Legal Institutions, Sectoral Heterogeneity, and Economic Development *

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Abstract

We provide evidence that firms engaged in the production of investment goods face higher baseline idiosyncratic risk than firms producing consumption goods. In a model of capital accumulation where the protection of investors' rights is incomplete, this difference in volatility induces a wedge between the returns on investment in the two sectors. Everything else equal, risk-sharing and firm size will be lower in the investment good sector. We investigate the implications of different levels of investor protection for important features of economic development. We find that countries with better institutions tend to (i) have higher investment rates, (ii) be richer, (iii) have a lower relative price of capital goods, (iv) have a higher measured aggregate TFP, and (v) have a larger relative firm size in the investment goods sector. We provide evidence in support of the latter prediction.

Key words.
JEL Codes: .

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1 Introduction

One of the most staggering features of economic development is the enormous disparity of levels and growth rates of per capita output across countries. Such disparity is associated to differences in both factors accumulation and total factor productivity. While authors such as Mankiw, Romer, and Weil (1992) have emphasized the role of the former, others, such as Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999), have insisted on the importance of the latter. The economics profession seems to be divided on the relative importance of the two determinants. The purpose of this paper is not to contribute to this debate. Rather, the main objective of this research is to show that the cross-country variation in the quality of legal institutions may account for the cross-country heterogeneity in both investment rates and measured total factor productivity.

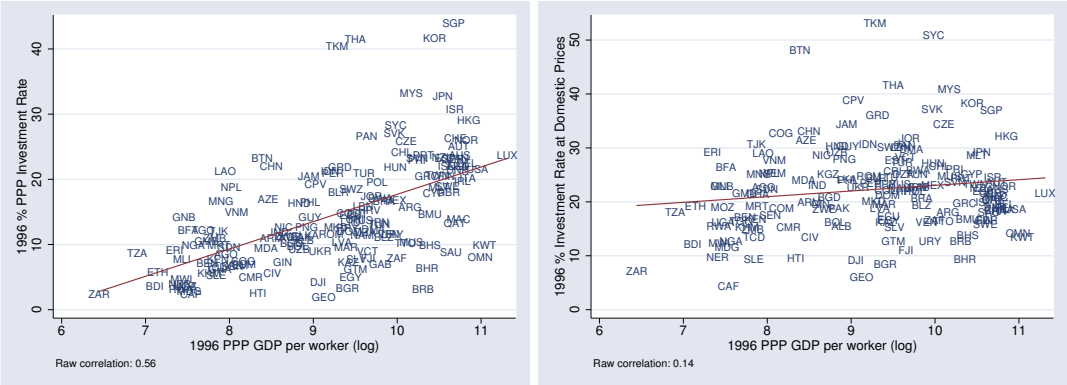

Figure 1: Investment Rates and Income Levels.

Heston and Summers (1988, 1996) first emphasized that the behavior of investment rates in the cross-section of countries depends on the prices used to compute them. Investment rates covary positively with income only if investment goods are valued using international prices. When domestic prices are used, investment rates do not seem to covary with income. These features of the data are documented in Figure 1, which was constructed using data from Heston, Summers, and Aten's (2002) Penn World Tables, version 6.1. Consistently with this finding, De Long and Summers (1991), Easterly (1993), and Jones (1994), report that the relative price of investment goods with respect to consumption goods is negatively correlated with income. This fact is documented in Figure 2. These observations suggest that rich and poor countries devote a similar fraction of income to investment expenditures,

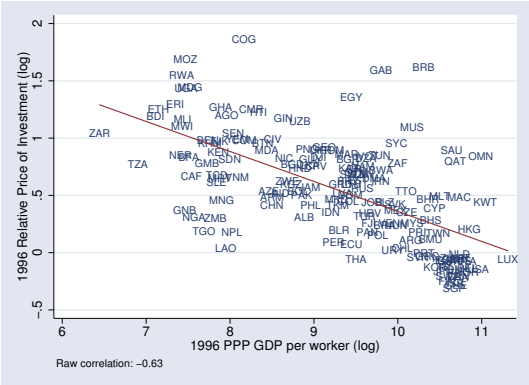

Figure 2: Relative price of Investment Goods and Income Levels.

but the real investment outcome turns out to be higher in richer countries. In this paper we present a model of economic growth whose predictions are consistent with these findings. The novelty of our approach lies on the assumption that countries only differ with respect to the legal institutions that protect investors from exploitation from insiders. Technologies and tax policies are assumed to be the same across countries.

We consider a fairly standard two-sector overlapping generation model of capital accumulation. The two sectors produce investment goods and consumption goods, respectively. Each individual is born endowed with entrepreneurial talent and decides whether to allocate it to the production of investment or consumption goods. In either sector, the technology displays decreasing returns to capital, which is the only input. The outcome of the production process is stochastic, i.i.d. across technologies, and known only to the technology's owner. The crucial difference across sectors is in the volatility of cash-flows. We assume that cash flows are more volatile in the investment goods sector than in the consumption goods sector.

Lacking an initial endowment, and needing resources to use their technology, young individuals, who we refer to as entrepreneurs, borrow capital from the old through financial intermediaries. Intermediaries transfer resources from the old to the young by borrowing from the old at the equilibrium rental rate and lending to the young using optimal lending contracts with terms contingent on all public information. In common with much of the literature on optimal contracts with hidden information, we model the interaction between intermediaries and entrepreneurs as a message game. We assume that entrepreneurs who misreport their outcomes and hide resources face a deadweight loss. A fraction of the resources hidden from investors

gets wasted. Our hiding cost resembles the falsification cost considered by Lacker and Weinberg (1989) and is intended to capture all institutional features that limit the ability of insiders to expropriate outside investors.

The optimal lending contract dictates that in either sector risk-sharing is increasing in the level of investor protection and decreasing in cash flow volatility. Therefore, our assumption on the cross-sectoral variation in volatility implies a wedge between the returns to investment in the consumption and in the investment good sector. Comparative statics exercises show that the size of this wedge is decreasing in the level of investor protection. In turn, this implies that the relative price of capital goods and the relative size of firms in the consumption good sector are also decreasing in the level of investor protection. Finally, investment rates, aggregate TFP, and national income are all shown to be increasing in the quality of the legal system.

Our main conclusion is that differences in the quality of the legal system can generate correlation patters between the relative price of capital goods, investment rates, measured aggregate TFP, and income levels, which are qualitatively in line with the data.

Ours is not the first attempt at providing a rationalization of the development facts described above. Restuccia and Urrutia (2001) and Chari, Kehoe, and McGrattan (1996) have emphasized the role of distortionary taxation: government of poor countries may be more likely to impose higher distortionary taxes on capital goods. However, Hsieh and Klenow (2003) have argued that taxes or tariffs on investment goods imply that their absolute prices should correlate negatively with income levels. According to Hsieh and Klenow (2003), this is not the case: the cross-country correlation between per-capita income and relative price of investment is due to the variation in the absolute prices of consumption goods, which tend to be lower in poor countries. Absolute prices of investment goods do not change systematically with income. Hsieh and Klenow (2003) and Restuccia and Urrutia (2001) argue that poor countries may have lower investment rates because they are relatively more efficient in the production of consumption goods. This would make investment goods relatively more expensive, thereby lowering PPP investment rates. We see our contribution as complementary to theirs. In fact our model takes in input the documented cross-country variation in the quality of legal institutions and generates as output the variation in relative productivity that is at the heart of their work.

The remainder of this paper is organized as follows. In Section 2 we provide evidence in support of our assumption on the cross-sectoral variation of cash flow

volatility. We introduce the model in Section 3. In Section 4 we define and characterize the competitive equilibrium allocation. In Section 5 we show that cross-country data suggest that, in agreement with our model, the relative size of firms operating in consumption good sectors decreases with the level of investor protection. Section 6 concludes.

2 Empirical Evidence on Firm-Level Volatility

One central assumption behind our results is that firms in the investment good sector display higher idiosyncratic volatility than firms in the consumption good sector. In this section we provide empirical evidence in support of this claim. We rely on firm-level data from Standard & Poor's COMPUSTAT Database. This data covers a wide range of publicly-traded US firms, and we concentrate on yearly data from 1950 until 2003.

For each firm in the data set, we have information on the main industry in which it operates. We concentrate our attention on the 3-digit NAICS aggregation level. We rely on the Bureau of Economic Analysis' benchmark input-output tables for the US in order to assign industries to either the consumption or the investment good sector. The I-O tables provide information on the contribution of each industry to consumption and investment final demand uses. We assign a 3-digit industry to the consumption good sector, say, if the ultimate destination of a sufficiently large share of its output is to final consumption uses. We use an analogous rule to assign industries to the investment good sector, and we discard sectors with very similar contributions to final consumption and investment uses. See Appendix A for further details on this procedure.

For each firm, we also have information on the value of net sales (Compustat # 12). Our main goal is to estimate the industry average firm-level volatility of sales growth in order to assess whether firms in industries classified as investment good sectors are actually subject to higher baseline idiosyncratic risk.

For each firm, we compute the mean absolute deviation of sales growth relative to the median.[1] The figures used to construct Figure 3 are averages of this volatility measure over all firms in each 3-digit industry.[2] More specifically, for every industry

[1] We use the mean absolute deviation relative to the median rather than the standard deviation, say, because the former is less sensitive to the presence of outliers. However, we found similar results based upon the standard deviation.

[2] As a further way to prevent outliers from biasing our results, we dropped industries with less than 15 observations.

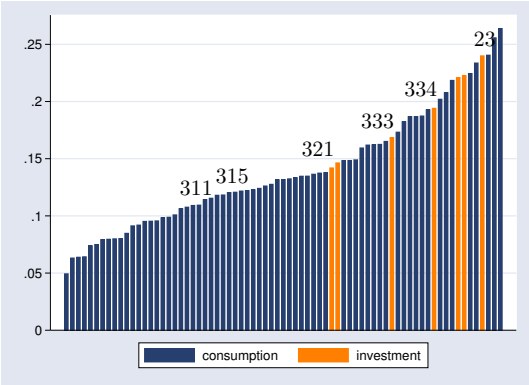

Figure 3: Volatility of sales growth per 3-digit industry.

i, the measure of volatility is

$$\text{vol_ts}_i = \frac{1}{I_i T_{ij}} \sum_{j=1}^{I_i} \sum_{t=1}^{T_{ij}} \left| gs_{tij} - gs_{ij}^m \right| ,$$

where I_i is the total number of firms in industry i, T_{ij} is the total number of observations for firm j in sector i, gs_{tij} is sales growth between t and $t+1$ for firm j, and gs_{ij}^m is the median growth rate of sales for the same firm.

Figure 3 also indicates whether a particular industry is classified as either consumption or investment good sector. This figure clearly shows that investment good firms are among the most volatile in the economy. For example, firms in either the Food Manufacturing (311) or the Apparel Manufacturing (315) sectors, two of the largest sectors in terms of value-added in all economies, are distinctly less volatile than firms in any of the investment good sectors, namely Wood Product Manufacturing (321), Machinery Manufacturing (333), Computer and Electronic Product Manufacturing (334) or Construction (23).

Figure 3 might reflect a bias if firms in the investment good sector tend to be smaller and/or younger than firms in the consumption good sector. In fact, as is well-known in the empirical industrial organization literature (see Evans (1987); Hall (1987)), firm volatility is decreasing in both size and age. These concerns are addressed in Figures 4 and 5.

In Figure 4, we restrict the sample to large firms, by discarding the 10% smallest firms in every industry. It turns out that the pattern that emerged in Figure 3 is even more pronounced.

In Figure 5, instead, we restrict the sample to old firms, by discarding the first

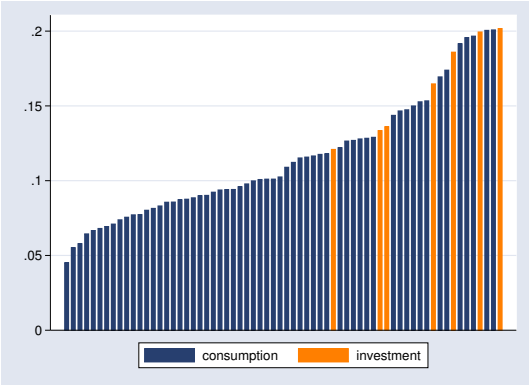

Figure 4: Volatility of sales growth per 3-digit industry: large firms only.

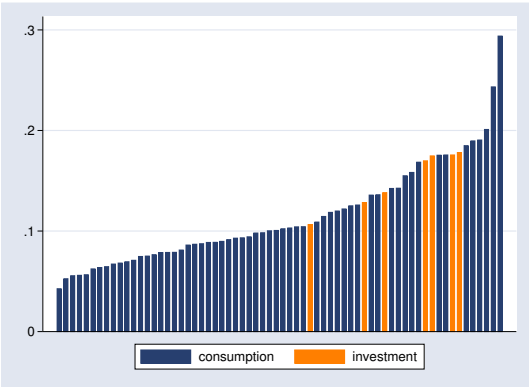

Figure 5: Volatility of sales growth per 3-digit industry: old firms only.

four years of observations for each firm.[3] Figure 5 shows that, also among older firms, investment good firms are very volatile.

Another potential concern about Figure 3 is that, rather than reflecting firm idiosyncratic volatility, it might instead reflect mostly aggregate volatility. In fact investment good expenditures are well-known to be much more volatile than consumption good expenditures at the business cycle frequency (see for example Kydland and Prescott (1990)).

To check whether the higher volatility of investment good firms is associated with the business cycle, we compute a measure of volatility in the cross-sectional dimension. For each year and each 3-digit industry, we compute the mean absolute standard deviation relative to the median of sales growth across all firms.[4] We obtain a time-

[3]Notice that most firms do not enter the sample in the year of birth. This implies that our procedure eliminates all firms which are four years old or younger.

[4]We found similar results when we used the standard deviation instead of the mean absolute standard deviation relative to the median. Also for the cross-sectional volatility measure, we dropped sectors with very few firm-observations. Specifically, we dropped sectors with a median number of

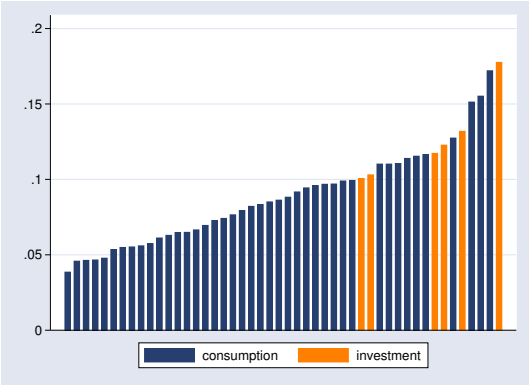

Figure 6: Volatility of sales growth per 3-digit industry: cross-sectional.

series of cross-sectional volatility measures per industry, which we then average over time. More specifically, for a given industry i, we report the following measure

$$\text{vol_cs}_i = \frac{1}{NI_{it}} \sum_{t=1}^{N} \sum_{j=1}^{I_{it}} \left| gs_{tij} - gs_{ti}^{m} \right| ,$$

where N is the total number of years in the sample, I_i is the total number of firms in industry i in period t, gs_{tij} is sales growth between t and $t+1$ for firm i in sector j, and gs_{it}^{m} is the median growth rate in sector i in period t.

These measures are reported in Figure 6, sorted in ascending order. Our conclusion is that the higher volatility of firms in the investment good sector does not simply reflect business cycle effects.

3 Model

We consider a simple extension of the standard two-period, two-sector Overlapping Generations Model. The population is constant and the measure of each cohort is normalized to one. Individuals are risk-averse. Preferences are time-separable and the period utility, denoted by $u(c_t)$, displays constant relative risk aversion.[5] Let σ denote the coefficient of relative risk aversion. Agents discount second-period utility at the rate β; $\beta > 0$.

Young individuals are endowed with entrepreneurial talent and decide whether to use such talent to produce either consumption goods or investment goods. The

firms over the time dimension which is lower than 15.

[5]We restrict our attention to the CRRA family, because utility functions in this class display non-increasing absolute risk-aversion and imply indirect utility functions that are log-separable in the interest rate.

technologies in the two sectors are described by the production functions $y_{Ct} = z_{Ct}k_{Ct}^{\alpha}$ and $y_{It} = z_{It}k_{It}^{\alpha}$, with $\alpha \in (0,1)$. In either sector, capital depreciates at the constant rate $\delta \in (0,1)$. We assume that $z_{jt} \in \left\{z_j^h, z_j^l\right\}$ and $pr\left\{z_{jt} = z_j^h\right\} = \rho_j$, $\rho_j \in (0,1)$, for $j = C, I$. Let p_t be the relative price of the investment good in terms of consumption goods, and N_t the fraction of entrepreneurs (i.e. the fraction of young agents) engaged in the production of investment goods. Old individuals do not work, and consume from assets accumulated when young.

The two sectors only differ with respect to the support and probability distribution of the random variables z_{Ct} and z_{It}. Importantly, we assume that $\Delta_I > \Delta_C$, where $\Delta_j \equiv z_j^h - z_j^l$ for $j = C, I$. That is, we assume that in the investment good sector the cash-flow process is more volatile than in the consumption good sector.

The output realization is private information for the entrepreneurs, who have the option of hiding some of their cash-flows from their financiers. Hiding, however, is costly. For every unit of cash-flow hidden, an entrepreneur ends up with only the fraction $\xi \in [0,1]$. The balance is lost in the hiding process.[6] The parameter ξ is our measure of the economywide level of investor protection – the larger is ξ, the lower the protection. The two extreme values identify the cases of complete absence of protection ($\xi = 1$) and perfect protection ($\xi = 0$).

Figure 7 displays the timing assumed in the model. At the outset, an entrepreneur operating in sector j borrows capital, k_{jt}, from an intermediary, then invests and produces output equal to $z_{jt}f(k_{jt})$. Next, he makes a claim about the quality of his project $\hat{z}_{jt} \in \{z_j^h, z_j^l\}$, gives the intermediary output consistent with this claim, i.e. $\hat{z}_{jt}f(k_{jt})$, and receives a contingent transfer $\tau_{jt}(\hat{z}_{jt})$.[7] Therefore a financing contract offered to a sector-j entrepreneur consists of a capital advance, k_{jt}, and contingent transfers τ_{jt}^h and τ_{jt}^l.

At the end of the first period, entrepreneurs end up with income we denote by m_t. If the project is of low quality, necessarily $m_t = \tau_{jt}^l$. Having no endowment, an agent is unable to misreport in the low state, since that would entail surrendering a level of output $z_j^h f(k_{jt})$. If the project is of high quality, truthful reporting yields $m_t = \tau_{jt}^h$, and concealing yields $m_t = \tau_{jt}^l + \xi\Delta_j f(k_{jt})$. By misreporting, the entrepreneur receives

[6] All of our results follow even when a portion, or the totality of this balance accrues to the intermediaries. The only caveat is that in such case it is necessary to work with a continuum of outcomes. Otherwise, any hiding would be detected by the lender. See the Appendix to Castro, Clementi, and MacDonald (2004) for details.

[7] In the appendix to Castro, Clementi, and MacDonald (2004) we show that under our assumptions the Constrained-Pareto optimal contract always requires the output surrendered to be consistent with the report. In turn, this implies no hiding along the equilibrium path.

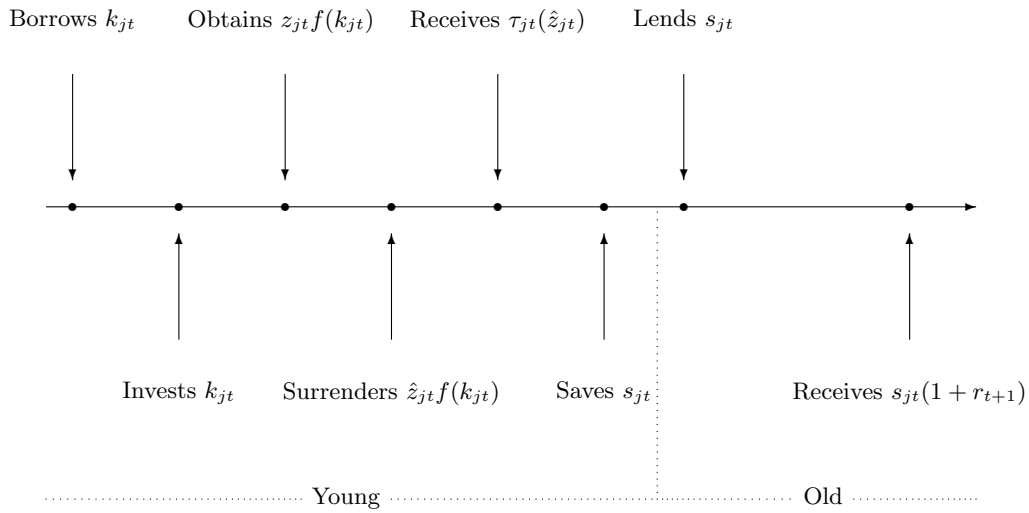

Figure 7: Timing.

the transfer intended for low quality projects, τ^l_{jt}, plus the fraction ξ of the hidden output $\Delta_j f(k_{jt})$. At the end of the first stage of their lives, agents consume part of their income and save the rest. At the beginning of the second stage, they lend their savings to intermediaries at the market rate. Intermediaries channel those funds to the new cohort of young people. At the end of their lives, agents receive and consume principal and interest.[8]

In order to facilitate the exposition, we will analyze the case in which $\Delta_C = 0$. In that case, the output realization in the consumption good sector is public information. In Section ** it will become clear that all of results follow even in the more general case in which $\Delta_C > 0$. Because of this assumption, we will adopt the following notational conventions: $\Delta \equiv \Delta_I$, $\rho \equiv \rho_I$, $z^h_{It} \equiv z_{ht}$, $z^l_{It} \equiv z_{lt}$, $\tau^h_{It} \equiv \tau_{ht}$ and $\tau^l_{It} \equiv \tau_{lt}$.

4 Competitive equilibrium

We start by considering an entrepreneur's consumption-saving decision. This simple problem is the same for all agents. Let $v(m_t, r_{t+1})$ denote the indirect utility of an agent born at time t, conditional on having received an income m_t and on facing an interest rate r_{t+1}. Then,

$$v(m_t, r_{t+1}) \equiv u\left[m_t - s(m_t, r_{t+1})\right] + \beta u\left[(1 + r_{t+1})s(m_t, r_{t+1})\right],$$

[8]Notice that the rate r_t denotes the return in consumption goods to the investment of one unit of consumption good.

where the optimal saving function $s(m_t, r_{t+1})$ is

$$s\left(m_t, r_{t+1}\right) \equiv \arg\max_s \left\{u\left(m_t - s\right) + \beta u\left[\left(1 + r_{t+1}\right) s\right]\right\}.$$

Given our assumptions, it is clear that entrepreneurs in the consumption good sector will always achieve perfect risk-sharing and will be able to implement the efficient scale. Their income τ_{Ct} is the value of the following problem:

$$\max_{k_{Ct}} z_C k_{Ct}^{\alpha} - (r_t + \delta) p_t k_{Ct}. \tag{P1}$$

Entrepreneurs in the investment good sector will be offered contracts $(k_{It}, \tau_{ht}, \tau_{lt})$ that solve the optimization problem:

$$\max_{k_{It}, \tau_{ht}, \tau_{lt}} \rho v\left(\tau_{ht}, r_{t+1}\right) + (1 - \rho) v\left(\tau_{lt}, r_{t+1}\right), \tag{P2}$$

subject to incentive compatibility for entrepreneurs whose projects are high quality, i.e.,

$$v\left(\tau_{ht}, r_{t+1}\right) \geq v\left[\tau_{lt} + \xi p_t \Delta k_{It}^{\alpha}, r_{t+1}\right], \tag{1}$$

and the zero-profit condition for intermediaries:

$$\bar{\tau}_t \equiv \rho \tau_{ht} + (1 - \rho) \tau_{lt} = p_t \bar{z}_I k_{It}^{\alpha} - (r_t + \delta) p_t k_{It}, \tag{2}$$

with $\bar{z}_I = \rho z_h + (1 - \rho) z_l$. We now define a competitive equilibrium.

Definition 1 *Given an initial aggregate capital stock $K_0 > 0$, a competitive equilibrium is a consumption level of the initial old c_0^o, contingent consumption allocations for young and old individuals in the investment good sector, $\{c_{ht}^y, c_{lt}^y\}_{t=0}^{\infty}$ and $\{c_{ht}^o, c_{lt}^o\}_{t=1}^{\infty}$, consumption allocations for young and old individuals in the consumption good sector $\{c_t^y\}_{t=0}^{\infty}$ and $\{c_t^o\}_{t=1}^{\infty}$, sequences of contracts $\{k_{It}, \tau_{ht}, \tau_{lt}\}_{t=0}^{\infty}$ and $\{k_{Ct}, \tau_{Ct}\}_{t=0}^{\infty}$, individuals' allocation across the two sectors $\{N_t\}_{t=0}^{\infty}$, relative prices $\{p_t\}_{t=0}^{\infty}$, and interest rates $\{r_t\}_{t=0}^{\infty}$, such that*

1. $c_0^o = p_0 K_0 (1 + r_0)$
2. *for the entrepreneurs in the investment good sector and for $i = h, l$ and $t \geq 0$, $c_{it}^y = \tau_{it} - s(\tau_{it}, r_{t+1})$ and $c_{it+1}^o = s(\tau_{it}, r_{t+1})(1 + r_{t+1})$;*
3. *for the entrepreneurs in the consumption good sector $c_t^y = \tau_{Ct} - s(\tau_{Ct}, r_{t+1})$ and $c_t^o = s(\tau_{Ct}, r_{t+1})(1 + r_{t+1})$ for all $t \geq 0$*

4. *the scale in the consumption good sector is efficient, i.e. it solves problem (P1) for all* $t \geq 0$

5. *lending contracts are optimal, i.e. for all* $t \geq 0$, *they solve problem (P2);*

6. *at all* $t \geq 0$ *young individuals are indifferent between the two sectors:*

$$v(\tau_{C_t}, r_{t+1}) = \rho v(\tau_{ht}, r_{t+1}) + (1-\rho) v(\tau_{lt}, r_{t+1}) \tag{3}$$

7. *at all* $t \geq 0$ *aggregate savings are equal to the value of the capital stock:*

$$p_t K_{t+1} = N_t \left[\rho s\left(\tau_{ht}, r_{t+1}\right) + (1-\rho)\, s\left(\tau_{lt}, r_{t+1}\right)\right] + (1-N_t) s\left(\tau_{Ct}, r_{t+1}\right) \tag{4}$$

8. *at all* $t \geq 0$ *gross investment equals the production of investment goods*

$$K_{t+1} = (1-\delta) K_t + N_t \bar{z}_I k_{It}^{\alpha} \tag{5}$$

9. *at all* $t \geq 0$ *the market for capital clears*

$$K_t = N_t k_{It} + (1-N_t) k_{Ct}. \tag{6}$$

In the remainder of this section we characterize the equilibrium allocation, and then explore how it changes in response to variations in the investor protection parameter ξ.

4.1 Benchmark: Perfect investor protection ($\xi = 0$)

In this section we show that for $\xi = 0$, our model boils down to the standard two-period, two-sector model of capital accumulation. The necessary condition for problem (P1) is:

$$\alpha z_C k_{Ct}^{\alpha-1} = (r_t + \delta) p_t. \tag{7}$$

In turn, this implies that

$$\tau_{Ct} = (1-\alpha) z_C k_{Ct}^{\alpha}. \tag{8}$$

It is easy to see that for $\xi = 0$, the optimal contract in the investment good sector coincides with the first-best allocation. Such allocation must satisfy

$$\alpha \bar{z}_I k_{It}^{\alpha-1} = (r_t + \delta). \tag{9}$$

and

$$\tau_{It} \equiv \tau_{ht} = \tau_{lt} = p_t(1-\alpha)\bar{z}_I k_{It}^{\alpha}. \tag{10}$$

Conditions (7) and (11) imply that the relative price of the investment good satisfies

$$p_t = \frac{z_C}{\bar{z}_I}\left(\frac{k_{Ct}}{k_{It}}\right)^{\alpha-1}. \tag{11}$$

Using (8) and (10), we can rewrite the occupational choice condition (3) as

$$v\left[(1-\alpha)z_C k_{Ct}^{\alpha}, r_{t+1}\right] = v\left[p_t(1-\alpha)\bar{z}_I k_{It}^{\alpha}, r_{t+1}\right]. \tag{12}$$

Since v is strictly increasing in its first argument, conditions (11) and (12) imply that $k_{Ct} = k_{It}$. This, along with condition (6), implies that $k_{Ct} = k_{It} = K_t$, and so $p_t = z_C/\bar{z}_I$ and $\tau_t \equiv \tau_{Ct} = \tau_{It}$.

Under our assumption on preferences, it follows that

$$s(\tau, r_{t+1}) = \kappa\left(r_{t+1}\right)\tau_t,$$

where

$$\kappa\left(r_{t+1}\right) = \frac{1}{1+\beta^{-\frac{1}{\sigma}}\left(1+r_{t+1}\right)^{\frac{\sigma-1}{\sigma}}}.$$

Therefore (4) implies that

$$K_{t+1} = (1-\alpha)\kappa(r_{t+1})\bar{z}_I K_t^{\alpha} \tag{13}$$

The above condition, along with (9), can be used to fully characterize the equilibrium allocation. The sequence for N_t can be recovered using condition (5). Therefore, aggregation holds. When $z_C = \bar{z}_I$, the model's implications are identical to those of the standard one-sector model.

4.2 Imperfect investor protection ($\xi \in (0,1]$)

Given our assumption on preferences, it follows that Problem (P2) is independent from r_{t+1}. Optimal contracts in the investment good sector therefore solve the following problem:

$$\max_{k_{It},\tau_{ht},\tau_{lt}} V(\tau_{ht},\tau_{lt}) \equiv \rho v(\tau_{ht}) + (1-\rho)v(\tau_{lt}),$$

subject to

$$v(\tau_{ht}) \geq v\left(\tau_{lt} + \xi p_t \Delta k_{It}^{\alpha}\right) \tag{14}$$

$$\bar{\tau}_{It} \equiv \rho\tau_{ht} + (1-\rho)\tau_{lt} = p_t[\bar{z}_I k_{It}^{\alpha} - (r_t+\delta)\, k_{It}]. \tag{15}$$

Strict concavity of the utility function implies that the constraint (14) binds. Then, by strong monotonicity of $u(\cdot)$, it follows that

$$\tau_{ht} = \tau_{ht} + \xi p_t \Delta k_{It}^{\alpha}. \tag{16}$$

Given this, the contracting problem may be rewritten as

$$\max_{k_{It},\bar{\tau}_t} \rho v\left[\bar{\tau}_t + (1-\rho)\xi p_t \Delta k_{It}^{\alpha}\right] + (1-\rho) v\left[\bar{\tau}_t - \rho\xi p_t \Delta k_{It}^{\alpha}\right] \tag{P3}$$

subject to

$$\bar{\tau}_t = p_t[\bar{z}_I k_{It}^{\alpha} - (r_t+\delta)k_{It}].$$

The necessary condition for maximization is:

$$r_t + \delta = \alpha k_{It}^{\alpha-1}\left[\bar{z}_I + \rho(1-\rho)\xi\Delta\omega_t\right] \tag{17}$$

where

$$\omega_t \equiv \frac{u'(\tau_{ht}) - u'(\tau_{lt})}{\rho u'(\tau_{ht}) + (1-\rho)u'(\tau_{lt})}.$$

By conditions (7) and (17), we can express the relative price of the investment good as:

$$p_t = \frac{z_C}{\bar{z}_I + \rho(1-\rho)\xi\Delta\omega_t} Q_t^{\alpha-1}, \tag{18}$$

where $Q_t \equiv k_{Ct}/k_{It}$.

It turns out that under our assumptions, Q_t and p_t are time-invariant.

Lemma 2 *For all $t \geq 0$, $p_t = p$, $Q_t = Q$, and $\omega_t = \omega$. Furthermore, $\tau_{ht} = pg_h k_{It}^{\alpha}$ and $\tau_{lt} = pg_l k_{It}^{\alpha}$, for some constants g_h and g_l.*

Proof. Conjecture that $\tau_{ht} = p_t g_h k_{It}^{\alpha}$ and $\tau_{lt} = p_t g_l k_{It}^{\alpha}$. Then,

$$r_t + \delta = \alpha k_{It}^{\alpha-1}\left[\bar{z}_I + \rho(1-\rho)\xi\Delta\frac{u'(g_h) - u'(g_l)}{\rho u'(g_h) + (1-\rho)u'(g_l)}\right]$$

Substituting the above into the following two conditions,

$$\tau_{lt} = p_t[(\bar{z}_I - \rho\xi\Delta)\, k_{It}^{\alpha} - (r_t + \delta)\, k_{It}] \tag{19}$$

and

$$\tau_{ht} = p_t[(\bar{z}_I + (1-\rho)\,\xi\Delta)\, k_{It}^{\alpha} - (r_t + \delta)\, k_{It}]. \tag{20}$$

One can verify the conjecture and show that g_h and g_l are the solutions to the following system of equations.

$$\begin{aligned}
g_h &= (\bar{z}_I + (1-\rho)\xi\Delta) - \alpha[\bar{z}_I + \rho(1-\rho)\xi\Delta\omega]) \\
g_l &= (\bar{z}_I - \rho\xi\Delta) - \alpha[\bar{z}_I + \rho(1-\rho)\xi\Delta\omega] \\
\omega &= \frac{g_h^{-\sigma} - g_l^{-\sigma}}{\rho g_h^{-\sigma} + (1-\rho) g_l^{-\sigma}}.
\end{aligned}$$

Then, the occupational choice condition (3) becomes:

$$u[(1-\alpha) z_C k_{Ct}^{\alpha}] = \rho u(p_t g_h k_{It}^{\alpha}) + (1-\rho) u(p_t g_l k_{It}^{\alpha})$$

or

$$u[(1-\alpha) z_C Q_t^{\alpha}] = [\rho u(p_t g_h) + (1-\rho) u(p_t g_l)] \tag{21}$$

Conditions (18) and (21) imply that Q_t and p_t are indeed time invariant. ■

Lemma 2 simplifies the characterization of the dynamics of our economy. From (4) and (5), we obtain that

$$\kappa(r_{t+1})\left\{N_t\left[\rho\tau_{ht} + (1-\rho)\tau_{lt}\right] + (1-N_t)\tau_{Ct}\right\} = p(1-\delta)K_t + pN_t\bar{z}_I\left(\frac{K_t}{N_t + (1-N_t)\,Q}\right)^{\alpha}. \tag{22}$$

Then condition (6) implies that $k_{It} = \frac{K_t}{N_t + (1-N_t)Q}$. Therefore we can express τ_{ht}, τ_{lt}, and τ_{Ct} as functions of K_t and N_t only:

$$\begin{aligned}
\tau_{ht} &= p g_h \left(\frac{K_t}{N_t + (1-N_t)\,Q}\right)^{\alpha}, \\
\tau_{lt} &= p g_l \left(\frac{K_t}{N_t + (1-N_t)\,Q}\right)^{\alpha}, \\
\tau_{Ct} &= (1-\alpha)\, z_C \left(\frac{QK_t}{N_t + (1-N_t)\,Q}\right)^{\alpha}.
\end{aligned}$$

We can also write that

$$r_{t+1} + \delta = \frac{1}{p}\alpha z_C \left(\frac{Q\left(1-\delta\right)K_t + QN_t\bar{z}_I\left(\frac{K_t}{N_t+(1-N_t)Q}\right)^{\alpha}}{N_{t+1} + \left(1-N_{t+1}\right)Q} \right)^{\alpha-1} \tag{23}$$

and

$$K_{t+1} = (1-\delta)K_t + N_t\bar{z}_I\left(\frac{K_t}{N_t+(1-N_t)Q}\right)^{\alpha}. \tag{24}$$

For given K_0, equations (22) and (24) determine the equilibrium paths for N_t and K_t. We will use them to analyze how the equilibrium allocation changes with the quality of legal institutions, that is the parameter ξ. Given the high nonlinearity of the above expression, we will resort to a numerical approximation of the allocation. However, it is possible to prove (see Proposition 1) that both the relative price of the investment good p and the ratio $Q = \frac{k_{Ct}}{k_{It}}$ are higher when the quality of institutions is worse.

Proposition 1 *p and Q are both strictly increasing in ξ.*

Proof.

[To be included] ■

4.3 Comparative Dynamics

The purpose of this section is to use our model to develop predictions for the co-variation between the quality of legal institutions and a number of variables of interest such as GDP, TFP, and investment rate, measured both in the domestic and international prices, the relative price of capital goods, and the relative size of firms operating in the consumption good sector. To this effect, we conduct a comparative dynamics exercise. For given initial aggregate capital stock, we characterize the competitive allocation of two economies equal in every respect but in the level of investor protection. For the variables of interest, Figure 8 depicts the competitive equilibrium dynamics implied by levels of investor protection $\xi = 0$ and $\xi = 1$, respectively. The remaining parameter values are as follows:

β	α	δ	ρ	z_h	z_l	σ
0.99	2/3	0.15	0.4	3	1.33	0.8

Given the stylized features of our model, a calibration is not in order. This exercise is to be intended as an illustration of some of the qualitative properties of the competitive equilibrium allocation.

Under our assumption on the cross-sectoral variation in baseline idiosyncratic risk, poor investor protection introduces a distortion in the allocation of resources between the investment good and consumption good sector. Such distortion is ultimately responsible for the lower level of capital stock and GDP. Notice however that, when measured in domestic prices, investment rates do not vary substantially with investor protection. The reason is that relative prices adjust for the change in the relative efficiency across sectors. When international prices are used, it is clear that the investment rate is substantially smaller in the case of poor investor protection.[9]

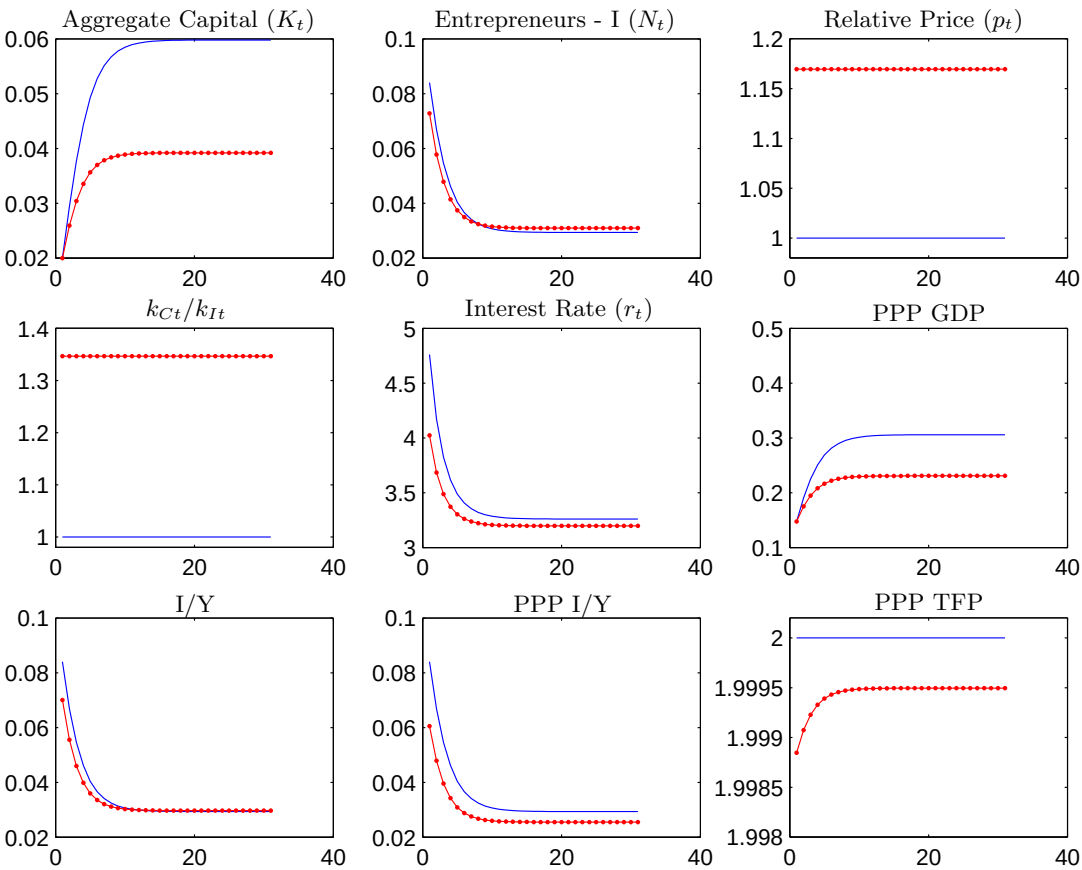

Figure 8: Comparative Dynamics (Dotted line = higher ξ).

Interestingly, our theory also implies that measured aggregate TFP increases with investor protection. Consistently with the empirical literature[10], the Solow residual is

[9]The PPP-adjusted variables use $p^w = 1$ as the relative price of investment. This is the price that would prevail if $\xi = 0$ in the rest of the world.

[10]See for example Hall and Jones (1999) and Klenow and Rodriguez-Clare (1997)

computed as $Z_t = Y_t^{PPP} K_t^{-\alpha}$, where $Y_t^{PPP} = (1 - N_t) z_C k_{Ct} + p^w N_t z_C k_{It}$. It appears that cross-country differences in legal institutions are able to generates differences in both aggregate total factor productivity and accumulation rates, the two forces that are unanimously singled out as the determinants of cross-country differences in income per worker.

Next, we are interested in understanding how the implications of our model would differ if the source of cross-country heterogeneity was in relative productive efficiency, rather than in the quality of legal institutions. To this effect, we carry out a comparative dynamics exercise similar to the one above. The only difference is that now the two economies differ in the productive efficiency of the investment good sector ($\bar{z}_I$), rather than in investor protection (we assume $\xi = 0$ for both economies). The exercise shows that the qualitative implications are the same, the only exception consisting in the prediction for relative firm size. Differently from the heterogeneity in legal institutions, differences in relative productive efficiency do not generate cross-country variation in relative size. In principle, this difference in predictions could be exploited to discriminate among the two mechanisms. In Section 5 we provide some preliminary evidence in support of the prediction that relative size does indeed vary with the quality of legal institutions.

5 Further empirical implications

In Section 4 we have shown that our model generates implications for the cross-country variation in the relative price of investment goods, investment rates, and measured TFP, which are qualitatively consistent with the evidence.

The model can also be used to derive predictions for the relation between volatility and firm size. The analysis conducted in Section 4 suggests that in countries characterized by poor investor protection, more volatile firms should be smaller relative to less volatile firms.

In the reminder of this section we test this implication using the indicators of investor protection introduced by La Porta, Lopez-de Silanes, Shleifer, and Vishny (1998) along with data from the 2003 UNIDO Industrial Statistics Database. La Porta, Lopez-de Silanes, Shleifer, and Vishny's (1998) indicators quantify explicit protections awarded to shareholders and creditors by corporate, bankruptcy, and reorganization laws, as well as the quality of law enforcement. We focus on three of them. The

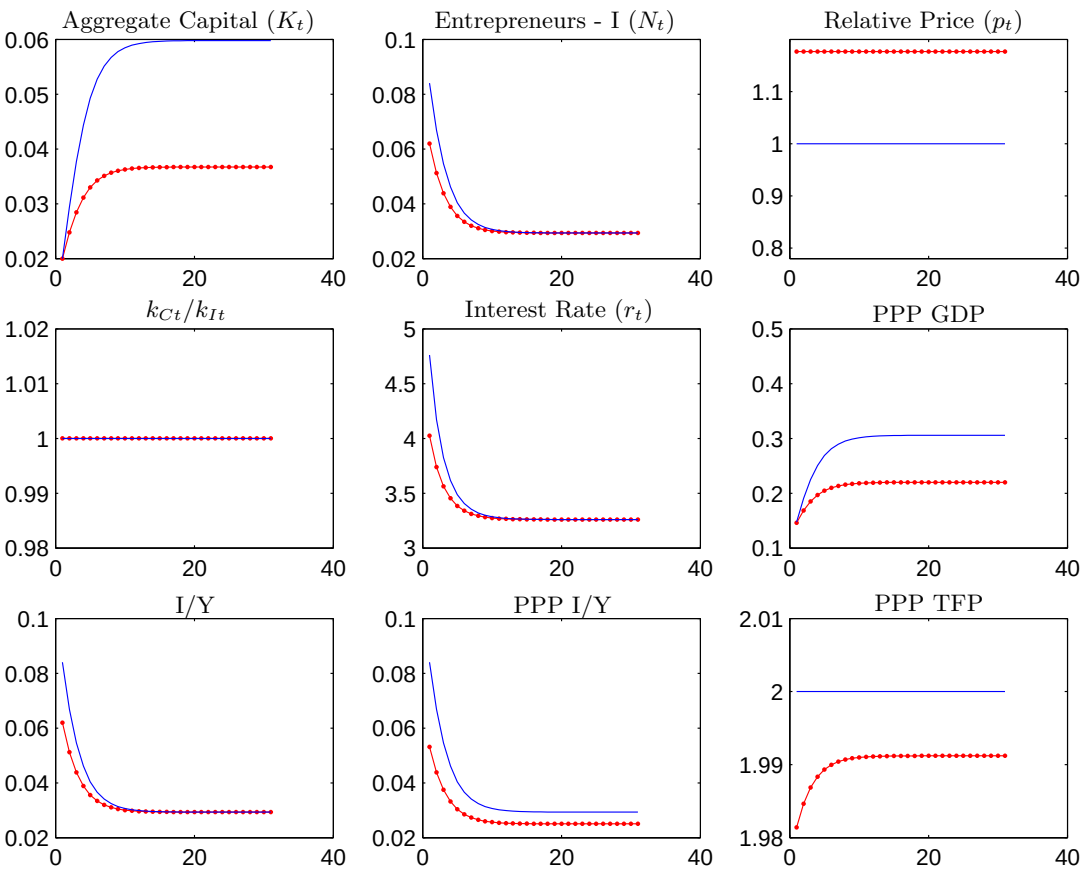

Figure 9: Comparative Dynamics (Dotted line = lower $\bar{z}_I$).

variable CR is an index aggregating different *creditor rights* in firm reorganization and liquidation upon default. The indicator *anti-director rights, AR*, is an index of shareholder rights geared towards measuring the ability of small shareholders to participate in decision-making. Finally, the index *rule of law, RL*, proxies for the quality of law enforcement. The 2003 UNIDO Industrial Statistics Database provides information on average employment for companies in 151 3- and 4-digit ISIC manufacturing industries for 102 countries during the period 1990-2001.

Our procedure is as follows. We rank the 3-digit NAICS industries according to their volatility as estimated in Section 2. We then use the concordance table between the 1997 revision of the North American Industry Classification System (NAICS) and the International Standard Industrial Classification (ISIC) Rev.3 in order to identify the 3-digit NAICS sectors to which the companies in each 3-digit ISIC sector belong. A 3-digit ISIC industry is classified as high-volatility if and only if all the corresponding 3-digits NAICS sectors' estimated volatilities are higher than the volatility of the

median sector. Analogously, a 3-digit ISIC industry is classified as low-volatility if and only if all the corresponding 3-digits NAICS sectors' estimated volatilities are lower than the volatility of the median. Then we restrict our attention to the countries that are included in both datasets. For all such countries, and for every pair formed by a low- and a high-volatility sector, we compute the ratio between the average employment of the former and the average employment of the latter. For every pair of sectors, this allows us to compute the correlation between the ratio of sizes and the measures of investor protection.[11]

Figure 10 plots the logarithm of relative size against the indicator *rule of law*, in the case of two pairs of consumption and investment goods. Consistently with our assumption and with the evidence introduced in Section 2, the former are classified as low-volatility, and the latter as high-volatility. The consumption good sectors are ISIC 152 and 173 (*Diary Products* and *Knitted and Crocheted Fabrics and Articles*, respectively). The investment good sectors are ISIC 291 and 300 (*General Purpose Machinery* and *Office, Accounting, and Computing Machinery*, respectively).

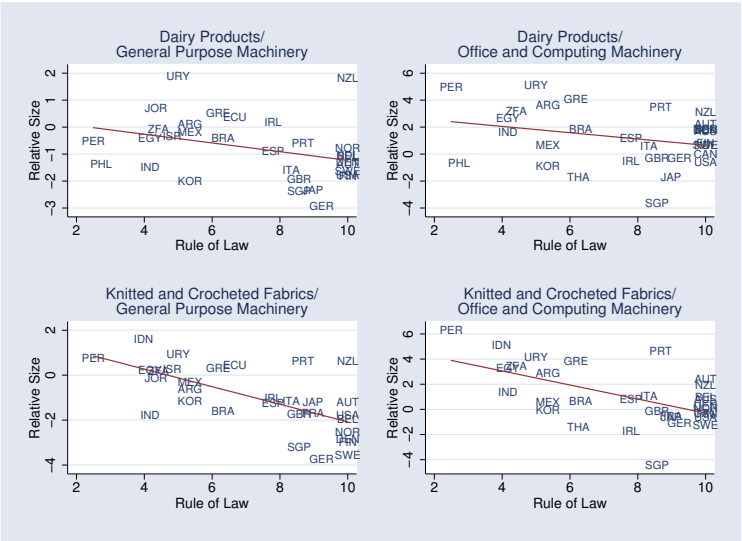

Figure 10: Correlation between relative size and investor protection.

Figures 11 and 12 show that these are not carefully chosen examples. The histograms represent the frequency distributions of the correlation coefficients, for each of the investor protection measures.

The data clearly suggests that, in accordance with the prediction of our theory,

[11]The number of countries is not the same for all pairs because there are missing values in the UNIDO Industrial Statistics Database. We include in our analysis only the pairs for which we have more than 10 observations.

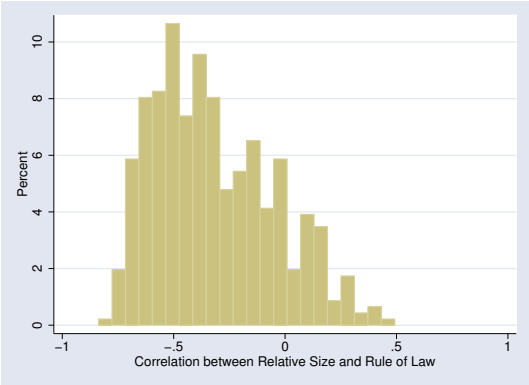

Figure 11: Correlation between relative size and investor protection.

there exists a negative correlation between the relative size of firms in the consumption good sector and investor protection.[12] When the variable RL is used, the results are staggering.

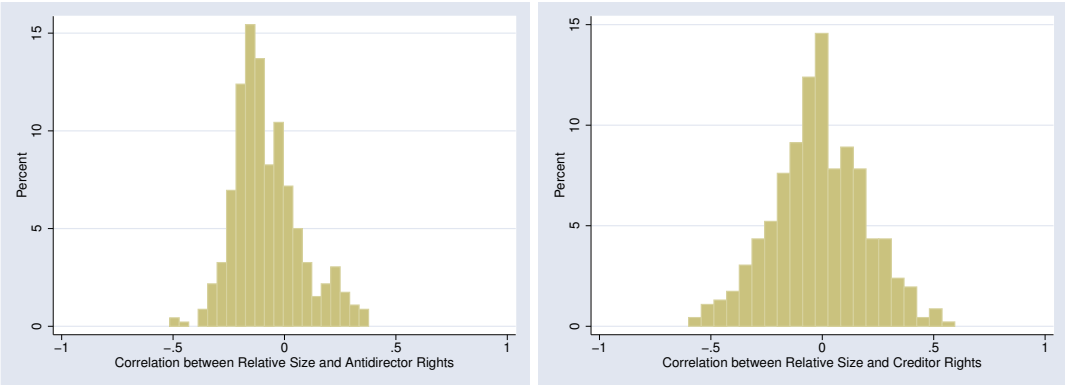

Figure 12: Correlation between relative size and investor protection.

6 Conclusion

TO BE ADDED

A Data

We explain in some extra detail our procedure for assigning 3-digit NAICS codes to the consumption and the investment good sector categories. Our procedure is

[12] Our results are very similar when we use the rank (Spearman) correlation coefficient to measure the association between the two variables.

very similar to the one described in Appendix 2 of Chari, Kehoe, and McGrattan (1996). We rely on the Bureau of Economic Analysis' 1997 Benchmark Input-Output Use Summary Table for the US. This table provides information on the total value of commodities produced by each 3-digit industry that are (i) used by each 3-digit industry, and (ii) used in final demand uses.

We first group final demand uses into two categories, consumption (C) and investment (I). We do this by aggregating personal consumption expenditures with federal and state consumption expenditures into a single consumption category, and similarly for investment expenditures. Since the Use Table does not provide a breakdown of imports, exports, and changes in inventories into consumption and investment, we chose to ignore these final demand items.

Denote by A the square matrix of unit input-output coefficients, which may be easily constructed from the original Use Input-Output Matrix, by normalizing each row by the total commodity column. We define the total output of the consumption and the investment good sectors per 3-digit industry by, respectively

$$\begin{aligned} Y_C &= AY_C + C \Leftrightarrow Y_C = (I - A)^{-1} C \\ Y_I &= AY_I + I \Leftrightarrow Y_I = (I - A)^{-1} I. \end{aligned}$$

This means we consider consumption good production as being all production, including intermediate good production, whose ultimate destination is final consumption, and similarly for investment.

We then compute the share of consumption production for each 3-digit industry, $Y_C(j)/\left(Y_C(j) + Y_I(j)\right)$, for $j = 1, \ldots, N$, where N is the number of industries. Based upon this measure, we assign all industries with a share greater than or equal to 60% to the consumption good sector, and those with a share lower than or equal to 40% to the consumption good sector. We discard the remaining industries.

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