Corporate Governance and Asset Prices in a Two-Country Model*

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Abstract

There is considerable cross-country variation in corporate governance laws protecting outside investors. Studies have shown that weaker protection of outside investors is associated with higher average equity returns and return volatility, particularly in emerging markets. Moreover, Johnson et al. (2000) show that during the East Asian crisis, countries with better investor protection went through a lower depreciation of their currency's exchange rate relative to the U.S. dollar. This paper provides an international asset pricing model where differences in investor protection can explain the cross-country dispersion in equity mean returns and volatility, as well as mean exchange rate returns. The paper also develops theoretical predictions for time-varying moments of equity, bond and exchange rate returns.

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1 Introduction

Unlike the dispersed corporate ownership structure in the U.S., corporations in most countries, namely emerging market economies, often have controlling shareholders. These controlling shareholders derive private benefits from control at the cost of outside minority shareholders, specially under weak protection of minority shareholders.[1] Naturally, if stock markets are efficient, prices will have already reflected the possibility of such events. In fact, there is now considerable evidence that suggests that firm value increases with the extent of protection of minority investors, and with the stock ownership of controlling shareholders if their cash flow rights exceed their control rights.[2] While this has been the end of the story in most of the literature, in our view there is more to be told. Given an asset ownership structure and investor protection, controlling shareholders are likely to distort production, investment, and payout policies leading to changes in the volatility and riskiness of firms. In this paper, we show that stock return volatility and the cost of capital are related to the degree of investor protection, because the controlling shareholder's investment decision impacts the representative consumer's marginal rate of substitution. Moreover, we show that investor protection, and its effect on corporate investment, also affects the equilibrium term structure of interest rates and exchange rates.

We develop a two-country stochastic general equilibrium asset pricing model which acknowledges the importance of investor protection. The two countries are labeled as 'foreign' and 'home'. The foreign country has perfect investor protection whereas the home country has imperfect investor protection. There is a single representative firm in each country. To see how the model works, consider first the production problem faced by the controlling shareholder in the home country. The controlling shareholder pursues his private benefits and extracts rents from outside minority shareholders. Private benefits and rents are proportional to firm size, which creates an incentive to overinvest by the

[1] For example, in a recently proposed merger between AmBev, a Brazilian brewer, and Belgium's Interbrew, owners of ordinary shares in AmBev will swap them for Interbrew stock, "probably at a premium," leaving owners of non-voting preference shares out of the deal and with what appears to be "high-priced junk" (*The Economist*, March 27, 2004). See Barclay and Holderness (1989) for early work on the empirical evidence in support of private benefits of control. See also Dyck and Zingales (2004) and Bae, Kang and Kim (2002).

[2] See Claessens et al. (2002), La Porta et al. (2002), Black et al. (2003), Gompers et al. (2003), and Baek et al. (2004). See La Porta et al. (2000b) and Denis and McConnell (2003) for surveys on the investor protection literature. La Porta et al. (2002) and Shleifer and Wolfenzon (2002) provide static models of firm valuation whereas Lan and Wang (2004) provide a dynamic model of firm valuation. These are closed economy models which do not have results on expected equity returns or exchange rates.

controlling shareholder. Overinvestment is in line with Jensen's (1986) free-cash flow and empire-building hypothesis and with evidence in Lang, Stulz, and Walking (1991) and Harford (1999). Naturally, a firm that overinvests is growing at faster rates than suggested by firm value optimization and thus firm value is below the first best level. Overinvestment also implies that investment becomes more sensitive to productivity shocks and that payout volatility is higher.

Consider now the way in which minority investors price the stock of this firm. Minority investors take the investment and payout decisions by the controlling shareholders as given, and solve an intertemporal portfolio problem à la Merton (1971). Given their preferences, the higher volatility in the firm's payout generates a higher discount rate of future payouts, and hence higher risk premium. This is a novel prediction that can help us understand the higher expected stock returns in emerging market economies (see Bekaert and Harvey (1997)) and in countries with low capital market governance (see Daouk, Lee, and Ng (2004)). The existence of overinvestment in the productive sector also makes the economy as a whole more responsive to shocks. This leads to volatility in other dimensions of the economy as well. The risk free rate becomes more volatile and the long term bond spread increases.

One of the main contributions of our paper is to link investor protection to exchange rate returns. In our model, the real exchange rate is given by the ratio of the equilibrium consumer price indices in the two countries. We assume that there are two goods also labeled as 'home' and 'foreign', corresponding to the country of production. Minority shareholders determine the basket of goods that compose the price index of each country, by optimizing their preferences over these two imperfectly substitutable goods. As in the international literature, we assume that home minority investors have a greater preference for the home good than do foreign minority investors, and *vice versa*. As a result, when the relative price of the home good increases, the exchange rate also increases (i.e., home appreciation). We show that the unconditional mean rate of appreciation in the economy equals the difference in investment-capital ratios in the foreign and home countries. The intuition is simple. A lower investment-capital ratio in the home country (versus that of the foreign country) implies a relatively less abundant supply of the home good in the future and thus a higher future relative price of the home good, i.e., an exchange rate appreciation. Because better investor protection leads to less overinvestment, *ceteris paribus*, our model predicts a higher mean rate of appreciation of the exchange rate in countries with stronger investor protection. Similarly, a larger ownership by the controlling shareholder in the home country, reduces the overinvestment problem, and leads to a higher expected rate of appreciation of the exchange rate. Our model thus provides a corporate governance based explanation to the empirical evidence on exchange rate returns documented in Johnson et al. (2000).

Our model also has additional implications for conditional moments of asset returns over the business cycle. Uncertainty is modeled as a regime-switching process on productivity shocks. When productivity shocks have asymmetric persistence, specifically greater persistence in the expansion regime than in the recession regime as empirically observed, then they also have conditional heteroskedasticity. In this case we show that the volatilities of the stock return, interest rate, and of the exchange rate are all higher in the recession regime than in the expansion regime.[3] The equity premium is also higher in the recession regime. Moreover, in numerical simulations, comparative statics exercises suggest that the business cycle amplitude (from peak to trough) is higher in countries with weaker protection of minority investors. As a result, the volatilities of all asset returns, conditional or unconditional, decrease with the degree of investor protection.

The model relates to papers studying the asset pricing implications of corporate financing frictions. The papers in this literature that are closest to ours are Dow et al. (2003) and Albuquerque and Wang (2004). Dow et al. (2003) develop a closed-economy model in which the manager has an empire building preference and wants to invest all of the firm's free cash flow if possible. Shareholders can spend some of the firm's resources on auditors to constrain the manager. In contrast, our model acknowledges that managers in firms in most countries around the world are often controlling shareholders who themselves have cash flow rights in the firm and thus do not simply burn all of the firm's free cash flow. Rather, the controlling shareholder trades off his gain from pursuing his private benefits with the cost of seeing his share of firm value decrease due to the distortion of investment decisions. The critical determinant of this trade-off is the extent of investor protection. Hence, our model allows us to derive predictions on asset prices and investor protection. Building on this property of the data Albuquerque and Wang (1994) present a closed economy asset pricing model. In their model, but not in ours nor in Dow et al. (2003), minority investors and controlling shareholders interact in both the equity and bond markets which leads to a feedback effect of the equilibrium allocations to the investment decisions of the controlling shareholder. Unique to our paper is the derivation of predictions on conditional (business cycle) asset return moments and the international setting with the predictions on exchange rates.

[3]Schwert (1989) provides evidence on conditional heteroskedasticity of stock returns and interest rates and also finds that the growth rate of industrial production displays counter-cyclical conditional volatility.

Gorton and He (2003) present a model with heterogeneous investors where managerial incentives to spend effort are given through trading in the firm's equity between the manager and the outside investors (and not a compensation contract). The model is cast in a setup where managerial effort is unobservable giving rise to a moral hazard problem. Intuitively, a higher equity share owned by the manager leads to higher effort and, conditionally, higher mean output. Hence, firm value increases. In another agency-cost based asset pricing model, Holmstrom and Tirole (2001) propose an equilibrium asset pricing model by assuming that the controlling shareholder is able to extract private benefits from the firm and cannot promise the investors to fully return their funds. In equilibrium, this generates a desire to hoard liquidity or collateralizable assets (i.e., assets that maintain their value in states of liquidity shortages) *ex ante* by firms in order to increase funding thus leading to a liquidity premium.

The remainder of the paper is organized as follows. The next section presents the model and some basic results. Section 3 develops model's predictions on firm value and stock returns and section 4 analyzes the term structure of interest rates. Section 5 studies equilibrium exchange rates. Section 6 generalizes our benchmark two-regime model of Section 2 to a more realistic setting with multi-regimes. Sections 7 and 8 propose a calibration of the model and present some numerical results, respectively. Section 9 concludes. The appendices contain the technical details.

2 Model

Consider a world economy with two countries, labeled 'home' and 'foreign'. The home country is populated with two types of agents, the controlling shareholder and the representative minority investor. The home country produces one good that can be either consumed domestically or exported. We treat the economic environment in the foreign country exactly the same way. Hence, below we present only the economic environment of the home country.

2.1 Model Description

Controlling Shareholder

The controlling shareholder manages the single firm in the home country. Giving all the control rights to the controlling shareholder is in line with evidence in La Porta et al. (1999) who document for many countries that the control of firms is often heavily concentrated in the hands of a founding family. Control rights generally differ from cash flows rights and in fact a fraction of votes higher than that of cash flow rights can be obtained by either owning shares with superior voting rights, or through ownership pyramids and cross ownership, and controlling the board (for more examples see Bebchuk et al. (2000)). We denote by α the controlling shareholder's cash-flow ownership in the firm. We treat α as constant through time. This greatly simplifies our analysis and is consistent with La Porta et al. (1999) who argue that the controlling shareholder's ownership is extremely stable over time. In a similar setup to ours, Albuquerque and Wang (2004) show that a constant share of cash flow ownership is indeed optimal for the controlling shareholder based on an free-rider argument.

The controlling shareholder is risk neutral and discounts future consumption of the domestic good at the rate of time preference $\rho > 0$. Taking as constant his ownership of the firm α, the controlling shareholder makes investment decisions for the firm and also chooses the level of private benefits to maximize his life-time utility.

Modeling Investor Protection

Because of agency costs, firm profits are not shared on a *pro rata* basis among outside minority shareholders and controlling shareholders. Indeed, the controlling shareholder can divert a part of the firm's gross output for his own private benefits. This socially inefficient usage of funds may take a variety of forms such as excessive salary, transfer pricing, employing unqualified relatives and friends, to name a few.[4] In general, expropriation is costly to both the firm and the controlling shareholder and, *ceteris paribus*, pursuing private benefits is more costly when investor protection is stronger. If the controlling shareholder diverts a fraction s of the gross revenue R, then he pays a cost $C(s,R)$ given by

$$C(s,R) = \frac{\eta}{2}s^2 R. \tag{1}$$

The cost function (1) is increasing and convex in the fraction s of gross output that the controlling shareholder diverts for private benefits. The convexity of $C(s,R)$ in s guarantees that it is more costly to divert a larger fraction of private benefits. Moreover, we assume that the cost of diverting a given fraction s of cash from a larger firm is assumed to be higher, because a larger amount sR of gross output is diverted. That is, $\partial C(s,R)/\partial K > 0$.

Following La Porta et al. (2002), we interpret the parameter η as a measure of investor protection. A higher η implies a larger marginal cost ηR of diverting cash for private benefits. In the case of $\eta = 0$, there is no cost of diverting cash for private benefits and the financing channel breaks down, because investors anticipate no payback from

[4] See Barclay and Holderness (1989), Dyck and Zingales (2004), and Bae, Kang and Kim (2002).

the firm after they sink their funds. As a result, *ex ante*, no investor is willing to invest in the firm. In contrast, in the limiting case of $\eta = \infty$, the marginal cost of pursuing a marginal unit of private benefit is infinity and minority shareholders are thus fully protected from expropriation.[5] Without loss of generality, we assume that the foreign country has perfect investor protection.

Production and Investment Technologies

The production technology in home country combines the firm's capital stock $K(t)$ at time t with a stochastic productivity shock $f(t)$ to generate gross output of $R(t) = f(t)K(t)$. The productivity level varies with the business cycle. Specifically, the transition of productivity over time follows a regime-switching model as in Hamilton (1989). For technical convenience, we cast the model in continuous time.[6] For presentation reasons we consider a two-regime model in which f_1 and f_2 correspond to the productivity levels in the expansion regime and the recession regime, respectively (i.e., $f_1 > f_2$). Below we generalize our model to allow for any finite number of regimes. For expositional simplicity, we assume that the productivity shocks in the two countries are independent. We may easily generalize this assumption at additional notational complexity.

Let current time be t and $N(t) \in \{1, 2\}$ be the current regime. The current underlying regime $N(t)$ is common knowledge to everyone domestically and abroad and hence the current level of productivity $f(t) = f_{N(t)}$ is known exactly. To fix ideas, suppose the home economy is now in an expansion regime. Over an infinitesimal time interval Δt, the conditional probability of transiting from the expansion regime to the recession regime is given by $\lambda_{12}\Delta t$, and that of remaining in the expansion regime is $(1 - \lambda_{12}\Delta t)$. The parameter λ_{12} describes the likelihood (rate) of transiting out of the expansion regime over a small time interval. Thus, the transition probability matrix for the two-state Markov chain is given by:[7]

$$\begin{pmatrix} 1 - \lambda_{12}\Delta t & \lambda_{12}\Delta t \\ \lambda_{21}\Delta t & 1 - \lambda_{21}\Delta t \end{pmatrix},$$

[5] Net private benefits of control for the entrepreneur of diverting s percent of gross revenue are $sR - C(s, K)$.

[6] Hamilton's model is cast in discrete time. In continuous time, there is an embedded discrete-time regime switching probability matrix. Naik and Lee (1997) build a neoclassical equilibrium term structure model of interest rate in a regime switching setting.

[7] Formally, the continuous time Markov chain is fully described by the following transition rate matrix

$$\Lambda = \begin{pmatrix} -\lambda_{12} & \lambda_{12} \\ \lambda_{21} & -\lambda_{21} \end{pmatrix}.$$

where $\lambda_{12}, \lambda_{21} > 0$. The parameters λ_{12} an λ_{21} govern the persistence and conditional volatility of the productivity shocks. In particular, $\lambda_{21} > \lambda_{12}$ implies that the expansion regime has higher persistence and lower volatility than the recession regime.

The capital stock accumulates at the rate of chosen gross investment $I(t)$ and depreciates at a constant rate of $\delta > 0$, in that

$$dK(t) = (I(t) - \delta K(t))\, dt. \tag{2}$$

When the firm adjusts its capital stock as described by (2) it incurs an adjustment cost. The assumption of an adjustment cost is both empirically plausible and widely adopted in the investment literature.[8] This adjustment cost takes the following functional form:

$$\Phi(I, K) = \frac{\theta}{2} \left(\frac{I}{K} \right)^2 K, \tag{3}$$

where the parameter $\theta > 0$ measures the magnitude of the adjustment cost. Note that the adjustment cost function given in (3) is homogeneous of degree one in capital stock K and investment I. The homogeneity assumption of the adjustment cost is standard in the investment literature. The homogeneity of $\Phi(I, K)$ together with the homogeneity of degree one in K of the cost of diversion $C\,(s, K)$ greatly simplify our analysis without loss of economic intuition.

Minority Investors

The representative minority investor in the home country has the following time-additive separable preference:

$$E \left[\int_0^\infty e^{-\rho t} u(c_h(t), c_f(t)) dt \right], \tag{4}$$

where ρ is the subjective discount rate, $c_h(t)$ and $c_f(t)$ are the investor's consumption allocations of the home and foreign good at time t, respectively, and the felicity function is given by

$$u(c_h, c_f) = \log \left(c_h^{\gamma} c_f^{1-\gamma} \right).$$

Similarly for the representative minority investor of the foreign country, his felicity function is $u^*(c_h^*, c_f^*) = \log \left((c_h^*)^{\gamma^*} \left(c_f^*\right)^{1-\gamma^*} \right)$. The parameters γ and γ^* capture the investors' preference weights on home goods relative to foreign goods. The choice of logarithmic utility greatly simplifies the exposition.

[8] See Hayashi (1982) and Abel (1983) for important work on adjustment costs and intertemporal investment.

The representative investors of both countries take the production decisions made by the controlling shareholders as given. Minority shareholders are allowed to trade on a full set of assets which complete the markets. Let $p(t)$ denote the time t state contingent price of the domestic good in time 0 units of the home good and let $p^*(t)$ denote the time t state contingent price of the foreign good also in time 0 units of the home good. Minority investors maximize (4) by choosing a consumption process that satisfies the intertemporal budget constraint:

$$w_0 = E\left[\int_0^\infty \left(p(t)\, c_h(t) + p^*(t)\, c_f(t)\right) dt\right],$$

where $w_0 > 0$ is the investor's initial wealth level in units of the home good.

2.2 Controlling Shareholder's Optimization Problem

When investor protection is imperfect ($\eta < \infty$), the controlling shareholder naturally has incentives to divert some cash for his private benefits. Moreover, the controlling shareholder's ability to choose the evolution of the size of the firm gives him an additional channel through which to pursue his private benefits. The dividend paid out by the controlling shareholder to shareholders (including himself) is given by

$$Y(t) = f(t)K(t) - I(t) - \Phi(I(t), K(t)) - s(t)\, f(t)K(t), \tag{5}$$

where the last term on the right-hand side of (5) is the total amount of output diverted from the firm by the controlling shareholder as private benefits. The controlling shareholder's total cash flow $M(t)$ is then given by the sum of his entitled dividend and his private benefits of control less the cost of diversion:

$$M(t) = \alpha Y(t) + s(t)f(t)K(t) - C(s(t), R(t)). \tag{6}$$

Note that the controlling shareholder only benefits from the portion diverted from outside shareholders, not his own portion α of the firm. We may re-write (6) as follows:

$$M(t) = \left(s(t) + \alpha\left(1 - s(t)\right)\right) R(t) - \left[\alpha\left(I(t) + \Phi(I(t), K(t))\right) + C(s(t), R(t))\right]. \tag{7}$$

The first term on the right-hand side of (7) is the gross cash inflow from both the diverted cash from outside minority shareholders and the controlling shareholder's equity ownership. The second term is the total cost paid by the controlling shareholder, including his share of total investment costs $(I + \Phi(I, K))$ and the diversion cost $C(s(t), R(t))$.

Because the controlling shareholder consumes all his domestic good flow $M(t)$ at time t, his optimization problem becomes:

$$\max_{s(t),\, I(t)} \quad E\left[\int_0^\infty e^{-\rho t} M(t)dt\right], \tag{8}$$

subject to the flow-of-funds equation (7), the investment dynamics (2), a limited capital stock growth condition (9):

$$\lim_{T\to\infty} E\left[e^{-\rho T} K(T)\right] = 0, \tag{9}$$

and an initial condition $K(0) = K_0 > 0$.

Let $U(K,n)$ denote the controlling shareholder's value function (equal to the maximal value in (8)) when the firm's capital stock is K and the regime $N(t) = n$. Suppose that the current regime is expansion ($N(t) = 1$), then the controlling shareholder's value function $U(K,1)$ solves the following Hamilton-Jacobi-Bellman (HJB) equation:

$$\rho U(K,1) = \sup_{s(t),\, I(t)} \left\{M + (I - \delta K)\, U_K(K,1) + \lambda_{12}\left[U(K,2) - U(K,1)\right]\right\}. \tag{10}$$

There is a similar equation for the recession regime ($N(t) = 2$). The left-hand side of (10) is the flow measure of the controlling shareholder's value function. The right-hand side has three terms: (i) the current cash flow to the controlling shareholder $M(t)$; (ii) the marginal benefit to the controlling shareholder of newly installed capital and (iii) the expected changes in his value function due to the likelihood of transition from the expansion regime to the recession regime. In an interior solution, the controlling shareholder's intertemporal optimality states that he chooses a fraction s of gross output to divert and a gross investment of I to equate the two sides of (10). Note however, that while the chosen levels of s and I are optimal from the controlling shareholder's perspective, they are not necessarily in the best interest of outside shareholders.

We conjecture that the controlling shareholder's value function $U(K,n)$ is linear in the firm's capital stock and that the proportionality constant depends on the underlying regime:

$$U(K,n) = u_n K,$$

for some numbers u_n to be determined. Under this conjecture, the first-order conditions with respect to cash diversion s in both regimes give

$$s_n = \phi \equiv \frac{1-\alpha}{\eta}.$$

The first-order condition for investment yields for each regime n, $u_n = \alpha\,(1 + \theta i_n)$, where i_n is the investment-capital ratio in regime n. For convenience, we sometimes use the term "investment rate" to refer to the investment-capital ratio $i = I/K$. Replacing the expression for u_n in (10) yields a system of two nonlinear equations that can be solved for constant investment rates i_n. Appendix A gives the details on the system of equations and proves that at the optimal investment rates decline with η and α.

Proposition 1 *Optimal investment rates decline with both η and α.*

The implied optimal payout-capital ratio, or payout rate $y(t) = Y(t)/K(t)$ is given by

$$y_n = (1-s) f_n - i_n - \frac{\theta}{2} i_n^2. \tag{11}$$

The investment rate increases in the level of the productivity shock and thus the investment rate is higher in an expansion. A higher investment rate thus contributes to a lower payout rate y in expansions. But the overall effect of an expansion on the payout rate depends on the strength of the direct effect of productivity on the payout rate versus the indirect effect on the investment rate. In what follows we assume that the productivity effect is stronger and that the payout rate is higher in expansions than in recessions, i.e., $y_1 > y_2$. Appendix A provides a sufficient condition.

In order to gain some intuition behind the determinants of investment decisions under different regimes we provide an approximate analytical solution to the optimal investment rates:

$$\begin{pmatrix} i_1 \\ i_2 \end{pmatrix} \approx \begin{pmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_2 \end{pmatrix}, \tag{12}$$

where $w_{11} = 1 - w_{12}$, $w_{22} = 1 - w_{21}$,

$$\begin{aligned} w_{12} &= \frac{\lambda_{12}}{\rho + \delta + \lambda_{12} + \lambda_{21}}, \qquad w_{21} = \frac{\lambda_{21}}{\rho + \delta + \lambda_{12} + \lambda_{21}}, \\ \beta_1 &= \frac{(1+\psi) f_1 - (\rho + \delta)}{\theta(\rho + \delta)}, \qquad \beta_2 = \frac{(1+\psi) f_2 - (\rho + \delta)}{\theta(\rho + \delta)}, \end{aligned} \tag{13}$$

and $\psi = (1-\alpha)^2 / (2\alpha\eta)$. We refer the reader to Appendix A for further details on the approximation. The parameters β_1 and β_2 capture the approximate gains per unit of capital to the controlling shareholder in expansion and recession, respectively. Equation (12) shows that investment rate is a weighted-average of β_1 and β_2. Intuitively, a larger adjustment cost implies a smaller gain, *ceteris paribus*. The term $(\rho + \delta)$ in the denominator converts the flow measure (the numerator) into a stock measure by taking into account discounting and depreciation of capital stock.

The lack of investor protection gives rise to overinvestment (in (12) ψ increases as η decreases). The intuition is that the controlling shareholder extracts rents that are proportional to firm size and hence wishes to see the firm grow as fast as possible. On the other hand better investor protection decreases the overinvestment problem and increases the payout rate y consistent with La Porta et al. (2000a) who report evidence that dividends are higher in countries where minority shareholders have better rights. The comparative statics for the controlling shareholder's share α are qualitative identical.

Equation (12) shows that the investment rate in each regime reflects the expected gains across all regimes of building up the capital stock today. If regime 1 has a larger degree of persistence (a smaller λ_{12}), then the productivity level f_1 carries a larger weight (a bigger w_{11} and a smaller w_{22}) in calculations for the optimal investment rates in both regime 1 and 2.

Next, we turn to the description of equilibrium in the world economy.

2.3 World Economy Equilibrium

In the world economy equilibrium, minority investors take the production decisions of the controlling shareholders in each country as given as well as prices when solving their problems. Trading occurs between investors of the two countries at prices $(p(t), p^*(t), t \geq 0)$ so that market clearing holds and total distributed dividends equals world consumption in each good:

$$c_h(t) + c_h^*(t) = (1-\alpha) Y(t), \tag{14}$$

$$c_f(t) + c_f^*(t) = Y^*(t). \tag{15}$$

Controlling shareholders in the home and foreign countries choose diversion ratios and investment rates to maximize life-time utility and consume their flow of the respective good (i.e., $M(t)$ and $M^*(t)$ for the home and foreign controlling shareholders, respectively). Appendix B contains the proof to the following result.

Proposition 2 *There exists a unique world economy equilibrium. Equilibrium consumption allocations are*

$$\begin{aligned} c_h(t) &= \xi_h (1-\alpha) Y(t), \qquad c_h^*(t) = (1-\xi_h)(1-\alpha) Y(t), \\ c_f(t) &= \left(1-\xi_f\right) Y^*(t), \qquad c_f^*(t) = \xi_f Y^*(t). \end{aligned}$$

Expressions for the equilibrium state contingent prices are given in Appendix B, and:

$$p(t) = p^*(t) \frac{AY^*(t)}{Y(t)}.$$

The constants $0 < \xi_h, \xi_f < 1$ and $A > 0$ are given in Appendix B.

From the equilibrium we can construct two important prices. Define the *stochastic discount factor* of the home minority shareholder as

$$\xi(t) \equiv p(t).$$

The stochastic discount factor will be used extensively to determine various equilibrium asset prices. Define the *home country terms of trade* or the relative price of home exports in terms of imports by

$$q(t) \equiv \frac{p(t)}{p^*(t)} = A\frac{Y^*(t)}{Y(t)}. \tag{16}$$

When the home export good becomes relatively more abundant (i.e., $Y(t)$ increases relative to $Y^*(t)$) the relative price of exports falls or equivalently the home country terms of trade $q(t)$ fall.

Remarks

We have constructed this equilibrium to highlight a mechanism through which corporate governance concerns influence investment and asset prices in this order. There is another 'feedback' mechanism through which asset prices, the interest rate in particular, affect investment. According to this feedback mechanism, interactions of both controlling shareholders and minority investors in both the goods and asset markets change the wealth distribution in the economy, the discount rate, and investment (see Albuquerque and Wang (2004)). In this paper we chose to omit the later mechanism, eliminating all trade between minority investors and controlling shareholders. Our choice is based on three reasons. First, by doing so we gain in analytical tractability and can extensively characterize the equilibrium price behavior in the economy providing intuition for how the first channel works. Second, the channel we work with is able to explain several facts on asset prices over the business cycle and across countries, confirming that it is an important mechanism. Finally, as Albuquerque and Wang (2004) show this does not in any way reverse the results from the first mechanism.

The framework adopted in this paper to study the role of corporate governance in explaining asset prices relies on the notions of private benefits of control and overinvestment. Overinvestment is a story that we think is particularly attractive given the widespread evidence coming from emerging market economies. For example, prior to the 1997 East Asian crisis, the countries in East Asia that suffered the crisis were also running significant current account deficits, putting the borrowed money into questionable local investments. Burnside et al. (2001) use Thailand and Korea as examples of countries that borrowed significant amounts in foreign currency at low interest rates to lend locally at higher rates benefitting from a fixed exchange rate regime and from a government bailout policy. The volume of non-performing loans was already at 25 percent of GDP for Korea and 30 of GDP for Thailand prior to 1997. China is yet another example of a country with very large amounts of non-performing loans in the banking sector fruit of a government that tirelessly dumps cash in inefficient state owned enterprises. Allen et al. (2002) show that China has had consistent high growth rates since the beginning of the economic reforms in the late 1970s, even though its legal system is not well developed and law enforcement is poor. Our paper argues that the incentives for the controlling shareholders (for example, government officials running the state-owned enterprises on behalf of the state) to overinvest can at least partly account for China's high economic growth despite weak investor protection.[9]

The assumption of perfect risk sharing between minority investors in both countries implies that these investors share the same marginal rates of substitution and thus price securities in the same way. Moreover, the valuation of the home firm in foreign good units is perfectly correlated with the valuation of the foreign firm in foreign good units. This prediction may be modified by introducing stochastic preference shocks. With this in mind we focus on equity returns of the home firm in home good units.

Next, we turn our attention to the model predictions regarding asset prices.

3 Firm Value and Stock Returns

In this section, we derive the model's predictions for firm value (market to book ratio) and stock returns. We start by computing the stock market value in the home country. We use the home minority shareholders' stochastic discount factor to value the stream of home firm dividends $\{Y(s), s \geq t\}$ at time t in units of the home good:

$$S(t) = E_t\left[\int_t^\infty \frac{\xi(s)}{\xi(t)} Y(s) ds\right] = \frac{Y(t)}{\rho}.$$

The market to book value of assets is the ratio of $S(t)$ to the book value of capital $K(t)$:

$$MB(t) = \frac{S(t)}{K(t)} = \frac{y(t)}{\rho}.$$

The market to book value of assets increases with better investor protection (η). The intuition is that better investor protection mitigates the overinvestment problem

[9]See also Harford (1999), Pinkowitz (1999), Lang, Stulz, and Walking (1991), Blanchard, Lopez-de-Silanes, and Shleifer (1994), and Pinkowitz, Stulz, and Williamson (2003).

associated with the existing capital stock and yields a higher payout rate y and stock market firm value. This prediction is consistent with the overall empirical evidence on the effects of investor protection on firm value (La Porta et al. (2002), Black et al. (2003) and Gompers et al. (2003)).

Similarly, changes in the share of stock held by the controlling shareholder (α) lead to a higher market-to-book value through a higher payout rate y. The higher payout rate is optimal for the controlling shareholder as he has less incentives to steal from minority shareholders: a larger α means that a greater share of the controlling shareholder's compensation comes from maximizing firm value. This prediction relates directly to the evidence in Claessens et al. (2002) on firm value and cash flow ownership, and with the evidence for Korea in Baek et al. (2004) where it is found that *non-chaebol* firms experienced a smaller reduction in their share value during the East Asian crisis.

The next proposition summarizes the results obtained thus far.

Proposition 3 *Market to book value of assets $MB(t)$ increases with better investor protection and with the share of stock held by the controlling shareholder.*

We next turn to the predictions on stock returns. The stock price dynamics is given by:

$$\frac{dS(t)}{S(t)} = (i(t) - \delta)\, dt + \frac{1}{y(t)} \Delta y(t), \tag{17}$$

where $\Delta y(t)$ is the instantaneous change of $y(t)$ over the next instant. The drift component of (17) gives the expected capital gains component of stock returns. The stock also pays dividends at the rate of ρ (in terms of the stock price). Thus, the cum-dividend conditional expected stock return in the expansion ($\mu_{S,1}$) and recession regimes ($\mu_{S,2}$) are given by:

$$\mu_{S,1} = \rho + i_1 - \delta + \lambda_{12} \left(\frac{y_2 - y_1}{y_1} \right), \quad \mu_{S,2} = \rho + i_2 - \delta + \lambda_{21} \left(\frac{y_1 - y_2}{y_2} \right). \tag{18}$$

Conditional stock returns vary with corporate governance through two channels. One is the investment rate. Better corporate governance leads to less overinvestment, slower build-up of the capital stock and lower expected return. The other, is through its impact on the payout ratio. This channel has different implications depending on the current regime. The calibration we propose below yields that the business cycle amplitude y_1/y_2, declines with investor protection (η), which implies that better investor protection increases the conditional equity return in expansions and decreases that in recessions. Hence, the cumulative effect of better investor protection in recessions is to reduce the expected return. In our simulations it also reduces the expected return in expansions. A similar reasoning applies to comparative statics on the controlling shareholder's share (α).

To construct an expected excess return on the stock we subtract the instantaneous interest rate. The next section shows that the equilibrium short-term interest rate in expansion and recession in the home country (in units of the home good) are given by

$$r_1 = \rho + i_1 - \delta + \lambda_{12}\left(\frac{y_2 - y_1}{y_2}\right), \qquad r_2 = \rho + i_2 - \delta + \lambda_{21}\left(\frac{y_1 - y_2}{y_1}\right). \tag{19}$$

We leave the discussion on this pricing formula for the next section. Let $EP_n \equiv \mu_{S,n} - r_n$ denote the equity premium in regime n ($N_t = n$). We have that

$$EP_1 = \lambda_{12}\frac{(y_2 - y_1)^2}{y_1 y_2}, \qquad EP_2 = \lambda_{21}\frac{(y_2 - y_1)^2}{y_1 y_2}.$$

The equity premium EP depends on the volatility in the payout rate and is larger in states that have less persistence. In the calibration section below, we show that empirically λ_{21} is 3 to 4 times greater than λ_{12}. Intuitively, the expansion regime is much more persistent than the recession regime and carries a smaller equity premium, making the equity premium counter-cyclical (see Campbell et al. (1997) for a summary of evidence on conditional risk premium). Similarly, the conditional stock return volatility is:

$$\sigma_{S,1}^2 = \lambda_{12}\left(\frac{y_2 - y_1}{y_1}\right)^2, \qquad \sigma_{S,2}^2 = \lambda_{21}\left(\frac{y_1 - y_2}{y_2}\right)^2.$$

So long as $\lambda_{12} \leq \lambda_{21}$ conditional volatility of stock returns is higher in recessions as documented in Schwert (1989). Note that counter-cyclical conditional heteroskedasticity in returns in our model arises endogenously. That is, even if $\lambda_{12} = \lambda_{21}$, so productivity shocks are homoskedastic, $\sigma_{S,1}^2 < \sigma_{S,2}^2$. Here again, Schwert (1989) documents that growth rates of industrial production display greater volatility in recessions as measured by the NBER dates. Moreover, our calibration indicates that y_1/y_2 declines with investor protection (η), which implies that better corporate governance (or higher share of stock held by the controlling shareholder) contributes to lower conditional equity premium and volatility of returns.

We can also obtain the long run (or unconditional) expected stock return and equity premium. Let π_1 and π_1^* be the stationary probabilities of being in the expansion regime in the home and foreign countries, respectively. These probabilities are given by

$$\pi_1 = \frac{\lambda_{21}}{\lambda_{12} + \lambda_{21}}, \qquad \pi_1^* = \frac{\lambda_{21}^*}{\lambda_{12}^* + \lambda_{21}^*}.$$

The long run expected stock return is given by

$$\mu_S = \rho + \bar{i} - \delta + \frac{\lambda_{12}\lambda_{21}}{\lambda_{12}+\lambda_{21}} \frac{(y_1 - y_2)^2}{y_1 y_2},$$

and the long run equity premium is

$$\mu_{EP} = \mu_S - \bar{r} = \frac{2\lambda_{12}\lambda_{21}}{\lambda_{12}+\lambda_{21}} \frac{(y_1 - y_2)^2}{y_1 y_2}.$$

Note that $\bar{i}$ and $\bar{r}$ are the long-run expected levels of home investment rate and interest rates. In these formulae it is clear that the volatility in the payout rate is tied to the risk premium. Hence, given our previous discussion, better investor protection is associated with a lower equity premium and lower expected returns. The model thus have the ability to predict the high returns, volatility, and equity premia detected in many emerging markets where corporate governance is arguably weaker (e.g. Daouk, Lee, and Ng (2004), Bekaert and Harvey (1997), and Bekaert and Urias (1999)). Daouk, Lee, and Ng (2004) create an index of capital market governance which captures differences in insider trading laws, short-selling restrictions, and earnings opacity. They model excess equity returns using an international capital asset market model which allows for varying degrees of financial integration and show that improvements in the capital market governance index are associated with lower equity risk premia. Bekaert and Harvey (1997) correlate their estimated conditional stock return volatilities with microstructure and macroeconomics variables and find some evidence that countries with lower country credit ratings (as measured by Institutional Investor) have higher volatility, though none of their variables truly captures changes in corporate governance. Erb et al. (1996) show that expected returns, as well as expected volatility, are higher when country credit risk is higher.

Next, we turn to the model's predictions on the term structure of interest rates.

4 Term Structure of Interest Rates

The stochastic discount factor in the model (in the units of the home good) is given by $\xi(t) = e^{-\rho t}\gamma\omega/Y(t)$ where $\omega > 0$ is constant (see Appendix B). Thus, the dynamics of the stochastic discount factor ξ are given by

$$d\xi(t) = -\rho\xi(t)dt - (i(t) - \delta)\xi(t)dt + \xi(t)y(t)\Delta\left(\frac{1}{y(t)}\right). \tag{20}$$

Let r_1 and r_2 denote the equilibrium short term interest rate in the expansion regime and recession regime, respectively. Since the drift of the stochastic discount factor ξ is equal to $-r(t)\xi(t)$, we have

$$r_1 = \rho + i_1 - \delta - y_1\lambda_{12}\left(\frac{1}{y_2} - \frac{1}{y_1}\right), \tag{21}$$

if currently the regime is expansion ($N_t = 1$). The equilibrium interest rate is composed of three terms: (i) the investor's subjective discount rate ρ; (ii) the net investment rate $(i-\delta)$ and (iii) the effect of precautionary saving motives. In a risk-neutral world, the interest rate must equal the subjective discount rate in order to clear the market. This explains the first term. The second term captures the economic growth effect on the interest rate. A higher net investment rate $(i-\delta)$ implies higher future consumption and thus pushes up demand for current consumption relative to future consumption. To clear the market, the interest rate must increase. The third term indicates that a high net investment rate increases the riskiness of firm's cash flows, and thus makes agents more willing to save. This preference for precautionary savings reduces current demand for consumption and lowers the interest rate, *ceteris paribus*.

If currently $n = 1$ (expansion regime), the likelihood of moving into a recession state with lower future consumption decreases the interest rate because the investor has a precautionary saving motive. The interest rate differential between the expansion and recession regimes is:

$$r_1 - r_2 = i_1 - i_2 - (y_1 - y_2)\left(\frac{\lambda_{12}}{y_2} + \frac{\lambda_{21}}{y_1}\right).$$

The above equation predicts that there are two offsetting effects on the interest rate differential: the investment effect and the precautionary saving effect. The investment effect increases the interest differential, because the productivity in the expansion regime is higher than in recession regime. The precautionary savings effect makes the interest rate gap smaller, *ceteris paribus*.

The conditional variances of the interest rate in expansion and recession are given by

$$\sigma_{r,1}^2 = \lambda_{12}\left(r_1 - r_2\right)^2, \qquad \sigma_{r,1}^2 = \lambda_{21}\left(r_1 - r_2\right)^2.$$

Because in our calibration expansions are more persistent than recessions (λ_{21} is 3 to 4 times greater than λ_{12}), our model predicts that the volatility of the interest rate is larger in recession than in expansion. Our model's prediction is consistent with Schwert (1989)'s finding of counter-cyclical volatility of interest rates.

When the current regime is expansion ($N_t = 1$), using (21), we may write the stochastic discount factor dynamics (20) as follows:

$$\frac{d\xi(t)}{\xi(t)} = -r(t)dt - \Gamma_{12}\left(dZ_1(t) - \lambda_{12}dt\right),$$

where

$$\Gamma_{12} = -y_1 \left(\frac{1}{y_2} - \frac{1}{y_1} \right) = -\frac{y_1 - y_2}{y_2}, \tag{22}$$

and $Z_1(t)$ is a pure jump process from the expansion regime to the recession regime with intensity λ_{12}. Similarly, we construct Γ_{21} for the recession regime as follows:

$$\Gamma_{21} = -y_2 \left(\frac{1}{y_1} - \frac{1}{y_2} \right) = \frac{y_1 - y_2}{y_1}. \tag{23}$$

By applying Girsanov's theorem, the transition rate matrix under the risk-neutral probability measure is thus given by

$$\mathbf{\Lambda^Q} = \begin{pmatrix} -\lambda_{12}^Q & \lambda_{12}^Q \\ \lambda_{21}^Q & -\lambda_{21}^Q \end{pmatrix},$$

where

$$\begin{aligned} \lambda_{12}^Q &= \lambda_{12}\left(1 - \Gamma_{12}\right) = \frac{y_1}{y_2}\lambda_{12} \\ \lambda_{21}^Q &= \lambda_{21}\left(1 - \Gamma_{21}\right) = \frac{y_2}{y_1}\lambda_{21}. \end{aligned}$$

The ratio y_1/y_2 which gives the business cycle amplitude also represents a risk adjustment to the physical transition rates λ_{12} and λ_{21}. Intuitively, a larger marginal rate of substitution between the two regimes (measured by a bigger y_1/y_2 ratio) leads to a larger compensation for risk. This is reflected by a bigger difference between λ_{12}^Q and λ_{12}. Because the output-capital ratio is higher in expansion regime than in recession regime ($y_1 > y_2$), the stationary probability of expansion regime under the risk-neutral measure, $\pi_1^Q = \lambda_{21}^Q/(\lambda_{12}^Q + \lambda_{21}^Q)$, is lower than π_1, the stationary probability of expansion regime under the physical measure. Intuitively, the equilibrium risk premium implies that the investor puts 'more' weight on the 'recession' regime by having a higher 'risk-neutral' probability measure relative to the physical probability measure.

After having understood the short-term interest rate and equilibrium risk premium, next we turn to the equilibrium term structure of interest rates. For brevity, in the main text we restrict attention to the price and yield of a perpetuity bond; a bond that pays 1 unit of the domestic good continuously. Appendix C shows that the price of this bond depends on the underlying economic regime and is given by

$$\begin{pmatrix} B_1(\infty) \\ B_2(\infty) \end{pmatrix} = \frac{1}{r_1 r_2 + \lambda_{12}^Q r_2 + \lambda_{21}^Q r_1} \begin{pmatrix} r_2 + \lambda_{21}^Q + \lambda_{12}^Q \\ r_1 + \lambda_{21}^Q + \lambda_{12}^Q \end{pmatrix}.$$

The yield on the perpetuity bond is $\iota(\infty) = 1/B(\infty)$.

With closed-form solutions for both the long-term and short-term rates, the term spread between the perpetuity yield and the short-term interest rate can be shown to be:

$$\begin{aligned}\iota_1(\infty) - r_1 &= \frac{\lambda_{12}^Q}{r_2 + \lambda_{12}^Q + \lambda_{21}^Q}(r_2 - r_1) \\ \iota_2(\infty) - r_2 &= \frac{\lambda_{21}^Q}{r_1 + \lambda_{12}^Q + \lambda_{21}^Q}(r_1 - r_2).\end{aligned}$$

Let $\bar{\iota}(\infty) - \bar{r}$ be the unconditional term spread between the long yield (perpetuity) and the short term interest rate. That is, $\bar{\iota}(\infty) - \bar{r} = \pi_1 (\iota_1(\infty) - r_1) + (1 - \pi_1)(\iota_2(\infty) - r_2)$. The unconditional term spread is given by

$$\begin{aligned}\bar{\iota}(\infty) - \bar{r} &= \frac{1}{\lambda_{12} + \lambda_{21}} \frac{\lambda_{21}\lambda_{12}^Q - \lambda_{12}\lambda_{21}^Q}{r_2 + \lambda_{12}^Q + \lambda_{21}^Q}(r_2 - r_1) \\ &= \frac{\lambda_{12}\lambda_{21}}{\lambda_{12} + \lambda_{21}} \frac{1}{r_2 + \lambda_{12}^Q + \lambda_{21}^Q}\left(\frac{y_1}{y_2} - \frac{y_2}{y_1}\right)(r_2 - r_1).\end{aligned}$$

In the numerical section below we investigate the comparative statics of term spreads with respect to investor protection and with respect to share ownership of the controlling shareholder.

Thus far we have focused the analysis on equilibrium prices of domestic assets for the home country. Next, we turn to the model's prediction on the equilibrium exchange rate.

5 Equilibrium Exchange Rate

As in standard international setting, the exchange rate is the ratio of consumer price indices in the home (CPI) and foreign (CPI^*) countries. The CPI describes the minimum expenditure required to purchase a unit of the basket of goods $c_h^\gamma c_f^{1-\gamma}$ relevant for the consumer (recall that the felicity function is $u(c_h, c_f) = \log\left(c_h^\gamma c_f^{1-\gamma}\right))$ in time zero units of the home good.[10] For the home country, we have

$$\begin{aligned}CPI = \min_{c_h, c_f} \quad & [pc_h + p^* c_f] \\ s.t. \quad & c_h^\gamma c_f^{1-\gamma} \geq 1.\end{aligned}$$

Thus, the CPI is given by

$$CPI = \left(\frac{p}{\gamma}\right)^\gamma \left(\frac{p^*}{1-\gamma}\right)^{1-\gamma}.$$

[10] See Obstfeld and Rogoff (1996), Chapter 4.

The exchange rate is the price of the home consumption basket per unit of the foreign consumption basket:

$$\mathcal{E}(t) \equiv \frac{CPI}{CPI^*} = \mathcal{E}_0 q\,(t)^{\Delta_\gamma}\,,$$

where the constants $\Delta_\gamma \equiv \gamma - \gamma^*$ and $\mathcal{E}_0 > 0$.[11] Given the units of the exchange rate, an increase in the exchange rate is equivalent to a home currency real appreciation. We assume that the home country minority investor values the home good more than the foreign country minority investor does (i.e., $\Delta_\gamma > 0$), which implies that an improvement in the terms of trade leads to a real appreciation. With this assumption commonly made in the international finance literature and documented in the calibration below, a temporary increase in foreign productivity makes the foreign good more abundant and thus improves the terms of trade of the home country. Because the home CPI puts a smaller weight on the foreign good (whose relative price dropped) than does the foreign CPI, the exchange rate appreciates, i.e., $\mathcal{E}(t)$ increases. The model effects of a temporary productivity shock on home terms of trade and exchange rate thus coincide with the implications from traditional international finance and macroeconomics models (see Obstfeld and Rogoff (1996)).

The dynamics of the logarithm of the exchange rate is given by

$$d\log\mathcal{E}\,(t) = \Delta_\gamma d\log q(t),$$

where the dynamics for the terms of trade is

$$d\log q(t) = \Delta\log y^*(t) - \Delta\log y(t) + (i^*(t) - i(t))\,dt.$$

To facilitate our discussions about the determinants of the expected instantaneous change of $\log q$ (proportional to the expected rate of appreciation $d\log\mathcal{E}$) suppose that both home and foreign countries are in the expansion regime.[12] Then, the conditional mean and variance of the instantaneous change of $\log q$ are given by:

$$\mu_{q,1} = \lambda_{12}^*\log\frac{y_2^*}{y_1^*} - \lambda_{12}\log\frac{y_2}{y_1} + i_1^* - i_1,$$

[11] The parameter $\mathcal{E}_0$ is given by:

$$\mathcal{E}_0 = \frac{\left(\frac{1}{\gamma}\right)^{\gamma}\left(\frac{1}{1-\gamma}\right)^{1-\gamma}}{\left(\frac{1}{\gamma^*}\right)^{\gamma^*}\left(\frac{1}{1-\gamma^*}\right)^{1-\gamma^*}}.$$

[12] Obviously, the analyses in other regimes remain essentially the same as this one.

$$\sigma_{q,1}^2 = \lambda_{12}^* \left[\log\left(\frac{y_2^*}{y_1^*}\right)\right]^2 + \lambda_{12}\left[\log\left(\frac{y_2}{y_1}\right)\right]^2.$$

See Appendix C for a derivation of the conditional variance. The conditional expected rate of appreciation has two components. First, the exchange rate tends to depreciate if the home investment rate is high because a high investment rate translates into more future home capital and output and hence worse future home terms of trade. We refer to this as the investment component. Second, the likelihood of moving to the recession state implies that the payout may be lowered ($y_2 < y_1$) and that the exchange rate is likely to appreciate: a lower future payout means that the home good is less abundant and relatively more expensive. We refer to this component as the payout component. Similarly, both investment and payout components exist in the foreign country and thus also have implications on equilibrium determination of the exchange rate.

The conditional variance of the rate of appreciation ($\sigma_{\mathcal{E},1}^2 = \Delta_\gamma^2 \sigma_{q,1}^2$) is given by the transition likelihood (λ_{nm}) and the output-capital ratio gap ($y_1 - y_2$). As alluded to before, calibrated values for λ_{21} are about 3 to 4 times larger than those for λ_{12} which implies that the conditional volatility of the rate of appreciation of the exchange rate is counter-cyclical.

While both investment and payout components matter in determining the conditional expected rate of appreciation, we show next that the investment component matters both in the long and short run, but that the payout component only matters at the business cycle frequency. The long-run or unconditional expected drift of changes in $\log q(t)$ is given by

$$\begin{aligned}
\mu_q &= \pi_1^*\lambda_{12}^* \log\frac{y_2^*}{y_1^*} + \pi_2^*\lambda_{21}^*\log\frac{y_1^*}{y_2^*} - \pi_1\lambda_{12}\log\frac{y_2}{y_1} - \pi_2\lambda_{21}\log\frac{y_1}{y_2} + \bar{i}^* - \bar{i}, &(24)\\
&= \bar{i}^* - \bar{i}. &(25)
\end{aligned}$$

The unconditional variance of $d\log q$ is given by

$$\sigma_q^2 = \frac{2\lambda_{21}^*\lambda_{12}^*}{\lambda_{12}^*+\lambda_{21}^*}\left[\log\left(\frac{y_2^*}{y_1^*}\right)\right]^2 + \frac{2\lambda_{21}\lambda_{12}}{\lambda_{12}+\lambda_{21}}\left[\log\left(\frac{y_2}{y_1}\right)\right]^2.$$

The first four terms in (24) describe the payout component and sum to zero because $\pi_1\lambda_{12} = \pi_2\lambda_{21} = \frac{\lambda_{21}\lambda_{12}}{\lambda_{12}+\lambda_{21}}$: in the long run, in our two-state regime economy, it is as likely that the economy is in the expansion regime and switches to the recession regime or the reverse. Thus, the long-run average appreciation rate is proportional to the difference between investment rates in the foreign and home countries:

$$\mu_{\mathcal{E}} = \Delta_\gamma \mu_q = \Delta_\gamma\left(\bar{i}^* - \bar{i}\right). \qquad (26)$$

Intuitively, a higher investment rate in the foreign (home) country implies a more abundant supply of the foreign (home) good in the future and thus higher (lower) home terms of trade growth and higher (lower) exchange rate. The strength of this investment component on the exchange rate appreciation is given by Δ_γ, which captures the differences in home good preferences between the home and the foreign investors. When $\bar{i}^* > \bar{i}$, a bigger Δ_γ means that the foreign country CPI^* falls faster than the home country CPI with the drop in relative prices from the increased relative abundance of the foreign good. Hence the exchange rate appreciates by more.[13]

Now, we turn to the discussion of how investor protection affects the equilibrium exchange rate. As we have shown earlier, our model predicts overinvestment, but stronger investor protection lowers the incentive to steal and hence the incentive to build larger firms. Thus, our model predicts that by improving investor protection the home country will see its unconditional average appreciation rate increase, *ceteris paribus*. The intuition is as follows. In the long run, the exchange rate is determined by the long-run investment rates. Stronger investor protection provides fewer incentives to overinvest and thus less relative abundance of the home good in the long run and better home terms of trade. The following comparative statics confirms the intuition:

$$\frac{d\mu_q}{d\eta} = -\frac{d\bar{i}}{d\eta} > 0.$$

This model prediction can be confronted with the data. Looking at a cross-section of emerging market economies, Johnson et al. (2000) observed that during the period of the East Asian crisis countries with better investor protection went through a lower depreciation of their currency's exchange rate relative to the U.S. dollar. Moreover, investor protection measures did better at predicting the amount of exchange rate depreciation than did standard macroeconomic variables. Our model is the first dynamic asset pricing equilibrium model that can explain this fact.

Higher ownership concentration (higher α) leads to greater alignment of incentives between minority investors and the controlling shareholder and less overinvestment. In turn, this translates into a long run higher appreciation rate of the equilibrium exchange

[13] In our model economies grow over time. If corporate governance institutions did not change dynamically as economies grow, then countries with weak governance laws inevitably would overtake countries with better governance. But, the observed positive correlation between income per capita and quality of governance systems indicates that indeed governance changes endogenously with economic growth. This is an interesting topic to understand the long run dynamics of asset prices in emerging market and transition economies but is outside the scope of this paper.

rate:

$$\frac{d\mu_q}{d\alpha} = -\frac{d\bar{i}}{d\alpha} > 0.$$

As for long run volatility of the rate of appreciation we see that it captures the same volatility as prices in the stock market do. Furthermore, given our calibration below, improvements in investor protection or increases in the controlling shareholder's share lead to a decrease in the business cycle amplitude (y_1/y_2) and thus to lower (conditional and unconditional) volatility. Exchange rates (relative to say the U.S.) of emerging market economies, whose countries tend to have worse investor protection, are thus more volatile. We return to this point in the numerical results section.

It is possible to rewrite (25) in a way that relates exchange rate changes to the interest rate differential. Using (26) and an unconditional version of (19), we can write the appreciation rate of the exchange rate as:

$$\Delta_\gamma^{-1}\mu_{\mathcal{E}} = \overline{r}^* - \overline{r} + \frac{\lambda_{12}^*\lambda_{21}^*}{\lambda_{12}^* + \lambda_{21}^*}\frac{(y_1^* - y_2^*)^2}{y_1^* y_2^*} - \frac{\lambda_{12}\lambda_{21}}{\lambda_{12} + \lambda_{21}}\frac{(y_1 - y_2)^2}{y_1 y_2}.$$

The long run appreciation rate is the difference between long run foreign and home interest rates plus foreign exchange risk premia. Ignoring fluctuations in risk premia, the exchange rate appreciates when the foreign interest rate exceeds the home interest rate: an increase in $\overline{i}$ (holding $\overline{i}^*$ fixed) requires a drop in current consumption which can occur in equilibrium only if the interest rate increases, but the high future capital and output of the home good predict a worsening of the terms of trade and a home depreciation. However, uncovered interest parity does not hold unconditionally because of the presence of the risk premia, which equals the difference between foreign and home stock market risk premia.

The following proposition summarizes the main results developed in this section.

Proposition 4 *The unconditional rate of appreciation of the exchange rate $\mu_{\mathcal{E}}$ increases with better investor protection and the share of stock held by the controlling-shareholder-controlling shareholder.*

6 Generalization to Multi-Regime Economies

This section extends our benchmark two-regime economy to allow for multiple regimes. We extend our model for at least two reasons. First, empirically, the two-regime economy has a worse numerical fit. Second, theoretically, we show that the key predictions (for example on exchange rates) apply more generally to a large class of multi-regime economy.

We specify the regime transition in a multi-regime economy via the following transition rate matrix $\mathbf{\Lambda}$:

$$\mathbf{\Lambda} = \begin{pmatrix} -\lambda_1 & \lambda_{12} & \cdots & \lambda_{1N} \\ \lambda_{21} & -\lambda_2 & \cdots & \lambda_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \lambda_{N1} & \cdots & \cdots & -\lambda_N \end{pmatrix}, \tag{27}$$

and $\lambda_n = \sum_{m \neq n} \lambda_{nm}$. This transition matrix specifies that over an infinitesimal time interval Δt, the transition probability from regime n to m is given by $\lambda_{nm}\Delta t$. If the current regime is n, the probability for the economy to switch out of current regime is thus $\lambda_n \Delta t = \sum_{m \neq n} \lambda_{nm}\Delta t$. The transition rate matrix $\mathbf{\Lambda}$ to a continuous-time Markov chain is as the transition probability matrix to a discrete-time Markov chain. Two crucial properties of a transition rate matrix are the following: (i) each row of the transition rate matrix sums to zero and (ii) the off-diagonal elements measure the rates at which the economy transits between two distinct regimes and thus are non-negative.

Investment Rates

Let $\mathbf{i}$ denote the vector of investment rate, in that $\mathbf{i}^T = (i_1, i_2, ..., i_N)$. In Appendix A, we show that the investment rate may be approximated by the following equation:

$$\mathbf{i} \approx \frac{1}{\theta} \left[(\rho+\delta)\mathbf{I_N} - \mathbf{\Lambda}\right]^{-1} \left[(1+\psi)\,\mathbf{f} - (\rho+\delta)\mathbf{1_N}\right], \tag{28}$$

where $\mathbf{\Lambda}$ is the transition rate matrix, given by (27). The intuition behind (28) is similar to that behind (12), the approximate investment rate in a two-regime economy. The term $\left[(1+\psi)\,\mathbf{f} - (\rho+\delta)\mathbf{1_N}\right]$ measures the difference between, $(1+\psi)\mathbf{f}$, the return to the controlling shareholder,[14] and $(\rho+\delta)\mathbf{1_N}$, the opportunity cost for each unit of capital. This difference captures the net value added to the controlling shareholder for each unit of capital installed. The matrix $\left[(\rho+\delta)\mathbf{I_N} - \mathbf{\Lambda}\right]^{-1}$ incorporates the discounting effect $((\rho+\delta)\mathbf{I_N})$ and the mean reversion effect of productivity (due to regime switching) in a multi-regime economy.

Stock Returns and Interest Rates

[14] Note that the proportionality coefficient ψ captures the additional private benefits accrued to the entrepreneur per unit of productivity level.

The cum-dividend conditional expected stock return and the equilibrium short-term interest rate in the home country (in units of the home good) are given by:

$$\begin{aligned}\mu_{S,n} &= \rho + i_n - \delta + \sum_{m\neq n} \lambda_{nm}\left(\frac{y_m - y_n}{y_n}\right),\\ r_n &= \rho + i_n - \delta + \sum_{m\neq n} \lambda_{nm}\left(\frac{y_m - y_n}{y_m}\right),\end{aligned}$$

for any regime n. The implied equity premium $EP_n \equiv \mu_{S,n} - r_n$ is

$$EP_n = \sum_{m\neq n} \lambda_{nm}\frac{(y_m - y_n)^2}{y_m y_n}.$$

The equity premium EP depends on the volatility in the payout ratio and transition rates λ_{nm}. The conditional stock return variance in regime n is given by

$$\sigma^2_{S,n} = \sum_{m\neq n} \lambda_{nm}\left(\frac{y_m - y_n}{y_n}\right)^2.$$

The conditional variance of the interest rate in regime n is given by

$$\sigma^2_{r,n} = \sum_{m\neq n} \lambda_{nm}\left(r_m - r_n\right)^2.$$

Time Reversibility of Regimes

Next, we consider a sub-class of multi-regime economies that allows us to obtain essential economic insights in multi-regime economies with little additional mathematical complication beyond what we used to analyze the two-regime economy. This sub-class of regime-switching economies is described by continuous-time Markov chains with the feature called 'time-reversibility.' Intuitively, if running a Markov chain forward is statistically equivalent to running the *reversed* Markov chain, then we call the Markov chain time reversible.[15] It turns out that for a stationary Markov chain, the Markov chain is time reversible, if and only if the following property for the Markov chain is satisfied:

$$\pi_n \lambda_{nm} = \pi_m \lambda_{mn}, \tag{29}$$

[15]Formally, let $\mathbf{X} = \{X(t) : -\infty < t < \infty\}$ be the stationary continuous-time Markov chain, then $\mathbf{Y} = \{Y(t) = X(-t) : -\infty < t < \infty\}$ is the time-reversed process. Note that the process $\mathbf{Y}$ is also a continuous-time Markov chain. However, the transition rate matrix $\mathbf{\Lambda^Y}$ for $\mathbf{Y}$ in general is different from $\mathbf{\Lambda}$, the one for $\mathbf{X}$. When the transition rate matrix $\mathbf{\Lambda^Y}$ is the same as the rate matrix $\mathbf{\Lambda}$, then the chain $\mathbf{X}$ is time reversible.

for any regime pairs n and m (with $n \neq m$), with π_n and π_m being the stationary probabilities of regime n and m, respectively. The above equation describes what is known as the 'local' (also known as 'detailed') balance condition. Note that the conditional transition probabilities over an infinitesimal time interval Δt from regime n to regime m and *vice versa* are given by $\lambda_{nm}\Delta t$ and $\lambda_{mn}\Delta t$, respectively. Equation (29) states that the transition rate going *directly* from regime n to regime m is equal to the transition rate going *directly* in the reverse direction, taking the stationary probabilities of the economy in each regime into account.[16]

Next, we provide a few examples for time-reversible multi-regime economies. First, consider a three-regime economy. In general, it is empirically very difficult to calibrate the economy accurately with a two-regime setting. A three-regime setting allows us not only to incorporate 'expansion' and 'recession' regimes, but also a third 'normal' times regime which lies between the first two. Alternatively, we may think about the regimes as a "expansion", "recession" and a "depression" (or a "disaster") regime. For the rest of three-regime discussion, let us use the regime labels "expansion", "normal", and "recession" for regimes 1, 2, and 3, respectively. One easy way to incorporate the time reversibility feature into the regime-switching setting is to only allow for immediate transitions among 'adjacent' regimes. Specifically, there are two pairs of adjacent regimes in this economy: (i) expansion and normal regimes; and (ii) "normal and recession regimes. Thus, we are ruling out *direct* instantaneous transitions from the expansion regime to the recession regime or *vice versa.* However, we are *not* ruling out transition from expansion to recession in any given fixed time interval, because the economy may go through the normal regime in transiting from expansion to recession. Formally, we may write down the following transition rate matrix:

$$\mathbf{\Lambda} = \begin{pmatrix} -\lambda_{12} & \lambda_{12} & 0 \\ \lambda_{21} & -\lambda_2 & \lambda_{23} \\ 0 & \lambda_{32} & -\lambda_{32} \end{pmatrix} ,$$

where $\lambda_2 = \lambda_{21} + \lambda_{23}$. Intuitively, $\lambda_2 \Delta t$ is the probability at which the economy leaves the "normal" regime, if the current regime is "normal." No direct instantaneous transition among non-adjacent regimes implies $\lambda_{13} = \lambda_{31} = 0$ in this setting. The stationary

[16] It is much easier to solve for the stationary distribution $\boldsymbol{\pi} = (\pi_1, ..., \pi_N)$ if the Markov chain satisfies the local balance equation (29), than to solve the system of $0 = \boldsymbol{\pi}\mathbf{\Lambda}$. For an economy satisfying the local balance condition, for each regime, solving (29) only involves two unknowns, instead of N, the total number of regimes.

distribution $\boldsymbol{\pi} = (\pi_1, \pi_2, \pi_3)$ of this three-regime (time-reversible) economy is given by

$$\pi_1 = \left(1 + \frac{\lambda_{12}}{\lambda_{21}} + \frac{\lambda_{12}\lambda_{23}}{\lambda_{32}\lambda_{21}}\right)^{-1}, \qquad \pi_2 = \frac{\lambda_{12}}{\lambda_{21}}\pi_1, \qquad \pi_3 = \frac{\lambda_{12}\lambda_{23}}{\lambda_{32}\lambda_{21}}\pi_1.$$

The above analysis may easily be extended to an N-regime continuous-time Markov chain in which immediate regime transition is adjacent.

One way to argue in favor of modeling the underlying economic shock with regimes is to tie them to the fundamentals of the business cycle as we have done. Alternatively, we may view each regime simply as a possible realization of one of the many levels of productivity levels. Then, it might be reasonable to substantially increase the number of regimes, even possibly to countably but infinite number of regimes. While increasing the number of regimes, we may still retain the analytical tractability of the regime-switching analysis that we have developed so far, by keeping the number of parameters used to model the regimes small. For simplicity in such an infinite-regime setting, let us also assume that among *direct* regime transitions, only transitions between adjacent regimes are admissible. Moreover, to keep the number of parameters small, we assume that the transition from regime n to regime $n+1$, the *higher* adjacent regime, is λ_u, and the transition from regime n to regime $n-1$, the *lower* adjacent regime, is λ_d for all regimes $(n \geq 2)$. In order to ensure that the stationary distribution exists, we require that the rate at which the economy is moving to a higher-numbered regime is lower than the rate at which the economy is moving back to lower-numbered regime, in that $(\lambda_d > \lambda_u)$. Intuitively, the rate at which the economy visits the increasingly higher numbered regime decreases exponentially. It is easy to verify that when this regularity condition holds, the stationary distribution $\boldsymbol{\pi}$ of this time-reversible countably infinite-regime economy is given by

$$\pi_1 = 1 - \frac{\lambda_u}{\lambda_d}, \quad \pi_n = \left(\frac{\lambda_u}{\lambda_d}\right)^{n-1}\left(1 - \frac{\lambda_u}{\lambda_d}\right), \quad n \geq 2.$$

Indeed, the stationary probability for higher numbered regime decreases exponentially.

Terms of Trade and Exchange Rates

Next, we turn to the model's implications on terms of trade and equilibrium exchange rates.

Proposition 5 *For time-reversible Markov chains, the long-run drift for* $\log q$*, the logarithm of the terms of trade, is given by the difference in the long-run average investment rates in foreign and home countries:*

$$\mu_q = \bar{i}^* - \bar{i}.$$

The appendix C contains a proof. Note that as was already true for the 2-regime economy, $\mu_{\mathcal{E}} = \Delta_\gamma \mu_q$. The conditional variances of exchange rate changes are given by

$$\Delta_\gamma^{-2} \sigma_{\mathcal{E},n}^2 = \sum_{m \neq n} \lambda_{nm} \left[\log \left(\frac{y_m}{y_n} \right) \right]^2 + \sum_{m \neq n} \lambda_{nm}^* \left[\log \left(\frac{y_m^*}{y_n^*} \right) \right]^2,$$

when the current regime is $N_t = n$. Next, we calibrate our model economy.

7 Calibration

We calibrate the model for Korea (home country) and the U.S. (foreign country).[17] The calibration fixes parameter values that are economically sensible. The data used comes from several sources: Korean trade by country is taken from OECD trade data, stock market valuations are from Datastream, and productivity data is computed using output per worker and capital per worker variables from the Heston, Summers and Aten (2002) Penn World Tables. Data for household wealth was obtained from the U.S. Census Bureau and the Korean National Statistics Office. From Worldscope we obtain the average share held by the controlling shareholder. Remaining data is taken from the World Bank database of World Development Indicators. Throughout, a time period is taken to correspond to one calendar year.

Consumer parameters

The intertemporal rate of time preference is set at $\rho = 0.06$ (this yields a long run annual real interest rate in units of the home good of 3 percent). To calibrate the preference parameter γ (γ^*) we note that in the model γ (γ^*) is the Korean (the U.S.) minority investors' consumption share of the Korean good. Thus, we set:

$$\begin{aligned} \gamma &= 1 - \frac{c_f(t)}{q(t)\, c_h(t) + c_f(t)} \\ &= 1 - \frac{1}{3} \sum_{t=1994}^{1996} \frac{\text{Korean Imports from the U.S. }_t}{\text{Total Korean Tradables' Expenditure}_t} = 0.88, \end{aligned}$$

where *Total Korean Tradables' Expenditure* is equal to the share of tradables in domestic absorption (private consumption plus businesses investment plus government spending). To get this share we use the share of tradables in private consumption of 48 percent from Burstein et al. (2003) computed from the Korean 1995 input-output matrix. We assume that the share of tradables in investment and government spending is also 48

[17] We take the US to have perfect investor protection for simplicity, and clearly not for realism.

percent. The mean covers the pre-East-Asian crisis period of 1994-1996 as the OECD did not collect data before 1994 for Korea. Similarly, to calibrate the U.S. consumer's consumption share of the Korean (and the U.S.) traded good we set:

$$
\begin{aligned}
\gamma^* &= \frac{q(t)\, c_h^*(t)}{q(t)\, c_h^*(t) + c_f^*(t)} \\
&= \frac{1}{3} \sum_{t=1994}^{1996} \frac{\text{Korean Exports to the U.S.}_{\ t}}{\text{Total U.S. Tradables' Expenditure}_t} = 0.005,
\end{aligned}
$$

where *Total U.S. Tradables' Expenditure* is equal to the share of tradables in domestic absorption. We use a share of tradables in private consumption of 54 percent from Engel (1999) computed using the share of nontradables in the U.S. consumption price index. Normalizing by population is needed because in the model countries have identical size populations.

The calibrated number for γ likely overstates the true preference for Korean goods vis-a-vis imported goods from the U.S. as we have no way of subtracting from the total spending on tradables the component originating in countries other than the U.S. Similarly, γ^* is likely to be an understatement of the true preference for Korean goods by the U.S. consumers. However, this is not a problem for us. Most of our results rely only on (the sign of) the difference between γ and γ^* which any reasonable calibration seems to indicate is positive.

Production parameters

Besides the productivity parameters, there are 8 parameters associated with the production side of the Korean and the U.S. economies $(\delta, \theta, \alpha, \alpha^*, \eta, \eta^*, K(0), K^*(0))$. The parameters (δ, θ) are chosen to be equal across the two countries. The depreciation rate is set to 7 percent. The parameter θ that describes the cost of adjusting investment is set to 10 which is within the bounds of estimates from Erickson and Whited (2000).

Following Dahlquist et al. (2003) we take the share of stock held by the controlling shareholder to be given by Worldscope Database percentage of market capitalization that is closely held at the end of year 1997. For Korea this number is $\alpha_{Korea} = 0.392$ and for the U.S. this number is $\alpha_{US} = 0.0794$. Dahlquist et al. (2003) discuss the possible upward and downward biases of this measure. Perhaps the most important downward bias is that Worldscope only contains data for large corporations. For any country, it is likely that controlling shareholders are more prevalent in smaller companies. The potential upward bias in these numbers results from having included large holdings from shareholders who do not act on the behalf of the effective controlling shareholder.

So far we measured all our parameters by using direct observable measures from data. There is however one parameter η, associated with the cost of stealing that we need to calibrate differently. For the U.S., we assume investor protection is perfect, $(\eta_{US} \to \infty)$.[18] A larger cost of stealing yields less of an empire building incentive and thus less overinvestment. Hence, we choose $\eta_{Korea} < \infty$ to so that the model matches the ratio of sample average investment rates over the period 1990-1996 in the U.S. versus Korea:

$$\frac{I_t^{US}}{Y_t^{US}} \bigg/ \frac{I_t^{Korea}}{Y_t^{Korea}} = 0.47. \tag{30}$$

The calibrated value of $\eta_{Korea} = 6$ which yields a cost of stealing as a fraction of gross output, $C(s, K)/R = \frac{1-\alpha}{2\eta}$, of 5 percent. To get a sense of the reasonableness of the magnitude of this cost we can look for example at the size of non-performing loans in Korea as presumably a substantial part of them resulted from inefficient overinvestment and stealing. Burnside et al. (2001) estimate that non-performing loans in Korea were 25 percent of GDP *prior* to the East Asian crisis in 1997. In the U.S. the highest this number got to in the 1990s was in 1992 just after the savings and loan (S&L) crisis. Weiss Ratings, Inc., a company that provides ratings of financial services companies, reports that non-performing loans in the U.S. in 1992 amounted to 1.2 percent of the U.S. GDP. Finally, we set $K(0) = 1$ and choose $K^*(0) = 2.17$ to match the 1990 ratio of capital stocks.

Productivity parameters

To calibrate the process for productivity we use the annualized process in Cooley and Prescott (1995) for the U.S. :

$$\log\left(A_t^{US}\right) = 0.815 \log\left(A_{t-1}^{US}\right) + 0.013\varepsilon_t^{US}. \tag{31}$$

To calibrate the process for productivity in Korea we use annual measures of GDP per worker (Y_t) and capital stock per worker (K_t) in constant international prices available from the Heston et al. (2002) database. Data is available for 1965-1990. Using the output share of capital in Barro and Sala-i-Martin (1995, Table 10.8 Panel B), we get the Solow residuals

$$\log\left(A_t^{Korea}\right) = \log\left(Y_t^{Korea}\right) - 0.32 \log\left(K_t^{Korea}\right).$$

[18] While there is much research on corporate governance in the U.S., the U.S. has overall substantially stronger investor protection than most other countries. Note that with $\eta_{US} \to \infty$ the exact value of α_{US} becomes irrelevant for investment decisions (so long as it is strictly positive) as no stealing occurs and entrepreneurs maximize firm value.

After detrending the productivity time series using the Hodrick-Prescott filter we reach the following independent AR(1) specification:

$$\log\left(A_t^{Korea}\right) = 0.573 \log\left(A_{t-1}^{Korea}\right) + 0.016\varepsilon_t^{Korea}. \tag{32}$$

Cooley and Prescott (1995) estimate the process in (31) assuming that at the quarterly frequency changes in the capital stock are negligible, as there is no quarterly data on the stock of capital. However, omitting capital can lead to an upward bias on the persistence of productivity shocks if there is time-to-build in production and may justify the difference with the persistence implied by (32).

We approximate the AR(1) processes described above each by a two-state Markov process in the following way. Let one-period transition probability matrix be the following

$$\begin{pmatrix} p_{11} & 1-p_{11} \\ 1-p_{22} & p_{22} \end{pmatrix},$$

where p_{12} denotes the conditional transition probability from the expansion regime to the recession regime. The stationary probabilities are thus given by $\pi_1 = p_{21}/(p_{12}+p_{21})$ and $\pi_2 = 1-\pi_1$. Appendix D provides details on how $(\ln A_1, \ln A_2, p_{11}, p_{22})$ are chosen.[19] The numbers for A_n can be used to calibrate the model's productivity shocks f_n in each regime. We calibrate the mean productivity $\overline{f} = E(f_n)$ in a way that makes the capital output ratio of the model consistent with that in the data. Using the U.S. long-run average capital-output ratio of about 2.5 from Maddison (1995):

$$\begin{aligned} \overline{f} &= \frac{GDP - \text{labor input payments}}{\text{Private Fixed Capital}} \\ &= \text{U.S. Capital's Share of GDP} \frac{GDP}{\text{Private Fixed Capital}} \\ &= 0.41 \times \frac{1}{2.5} = 0.16. \end{aligned}$$

Note that labor payments are deducted because the model's output measure excludes labor payments. Finally,

$$f_n = A_n \frac{\overline{f}}{\pi_1 A_1 + \pi_2 A_2},$$

gives the model's productivity levels. We use the same number $\overline{f} = 0.16$ for Korea. This calibration yields a long run investment rate of 20 percent of GDP for the U.S. Thus, we are not only able to match the ratio of investments (through imposing (30)), but also the level of investment-GDP ratios in both countries.

[19] For Korea, we have $(\ln A_1, \ln A_2, p_{12}, p_{21}) = (-0.0327, 0.0117, 0.315, 0.1123)$ and for the U.S., we get $(\ln A_1, \ln A_2, p_{12}, p_{21}) = (-0.0376, 0.0134, 0.136, 0.0487)$.

8 Numerical Results

This section presents a variety of comparative statics results on changes in corporate governance and controlling shareholders' equity stakes.

Business Cycle Amplitude

Risk in our economy is determined by the business cycle amplitude as measured by the change in payout rates from one regime to the other, y_1/y_2. For the home country (Korea) $y_1/y_2 = 1.05$ and for the foreign country (the U.S.) $y_1^*/y_2^* = 1.037$. For the U.S., this is similar to the long run business cycle observation that estimates an average growth of real GNP in expansions of 2.1 percent and in recessions of -2.5 percent (see Zarnowitz (1992)).

The difference in business cycle amplitudes for home and foreign country could be due to several factors including the level of corporate governance or the volatility of productivity shocks in each country. As the ratio of y_1/y_2 varies from the Korean level of investor protection of $\eta = 6$ to a large value of $\eta = 100$ (better investor protection), the business cycle amplitude decreases from 1.05 to 1.045 covering close to half the difference to that of the U.S. The intuition for this result can be seen from (12): investment rates become less volatile with better investor protection and so do payout rates.

Investor Protection and Risk and Return in Asset Markets

It is important to note that our model cannot capture the absolute *levels* of volatilities and risk premia. This had to be the case given the restriction to logarithmic preferences adopted in the paper. Nonetheless, our goal is to analyze the *changes* in these variables as investor protection changes. It is our belief that these ratios are less sensitive to changes in risk aversion and that our analysis is robust to adopting a more general utility specification.

We are interested in how conditional volatilities and excess returns in both stock and foreign exchange vary with investor protection. Figure 1 reports the results from our model. We start the level of investor protection at the Korean level and vary it to the value of $\eta = 100$. This is equivalent to go from a 10 percent stealing fraction to a stealing fraction of 0.6 percent. Each variable is normalized to be equal to 1 at $\eta = 100$, which approximates perfect investor protection. The figure shows that the lower business cycle amplitudes that are associated with better investor protection reflect themselves in lower asset return volatilities and smaller excess return premia. The magnitudes of the changes are quite significant. Going from a level of investor protection as observed in the U.S. to the Korean level of investor protection increases the equity premium by 20 percent!

Stock return volatility (as measured by the standard deviation) increases by 10 percent going from high investor protection to the Korean investor protection level. The foreign exchange returns are somewhat less affected. The standard deviation of the exchange rate returns increases by only 8 percent relative to the better investor protection scenario. The unconditional term spread falls considerably as investor protection improves and short term business cycle volatility declines.

Controlling Shareholder's Incentives and Risk and Return in Asset Markets

One way through which minority investors can be better protected is by having the controlling shareholder's incentives more in line with firm value maximization. In fact, in many stock markets around the world the majority of publicly traded companies are family owned businesses (e.g. the magazine *The Economist* (2004) reports that 43 percent of Mexico's stock market is held by the family of Carlos Slim.) A concentrated ownership by the controlling shareholder is desired if the legal system and law enforcement protecting minority investors are not well developed. We do not address ownership endogeneity in this paper and refer interested readers to earlier work (see Shleifer and Wolfenzon (2002) and Lan and Wang (2004)). We conduct comparative statics exercises on various economic variables with respect to the controlling shareholder's share. Figure 2 provides the results. Each variable is normalized to be equal to 1 at $\alpha = 1$. The figure shows that increasing the share ownership of the controlling shareholder reduces volatility in stock and foreign exchange returns and risk premia. Perhaps more importantly, *reducing* the share ownership of the controlling shareholder when investor protection is low can be disastrous. For example, the equity premium increases by 18 percent if the share of equity held by the controlling shareholder in Korea were to go from 40 percent to 30 percent, *ceteris paribus*. Volatility in stock returns would increase by 9 percent.

9 Conclusion

Agency conflicts are at the core of modern corporate finance. The large corporate finance literature on investor protection has convincingly documented that corporations in most countries, especially with weak investor protection, often have controlling shareholders and that these controlling shareholders derive private benefits at the cost of outside minority shareholders. In fact, several recent papers have shown that firm value is lower in countries with weaker investor protection thus providing support for the hypothesis that weak investor protection allows the distortion of investment and payout decisions by controlling shareholders.

Our goal is to go one step further and argue that these corporate policy distortions have implications for asset prices (equities, bonds, and exchange rates). Towards this goal, we have provided a two-country dynamic stochastic general equilibrium asset pricing model that acknowledges the importance of investor protection. The main model predictions are that countries with stronger investor protection have (*i*) higher market to book values, (*ii*) lower volatilities of equity returns, interest rates, and exchange rate changes, (*iii*) lower equity risk premia and foreign exchange risk premia, and (*iv*) higher expected exchange rate appreciation. Our predictions are consistent with evidence. Here we emphasize the finding in Johnson et al. (2000) that exchange rates depreciate more in countries with weaker investor protection during crisis periods.

Appendices

A The controlling shareholder's Optimization Problem

In this appendix, we formalize the N-regime solution to the investment problem of the controlling shareholder. We further provide a convenient approximation used in the text in order to help understand the intuition behind the optimal investment rates. Let the value function for the controlling shareholder be $U(K,n)$ with capital stock K and in regime n. Let $U(K,n)$ be the controlling shareholder's value function. The HJB equation for the controlling shareholder's optimization problem is given by:

$$0 = \sup_{s,I} \left\{ M - \rho U(K,n) + \mathcal{D}^{(s,I)} U(K,n) \right\}, \tag{A.1}$$

where

$$\mathcal{D}^{(s,I)} U(K,n) = (I - \delta K) U_K(K,n) + \sum_{m \neq n} \lambda_{nm} \left(U(K,m) - U(K,n) \right).$$

The first-order condition with respect to cash diversion s gives $s = (1-\alpha)/\eta$ as in the two-regime case. The FOC with respect to I gives

$$\alpha \left(1 + \theta \frac{I}{K} \right) = U_K(K,n). \tag{A.2}$$

We conjecture that the controlling shareholder's value function is given by $U(K,n) = u_n K$, for some constants u_n to be determined. The optimal investment rate is then given by:

$$i_n = \frac{I}{K} = \frac{1}{\theta} \left(\frac{u_n}{\alpha} - 1 \right).$$

Plugging the candidate optimal decision rules s and I into the HJB equation gives

$$0 = \alpha \left[(1+\psi) f_n - \frac{1}{2\theta} \left(\left(\frac{u_n}{\alpha} \right)^2 - 1 \right) \right] - \rho u_n + (i_n - \delta) u_n + \sum_{m \neq n} \lambda_{nm} (u_m - u_n). \tag{A.3}$$

Simplifying the above formula gives the following equation

$$0 = \frac{1}{\theta} \left[(1+\psi) f_n - (\rho + \delta) \right] + \frac{1}{2} i_n^2 - (\rho + \delta) i_n + \sum_{m \neq n} \lambda_{nm} (i_m - i_n), \tag{A.4}$$

for each regime n. The transversality condition:

$$\lim_{T\to\infty} E\left[e^{-\rho T}K_T\right] = \lim_{T\to\infty} E\left[\exp\left(\int_0^T \left[i_{N(t)} - (\rho+\delta)\right] dt\right)\right] K_0 = 0$$

is guaranteed to be satisfied if

$$\rho + \delta - \max\{i_n\} > 0, \tag{A.5}$$

which we assume.

Under (A.5) it is possible to derive a sufficient condition under which $y_1 > y_2$. Manipulating (11) together with (A.4) for the 2-regime case, and using the investment rate upper bound in (A.5), we get that $y_1 > y_2$ if

$$\frac{1-\phi}{1+\psi} > \frac{\frac{1}{\theta}+\rho+\delta}{\lambda_{12}+\lambda_{21}}.$$

In the 2-regime economy studied in detail in the paper differentiating (A.3) with respect to the agency parameter ψ yields

$$\begin{aligned}
\frac{di_1}{d\psi} &= \frac{1}{\theta}\frac{f_1\left[\rho+\delta+\lambda_{21}-i_2\right]+\lambda_{12}f_2}{\left[\rho+\delta+\lambda_{21}-i_2\right]\left[\rho+\delta+\lambda_{12}-i_1\right]-\lambda_{12}\lambda_{21}} \\
\frac{di_2}{d\psi} &= \frac{1}{\theta}\frac{f_2\left[\rho+\delta+\lambda_{12}-i_1\right]+\lambda_{21}f_1}{\left[\rho+\delta+\lambda_{12}-i_1\right]\left[\rho+\delta+\lambda_{21}-i_2\right]-\lambda_{12}\lambda_{21}},
\end{aligned}$$

which are both positive under (A.5). Because ψ varies negatively with both η and α we have that investment rates decline with both investor protection and the controlling shareholder's share.

Let $\mathbf{u} = \begin{pmatrix} u_1 & u_2 & \cdots & u_N \end{pmatrix}^T$ denote the vector of utility-capital ratios and $\mathbf{f} = \begin{pmatrix} f_1 & f_2 & \cdots & f_N \end{pmatrix}^T$ denote the vector of productivity levels in each regime. To obtain our approximate solution we drop the quadratic term $\alpha\theta i_n^2/2$ in (A.4). This allows us to solve (A.4) obtaining:

$$\begin{aligned}
\mathbf{i} &\approx \frac{1}{\theta}\left[(1+\psi)\left[(\rho+\delta)\mathbf{I_N}-\mathbf{\Lambda}\right]^{-1}\mathbf{f}-\mathbf{1_N}\right], && \text{(A.6)}\\
&= \frac{1}{\theta}\left[(\rho+\delta)\mathbf{I_N}-\mathbf{\Lambda}\right]^{-1}\left[(1+\psi)\,\mathbf{f}-(\rho+\delta)\mathbf{1_N}\right]. && \text{(A.7)}
\end{aligned}$$

Plugging $\mathbf{u} = \alpha(1+\theta\mathbf{i})$ into the above gives the investment rate as follows:

$$\mathbf{u} = \alpha\,(1+\psi)\left[(\rho+\delta)\mathbf{I_N}-\mathbf{\Lambda}\right]^{-1}\mathbf{f}. \tag{A.8}$$

For a one-regime economy, then we trivially have

$$\mathbf{i} \approx \frac{1}{\theta}\left[\left(\frac{1+\psi}{\rho+\delta}\right) f - 1\right] = \frac{(1+\psi)\, f - (\rho+\delta)}{\theta(\rho+\delta)}.$$

For a two-regime economy, we have

$$\mathbf{i} \approx \frac{1}{\theta}\left(\frac{1}{\rho+\delta}\right)\begin{pmatrix} 1-w_{12} & w_{12} \\ w_{21} & 1-w_{12} \end{pmatrix}\begin{pmatrix} (1+\psi)f_1 - (\rho+\delta) \\ (1+\psi)f_2 - (\rho+\delta) \end{pmatrix},$$

where w_{12} and w_{21} are given in (13) in the main text.

B Proof of Proposition 2

Proof. We solve the world economy equilibrium allocation problem by appealing to the welfare theorems. Specifically, let ω be the Negishi's weight on the home country minority investor and correspondingly $(1-\omega)$ be the Negishi's weight on the foreign country minority investor. Then, the resource allocation problem may be written as solving:

$$\max_{c_h, c_f, c_h^*, c_f^*} \qquad E\left[\int_0^\infty e^{-\rho t}\left(\omega u(c_h(t), c_f(t)) + (1-\omega) u^*(c_h^*(t), c_f^*(t))\right) dt\right],$$

subject to resource constraints (14) and (15). This amounts to a continuum of static optimization problems. Because of the logarithmic utility preferences the consumption levels of home and foreign investors of each good are proportional. This implies consumption allocations that are proportional to total output with the constants of proportionality given by

$$\xi_h = \frac{\gamma\omega}{\gamma\omega + \gamma^*(1-\omega)} \tag{B.1}$$

$$\xi_f = \frac{(1-\gamma^*)(1-\omega)}{(1-\gamma)\omega + (1-\gamma^*)(1-\omega)}. \tag{B.2}$$

The equilibrium state contingent prices $p\,(t)$ and $p^*\,(t)$ are the Lagrange multipliers associated with the resource constraints and are given by

$$p\,(t) = e^{-\rho t}\frac{\omega\gamma}{c_h\,(t)}$$

$$p^*\,(t) = e^{-\rho t}\frac{(1-\omega)(1-\gamma^*)}{c_f^*\,(t)}.$$

Hence, letting $p(t) = p^*(t) \frac{AY^*(t)}{Y(t)}$ we get

$$A = \frac{1}{1-\alpha} \frac{\gamma_h \omega + \gamma_f (1-\omega)}{(1-\gamma_h)\omega + (1-\gamma_f)(1-\omega)}.$$

Given the equilibrium prices and the consumption allocations the Negishi weights can be picked uniquely so that the budget constraints of each investor hold. This is done by picking $\omega = w_0 / (w_0 + w_0^*)$, i.e. ω is the relative wealth of the home investor at time 0.
■

C Derivations for Asset Prices

This appendix contains the detailed derivations for interest rates, stock returns, and exchange rates.

C.1 The Term Structure of Interest Rates

The stochastic discount factor in this model (in the units of the home good) is given by $\xi(t) = e^{-\rho t}\gamma\omega / Y(t)$ with $\omega > 0$ constant. Thus, the instantaneous drift is given by

$$d\xi(t) = -\rho\xi(t)dt - (i(t) - \delta)\xi(t)dt + \xi(t)y(t)\Delta\left(\frac{1}{y(t)}\right).$$

Since the drift of the stochastic discount factor ξ is equal to $-r(t)\xi(t)$, thus we have

$$r(t) = \rho + i(t) - \delta - y(t) \sum_{m \neq N_t} \lambda_{N_t,m} \left(\frac{1}{y_m} - \frac{1}{y_{N_t}}\right).$$

In a 2-regime economy, and if the current regime is a recession ($N_t = 2$), then the pricing kernel dynamics may be written as

$$\frac{d\xi(t)}{\xi(t)} = -r(t)dt - \Gamma_{21}\left(dZ_2(t) - \lambda_{21}dt\right),$$

where Γ_{21} is as in (23) and $Z_2(t)$ is a pure jump process from recession regime to expansion regime with intensity λ_{21}.

Now we determine the price of a bond maturing at T. The equilibrium pricing relationship for a bond whose time to maturity is $\tau = T - t$ is given by

$$\begin{pmatrix} \dot{B}_1(\tau) \\ \dot{B}_2(\tau) \end{pmatrix} + \begin{pmatrix} r_1 + \lambda_{12}^Q & -\lambda_{12}^Q \\ -\lambda_{21}^Q & r_2 + \lambda_{21}^Q \end{pmatrix} \begin{pmatrix} B_1(t) \\ B_2(t) \end{pmatrix} = 0.$$

with the boundary condition $B_1(0) = B_2(0) = 1$. This is easy to solve by appealing to the a diagonalization of the 2×2 matrix and the boundary condition. We may uncover the yield with maturity $\tau = T - t$ by simply solving

$$\iota(\tau) = -\frac{1}{\tau} \ln B(\tau).$$

The bond price and implied yield on the perpetuity bond, a bond that pays \$1 coupon continuously, can now be easily determined by solving the following equation:

$$\begin{pmatrix} 1 \\ 1 \end{pmatrix} = \begin{pmatrix} r_1 + \lambda_{12}^Q & -\lambda_{12}^Q \\ -\lambda_{21}^Q & r_2 + \lambda_{21}^Q \end{pmatrix} \begin{pmatrix} B_1(\infty) \\ B_2(\infty) \end{pmatrix}.$$

The explicitly solved bond prices are given in the text.

For a multi-regime economy, the dynamics of the interest rate may be written as

$$dr(t) = \sum_{m \neq N_t} \lambda(N_t, m) \left(r_m - r_{N_t} \right) dt + \sum_{m \neq N_t} \left(r_m - r_{N_t} \right) \left[dZ_m(t) - \lambda(N_t, m) dt \right]. \tag{C.1}$$

Note that $dZ_m(t) = 1$, if and only if the regime switches from regime N_t to regime m. Thus, the drift of the interest rate in regime n is thus given by

$$\mu_{r,n} = \sum_{m \neq n} \lambda_{nm} \left(r_m - r_n \right). \tag{C.2}$$

The conditional variance of the interest rate is

$$\begin{aligned} \sigma_{r,n}^2 &= \lim_{\Delta t \to 0} \frac{1}{\Delta t} E_t \left[\left(r(t + \Delta t) - r(t) - \mu_{r,N_t} \Delta t \right)^2 \middle| N_t = n \right] && \text{(C.3)} \\ &= \sum_{m \neq n} \lambda_{nm} \left(r_m - r_n \right)^2. && \text{(C.4)} \end{aligned}$$

C.2 Stock Returns

Recall that

$$dS(t) = S(t) \left(\frac{\Delta y(t)}{y(t)} + (i(t) - \delta)\, dt \right).$$

The expected stock return in regime n is thus given by

$$\mu_{S,n} = i_n - \delta + \sum_{m \neq n} \lambda_{nm} \frac{y_m - y_n}{y_n} + \rho. \tag{C.5}$$

Using the law of iterated expectation, the instantaneous mean of the stock return (without knowing the underlying regime) may be computed as follows:

$$\mu_S = \bar{i} - \delta + \rho + \sum_n \pi_n \sum_{m \neq n} \lambda_{nm} \frac{y_m - y_n}{y_n}.$$

For time-reversible Markov chains, using the local balance equation (29), we have the result that

$$\begin{aligned}\mu_S &= \rho + \bar{i} - \delta + \sum_n \pi_n \sum_{m>n} \lambda_{nm} \frac{(y_m - y_n)^2}{y_m y_n} \\ &= \rho + \bar{i} - \delta + \frac{1}{2} \sum_n \pi_n \sum_{m \neq n} \lambda_{nm} \frac{(y_m - y_n)^2}{y_m y_n}.\end{aligned}$$

The conditional variance of stock returns in regime n is thus given by

$$\sigma^2_{S,n} = \lim_{\Delta t \to 0} \frac{1}{\Delta t} E_t \left[\left(\frac{S(t+\Delta t) - S(t) + Y(t)\Delta t}{S(t)} - \mu_{S,N_t} \Delta t \right)^2 \middle| N_t = n \right] \quad \text{(C.6)}$$

$$= \sum_{m \neq n} \lambda_{nm} \left(\frac{y_m - y_n}{y_n} \right)^2. \quad \text{(C.7)}$$

By the law of iterated expectation, we may write the unconditional instantaneous variance of stock returns as follows:

$$\begin{aligned}\sigma^2_S &= \lim_{\Delta t \to 0} \frac{1}{\Delta t} E_t \left[E_t \left[\left(\frac{S(t+\Delta t) - S(t) + Y(t)\Delta t}{S(t)} - \mu_{S,N_t} \Delta t \right)^2 \middle| N_t = n \right] \right] \\ &= E_t \left[\sum_{m \neq n} \lambda_{nm} \left(\frac{y_m - y_n}{y_n} \right) \right]^2 = \sum_n \pi_n \sum_{m \neq n} \lambda_{nm} \left(\frac{y_m - y_n}{y_n} \right)^2.\end{aligned}$$

C.3 Terms of Trade and Exchange Rates

Now, let us revisit the implications of the drift of $\log q$ in state N_t in a general finite-state Markov chain. Suppose that the Markov chain is time reversible and satisfies the local balance condition (29). Let the home country regimes are denoted by the subscript n and the foreign country regimes be denoted by the subscript n^*. The conditional mean of the terms of trade drift is

$$\mu_{q,nn^*} = \sum_{m \neq n^*} \lambda^*_{n^*m} \log \frac{y^*_m}{y^*_{n^*}} - \sum_{m \neq n} \lambda_{nm} \log \frac{y_m}{y_n} + i^*_{n^*} - i_n.$$

The unconditional mean of the terms of trade drift is then:

$$\mu_q = \sum_{n^*} \pi^*_{n^*} \sum_{m \neq n^*} \lambda^*_{n^*m} \log \frac{y_m}{y_{n^*}} - \sum_n \pi_n \sum_{m \neq n} \lambda_{nm} \log \frac{y_m}{y_n} + \bar{i}^* - \bar{i} \quad \text{(C.8)}$$

$$= \bar{i}^* - \bar{i}, \quad \text{(C.9)}$$

where the first two terms cancel out due to time reversible Markov chains. To see this last step expand the summation:

$$\sum_n \pi_n \sum_{m\neq n} \lambda_{nm} \log \frac{y_m}{y_n} = \pi_1 \sum_{m\neq 1} \lambda_{1m} \log \frac{y_m}{y_1} + \pi_2 \sum_{m\neq 2} \lambda_{2m} \log \frac{y_m}{y_2} + ...$$

and note that for every term in the first summation on the right hand side there is a corresponding term in the remaining summations with opposite sign. For example:

$$\pi_1\lambda_{12} \log \frac{y_2}{y_1} \text{ and } \pi_2\lambda_{21} \log \frac{y_1}{y_2}.$$

Next, we turn to the conditional variance of changes in the exchange rate. Let $\sigma^2_{\mathcal{E},n}$ be the instantaneous conditional variance of exchange rate if the current regime is n. For a given infinitesimal time interval increment Δt, the instantaneous conditional variance is thus given by (ignoring the terms relative to the foreign country):

$$\begin{aligned}
\sigma^2_{\mathcal{E},n} &= \lim_{\Delta t\to 0} \frac{1}{\Delta t} E_t \left[\left[\log\left(\frac{y(t+\Delta t)}{y(t)}\right) - \mu_{\mathcal{E},N_t}\Delta t \right]^2 \middle| N_t = n \right] \\
&= \lim_{\Delta t\to 0} \sum_{m\neq n} \lambda_{nm} \left[\log\left(\frac{y_m}{y_n}\right) - \mu_{\mathcal{E},n}\Delta t \right]^2 + \left(1 - \sum_{n\neq m} \lambda_{nm}\Delta t\right) \left(\mu_{\mathcal{E},n}\right)^2 \Delta t \\
&= \sum_{m\neq n} \lambda_{nm} \left[\log\left(\frac{y_m}{y_n}\right) \right]^2.
\end{aligned}$$

By the law of iterated expectation, we may write the instantaneous variance of the exchange rate return as follows (again ignoring the terms relative to the foreign country):

$$\begin{aligned}
\sigma^2_{\mathcal{E}} &= \lim_{\Delta t\to 0} \frac{1}{\Delta t} E_t \left[E_t \left[\left[\log\left(\frac{y(t+\Delta t)}{y(t)}\right) - \mu_{\mathcal{E}}\Delta t \right]^2 \middle| N_t = n \right] \right] \\
&= \sum_n \pi_n \sum_{m\neq n} \lambda_{nm} \left[\log\left(\frac{y_m}{y_n}\right) \right]^2.
\end{aligned}$$

Thus, the instantaneous variance of exchange rate returns is simply equal to the expectation of conditional instantaneous variance in each regime. By variance decomposition, we thus know that the variance of $\mu_{\mathcal{E},n}$, the instantaneous conditional expectation of the exchange rate return in regime n, is negligible in contributing to the overall volatility of the exchange rate return.

D Calibration Details

Using the estimates from (32) and (31) we construct a two-state Markov process by matching the following moments:

$$\begin{aligned} \sum_{i=1,2} \pi_i \ln A_i &= 0 \\ \sum_{i=1,2} \pi_i (\ln A_i)^2 &= \frac{\sigma_\varepsilon^2}{1-\rho_A^2} \\ \rho_{\ln A_t, \ln A_{t-1}} &= \rho_A \\ \pi_1 &= \bar{\pi}, \end{aligned}$$

where $\bar{\pi} = 0.263$ for both the U.S. and Korea (using Hamilton's (1989) estimate for the U.S.). This is a system of 4 equations in 4 unknowns that can be uniquely solved to obtain:

$$\begin{aligned} p_{12} &= (1-\rho_A)(1-\bar{\pi}) \\ p_{21} &= (1-\rho_A)\bar{\pi} \end{aligned}$$

$$\begin{aligned} \ln A_2 &= \frac{\sigma_\varepsilon}{\sqrt{1-\rho_A^2}}\sqrt{\frac{\bar{\pi}}{1-\bar{\pi}}} \\ \ln A_1 &= -\frac{\sigma_\varepsilon}{\sqrt{1-\rho_A^2}}\sqrt{\frac{1-\bar{\pi}}{\bar{\pi}}}. \end{aligned}$$

This system of equations always has one solution if and only if $\bar{\pi} \in [-\rho_A/(1-\rho_A), 1/(1-\rho_A)]$. This condition never binds for $\rho_A > 0$.

In this calibration the mean of $\log A$ is zero, but this is not appealing in the model as it does not generate a realistic value for the capital to output ratio. Therefore, let $A_i = f_i/F$ and $\bar{f} = \pi_1 f_1 + \pi_2 f_2$. Then, $\overline{f} = (\pi_1 A_1 + \pi_2 A_2) F$. In possession of (A_i, π_i) obtained from the procedure above and of the calibrated value for $\overline{f}$, we get the model numbers:

$$f_n = A_n \frac{\overline{f}}{\pi_1 A_1 + \pi_2 A_2}.$$

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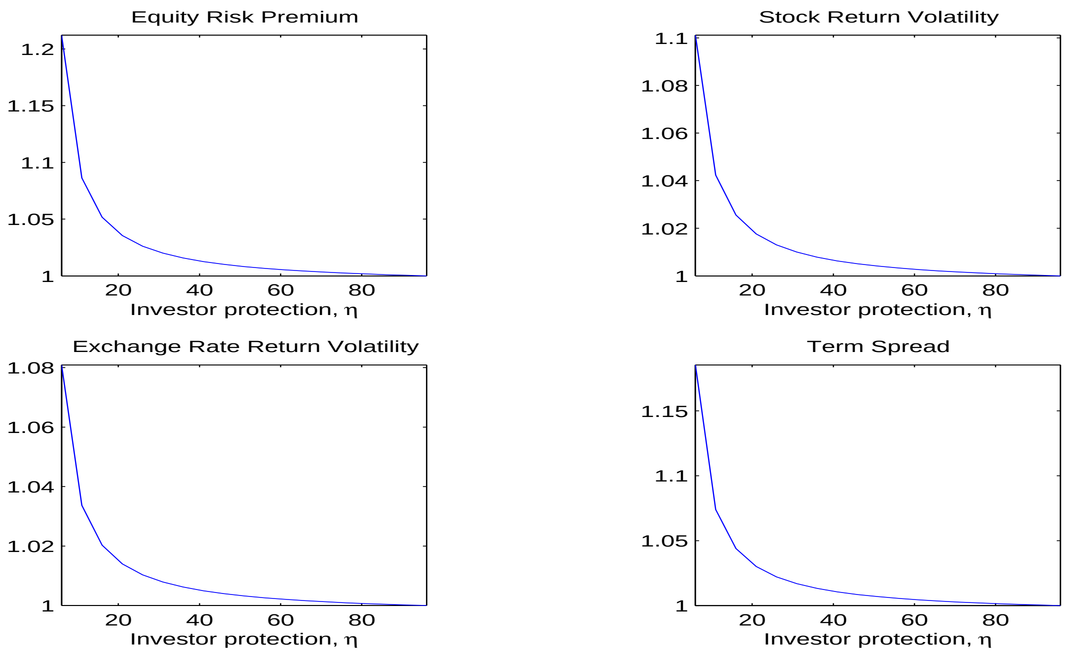

Figure 1: Comparative statics with respect to investor protection η. All variables are normalized so that at $\eta = 100$ they take the value of 1.

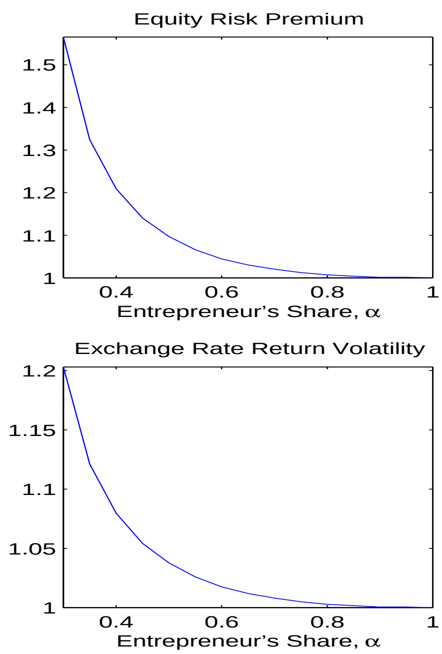

Figure 2: Comparative statics with respect to entrepreneur's equity share α. All variables are normalized so that at $\alpha = 1$ they take the value of 1.