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CREDIT CRUNCH, CREDITOR PROTECTION, AND ASSET PRICES

Galina Hale, Assaf Razin and Hui Tong

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Credit Crunch, Creditor Protection, and Asset Prices

Galina Hale*
Federal Reserve Bank of San Francisco

and

Assaf Razin†
Tel-Aviv University
Cornell University
Centre for Economic Policy Research
National Bureau of Economic Research
CESifo
Hong Kong Institute for Monetary Research

and

Hui Tong‡§
International Monetary Fund

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Abstract

In a Tobin's q model with productivity and liquidity shocks, we study the mechanism through which strong creditor protection increases the level and lowers the volatility of stock market prices. There are two channels at work: (1) the Tobin's q value under a credit crunch regime increases with creditor protection; and, (2) the probability of a credit crunch falls for given stochastic processes of underlying shocks when creditor protection improves.

We test these predictions by using cross-country panel regressions of the stock market price level and volatility, in 40 countries, over the period from 1984 to 2004, at annual frequency. We create indicators for liquidity shocks based on quantity and price measures. Estimated probabilities of big shocks to liquidity are used as forecasts of credit crunch. We find broad empirical support for the hypothesis that creditor protection increases the stock market price level and reduces its volatility directly and via its negative effect on the probability of credit crunch. Our empirical findings are robust to multiple specifications.

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* Federal Reserve Bank of San Francisco; galina.b.hale@sf.frb.org.

† Tel-Aviv University and Cornell University, CEPR, NBER, and CESifo; razin@post.tau.ac.il.

‡ International Monetary Fund; htong@imf.org.

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1. Introduction

Recent literature on law and finance has emphasized the role of strong institutions, such as creditor protection, in fostering the development of financial markets. Creditor rights regulation helps mitigate the problems of information asymmetry and moral hazard between creditors and borrowers.

A central problem in the credit market is that lenders are reluctant to make loans because they cannot easily determine whether a prospective borrower has resources to repay the loan. If the loan is made, the lender is concerned whether the borrower will engage in risky behavior that could lower the probability that the loan will be repaid. Collateral reduces this information asymmetry problem because good collateral (that is, assets that are easily valued and easy to take control of) significantly decreases the losses to the lender if the borrower defaults on the loan. Good collateral also reduces the moral hazard problem because the borrower is reluctant to engage in excessively risky behavior since now he or she has something to lose. Creditor protection enhances the ability of the lender to take control of the collateral in case of default and thereby alleviate credit constraints. Thus, creditor rights regulation helps mitigate the problems of information asymmetry and moral hazard between creditors and borrowers.

Accordingly, creditor rights' protection is shown to affect the credit cycle and credit market breadth. For example, La Porta et al. (1997) find that countries with poor creditor protection have smaller debt markets. Their findings are confirmed by Levine (2004) as well as Djankov, McLiesh and Shleifer (2006), with broader country coverage. Burger and Warnock (2006) further find that countries with strong creditor rights have more developed local bond markets and rely less on foreign-currency bonds. Moreover, Galindo and Micco (2005) report that strong creditor rights can reduce the volatility of the credit market. Besides the impact on the macroeconomy, creditor protection also affects firms' investment and operation. Specifically, it lowers each firm's borrowing costs and increases firm's value (e.g., La Porta et al., 2000; Bae and Goyal, 2003) and reduces cash-flow risk, operating income variability, and operating leverage (e.g., Claessens, Djankov and Nenova, 2001).

These studies have focused mainly on the credit market, but little attention has been given to the effect of creditor protection on the stock market. In this paper, we attempt to fill this gap by looking at how creditor rights affect the stock return and its volatility for market aggregates.[1] We are motivated by an observation that in a cross-country panel better creditor protection is associated with higher stock price and lower stock return volatility (See Appendix 1); and we attempt to investigate the mechanism behind it.

In principle, creditor protection affects stock price in two ways. On the one hand, the probability of falling into a credit crunch situation can be reduced with better creditor protection. Consequently the firm value (the first moment) will rise. On the other hand, in a situation in which the credit constraint

[1] Some studies have examined how corporate control affects the dispersion of stock prices within a market. For example, Morck, Yeung, and Yu (2000) look at the stock price co-movement within a country. They find that comovement is more pronounced in poor economies than in rich economies, which they attribute to cross-country differences in property rights. Our work is not concerned with the idiosyncratic dispersion of stock prices, but rather with the instability in the aggregate.

binds, better creditor protection will increase the stock price level because the credit becomes more available. Restricted investment would reduce the potential for an upside productivity shock by constraining the firm growth. Creditor protection relaxes this constraint and thus allows good shocks to boost investment, thereby raising the firm's market values.

We illustrate this mechanism with a standard Tobin's q investment model. We start with the free market benchmark case under a stochastic productivity process but with no liquidity shocks. We log linearize the first order conditions and derive a closed-form solution for the Tobin's q (the theoretical counterpart of stock market price). We then introduce a liquidity shock and a credit constraint, which depends on the degree of creditor protection. We solve the log linear approximation given the stochastic distributions of the productivity and liquidity shocks. We demonstrate that an improvement in the creditor protection increases the stock market price directly and through a reduction in the probability of a future credit crunch. We also show that through the same mechanism creditor protection reduces the volatility of the stock price.

In the empirical part we look at the aggregated stock price in 40 countries over the years 1984-2004. We use a two-stage analysis to further examine the relationship between stock market price and creditor protection. In the first stage, we look at how creditor protection affects the probability of a liquidity crisis, which we define alternatively as a large decline in bank credit to the private sector or as a large rise in the real interest rate. We find that better creditor protection reduces the probability of a liquidity crisis. We use probit regression results to construct predicted crisis probability measures to be used in the second stage.

In the second stage, we examine whether the predicted crisis probability has an expected effect on the stock market price. In regressions with country fixed effects we find that a higher crisis probability is indeed connected with a lower stock price and higher stock return volatility. Moreover, in several cases the effect of the predicted crisis probability is larger when the indicator of high creditor protection is included in the first stage probit regressions, compared to the case when it is omitted, illustrating the indirect effect of the creditor protection. Next, in regressions with only regional fixed effects we include the indicator of creditor protection along with the predicted crisis probability and find support for our prediction that creditor protection has both direct and indirect effects on stock price level and volatility.[2]

2 In the regressions of the stock market price level, the direct effect is limited to the subsample of developing countries.

2. Theory

This section develops a Tobin's q investment model, which yields relationships between a creditor protection parameter, aggregate liquidity shocks, and the stock market expected price and volatility.

2.1 The Credit-Unconstrained Regime

We first consider a small open economy producing a single aggregate tradable good. The production function is Cobb-Douglas:[3]

$$Y_t = A_t K_t^{1-\rho} \tag{1}$$

where A_t, 1 – ρ, and K_t denote an idiosyncratic productivity parameter, the distributive share of capital, and the capital stock, respectively. We assume that productivity levels follow a first-order auto-regressive stochastic process:

$$\ln(A_{t+1}) = \gamma \ln(A_t) + \varepsilon_{t+1} \tag{2}$$

where ε_{t+1} follows a uniform distribution over the region [–1, 1]. We denote by lowercase letters the log of variables in uppercase letters. Accordingly, equation (2) is rewritten as

$$a_{t+1} = \gamma a_t + \varepsilon_{t+1} \tag{3}$$

A cost-of-adjustment investment technology for gross investment (Z_t) is specified by

$$Z_t = I_t \left(1 + \frac{1}{2}\frac{1}{v}\frac{I_t}{K_t}\right) \tag{4}$$

where $I_t = K_{t+1} - K_t$, denotes net capital formation (assuming zero depreciation) and $\frac{1}{v}$ is a cost-of-adjustment coefficient. As usual, gross investment exceeds net capital formation because of the additional reorganization and retraining costs that are typically associated with the installation of new capital equipment.

Producers maximize the expected value of the discounted sum of profits, subject to the available production technology and cost-of-adjustment investment technology. The Lagrangian is

$$L = E\left[\Sigma_{t=0}^{\infty} \frac{1}{(1+r)^t}\left(A_t K_t^{1-\rho} - Z_t + q_t\left(K_t + I_t - K_{t+1}\right)\right)\right] \tag{5}$$

We denote by r the world interest rate. The Lagrange multiplier q_t is interpreted as the Tobin's q market value of a unit of new capital.

3 The model is based on Krugman (1998) and Frenkel and Razin (1996, Chapter 7).

A first-order condition (derived with respect to I_t) is

$$1 + \frac{1}{v}\frac{I_t}{K_t} = q_t \tag{6}$$

Linearizing $\ln\left(v\left(q_t - 1\right) + 1\right)$ yields

$$k_{t+1} = k_t + v\left(q_t - 1\right) \tag{7}$$

Another first-order condition (derived with respect to K_{t+1}) is

$$q_t = \frac{1}{1+r}\left(E_t\left[R_{t+1}\right] + \frac{1}{2}\frac{1}{v}\left(\frac{I_{t+1}}{K_{t+1}}\right)^2 + E_t\left[q_{t+1}\right]\right) \tag{8}$$

where R_{t+1} denotes the $t+1$ capital rental rate. The maximizing value rule in equation (8) implies that the cost of investing an additional unit of capital in the current period must be equal to the expected present value of the next period's marginal productivity of capital, plus the next period's induced fall in the adjustment cost of investment (resulting from the enlarged stock of capital due to current investment), plus the continuation value in the capital remaining for the entire future.

Note that from equation (1) and perfect competition in the capital market we have

$$R_{t+1} = \left(1 - \rho\right) A_{t+1} K_{t+1}^{-\rho} \tag{9}$$

Linearizing ln (R_{t+1}), and using the expression $\pi \equiv 1 + \ln\left(1 - \rho\right)$, yields

$$R_{t+1} = \pi - \rho k_{t+1} + a_{t+1} \tag{10}$$

According to equation (6),

$$\frac{1}{v}\left(\frac{I_{t+1}}{K_{t+1}}\right)^2 = v\left(q_{t+1} - 1\right)^2 \tag{11}$$

Hence, equation (8) becomes

$$q_t = \frac{1}{1+r}E_t\left(\left(1 + R_{t+1}\right) + \frac{1}{2}v\left(q_{t+1} - 1\right)^2 + \left(q_{t+1} - 1\right)\right) \tag{12}$$

At the deterministic steady state, I_t = 0 and q_t = 1. Therefore, the term $\left(q_{t+1} - 1\right)^2$ around the steady state is an order of magnitude smaller than the term $\left(q_{t+1} - 1\right)$. Accordingly we drop the $\left(q_{t+1} - 1\right)^2$ term from equation (12) to obtain

$$(1 + r)q_t = E_t\left[R_{t+1}\right] + E_t\left[q_{t+1}\right] \tag{13}$$

Combining equations (7), (10), and (13), we get

$$q_t = \frac{(\pi + \rho v - \rho k_t + \gamma a_t \ + E_t q_{t+1})}{1 + r + \rho v} \tag{14}$$

We then solve for the equilibrium q_t by "guessing" a linear equilibrium relationship as follows:

$$q_t = B_0 + B_1 a_t + B_2 k_t \tag{15}$$

From equations (7) and (15), we get

$$E_t q_{t+1} = B_0 + B_1 (\gamma a_t) + B_2 (k_t + v (q_t - 1)) \tag{16}$$

Substituting equations (15) and (16) into equation (14), we solve for B_0, B_1, and B_2 by comparing coefficients for a_t and k_t:

$$\begin{aligned} B_0 &= \tfrac{-\pi - \rho v + v B_2}{-r - \rho v + v B_2} \\ B_1 &= \tfrac{\gamma}{1 + r + \rho v - v B_2 - \gamma} \\ B_2 &= \tfrac{r + \rho v - \sqrt{(r + \rho v)^2 + 4 \rho v}}{2v} \end{aligned} \tag{17}$$

Note that the equilibrium value, q_t, is negatively related to the capital stock, k_t.

Based on equations (6) and (17), the equilibrium investment level is

$$I_{t0} = v K_t (B_0 + B_1 a_t + B_2 k_t - 1) \tag{18}$$

As expected, investment rises with a positive productivity shock (B_1 is positive). Also the stock price declines when the stock of capital increases (B_2 is negative)

2.2 Liquidity Shocks, Credit-Constrained Regime, and Expected Stock Market Price

We now analyze a Tobin-q model in the presence of credit constraints and liquidity shocks.[4]

Assume that the credit constraint is

$$I_t \ \leq \omega K_t - W_t \tag{19}$$

where ω is a creditor protection parameter (better credit protection is associated with a larger ω).[5] The variable W_t stands for debt repayment, triggered by an exogenous aggregate liquidity shock. A firm

[4] See the related literature of Bernanke and Gertler (1989), Hart and Moore (1994), Kiyotaki and Moore (1997), and Mendoza (2006a,b).

[5] In the literature on credit constraint and financial accelerator, the constraint tends to be based on a firm's market value $\omega q_t K_t$. However, if both q_t and K_t are endogenous as in Mendoza (2006b), then no tractable solution is available for q_t. By using ωK_t rather than $\omega q_t K_t$ we are able to provide tractable closed-form solutions for q_t and its volatility.

may be required to pay back more of its existing debt when such a shock occurs. Because an aggregate liquidity shock increases W_t, it results in smaller investment, I_t.

Let us start with the constrained regime, where the investment constraint always binds, i.e.,

$$I_t \;= \omega K_t - W_t \tag{20}$$

To simplify the analysis we assume that the aggregate liquidity shock, W_t, is permanent. That is, if the shock occurs in period t, then the credit constraint will be binding forever.

The Lagrangian with the constrained regime is

$$L' = E\left[\Sigma_{t=0}^{\infty}\frac{1}{(1+r)^t}\left(A_t K_t^{1-\rho} - Z_t + q_t\left(K_t + I_t - K_{t+1}\right) + \lambda_t\left(I_t \;- \omega K_t + W_t\right)\right)\right] \tag{21}$$

The Lagrangian coefficient λ_t is associated with the credit constraint.

The first-order condition (derived with respect to I_t) is

$$1 + \frac{1}{\upsilon}\frac{I_t}{K_t} = q_t + \lambda_t \tag{22}$$

Linearizing $\ln\left(\upsilon\left(q_t + \lambda_t - 1\right) + 1\right)$ gives

$$\lambda_t = 1 - q_t + \frac{k_{t+1} - k_t}{\upsilon} \tag{23}$$

Another first-order condition (derived with respect to K_{t+1}) is

$$q_t = \frac{1}{1+r}\left(E_t\left[R_{t+1}\right] + \frac{1}{2}\frac{1}{\upsilon}\left(\frac{I_{t+1}}{K_{t+1}}\right)^2 + E_t\left[q_{t+1}\right] - \omega E_t\left[\lambda_{t+1}\right]\right) \tag{24}$$

where R_{t+1} is the capital rental rate. Equation (24) can then be simplified as

$$(1+r)q_t = E_t\left[\pi - \rho k_{t+1} + a_{t+1}\right] + E_t\left[q_{t+1}\right] - \omega E_t\left[\lambda_{t+1}\right] \tag{25}$$

Substituting $E_t\left[\lambda_{t+1}\right]$ in equation (25) with equation (23) , we get

$$(1+r)q_t = E_t\left[\pi - \rho k_{t+1} + a_{t+1}\right] + E_t\left[q_{t+1}\right] - \omega E_t\left[\frac{k_{t+2} - k_{t+1}}{\upsilon} + 1 - q_{t+1}\right] \tag{26}$$

In the constrained regime,

$$K_{t+2} = (1+\omega)\,K_{t+1} + W_t \tag{27}$$

Without the loss of generality, we assume $W_t = 0$ at the moment, then

$$k_{t+2} = \ln(1+\omega) + k_{t+1}$$

where k_{t+1} is the log of K_{t+1}. Equation (26) can then be rewritten as

$$(1+r)q_t = \pi - \rho k_{t+1} + E_t[a_{t+1}] + E_t[q_{t+1}] - \omega E_t\left[\frac{\ln(1+\omega)}{v} + 1 - q_{t+1}\right] \tag{28}$$

To solve for Tobin's q_t', we assume that

$$q_t' = B_0' + B_1' a_t + B_2' k_t \tag{29}$$

By plugging equation (29) into equation (28), we have

$$\begin{aligned} & (1+r)\left(B_0' + B_1' a_t + B_2' k_t\right) \\ = \; & \pi - \rho(\ln(1+\omega) + k_t) + \gamma a_t + B_0' + B_1'\gamma a_t + B_2'(\ln(1+\omega) + k_t) \\ & -\omega\left(\frac{\ln(1+\omega)}{v} + 1 - \left(B_0' + B_1'\gamma a_t + B_2'(\ln(1+\omega) + k_t)\right)\right) \end{aligned} \tag{30}$$

By comparing coefficients, we get

$$B_0' = \frac{\left(\omega^2 - r\omega - v\rho - rv\rho\right)\ln(1+\omega) + v(r-\omega)(\pi-\omega)}{v(r-\omega)^2}$$
$$B_1' = \frac{\gamma}{1+r-\gamma-\gamma\omega}$$
$$B_2' = \frac{\rho}{\omega - r}$$

The credit-unconstrained q must be larger than the credit-constrained q', because $1 + \frac{1}{v}\frac{I_t}{K_t} = q_t$, and $I'_{t,constrained} = \omega K_t - W_t < I_{t,unconstrained} = vK_t(B_0 + B_1 a_t + B_2 k_t - 1)$. Hence $q_{t,unconstrained} = B_0 + B_1 a_t + B_2 k_t > q'_{t,constrained} = B_0' + B_1' a_t + B_2' k_t$.

We are in a position now to derive the expression for the expected return in the stock market, as a function of the probability of credit crunch. Let U_t be a dummy indicator for the binding regime. That is, $U_t = 1$ when the constraint binds, and $U_t = 0$ when the credit constraint does not bind. The expected price is:

$$\begin{aligned} E[q_t; a_t, k_t, \omega] &= \Pr(U_t = 0)(B_0 + B_1 a_t + B_2 k_t) + \\ & \quad (1 - \Pr(U_t = 0))(B_0' + B_1' a_t + B_2' k_t) \\ &= \Pr(U_t = 0)\left[(B_0 + B_1 a_t + B_2 k_t) - (B_0' + B_1' a_t + B_2' k_t)\right] \\ & \quad + (B_0' + B_1' a_t + B_2' k_t) \end{aligned}$$

$$\begin{aligned}\frac{\partial E\left[q_t; a_t, k_t, \omega\right]}{\partial \omega} &= \frac{\partial \Pr\left(U_t=0\right)}{\partial \omega}\left[q_{t,unconstrained} - q'_{t,constrained}\right] \\ &+ \frac{\partial (q'_{t,constrained})}{\partial \omega}\left(1-\Pr\left(U_t=0\right)\right)\end{aligned} \tag{31}$$

Note that $\partial B'_1/\partial\omega > 0$ and $\partial B'_2/\partial\omega < 0$. If we assume $\partial B'_1/\partial\omega$ dominates $\partial B'_2/\partial\omega$, then $\partial(q'_{constrained})/\partial\omega > 0$. The probability of a credit crunch is given by

$$\Pr\left(U_t=1\right) = 1-\Pr\left(U_t=0\right) = \Pr\left(I_{t0} > \omega K_t - W_t\right)$$

Note that $\partial \Pr\left(U_t=1\right)/\partial\omega < 0$, because the expression $\Pr\left(I_{t0} > \omega K_t - W_t\right)$ depends negatively on ω.

We thus demonstrate that $E\left[q_t;\omega, a_t, k_t\right]$ rises in ω. This is summarized as follows.

Proposition 1: Upon strengthening the creditor protection, the expected return in the stock market rises, for two reasons: (1) the credit-crunch value of the Tobin's q rises; and (2) the probability of a credit crunch falls.

The Proposition is proved by noting that the expression for $\partial E\left[q_t; a_t, k_t, \omega\right]/\partial\omega$ above is positive because $\frac{\partial \Pr(U_t=0)}{\partial\omega} > 0$, $\left[q_{unconstrained} - q'_{constrained}\right] > 0$, and $\frac{\partial(B'_0 + B'_1 a_t + B'_2 k_t)}{\partial\omega} > 0$.

2.3 Tobin's q Variance and the Probability of a Credit Crunch

In the preceding section we derive the expressions for the level of Tobin's q under the binding credit-constraint regime (equation (29)) and the non-binding regime (equation (15)) respectively. We now turn to the analysis of the variance of Tobin-q in the presence of two states: credit-unconstrained state and credit-crunch state. Recall that there are two random variables: an aggregate productivity shock ε_t and an aggregate liquidity shock W_t. That is, we allow for aggregate uncertainty unrelated to liquidity shocks in addition to the liquidity shocks, and will flash out the distinction between productivity and liquidity aggregate shocks. Assume ε_t and W_t are independent. Then, by variance decomposition, we can write the overall variance of Tobin's q as

$$Var\left[q_t\right] = E\left[Var\left[q_t|U_t\right]\right] + Var\left[E\left[q_t|U_t\right]\right] \tag{32}$$

where the dummy U_t = 1 when the constraint binds.

Note that

$$E\left[Var\left[q_t|U_t\right]\right] = \Pr\left(U_t=0\right) Var\left[q_{t,unconstrained}|U_t=0\right] + \Pr\left(U_t=1\right) Var\left[q_{t,constrained}|U_t=1\right]$$

Combining equations (15) and (29), we have

$$E\left[Var\left[q_t|U_t\right]\right] = \left(\Pr\left(U_t=0\right) B_1^2 + \Pr\left(U_t=1\right) B_1'^2\right) Var\left[\varepsilon_t\right]$$

Moreover,

$$Var\left[E\left[q_t|U_t\right]\right] = \Pr\left(U_t = 1\right)\left(1 - \Pr\left(U_t = 1\right)\right)\left(\bar{q}_{t,unconstrained} - \bar{q}_{t,constrained}\right)^2,$$

where $\bar{q}_{t,constrained}$ stands for $E\left[q_t|U_t = 1\right]$ and $\bar{q}_{t,constrained}$ for $E\left[q_t|U_t = 0\right]$.

The effect of ω on $Var\left[q_t\right]$ is complex, as ω appears as an argument in the various expressions including $\Pr\left(U_t = 1\right)$, B_1' and $\bar{q}_{t,constrained}$. Take the extreme case where the technology is constant, i.e., $Var\left[\varepsilon_t\right] = 0$, we have

$$\begin{aligned} Var\left[q_t\right] &= Var\left[E\left[q_t|U_t\right]\right] \\ &= \Pr\left(U_t = 1\right)\left(1 - \Pr\left(U_t = 1\right)\right)\left(\bar{q}_{t,unconstrained} - \bar{q}_{t,constrained}\right)^2 \end{aligned} \tag{33}$$

and

$$\begin{aligned} \frac{\partial Var\left[q_t\right]}{\partial \omega} &= \left(1 - 2\Pr\left(U_t = 1\right)\right)\left(\bar{q}_{t,unconstrained} - \bar{q}_{t,constrained}\right)^2 \frac{\partial \Pr\left(U_t = 1\right)}{\partial \omega} + \\ &\quad \Pr\left(U_t = 1\right)\left(1 - \Pr\left(U_t = 1\right)\right) \frac{\partial\left(\bar{q}_{t,unconstrained} - \bar{q}_{t,constrained}\right)^2}{\partial \omega} \end{aligned} \tag{34}$$

Now let us examine how each component of equation (34) is affected by the creditor protection parameter ω.

From the preceding section, $\partial \Pr\left(U_t = 1\right)/\partial \omega < 0$. Meanwhile, as shown above, $\left(\bar{q}_{t,unconstrained} - \bar{q}_{t,constrained}\right)^2$ shrinks as ω rises. Hence $\frac{\partial Var\left[q_t\right]}{\partial \omega} < 0$.[6]

Proposition 2: Upon strengthening the creditor protection, the expected volatility in the stock market declines, for two reasons: (1) the difference of the Tobin's q across constrained and unconstrained regimes decreases; and (2) the probability of a credit crunch falls.

That is, by strengthening creditor protection, regulatory authorities may make the correlation between the regime-switch probability and the volatility of stock prices less pronounced. We will confront these predictions with cross-country panel data in the next section.

As a final note to the theoretical part, we want to mention that there is a simplification in our model. In the discussions on q_t' and $Var\left[q_t\right]$, we assume that the regime switch is permanent and occurs with a probability in period t. In a more general case where oscillations can take place in any future period, we can have the following Bellman equation

6 If $Var\left[\varepsilon_t\right]$ is not equal to 0, then we can see that as ω rises, B_1' will increase, and hence the volatility of q_t' will also increase in reaction to a shock to the technology, a_t. That is, when the constraint always binds, weak creditor protection will reduce the stock price volatility. The intuition is that a binding credit constraint would reduce the upside potential of good productivity shocks by constraining the firm growth.

$$V\left(K_t, A_t, U_t; \omega\right) = \max_{Z_t, K_{t+1}} \left\{ A_t K_t^{1-\rho} - Z_t + \frac{1}{1+r} \sum_{U_{t+1}} \Pr\left(U_{t+1}|U_t\right) V\left(K_{t+1}, A_{t+1}, U_{t+1}; \omega\right) \right\}$$

where there is a Markov structure for the credit-constrained regime indicator U_t. The variance of firm's value, $Var\left[V\left(K_t, A_t, U_t; \omega\right)\right]$, will depend on the probability of the regime switch, $\Pr\left(U_{t+1}|U_t\right)$. With higher ω, we can expect higher $\Pr\left(U_{t+1}=0|U_t=0\right)$ and $\Pr\left(U_{t+1}=0|U_t=1\right)$, and lower $\Pr\left(U_{t+1}=1|U_t=0\right)$ and $\Pr\left(U_{t+1}=1|U_t=1\right)$. As higher ω reduces the probability of the switch from $U_t=0$ to $U_{t+1}=1$, we would still expect that the overall effect of ω on $Var\left[V\left(K_t, A_t, U_t; \omega\right)\right]$ is negative for a large class of distribution functions for W_t.

3. Empirical Analysis

In our theoretical model, the credit constraint mechanism works through a random situation where the constraint moves between binding and nonbinding. That is, the mechanism is based on a probability that the credit constraint is binding. In the empirical model, we use the probability of a liquidity crisis to proxy for the probability of a binding constraint. Hence, our empirical measure of the liquidity crisis is directly related to the theoretical counterpart of the credit constraint.

3.1 Empirical Approach and Data

We define a liquidity crisis in two ways: First, as a sharp decline in bank credit to the private sector (quantity approach); second, as a sharp increase in the real interest rate (price approach). In both cases we define observations in the top 10 or 5 percent tail of annual changes in the underlying variable as crises. This corresponds to the annual decline of credit to the private sector by 5.1 percent and 10 percent, respectively, and to an increase in real interest rate of over 4.3 or 8.4 percentage points in one year, respectively.[7] Table 1 presents a list of countries and years for which our measure indicates a liquidity crisis has occurred. Thus, our liquidity crisis variable measures domestic liquidity crises and proxies for the times when credit constraints are likely to be binding.[8] Note that by construction the frequency of crises in the full sample is 10 percent and 5 percent with weaker and stricter measures, respectively.

Our creditor protection index comes from La Porta, et al. (1998).[9] The creditor rights index ranges from 0 to 4 with a higher number associated with better protection for creditors. The index is formed by adding one for each of the following four institutions: when the country imposes restrictions, such as requiring a firm to obtain creditor consent or pay minimum dividends to file for reorganization; when

7 We obtain the data on interest rates from IMF International Financial Statistics. We use line 22d for the bank credit to private sector and divide it by the CPI. For the interest rate, in most cases we use the money market rate. When the money market rate is not available, we use the discount rate. We calculate the real interest rate by subtracting the CPI inflation rate from the nominal interest rate. We then calculate annual percentage changes in these variables to identify liquidity crisis episodes.

8 Note that because we are interested not only in the onset of the crisis, but in the crisis *situation*, we keep our indicator to be equal to 1 in all the years that our procedure determines as crises, and not only in the first crisis year.

9 See http://post.economics.harvard.edu/faculty/shleifer/Data/l&fweb.xls.

secured creditors are able to gain possession of their security as soon as the reorganization petition has been approved (with no automatic stay); when secured creditors are ranked first in the distribution of the proceeds that result from the disposition of the assets of a bankrupt firm; and when the debtor does not retain the administration of its property pending the resolution of the reorganization. Figure 1 shows the countries in our sample that fall into different categories of the creditor rights index.

Following the methodology in Razin and Rubinstein (2006), we use our liquidity crisis indicator to estimate the following model:

$$\mathrm{I(crisis)}_{it} = \begin{cases} 1 \ \text{ if } \ y_{it} > 0 \\ 0 \ \text{ if } \ y_{it} \leq 0 \end{cases}$$

where y is a latent variable and a function of our independent variables

$$y_{it} = X_{it}'\beta + \varepsilon_{it}$$

and ε has either a normal or a logistic PDF. X_{it}' includes the indicator of the political situation in the country, as measured by the ICRG political risk index; a measure of capital mobility (*CAP*); a measure of financial contagion proxied by an indicator of a sudden stop in any country; and the lagged liquidity crisis indicator. We then construct a measure of the probability of a liquidity crisis (*PLC*) as a predicted value from the above estimation, which we use in the analysis of stock market level and volatility.[10]

To proxy for stock price level and volatility, we use stock market indexes from Global Financial Data. We use monthly data calculated by central banks, national statistical agencies, or stock exchanges themselves as of the end-of-month closes. We scale down all stock market indexes by the local CPI at the end of the month. To measure stock market level (q), we average the scaled down index for each country for each calendar year. For regressions without fixed effects, we normalize all indexes to be equal to 1 in 1997.[11] We use the log of this variable in our regressions. To measure the stock return volatility (σ), we compute non-overlapping standard deviations for the monthly stock returns for each calendar year. As alternatives, we used range measure of volatility proposed by Alizadeh et. al. (2001) and found that our results are not sensitive to such alterations. We use logs of these measures in our regressions.

[10] As Heckman (1978) points out, consistent estimates of variance can be obtained if the predicted probability is used as an instrument for the binary variable on the right-hand side. We reestimated our model in this way (with and without fixed effects), using GMM, and found that our results are robust to this correction, i.e. significance levels of our coefficients are not affected. We will present the results of regressions without correction, because they are more transparent and are faster to estimate.

[11] 1997 is chosen because in this year we have stock market data for all countries in our sample. The results are not sensitive to the normalization point.

In the second stage, we measure the effect of the crisis probability on the level and volatility of the stock market by estimating the following equations using iterated FGLS:

$$\ln(\ln q_{it}) = \rho * \ln(q_{it-1}) + \alpha_i + \gamma_1 * PLC_{it+1} + \gamma_2 * CRH_i + Z'_{it}\delta + \eta_{it}$$

$$\ln(\ln \sigma_{it}) = \rho * \ln(q_{it-1}) + \alpha_i + \gamma_1 * PLC_{it+1} + \gamma_2 * CRH_i + Z'_{it}\delta + \eta_{it}$$

where $\{\alpha_i\}$ are country or region fixed effects,[12] CRH_i is a time-invariant indicator of strong creditor rights protection (only included in the model without country fixed effects), errors η_{it} are allowed to be serially correlated and heteroskedastic. Z_{it} is a set of control variables, including the size of the stock market measured by the log of the number of listed firms, the growth rate of GDP per capita, and *de jure* financial account openness from Edwards (2006).[13] We include the lead of the predicted crisis probability to reflect the forward-looking nature of the stock markets.[14]

In order to isolate the indirect effect of the creditor rights on the level and the volatility of the stock market, we employ the following procedure. First, in the first stage probit regression, we omit creditor protection indicator to construct *PLC* variables that are independent of creditor protection in addition to those that include creditor rights index. In the second stage, then, we compare the effect of *PLC* indexes that include creditor protection to that of *PLC* that do not. We expect the former to be larger. We do this for both quantity- and price-based indicators of liquidity crises.

Our theory guides us to distinguish between the effects of liquidity and productivity shocks on stock price volatility. That is why we include above two group of determinants of the stock market level and volatility: a) those associated with productivity-based shocks, such as the GDP growth rate; and b) those associated with the probability of liquidity shocks, i.e, PLC_{it}.

Evidently, one cannot possibly explain all the cross-country differences that would affect the stock market level volatility variation across countries by institutional variables. Thus, we employ country-specific fixed-effects regression analysis, estimating the above equation by iterated feasible GLS (FGLS) with AR(1) disturbances. Note that since our measure of creditor rights protection does not vary over time, it drops out from these regressions. Alternatively, we include region fixed effects instead of country fixed effects, which allows us to keep the creditor protection measure in the regressions. Since the level of financial development varies vastly across countries, we believe the determinants of stock market volatility may vary as well. Thus, we estimate the second-stage regressions for the sub-samples of developed and developing countries as well as for the full sample.

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12 We define the following five regions: Continental Europe, Latin America, East Asia excluding Japan, other Asia and Africa, Commonwealth countries plus Japan. Our results are not sensitive to the definition of regions.

13 See Appendix for the description of data sources.

14 In the regressions with region fixed effects and CRH, we omit the lagged dependent variable to allow for cross-country differences to be captured by CRH. In the stock market level regressions including the lagged dependent variable makes the effect of CRH become insignificant. In the stock market volatility regressions adding the lagged dependent variable does not affect the results.

The above two-stage system can be identified with any set of explanatory variables through functional form. Functional form identification, however, tends to be weak, which is why in first stage regressions we include variables that are likely to affect the probability of a liquidity crisis but that are unlikely to have a direct effect on stock market volatility. In the first stage we use as instruments the indicator of a liquidity crisis lagged by one year and, in price-based regressions, a one-year lag of the contagion indicator, which is set to one in the years when any of the countries in our sample experience a sudden stop in capital flows (Calvo et al., 2006). Because stock market prices tend to be forward-looking and efficient in processing information, past liquidity crises are unlikely to have a *direct* effect on the volatility of the stock market, although they are likely to affect the probability of future crises.[15]

We test this exclusion restriction informally and find that, in the regressions of the stock market price and volatility, past liquidity crises indeed do not have explanatory power in regressions with country fixed effects, with the exception of the price level regression with the quantity crisis indicator (Table 2). The contagion indicator is an aggregate for the entire sample and thus its lag is exogenous for each particular country, even though statistically we find a positive effect in the stock price level regressions. Thus, we identify this system by both functional form and exclusion restriction.[16] Further, we experiment with additional lags of liquidity crises and find that, while the fit of the first stage improves, the second-stage results are unaffected. Finally, we reestimated our model using the Arellano-Bond (1991) dynamic panel technique and found the results to be qualitatively the same.

3.2 Empirical Findings

We now report the results of the two-stage estimation procedure: probability of crises in the first stage and stock price level and volatility in the second stage. Here we report the results of our analysis using the less strict definition of a liquidity crisis. We estimated all the models with a more strict definition and found that our results are very similar, except the coefficients of interest in the second stage are larger in magnitude.

3.2.1 The Probability of Credit Crunch

Table 3 reports the results of four probit regressions. The first two columns use the quantity-based definition of the liquidity crisis, the second two use the price-based definition. The first and the third regressions do not include the creditor rights indicator. We use predicted probabilities from each regression in the second stage, and we will refer to them as *PLCQ1* and *PLCQ2* for quantity indicators, and *PLCP1* and *PLCP2* for price indicators. While we experimented with a number of explanatory variables, here we use parsimonious specifications in which only the variables that have significant effects are included.

We find that crises are persistent and that better creditor protection and a more stable political situation lower the probability of a liquidity crisis, regardless of the definition used. Moreover, when the crises are

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15 See Fama (1991) for empirical evidence of the weak-form efficient market hypothesis.

16 Note that, according to Table 2, the political risk index can also be interpreted as an instrument, since it does not appear to have a direct statistical effect on the stock return volatility in all but two regressions. This helps us identify the model. However, we do not rely heavily on this index as an instrument because we do not have theoretical grounds to believe in its exogeneity.

defined as a decline in the bank credit to the private sector, higher per capita GDP growth is associated with a lower probability of a liquidity crisis.[17] Finally, when crises are defined as a rise in the real interest rate, a more open financial account lowers the probability of a domestic liquidity crisis, while the lagged contagion indicator increases it. In terms of the magnitude of the effects, an increase in the creditor rights index from a low level of 0, 1, or 2 to a high level of 3 or 4 lowers the probability of a liquidity crisis by 5.5 percentage points if the quantity definition of crises is used, and by 7.8 percentage points if the price definition is used. These effects are quite large given that the share of crises in the sample is 10 percent by construction.

The distribution of predicted crisis probability measures corresponding to regressions in Table 3 are shown for developed and developing countries by the level of credit protection index in Figures 2 and 3.[18] Figure 2 shows the distribution of the predicted crisis probability based on the quantity measure of the crisis, while Figure 3 shows the distribution based on the price measure. Clear bars correspond to the regressions in which CRH was not included and solid bars correspond to the regressions with CRH. We can see that according to both definitions credit crises are less likely in developed countries and are also less likely in countries with a high value of the creditor rights protection index.

The model features the probability of next period liquidity crisis as a predictor of the stock price level and volatility. Guided by this theory, we regress, in the second stage, the stock price level and volatility on the 1-period lead of the predicted probability of liquidity crisis and on other covariates.

3.2.2 The Level of the Stock Market Index

Tables 4 and 5 report the results of our second-stage estimation of the stock market index. Since the initial level of the index has no economic meaning, we include country fixed effects in the regressions reported in Table 4. In the regressions reported in Table 5, with only region fixed effects, we normalize all indexes to be equal to 1 in the middle of the sample period. In addition we include the lagged dependent variable (only in Table 4 regressions) and control for the growth rate of GDP per capita (other control variables did not enter significantly and were dropped). Columns (1) and (2) show the effects of predicted crisis probability constructed from the quantity-based crisis measure, while columns (3) and (4) use the price-based measure. *PLC* measures in columns (1) and (3) exclude the effect of the creditor protection index, while *PLC* measures in columns (2) and (4) include them. We maintain this structure of tables for all of our main results (both levels and volatility regressions).

We find that, as the model predicts, higher probability of the credit crunch, proxied for by the predicted crisis probability, lowers the level of the stock market, regardless of the measure used. This decline is statistically significant and substantial in magnitude: an increase in the predicted probability of a liquidity crisis from 0 to its average level of 10 percent would lower the stock market level by 6-10 percent, depending on specification.

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[17] We did not lag the GDP growth variable because we believe it to be predetermined and only affected by the liquidity crisis with a lag.

[18] Including a developed country dummy in the probit regression has only minor effect on this distribution.

Moreover, when we use the quantity-based measures of the probability of liquidity crisis, we find that the measure that includes the creditor protection index (*PLCQ2*) has a larger impact than the one that excludes it (*PLCQ1*). This is consistent with our theoretical finding that the creditor protection has an indirect effect on the level of the stock market through its effect on the probability of the credit crunch. The difference between the effects of these two measures, however, is not statistically significant. We don't find the same effect with the price-based measure.

To see whether the prediction of our model about the direct effect of the creditor protection on the stock market level is consistent with the data, we now turn to Table 5. Because the creditor protection index does not vary over time, we cannot include it in the regression that also includes country fixed effects. Instead, we include only region fixed effects in these regressions. We also drop the lagged dependent variable in order to fully explore cross-sectional differences between the countries. As Table 5 shows, while we still observe an indirect effect of the creditor rights index (compare columns (2) and (4) with columns (1) and (3)), we do not find a direct effect of the creditor rights index on the stock market level.[19]

We further analyze the effects in two subsamples of our data — developing and developed countries (see Figure 1 for the classification of the countries in our sample). These results are reported in Tables 8-9 and 12-13, respectively.

We find that the results for developing countries are very similar to those for the full sample, both in significance and in magnitude. We also find in this subsample the evidence of a direct effect of the creditor right protection index when the quantity-based *PLC* index is used (Table 9, columns (1) and (2)). The direct effect of improving creditor rights protection from a low to high level is comparable in magnitude to the effect of lowering the probability of a liquidity crisis from 100 to 0 percent, which implies that if a country has a high probability of a liquidity crisis, its effect on the stock market level can be swamped by an offsetting increase in creditor rights protection.

For the subsample of developed countries we find that the probability of a credit crunch only lowers the stock market level if it is proxied by the quantity–based measure. This is not surprising — as we can see from Figures 2 and 3, there is more variance in quantity–based *PLC* indexes for developed countries than in price–based indexes. Again, the effects here are similar in magnitude to those in the full sample. We do not find evidence in support of a direct effect of creditor protection on the level of the stock market index for this subsample, neither do we find evidence against our model's predictions.

To summarize our empirical results with respect to the stock market level, we find an overwhelming support in the data for the negative effect of the increasing credit crunch probability on the level of the stock market. This effect is substantial and statistically significant. Our results are less certain with respect to the effect of creditor protection — we find some evidence of its direct and indirect effect, but it is not prominent in all subsamples and is not robust to the choice of the *PLC* index.

[19] Because in Table 5 the left-hand side variable is normalized, smaller coefficients on the *PLC* indexes in Table 5 represent the same magnitude of their effect as in Table 4.

3.2.3 The Volatility of the Stock Market Return

Tables 6 and 7 report the results of our second-stage regression of the stock market volatility. Regressions in Table 6 include country fixed effects and the lagged dependent variable, while those in Table 7 omit those and include region fixed effects and the indicator of the high creditor rights index level. As additional control variables we include the growth rate of GDP per capita, log of the number of firms listed on the stock market,[20] and financial account openness.

As the model predicts, our proxy for the tightness of the credit constraint, the predicted probability of liquidity crisis, increases stock market volatility, regardless of the *PLC* index used. Coefficients on all *PLC* indexes are statistically significant and economically important: an increase in the probability of a credit crunch from 0 to 10 percent increases the volatility of the stock market by 3-8 percent, depending on the index used.

Here again we find some weak evidence for an indirect effect of the creditor rights index on the stock market volatility, as represented by higher coefficients on *PLCP2* compared to *PLCP1* in Table 6 and Table 7 and by higher coefficient on *PLCQ2* compared to *PLCQ1* in Table 7. As it was the case in the stock market level regressions, the differences between these coefficients are not statistically significant.

Table 7 shows that there is evidence of a direct effect of creditor rights protection on stock market volatility. As shown in Table 7, regardless of specification, the coefficient on the indicator of a high creditor rights protection index is negative and statistically significant. The magnitude of the creditor rights protection effect in Table 7 is comparable to a 10-30 percentage points decline in the probability of credit crunch, depending on specification.

Results of similar regressions for the subsamples of developing and developed countries are reported in Tables 10-11 and 14-15, respectively.

We find similar effects for developing countries to those we find for a full sample, with similar magnitudes and statistical significance, with the exception of price-based indicators in Table 11, which are not statistically significant. Another notable difference is in columns (3) and (4) of Table 10, which show the effect of the price-based *PLC* index on the stock market volatility in developing countries. While the *PLCP1* index, which does not include the creditor rights indicator, does not have a significant effect on the stock market volatility, the *PLCP2* index, which includes the creditor rights indicator, has a significant effect, which is also larger in magnitude. However, as before, the difference between these two coefficients is not statistically significant. The direct effect of creditor protection on stock market volatility in developing countries (Table 11) is very strongly significant and is as large as in the full sample regressions.

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[20] While this variable does not come in significantly in Table 6 regressions, it comes in significantly in subsamples, which is why we left it in the main specification.

While the price-based index seems to have less effect in the subsample of developing countries, it appears to have a much larger effect in the subsample of developed countries. These results should be interpreted with caution, however, because there is not much variance in the price-based *PLC* indexes for the subsample of developed countries, as shown in Figure 3. As Table 15 shows, we do not find any direct effect of the creditor rights protection index on the stock market volatility in developed countries.

To summarize the results presented in this section: We find overwhelming evidence of the positive effect of the predicted liquidity crisis probability on the stock market volatility. We find some weak evidence of an indirect effect of creditor rights protection in the subsample of developing countries. Importantly, we find strong evidence of the direct effect of creditor rights protection on the stock market volatility, which is driven by the subsample of developing countries.

Overall, we find that the data broadly support predictions of our model. While many factors determine the level and the volatility of stock market indexes, we find a substantial contribution of the predicted probability of liquidity crisis and of the creditor rights protection index in explaining their cross-country and time-series variation. While some of the coefficients are not statistically significant, we do not find any results that contradict predictions of our model.

3.2.4 Robustness Tests

We conduct a series of robustness tests to make sure our findings are not driven by the exact specification we have chosen. We describe them in this section but do not report the regression tables in the interest of space. The tables are available from the authors upon request.

We experimented with additional control variables, such as the fiscal situation in the country, current account, stock market price/earnings ratio, fixed and floating exchange rate regime indicators (Reinhart & Rogoff, 2004), and volatility of the U.S. 3-year Treasury-bill rate, but none of these variables entered the regressions with significant coefficients or affected the results in any way, save for some of them limiting the sample. Sovereign credit rating does enter significantly in the regressions, but it is highly correlated with the growth rate of GDP per capita (with the correlation coefficient of 0.79), which is why we did not include it in the main specification.

We reestimated our first-stage regressions using two or three lags of liquidity crisis. The fit of these probit regressions improved and all the lags had positive and significant effects. The results of our second-stage regressions, however, were not qualitatively affected. Quantitatively, coefficients on the predicted crisis probability increased in magnitude.

We repeated our analysis with alternative (more strict) definitions of liquidity crises in the first stage, which led to a different set of *PLC* indexes. These indexes were highly correlated with the ones we used in the main specification (with correlation coefficients of about 0.9). We repeated our second-stage estimation with these new crisis probability measures and found no qualitative differences in our results. Quantitatively, the effects of crisis probability were larger, as expected.

Going back to our original definition of liquidity crisis, we used a logit model to construct our predicted crisis probability. The correlation of new measures with original ones was again very high: 0.99. We reestimated our second-stage regressions using these new predictions. As expected, given the high correlation of the measures of crisis probability, the estimated coefficients were almost identical to our main specification. Alternatively, we included a developed country dummy in our probit regressions, which also left our results unchanged.

Instead of using a binary indicator for a high level of creditor rights protection, we used a raw index as if it were a continuous variable and, alternatively, a set of five dummy variables, one for each value of the index. Our results were qualitatively the same, with most of the effect of the high level of creditor rights protection appearing in the coefficient on the dummy variable indicating that the creditor rights protection index is equal to 4.

We repeated our analysis adding year fixed effects. We found that our results were qualitatively the same — all the coefficients that had been initially significant were still significant and had the same sign. The only important quantitative effect was in smaller coefficients on the crisis probability in all regressions (about half the size of those in the main specification).

Finally, instead of classifying countries into developed and developing, we reclassified them into OECD and non-OECD, which affected the classification of Mexico, Turkey, and Korea. In the case of Mexico and Korea, we only reclassified them for the years they were actually in the OECD. Our results remained qualitatively the same, indicating that none of these three countries had a strong influence on our results.

4. Conclusion

In this paper, we examine the connection between creditor rights protection and the volatility of stock market prices. Obtaining an analytical solution in a version of a Tobin's q investment model with credit constraints allows us to focus on predictions regarding the first and second moments of Tobin's q. Our application of the Tobin's q model predicts that credit protection reduces the probability of credit crunch. We demonstrate that by strengthening creditor protection the expected return in the stock market rises for two reasons: (1) the Tobin's q value under a credit crunch rises; and (2) the probability of a credit crunch falls. Through the credit-crunch probability channel, creditor protection also reduces the volatility of Tobin's q. Note that financial contagion may exhibit itself in a similar way and that, in fact, we find that financial contagion increases the probability of a liquidity crisis.

Using a panel of 20 developed and 20 developing countries for the last 20 years, we find empirical support for the predictions of our model: weak creditor protection increases the probability of liquidity crises, which is our proxy for the probability of the regime with a binding credit constraint, and hence lowers the stock market level and increases the aggregate stock price volatility. We also find some support for the direct effect of the creditor protection on stock market level and volatility, in addition to its effect on the probability of a credit crunch.

Our paper thus illustrates the importance of creditor protection on the development of a sound stock market: strong creditor rights not only increase the stock value, but also crucially, reduce the counterproductive volatility of the stock market. This finding is relevant for the recent credit crunch in developed markets that was associated with high stock market volatility. While Germany was the country most affected by the liquidity crisis, the stock market volatility increase was less pronounced in Germany than it was in France, Australia, or Japan, which all have a lower degree of creditor rights protection.

Finally, we mention that there are other mechanisms through which creditor protection may affect the volatility of stock market prices. For instance, Hale, Razin, and Tong (2006) discuss the moral hazard channel. Weak creditor protection induces firms to make riskier investments, as firms will benefit from the upper range of the realized capital return, with no need to worry about the lower range. Such moral hazard can increase stock price volatility. We leave it to future work to test this prediction.

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Table 1. List of Liquidity Crises in the Sample

Country	Years of financial crisis	
	Quantity definition	Price definition
Argentina	1988[a], 1990, 2001-2003	1984, 1987-1990, 1992, 1993-1994[a], 2001, 2004[a]
Brazil	1989, 1990, 1998	1987-1990, 1992-1994, 1996, 1997-1998[a]
Chile	1985[a], 1990[a]	1984[a], 1987[a], 1989
China	1988[a]	1990[a], 1995[a], 1996[a]
Colombia	1998[a], 1999, 2000	1998
Denmark	1991, 1993, 1994[a]	
Egypt	1989[a], 1991	1985[a], 1990[a], 1992[a], 1996[a]
Finland	1992[a], 1993, 1994	
France	1993[a]	
Greece	1987[a], 1990[a], 1993[a]	1987[a], 1988[a]
Hong Kong	1991, 1999[a]	1999[a]
India	1991[a]	1984[a], 1989[a], 1995[a]
Indonesia	1998, 1999	1984[a], 1997
Ireland	1991[a]	
Japan	2001, 2002[a]	
Malaysia	1990, 1998[a]	
Mexico	1985[a], 1986, 1987[a], 1995-1996, 1998-1999[a], 2001	1984, 1985, 1989, 1995, 1998
Pakistan	1990[a]	
Peru	1989, 2000[a], 2003[a]	1991, 1992, 1993, 1995[a], 1999[a]
Philippines	1984-1986, 1991[a], 1998, 1999[a], 2001[a]	1985, 1986, 1992, 1997[a]
Portugal	1985[a]	1985[a], 1991[a]
Singapore	2002[a]	
South Africa	1986[a], 2002	1984[a], 1988[a]
Spain	1984[a]	1987[a]
Sweden	1991[a], 1993, 1994[a]	1992
Thailand	1998-2000, 2001[a]	1997[a]
Turkey	1988, 1994, 1998[a], 1999, 2001	1990, 1991, 1994, 1996, 1998[a], 1999, 2001, 2003[a]

[a] No liquidity crisis by on a more strict definition.

Countries that did not have crises: Australia, Austria, Belgium, Canada, Germany, Italy, Israel, Korea, Netherlands, New Zealand, Norway, Switzerland, United Kingdom.

Table 2. Informal Tests of Exclusion Restrictions

	Stock price level				Stock price volatility			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged dependent	0.75***	0.99***	-0.10***	0.008	-0.063***	-0.060***	0.28***	0.44***
variable	(0.023)	(0.006)	(0.018)	(0.010)	(0.020)	(0.021)	(0.036)	(0.033)
Growth rate of	0.17**	0.13*	-0.28**	-0.21	0.31***	0.20**	-0.43***	-0.43***
GDP per capita	(0.068)	(0.072)	(0.118)	(0.128)	(0.075)	(0.083)	(0.115)	(0.124)
ICRG political	0.000	-0.004***	-0.002	-0.003	0.006***	-0.000	-0.004	-0.002
risk index	(0.002)	(0.001)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Capital controls			-0.000	-0.003**	0.008***	0.006***	-0.001	-0.002**
(de jure)			(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log(# of publicly					0.32***	0.63***	-0.032	-0.011
listed firms)					(0.039)	(0.044)	(0.043)	(0.018)
Lagged quantity	-0.035	0.021			-0.11***	-0.069*		
crisis indicator	(0.030)	(0.030)			(0.032)	(0.037)		
Lagged price			0.063	0.20**			0.085	0.19**
crisis indicator			(0.070)	(0.087)			(0.069)	(0.082)
Lagged contagion			0.012**	0.011*			0.008	0.004
indicator			(0.006)	(0.006)			(0.006)	(0.006)
I(Creditor rights		-0.026		-0.100		-1.72***		-0.075*
index = 3 or 4)		(0.029)		(0.063)		(0.103)		(0.042)
I(Latin America)		-0.017		0.20**		9.94***		0.020
I(East Asia-J)		-0.074*		0.28***		1.48***		0.16***
I(Asia,Africa)		-0.084		0.020		0.55***		0.031
I(Commonwealth+J)		-0.031		-0.20***		0.21**		-0.10*
Observations	693	693	693	693	679	679	679	679
LL	5.10	-50.19	-341.0	-397.6	-70.61	-366.7	-331.7	-375.2
AR1	0.23	0.24	0.21	0.30	0.52	0.79	0.00	-0.02

Iterated FGSL. Standard errors in parentheses. 40 countries.

Dependent variable is log of stock price level (columns (1)-(4)) and volatility (columns (5)-(8)).

Country fixed effects are included in odd-numbered columns.

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

Table 3. Marginal Effects of the First–Stage Probit Regressions

Dependent variable: I(liquidity crisis)	Quantity definition		Price definition	
	(1)	(2)	(3)	(4)
Lagged dependent variable	0.142***	0.119**	0.089*	0.047
	(0.047)	(0.047)	(0.058)	(0.040)
ICRG political risk index	-0.002***	-0.002***	-0.003*	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Growth rate of GDP per capita	-0.349***	-0.337***		
	(0.102)	(0.102)		
Capital controls (de jure)			-0.001**	-0.002***
			(0.001)	(0.001)
Lagged contagion indicator			0.005*	0.005*
			(0.003)	(0.003)
I(Creditor rights index = 3 or 4)		-0.055***		-0.078***
		(0.020)		(0.021)
McFadden's R^2	0.16	0.18	0.16	0.21
Predicted probability variable	PLCQ1	PLCQ2	PLCP1	PLCP2

Probit regressions' marginal effects. Standard errors in parentheses. 707 observations.

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

Table 4. Second–Stage Regressions of the Stock Market Level. Full Sample. Country FEs.

	(1)	(2)	(3)	(4)
Lagged dependent variable	0.747***	0.745***	0.711***	0.710***
	(0.020)	(0.020)	(0.022)	(0.022)
Growth rate of GDP per capita	0.075	0.076	0.073	0.082
	(0.067)	(0.067)	(0.066)	(0.067)
PLCQ1	-0.645***			
	(0.124)			
PLCQ2		-0.675***		
		(0.125)		
PLCP1			-1.034***	
			(0.192)	
PLCP2				-0.835***
				(0.198)
LL	18.59	19.14	20.92	16.33
AR1	0.18	0.18	0.21	0.21

Iterated FGSL. Standard errors in parentheses. 40 countries. 654 observations.

Dependent variable is log of real stock market index.

Country fixed effects are included.

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

Table 5. Second-Stage Regressions of the Stock Market Level. Full Sample. Region FEs.

	(1)	(2)	(3)	(4)
Growth rate of GDP per capita	0.034***	0.036***	0.015*	0.018**
	(0.009)	(0.009)	(0.008)	(0.009)
PLCQ1	-0.066***			
	(0.014)			
PLCQ2		-0.073***		
		(0.015)		
PLCP1			-0.175***	
			(0.025)	
PLCP2				-0.195***
				(0.030)
I(Creditor rights index = 3 or 4)	0.001	-0.002	-0.001	-0.011
	(0.011)	(0.011)	(0.011)	(0.011)
I(Latin America)	0.017	0.017	0.034**	0.042**
I(East Asia-Japan)	0.031**	0.031**	0.035**	0.037***
I(Asia+Africa)	0.047***	0.047***	0.069***	0.063***
I(Commonwealth+Japan)	0.037***	0.037***	0.035***	0.035***
LL	1220.56	1223.54	1229.32	1229.23
AR1	0.71	0.72	0.70	0.71

Iterated FGSL. Standard errors in parentheses. 40 countries. 693 observations.

Omitted region is Continental Europe.

Dependent variable is log of real stock market index.

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

Table 6. Second-Stage Regressions of the Stock Market Volatility. Full Sample. Country FEs.

	(1)	(2)	(3)	(4)
Lagged dependent variable	0.266***	0.266***	0.270***	0.263***
	(0.036)	(0.036)	(0.036)	(0.036)
Growth rate of GDP per capita	-0.268**	-0.271**	-0.217*	-0.211*
	(0.115)	(0.115)	(0.116)	(0.114)
Log(# publicly listed firms)	0.009	0.011	0.019	0.022
	(0.041)	(0.041)	(0.041)	(0.041)
Capital controls (de jure)	-0.002*	-0.002*	-0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.002)
PLCQ1	0.340**			
	(0.158)			
PLCQ2		0.318**		
		(0.155)		
PLCP1			0.714***	
			(0.258)	
PLCP2				0.759***
				(0.238)
LL	-306.87	-307.08	-305.87	-304.74
AR1	-0.01	-0.01	-0.01	-0.01

Iterated FGSL. Standard errors in parentheses. 40 countries. 644 observations.

Dependent variable is log of real stock return volatility.

Country fixed effects are included.

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

Table 7. Second-Stage Regressions of the Stock Market Volatility. Full Sample. Region FEs.

	(1)	(2)	(3)	(4)
Growth rate of GDP per capita	-0.101	-0.100	-0.059	-0.039
	(0.134)	(0.134)	(0.134)	(0.133)
Log(# publicly listed firms)	0.035	0.036	0.034	0.034
	(0.027)	(0.027)	(0.027)	(0.027)
Capital controls (de jure)	-0.002	-0.002	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
PLCQ1	0.411**			
	(0.203)			
PLCQ2		0.452**		
		(0.203)		
PLCP1			0.630**	
			(0.316)	
PLCP2				0.909***
				(0.294)
I (Creditor rights index = 3 or 4)	-0.140**	-0.120*	-0.143**	-0.108*
	(0.063)	(0.064)	(0.062)	(0.065)
I(Latin America)	0.225**	0.204**	0.234**	0.159
I(East Asia-Japan)	0.305***	0.303***	0.298***	0.302***
I(Asia+Africa)	0.093	0.097	0.062	0.110
I(Commonwealth+Japan)	-0.207***	-0.209***	-0.199**	-0.199**
LL	-405.87	-405.62	-406.23	-404.52
AR1	0.32	0.31	0.32	0.32

Iterated FGSL. Standard errors in parentheses. 40 countries. 682 observations.

Omitted region is Continental Europe.

Dependent variable is log of real stock return volatility.

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

Table 8. Second-Stage Regressions of the Stock Market Level. Developing Countries. Country FEs.

	(1)	(2)	(3)	(4)
Lagged dependent variable	0.737***	0.730***	0.684***	0.687***
	(0.025)	(0.026)	(0.029)	(0.030)
Growth rate of GDP per capita	0.724***	0.729***	0.535***	0.613***
	(0.106)	(0.107)	(0.103)	(0.105)
PLCQ1	-0.537***			
	(0.144)			
PLCQ2		-0.625***		
		(0.150)		
PLCP1			-0.966***	
			(0.207)	
PLCP2				-0.749***
				(0.212)
LL	-73.24	-72.70	-69.81	-73.41
AR1	0.06	0.07	0.09	0.10

Iterated FGSL. Standard errors in parentheses. 20 countries. 329 observations

Dependent variable is log of real stock market index.

Country fixed effects are included.

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

Table 9. Second-Stage Regressions of the Stock Market Level. Developing Countries. Region FEs.

	(1)	(2)	(3)	(4)
Growth rate of GDP per capita	0.039***	0.043***	0.013	0.019*
	(0.012)	(0.012)	(0.010)	(0.011)
PLCQ1	-0.049***			
	(0.016)			
PLCQ2		-0.056***		
		(0.017)		
PLCP1			-0.182***	
			(0.027)	
PLCP2				-0.219***
				(0.035)
I(Creditor rights index = 3 or 4)	0.062**	0.056**	0.040	0.001
	(0.028)	(0.028)	(0.026)	(0.028)
I(East Asia-Japan)	-0.043	-0.040	-0.038	-0.019
	(0.029)	(0.029)	(0.027)	(0.028)
I(Asia+Africa)	-0.032	-0.029	-0.008	0.005
	(0.031)	(0.031)	(0.029)	(0.030)
LL	533.59	535.93	546.49	543.03
AR1	0.67	0.68	0.66	0.67

Iterated FGSL. Standard errors in parentheses. 20 countries. 348 observations

Omitted region is Latin America.

Dependent variable is log of real stock market index.

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

Table 10. Second–Stage Regressions of the Stock Market Volatility. Developing Countries. Country FEs.

	(1)	(2)	(3)	(4)
Lagged dependent variable	0.345***	0.345***	0.350***	0.345***
	(0.046)	(0.046)	(0.046)	(0.046)
Growth rate of GDP per capita	-0.564***	-0.572***	-0.521***	-0.499***
	(0.138)	(0.138)	(0.143)	(0.140)
Log(# publicly listed firms)	-0.091*	-0.088*	-0.075	-0.072
	(0.048)	(0.048)	(0.049)	(0.049)
Capital controls (de jure)	-0.002	-0.002	-0.001	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)
PLCQ1	0.367**			
	(0.164)			
PLCQ2		0.334**		
		(0.163)		
PLCP1			0.396	
			(0.269)	
PLCP2				0.509**
				(0.253)
LL	-171.90	-172.29	-173.23	-172.46
AR1	0.02	0.02	0.02	0.03

Iterated FGSL. Standard errors in parentheses. 20 countries. 328 observations

Dependent variable is log of real stock return volatility.

Country fixed effects are included.

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

Table 11. Second-Stage Regressions of the Stock Market Volatility. Developing Countries. Region FEs.

	(1)	(2)	(3)	(4)
Growth rate of GDP per capita	-0.425***	-0.427***	-0.333**	-0.319**
	(0.159)	(0.159)	(0.162)	(0.161)
Log(# publicly listed firms)	0.109**	0.109**	0.107**	0.109**
	(0.046)	(0.046)	(0.047)	(0.046)
Capital controls (de jure)	-0.001	-0.001	-0.000	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)
PLCQ1	0.371*			
	(0.200)			
PLCQ2		0.343*		
		(0.200)		
PLCP1			0.268	
			(0.297)	
PLCP2				0.410
				(0.315)
I(Creditor rights index = 3 or 4)	-0.946***	-0.917***	-0.959***	-0.889***
	(0.119)	(0.123)	(0.118)	(0.134)
I(East Asia-Japan)	0.791***	0.788***	0.769***	0.759***
	(0.141)	(0.141)	(0.141)	(0.142)
I(Asia+Africa)	0.599***	0.600***	0.585***	0.573***
	(0.117)	(0.117)	(0.118)	(0.119)
LL	-241.17	-241.33	-242.33	-242.18
AR1	0.38	0.38	0.38	0.38

Iterated FGSL. Standard errors in parentheses. 20 countries. 347 observations

Omitted region is Latin America.

Dependent variable is log of real stock return volatility.

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

Table 12. Second-Stage Regressions of the Stock Market Level. Developed Countries. Country FEs.

	(1)	(2)	(3)	(4)
Lagged dependent variable	0.785***	0.785***	0.782***	0.781***
	(0.028)	(0.028)	(0.029)	(0.029)
Growth rate of GDP per capita	-0.240***	-0.236***	-0.213**	-0.214**
	(0.083)	(0.083)	(0.085)	(0.085)
PLCQ1	-1.000***			
	(0.222)			
PLCQ2		-0.896***		
		(0.210)		
PLCP1			-0.350	
			(0.624)	
PLCP2				-0.279
				(0.511)
LL	114.96	113.97	107.56	107.60
AR1	0.23	0.23	0.25	0.25

Iterated FGSL. Standard errors in parentheses. 20 countries. 325 observations

Dependent variable is log of real stock market index.

Country fixed effects are included.

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

Table 13. Second-Stage Regressions of the Stock Market Level. Developed Countries. Region FEs.

	(1)	(2)	(3)	(4)
Growth rate of GDP per capita	0.023*	0.022*	0.013	0.012
	(0.013)	(0.013)	(0.014)	(0.013)
PLCQ1	-0.143***			
	(0.032)			
PLCQ2		-0.123***		
		(0.029)		
PLCP1			-0.084	
			(0.085)	
PLCP2				-0.085
				(0.072)
I(Creditor rights index = 3 or 4)	-0.011	-0.014	-0.009	-0.011
	(0.013)	(0.013)	(0.013)	(0.013)
I(Commonwealth+Japan)	0.039***	0.039***	0.036***	0.036***
	(0.010)	(0.010)	(0.010)	(0.010)
LL	694.69	694.66	691.33	692.77
AR1	0.75	0.75	0.75	0.75

Iterated FGSL. Standard errors in parentheses. 20 countries. 345 observations

Omitted region is Continental Europe.

Dependent variable is log of real stock market index.

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

Table 14. Second-Stage Regressions of the Stock Market Volatility. Developed Countries. Country FEs.

	(1)	(2)	(3)	(4)
Lagged dependent variable	0.120**	0.116**	0.096*	0.104*
	(0.057)	(0.057)	(0.055)	(0.056)
Growth rate of GDP per capita	0.235	0.245	0.200	0.207
	(0.191)	(0.191)	(0.185)	(0.186)
Log(# publicly listed firms)	0.144*	0.153**	0.178**	0.178**
	(0.077)	(0.078)	(0.074)	(0.075)
Capital controls (de jure)	-0.001	-0.001	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
PLCQ1	0.388			
	(0.426)			
PLCQ2		0.512		
		(0.394)		
PLCP1			4.536***	
			(1.347)	
PLCP2				3.014***
				(1.050)
LL	-123.49	-123.08	-118.98	-120.34
AR1	0.01	0.01	0.01	0.01

Iterated FGSL. Standard errors in parentheses. 20 countries. 316 observations

Dependent variable is log of real stock return volatility.

Country fixed effects are included.

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

Table 15. Second-Stage Regressions of the Stock Market Volatility. Developed Countries. Region FEs.

	(1)	(2)	(3)	(4)
Growth rate of GDP per capita	0.237	0.241	0.202	0.213
	(0.189)	(0.189)	(0.184)	(0.186)
Log(# publicly listed firms)	0.005	0.005	0.007	0.004
	(0.032)	(0.032)	(0.031)	(0.031)
Capital controls (de jure)	-0.002	-0.002	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
PLCQ1	0.347			
	(0.414)			
PLCQ2		0.494		
		(0.383)		
PLCP1			3.899***	
			(1.169)	
PLCP2				2.431***
				(0.890)
I(Creditor rights index = 3 or 4)	-0.084	-0.065	-0.069	-0.012
	(0.068)	(0.070)	(0.066)	(0.072)
I(Commonwealth+Japan)	-0.174**	-0.174**	-0.162**	-0.158**
	(0.081)	(0.081)	(0.079)	(0.079)
LL	-149.34	-148.99	-145.11	-146.72
AR1	0.25	0.25	0.25	0.25

Iterated FGSL. Standard errors in parentheses. 20 countries. 335 observations

Omitted region is Continental Europe.

Dependent variable is log of real stock return volatility.

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

Figure 1. The Distribution of Countries over Creditor Rights Index (CR)

	Developing	Developed
CR=0	Colombia, Mexico, Peru, Philippines	France
CR=1	Argentina, Brazil	Australia, Canada, Finland, Greece, Ireland, Portugal, Switzerland
CR=2	Chile, Turkey	Belgium, Italy, Japan, Netherlands, Norway, Spain, Sweden
CR=3	Korea, South Africa, Thailand	Austria, Denmark, Germany, New Zealand
CR=4	China, Egypt, Hong Kong, India, Indonesia, Israel, Malaysia, Pakistan, Singapore	United Kingdom

Figure 2. The Distribution of Predicted Probability of Liquidity Crisis: Quantity Approach

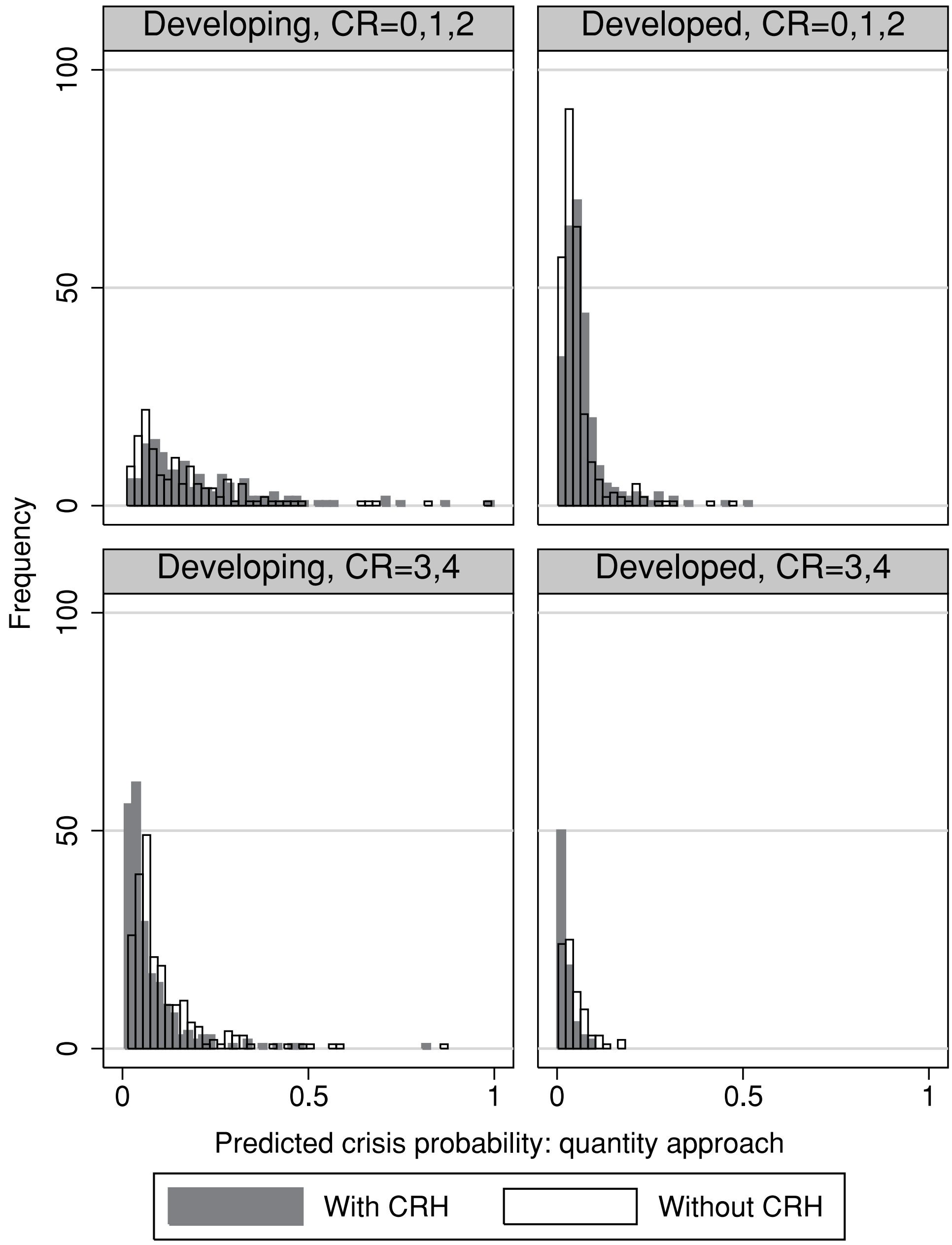
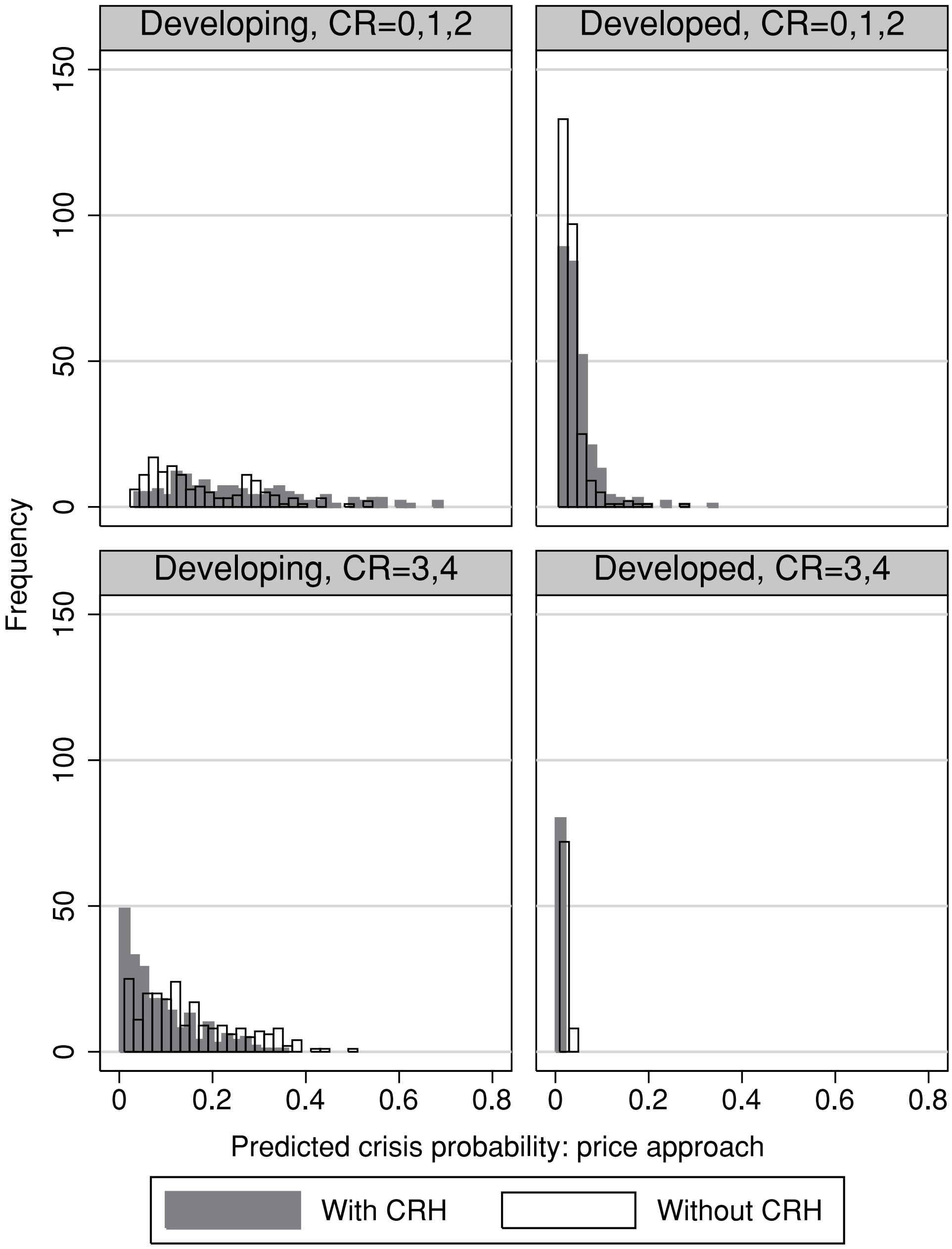


Figure 3. The Distribution of Predicted Probability of Liquidity Crisis: Price Approach



Appendix 1. Creditor Protection and Stock Price: Empirical Regularity

The data shows a strong positive link between the creditor protection and the level of stock market prices and a negative link between the creditor protection and the volatility of the stock market. To demonstrate it in the simplest way possible, we group the values of the creditor rights protection index (CR) into high (3,4) and low (0,1,2) so that our results are not influenced by individual countries.[21] Using this measure we estimate a linear regression of the log of deflated stock market index (q) and stock return volatility (σ) on the indicator of a high level of credit rights protection (CRH),[22] developed country dummy (DEV), and the interaction of the two yields the following results:

$$Log(q) = -0.06 + 4.49 * DEV + 3.58 * CRH - 2.82 * DEV * CRH + \varepsilon_q$$

$$Log(\sigma) = 2.33 - 0.59 * DEV - 0.42 * CRH + 0.29 * DEV * CRH + \varepsilon_\sigma$$

where ε is a robust standard error. All coefficients are statistically significant at 1-percent confidence level. The total effect of CRH for developed countries is significantly positive at the 4-percent level in the stock price level regression and is significantly negative at the 3-percent confidence level in the volatility regression. Adjusted R^2's are equal to 0.25 and 0.21, respectively, and 774 observations were used.

The magnitude of the effect of creditor right on the *level* of the stock market index is substantial for developing countries (for an average developing country an improvement in creditor protection from low to high would increase the level of the stock market index by 1.5 standard deviations), but is quite small for developed countries. This result is consistent with Mendoza (2006b).

The magnitude of the effect of creditor rights on stock market *volatility* is non-negligible, although not very large — an increase in creditor protection from low to high for an average developing country would lower its stock market volatility by 80 percent of the standard deviation; for an average developed country, it would lower volatility by about a quarter of the standard deviation.

21 We repeat all the results below with both the raw index and the full set of five indicators for each value of the index. As we report in the robustness tests section, our results are not affected qualitatively by these modifications.

22 See text for the discussion of this variable.

Appendix 2. Data Sources

In the regressions that are reported we used the data series constructed from the variables listed below. In our robustness tests we used a host of additional control variables that were obtained mostly from the IFS and the Global Financial Data.

Variable	Units	Frequency	Source
Creditor rights index	Index 0-4	cross-section	La Porta, et al. (1998)
Composite stock market close	Index	monthly (eop)	Global Financial Data
Exchange rate against U.S. dollar	n.c./U.S.dollar	monthly (eop)	Global Financial Data
U.S. CPI	Index	monthly (eop)	Global Financial Data
Bank credit to private sector	millions of n.c.	annual	IFS, line 22d
Deposit rate	percent	annual/monthly (eop)	IFS, line 60l
Money market rate	percent	annual/monthly (eop)	IFS, line 60b
Inflation rate	percent	annual/monthly	IFS, line 64..x
GDP in U.S. dollars	millions of USD	annual	Global Financial Data
Population	thousands of people	annual	Global Financial Data
De jure financial account openness	Index 0-100	annual	Edwards (2006)
Index of political stability	Index 0-100	annual	ICRG
Index of *de jure* capital controls	Index	annual	Edwards (2006)
Systemic sudden stop	Binary	annual	Calvo et al. (2006)
Companies listed on stock markets	units	annual	Global Financial Data