Legal Institutions, Sectoral Heterogeneity, and Economic Development*

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Preliminary and Incomplete - Comments Welcome

Abstract

In this paper we provide a novel rationalization for the the observed correlations between income per worker, investment rate, and relative price of capital goods. Our analysis is based on two observations: 1) countries differ with respect to the rights enjoyed by outside investors (such as bondholders and minority shareholders) and 2) firms producing capital goods tend to face a higher level of idiosyncratic risk than their counterparts producing consumption goods. In a model of capital accumulation where the protection of investors' rights is incomplete, this difference in risk induces a wedge between the returns on investment in the two sectors. In accordance with the evidence, we find that countries with better institutions (better investor protection) tend to (i) have higher investment rates, (ii) be richer, (iii) have a lower relative price of capital goods, and (iv) have a higher measured aggregate TFP.

Key words.
JEL Codes: .

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1 Introduction

One of the most staggering features of economic development is the enormous disparity of per capita output levels across countries. It is well known that such disparity is associated with differences in both factors of accumulation and total factor productivity: rich countries invest more, but also use their inputs more productively. The main objective of this research is to show that the cross-country variation in the quality of legal institutions may account for the observed correlation between per-capita income, investment rates, and measured total factor productivity.

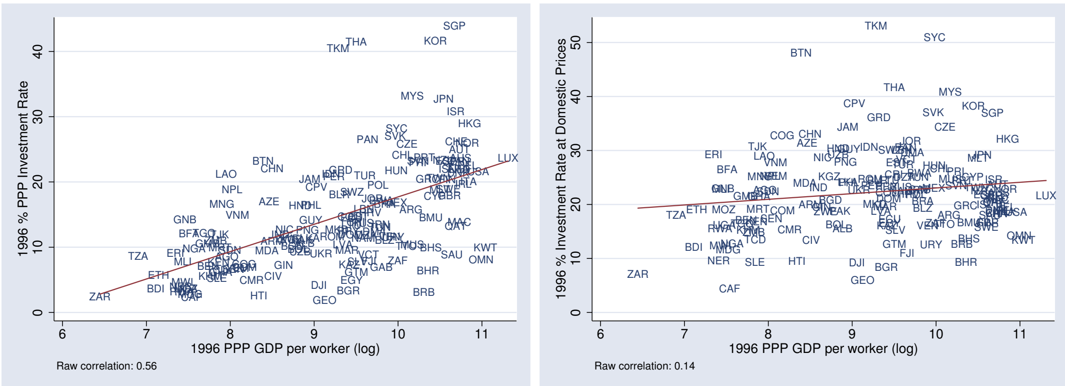

Figure 1: Investment Rates and Income Levels.

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. When capital goods are valued using international prices, investment rates covary positively with income. However, when domestic prices are used, this positive association disappears: 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 Table, version 6.1. A third fact, also reported by De Long and Summers (1991), Easterly (1993), and Jones (1994), and documented in Figure 2, is that the relative price of investment goods with respect to consumption goods is negatively correlated with income.[1] These observations suggest that rich and poor countries devote similar fractions of their incomes to investment expenditures, but the former obtain a higher yield in terms of capital

[1]The series of relative prices was constructed using the price indexes for consumption and investment goods reported in the Penn World Table 6.1. The methodology followed in constructing these indexes is outlined in Heston and Summers (1991) and in the technical documentation available at http://pwt.econ.upenn.edu/

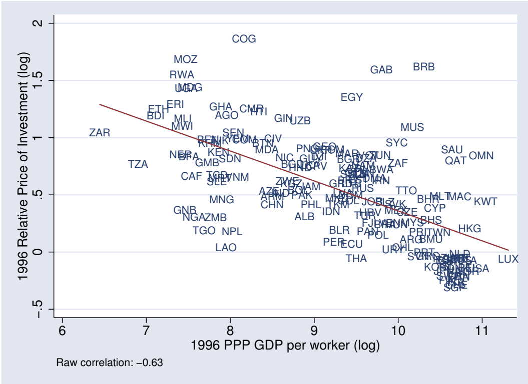

Figure 2: Relative price of Investment Goods and Income Levels.

goods. In this paper we present a model of economic growth whose predictions are consistent with these findings.

The novelty of our approach lies in the assumption that countries differ with respect to the legal institutions that protect investors from exploitation from insiders. Several recent papers provide evidence in support of this claim. La Porta, Lopez-de Silanes, Shleifer, and Vishny (1998), for example, document that countries differ dramatically with respect to the nature and enforcement of the rights the law awards to outside investors. The other crucial assumption is that firms producing investment goods face higher baseline idiosyncratic risk than firms producing consumption goods. Data drawn from the COMPUSTAT Files provide strong support for this hypothesis. In Section 2 we show that, even after controlling for a set of observable characteristics and for unobserved heterogeneity, companies producing capital goods do display a much higher volatility of sales. In our model, technologies and tax policies are assumed to be the same across countries. This assumption, albeit counterfactual, allows us to isolate the effect of heterogeneity in institutions.

Ours is 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. Regardless of his choice, he will have access to a technology displaying decreasing returns to capital. The output outcome is stochastic, i.i.d. across technologies, and known only to the technology's owner. The only difference across sectors is that cash flows are more volatile in the case of firms producing investment goods. Young individuals, who we refer to as entrepreneurs, borrow capital from the old through financial intermediaries. The interaction between entrepreneurs and intermediaries takes the familiar form of an optimal contracting problem under asymmetric information. The optimal contract trades off risk-sharing and incentive provision. We model institutions by assuming that entrepreneurs who misreport their outcomes and hide resources face a deadweight loss. This loss, which we call *hiding cost*, is intended to capture all institutional features that limit the ability of insiders to expropriate outside investors. The higher the cost, the better the investor protection (the quality of institutions).[2]

The optimal contract dictates that in either sector risk-sharing is increasing in the level of investor protection and decreasing in the volatility of cash flows. Given our assumption on the cross-sectoral variation in volatility, this implies a wedge between the returns to investment in the consumption and in the investment good sector. Comparative dynamics exercises show that the size of this wedge is larger, the poorer the 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 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. This happens because the wedge between the rates of return on investment in the two sector induces an allocative inefficiency, whose magnitude depends negatively on the level of investor protection.

Our main conclusion is that differences in the quality of the legal system can generate correlation patterns between income levels and the relative price of capital goods, investment rates, and measured aggregate TFP, which are qualitatively in line with the data. Interestingly, our model also predicts that the relative size of high-volatility firms should be higher in countries with better investor protection. In spite of severe data limitations, we attempt to test this implication. Our results are mixed, and clearly beg for further investigation.

Ours is not the first attempt to provide a rationalization for the observed correlations between income levels, investment rates, and relative prices. Restuccia and Urrutia (2001) and Chari, Kehoe, and McGrattan (1996) have emphasized the role that might be played by distortionary taxation: governments 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. This conclusion,

[2] Our hiding cost resembles the falsification cost considered by Lacker and Weinberg (1989).

still according to Hsieh and Klenow (2003), is not supported by the data: absolute prices of investment goods do not change systematically with income.[3] Hsieh and Klenow (2003) argue that poor countries may have lower investment rates because they are relatively more efficient in the production of consumption goods.[4] 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 as input the documented cross-country variation in the quality of legal institutions and generates as output the variation in relative productivity that constitutes the base of their work.

Our paper is also closely related to recent contributions by Restuccia and Rogerson (2003), Guner, Ventura, and Yi (2005), Restuccia (2004), and Erosa and Hidalgo-Cabrillana (2004). In common with these authors, we posit that allocative inefficiencies may be responsible for the observation that poor countries tend to have both lower TFP and lower accumulation rates of reproducible factors. Restuccia and Rogerson (2003) and Guner, Ventura, and Yi (2005) study the effects of distortionary policies that lead to the misallocation of resources across plants. In the case of Restuccia (2004), countries differ with respect to a technology parameter that determines the rate at which output is transformed into capital. Since modern (more productive) technologies are more capital intensive, countries where capital accumulation is costlier in terms of consumption goods will be slower at adopting new technologies. This will result in lower income, slower capital accumulation, and lower TFP (because the labor force will be allocated to less productive uses). Our work provides a micro-foundation for the assumption of cross-country heterogeneity in the efficiency of the capital accumulation process. We see our paper as being closest to Erosa and Hidalgo-Cabrillana's (2004). As it is the case here, in their work the source of allocative inefficiencies resides in information asymmetries in financial markets. Similarly to us, they assume that countries differ with respect to the enforcement of investors' rights, and obtain that the inefficiency is smaller, the more effective the enforcement. An important difference between the two environments is that in their model industries differ in their fixed costs, rather than in the volatility of cash flows.

We would also like to emphasize that ours is one of the first models of economic

[3]Rather, 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.

[4]Restuccia and Urrutia (2001) also develop a version of their model with cross-country differences in sectoral productivities rather than in investment distortions.

development to deliver predictions for cross-country and cross-industry variation in firm size and financing choices. With respect to firm size, our model generates implications that are similar in spirit to the hypothesis tested by Rajan and Zingales (1998), Beck, Demirguc-Kunt, and Maksimovic (2005), and Beck, Demirguc-Kunt, Laeven, and Levine (2004). Our view is that as we amend existing frameworks by introducing more and more detailed models of firm behavior, results reached by the industrial organization and the corporate finance literatures may prove very handy in trying to understand economic development.

Finally, our paper is also part of a recent literature that models investor protection in general equilibrium. Shleifer and Wolfenzon (2002) study the effect of investor protection on the size of the equity market and the number of public firms. Fabbri (2004) extends this analysis to consider the impact of the quality of legal institutions on firm size and aggregate activity. Albuquerque and Wang (2004) look at the asset-pricing implications.

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, and derive our main result. In Section 5 we employ cross-country firm-level data to investigate whether the correlation between firm size and investor protection depend on the volatility of cash flows. Section 6 concludes.

2 Empirical Evidence on Firm-Level Volatility

In this section we provide empirical evidence in support of our claim that firms in the investment good sector face higher baseline idiosyncratic risk than firms in the consumption good sector. As it will become clearer in Section 3, we are interested in assessing the fraction of risk that is not accounted for by factors that would be known to a firm's financier. Among these factors, some are also observable to the econometrician: size, age, and the sensitivity to aggregate fluctuations; others, such as firm specific characteristics, are not. Our objective is to test whether in the case of firms producing investment goods the *conditional* standard deviation of sales is systematically higher than in the case of firms producing consumption goods.

Our dataset is an unbalanced panel of 9,991 firms, distributed in 63 3-digit NAICS sectors. It consists of a total of 125,895 firm-year observations, drawn from Standard

& Poor's COMPUSTAT North-America Industrial Annual Database from 1950 to 2003.[5] We classify industries as consumption or investment good producing, based on the final destination of their output. The Bureau of Economic Analysis' Benchmark Input-Output tables provide information on the contribution of each industry to consumption and investment final demand uses. We classify an industry as a consumption good sector, say, if the ultimate destination of a sufficiently large share of its output is final consumption. We use an analogous rule to assign industries to the investment good category, and we discard sectors with very similar contributions to either final use.[6]

Our measure of sales is Compustat item # 12, *net sales.* We first compute the portion of sales growth that is not accounted for by factors, either known or unknown to the econometrician, that are strongly associated with firm growth. We accomplish this task by estimating the following regression:

$$\Delta \ln(sales)_{ijt} = \alpha_i + \delta_j \Delta \ln(GDP)_t + \beta_{1j} \ln(size)_{ijt} + \beta_{2j} \ln(age)_{ijt} + \epsilon_{ijt}. \quad (1)$$

The dependent variable is the growth rate of real sales (net sales over the GDP deflator) for firm i in sector j between years t and $t+1$. The dummy variable α_i is a firm-specific fixed effect that accounts for unobserved heterogeneity across firms, i.e. for the eventuality that firms have permanently different growth rates for reasons that are unknown to us. Real GDP growth is introduced to control for the variability in sales induced by business cycle fluctuations. The coefficient δ_j is sector-specific because industries differ in their sensitivity to such fluctuations. In particular, since investment expenditures are well-known to be much more volatile than consumption expenditures at the business cycle frequency,[7] we expect δ_j to be larger for sectors producing capital goods. Finally, size and age are included because the empirical Industrial Organization literature[8] has shown that firm growth declines systematically with both of these variables. Size is Compustat item # 29, *employees*, whereas age is the time since a firm first appeared in the sample.[9]

[5] Our sample selection procedure is detailed in Appendix A.1.

[6] Ideally, one would like to consider durable consumption expenditures as investment expenditures. The estimates reported in Table 2 in Appendix A.1 indicate that consumption sectors that according to common wisdom are more likely to produce durables behave much like investment good sectors. Unfortunately, the I-O tables do not break down consumption expenditures into durables and non-durables.

[7] See for example Kydland and Prescott (1990).

[8] See Evans (1987) and Hall (1987).

[9] The number of employees is the most common measure of firm size in the empirical IO literature. Its main advantage is that it is relatively immune to measurement problems.

The OLS estimates are reported in Table 3 in Appendix A.1. Overall, these results are consistent with the well known findings that firm growth is decreasing in both age and size, and that the sales of investment-good firms are more sensitive to aggregate fluctuations than their consumption-good counterparts'.

The objects of our interest, however, are the residuals $\hat{\epsilon}_{ijt}$, as they can be used to test for systematic differences in conditional volatility across sectors. The null hypothesis is that $var(\epsilon_{ijt})$ is the same for firms belonging to consumption and investment good sectors. The Breusch-Pagan test rejects it categorically at the conventional significance level.[10]

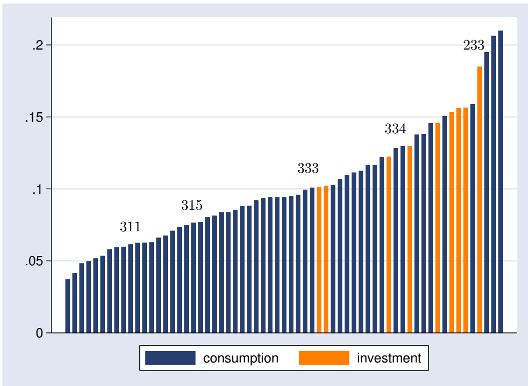

Figure 3: Volatility of sales growth per 3-digit industry.

Next, we would like to understand whether the test's result is driven by a small number of large and very volatile investment good sector, or whether it is the consequence of a more general tendency. To this end, we estimate the following regression:[11]

$$\ln \hat{\epsilon}^2_{ijt} = \theta_j + u_{ijt}. \tag{2}$$

Letting $\hat{\theta}_j$ denote the point estimate of the dummy coefficient θ_j, $\sqrt{\exp(\hat{\theta}_j)}$ is our estimate of the conditional standard deviation of sales for firms in sector j. The estimates for all sectors are reported in Table 3 and graphed in Figure 3, sorted in ascending order. It appears that the firms in all investment good sectors are among the most volatile in the economy. This is the case, for example, for companies in Machinery Manufacturing (NAICS code 333), Computer and Electronic Product Manufacturing (334), and Construction (233). Conversely, firms in either Food Manufacturing (311)

[10]We base this test on a regression similar to (2). The Breusch-Pagan test statistic is equal to 856.06, with a p-value lower than 0.0001.

[11]This formulation results from the assumption of a particular functional form for the sectoral variance, $\sigma_j^2 = \sigma^2 \exp(\theta_j)$. The reader may realize that this is a special case of the multiplicative heteroscedasticity model analyzed by Harvey (1976).

or Apparel Manufacturing (315), two of the largest industries in terms of value-added in most economies, appear to be among the least volatile.

We have conducted a series of robustness checks, the details of which are reported in Appendix A.1. Our results do not change in any appreciable way when we change the sample selection procedure or the regression equation specification. Therefore we interpret these findings as providing strong support for the claim that firms producing investment goods face a higher idiosyncratic risk than firms producing consumption goods.

While providing a rationalization for this finding is not the purpose of this paper, we feel that it would be of independent interest to do so. Accounting for it may also provide insights into the determinants of the post-WWII increase in sales volatility recently documented by Comin and Philippon (2005). Our conjecture is that in the case of most investment and durable goods there is a greater scope for process and product innovation. The findings of Klenow (1996) seem to be consistent with this hypothesis.[12] Our idea is that in these industries firms are arranged on a quality ladder. The adoption of an innovation ahead of its peers allows a laggard to advance to the frontier, boosting its sales, possibly in a rather dramatic way. Conversely, the early adoption by a competitor has the potential to depress its results. Our argument is in the spirit of the quality ladder models of endogenous economic growth à la Grossman and Helpman (1991) and Aghion and Howitt (1992). We now turn to the model.

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.[13] 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

[12] We refer to distribution of R&D expenditures across 2- and 3-digit industries, documented in Tables 2 and 3 of that paper, respectively.

[13] 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.[14] 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 4 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 $\tau_{jt}(\hat{z}_{jt})$.[15] 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 $m_t = \tau_{jt}^l + \xi p_{jt}\Delta_j f(k_{jt})$, where p_{jt} is the price of the sector-j

[14] 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.

[15] 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.

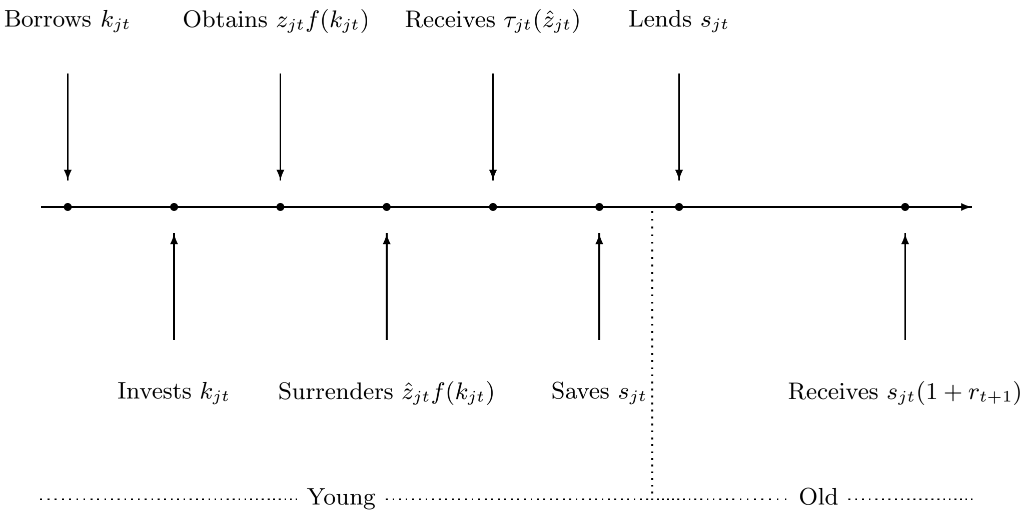

Figure 4: Timing.

good in terms of consumption ($p_{Ct} = 1$). By misreporting, the entrepreneur receives the transfer intended for low quality projects, τ^l_{jt}, plus the fraction ξ of the hidden output $p_{jt}\Delta_j f(k_{jt})$. 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.[16]

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: $\Delta \equiv \Delta_I$, $\rho \equiv \rho_I$, $z^h_{It} \equiv z_{ht}$, $z^l_{It} \equiv z_{lt}$, $p_{It} = p_t$, $\tau^h_{It} \equiv \tau_{ht}$ 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

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

interest rate r_{t+1}. Then,

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

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.,

$$v\left(\tau_{ht}, r_{t+1}\right) \geq v\left[\tau_{lt} + \xi p_t \Delta k_{It}^{\alpha}, r_{t+1}\right], \tag{3}$$

and the zero-profit condition for intermediaries:

$$\bar{\tau}_t \equiv \rho\tau_{ht} + (1 - \rho)\,\tau_{lt} = p_t \bar{z}_I k_{It}^{\alpha} - \left(r_t + \delta\right) p_t k_{It}, \tag{4}$$

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:*

$$v(\tau_{C_t}, r_{t+1}) = \rho v(\tau_{ht}, r_{t+1}) + (1 - \rho) v(\tau_{lt}, r_{t+1}) \tag{5}$$

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

$$p_t K_{t+1} = N_t \left[\rho s\left(\tau_{ht}, r_{t+1}\right) + (1 - \rho)\, s\left(\tau_{lt}, r_{t+1}\right)\right] + (1 - N_t) s\left(\tau_{Ct}, r_{t+1}\right) \tag{6}$$

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

$$K_{t+1} = (1 - \delta) K_t + N_t \bar{z}_I k_{It}^{\alpha} \tag{7}$$

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

$$K_t = N_t k_{It} + (1 - N_t) k_{Ct}. \tag{8}$$

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:

$$\alpha z_C k_{Ct}^{\alpha - 1} = (r_t + \delta) p_t. \tag{9}$$

In turn, this implies that

$$\tau_{Ct} = (1-\alpha) z_C k_{Ct}^{\alpha}. \tag{10}$$

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

$$\alpha \bar{z}_I k_{It}^{\alpha-1} = (r_t + \delta). \tag{11}$$

and

$$\tau_{It} \equiv \tau_{ht} = \tau_{lt} = p_t (1-\alpha) \bar{z}_I k_{It}^{\alpha}. \tag{12}$$

Conditions (9) and (13) imply that the relative price of the investment good satisfies

$$p_t = \frac{z_C}{\bar{z}_I} \left(\frac{k_{Ct}}{k_{It}} \right)^{\alpha-1}. \tag{13}$$

Using (10) and (12), we can rewrite the occupational choice condition (5) as

$$v\left[(1-\alpha) z_C k_{Ct}^{\alpha}, r_{t+1}\right] = v\left[p_t (1-\alpha) \bar{z}_I k_{It}^{\alpha}, r_{t+1}\right]. \tag{14}$$

Since v is strictly increasing in its first argument, conditions (13) and (14) imply that $k_{Ct} = k_{It}$. This, along with condition (8), 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 (6) implies that

$$K_{t+1} = (1-\alpha) \kappa(r_{t+1}) \bar{z}_I K_t^{\alpha} \tag{15}$$

The above condition, along with (11), can be used to fully characterize the equilibrium allocation. The sequence for N_t can be recovered using condition (7). 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

$$v(\tau_{ht}) \geq v\left(\tau_{lt} + \xi p_t \Delta k_{It}^{\alpha}\right) \tag{16}$$

$$\bar{\tau}_{It} \equiv \rho\tau_{ht} + (1-\rho)\tau_{lt} = p_t[\bar{z}_I k_{It}^{\alpha} - (r_t+\delta)\, k_{It}]. \tag{17}$$

Strict concavity of the utility function implies that the constraint (16) binds. Then, by strong monotonicity of $u(\cdot)$, it follows that

$$\tau_{ht} = \tau_{ht} + \xi p_t \Delta k_{It}^{\alpha}. \tag{18}$$

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:

$$r_t + \delta = \alpha k_{It}^{\alpha-1}\left[\bar{z}_I + \rho(1-\rho)\xi\Delta\omega_t\right] \tag{19}$$

where

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

By conditions (9) and (19), we can express the relative price of the investment good as:

$$p_t = \frac{z_C}{\bar{z}_I + \rho(1-\rho)\xi\Delta\omega_t} Q_t^{\alpha-1}, \tag{20}$$

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,

$$\tau_{lt} = p_t[(\bar{z}_I - \rho\xi\Delta)\, k_{It}^{\alpha} - (r_t + \delta)\, k_{It}] \tag{21}$$

and

$$\tau_{ht} = p_t[(\bar{z}_I + (1-\rho)\,\xi\Delta)\, k_{It}^{\alpha} - (r_t + \delta)\, k_{It}]. \tag{22}$$

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 (5) 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

$$u[(1-\alpha)z_C Q_t^{\alpha}] = [\rho u(p_t g_h) + (1-\rho)u(p_t g_l)] \tag{23}$$

Conditions (20) and (23) imply that Q_t and p_t are indeed time invariant. ■

Lemma 2 simplifies the characterization of the dynamics of our economy. From (6) and (7), we obtain that

$$\kappa(r_{t+1})\left\{N_t\left[\rho\tau_{ht} + (1-\rho)\tau_{lt}\right] + (1-N_t)\tau_{Ct}\right\} = \\ p(1-\delta)K_t + pN_t\bar{z}_I\left(\frac{K_t}{N_t + (1-N_t)\,Q}\right)^{\alpha}. \tag{24}$$

Then condition (8) 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:

$$\tau_{ht} = pg_h \left(\frac{K_t}{N_t + (1 - N_t) Q} \right)^{\alpha},$$
$$\tau_{lt} = pg_l \left(\frac{K_t}{N_t + (1 - N_t) Q} \right)^{\alpha},$$
$$\tau_{Ct} = (1 - \alpha) z_C \left(\frac{QK_t}{N_t + (1 - N_t) Q} \right)^{\alpha}.$$

We can also write that

$$r_{t+1} + \delta = \frac{1}{p} \alpha z_C \left(\frac{Q (1 - \delta) K_t + Q N_t \bar{z}_I \left(\frac{K_t}{N_t + (1 - N_t) Q} \right)^{\alpha}}{N_{t+1} + (1 - N_{t+1}) Q} \right)^{\alpha - 1} \tag{25}$$

and

$$K_{t+1} = (1 - \delta) K_t + N_t \bar{z}_I \left(\frac{K_t}{N_t + (1 - N_t) Q} \right)^{\alpha}. \tag{26}$$

For given K_0, equations (24) and (26) 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 $Q = k_{Ct}/k_{It}$ 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 develop predictions for the co-variation between the quality of legal institutions and a number of variables of interest: GDP, the Solow residual and investment rate, measured both in the domestic and international prices, and the relative price of capital goods. 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 5 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	z_C
0.99	2/3	0.15	0.4	3	1.33	0.8	2

Note that this parameterization implies $\bar{z}_I = z_C$. Given the stylized features of our model, a calibration is not in order. This exercise is intended as an illustration of the key 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 the relative price adjusts for the change in the relative efficiency across sectors. When international prices are used, it is clear that under weak protection the investment rate is substantially smaller.[17]

Our theory also implies that measured aggregate TFP increases with investor protection. Consistently with the empirical literature,[18] the Solow residual is computed as $Z_t = Y_t^{PPP} K_t^{-\alpha}$, where $Y_t^{PPP} = p^w N_t y_{It} + (1 - N_t) y_{Ct}$. This yields:

$$Z_t = z_C \left[p^w N_t \left(\frac{k_{It}}{K_t} \right)^\alpha + (1 - N_t) \left(\frac{k_{Ct}}{K_t} \right)^\alpha \right]. \tag{27}$$

Recall that in the benchmark case of perfect investor protection, $k_{It} = k_{Ct} = K_t$. In that scenario, $p^w = 1$ implies $Z_t = z_C$. Compare now this economy with one where $\xi > 0$. We already know that k_{It}/k_{Ct} will be lower. The market clearing condition (8) then implies $k_{It}/K_t < 1$ and $k_{Ct}/K_t > 1$: there is a misallocation of capital across the two sectors relative to the case of perfect investor protection. Its effect on measured TFP will depend on world relative price. The higher p^w, the largest the change in the Solow residual. Notice that the lowest possible world relative price is $p^w = 1$, corresponding to a situation in which investor protection is perfect in all countries. Assume $p^w = 1$ and, to start with, ignore the adjustment of N_t. From (27) it follows that the resource misallocation leads to a drop in measured TFP. Figure 5 shows that N_t adjusts, but its impact seems of second-order importance. In conclusion, it appears that cross-country differences in legal institutions are able to generates differences in both accumulation rates and aggregate total factor productivity.

[17]The PPP-adjusted figures are computed using $p^w = 1$ as the relative price of investment. This is the price that would prevail if $\xi = 0$ in the rest of the world. Notice that the particular value taken by p^w is unimportant. What matters is that it is constant across countries.

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

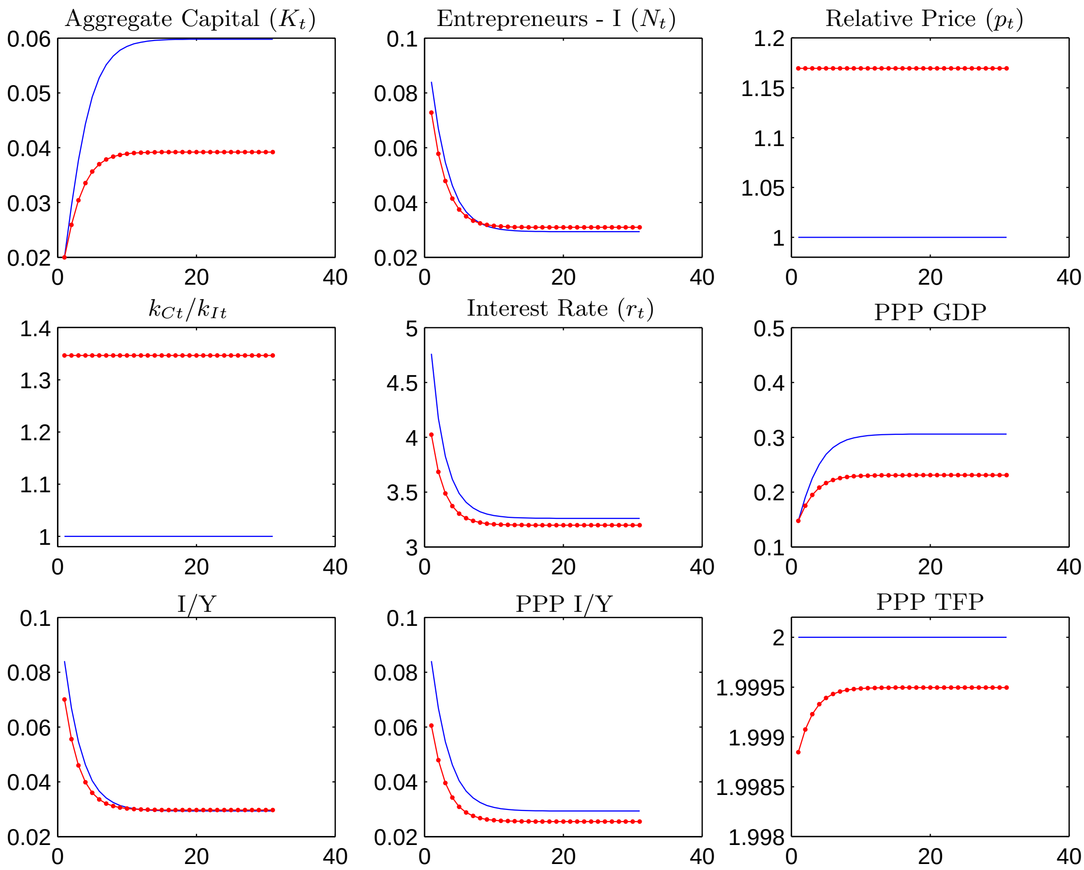

Figure 5: Comparative Dynamics (Dotted line = higher ξ).

Hsieh and Klenow (2003) pointed out that the cross-country correlation between income, investment rates, and relative prices are consistent with rich countries being more productive (having an absolute advantage) and having a comparative advantage in the production of the investment good. Here we are interested in understanding to what extent, in the context of our model, the implications of cross-country heterogeneity in relative productivity differ from the ones due to variation in the quality of legal institutions. To this effect, we carry out an 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. In fact, differences in relative productive efficiency do not generate cross-country variation in relative size. This happens because the change in the relative price of investment fully compensates for the productivity differential. It turns out, however, that this only occurs under perfect risk-sharing. In all circumstances in which entrepreneurs are left bearing some risk, which in our model corresponds to $\xi > 0$, a decrease in $\bar{z}_I$ will not be fully accommodated by an increase in the relative price. Therefore the relative size of investment good firms will decline.[19] From this exercise, we conclude that in the context of our model imperfect investor protection is necessary to generate cross-country differences in relative firm size. We also predict that in the cross section of countries, the better investor protection, the higher the relative size of investment good firms. In Section 5 we investigate whether the data supports this conclusion.

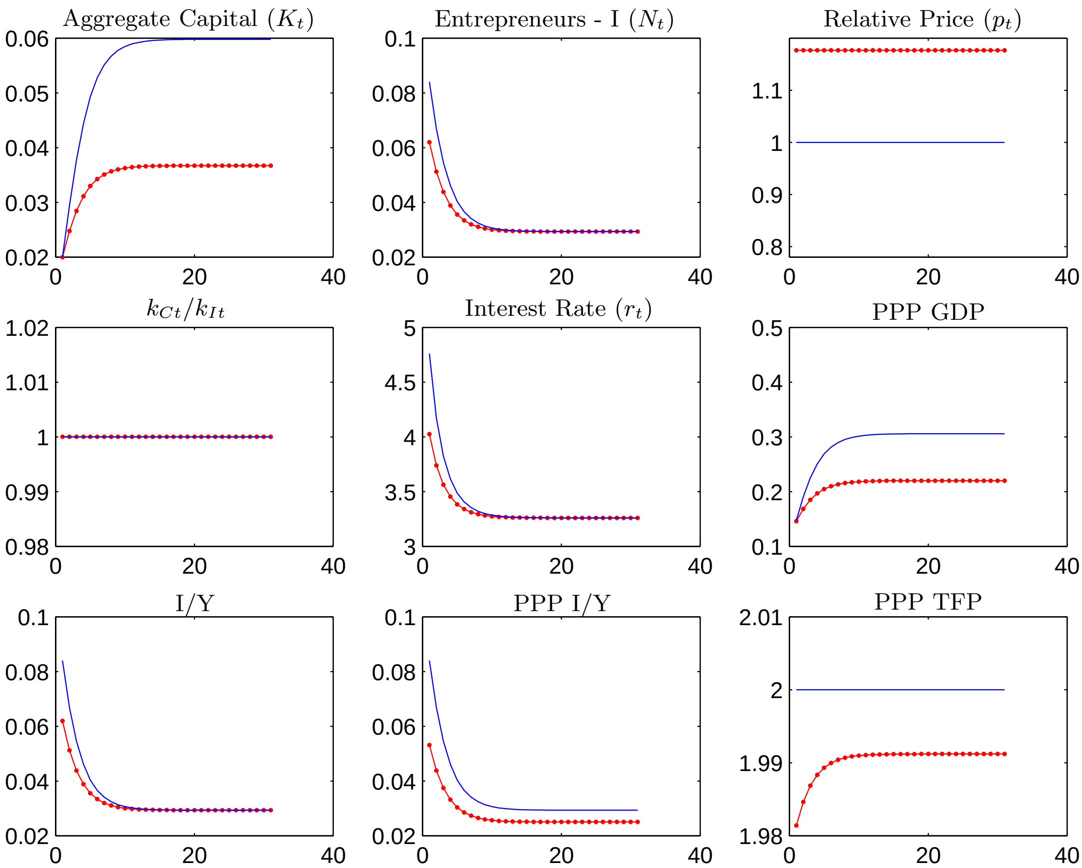

Figure 6: Comparative Dynamics (Dotted line = lower $\bar{z}_I$).

[19]Exactly the same considerations apply to the case in which a tax on investment goods was introduced.

5 Cross-country variation in relative firm size

Our theory predicts that the relative size of firms in high-volatility sectors should be higher in countries characterized by better investor protection. Testing this implication is not an easy task, for a variety of reasons. Among them, three stand out: 1) cross-country data on firm size are hard to come by, and the available samples are likely to suffer from serious selection biases, on which we have no control; 2) investor protection is very hard to measure; and 3) ours being a conditional statement, there may be determinants of firm size, not considered in our analysis, that interact with investor protection to generate a correlation pattern opposite to that implied by our model. Still, we feel we should make the best possible use of the available data in order to test our prediction.

We draw our information on firm size from the Standard & Poor's Global COMPUSTAT database, which contains annual information on a large number of publicly traded firms based in more than 80 countries, from 1993 to 2003. Our sub-sample consists of approximately 13,500 firms in 45 countries. On average, we have nearly 300 firms per country, operating in 38 sectors.[20] Size is defined as average employment over the years the firm appears in the sample.

We account for the cross-country variation in the quality of legal institutions by adopting the investor protection indicators introduced by La Porta, Lopez-de Silanes, Shleifer, and Vishny (1998). These indices assign scores to countries based on the rights that corporate, bankruptcy, and reorganization laws award to shareholders and creditors, as well as on the quality of law enforcement. The variable CR is higher, the wider the range of *creditor rights* in firm reorganization and liquidation upon default. The indicator *anti-director rights,* AR, and the dummy *one share-one vote,* OV, are two indices geared towards assessing the ability of small shareholders to participate in decision-making. Finally, the index *rule of law,* RL, proxies for the quality of law enforcement. Our model is too stylized to provide guidance in the selection of a particular indicator. For this reason, we consider all of them at once. We run the following regression:

$$\ln(size)_{ijc} = \alpha_c + \theta_j + \beta' \left(vol_j \times IP_c\right) + u_{ijc},$$

where the indexes i, j, and c identify firms, sectors, and countries, respectively. The regressors are a country fixed effect, a sector fixed effect, and the interaction between

[20] Our sample selection procedure is detailed in Appendix A.2.

our estimate of the average conditional standard deviation of sales in sector j as computed in Section 2, and the full set of investor protection indicators (IP_c). The results are reported in Table 1.

Table 1: Firm Size, Volatility, and Investor Protection

Dependent Variable: Log average firm size	
Volatility × AR	-1.33272***
	(0.36137)
Volatility × CR	-0.05900
	(0.37853)
Volatility × RL	0.08946
	(0.34340)
Volatility × OV	9.40957***
	(0.91875)
Number of firms / sectors / countries	13328 / 63 / 39
Adjusted R^2	0.187

Notes: Country and sector fixed effects omitted. White standard errors in parenthesis.
Sources: La Porta, Lopez-de Silanes, Shleifer, and Vishny (1998) and Global Compustat 1993-2003.
***Significant at 1%; **Significant at 5%; *Significant at 10%.

Our theory predicts that the coefficients associated with the interaction terms should have positive signs: the (positive) impact of an improvement in investor protection (a higher score of the protection indicator) on size should be greater for high-volatility firms. The results are mixed: one can evince from the table that the coefficient of the interaction of volatility with OV conforms with our model's prediction, while the opposite occurs in the case of the variable AR. The remaining coefficients are not statistically different from zero. It looks like the data does not allow us to reach an uncontroversial conclusion.

5.1 Discussion

There are several ways to rationalize the lack of support for our model's prediction. To start with, it is likely that our data suffers from sample selection bias. With few exceptions, the criterion for inclusion in the Global Compustat data set is that the company's stock be traded in a major stock exchange. In order to access organized exchanges, firms incur substantial fixed costs. If these costs are similar across firms, companies with better prospects will be more likely to go public. Coeteris paribus, the average firm on the market will be larger than the average firm in the population. According to our model's mechanism, the weaker the legal institutions, the higher the minimum level of expected productivity that makes it convenient to go public. Furthermore, given that the negative effect of poor protection on risk sharing is stronger the higher the idiosyncratic risk, that threshold is likely to increase faster, the higher the volatility. Thus we may find out that the relative size of high-volatility firms is on average higher in poorer investor protection countries, rather than lower as predicted by our model.

Alternatively, our inability to find uncontroversial support for our prediction may be due to selection at entry. The argument is similar to the one just outlined. If firms pay a fixed cost to start operating, those with lower expected productivity will be less likely to be financed. If the adverse effect of weak institutions is stronger for more volatile firms, as investor protection worsens the productivity distribution of entrants will improve faster, the higher the volatility. This selection effect may be strong enough to conceal that, conditional on productivity, the size of entrants decreases at a faster rate for more volatile firms.

Finally, our parsimonious framework fails to consider several factors that may be relevant for firm size. These factors may interact with firm volatility and investor protection to produce a correlation pattern between relative firm size and protection opposite to that predicted by our model. Government policy, for example, may play an important role. In a country afflicted by weak legal institutions, the government may decide to favor firms operating in the sectors that most suffer from poor investor protection. It may do so via its competition policy, by awarding monopoly rights to incumbents, or via its industrial policy, by granting subsidies or tax breaks. In either scenario, government intervention has the potential to attenuate, and possibly overcome the negative effect of poor protection on the size of volatile firms. Even in the absence of a policy response, in the real world firms can reduce the adverse effects of weak institutions by combining to form larger entities. By doing so, production units blessed with good investment opportunities can acquire cash flows from less productive units, without incurring in the informational costs that characterize the relationships with outside investors. Since riskier firms have greater incentives to integrate, we may observe the relative size of highly volatile firms to increase as investor protection worsens, rather than decrease as predicted by our model.

What lesson should we draw from our simple regression? Obviously, we cannot rule out the possibility that relative size does not actually covary with investor protection in the way our model predicts. An alternative conclusion is that selection and/or the role played by other determinants of firms size make it impossible to uncover the correlation implied by our famework, which we predict should hold only in a conditional sense. In fact, our conjecture is that we can write down a more general version of our setup (i.e. one of which the model presented in Section 3 is a special case) that retains intact the implications for the cross-country variation of relative prices and for the *conditional* correlation of relative size, but whose prediction for the sign of the *unconditional* correlation of relative size may well be ambiguous, in line with the empirical evidence. Here is an example. Suppose that, differently from what assumed in Section 3, entrepreneurs are born differing in their ability to manage technologies in the investment good sector. For simplicity, keep on assuming that they have the same ability in handling projects in the consumption good sector. In equilibrium, only the entrepreneurs whose productivities in the investment good sector are higher than a certain threshold will operate in that industry. We conjecture that, as it is the case in our model, poorer investor protection implies that firms operating in the investment good sector will contract more than their consumption goods counterparts. However, the threshold just mentioned will increase. As a result, the average relative size of firms in the investment good sector may well turn out to be increasing in investor protection, rather than decreasing. It is likely that the framework just outlined would have a further advantage with respect to our benchmark model: differences in the quality of institutions would be associated with more sizeable differences in measured TFP.

6 Conclusion

The empirical evidence shows that cross-country differences in per capita income are associated with differences in factors accumulation, relative prices of capital goods, and total factor productivity. In this paper we have argued that the cross-country variation in the quality of legal institutions that safeguard investors' rights may be responsible for generating all of these patterns.

We have documented that firms engaged in the production of investment goods face a higher idiosyncratic baseline risk than firms producing consumption goods. Incorporating this feature in a simple model of firm finance with asymmetric information and risk-averse entrepreneurs leads to conclude that, everything else equal, individuals operating in the investment good sector achieve less risk-sharing and obtain less resources from outside investors. Our analysis also shows that in such an environment the ability to share risk and obtain financing depends on the quality of legal institutions: the poorer the protection of investors' rights, the lower the risk-sharing and the size of firms.

Imbedding such model of firm finance in a general equilibrium two-sector model of capital accumulation allows us to characterize the implications of different levels of investor protection for variables such as per-capita income, investment rates, relative prices, and TFP. We find that the cross-sectoral variation in volatility induces a wedge between the rates of return on investment in the two sectors. Such wedge induces an inefficiency in the competitive allocation, distracting resources away from the investment good sector and towards the consumption good sector. In turn, this implies an increase in the relative price of capital and a decrease in TFP, investment rate, and ultimately income. Importantly, the size of the inefficiency is larger, the poorer the investor protection. Therefore, our main conclusion is that the heterogeneity in investor protection might be a driving force of the observed cross-country correlation between per-capita income, relative prices, investment rates, and TFP.

The model also delivers the implication that, everything else equal, the relative size of firms in high-volatility sectors should be larger, the better the protection of investors. Unfortunately data limitations preclude us from finding evidence either in favor or against this claim.

A Data

A.1 North-America Compustat

Our data draws from the COMPUSTAT North-America Industrial Annual Database from 1950 to 2003. After dropping all observations for which either net sales, employment, or the NAICS code are missing, our dataset consists of 247,592 firm-year observations. We then proceed to delete all firms that have less than 3 observations and those belonging to 3-digit NAICS sectors for which the average number of firms in the sample is less than 8. We also eliminate those observations for which the sales figure increased by more than 50% with respect to the previous year because of a merger or acquisition. Finally, we drop all firms in the Finance and Insurance (3-digit NAICS from 520 to 529), Utilities (220 to 229), and Real Estate (531) industries. We also drop the firms classified by Compustat in the 3-digit sector 999, which turns out to be a residual category. Firms categorized by Compustat in sectors 515 and 517 are included in 513. Firms in sectors 518 and 238 are attributed to 514 and 235, respectively.

Next, we need to label each of the remaining sectors as either consumption or investment good producing. Our procedure is 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. The Use Table tells us the fraction of output that flows from each 3-digit sector to any of the other 3-digit industries and to final demand, respectively. We first group final demand uses into two categories, consumption (C) and investment (I). We do this by aggregating personal, 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 choose to ignore these final demand items. Now denote by A the square matrix of unit input-output coefficients. This matrix can be easily constructed from the original Use Input-Output Matrix by normalizing each row by the total commodity column. Then define the total output of the consumption and the investment good sectors by

$$Y_C = AY_C + C \Leftrightarrow Y_C = (I - A)^{-1} C$$

and

$$Y_I = AY_I + I \Leftrightarrow Y_I = (I - A)^{-1} I,$$

respectively. This means that we include in the output of the consumption good sector all the intermediate good products whose ultimate destination is final consumption, and similarly for investment. Finally, for each 3-digit industry j, we compute the share of output destined to consumption, $Y_C(j)/(Y_C(j)+Y_I(j))$. 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.

A the end of this process we are left with an unbalanced panel of 9,991 firms, distributed in 63 sectors, for a total of 125,895 firm-year observations. For each sector, Table 2 reports value added as a fraction of GDP as evinced from the Input-Output Table, and the fraction of output ultimately destined to consumption. Table 3 reports the average number of firms per sector and the results of the estimation of equations (1) and (2).

We carried out a variety of robustness checks. We repeated the analysis by deleting all firm-year observations in which an IPO or merger took place. As expected, the volatility estimates decrease, but they do so across the board, leaving our results on the relative volatility intact. Finally, we also experimented with alternative specifications of the regression equation (1). In particular, we introduced a firm-specific time trend, in order to control for trends in the growth process that are not captured by either age or size. It turns out that adding this factor adds very little to the predictive power of the equation, therefore leaving our results unchanged.

Table 2: Summary Statistics

NAICS	Description	Value Added	Cons. Share
	Investment Sectors		
213	Support Activities for Mining	0.13	12.55
233	Building, Developing, and General Contracting	3.61[21]	10.49
234	Heavy Construction	3.61	10.49
235	Special Trade Contractors	3.61	10.49
236	Construction of Buildings	3.61	10.49
237	Heavy and Civil Engineering	3.61	10.49
321	Wood Product Manufacturing	0.31	39.97
333	Machinery Manufacturing	1.21	19.50
334	Computer and Electronic Product Manufacturing	1.96	35.72
	Consumption Sectors		
111	Crop Production	0.79	96.75
211	Oil and Gas Extraction	0.44	85.10
212	Mining (except Oil and Gas)	0.30	63.98
311	Food Manufacturing	1.21	99.02
312	Beverage and Tobacco Product Manufacturing	0.60	99.60
313	Textile Mills	0.18	87.75
314	Textile Product Mills	0.12	80.45
315	Apparel Manufacturing	0.29	99.40
316	Leather and Allied Product Manufacturing	0.04	96.20
322	Paper Manufacturing	0.58	84.01
323	Printing and Related Support Activities	0.51	88.51
324	Petroleum and Coal Products Manufacturing	0.24	83.71
325	Chemical Manufacturing	1.65	83.15
326	Plastics and Rubber Products Manufacturing	0.73	69.10
339	Miscellaneous Manufacturing	0.57	75.65
421	Wholesale Trade, Durable Goods	5.88[22]	69.35
422	Wholesale Trade, Nondurable Goods	5.88	69.35
423	Merchant Wholesalers, Durable Goods	5.88	69.35
424	Merchant Wholesalers, Nondurable Goods	5.88	69.35
441	Motor Vehicle and Parts Dealers	5.72[23]	89.80
442	Furniture and Home Furnishings Stores	5.72	89.90

[21] This figure refers to the aggregate of the I–O Tables' categories "New Residential Construction", "New Nonresidential Construction", and "Maintenance and Repair Construction".

[22] This figure refers to the "Wholesale Trade" category. The I–O Tables do not disaggregate it further.

[23] This figure refers to the "Retail Trade" category. The I–O Tables do not disaggregate it further.

Table 2: (continued)

NAICS	Description	Value Added	Cons. Share
	Consumption Goods		
443	Electronics and Appliance Stores	5.72	89.80
444	Building Material and Garden Equipment	5.72	89.80
445	Food and Beverage Stores	5.72	89.80
446	Health and Personal Care Stores	5.72	89.80
448	Clothing and Clothing Accessories Stores	5.72	89.80
451	Sporting Goods, Hobby, Book, and Music Stores	5.72	89.80
452	General Merchandise Stores	5.72	89.80
453	Miscellaneous Store Retailers	5.72	89.80
454	Nonstore retailers	5.72	89.80
481	Air Transportation	0.53	85.28
482	Rail Transportation	0.28	73.99
483	Water Transportation	0.07	85.68
484	Truck Transportation	0.97	71.92
486	Pipeline Transportation	0.10	87.54
488	Support Activities for Transportation	0.25[24]	79.96
512	Motion Picture and Sound Recording Industries	0.31	97.44
513	Broadcasting and Telecommunications	2.38	88.68
514	Information and Data Processing Services	0.36	81.83
532	Rental and Leasing Services	0.67	83.65
533	Lessors of Nonfinancial Intangible Assets	1.18	79.14
541	Professional, Scientific and Technical Services	6.20	67.91
561	Administrative and Support Services	2.69	80.80
562	Waste Management and Remediation Services	0.27	83.88
611	Educational Services	0.75	98.12
621	Ambulatory Health Care Services	3.15	99.98
622	Hospitals	1.82	100.00
623	Nursing and Residential Care Facilities	0.69	100.00
711	Performing Arts, Spectator Sports, ...	0.36	93.26
713	Amusement, Gambling, and Recreation Industries	0.54	98.62
721	Accommodation	0.92	92.45
722	Food Services and Drinking Places	1.79	96.96
811	Repair and Maintenance	0.95	85.06
812	Personal and Laundry Services	0.67	98.73

[24] This figure refers to the I–O Tables' category "Sightseeing Transportation and Transportation Support".

Table 3: Estimates

NAICS	$\Delta \ln(GDP)$	$\ln(size)$	$\ln(age)$	volatility (ranking)	avg # firms
			Investment Sectors		
213	-1.689858**	-.0232684	-.034326	.1559606 (7)	87
233	5.314751***	-.0258425	-.1045843*	.1848723 (4)	90
234	-.873793	.1616721***	-.1362813	.1531023 (8)	23
235	3.240134**	-.0759484**	-.1324133	.144072 (10)	48
236	3.862762***	-.0190501	-.0394965	.1222786 (17)	38
237	.6173461	-.0104888	-.0571829	.1563333 (6)	29
321	3.955892***	-.0583849***	-.0255576	.1020976 (26)	70
333	1.862894***	-.0636902***	-.0504126***	.1010109 (27)	556
334	2.252385***	-.096082***	-.1235036***	.1296969 (14)	1585
			Consumption Sectors		
111	.9275995	-.1276858***	-.0449226	.1022951 (25)	31
211	-1.035298**	-.0432616***	-.1637221	.1947566 (3)	447
212	1.806483**	-.0078911	-.0122709***	.1376605 (13)	151
311	.6094191***	-.0575977***	-.00482	.061328 (54)	216
312	.6120974*	-.0086774	-.0093379	.057941 (57)	78
313	2.086494***	-.0178182	-.0444137**	.0674364 (49)	67
314	2.159797***	-.0389331*	-.0328683	.0734959 (47)	24
315	1.431718***	-.0560599***	-.0448576***	.0764293 (45)	145
316	1.365119***	-.0968092***	-.0814907***	.070859 (48)	51
322	1.572544***	-.0680536***	.0086946	.0596662 (55)	125
323	.9639128***	.0015569	-.0625205***	.0627642 (51)	81
324	.5350855	-.021378	-.012919	.0747122 (46)	75
325	1.151393***	-.0469474***	-.0480146***	.1125104 (21)	821
326	2.627793***	-.0406592***	-.0349798**	.0768694 (44)	182
339	1.11403***	-.0761142***	-.1191138***	.1065912 (24)	374
421	2.289637***	-.1276524***	-.1358073***	.1163485 (20)	225
422	.7740978	-.1425323***	.0414137	.0942652 (32)	133
423	3.039808***	-.0844813***	-.0412613**	.0939015 (34)	138
424	.4644528	-.0395554***	-.0520426*	.0834775 (40)	89
441	4.353642***	-.0461108	-.0806095	.1007407 (28)	42
442	2.71877***	-.0990023***	-.0295326	.0660247 (50)	27
443	3.158164***	-.04738***	-.0641855*	.0918247 (36)	39
444	1.506088***	-.0678201***	-.0391036*	.0592847 (56)	34
445	.5578711***	-.0302528***	-.0231351**	.0371789 (63)	89
446	.8814988*	-.1318716***	.0787414***	.0624814 (53)	54

***Significant at 1%; **Significant at 5%; *Significant at 10%.

Table 3: (continued)

NAICS	$\Delta \ln(GDP)$	$\ln(size)$	$\ln(age)$	volatility (ranking)	avg # firms
			Consumption Goods		
448	1.33959***	-.0413216***	-.0749638***	.0534314 (58)	117
451	1.578496***	-.0400712**	-.1172667***	.0515848 (59)	49
452	1.086929***	-.0298385***	-.0162019**	.0415502 (62)	99
453	2.754872**	-.1255515***	-.0596128	.0993114 (29)	37
454	2.661791**	-.030208	-.2431308***	.1280344 (16)	108
481	1.30679***	-.0737263***	.0056314	.0625175 (52)	90
482	1.377181***	-.0730971***	-.0712519***	.0480719 (61)	46
483	.7284918	-.0716703***	-.0657627	.0947188 (31)	31
484	2.341752***	-.0214616***	-.0834315***	.0496359 (60)	80
486	-.217338	-.0126904	-.1468302***	.0941898 (33)	45
488	.3107207	-.0985449***	-.0239937	.0882113 (37)	45
512	1.956016**	-.0495672**	-.0478781	.1503224 (9)	121
513	1.287631***	-.1152791***	-.0538601***	.0813192 (42)	543
514	5.975484***	-.0800712***	-.4946504***	.2097501 (1)	225
532	1.176252*	-.0667644***	-.1404026***	.1112486 (22)	100
533	3.122665**	.0412211	-.1670027**	.206142 (2)	93
541	2.244586***	-.0760007***	-.1362431***	.1378682 (12)	692
561	2.404557***	-.0798423***	-.0794319**	.1164482 (19)	244
562	5.043097***	.0437959	-.302883***	.1586413 (5)	93
611	1.702306	-.0338815	-.1781773**	.1093033 (23)	44
621	3.010798***	-.0993133***	-.2347995***	.1454825 (11)	184
622	.1734467	-.0045096	-.2842***	.0932955 (35)	43
623	2.26818***	-.0574264***	-.0864855	.0853121 (39)	54
711	2.146371***	-.0893429**	.0079634	.0834745 (41)	42
713	-.1182289	.0290855	-.2940977***	.1218573 (18)	86
721	1.598557**	-.0813414***	-.040523	.0958133 (30)	115
722	2.065548***	-.0912911***	-.1150956***	.0801585 (43)	226
811	1.638869	-.0909763**	-.3182746**	.1295846 (15)	24
812	1.113649	-.165618***	-.0012119	.0879876 (38)	51

***Significant at 1%; **Significant at 5%; *Significant at 10%.

A.2 Global Compustat

Our international firm-level data draws from the Global COMPUSTAT Annual Database from 1993 to 2003. We drop observations for which either net sales, employment, or the NAICS code are missing, or zero employment is reported. We use the NAICS/SIC Correspondence Tables from the U.S. Census bureau website to assign 3-digit NAICS codes to firms for which only a 2-digit NAICS code is reported. We only consider those sectors for which we have a measure of volatility as computed in Section 2. Finally, we drop all observations relative to countries for which we either miss information on investor protection (the investor protection indicators are not available for China, the Czech Republic, Hungary, Luxembourg, Poland, and Russia) or we are left with data on less than 10 firms. This procedure leaves us with 13,328 firms in 63 sectors and 39 countries, with a median of 5 observations per firm, 3 firms per sector, and 40 sectors per country.

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