector (K_c/K) constant at 60 percent. In this case, the TFP parameter of the corporate sector, A_c, must decrease to keep the share of this sector constant, when enforcement decreases and/or intermediation costs increase. In both interest rate cases the results are roughly similar to table 5 except the credit to output ratio drops more significantly. For the share of capital in the corporate sector to be constant, productivity in this sector must decrease.

- The quantitative implications of financial frictions depend on whether the interest rate is endogenous or exogenous, with the effects on output typically more pronounced when the interest rate is exogenous. An unconstrained corporate sector tends to exacerbate the impact of financial frictions on output, because corporate firms are not necessarily more efficient than some of the constrained entrepreneurs.

We conclude by discussing three related strands of literature. As noted at the outset, our paper is related to the literature on occupational choice and the dynamics of economic development and inequality (e.g., Aghion and Bolton (1997), Banerjee and Newman (1993), Lloyd-Ellis and Bernhardt (2000), and Lucas (1978)). We differ from this literature because our goal is not to study analytically the path of economic development, occupational choice or inequality; we investigate quantitatively how financial frictions affect these variables in the long run. The second literature seeks to explain why some countries are much richer than others. Part of this literature uses development accounting to investigate whether observed income disparities across countries are explained by factor accumulation or total factor productivity (e.g., Hall and Jones (1999) and Prescott (1998)). Another part uses a modified version of the neoclassical growth model to study whether plausible differences in policy distortions and barriers to the use of better technologies can account for differences in income per worker across countries (e.g., Acemoglu and Ventura (2002) and Parente and Prescott (1999)). Our analysis is similar, but focuses on financial frictions and two important micro-foundations, occupational choice and limited commitment to financial contracts. We also investigate other dimensions of the data, such as credit as a share of output and inequality.

Finally, our paper is related to a large literature on finance, economic growth and development (e.g., Bencivenga and Smith (1991), Boyd and Smith (1998) and Greenwood and Jovanovic (1990)).[25] We do not study the evolution of financial markets over the process of development. Instead, we focus on how the reform of exogenous financial policies affects the economy. In this respect, Amaral and Quintin (2005), Castro, Clementi and MacDonald (2004), Erosa and Hidalgo-Cabrillana (2007), Jeong and Townsend (2007), Quintin (2001) and Shleifer and Wolfenzon (2002) are closest to our work. Castro et al. (2004) and Shleifer and Wolfenzon (2002) derive important theoretical results, but do not study the quantitative implications of the model;[26] they use econometrics to test a number of qualitative results. Erosa and Hidalgo-Cabrillana (2007) study the quantitative implications of capital market imperfections in the steady-state equilibrium at a fixed interest rate (equal to the rate of time preference), but do not consider general equilibrium effects. Amaral and Quintin (2005) also consider a fixed interest rate (small open economy). The Jeong and Townsend (2007) model is similar to ours, but their quantitative exercises are different. With Thailand data, they use occupational choice and credit constraints to show that the effects of financial deepening on TFP depend on factor prices (general equilibrium). Quintin (2001) studies a dynamic general equilibrium model which focuses on the link between limited enforcement and international differences in firm size and Guner et al. (2004) examine a broader set of policies that restrict firm size. Their focus is on international firm size distributions.

[25] There is also an important literature that studies empirically the relationship between financial development and economic development. See King and Levine (1993), Levine (1997), and Rajan and Zingales (1998).

[26] In a costly state verification model with a credit market imperfection and no choice, Castro et al. (2004) show that the effect of investor protection on capital accumulation is not linear. As here, there are two effects: a demand effect and a general equilibrium (supply) effect.

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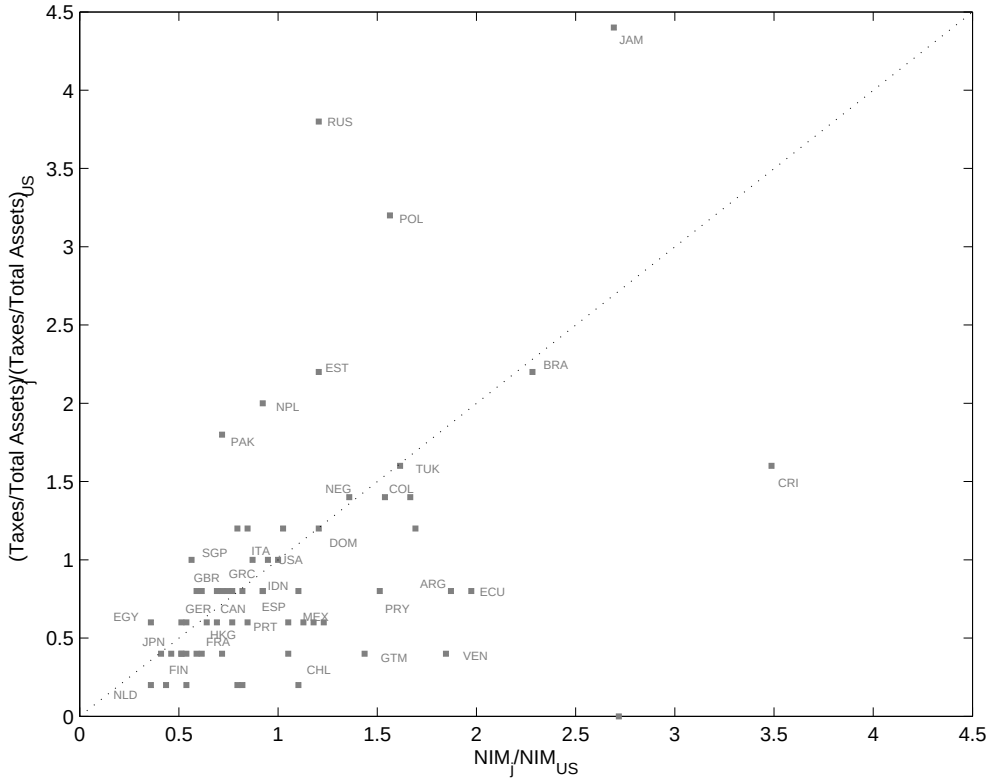
A Sensitivity Analysis

A.1 Definition of τ

In the quantitative exercises we use data on intermediary taxes over total assets as a measure of intermediation costs. Instead, we could have used the net interest margin. Figure 5 shows that intermediary taxes in country j relative to intermediary taxes in the U.S. are strongly correlated with the net interest margin in country j relative to the net interest margin in the U.S. Thus, the results are broadly similar.

Figure 5: Net Interest Margin of country j relative to the net interest margin of the U.S. versus intermediary taxes of country j relative to intermediary taxes of the U.S. The dashed line is the 45^0 line.



A.2 Parameter Sensitivity

In this section we show how the baseline economy changes with each parameter of the model. We evaluate the effects of a deviation of one percent in each parameter from its baseline value on output per capita, the wage rate, the percent of entrepreneurs, total private credit as a share of output, entrepreneurs' income inequality and the interest rate. Table 10 shows that our results are robust to all parameters except for the utility parameter γ. Notice that $1-\gamma$ is the fraction of income that is left to the next generation. Therefore, a lower γ implies higher savings and therefore higher capital and output.

Table 10: Sensitivity Analysis. Subscript 'base' stands for the baseline parameter values.

	Output per capita, % baseline	Wage, % baseline	% of entrepreneurs	Credit to output ratio	Entrepreneurs' income Gini	Interest rate
Part (a): Exogenous interest rate, r.						
Baseline	100.00	100.00	8.80	2.02	45.35	1
$\gamma_1 = 1.01 \times \gamma_{\text{base}}$	98.64	99.25	8.61	2.03	45.75	1
$\gamma_2 = 0.99 \times \gamma_{\text{base}}$	101.55	100.75	8.95	1.99	44.91	1
$\epsilon_1 = 1.01 \times \epsilon_{\text{base}}$	99.90	99.85	8.72	2.01	45.47	1
$\epsilon_2 = 0.99 \times \epsilon_{\text{base}}$	100.19	100.15	8.83	2.01	45.18	1
$\alpha_1 = 1.01 \times \alpha_{\text{base}}$	98.83	98.80	8.66	2.01	45.80	1
$\alpha_2 = 0.99 \times \alpha_{\text{base}}$	101.16	101.35	8.91	2.01	44.92	1
$\beta_1 = 1.01 \times \beta_{\text{base}}$	102.13	102.55	8.51	1.98	45.82	1
$\beta_2 = 0.99 \times \beta_{\text{base}}$	97.96	97.45	9.06	2.03	44.94	1
Part (b): Endogenous interest rate, r.						
$\gamma_1 = 1.01 \times \gamma_{\text{base}}$	92.34	91.31	8.77	1.68	45.23	1.39
$\gamma_2 = 0.99 \times \gamma_{\text{base}}$	106.88	107.93	8.80	2.35	45.49	0.71
$\epsilon_1 = 1.01 \times \epsilon_{\text{base}}$	99.90	99.85	8.72	2.02	45.50	1
$\epsilon_2 = 0.99 \times \epsilon_{\text{base}}$	100.09	100.15	8.83	2.01	45.19	1
$\alpha_1 = 1.01 \times \alpha_{\text{base}}$	98.93	98.80	8.65	2.02	45.81	1
$\alpha_2 = 0.99 \times \alpha_{\text{base}}$	101.19	101.06	8.91	2.01	44.93	1
$\beta_1 = 1.01 \times \beta_{\text{base}}$	102.71	103.44	8.48	2.02	45.85	0.97
$\beta_2 = 0.99 \times \beta_{\text{base}}$	97.38	96.85	9.07	2.01	44.89	1.02

B Additional Counterfactual Simulations

Compare tables 9 and 10 to tables 6 and 7. They show that the results for two other Latin American countries, Argentina and Chile, are roughly similar to Brazil. For the European countries, Italy is similar to France but Germany and the U.K. over predict output and credit. Transition country Poland is similar to Russia. Finally, high growth Asian countries Hong Kong and S. Korea are similar to Singapore (i.e., over predict output and credit). The over predictions of the high growth Asian countries, Germany and the U.K. suggest that other factors, which we abstract from, are important for explaining the output and credit market gaps between these countries and the U.S. (e.g., labor market institutions, government policies, etc.)

Table 11: *De juris* ϕ. Empirical Data and Model Predictions for Reference Economies.

			Exogenous interest rate		**Endogenous interest rate**	
	ϕ	τ	Output per capita, % baseline	Credit to output ratio	Output per capita % baseline	Credit to output ratio
Baseline case	**0.26**	**0.5%**	**100**	**2.02**	**100**	**2.02**
Argentina (data)	**0.11**	**0.4%**	**29**	**0.19**	**29**	**0.19**
Model's predictions						
1) Intermed. costs	0.26	0.4%	101.01	2.05	100.38	2.02
2) Enforcement	0.11	0.5%	70.58	0.79	97.96	1.95
3) Intermed. costs and enforcement	0.11	0.4%	68.44	0.73	98.06	1.94
Chile (data)	**0.1486**	**0.1%**	**27**	**0.62**	**27**	**0.62**
Model's predictions						
1) Intermed. costs	0.26	0.1%	103.88	2.16	101.47	2.02
2) Enforcement	0.1486	0.5%	79.80	1.09	98.44	1.97
3) Intermed. costs and enforcement	0.1486	0.1%	82.62	1.17	99.80	1.97
Germany (data)	**0.2971**	**0.3%**	**74**	**1.15**	**74**	**1.15**
Model's predictions						
1) Intermed. costs	0.26	0.3%	102.04	2.08	100.77	2.02
2) Enforcement	0.2971	0.5%	105.24	2.34	100.78	2.02
3) Intermed. costs and enforcement	0.2971	0.3%	107.38	2.43	101.06	2.03
Hong Kong (data)	**0.37**	**0.3%**	**76**	**1.58**	**76**	**1.58**
Model's predictions						
1) Intermed. costs	0.26	0.3%	102.04	2.08	100.77	2.02
2) Enforcement	0.37	0.5%	113.67	3.02	101.06	2.05
3) Intermed. costs and enforcement	0.37	0.3%	115.92	3.14	101.74	2.05
Italy (data)	**0.11**	**0.5%**	**74**	**0.69**	**74**	**0.69**
Model's predictions						
1) Intermed. costs	0.26	0.5%	100	2.02	100	2.02
2) Enforcement	0.11	0.5%	70.58	0.79	97.96	1.95
3) Intermed. costs and enforcement	0.11	0.5%	70.58	0.79	97.96	1.95
Korea, South (data)	**0.2229**	**0.2%**	**51**	**0.85**	**51**	**0.85**
Model's predictions						
1) Intermed. costs	0.26	0.2%	103.01	2.12	101.06	2.02
2) Enforcement	0.2229	0.5%	94.07	1.69	99.51	2.01
3) Intermed. costs and enforcement	0.2229	0.2%	96.89	1.78	100.58	2.00
Poland (data)	**0.11**	**1.6%**	**31**	**0.25**	**31**	**0.25**
Model's predictions						
1) Intermed. costs	0.26	1.6%	89.22	1.6	95.25	2.00
2) Enforcement	0.11	0.5%	70.58	0.79	97.96	1.95
3) Intermed. costs and enforcement	0.11	1.6%	63.78	0.63	93.12	1.93
United Kingdom (data)	**0.37**	**0.4%**	**79**	**1.31**	**79**	**1.31**
Model's predictions						
1) Intermed. costs	0.26	0.4%	101.01	2.05	100.38	2.02
2) Enforcement	0.37	0.5%	113.67	3.02	101.06	2.05
3) Intermed. costs and enforcement	0.37	0.4%	114.63	3.08	101.35	2.05

Table 12: *De facto* ϕ. Empirical Data and Model Predictions for Reference Economies

			Exogenous interest rate		**Endogenous interest rate**	
	ϕ	τ	Output per capita, % baseline	Credit to output ratio	Output per capita % baseline	Credit to output ratio
Baseline case	**0.26**	**0.5%**	**100**	**2.02**	**100**	**2.02**
Argentina (data)	**0.0494**	**0.4%**	**29**	**0.19**	**29**	**0.19**
Model's predictions						
1) Intermed. costs	0.26	0.4%	101.01	2.05	100.38	2.02
2) Enforcement	0.0494	0.5%	52.52	0.34	96.61	1.91
3) Intermed. costs and enforcement	0.0494	0.4%	52.81	0.35	96.70	1.90
Chile (data)	**0.1414**	**0.1%**	**27**	**0.62**	**27**	**0.62**
Model's predictions						
1) Intermed. costs	0.26	0.1%	103.88	2.16	101.47	2.02
2) Enforcement	0.1414	0.5%	78.15	1.08	98.44	1.97
3) Intermed. costs and enforcement	0.1414	0.1%	81.07	1.11	99.80	1.97
Germany (data)	**0.3149**	**0.3%**	**74**	**1.15**	**74**	**1.15**
Model's predictions						
1) Intermed. costs	0.26	0.3%	102.04	2.08	100.77	2.02
2) Enforcement	0.3149	0.5%	107.47	2.50	100.78	2.03
3) Intermed. costs and enforcement	0.3149	0.3%	109.71	2.60	101.26	2.03
Hong Kong (data)	**0.3536**	**0.3%**	**76**	**1.58**	**76**	**1.58**
Model's predictions						
1) Intermed. costs	0.26	0.3%	102.04	2.08	100.77	2.02
2) Enforcement	0.3536	0.5%	111.94	2.88	101.06	2.04
3) Intermed. costs and enforcement	0.3536	0.3%	114.17	2.97	101.74	2.05
Italy (data)	**0.0927**	**0.5%**	**74**	**0.69**	**74**	**0.69**
Model's predictions						
1) Intermed. costs	0.26	0.5%	100	2.02	100	2.02
2) Enforcement	0.0927	0.5%	65.92	0.66	97.57	1.94
3) Intermed. costs and enforcement	0.0927	0.5%	65.92	0.66	97.57	1.94
Korea, South (data)	**0.1887**	**0.2%**	**51**	**0.85**	**51**	**0.85**
Model's predictions						
1) Intermed. costs	0.26	0.2%	103.01	2.12	101.06	2.02
2) Enforcement	0.1887	0.5%	88.06	1.41	99.03	1.98
3) Intermed. costs and enforcement	0.1887	0.2%	90.48	1.49	100.09	1.99
Poland (data)	**0.0879**	**1.6%**	**31**	**0.25**	**31**	**0.25**
Model's predictions						
1) Intermed. costs	0.26	1.6%	89.22	1.6	95.25	2.00
2) Enforcement	0.0879	0.5%	64.56	0.63	97.48	1.93
3) Intermed. costs and enforcement	0.0879	1.6%	58.73	0.50	92.63	1.91
United Kingdom (data)	**0.4011**	**0.4%**	**79**	**1.31**	**79**	**1.31**
Model's predictions						
1) Intermed. costs	0.26	0.4%	101.01	2.05	100.38	2.02
2) Enforcement	0.4011	0.5%	116.50	3.33	101.26	2.06
3) Intermed. costs and enforcement	0.4011	0.4%	117.86	3.40	101.65	2.06