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Financial Frictions, Investment, and Institutions

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Abstract

Financial frictions have been identified as key factors affecting economic fluctuations and growth. But, can institutional reforms reduce financial frictions? Based on a canonical investment model, we consider two potential channels: (i) financial transaction costs at the firm level; and (ii) required return at the country level. We empirically investigate the effects of institutions on these financial frictions using a panel of 75,000 firm-years across 48 countries for the period 1990–2007. We find that improved corporate governance (e.g., less informational problems) and enhanced contractual enforcement reduce financial frictions, while stronger creditor rights (e.g., lower collateral constraints) are less important.

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I. Introduction

Financial frictions have long been identified as key factors in driving both short-run economic fluctuations and long-run growth. Many analytical models imply that, by reducing financial frictions, a country can lower macroeconomic volatility and enhance its growth potential. The natural empirical and policy questions that arise are: Can a country reduce financial frictions through institutional reforms? And if so, which institutional reforms are most effective?

Adapting a canonical investment model where changes in Tobin's Q drive investment to allow institutional differences to affect financial frictions, and studying empirically how institutional factors affect financial frictions related to investment decisions, we offer novel approach and answers to these questions. Using a large panel data of listed firms—about 75,000 firm-year observations, from 48 major advanced and emerging market economies over the period 1990-2007—we find that improved corporate governance (e.g., lower informational problems) and enhanced contractual enforcement reduce financial frictions affecting investment. And we find stronger creditor rights alleviating collateral constraints to be less important in reducing financial frictions.

Our work relates to various strands in literature, important among which is that on finance and macroeconomic fluctuations. In this literature, models often rely on frictions to explain endogenous fluctuations in investment behavior which, in turn, create or amplify macroeconomic cycles. Kiyotaki and Moore (1997), for example, assume a simple collateral constraint arising from financial frictions by which drops (increases) in asset values lead to tighter (more relaxed) credit conditions. This leads to an increase (a decrease) of investment and generates economic cycles. Bernanke and Gertler (1989) show how costly-state-verification (in the spirit of Townsend, 1979), an informational friction, amplifies productivity shocks through affecting investment.

Motivated in part by the recent financial crisis, the literature on the effects of financial frictions has further expanded. Gertler and Kiyotaki (2010), for example, model how misconduct by bank managers can create principal-agent problems, which, in turn, alter firm investment and generate economic cycles.[2] Recent empirical work explicitly investigating the validity of the assumptions regarding frictions in these models has largely been undertaken using aggregate data (e.g., Chari, Kehoe, and McGrattan, 2006, and Christiano, Motto, and Rostagno. 2010).

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[2] There is a parallel theoretical literature of finance and growth. For example, Greenwood and Jovanovic (1990) study the growth implications of costly state verification. Banerjee and Newman (1993) look at development with collateral constraints, whereas Acemoglu and Zilibotti (1997) relate it to incomplete financial markets.

Another large literature our work relates to is that investigating the occurrence and impact of credit constraints at the firm level. Starting with Fazzari, Hubbard, and Petersen (1988), this literature, mostly based on reduced-form regressions, investigates how investment relates to firm characteristics, including the availability of internal and external financing. However, as Gomes (2001) shows, by introducing simple financial transaction costs in the model, these reduced-form regression studies face serious identification problems. Most importantly, since Q reflects not only growth opportunities but also financial frictions (e.g., credit constraints), results of regressions of investment on Q do not allow for identification of credit constraints. Furthermore, with auto-correlated productivity shocks ("growth opportunities"), current profits contain information on future profitability as well as affect internal financing conditions, with both affecting investment decisions.

Recent studies have therefore modeled frictions (e.g., asymmetric information or limited contract enforcement) from first principles to overcome identification problems. Empirical applications have proven difficult, however, in part due to computational challenges, and so far have largely relied on calibration exercises (e.g., Lorenzoni and Walentin, 2007) or simulation based estimations using restricted samples and limited control variables (Karaivanov, et. al. 2010). It has also proven difficult to compare statistically in such models the relative importance of various financial frictions. Another approach has been to include generic financial transaction costs in a model and then to estimate it. For example, Hennessy, Levy, and Whited (2007) empirically identify the presence of such costs using data for large US individual firms. So far, however, this literature has not investigated the role of institutional differences.

Our work also relates to the large literature on the importance of institutions for economic and financial development. Many studies have documented that institutional differences, especially those related to financial intermediation, help explain differences in economy-wide development and productivity (see reviews by Morck, Wolfenzon, and Yeung, 2005; Demirguc-Kunt and Levine, 2001; Levine, 2005; and La Porta, Lopez-de-Silanes, and Shleifer, 2008).[3] This line of research generally relies, however, on aggregate measures of financial and/or institutional development, and typically analyzes how a country's economic growth or overall level of development relates to these measures (e.g., Beck, Levine, and Loayza, 2000; De Nicolo, Laeven, and Ueda, 2008). It has typically not identified specific causal channels as most often it does not estimate a specific structural model. Somewhat more insightful in identifying specific channels are industry-level studies on the impact of financial development. Rajan and Zingales (1998), and many subsequent

[3] In the broader growth literature, differences in total factor productivity are considered to be the major factor determining differences in GDP across countries (Klenow and Rodriguez-Clare, 1997).

papers, for example, show that industries more dependent on external finance tend to grow faster in countries with more developed financial and accounting systems.[4]

Our study builds on these strands in the literature by developing an innovative approach to help identify the types of financial frictions which are likely to be present at the firm level. The key firm behavior we study follows Tobin's original insight (Tobin, 1969): a firm with high market to replacement value of capital, a high Q firm, should add more capital since the value of new capital goods exceeds its cost; and a low Q firm should shed off capital. With no uncertainty, investment (or disinvestment) then forces a firm's Q back to its steady-state level every period. With shocks to profits, the stochastic version of the theory implies that the realized value of Q will vary around its steady state, with the average movement over the next period predictable on the basis of current period's Q and profits (e.g., a high current Q will decline over time).

We expand on this original Q model, and the subsequent canonical investment model of Abel and Eberly (1994), by introducing financial frictions in a way similar to Hennessy, Levy, and Whited (2007). We then use this model to derive the speed of adjustment of Q explicitly as a function of the nature of financial frictions. We next model institutions to give rise to financial frictions in specific ways. This then allows us to derive a theoretical relation between institutions and the movements of Q over time. So far, empirical applications in this literature have used firm-level data from the U.S. or other advanced countries with well-developed institutions, and could thus not investigate the effects of institutions on frictions. Our empirical innovation is that we exploit the large cross-country differences in institutions to identify explicitly which institutional differences give rise to financial frictions.

We incorporate two generic forms of financial frictions in our model. The first are firm-specific costs associated with financial transactions. Here, better institutions in a country are assumed to reduce financial transaction costs and thereby lower the sensitivity of investment to current firm cash flows. This in turn translates into a smaller expected movement in Q for a given shock to profitability. The other form relates to the overall cost of capital, determined partly at the country level and partly by firm-specific required rates of return. When current Q is high, Q can be expected to fall over the next period. Such a reduction in Q amounts to a capital loss. Because the sum of the expected drop in Q and the current profits equals the required rate of return, for a given level of current profits, Q will fall more in countries with a lower cost of capital, possibly brought about by better institutions.

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[4] For example, Wurgler (2000) using a measure of industry-specific investment opportunities derived from growth in value added, shows that financially more developed countries allocate more capital to growing industries and less to declining sectors.

Equipped with this model, we develop a simple regression methodology to estimate the effect of different forms of frictions on firm behavior. Specifically, differences between predicted values and realized values of Q are used to estimate the structural parameters linking institutions to each form of frictions. Using a very large international firm-level data and exploiting the large, but slowly changing, variation in institutional differences across countries, we identify which institutions most importantly drive financial frictions and decompose their effects onto the two forms of financial frictions.

We find that good corporate governance lowers the required rate of return for all firms and especially the financial transaction costs small firms face. These effects are likely to arise because good corporate governance lowers informational and agency problems, and thereby reduces financial frictions. A better general enforcement of financial contracts (e.g., adherence to the rule of law and well-established property rights) also reduces financial transaction costs for small firms. However, stronger creditor rights do not robustly affect either financial transaction costs or the required rate of return. Because stronger creditor rights mean relatively higher collateral values, this suggests that collateral constraints are not important, at least not for our sample of listed firms. An alternative interpretation is that collateral constraints do matter (e.g., as they alter the supply of external financing), but that creditor rights, at least as measured, do not affect the constraints.

Econometrically, we address the identification problems traditionally associated with investment regressions. We estimate parameter values by minimizing (the squared sum of) the one-period ahead forecast errors, the difference between theory-based predictions and the realized values of Q at the firm level every year in our sample. We show that this simple regression produces unbiased and consistent estimators. A disadvantage of using Q is often considered to be its "noisy" nature, potential due to inefficient stock markets, limited arbitrage in stock prices, or poor accounting information. Also, the use of a specific model may create specification errors, translating into measurement errors of various kinds. We test and confirm, however, that measurement errors do not create a problem in our methodology as they are not significantly large compared to one-period ahead forecast errors. Nonetheless, we also conduct instrumental variable estimations and find our results to be robust.

Our work sheds new light on possible sources of inefficiency in investment across countries. In this regard, recent work by Hsieh and Klenow (2009) is closely related. They find a much larger dispersion in the (ex post) marginal product of capital for industrial plants in China and India than in the U.S., a result which they interpret as an evidence of a more efficient allocation of capital in the U.S. With only three countries in their sample, however, any assessment of the causes of this alleged inefficiency, and whether or not it is related to institutional differences, is difficult. Another related study is Abiad, Oomes, and Ueda (2008). They show that, under certain conditions and after controlling for industry and age effects, the cross-sectional dispersion of Q to be a proxy for the *ex ante* efficiency of capital allocation. While their measure can be used to capture within-country effects of policy changes, it is less useful for cross-country comparisons, in part because it assumes a steady-state dispersion for Q which is likely country-specific.[5]

The rest of the paper is organized as follows. Section II introduces a canonical investment model; Section III explains the estimation strategy and empirical approach; Section IV describes the data set used for this study; Section V presents the estimation results; Section VI examines measurement error issues, and Section VII concludes.

II. THEORETICAL MODEL

A. Model Setup

We develop a microeconomic-based law-of-motion for Q which incorporates the effect of institutions on capital adjustment. We do so by adapting the well-known investment models of Hayashi (1982), Abel and Blanchard (1986), and Abel and Eberly (1994), and by introducing financial frictions, generalizing the models with financial frictions of Gomes (2001) and Hennessy, Levy, and Whited (2007).

In each period, the timing structure is as follows. Based on the existing capital stock of the previous period, K^{-}, and the (revealed) productivity at the beginning of the current period, ε, investment I is determined, adjustment costs are paid, and a new capital stock K is formed immediately. Using the new capital stock, K, goods are produced with productivity ε. This timing structure is consistent with the continuous time model of Abel and Eberly (1994) as well as with discrete time models that have short lags between investment expenditure and the productive use of new machines.[6]

[5] While dispersion in *ex ante* (expected) marginal product of capital can reflect inefficiencies, *ex post* dispersion is not necessarily related to inefficiency. For example, better developed financial systems may allow firms to take high-risk and high-return projects which lead to a larger dispersion in the *ex post* marginal product of capital (around a higher mean). Other measures can also be used to gauge the *ex ante* efficiency of capital allocation: Acharya, Imbs and Sturguess (2010), for example, use a mean-variance measure of industrial output for each U.S. state and show that financial deregulation brings a state closer to the efficient frontier.

[6] In this formulation, there is no "time-to-build," which means that firm managers make their investment decisions after the revelation of productivity shocks. This affects both the theoretical dynamics and the interpretations of the estimated coefficients. In particular, both current and next period's Q matter for investment. This contrasts with Barnett and Sakellaris (1999), which is a special case of the "time-to-build" model and shows no equilibrium law of motion of Q. Nevertheless, our empirical results are robust to different timing assumptions (see Section VI).

Within-period "working capital" finance (using credit lines or trade credit) is assumed to involve no financial transaction costs.[7] Over-the-period external finance *B* is, however, costly to obtain, with the amount desired determined at the end of the period when gross profits (or the return to capital), π, are realized. We introduce a convex cost function for external finance following Gomes (2001), although our cost function is more general than his linear function.

Profits are denoted by $\pi(K_t, \varepsilon_t)$. Following Hayashi (1982), we model the labor decisions of the firm in a simple manner by assuming the labor market to be competitive with a constant-returns-to-scale production function, *f*, and a competitive wage *o* such that: $\pi(K_t, \varepsilon_t) = \varepsilon_t f(K_t, L_t) - o_t L_t$, with the usual marginal condition: $o_t = f_{Lt}$. Similarly, we assume the product market to be competitive. Shocks, ε, to productivity (or rents) are assumed to be serially correlated with a probability distribution function $P(\varepsilon^+|\varepsilon)$, so that a firm which receives a "good" shock in the current period is likely to have higher profits in the next period as well.[8]

The firm's capital stock increases with investment, *I*, but depreciates at a rate of δ:

$$K_t = (1-\delta)K_{t-1} + I_t. \tag{1}$$

Investment involves gross adjustment costs, $\hat{\phi}(I_t, K_t; X_t, W, \varepsilon_t) + \delta K_{t-1} + I_t$. Note that the gross adjustment costs, ϕ, include both depreciation and new investment. These adjustment costs are lost right after the investment is made because of, for example, costly learning associated with the introduction of new machines. In this specification, X denotes fundamental characteristics, which can be time-varying but are assumed to be non-stochastic and predictable (e.g., the industry and age of a firm age), W denotes "institutional quality," which agents assume to be time-invariant and exogenous, consistent with the fact that institutional quality is known to be stable. As in much of the literature, we assume the adjustment costs of investment, ϕ, to be linearly homogeneous of degree one in investment I and capital K.

Given the law of motion for capital (1), the adjustment costs of investment can be expressed solely as a function of capital in the current and previous periods:

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[7] An observationally equivalent assumption is that within-period credit is also costly but the transaction costs involved are proportional to the end-of-period net external finance. Either assumption works fine for within-period credit because, in the data, we observe only end-of-period balance sheet information from which we estimate financial transaction costs.

[8] This feature is similar to the imperfectly competitive market studied by Abel and Eberly (2008), who show that profits (or cash flows) measure rents or "growth opportunities," and also affect Q.

$$\phi(I(K_{t-1},K_t),K_t;X_t,W,\varepsilon_t) = \hat{\phi}(K_t-(1-\delta)K_{t-1},K_t;X_t,W,\varepsilon_t) - \delta K - I_t, \text{ if } I_t > 0; \\ = -\delta K_t, \text{ otherwise.} \tag{2}$$

A firm also faces financial transaction costs, $\hat{\lambda}(B_t, K_t; X_t, W, \varepsilon_t)$, where B denotes the amount of external finance. Financial transaction costs matter only when external finance is positive. Similar to the investment adjustment costs, we assume the financial transaction cost function to be linearly homogeneous in external finance, B, and in capital, K, the adjustment costs of investment. Hence, overall financial transaction costs λ can be also expressed as a function of the capital stock of the current and previous periods:

$$\lambda(B(K_{t-1},K_t,\varepsilon_t),K_t;X_t,W,\varepsilon_t) = \hat{\lambda}(K_t-(1-\delta)K_{t-1}-\pi(K_t,\varepsilon_t),K_t;X_t,W,\varepsilon_t), \text{ if } B_t > 0; \\ = 0, \text{ otherwise.} \tag{3}$$

We assume that a firm manager maximizes the value of capital for all claimholders, that is, both shareholders and creditors. This is in line with most of the investment literature, which does not distinguish between various sources of financing.[9] Consistently, the definition of profit, π, includes the returns to both creditors (interest payments) and shareholders (dividends and retained earnings). This implicitly assumes that a firm manager chooses the least costly of debt or equity external financing. And it assumes that a firm, even if it can no longer raise debt, can still issue equity, albeit perhaps at very high costs. This assumption is realistic for our sample of listed firms, which are listed and therefore in principle always able to issue equity at some price.[10]

Related, we assume that all assets, including cash and equivalents, are able to generate profits and are subject to financial frictions. In our framework, frictions associated with non-capital assets, such as cash holdings, are also reflected in the cost of external finance. For example, if cash management is not efficient, outside investors may fear the misuse of internal cash and the cost of external finance would be higher. We thus do not need to consider non-fixed capital, such as cash and equivalents, separately from fixed capital.[11]

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[9] This assumption is also broadly consistent with studies showing that the CEO compensation is more closely related to firm size rather than to profits (see a review by Tosi et. al., 2000). Also, in some countries, shareholder value maximization is far from the reality (Allen and Gale, 2000).

[10] Note that we treat the adjustment cost of investment, ϕ, as arising from purely technological issues, not from financing activities. This assumption is consistent with investment models without financial frictions, as well as Gomes' (2001) model. It differs though from Hennessy, Levy, and Whited (2007) who regard ϕ as the adjustment cost of equity finance. Unlike them, we do not make any distinction between equity and debt finance, and λ is defined as the costs associated with any form of external finance.

[11] In order to study cash holding itself, a more narrowly-focused study would be necessary, for example, from the viewpoint of optimal liquidity (e.g., Greenwood, 2005, and Bolton, Chen, and Wang, 2009) and from the viewpoint of corporate governance (e.g., Dittmar, Mahrt-Smith, and Servaes, 2003, and Almeida, Campello,

(continued…)

Both the real adjustment costs of investment and the financial transaction costs are incurred at the firm level, i.e., are *internal* to the firm. In addition, there is also an *external* or general-equilibrium effect of frictions (Mussa, 1977) varying by country. We model this effect through the certainty equivalent of the required rate of return, *r*. This rate is affected by macroeconomic factors, such as the (international) risk free rate, the inflation rate, and general macroeconomic volatility. The rate can also vary across countries with the quality of the institutional environment, *W*, which is non-stochastic. This is because institutional quality may affect the degree of overall risk taking (e.g., because of weak bankruptcy procedures or the possibility of nationalization). One of the hypotheses we test below therefore is that a good institutional environment is associated with a lower required rate of return.

The required rate of return may also vary with some firm characteristics, *X.* For example, it can differ across industries (due to return correlation relative to other sectors) or across vintages of capital (related to firm age). Firms within the same industry are assumed though to have the same covariance term with respect to the (overall) market portfolio, except that we allow firm age to matter. To control for these possibilities, we include industry dummies and age variables in the vector of firm characteristics, *X*.

We assume that each firm's productivity shock, *ε*, is observed by firm management, but that the aggregate and industry-specific common components of the shock are unknown to management when making investment decisions. Therefore, the discount factor is deterministic once expectations are taken over aggregate and industry-specific common shocks. Current profits, investment adjustment costs, financial transaction costs, and the value of the next-period capital stock are non-stochastic with respect to the current firm-level shock. Firm characteristics, *X*, are also non-stochastic.

In equilibrium, the required rate of return, given the current value of the firm, will be equal to the next period's expected profits minus investment adjustment and financial transaction costs, plus capital gains (see Appendix for more details on the derivation):

$$\begin{aligned}\left(1+r\left(E\left[\theta\right],X,W\right)\right)V(K^{-};X,W,\epsilon)=\max_{K}\ &\pi(K,\epsilon)-\phi(I,K;X,W,\epsilon)\\ &-\lambda(B,K;X,W,\epsilon)+E\left[V(K;X^{+},W,\epsilon^{+})\right].\end{aligned} \tag{4}$$

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and Weisbach, 2010). For our purpose, this narrower focus is not necessary and makes the empirical strategy more complex. Indeed, although the treatment of cash in our model is implicit, we investigate the empirical relationship between financial frictions and investments (including cash investment) more generally given an articulated model—an uncommon approach in the corporate cash-holding literature.

Here, the minus-sign, $^{-}$, in superscript denotes one-period past values and the plus-sign, $^{+}$, one-period ahead values. Note that both the real adjustment costs of investment (2) and the financial transaction costs (3) can be expressed as functions of solely the current and previous periods' capital stocks. Also, the value function (4) has only one state variable, capital *K*, in addition to the predetermined firm characteristics *X* and the time invariant country characteristics *W*.

B. Marginal Conditions and Equilibrium Law of Motion of Tobin's Q

Note that the derivative of firm value with respect to capital is equal to the replacement value of capital, that is, $V_1 = Q$. Then, the optimality condition for (4) can be expressed as (see Appendix):

$$(r+\delta)Q^{-} = E\left[Q - Q^{-}\right] + (1+\lambda_1)\pi_1 - \phi_2 - \lambda_2 \text{ .,} \tag{5}$$

where the terms λ_1 and λ_2 denote the partial derivatives of the financial transaction cost with respect to the first argument (i.e., external finance *B*) and to the second argument (i.e., capital *K*), respectively; and the ϕ_2 term denote the partial derivative of the investment adjustment cost with respect to the second argument (i.e., capital *K*).

This equation describes the equilibrium law-of-motion of Q and is almost exactly the same as the one derived by Abel and Eberly (1994). The left-hand-side is the required rate of return on the beginning-of -period value of capital. The right-hand-side is the sum of expected capital gains and profits, net of the marginal costs associated with investment and external finance. By rearranging (5), we can obtain a formula to be used in our empirical tests:

$$E\left[Q\right] = (1+r+\delta)Q^{-} - (1+\lambda_1)\pi_1 + \phi_2 + \lambda_2 . \tag{6}$$

Recall that the financial transaction costs are paid only when external finance is actually used. Therefore, when external finance is non-positive, the marginal financial transaction costs, the terms λ_1 and λ_2, vanish from equation (6). Similarly, when investment is non-positive, investment adjustment costs are zero and the ϕ_2 term drops from (6).[12]

[12] This assumption is in line with much of the literature, although we omit the potentially important effect of costly disinvestment (Abel and Eberly, 1994; Abel, Dixit, Eberly, and Pindyck, 1996). One reason to make this assumption is that information on fixed-asset sales is not widely available for our cross-country panel data set, in contrast with the U.S. data typically used in the literature.

C. Relation to the Speed of Adjustment of Tobin's Q

In a world without real and financial frictions, Q should quickly converge to one. Intuitively, we may therefore expect that the better the institutional environment, the faster convergence. In the model, however, the relationship between the adjustment speed and the institutional environment is ambiguous. To see this, we rewrite equation (6) as:

$$\frac{Q^{-}-E[Q]}{Q^{-}}=\frac{(1+\lambda_1)\pi_1-(1+\delta)(\phi_2+\lambda_2)}{Q^{-}}-(r+\delta)\,. \tag{7}$$

Equation (7) shows that the speed of adjustment of Q to its steady state value is a function of the required rate of return, *r*, and the (marginal) financial transaction costs, λ_1, but with opposite signs. If better institutions reduce both the required rate of return and the degree of financial frictions, then the effect on the adjustment speed is ambiguous.

To see this, imagine starting from a Q greater than one (or its steady state value) and consider the role of better institutions. The left hand side of (7) measures the decline of Q. Provided that better institutions ensure more efficient management and less misuse of funds, the required rate of return will be lower and Q has to decline more. Thus, the adjustment is speedier. However, if better institutions also reduce the marginal financial transaction costs, λ_1, then the Q will decline less for a given level of marginal profits, π_1. This is because the divergence of Q from its steady state for firms in countries with low financial transaction costs is small to begin with. The speed of adjustment is thus lower. These two opposite effects show that, theoretically, better institutions do not necessarily lead Q to adjust faster.

Note that equations (6) and (7) also allow for a size effect, λ_2 (i.e., the derivative of financial transaction costs with respect to capital). We discuss athis later in detail but we expect tsmaller firms to pay higher fees for the same external finance needs. Also, we predict that this small firm premium would be lower in countries with good institutions.

D. Average versus Marginal Q

As in other models, our predictions apply to the marginal Q, the derivative of firm value with respect to capital. The marginal Q can differ from the average Q, the ratio of firm value to assets. As in most of the literature, we follow Hayashi (1982) and assume that the marginal value of Q equals the average value of Q. Specifically, we assume the adjustment costs of investment to be linearly homogeneous of degree one in investment and capital. And, we assume similarly that the financial transaction cost function, λ, is linearly homogeneous of degree one in external finance and capital. Then, Hayashi's result still holds and the marginal Q equals the average Q.[13]

III. Estimation Methodology

A. Minimizing One Period Ahead Forecast Errors

Both investment adjustment and financial transaction costs are assumed to be linear functions of firm characteristics, X ($n \times k_1$ matrix, with n being the number of firm-year observations), and country institutions, W ($n \times k_2$ matrix). We can then write equation (6) as:

$$E[Q \mid \varepsilon] = X\gamma_1 + W\gamma_2 + Q^{-}\alpha_1 + (X * Q^{-})\alpha_2 + (W * Q^{-})\alpha_3 + Z\beta_1 + (X * Z)\beta_2 + (W * Z)\beta_3. \quad (8)$$

where $Z = \begin{bmatrix} -\pi_1 & -\lambda_1\pi_1 & \phi_2 & \lambda_2 \end{bmatrix}$ (an $n \times 4$ matrix), (X*Z) is the interaction term between X and Z (an $n \times 4k_1$ matrix), and likewise for the other interaction terms. Taking expectations over the next period's shock, ε^{+}, given current period's shock, ε, yields the expected values for end-of-the period Q.

In the data, we observe the realized values of end-of-period Q. The difference between the expected and realized values is the one-period-ahead forecast error:

$$\xi = Q - E\left[Q \mid \varepsilon\right]. \quad (9)$$

This one-period-ahead forecast error is serially uncorrelated even if underlying productivity shocks are serially correlated. Thus, OLS estimates are unbiased and consistent.[14]

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[13] The proof is a special case of the value function based on the system of homogeneous-of-degree-one functions, studied in Alvarez and Stokey (1998). The proof is omitted but a sketch is as follows. Given a competitive wage and product price (normalized to one), labor immediately adjusts to its optimal level. Because the production function exhibits constant returns to scale in capital and labor, profits are linear in capital given wage and product prices. Because adjustment costs are homogeneous of degree one in investment and capital, and financial frictions are also homogeneous of degree one in external finance and capital, and the optimal amounts of investment and external finance become linearly proportional to capital. The value of the firm becomes therefore linearly proportional to capital as well. Therefore, marginal Q equals average Q.

[14] We do need to correct for the possibility that firm years within a country are likely to be subject to correlated shocks (heteroskedasticity). We therefore use robust standard errors with clustering at the country-year level. Liu, Whited, and Zhang (2009) also use the canonical investment model (without financial frictions) but derive a different orthogonality condition, namely, the equivalence of stock returns and the levered investment returns (i.e., a variant of the returns on equity). They show that predictions based on Q-theory for stock returns of U.S. firms fit the data much better than previous models (e.g., CAPM, Fama-French four factors, and consumption-CAPM). This supports our use of a similar canonical investment model. However, the error terms they minimize are outside the model and arise from, for example, measurement errors.

B. Parameterization

As in most studies, we use investment adjustment costs that are linear, homogeneous and convex:[15]

$$\phi(I,K,\varepsilon) = c_1 I + c_2 K + \frac{c_3}{2}\left(\frac{I}{K}\right)^2 K . \qquad (10)$$

We think it is natural to assume a similar functional form for the financial transaction costs, which can be seen as a generalized version of Gomes (2001):

$$\lambda(B,K,\varepsilon) = b_1 B + b_2 K + \frac{b_3}{2}\left(\frac{B}{K}\right)^2 K . \qquad (11)$$

The partial derivatives of the investment adjustment and financial transaction cost functions drive the equilibrium law of motion of Q as in equation (6). In particular, the coefficients c_2, c_3, b_1, b_2, and b_3 determine the evolution of Q.[16] We next assume that each of these coefficients is a linear function of firm real characteristics, *X*, and country institutional factors, *W*.

Provided that all coefficients are positive, the financial transaction cost function is increasing in the amount of external finance used *B* (i.e., $\lambda_1 = b_1 + b_3(B/K) > 0$) and convex (i.e., $\lambda_{11} = b_3 / K > 0$). This means that the lower are b_1 and b_3, the lower are the financial transaction costs.

The coefficient b_2 is more complex. The financial transaction costs are assumed to be decreasing in the size of a firm—a small firm typically pays a premium for a given need of external finance (i.e., $\lambda_2 = b_2 - b_3(B/K)^2 < 0$ for *K* small relative to *B*). Note that this

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[15] Although there is no "pure" fixed cost in (10), the *K* term can be seen as a cost proportional to firm size regardless of the size of investment. Note that the real business cycle literature with representative agents uses a convex adjustment cost for *increases* in investment, not investment itself, to achieve smooth investment patterns over time. Although aggregate investment is smooth, firm level investment is known to vary. Thus, in a firm level study, as in this paper, adjustment costs are commonly defined in terms of investment, not in terms of increases in investment (for a reconciling effort see Khan and Thomas, 2008).

[16] The partial derivative of the adjustment cost function with respect to capital is: $\phi_2 = c_2 - \frac{c_3}{2}\left(\frac{I}{K}\right)^2$.

The partial derivatives of the financial friction function with respect to external finance and capital are: $\lambda_1 = b_1 + b_3\left(\frac{B}{K}\right)$ and $\lambda_2 = b_2 - \frac{b_3}{2}\left(\frac{B}{K}\right)^2$, respectively.

"smallness" also means "financially distressed," i.e., when a large sum of external finance is needed relative to the size of existing capital. The larger b_2, the more all firms need to pay for external financing. Relatively, however, this affects larger firms more than smaller firms —there is little change for firms with small K/B. In other words, relatively the small firm premium declines the larger b_2 is.

C. Estimation Equation

In line with the assumptions regarding the parameters of the investment adjustment cost function and the financial transaction costs, we also assume that the required rate of return, *r*, is a linear function of firm characteristics, *X,* and of country-specific institutional factors, *W*. This is reflected in the coefficients α_1, α_2, and α_3 on lagged *Q* in Equation (8). Here, we re-specify them as a coefficient vector, *a(X, W)*. We write the other coefficients, c_2, c_3, b_1, b_2, and b_3, similarly as vector functions.

Incorporating all of our assumptions, the version of Equation (8) to be estimated can be expressed as follows, where as a broad measure of the firm's capital stock, including cash and cash-equivalents, we use *Total Assets* (firm size), *A*.

$$
\begin{aligned}
Q_{i,j,k,t} = {} & \kappa\pi_{1,i,j,k,t} \\
& +\gamma\left(X_{j,k,t},W_k\right) \\
& +a\left(X_{j,k,t},W_k\right)Q_{i,j,k,t-1} \\
& -b_1\left(X_{j,k,t},W_k\right)\pi_{1,i,j,k,t}\chi_{i,j,k,t} \\
& +b_2\left(X_{j,k,t},W_k\right)\chi_{i,j,k,t} \\
& -b_3\left(X_{j,k,t},W_k\right)\left\{\left(\frac{B_{i,j,k,t}}{A_{i,j,k,t}}\right)\pi_{1,i,j,k,t}+\frac{1}{2}\left(\frac{B_{i,j,k,t}}{A_{i,j,k,t}}\right)^2\right\}\chi_{i,j,k,t} \\
& +c_2\left(X_{j,k,t}\right)\Psi_{i,j,k,t} \\
& -c_3\left(X_{j,k,t}\right)\left(\frac{I_{i,j,k}}{A_{i,j,k,t}}\right)^2\Psi_{i,j,k,t} \\
& +\xi_{i,j,k,t},
\end{aligned}
\tag{12}
$$

The indicator functions are defined as:

$$
\begin{aligned}
\Psi_{i,j,k,t} &= 1,\ \text{if} = \mathrm{I}_{i,j,k,t} > 0, \\
&= 0,\ \text{otherwise; and}
\end{aligned}
$$

$$\chi_{i,j,k,t} = 1, \text{ if } B_{i,j,k,t} > 0,$$
$$= 0, \text{ otherwise.}$$

The marginal return is approximated by

$$\pi_{1,i,j,k,t} = \frac{\pi_{i,j,k,t} - \pi_{i,j,k,t-1}}{A_{i,j,k,t} - A_{i,j,k,t-1}}.$$

The second term $\gamma\left(X_{j,k,t}, W_k\right)$ controls for level effects, including country and industry fixed effects.

The effects of institutions on the financial transaction cost function and the required rate of return can be identified from the interaction terms. Institutional variables are time invariant and therefore all the level effects of institutions are absorbed in the country fixed effects. The coefficients for investment and external finance are identified because their values differ.[17] In addition, because investment is not assumed to be influenced by current profits, but financing is, only external finance is interacted with profits (coefficient b_1). This is similar to what is implicitly assumed for the cash flow sensitivity in a typical investment regression, except that the mechanism in this paper allows for a more precise way of measuring financial frictions. We also assume that institutional factors do not affect the technological adjustment of the investment (though we revisit this issue).

IV. DATA DESCRIPTION

All variable definitions, data sources and some sample statistics are provided in Table 1. We use firm level data from the Worldscope database of Thomson Financial. The data cover the period 1990 to 2007 for 48 countries, and contains about 380,000 firm-year observations for which Q can be constructed.[18] We eliminate observations for a number of reasons with each criterion applied sequentially to the remaining data set. First, we eliminate observations if values are economically not meaningful, such as when the values for capital

[17] For example, positive investment does not require positive external finance, as firms may finance investments internally. Also, firms with negative profits and no investments may still seek external funds for working capital needs or to maintain capital.

[18] The number of original firm-year observations, including those for which Q cannot be constructed, is about one million, although those without Q may well include inactive firms. The 48 sample countries are: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Malaysia, Mexico, Netherlands, New Zealand, Norway, Pakistan, Peru, Philippines, Poland, Portugal, Russia, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Kingdom, United States, and Venezuela.

expenditures are negative. Second, on a statistical basis, observations in excess of three standard deviations from the mean for that variable in the U.S. sample are eliminated. Third, we eliminate countries having less than 15 non-financial companies per country with non-missing values for Q in the year 2000 (i.e., Egypt, Morocco, Slovakia, Slovenia and Zimbabwe). And fourth, 2-digit SIC industries which have less than five firms with non-missing values for age and Q in 2000, as well as all unclassified companies (SIC 99) are also deleted. After these deletions, about 300,000 firm-year observations with Q remain. For the regression results, because of the unavailability of lagged Q and other variables, the sample shrinks further, to about 75,000 firm-year observations in the benchmark regression.[19]

Marginal profit, π_I, is proxied by the increase in earnings divided by the increase in total assets. For earnings we use a cash flow measure, defined as *Net Income before Extraordinary Items and Preferred Dividends + Interest Expense on Debt + Depreciation and Amortization* (variable names correspond to those of Worldscope unless otherwise noted). While this measure can be susceptible to tax and other driven accounting adjustments hiding the true performance of a firm, some adjustments are legitimate (e.g., tax credits for R&D expenditures or future losses). Also, taxation matters for firm valuation. Nevertheless, for robustness, we also use a before-tax measure, namely *Operating Income + Depreciation and Amortization*.

For investment, *I*, we use the usual definition of investment *Capital Expenditure* as our benchmark. Our broader definition of capital stock also includes cash and equivalents, e.g., holdings of bonds and equity investments in other companies. As a robustness check, we therefore use a broader notion for investment, *Capital Expenditure + Change in Cash and Short-Term Investment*. Both are assumed to be subject to adjustment costs.

External finance, *B*, is defined in line with Rajan and Zingales (1998) and others as *Capital Expenditure + Change in Cash and Short-Term Investment – Cash Flow from Operation – Decrease in Inventory – Decrease in Receivables – Increase in Payables*. We add the change in cash to the original Rajan and Zingales (1998) definition, in line with our broad concept of investment. For robustness, we use a narrower external finance concept excluding trade credit, defined as the net increase in *Total Debt + Net Proceeds from Sale/Issue of Common and Preferred Stocks*.

[19] The firm age variable, described below, reduces the sample size considerably, from about 150,000 to 75,000. Even though firm age can be constructed for about 270,000 observations out of the original one million observations, the sample for which both Q and age are available is much smaller. We check below the robustness of our results by excluding firm age and using a bigger sample. Lack of other variables halves the sample size from 300,000 to 150,000. For those missing data that can be interpreted as zero, we substitute zeros (for example, *Net Proceeds from Sale/Issue of Common and Preferred Stocks*).

We define Q as the *Market Capitalization + Total Asset – Total Equity* over *Total Asset*. Q is measured at fiscal-year end, usually right after the ex-dividend date. This measure of Q is commonly used in cross-country empirical studies in the corporate finance literature. We use *Total Asset* as our broad measure of capital. The short time dimension of our data—our data set includes only 16 years—prevents more elaborate capital stock calculations based on the permanent inventory method (Blanchard, Rhee, and Summers, 1994). Also, debt is valued at par since corporate bond prices are not available for most firms in our sample.

As for firm characteristics, we include industry dummies and firm age (using the variable *Founded Date*). Firm size is not included as a control variable, because it is endogenous, and depends on financial frictions and investment adjustment costs. Also, several measures of firm size are related to firm capital stock, which is used in the regressions as an important variable to identify the effects of institutional and real factors on financial frictions and investment adjustment costs.

The required rate of return is the sum of the risk free rate and an unobservable risk premium. Our measure of the country-specific real short-term risk free rate is the short-term government Treasury bill rate minus the CPI inflation. To capture country-specific macroeconomic risks factors possibly reflected in the "risk free" rate, we include the CPI inflation rate and macroeconomic volatility, measured as the standard deviation of real GDP growth for the period 1995-2006. CPI and real growth rates come from the World Development Indicators, while short-term Treasury bill rates come mainly from the IMF's International Financial Statistics. We also allow these macroeconomic variables to affect financial frictions (e.g., a higher GDP volatility can lead to a higher cost of external finance).

To capture country-level institutions, *W*, we use several measures, covering both the *de jure* and *de facto* characteristics. Specifically, we use five measures with several indicators for each institutional measure (Table 1). In the benchmark regression, we use for the quality of corporate governance (*CorpGov)* the shareholder (anti-director) rights (La Porta et al., 1998), a measure commonly used in the literature on investor (shareholder) protection. For creditor rights (*Creditor*), we use the strength of legal protection for lenders and borrowers (World Bank, 2008a). For general institutional quality (*Institution),* we use the property rights measure of La Porta et al. (1998). For product market competition (*Compet*), we use a measure of trade barriers (World Economic Forum, 2007). For financial market development (*FinMkt)*, we use stock market-capitalization-to-GDP for 2005 (World Bank, 2008b).

Altogether, the interaction terms with lagged Q become:

$$
\begin{aligned}
a(X_{j,k,t,}W_k) = \textstyle\sum_j a_{1j} IndustryDummy_j + a_2 Age_{i,j,k,t} \\
+a_3 RiskFreeRate_k + a_4 Inflation + a_5 Macro \\
+a_6 CorpGov + a_7 Creditor + a_8 Institution \\
+a_9 Compet + a_{10} FinMkt.
\end{aligned} \tag{13}
$$

The coefficients on the other, interaction terms (***b*₁, *b*₂, *b*₃, *c*₂,** and ***c*₃**) take the same form. The level effect **γ** (which includes country fixed effects) is defined similarly as:

$$
\begin{aligned}
\gamma(X_{j,k,t,}W_k) = \textstyle\sum_k \gamma_{0k} CountryDummy_k \\
+\textstyle\sum_j \gamma_{1j} IndustryDummy_j + \gamma_2 Age_{i,j,k,t} \\
+\gamma_3 RiskFreeRate_k + \gamma_4 Inflation + \gamma_5 Macro \\
+\gamma_6 CorpGov + \gamma_7 Creditor + \gamma_8 Institution \\
+\gamma_9 Compet + \gamma_{10} FinMkt.
\end{aligned} \tag{14}
$$

V. Estimation Results

A. Benchmark Regression

Table 2 shows the benchmark regression results. Specifically, it shows by column the estimated coefficients of the interaction terms of interest, where each cell represents the interaction term between the corresponding row (e.g., *Corporate Governance*) and column (e.g., lagged Q, *Required Return*).[20]

In the first column, the coefficient on lagged Q captures the effects of institutions and firm variables on the required rate of return. Good corporate governance (shareholder protection) is associated with a significantly lower required rate of return, with a coefficient of -0.0433. The magnitude of the effect should be interpreted as follows: a one-standard-deviation improvement (increase of 1.3) in the anti-director rights index would lower Q in the next period by 0.16 for the average firm (with a Q of 3). In other words, Q would more quickly approach its steady state value with better corporate governance. More intense product market competition is associated with a higher required rate of return (although this coefficient is only significant at the 10 percent level). Higher firm age is also associated with a higher rate of return but the effect is negligible—Q increases by 0.01 for a firm which is one year older and has “average characteristics.” Other factors do not change the required rate of return.

[20] Because the number of coefficients for the benchmark regressions with all the institutional variables is large, we do not show the other coefficients (e.g., country and industry fixed effects) or interaction terms involving industry dummies (which can be provided upon request).

The second to fourth columns present the effects of institutions and other variables on firm-level financial transaction costs. The second column shows the effect of institutions on the slope of the financial transaction cost function, or equivalently, the intercept of the marginal cost curve. The third column captures the differential effect depends on size (i.e., the small-firm premium). And, the fourth column shows the effect on the curvature of the financial transaction cost function, or equivalently, the slope of the marginal cost curve. Note that the second and fourth columns are expected to have opposite signs.

Good corporate governance increases the intercept of the marginal financial transaction cost curve (column 2), but the effect is very small and significant only at the 10 percent level. Importantly, better corporate governance reduces the extra costs that small firms have to pay (column 3), with a one standard deviation improvement in investor protection (1.3) lowering this premium by about 3 percent of assets. Good general institutional quality also lowers the small-firm premium with a one standard deviation improvement (0.8) lowering the small-firm premium by about 4 percent of assets. Good creditor rights increase the small-firm premium, but the statistical significance of this result is low and not robust to other specifications. Other factors do not have statistically significant effects on firm-level financial transaction costs.

The results can also be interpreted in terms of the speed of convergence of Q, as per equation (7). Specifically, the results imply that Q is expected to move more rapidly towards its firm-specific steady state value for all firms in countries with better corporate governance because of the lower required rate of return effects. Also, the differences in the adjustment speed of Q between small firms and large firms are smaller in countries with good shareholder protection and with good general institutional environments.

B. Robustness Checks

To verify that the results are not driven by the specific measures we use, we examine a number of alternative proxies. We start with different measures of some of the firm level variables. In Table 3a, we use before-tax income rather than after-tax income. In Table 3b, we use a broader concept of investment, which includes, in addition to fixed capital investment, financial investments. In Table 3c, we use a narrower concept of external finance, excluding trade credit from the benchmark specification. The regressions with these different accounting measures (Tables 3a–c) essentially replicate the benchmark results. A slight difference is obtained when we use a narrower concept of external capital (Table 3c): here, the effects become less significant, except for the reduction in the small firm premium associated with better corporate governance. The effects of the real factors are not tabulated here (or in any following table) as they hardly differ from their effects in the benchmark regression.

Next, we check if the effects of any individual institutional measure are affected because other factors are correlated with it. We therefore estimate the effects of each institutional factor without including other factors. Each row of Table 4 shows the corresponding one-by-one regression. The results are virtually the same as in the benchmark regression, except that the effects of product market competition and financial market development are significant, unlike in the benchmark regressions that include all the institutional factors at once. This suggests that the correlation among the institutional variables does not generally lead to an over- or under-estimation of the true effects. In what follows, we continue to always include all five institutional factors, as in the benchmark regression.

We also examine alternative proxies for the institutional factors in Table 5—each row presents the effect of one alternative institutional variable. Other corporate governance measures broadly support the conclusion that good corporate governance reduces financial frictions, although the effect varies. When we use Spamann's version of the anti-director rights (Spamann, 2010), the signs are reversed, which is not surprising given that Spamann argues that his index is quite different from the original one developed by La Porta, et al. (1998). The difficulty of coding the laws and regulations has led researchers to construct *de facto*, rather than *de jure* variables. When we use the more up-to-date anti-self-dealing index of Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008), which is based on surveys of lawyers and is meant to reflect actual practices rather than law on the books, the benchmark results are mostly replicated, except that corporate governance no longer matters for the required rate of return. We also examine the De Nicolo, Laeven, and Ueda (2008) measure of *de facto* corporate governance quality (CGQ) at the country level reflecting disclosure practices and transparency of firms.[21] The benchmark results are, again, broadly replicated, except for the effect on the required rate of return.[22]

For creditor rights (*Creditor*), we alternatively use a measure that more narrowly captures the ability of creditors to secure and retrieve collateral (Djankov, McLiesh, and Shleifer, 2007). We find that this measure is associated with a higher small firm premium. This contrasts with most of the other regression results where a broader measure of creditor rights has low or little statistical significance. These differences could suggest that, if banks enjoy monopoly power, then better creditor protection narrowly defined increases the

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[21] This index measures corporate governance in three dimensions: disclosure (number of accounting items disclosed), transparency (disparity of earnings between before and after accounting ad hoc adjustments), and stock price comovement. Consistent with Doidge, Karolyi, and Stulz. (2007) which report that in cross-country studies, country-level corporate governance matters much more than firm-level corporate governance, we use only country-level corporate governance measures.

[22] Note that the mean of the *CGQ* index is five times smaller than the mean of anti-director rights. Correcting for this, the magnitudes of the coefficients are much higher than in the benchmark regression.

bargaining power of banks so that the small firm premium increases. If informational problems associated with small firms are central, however, then better creditor rights more broadly defined, including the ability to resolve financial distress efficiently, could reduce the small firm premium. Indeed, when we use a survey-based measure of the overall efficiency of bankruptcy procedures (Djankov, Hart, McLiesh, and Shleifer., 2008), we find the benchmark results to hold, that is, there is no effect of creditor rights on the dynamics of Q.

As an alternative measure of general institutional quality (*Institution*), we use the rule of law measure (from Kaufman, Kraay, and Mastruzzi, 2003) and trust in people (from the World Values Survey, www.worldvaluessurvey.org). Using either variable as a measure of general institutional quality reduces the small firm premium as in the benchmark regression. However, there is also an opposite effect, contributing to a higher curvature of the financial transaction cost function. However, this is not robust to different accounting definitions (Tables 3a-c), one-by-one regressions (Table 4), and other, untabulated specifications.

As an alternative measure of product market competition (*Compet*), we use the degree of new business entry (World Development Indicators*,* 2008) as well as the costs of business start-ups (World Bank Doing Business Survey, 2008). The effects are similar to those of corporate governance: easier entry is associated with a lower small-firm premium; and low start-up costs are associated with a low curvature for the financial transaction cost function. These effects may reflect more intense product market competition, but may also capture broader characteristics that facilitate new firm entry and lower start-up costs. Also these *de facto* measures closely relate to other institutional factors affecting financial development.

As an alternative measure of financial development (*FinMkt*), we use private credit to GDP and the absence of foreign ownership restrictions (both from World Economic Forum, 2007). Different measures of financial market development hardly alter the benchmark regression results.

We also conduct robustness checks for our measures of macroeconomic volatility (*Macro*). When we use the coefficient of variation of the exchange rate and the standard deviation of inflation rate, both from World Development Indicators, we find that the regression results are unchanged from the benchmark results (not tabulated).

We also check robustness to sample selection by using less restrictive samples. Because *Age* is often missing, we exclude the *Age* variables from our regression and rerun regressions with a sample size almost double in size, 147,711 instead of 74,272 observations (Table 6). The results are broadly similar to the benchmark regression results, except that corporate governance no longer matters for the required rate of return (Table 6). The regression results remain unchanged also when using either all firms or manufacturing firms only (not tabulated), rather than all non-financial firms.

Overall, the benchmark results are broadly replicated in most regressions. Good corporate governance and general institutional quality consistently lower the small firm premium in the financial transaction cost function. In addition, good corporate governance lowers the required rate of return in many specifications. All other factors do not show robust effects on either the required rate of return or financial transaction costs. The importance of shareholder, rather than creditor, protection suggests that differences in financial frictions are primarily driven by the availability of equity finance rather than by all forms of external finance. There are at least three possible explanations for this. First, our sample consists of listed firms and they can (in theory) resort to issuing equity even if debt costs are high. Therefore, at the margin, the cost of external finance is determined by the cost of equity finance, even though, in practice, most external finance is debt. Second, good corporate governance is necessary to ensure an efficient use of funds regardless of whether the source of funding is debt or equity finance. Third, credit constraints may be binding for firms in our sample, but weaker creditor rights do not much influence these constraints.

C. Real Adjustment of Investment and Institution

Institutional factors may affect the speed of investment not only by affecting financial frictions but also by changing real investment adjustment costs. We therefore investigate how institutional variables affect the coefficients that characterize the real adjustment costs of investment. The results (Table 7) confirm that good corporate governance lowers the rate at which costs increase with size (c_2), where the size effect itself is presumably due to technological and managerial diseconomies of scale.[23] However, this is somewhat offset by an increased slope of the marginal real adjustment cost curve: small new investments (relative to assets) appear to cost less but big new investments cost more.[24] Overall, the effect on investment (relative to assets) is unknown, however, partly because, unlike financial frictions, the intercept term is not identified econometrically.

As for the results on financial transactions costs and the required rate of return, all the effects of corporate governance, general institutional quality, and other factors remain virtually unchanged relative to the benchmark regressions.

[23]Managerial entrenchment (e.g., Myers and Majluf, 1984, Gaudet, Lasserre, and Van Long, 1998) or worker sabotage (Parente and Prescott, 2000) may give rise to diseconomies of scale.

[24] This contrasts with financial transaction cost for which B/K can be quite large in a distressed situation, in which case, costs are decreasing in K. However, large investments are less likely when in distress, I/K would consequently not be large at that time, and the cost function would be increasing in K.

VI. Measurement Errors

A. Source of Measurement Errors

Stock Price Movements

Stock markets may not always reflect fundamental values (see Duffie, 2010). For U.S. data, Abel and Blanchard (1986) address this issue by constructing a time series for Q based on a long time series of past marginal products of capital. Phillippon (2009) utilizes a long time series of corporate bond prices, also for U.S. firms. Because our cross-country data are short in the time dimension, we cannot utilize these strategies. Note that because price movements are quite volatile, the measurement errors, if any, should have little auto-correlation.

Accounting Issues

Accounting items are subject to some measurement errors. We run therefore robustness checks using different measures for the major variables other than Q (Table 3a-c). As for the mismeasurement of debt (in the numerator of Q) and the replacement cost of capital (in the denominator), country fixed effects should help address some of the persistent measurement errors.

Average Q vs. Marginal Q

Ever since Hayashi (1982), the theoretical difference between marginal and average values of Q has been recognized in the literature. As noted above, we follow conventional assumptions so that the two values should coincide in principle. However, as Hayashi (1982) shows, monopoly power in product markets may create a disparity between marginal and average Q. Moreover, as Abel and Eberly (2008) show, movements in Q can become larger with monopoly power and with decreasing returns to scale. In our estimations, the coefficients on product market competition are not robustly related to changes in Q. This suggests that, on average at the country level, the effect of monopoly power is small compared with other factors affecting the evolution of Q. Note that industry-specific movements, to the extent that they are due to monopolistic power, are controlled for since we include industry interaction terms. And within industry, any short-lived rents or monopolistic profits from innovative products are captured by serially correlated productivity shocks.

Different Timing Assumptions

Timing assumptions are also critical. Without the time-to-build assumption (i.e., with immediate use of capital after investment), investment would always follow the revelation of productivity shocks. In the special case of the "time-to-build" assumption, there would be no relationship between last period's Q^{-} and current Q, so that the coefficient *a* would be zero

(Barnett and Sakellaris, 1999). As can be seen from our regression results, this is not the case empirically.

Nevertheless, we can consider different timing assumptions regarding the revelation of productivity shocks. So far, we have assumed that the productivity shock is revealed at the beginning of the current period, so that the last period's Q^- can be observed together with information on the current shock. As such, it is non-stochastic from the point of the beginning of the current period. It may be the case, though, that the shock is not revealed at the beginning of the current period. In this case, investment decisions will still be made after the realization of the shock, but then we really observe $E[Q^-|\varepsilon^-]$, not Q^- itself. If so, there will be no observation errors in next period's Q, as we can observe $E[Q|\varepsilon]$ in the data. However, there will be another form of forecast errors in Q, which could be classified broadly as a measurement error: decisions are made on the basis of the realized value of Q^- but we only observe its forecast value $E[Q^-|\varepsilon^-]$. Since these errors are one-period-ahead forecast errors, however, they should not exhibit any auto-correlation.

B. Testing for Measurement Errors

All four forms of measurement errors possibly affect the observed values of Q. If sizable measurement errors indeed exist, then the OLS errors will exhibit serial correlation. To see this, note that, using Equation (8), the OLS errors can be expressed as:

$$u_{OLS} = (\xi + v) - \left\{ v^- \alpha_{1OLS} + (X * v^-)\alpha_{2OLS} + (W * v^-)\alpha_{3OLS} \right\}, \qquad (15)$$

where measurement errors v are assumed to have a mean of zero and be serially uncorrelated, that is, $E[v] = 0$ and $E[v' v^-] = 0$. In this case, the OLS errors have serial correlation equal to:

$$E\left[u_{OLS}' u_{OLS}^+\right] = -\left\{ E[v'v]\alpha_{1OLS} + E[v'(X * v)]\alpha_{2OLS} + E[v'(W * v)]\alpha_{3OLS} \right\}. \qquad (16)$$

This is expected to be non-zero in the presence of measurement errors. If the measurement errors, v, are also serially correlated, more terms would enter into (16) and the serial correlation of the OLS errors is likely to be larger.

By testing for serial correlation in the OLS errors, we can check if the magnitude of the measurement error problem is large or small. When we do so, we find that the null hypothesis of zero serial correlation in (16) cannot be rejected.[25] Hence, measurement errors, if any, are very small in comparison with one-period-ahead forecast errors.

C. Instrument Variable Estimation

While measurement errors are likely to be small, we can still check the robustness of our findings against measurement errors by using instrumental variable estimation. Given the very small measurement errors, it is likely that all measurement errors combined, if any, exhibit little auto-correlation.[26] This is plausible given that large swings in stock prices likely dominate other sources of measurement errors.

Based on (8), the one-period-ahead forecast errors including measurement errors can be expressed as:

$$\begin{aligned}\tilde{\xi} = (Q+\nu) - \{ & X\gamma_{1IV} + W\gamma_{2IV} \\ & +(Q^{-}+\nu^{-})\alpha_{1IV} + (X*(Q^{-}+\nu^{-}))\alpha_{2IV} + (W*(Q^{-}+\nu^{-}))\alpha_{3IV} \\ & + Z\beta_{1IV} + (X*Z)\beta_{2IV} + (W*Z)\beta_{3IV} \}.\end{aligned} \tag{17}$$

Then, using *S* to denote instrumental variables, we can write the estimation equation as the orthogonal condition with this one-period-ahead forecast errors including measurement errors:

$$E\left[S'\tilde{\xi}\right] = 0. \tag{18}$$

[25] Note that, with the fixed effect estimation we have assumed so far theoretically that the regression errors *u* have an additional autocorrelation (see Wooldridge, 2002, p.275). If we use only the last year sample in our dataset, we need to test for autocorrelation in (16) against the theoretical null hypothesis, $-1/(T-1)$, where the time dimension is $T=18$ in our case. We conduct this test correcting for potential heteroskedasticity and find the AR(1) coefficient of the fixed effect residuals to be 0.200 with a standard error of 0.162. The theoretical autocorrelation is – 0.059 (= – 1/17) and the *t*-statistic is 1.64, not significant. Alternatively, if we use all the observations in the dataset, we have to test the autocorrelation in (16) against the null of zero with robust errors to correct both for the theoretical possibility of varying serial correlations due to the fixed effect estimation, and for potential heteroskedasticity (again, see Wooldridge, 2002, p.275). We conduct this alternative test as well: the AR (1) coefficient is 0.050 with a standard error of 0.054 and the *t*-statistic is 0.91, not significant again. Note that the Durbin-Watson test for serial correlation does not work when the lagged dependent variable is used as a regressor. A generalized version, the Breusch-Godfrey test, does not work either with heteroskedastic errors.

[26] If our test had indicated the presence of large measurement errors and the possibility of autocorrelation in the measurement errors themselves, the best estimation technique would have been the measurement-error-robust GMM estimation developed by Erickson and Whited (2000). But, this is not the case. Also, their estimation technique does not work well with fixed effects and heteroskedasticity (Almeida, Campello, and Galvao, 2010). Therefore we use the simpler IV estimation strategy described below.

The usual requirement for instrumental variables, *S*, is that they need to be orthogonal to the original one-period-ahead forecast errors ξ. Here, in addition, they also need to be orthogonal to the measurement errors to remove the bias. We use twice-lagged Q as the instrumental variable for lagged Q. This is a legitimate choice because the twice-lagged Q is well correlated with the lagged Q, but orthogonal to the one-period-ahead forecast error in the current period and has a measurement error which is (empirically) orthogonal to the one associated with lagged Q. For the interaction terms, $(X*(Q^{-}+\nu^{-}))$ and $(W*(Q^{-}+\nu^{-}))$, other instrumental variables are necessary for identification. Following Wooldridge (2002, p.237), we construct them using the fitted value of lagged Q (i.e., the lagged *E[Q]* in the limit), that is, $(X*E[Q^{-}])$ and $(W*E[Q^{-}])$. These fitted values are obtained by OLS estimation. Otherwise, the procedure is a standard two-stage-least-square estimation using lagged values used in many other studies (e.g., Almeida and Campello, 2010).[27]

Table 8 shows the results for the benchmark specification using instrumental variables.[28] The results broadly replicate those of the OLS-fixed effects estimations. A notable difference is that the required rate of return is no longer affected by corporate governance but, instead, the curvature of financial frictions is now reduced significantly by better corporate governance. As in previous results, the small firm premium is lower in counties with good corporate governance and good general institutional quality. Creditor rights do not have any effects but more developed financial markets reduce the required rate of return (although this result is significant only at the 10 percent level). Finally, more product market competition increases the required rate of return, possibly because it reduces monopolistic rents which can make a firm safer to lend to, but this effect is not robust to other specifications.

[27] By construction, the equation is just-identified and the error term is not subject to serial correlation. Hence, the two stage least square procedure is both consistent and efficient. We do allow for potential heteroskedasticity (i.e., correlation in error terms) among firms in each country and each year, and correct this by clustering at the country-year level. Theoretically, any *n*-times lagged Q's (n>2) can also be used as instrumental variables to form an over-identified system (Arellano and Bond, 1991). As we have a not-so-small time dimension and a very large cross-section of firm, considering the computational burden, we use only the twice lagged Q with the just-identified system.

[28] Instruments include approximation errors, because they are not perfectly correlated with the original variables (weak instruments). There are no well-established tests for the weak instruments problem in the case of heteroskedasticity but, following Baum, Schaffer, and Stillman (2007), we conduct two tests. The Kleinbergen-Paap *rk* Wald test statistic is 5.14, which is not large enough to suggest that our instruments are not weak. However, the Anderson-Rubin *F*-statistic is 165, rejecting the null hypothesis of under-identification, suggesting that the instruments are not weak. Note that the latter test is considered stronger than the former. In addition, in our case, approximation errors may exacerbate multicollinearity problems because the new error, the difference between the lagged Q and the twice lagged Q, may be correlated with other regressors, *X* (if *X* is autocorrelated) and *W*. However, the empirical relevance of this problem is not well understood and this bias may be either small or large. Nevertheless, with instrumental variables, we can at least check the robustness of our findings so far, which have been based on OLS-fixed effect estimation.

VII. Concluding Remarks

We investigate how institutional environments affect financial frictions and thereby investment efficiency. Theoretically, we modify a canonical investment model to include general financial frictions. Investments are assumed to be affected by institutional factors through financial transaction costs at the firm level and the required rate of return at the macro level. We then develop an estimation strategy to identify the effects of various institutional factors on the financial transaction costs and on the required rate of return.

Our main empirical result is that good corporate governance, as reflected in strong shareholder protection and, somewhat less robustly, good general institutional quality, is associated with lower financial transaction costs, in particular, a reduced small-firm premium. Moreover, in many specifications, good corporate governance is associated with a lower required rate of return. Taken together, these results imply that good corporate governance and general institutional quality lead to a more efficient capital allocation.

The results also suggest that creditor rights—a narrower concept of contractual enforcement—play less of a role. This may well be due to the sample of firms we study (i.e., listed firms) which can relatively easily raise both debt and equity finance. For these firms, at least with respect to marginal investments, corporate governance and related informational and agency issues are likely more important in determining financial frictions and investment efficiency than creditor rights related to the (expected) values of loans and collateral. This is important evidence that questions the validity of many macroeconomic models which focus on collateral requirements or (synonymously) on limited liability constraints.

The importance of good corporate governance and the relative lack of importance of creditor protection rights can be consistent with differences in institutions and firm performance between the U.S. and advanced countries like France, Germany or Japan. Creditor protection in the U.S., where firms can easily file for Chapter 11, is often considered weak compared to the other advanced economies. If due to these weak creditor rights, collateral constraints constitute a more important financial friction in the U.S., then U.S. firms should find it more difficult to finance their investment than firms in France, Germany, or Japan. This is not what the general perception is, nor what we find. Instead, it may be that because in the U.S. firms are better governed than those in France, Germany, or Japan, informational problems are less severe, and therefore U.S. firms face fewer frictions and adjust investment faster than firms in other countries do. Our empirical results are consistent with this story.[29]

[29] We check if our results are largely driven by U.S. firms by rerunning the basic regressions after dropping U.S. firms from the sample. The benchmark results remain mostly unchanged (not tabulated).

Collateral constraints may well be important, however, for the vast majority of firms in many countries and indeed for countries' overall economic development. Small companies produce about half of the GDP in many countries, from the U.S. to Thailand (Paulson and Townsend, 2005). And borrowing constraints for business startups importantly explain differences in economic performance around the world (Cagetti and De Naridi, 2006, Paulson and Townsend, 2008, and Klapper and Love, 2010). While we find that cross-country differences in creditor rights do not influence limited liability constraints for our sample of firms, neither do we find evidence against the presence of such constraints in each country or in other data. Still, more data and analysis are needed to reconcile the general findings with those obtained in our study.

Our results have important policy implications regarding how a country can best reduce financial frictions, a major source of macroeconomic fluctuations and growth. Better corporate governance clearly reduces financial frictions and benefits firms. Therefore, improvements in this area are certainly desirable. By contrast, stronger creditor rights may be less important. This does not preclude adopting Chapter 11-like restructuring schemes in bankruptcy codes, however, since they can theoretically enhance ex-post contracting efficiency by reducing debt overhang problems and therefore could be a wise policy.

The advantage of our approach is that we rely on a canonical theory of investment to identify specific structural parameters rather than to document statistical associations among variables. It allows us to use a feasible estimation strategy and to utilize the large information contained in 75,000 to 150,000 observations to disentangle the channels by which institutional factors affect investment through financial frictions, channels which, without a theoretical model, we cannot identify. At the same time, our study comes with caveats. The move from a well-articulated theory to an empirical study requires some choices. In particular, we still use somewhat reduced-form financial frictions. This is because theoretical models are not yet sufficiently well advanced to derive from first principles (e.g., moral hazard problem) the effect of various institutions on financial frictions in an empirically implementable setting. This suggests an agenda for future research.

Table 1a. Variables: Definition, Sources and Descriptive Statistics

Variable	Definition/Source	Mean	Std.Dev	25%	Median	75%	Obs	Obs>0
Worldscope Data								
Q	Tobin's Q	3.3	157.2	1.0	1.3	1.9	290365	
Age	Company Age	33.4	35.3	9.0	23.0	49.0	270716	
Marginal Profit	Before-Tax Income	-0.2	80.8	-0.1	0.1	0.4	267702	
	After-Tax Income	-0.1	57.9	-0.1	0.1	0.4	266740	
Investment	capital expenditure over total assets	0.1	0.5	0.0	0.0	0.1	288089	262190
	capital expenditure plus change in cash over total assets	0.0	4.7	0.0	0.1	0.1	251275	198731
External Finance	capital expenditure plus change in cash correcting for invetories and trade credits over total assets	0.3	21.7	0.0	0.0	0.1	229828	99970
	change in total debt plus new cash from equity sales over total assets	0.1	15.7	0.0	0.0	0.1	266528	155578
Country Level Variables								
Interest	Interest Rate/IFS	6.9	9.6	2.4	4.0	7.4	816	
Inflation	Inflation Rate/IFS	17.2	116.3	1.8	3.2	8.3	766	
Corporate Gov	Antidirector Rights Index/ La Porta et al. (1998)	3.1	1.3	2.0	3.0	4.0	42	
	Antidirector Rights Index/Spamann (2009)	3.9	1.0	3.5	4.0	4.5	42	
	Self Dealing Index/ Djankov et al. (2008)	0.5	0.2	0.3	0.5	0.7	48	
	Corporate Governance Quality Index/ De Nicola, Leaven and Ueda (2008)	0.6	0.1	0.6	0.6	0.6	45	
Creditors' Right	Strength of Legal Right Index /Doing Business (2007)	6.1	2.3	4.0	7.0	8.0	48	
	Creditor Rights / Djankov et all (2008)	1.9	1.1	1.0	2.0	3.0	45	
	Efficiency of Bankruptcy Law/ Global Competitiveness Report (2004)	5.2	1.0	4.3	5.2	6.0	48	
Institional Quality	Property Rights/ Heritage Foundation and Wall Street Journal Index of Economic Freedom (1997)	4.3	0.8	4.0	4.5	5.0	40	
	Rule of Law in 2000/ Kraay and Kaufman(2003)	1.0	1.0	0.2	1.2	2.0	42	
	Trust in People/ World Values Survey 1990-1993	0.4	0.2	0.3	0.4	0.5	26	
Competitiveness	Barriers to Trade in 2007/World Economic Forum Global Competitiveness Report (2007)	5.0	0.8	4.2	5.1	5.5	48	
	Business Entry Rate in 2005 (New Registrations as % of Total)/WDI	9.9	3.6	6.7	9.9	12.7	38	
	Cost of Starting a Business in 2007(% of income per capita)/Doing Business	12.9	17.0	2.4	7.7	19.8	48	
Financial Dev	Market Capitalization to GDP in 2006 / WDI	102.5	83.0	43.6	83.7	126.7	47	
	Sum of stock market capitalization and private bond market capitalization and bank credit over GDP in 2007/ IFS	2.2	1.3	1.0	2.0	3.1	41	
	Foreign Ownership Restrictions/ World Economic Forum Global Competitiveness Report(2007)	5.4	0.7	5.0	5.5	6.0	48	
Macro Volatility	Standard Deviation of GDP growth/ WDI	2.8	1.6	1.4	2.1	3.7	47	
	Coefficient of Variation of Exchange Rate/WEO	0.4	0.6	0.1	0.2	0.4	48	
	Standard Deviation of inflation/ WDI	31.0	117.7	1.3	3.0	9.2	47	

Table 1b. Correlation among Country Level Variables

			[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
Corporate Gov	Antidirector Rights Index/ La Porta et al. (1998)	[1]	1.00																		
	Antidirector Rights Index/Spamann (2009)	[2]	0.45	1.00																	
	Self Dealing Index/ Djankov et al. (2008)	[3]	0.56	0.20	1.00																
	Corporate Governance Quality Index/ De Nicola, Leaven and Ueda (2008)	[4]	0.12	0.19	0.11	1.00															
Creditors' Right	Strength of Legal Right Index/Doing Business (2007)	[5]	0.39	0.25	0.50	0.45	1.00														
	Creditor Rights / Djankov et all (2008)	[6]	0.12	0.14	0.44	0.11	0.43	1.00													
	Efficiency of Bankruptcy Law/ Global Competitiveness Report (2004)	[7]	0.13	0.21	0.33	0.77	0.65	0.27	1.00												
Institional Quality	Property Rights/ Heritage Foundation and Wall Street Journal Index of Economic Freedom (1997)	[8]	0.11	0.12	0.28	0.58	0.48	0.41	0.67	1.00											
	Rule of Law in 2000/ Kraay and Kaufman(2003)	[9]	0.16	0.17	0.25	0.81	0.58	0.31	0.87	0.83	1.00										
	Trust in People/ World Values Survey 1990-1993	[10]	0.10	-0.17	0.11	0.54	0.51	0.09	0.67	0.51	0.70	1.00									
Competitiveness	Barriers to Trade in 2007/World Economic Forum Global Competitiveness Report (2007)	[11]	0.12	0.19	0.29	0.50	0.44	0.34	0.63	0.42	0.62	0.26	1.00								
	Business Entry Rate in 2005 (New Registrations as % of Total)/WDI	[12]	0.10	0.05	0.53	0.02	0.22	0.50	0.23	0.41	0.28	0.05	0.24	1.00							
	Cost of Starting a Business in 2007(% of income per capita)/Doing Business	[13]	-0.08	-0.21	-0.12	-0.48	-0.28	-0.16	-0.49	-0.62	-0.63	-0.31	-0.23	-0.30	1.00						
Financial Dev	Market Capitalization to GDP in 2006 / WDI	[14]	0.39	0.14	0.43	0.44	0.53	0.30	0.47	0.30	0.44	0.27	0.31	0.11	-0.30	1.00					
	Sum of stock market capitalization and private bond market capitalization and bank credit over GDP in 2007/ IFS	[15]	0.25	0.09	0.39	0.71	0.57	0.43	0.70	0.50	0.68	0.57	0.41	0.18	-0.44	0.85	1.00				
	Foreign Ownership Restrictions/ World Economic Forum Global Competitiveness Report(2007)	[16]	0.24	0.02	0.28	0.37	0.56	0.24	0.64	0.40	0.60	0.48	0.71	0.06	-0.16	0.35	0.40	1.00			
Macro Volatility	Standard Deviation of GDP growth/ WDI	[17]	-0.09	-0.23	-0.02	-0.41	-0.29	0.01	-0.56	-0.34	-0.54	-0.33	-0.35	0.07	0.28	-0.17	-0.39	-0.35	1.00		
	Coefficient of Variation of Exchange Rate/WEO	[18]	-0.19	0.01	-0.25	-0.15	-0.45	-0.14	-0.46	-0.51	-0.51	-0.60	-0.41	0.01	0.16	-0.25	-0.38	-0.51	0.46	1.00	
	Standard Deviation of inflation/ WDI	[19]	-0.03	0.18	-0.16	0.02	-0.30	-0.15	-0.23	-0.33	-0.24	-0.44	-0.30	0.02	-0.02	-0.08	-0.20	-0.39	0.22	0.87	1.00

Table 2. Benchmark Regression

	a Required Return [1]	-b1 (-) Fin. Friction Coeff. Ext. Fin. [2]	b2 Fin. Friction Coeff. Capital [3]	-b3 (-) Fin. Friction Curvature [4]	c2 Inv. Adj. Cost Coeff. Capital [5]	-c3 (-) Inv. Adj. Cost Curvature [6]
Institutional Factors						
Corporate Governance	-0.0433	-0.0028	0.0200	0.0230		
	[-2.403]**	[-1.778]*	[2.639]***	[1.167]		
Creditor Rights	-0.0099	-0.0042	-0.0102	0.0399		
	[-0.454]	[-1.119]	[-1.673]*	[1.148]		
Institution	-0.0007	0.0091	0.0639	-0.2282		
	[-0.016]	[0.734]	[3.683]***	[-1.750]*		
Competitiveness	0.0772	0.0003	-0.0071	-0.0950		
	[1.864]*	[0.045]	[-0.423]	[-0.858]		
Financial Markets	0.0001	0.0000	0.0001	-0.0004		
	[0.357]	[-0.167]	[0.414]	[-0.508]		
Real Factors						
Firm Age	0.0026	0.0001	-0.0003	0.0000	0.0034	0.0140
	[5.296]***	[1.501]	[-1.243]	[-0.035]	[0.987]	[1.146]
Risk Free Rate	0.0036	0.0002	0.0038	-0.0234	0.0170	-0.0656
	[0.346]	[0.102]	[1.521]	[-0.823]	[1.370]	[-0.729]
Inflation	-0.0075	0.0026	-0.0003	-0.0210	-0.0224	0.1453
	[-0.706]	[0.697]	[-0.101]	[-0.598]	[-1.613]	[1.308]
Macro Volatility	-0.0381	-0.0030	-0.0028	0.0025	0.1359	0.0068
	[-1.352]	[-1.120]	[-0.358]	[0.093]	[1.440]	[0.023]
Observations						74272
R-squared						0.496
Number of Clusters						608

Table 3a. Regression Using Before-Tax Income

	a Required Return [1]	-b1 (-) Fin. Friction Coeff. Ext. Fin. [2]	b2 Fin. Friction Coeff. Capital [3]	-b3 (-) Fin. Friction Curvature [4]
Institutional Factors				
Corporate Governance	-0.0443	-0.0039	0.0204	0.0284
	[-2.461]**	[-2.576]**	[2.613]***	[1.612]
Creditor Rights	-0.0098	0.0015	-0.0091	0.0158
	[-0.447]	[0.435]	[-1.406]	[0.355]
Institution	-0.0052	-0.0074	0.0628	-0.1433
	[-0.119]	[-0.460]	[3.588]***	[-0.706]
Competitiveness	0.0761	0.0018	-0.0080	-0.0986
	[1.825]*	[0.203]	[-0.481]	[-0.642]
Financial Markets	0.0001	0.0000	0.0001	-0.0008
	[0.356]	[-0.981]	[0.597]	[-1.007]
Observations				74249
R-squared				0.509
Number of Clusters				608

Table 3b. Regression Using a Broad Concept of Investment (incl. Security Investment)

	a Required Return [1]	-b1 (-) Fin. Friction Coeff. Ext. Fin. [2]	b2 Fin. Friction Coeff. Capital [3]	-b3 (-) Fin. Friction Curvature [4]
Institutional Factors				
Corporate Governance	-0.0456	-0.0030	0.0211	0.0259
	[-2.519]**	[-1.869]*	[2.837]***	[1.310]
Creditor Rights	-0.0105	-0.0039	-0.0100	0.0371
	[-0.482]	[-1.127]	[-1.644]	[1.161]
Institution	-0.0069	0.0076	0.0641	-0.2125
	[-0.158]	[0.663]	[3.681]***	[-1.800]*
Competitiveness	0.0767	-0.0006	-0.0066	-0.0792
	[1.867]*	[-0.094]	[-0.397]	[-0.808]
Financial Markets	0.0001	0.0000	0.0000	-0.0004
	[0.392]	[-0.131]	[0.135]	[-0.613]
Observations				74272
R-squared				0.503
Number of Clusters				608

Table 3c. Regression Using a Narrow Concept of External Finance (excl. Trade Credit)

	a	-b1	b2	-b3
	Required Return	(-) Fin. Friction Coeff. Ext. Fin.	Fin. Friction Coeff. Capital	(-) Fin. Friction Curvature
	[1]	[2]	[3]	[4]
Institutional Factors				
Corporate Governance	-0.0064	0.0005	0.0575	0.0095
	[-0.299]	[0.330]	[1.664]*	[0.492]
Creditor Rights	-0.0461	0.0008	0.0458	-0.0073
	[-1.140]	[0.854]	[0.767]	[-0.661]
Institution	0.0126	0.0023	0.0999	0.0000
	[0.182]	[0.972]	[0.937]	[.]
Competitiveness	0.0106	0.0010	-0.1212	0.0196
	[0.076]	[0.563]	[-0.513]	[0.710]
Financial Markets	0.0008	0.0000	-0.0008	0.0002
	[2.665]***	[-0.602]	[-1.301]	[0.550]
Observations				42421
R-squared				0.254
Number of Clusters				608

Table 4. One-by-One Regressions

	a	-b1	b2	-b3			
	Required Return	(-) Fin. Friction Coeff. Ext. Fin.	Fin. Friction Coeff. Capital	(-) Fin. Friction Curvature	Obs	R-Squared	Number of Clusters
	[1]	[2]	[3]	[4]			
Corporate Governance	-0.0494	-0.0037	0.0222	0.0335	74319	0.494	608
	[-2.665]***	[-1.603]	[2.964]***	[1.443]			
Creditor Rights	-0.0184	-0.0039	0.0077	0.0002	75816	0.490	608
	[-1.144]	[-1.587]	[1.340]	[0.010]			
Institution	-0.0632	-0.0062	0.0535	-0.0794	74272	0.492	608
	[-1.534]	[-0.893]	[3.299]***	[-1.187]			
Competitiveness	0.0858	0.0041	-0.0264	-0.0775	75816	0.491	608
	[2.154]**	[0.737]	[-1.814]*	[-0.965]			
Financial Market	-0.0003	-0.0001	0.0002	0.0009	75816	0.490	608
	[-0.920]	[-1.782]*	[1.494]	[1.684]*			

Table 5. Alternative Definitions of Institutional Factors

	a Required Return [1]	-b1 (-) Fin. Friction Coeff. Ext. Fin. [2]	b2 Fin. Friction Coeff. Capital [3]	-b3 (-) Fin. Friction Curvature [4]	Obs	R-Squared	Number of Clusters
Corporate Governance							
Spamnn's Version	0.0190	0.0108	-0.0258	-0.0693	74272	0.4950	608
	[0.853]	[2.451]**	[-2.237]**	[-1.169]			
Self-Dealing Index	-0.1745	-0.0187	0.1030	-0.0789	74272	0.4950	608
	[-1.267]	[-1.060]	[1.828]*	[-0.367]			
CGQ-Index	-0.7344	-0.3374	1.2952	2.9030	73619	0.4990	608
	[-0.756]	[-2.152]**	[2.930]***	[1.372]			
Creditor Rights							
Narrower Definition	-0.0083	0.0095	-0.0326	-0.0580	73887	0.4950	608
	[-0.272]	[1.454]	[-2.752]***	[-0.647]			
Bankruptcy Efficiency	0.0195	-0.0058	0.0385	-0.1338	74272	0.4960	608
	[0.328]	[-0.599]	[1.565]	[-1.125]			
Institution							
Rule of Law	0.0178	0.0189	0.0566	-0.3387	74319	0.4960	608
	[0.333]	[1.368]	[2.679]***	[-2.479]**			
People's Trust	0.3880	0.0377	0.2505	-0.5678	67431	0.5070	608
	[1.748]*	[1.381]	[2.945]***	[-2.025]**			
Competitiveness							
New Firm Entry	-0.0013	-0.0024	0.0063	0.0212	68040	0.4970	608
	[-0.190]	[-1.546]	[1.864]*	[0.934]			
Business Start-Up Cost	0.0006	-0.0003	-0.0005	0.0129	74272	0.4950	608
	[0.296]	[-1.522]	[-0.741]	[3.127]***			
Financial Market							
Private Credit/GDP	0.0360	0.0036	-0.0023	-0.0168	74272	0.4960	608
	[0.680]	[0.423]	[-0.137]	[-0.239]			
Absence of Foreign Ownership Restrictions	0.0238	0.0012	0.0097	0.0170	73325	0.4960	608
	[0.899]	[0.312]	[0.901]	[0.436]			

Table 6. Less Restricted Samples, Including Firms without Age

	a Required Return [1]	-b1 (-) Fin. Friction Coeff. Ext. Fin. [2]	b2 Fin. Friction Coeff. Capital [3]	-b3 (-) Fin. Friction Curvature [4]
Institutional Factors				
Corporate Governance	-0.0370	-0.0013	0.0283	0.0196
	[-1.460]	[-0.890]	[3.001]***	[1.127]
Creditor Rights	-0.0314	-0.0002	-0.0192	0.0182
	[-1.226]	[-0.106]	[-3.386]***	[0.912]
Institution	-0.0646	0.0051	0.1081	-0.0746
	[-0.959]	[0.787]	[6.159]***	[-0.986]
Competitiveness	0.0762	0.0026	-0.0248	0.0081
	[1.489]	[0.561]	[-1.654]*	[0.163]
Financial Markets	-0.0001	0.0000	0.0002	-0.0006
	[-0.382]	[0.620]	[1.390]	[-1.591]
Observations				147711
R-squared				0.435
Number of Clusters				608

Table 7. Including Institutional Effects in Real Investment Adjustment

	a Required Return [1]	-b1 (-) Fin. Friction Coeff. Ext. Fin. [2]	b2 Fin. Friction Coeff. Capital [3]	-b3 (-) Fin. Friction Curvature [4]	c2 Inv. Adj. Cost Coeff. Capital [5]	-c3 (-) Inv. Adj. Cost Curvature [6]
Institutional Factors						
Corporate Governance	-0.0424**	-0.0027*	0.0249***	0.0220	-0.1738***	-0.9204**
	[-2.346]	[-1.759]	[3.193]	[1.117]	[-3.300]	[-2.060]
Creditor Rights	-0.0102	-0.0042	-0.0100	0.0411	0.0324	-0.0422
	[-0.465]	[-1.142]	[-1.571]	[1.187]	[0.503]	[-0.185]
Institution	0.0010	0.0094	0.0638***	-0.2332*	-0.2343*	-0.1380
	[0.023]	[0.761]	[3.584]	[-1.786]	[-1.663]	[-0.238]
Competitiveness	0.0782*	0.0005	-0.0013	-0.1008	0.1335	-0.9498
	[1.885]	[0.076]	[-0.074]	[-0.903]	[0.852]	[-1.633]
Financial Markets	0.0001	0.0000	0.0000	-0.0003	0.0029	0.0063
	[0.356]	[-0.158]	[0.252]	[-0.498]	[1.291]	[0.586]
Observations						74272
R-squared						0.496
Number of Clusters						608

Table 8. Instrumental Variable Estimation

	a	-b1	b2	-b3
	Required Return	(-) Fin. Friction Coeff. Ext. Fin.	Fin. Friction Coeff. Capital	(-) Fin. Friction Curvature
	[1]	[2]	[3]	[4]
Institutional Factors				
Corporate Governance	-0.0209	-0.0022	0.0164	0.0361
	[-1.373]	[-1.473]	[2.321]**	[2.202]**
Creditor Rights	-0.0120	-0.0009	-0.0040	0.0221
	[-0.558]	[-0.205]	[-0.623]	[0.530]
Institution	-0.0113	0.0022	0.0578	-0.2333
	[-0.254]	[0.129]	[3.440]***	[-1.291]
Competitiveness	0.0811	0.0015	-0.0215	-0.1098
	[1.968]**	[0.162]	[-1.501]	[-0.782]
Financial Markets	0.0001	0.0000	0.0001	-0.0015
	[0.286]	[0.713]	[0.390]	[-1.789]*
Observations				74272
R-squared				0.496
Number of Clusters				608
Number of Regressors				506
Number of Instruments				507
Number of Excluded Instruments				71
Kleibergen-Paap Wald rk F statistic				5.14
Anderson-Rubin Wald test				F(71,607)=165.17

Appendix: Assumptions on Shocks and the Value Function

Suppose in each period a firm I is subject to a shock $\varepsilon \in \mathrm{E}$ which follows a *cdf F*. This overall shock has three sources: an aggregate shock, $\theta \in \Theta$, which follows a *cdf G*; an industry-specific shock, $\omega \in \Omega$, which follows a *cdf H*; and an idiosyncratic shock, $\upsilon \in \Upsilon$. The three components are assumed to be orthogonal to each other and each component follows a probability distribution with support (0, ∞), for example, a log-normal distribution.

We assume that firm managers can infer the overall shock, ε, when making investment decisions, but do not know the size of each component. We assume this in a strict sense, that is, $E\left[\theta+\omega \mid \varepsilon\right]=E\left[\theta+\omega \mid \varepsilon'\right]$ for any pair $(\varepsilon,\varepsilon') \in \mathrm{E}\times\mathrm{E}$.

We also assume that firm characteristics, *X*, are either time invariant (e.g., industry), or non-stochastic and predictable (e.g., age). For the institutional characteristics, *W*, we assume that they are stable and that any changes are perceived by firm managers as (unexpected) regime changes.

Based on those assumptions, the stochastic discount factor can be simply represented by $m(\theta,\omega;X,W)$ — it depends on the aggregate shock θ and the industry-specific shock ω, given firm characteristics *X* and institutions *W*. Note that this formulation already factors in the predictable change in the firm characteristics, as defined below using the original discount factor $\tilde{m}(\theta,\omega;gX,W)$ with *g*, the deterministic growth of *X*:

$$\tilde{m}(\theta,\omega;X^{+},W)=\tilde{m}(\theta,\omega;gX,W)=h(g)\tilde{m}(\theta,\omega;X,W)=m(\theta,\omega;X,W),$$

where, for simplicity, *h(g)* is assumed to be an increasing power function.

Using this normalized stochastic discount factor, the value function can now be expressed as

$$\begin{aligned}
V(K^{-};X,W,\varepsilon) &= \max_{K}\int_{\Theta\times\Omega} m(\theta,\omega;X,W)\Big\{\pi(K,\epsilon)-\phi(I,K;X,W,\epsilon) \\
&\quad -\lambda(B,K;X,W,\epsilon)+\int_{\mathrm{E}} V(K;X^{+},W,\epsilon^{+})dF\Big\}\,dGdH \\
&= \max_{K}\int_{\Theta\times\Omega} m(\theta,\omega;X,W)dGdH\,\Big\{\pi(K,\epsilon)-\phi(I,K;X,W,\epsilon) \\
&\quad -\lambda(B,K;X,W,\epsilon)+\int_{\mathrm{E}} V(K;X^{+},W,\epsilon^{+})dF\Big\} \qquad \text{(A1)} \\
&= \max_{K}\frac{1}{1+r\left(E\left[\theta\right],X,W\right)}\Big\{\pi(K,\epsilon)-\phi(I,K;X,W,\epsilon) \\
&\quad -\lambda(B,K;X,W,\epsilon)+\int_{\mathrm{E}} V(K;X^{+},W,\epsilon^{+})dF\Big\},
\end{aligned}$$

where the expected discount factor is defined as:

$$\frac{1}{1+r\left(E\left[\theta\right],X,W\right)}=\int_{\Theta\times\Omega}m(\theta,\omega;X,W)dGdH.$$

This varies with firm characteristics, *X,* and with institutional quality, *W*. The industry-specific risk premium stemming from the stochastic process ω is absorbed in the "industry effect" portion of firm characteristics, *X*. Unexpected regime changes in macro shocks and industry level shocks are also potentially allowed in this expression. Note that the last line of (A1) is equivalent to (4).

Marginal conditions can be easily derived. Assuming positive investment and positive external finance, the first-order condition is:

$$\phi_1+\lambda_1=\pi_1+\lambda_1\pi_1-\phi_2-\lambda_2+E\left[V_1\right].$$

And the envelope condition is:

$$(1+r)V_1^-=(1-\delta)(\phi_1+\lambda_1).$$

By combining the two conditions together, we obtain:

$$\frac{1+r}{1-\delta}V_1^-=(1+\lambda_1)\pi_1-\phi_2-\lambda_2+E\left[V_1\right].$$

By definition: $Q=V_1$. Using the approximation, $1+r+\delta\approx\frac{1+r}{1-\delta}$, we simplify the condition to:

$$(r+\delta)Q^-=E\left[Q-Q^-\right]+(1+\lambda_1)\pi_1-\phi_2-\lambda_2. \qquad \text{(A2)}$$

This is the same as (5).

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