CREDIT CONSTRAINTS AND STOCK PRICE VOLATILITY

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<u>**ABSTRACT**</u>

This paper addresses how creditor protection affects the volatility of stock market prices. Credit protection reduces the probability of oscillations between binding and non-binding states of the credit constraint; thereby lowering the rate of return variance. We test this prediction of a Tobin's q model, by using cross-country panel regression on stock price volatility in 40 countries over the period from 1984 to 2004. Estimated probabilities of a liquidity crisis are used as a proxy for the probability that credit constraints are binding. We find support for the hypothesis that institutions that help reduce the probability of oscillations between binding and non-binding states of the credit constraint also reduce asset price volatility.

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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 mitigating the problems of asymmetry information and moral hazard between creditors and borrowers. Hence, it is shown to affect 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 in Levine (2004) and Djankov et al. (2006), with more sophisticated econometric methods and boarder 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 credit market.

Beside the impact on macro economy, creditor protection also affect firm's investment and operation. It lowers firm's borrowing cost and increases firm's value (e.g. La Porta et al. (2000), and Bae and Goyal (2003)). Furthermore, it reduce cash-flow risk, operating income variability, and operating leverage (e.g. Claessens et al. (2001)).

So far, these studies focus on the credit market and very little on the stock market. In this paper, we try to fill a gap by looking at how creditor rights affect the stock return volatility for market aggregates.[1] We argue that creditor protection that may relax credit constraints is also associated with equity price volatility, and the institutional weakness in the credit market exacerbates the volatility. We expect that better creditor protection could reduce market volatility. The main intuition is as follows. Firms need to provide collaterals to creditors and thus face credit constraints. When the credit constraint oscillates between binding and non-binding, firms'

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[1]Some studies have examined how corporate control affects the dispersion of stock prices with a market. For example, Morck et al. (2000) look at the stock price co-movement within a country. They find that co-movement is more pronounced in poor economies than in rich economies, which they contribute 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.

investment, operation and capital return will fluctuate as well. But the probability of this oscillation can be reduced with better creditor protection. Consequently, firm value (first moment) will rise, and the volatility (second moment) of firm value will decline.

We illustrate this intuition with a Tobin's q investment model. We start with the free market case, and derive the closed-form solution of Tobin's q (our theoretical counterpart of stock price) and its volatility. We then introduce the credit constraint, which depends on the degree of creditor protection and firm's productivity. We show that given a distribution of productivity shocks, weak creditor protection causes more variation of Tobin's q, due to the oscillation between credit binding and nonbinding.

We then put the prediction into empirical testing. We look at aggregated stock return volatility in 41 countries over the years 1984-2004. We find a empirical regularity that better creditor protection is associated with lower stock price volatility. We then use a two-stage cross-country analysis to further examine this regularity. In the first stage, we look at how creditor protection affects the probability of liquidity crises, defined as a large rise of real interest rate, which serves as our proxy for the probability of credit binding. We find that better creditor protection reduces the probability of crises. In the second stage, we examine whether the predicted probability of crises has an expected effect on the stock market volatility. And we find that higher probability of crises is indeed connected with larger stock return volatility.

The remainder of the paper proceeds as follows. Section 2 presents the theory. Section 3 describes the data, empirical regularity, empirical approach and results. Section 4 summarizes the conclusions.

2   Theory

Here we propose a model that demonstrates potential links between creditor rights and stock price volatility. It is based on the Tobin's q investment model.

2.1   Tobin's q Model

Consider a small open economy, producing a single aggregate tradable good. The production function for that good, Y, is Cobb-Douglas:[2]

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

where A_t, $1 - \rho$, and K_t denote the productivity level, the distributive share of capital, and the capital stock, respectively. We assume that productivity levels follow a first-order autoregressive 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 $[-1, 1]$. Using small letters to denote logs of cap letters, we get

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

Firms maximize the expected value of the discounted sum of profits subject to the available production technology and to a cost-of-adjustment investment technology. According to the latter, gross investment (Z_t) is specified as

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

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

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

Denote r as the world interest rate, a representative firm will maximize the following Lagrangian:

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

where the Lagrangian q_t could be interpreted as Tobin's q.

Maximizing the Lagrangian gives two first order conditions. The first one is with respect to I_t:

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

Denoting $\ln(K_t)$ as k_t and linearizing $\ln\left(v\left(q_t - 1\right) + 1\right)$ gives

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

The second first-order condition 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} is the capital rental rate. The optimal-investment 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, plus the continuation value in the capital remaining for the entire future.

Note that from equation (1):

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

Linearizing $\ln(R_{t+1})$, and denoting $\pi \equiv 1 + \ln(1 - \rho)$, 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

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

At the deterministic steady state, $I_t = 0$, and $q_t = 1$. Therefore, around the steady state, the term $(q_{t+1} - 1)^2$ is in an order of magnitude smaller than $(q_{t+1} - 1)$. According to the log linearization approximation, we can then drop the square term from equation (12) and obtain:

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

2.1.1 Free Market Valuation of q

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 q_t by a "guess":

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

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

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

(16)

Substituting equations (15) and (16) into equation (14), we solve B_0, B_1, B_2 by comparing coefficients for a_t and k_t:[3]

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

(17)

2.2 Creditor Protection and Credit-Constrained Investment

We now analyze a Tobin's q mechanism that evolves around credit constraints.[4]

Assume that the firm has to borrow from the creditor a durable input W_t, where $W_t \in [0, 1]$. At the end of the period t, the firm needs to return W_t. For simplicity, assume that the interest rate paid on the durable input is zero. Then the firm will borrow up to 1. However, there are some chances that the firm is not willing, or able, to return W_t, and the creditor has to go to a costly court procedure to claim back the durable good W_t. Therefore, the creditor imposes an ex ante constraint on how much the firm can borrow. More specifically,

$$W_t \leq \min[\omega A_t, 1].$$

(18)

The borrowed input is constrained by the firm's productivity level A_t: as A_t decreases, the firm will have to borrow less. Finally, higher ω is associated with better creditor protection.[5]

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[3]Note that the jumping variable q_t is negatively related to the state variable k_t.

[4]See Bernanke and Gertler (1989), Hart and Moore (1994), Kiyotaki and Moore (1997), and Mendoza (2006).

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

Assume that production function is:

$$Y_t = A_t W_t K_t^{1-\rho}. \tag{19}$$

Therefore, if $W_t = \omega A_t$, then $Y = A_t \omega A_t K_t^{1-\rho}$. However, if $W_t = 1$, $Y = A_t K_t^{1-\rho}$.

According to equation (3), a_{t+1} lies uniformly within $[\gamma a_t - 1, \gamma a_t + 1]$, then the probability of a binding constraint is:

$$\Pr\left(W_{t+1} < 1\right) = \left(\frac{-\ln\omega - (\gamma a_t - 1)}{2}\right),$$

with the assumption that $\gamma a_t - 1 < -\ln\omega < \gamma a_t + 1$.

A representative firm will maximize the following Lagrangian:

$$L = E\left[\Sigma_{t=0}^{\infty}\frac{1}{(1+r)^t}\left(A_t W_t K_t^{1-\rho} - Z_t + q_t\left(K_t + I_t - K_{t+1}\right)\right)\right]. \tag{20}$$

where the Lagrangian multiplier, q_t, is interpreted again as Tobin's q.

Maximizing this Lagrangian will again gives us equations (7) and (8), although now the form for $E_t\left[R_{t+1}\right]$ is different. At time t, the firm needs to take into account whether the constraint will be binding or not at time $t + 1$. Equation (10) therefore becomes

$$
\begin{aligned}
E_t\left[R'_{t+1}\right] &= E_t\left[\pi - \rho k_{t+1} + a_{t+1} + \ln\left(W_{t+1}\right)\right] \tag{21}\\
&= E_t\left[\pi - \rho k_{t+1} + 2a_{t+1} + \ln\omega \mid W_{t+1} < 1\right] * \Pr\left(W_{t+1} < 1\right)\\
&\quad + E_t\left[\pi - \rho k_{t+1} + a_{t+1}|W_{t+1} = 1\right] * \Pr\left(W_{t+1} = 1\right)\\
&= \pi - \rho k_{t+1} + \gamma a_t - \frac{1}{4}\left(\ln\omega + (\gamma a_t - 1)\right)^2.
\end{aligned}
$$

Note that $E_t\left[\pi - \rho k_{t+1} + 2a_{t+1} + \ln\omega \mid W_t < 1\right]$ is the expected R_{t+1} when the constraint is binding, while $E_t\left[\pi - \rho k_{t+1} + a_{t+1}|W_t = 1\right]$ is the expected R_{t+1} when the constraint is not binding.

8

Combining equations (7), (8) and (21) generates

$$q'_t = \frac{\pi + \rho v - \rho k_t + \gamma a_t - \frac{1}{4}\left(\ln \omega + (\gamma a_t - 1)\right)^2 + E_t q_{t+1}}{1 + r + \rho v}. \tag{22}$$

Again we solve q'_t by guess:

$$q'_t = B'_0 + B'_1 a_t + B'_2 k_t + B'_3 a_t^2 \tag{23}$$

and

$$q'_{t+1} = B'_0 + B'_1 a_{t+1} + B'_2 k_{t+1} + B'_3 a_{t+1}^2. \tag{24}$$

Then

$$E_t q_{t+1} = B'_0 + B'_1 \left(\gamma a_t\right) + B'_2 \left(k_t + v\left(q'_t - 1\right)\right) + B'_3 \left(\gamma^2 a_t^2 + \frac{1}{3}\right). \tag{25}$$

Note that since a_{t+1} has a conditional uniform distribution over $[\gamma a_t - 1, \gamma a_t + 1]$, $E\left(a_{t+1}^2\right) = \gamma^2 a_t^2 + \frac{1}{3}$.

Plugging equations (23) and (25) into equation (22), we solve B'_0, B'_1, B'_2 and B'_3 by comparing coefficients for a_t and k_t:

$$
\begin{aligned}
B'_0 &= \frac{-\frac{1}{4}(1-\ln\omega)^2 - vB''_2 + \frac{1}{3}B''_3 + v\rho + \pi}{r + v\rho - vB''_2} \\
B'_1 &= \frac{(3-\ln\omega)\gamma}{2\left(r - \gamma + v\rho - vB''_2 + 1\right)} \\
B'_2 &= \frac{r + \rho v - \sqrt{(r+\rho v)^2 + 4\rho v}}{2v} \\
B'_3 &= -\frac{1}{4}\frac{\gamma^2}{r + v\rho - \gamma^2 - vB''_2 + 1}
\end{aligned}
\tag{26}
$$

Note that as credit-constraint laxity coefficient, ω, rises, so does the market value of the firm, q_t; because B'_0 is increasing in ω.[6]

---

[6] Note that $(1 - \ln \varpi)$ is positive in the model. Therefore, as ϖ increases, $(1 - \ln \varpi)^2$ decreases.

Conditional on information available at time t,

$$
\begin{aligned}
Var_t \left[q'_{t+1} - q'_t \right] &= Var_t \left[B'_0 + B'_1 a_{t+1} + B'_2 k_{t+1} + B'_3 a^2_{t+1} \right] \\
&= Var_t \left[B'_1 a_{t+1} + B'_3 a^2_{t+1} \right].
\end{aligned}
$$

As ω increases, B'_1 decreases, which lowers $Var_t \left[q'_{t+1} - q'_t \right]$. Therefore, better creditor protection reduces the price volatility. The intuition is that R_{t+1} fluctuates when the credit constraint oscillates between binding and non-binding (see equation (21)). As ω goes down, the difference in output in the state where $W_{t+1} = 1$ and the state where $W_{t+1} = \omega A_{t+1}$ becomes larger, thus output fluctuates more and as a result R_{t+1} becomes more volatile. Note that as ω increases, B'_0 increases, so Tobin q'_t increases rather than decreases.

Earlier, we assume that $\gamma a_t - 1 < -\ln \omega < \gamma a_t + 1$, which allows the constraint to shift between binding and non-binding. Now suppose that the constraint is always binding, i.e., $\gamma a_t + 1 < -\ln \omega$, then equation (21) becomes

$$
\begin{aligned}
E_t \left[R''_{t+1} \right] &= E_t \left[\pi - \rho k_{t+1} + a_{t+1} + \ln \left(W_{t+1} \right) \right] \qquad (27) \\
&= E_t \left[\pi - \rho k_{t+1} + 2a_{t+1} + \ln \omega \right]
\end{aligned}
$$

And equation (22) becomes

$$
q''_t = \frac{\left(\pi + \rho v - \rho k_t + 2\gamma a_t + \ln \omega + E_t q_{t+1} \right)}{1 + r + \rho v}
$$

Again, we can solve q_t'' by a "guess", and obtain

$$
\begin{aligned}
B_0'' &= 1 - \frac{\left(r+v\rho-\sqrt{(r+\rho v)^2+4\rho v}\right)(\pi-r+\ln\omega)}{2v\rho} \\
B_1'' &= \frac{2\gamma-2\gamma^2+\gamma\left(r+v\rho-\sqrt{(r+\rho v)^2+4\rho v}\right)}{r-2\gamma-r\gamma+\gamma^2-v\gamma\rho+1} \\
B_2'' &= \frac{\left(r+v\rho-\sqrt{(r+\rho v)^2+4\rho v}\right)}{2v}
\end{aligned}
\tag{28}
$$

Hence, when the credit constraint always binds, better creditor protection (i.e., higher ω) will increase the stock price, but may not have impact on the price volatility.

3   Empirical Analysis

In this section we test whether credit constraints and creditor protection indeed affect stock market volatility in the way predicted by the model. We first discuss the data, empirical regularities, the empirical approach, and then present the results.

3.1   Data

The data used in this project comes from the combination of sources as described in the Appendix.

Our creditor protection index comes from La Porta, et al. (1998).[7] The creditor rights index ranges from 0 to 4 and is formed by adding one when the country imposes restrictions, such as creditor consent or minimum dividends to file for reorganization; when secured creditors are able to gain possession of their security once the reorganization petition has been approved (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. Therefore, higher creditor rights index is associated with better protection for creditors. Figure 1 shows the countries in our sample that fall into different categories of the creditor rights index.

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

Figure 1: The distribution of countries over creditor rights index (CR)

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

The data for stock market indexes come from Global Financial Data. We have monthly data (end of month closes, as calculated by central banks, national statistical agencies, or stock exchanges themselves). The country coverage includes emerging economies as well as developed economies for the years 1984-2004.[8] We converted all stock market indexes in U.S. dollar terms by multiplying them by the end of month exchange rates and scaled them down by the U.S. CPI index at the end of the month.

To measure the stock return volatility (σ), we use the Officer's method (Officer (1973)). The Officer method estimates the stock return standard deviation for month 1 to month 12; next estimate the standard deviation from month 2 to month 13; and then repeat the procedure, rolling the sample forward continuously. A potential problem with Officer's approach is that the use of overlapping observations will create a correlation between standard deviations at different points in time. An alternative is to use non–overlapping observations. That is, to compute the standard deviation using, say, months 1 through 12, 13 through 24, and so forth. The problem is that this procedure results in relatively few data points. We tried both methods and obtain similar results.

3.2   Empirical Regularity

Figure 2 demonstrates the link between credit protection and stock return variability. We can see that better creditor protection is associated with lower stock price volatility. This relationship is confirmed statistically: the linear regression of the log of stock return volatility (σ) on creditor rights index (CR), OECD dummy and the interaction of the two yields the following result

$$Log(\sigma) = 2.26 - 0.47 * OECD - 0.11 * CR + 0.060 * OECD * CR + \varepsilon,$$

where ε is a robust standard error. All coefficients are statistically significant at one percent confidence level, the total effect of CR for OECD countries is significantly negative at four percent

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[8]The panel is unbalanced.

confidence level, and adjusted R^2 is equal to 0.11. 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 0 to 4 for a non-OECD country would lower stock market volatility by one standard deviation, while for an OECD country, by about a half of the standard deviation.

We obtain the data on interest rates from IMF International Financial Statistics. In most cases we use money market rate. When money market rate is not available, we use the discount rate. We calculate real interest rate by subtracting the inflation rate from the nominal interest rate. We then calculated annual percentage changes in these real interest rates to identify financial crisis episodes as described in the previous section. Table 1 lists the financial crisis episodes that we identified.
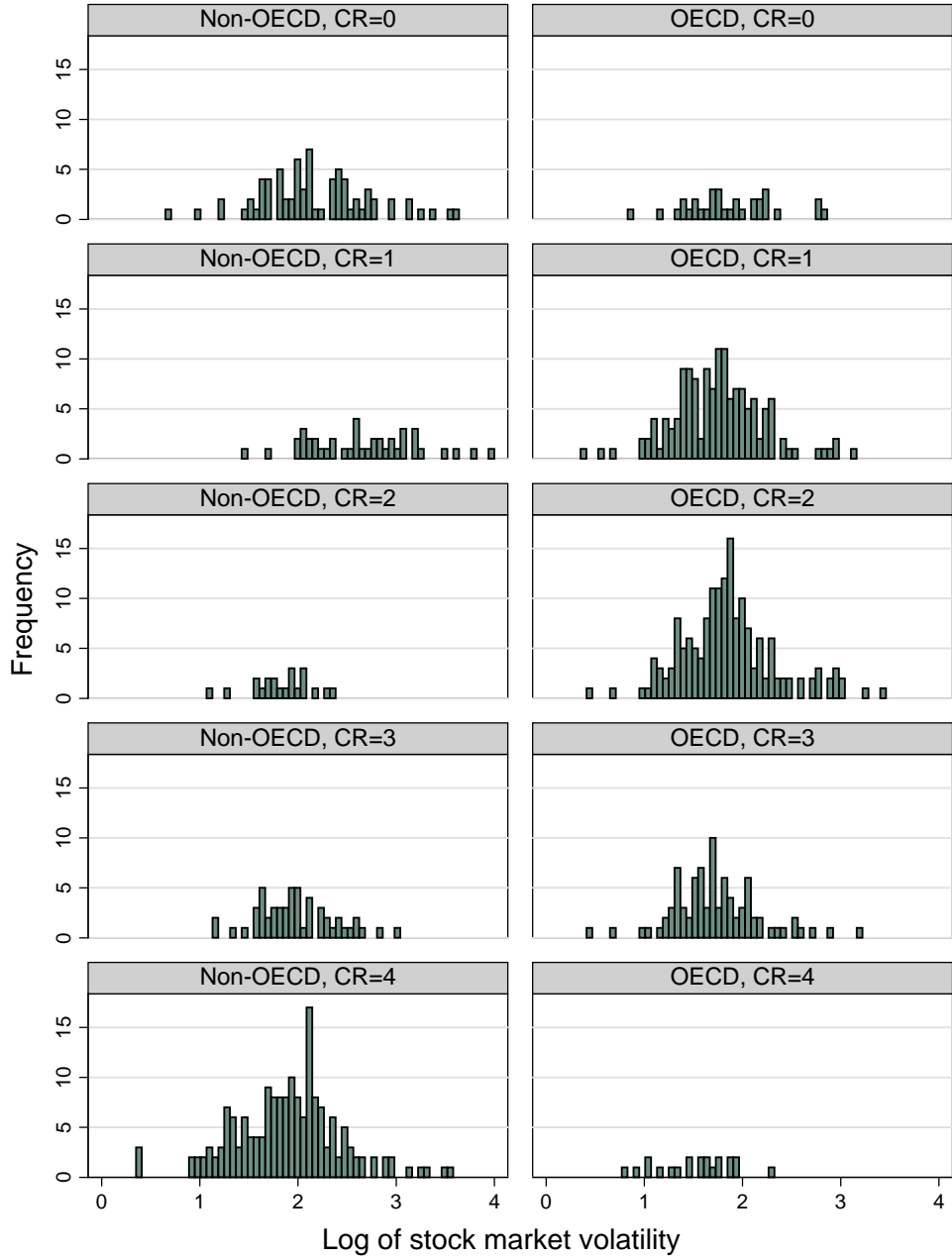
3.3 Empirical Approach

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

In recent literature, financial crises are triggered not only by fundamental shocks, but also by the degree to which market expectations about these fundamentals are coordinated. In the absence of common knowledge, an individual market participant receives only an independent and noisy signal about the fundamentals but also must have some uncertainty about the other market participants' expectations. Morris and Shin (2000) show how the market participants' knowledge about the statistical distributions of the signals and the market fundamentals (but not the actual realization of the fundamental and its idiosyncratic signals) helps to coordinate the behavior of market participants. The coordination of expectations induces a unique equilibrium in such a set up, in which there exists a unique threshold level of the fundamental.[9]

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[9]In a limiting case when the signal's residual approaches zero.

Figure 2: The distribution of stock market volatility.

This recent theory of financial crises can guide us as to how to design our empirical approach. Financial crises are cast in terms of self-fulfilling expectation games. Self-fulfilling expectations games played by market participants have elements of a "beauty contest" (Allen, Morris and Shin, 2003). Market participants must care not just about acting in the way that conforms with current fundamentals, but also about acting similarly to the way other do. Institutional features determine the stochastic distribution of the fundamentals and the effect of the market fundamentals on the performance of institutions. Thus, for example, creditor protection exerts not only a direct effect on stock return volatility, but it could also have an indirect effect on the volatility, through its impact on the probability of financial crises.

We define financial crisis as an event of a big increase in the real interest rate of over 5 percentage points in one year, which corresponds to highest 10% of annual changes in real interest rate in our sample. We also define an alternative measure, to be used for the robustness tests, where crisis is defined as an increase in the real interest rate of over 10 percentage points in one year, or top 5% of annual real interest rate changes. Table 1 presents a list of countries and years for which our financial crisis indicator is equal to 1. Thus, our financial crisis variable measures domestic financial crises and proxies for the times when credit constraints are likely to be binding.

Following the methodology in Razin and Rubinstein (2006), we use a financial crisis indicator to estimate the following model.

$$\text{I(crisis)}_{it} = \left\{ \begin{array}{ll} 1 & \text{if } y_{it} > 0 \\ 0 & \text{if } y_{it} \leq 0 \end{array} \right. ,$$

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

$$y_{it} = X'_{it}\beta + \varepsilon_{it},$$

and ε have either normal or logistic PDF.

We then construct a measure of the probability of financial crisis as a predicted value from the above estimation, which we use in the analysis of stock market volatility.

We first analyze the data in a panel regression without fixed effects with AR(1) and heteroschedasticity in errors, estimating it by feasible GLS (FGLS). In this regression we test whether credit constraints, as measured by the probability of financial crisis, as well as creditor rights index have an expected effect on the stock market volatility. Specifically, we estimate

$$\ln(\sigma_{it}) = \alpha + \gamma * \Pr(\text{crisis})_{it} + Z'_{it}\delta + \omega_{it},$$

where $\ln(\sigma_{it})$ is our measure of the stock market volatility, for December of each year; α is a constant term, Z_{it} is a set of control variables, errors ω_{it} are allowed to be serially correlated and heteroschedastic.

Evidently, one cannot possibly account by institutional variables for all the cross–country differences that would affect the variations in the stock market volatility between countries. Thus, we employ country specific fixed–effects regression analysis. Since our creditor rights measure does not vary over time, it drops out from these regressions. Nevertheless, we can still measure the effects of credit constraints. Specifically, we estimate

$$\ln(\sigma_{it}) = \alpha_i + \gamma * \Pr(\text{crisis})_{it} + Z'_{it}\delta + \omega_{it},$$

where $\ln(\sigma_{it})$ is our measure of the stock market volatility, for December of each year; α_i are country fixed effects, Z_{it} is a set of control variables, errors ω_{it} are allowed to be serially correlated and heteroschedastic. We use FGLS with AR(1) disturbances in order to estimate this regression.

The above two stage system can be identified with any set of explanatory variables through functional form. However, functional form identification tends to be weak, which is why we include in the first stage the variables that are likely to affect the probability of financial crisis but do not have a direct effect on stock market volatility, at least in our sample. Thus, we identify this system

by both functional form and exclusion restrictions.

Because 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 OECD and non–OECD countries as well as for the full sample.

In the first stage we use two additional controls: political situation, which is measured by the ICRG index; and *de jure* financial account openness, which we obtained from Edwards (2006). Higher value of the ICRG index indicates better political situation, higher value of the index of financial account openness indicates more capital mobility, fewer restrictions on capital flows.

In the regressions without country fixed effects in the second stage we control for the country's wealth measured as GDP in U.S. dollars divided by population and for the size of the stock market measured by the log of number of firms listed on the stock markets. These variables were all obtained from Global Financial Data. We also allow for different levels of stock market volatility under fixed and floating exchange rate regimes. We define exchange rate regime to be fixed if Reinhart & Rogoff (2004) coarse index is equal to either 1 or 2.

In addition, in the regressions with and without country fixed effects, we control for the growth rate of GDP per capita and for the volatility of the U.S. 3-year T-bill rate. We used the U.S. T-bill rate for the last day of each month from FAME and calculated the measure of volatility in the same way as we did for the stock returns. We attempted additional control variables, such as fiscal situation in the country, current account, capital mobility, stock market P/E ratio, but none of these variables entered the regressions with significant coefficients or affected the results in any way safe for some of them limiting the sample. Sovereign credit rating does enter significantly in the regressions, but it is highly correlated with 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.

3.4 Empirical Results

We now report the results of the two stage estimation procedure: probability of crises and stock price volatility.

3.4.1 Probability of Financial Crises

Here we report the results of our analysis using a less strict definition of a financial crisis. We estimated all the models with a more strict definition and found that our results are very similar, with the coefficients of interest in the second stage being larger in magnitude.

In the estimation of the first stage, we find that

$$\Pr(crisis) = 1.16 - 0.16 * CR - 0.02 * POL - 0.01 * CAP + \epsilon,$$

where ϵ is the standard error, POL is the indicator of political situation in the country, CAP is a measure of capital mobility. We find that better creditor protection, more stable political situation, and more open financial account all lower the probability of domestic financial crisis. The McFadden's adjusted R^2 for this regression is 0.15.[10] We use predicted values of this regression as a probability of financial crisis, our proxy for the tightness of the credit constraints, in the second stage.

3.4.2 Stock Market Volatility

Tables 2 and 3 report the results of our second stage estimation, with results of the GLS regressions without fixed effects reported in Table 2 and those with fixed effects reported in Table 3. We control for the growth rate of GDP per capita and for the volatility of the U.S. 3-year T-bill rate in both sets of regressions. In the regressions without country fixed effects we also control for the level of GDP per capita, the log of number of firms listed on the stock market, and the indicator of whether

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[10]The described regression is estimated using probit. We obtain almost identical results with logit regressions.

the country has a fixed exchange rate regime.

Both Tables present the results for the full sample (columns (1) and (4)), the non-OECD countries (columns (2) and (5)), and the OECD countries (columns (3) and (6)). The countries that joined the OECD during our sample period are classified as non–OECD prior to joining and as OECD in the aftermath.

In the regressions without fixed effects, presented in Table 2, we can estimate the effects of creditor rights index. As model predicts, we find that better creditor protection leads to lower volatility of the stock market. Adding our proxy for the tightness of the credit constraint, the predicted probability of financial crisis, we see that indeed some of the effect of the creditor protection works through the probability of the financial crisis, since the coefficients on the creditor rights index in columns (4)-(6) are lower than those in columns (1)-(3), which did not include the predicted probability of the financial crisis.[11] However, there remains a direct effect of creditor protection on the stock market volatility.

We note that the effect of creditor protection is much smaller in OECD countries, which is expected because the property rights protection in OECD countries tends to be better overall, making creditor protection less important. In fact, once we control for the probability of financial crisis, the creditor rights indicator no longer has a significant direct effect on the stock market volatility in OECD countries.

As predicted by our model, higher probability of financial crisis, which proxies for a higher chance that credit constraints are binding, increases the volatility of the stock market. This effect is especially pronounced for the OECD countries. However, we are concerned that this correlation between the probability of financial crisis and the stock market volatility arises because of unobserved differences between the countries. Thus, we estimated the model with country fixed effects to

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[11]Including the predicted probability of the financial crisis does limit our sample somewhat, thus one might be concerned that the difference in coefficients is driven by the change in sample rather than the inclusion of this variable. We re–estimated regressions in columns (1)-(3) limiting the sample to be the same as in columns (4)-(6) and found that limiting the sample affects the coefficients in a negligible way. The results are available from authors upon request.

analyze the time–series relationship between credit constraints and stock market volatility. Because creditor rights index does not vary over time for each country, it drops out of the regression.

Table 3 presents the results of the analysis with country fixed effects. We again confirm the model prediction that higher probability of tighter financial constraints, as proxied by the probability of financial crisis, increases stock market volatility. However, for the OECD sample the coefficient is no longer statistically significant, suggesting that some of the effect found in Table 2 was indeed driven by the cross–country rather than within country variation in the probability of financial crises. On the other hand, the regression coefficient is now higher in magnitude, most likely because the country fixed effects soak up a large amount of unexplained cross–country differences in stock market volatility.

The average probability of financial crisis in the sample is 0.08 with the standard deviation of 0.10. The coefficient in column (4) of Table 3 implies that an increase in the probability of financial crisis by one standard deviation is associated with a 10% increase in the stock market volatility.[12]

Thus, our empirical analysis confirms the effect of creditor protection on the stock market volatility in an economy with credit constraints. While the effects we find are not very large, they are likely to be biased downwards because of the measurement error associated with our proxy for credit constraints, as well as the measurement error in the *de jure* definition of creditor rights index.[13]

3.4.3 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 authors upon request.

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[12]Log of stock market volatility increases by 0.10, which means stock market volatility itself increases by 10%. While this number is economically meaningful, it is not very large, given that the standard deviation of our stock market volatility measure is about 70% of its mean.

[13]It is well known that while the creditor rights index takes on a value of 4 in countries like India and China, *de facto* creditor protection in these countries is low.

We repeat our analysis with an alternative (stricter) definition of the financial crisis in the first stage, which leads to a different predicted probability of the crisis. The correlation between our old and new predicted crisis probability is very high: 0.97. We repeat our second stage estimation with this new crisis probability and find no qualitative differences in our results and very small quantitative differences.

Going back to our original definition of financial crisis, we now use logit model to construct our predicted crisis probability. The correlation of the new measure with the original one is again very high: 0.99. We re–estimate Tables 2 and 3 using this new prediction. As expected, given the high correlation of the measures of crisis probability, the estimated coefficients are almost identical to our main specification.

We re–estimated the regressions in Tables 2 and 3 including the lagged dependent variable on the right–hand side. While the coefficient estimates are now slightly smaller, their signs and significance are not affected. As we would expect, when the lagged dependent variable is included on the right–hand side, the errors are no longer serially correlated.

In the estimation of Tables 2 and 3 we did not correct our standard errors for using the predicted probability as an explanatory variable. 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 re–estimated our model in this way (with and without fixed effects), using GMM, and found that our results are robust to this correction. In fact, with country fixed effects, the significance level of the coefficients rises.

Finally, we attempted to include a number of other macroeconomic variables as controls in first or second stage of our regressions, such as current account to GDP ratio, interest margin, inflation rate, change in real exchange rate etc. These variables do not have explanatory power and do not affect the results of our analysis.

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4 A Concluding Remark

In this paper, we examine the connection between creditor protection and the volatility of stock market prices. We first show in a Tobin's q investment model that better creditor protection, and hence lower collateral requirements, reduces the price volatility. The main intuition is that firm's investment, operation and capital return fluctuates when the credit constraint oscillates between binding and non–binding, but the probability of this oscillation can be reduced by better creditor protection. We then test the theoretical model using cross-country panel regression on aggregated stock price volatility in 41 countries over the period from 1984 to 2004. We find that weak creditor protection increases the probability of liquidity crises, our proxy of the probability of credit binding, and hence the aggregated stock price volatility. Our paper thus illustrates the importance of creditor protection on the development of sound stock market: strong creditor rights not only increases the stock value, but also crucially, reduces the counter–productive volatility of the stock market.

Finally, 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 take 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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Appendix

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
US CPI Index	Index	monthly (eop)	Global Financial Data
Deposit Rate	percent	annual	IFS, line 60l
Money Market Rate	percent	annual	IFS, line 60b
Inflation rate	percent	annual	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)
Exchange rate regime	Index 1-6	annual	Reinhart & Rogoff (2004)
ICRG Index of political stability	Index 0-100	annual	ICRG
Companies listed on stock markets	units	annual	Global Financial Data
U.S. 3-year T-bill rate	percent	monthly	FAME

Table 1: List of financial crises

Country	Years of financial crisis
Argentina	1984, 1987, 1988, 1989, 1990, 1992, 1993^a, 1994^a, 2001, 2004^a
Australia	1984^a
Brazil	1987, 1988, 1989, 1990, 1992, 1993, 1994, 1996, 1997^a, 1998^a
Chile	1984^a, 1987^a, 1989
China	1995^a, 1996^a
Colombia	1996^a, 1998
Egypt	1992^a, 1996^a
Greece	1987^a
Hong Kong	1999^a
India	1984^a, 1989^a,1995^a
Indonesia	1984^a, 1997
Israel	1984, 1986, 1987, 2003^a
Korea	1989^a
Mexico	1984, 1985, 19889, 1995, 1998^a
Peru	1991, 1992, 1993^a, 1995^a
Philippines	1985, 1986, 1992, 1997^a
Portugal	1985^a
South Africa	1984^a, 1988^a
Spain	1987^a
Sweden	1992
Thailand	1997^a
Turkey	1990, 1991, 1994, 1996, 1998^a, 1999, 2001, 2003^a

[a] No financial crisis by a strict definition

Table 2: Second stage regressions. No country fixed effects

	Full Sample (1)	non-OECD (2)	OECD (3)	Full Sample (4)	non-OECD (5)	OECD (6)
Growth rate of	-0.079	-0.53***	0.25**	-0.081	-0.48***	0.14
GDP per capita	(0.10)	(0.15)	(0.14)	(0.12)	(0.17)	(0.16)
GDP per capita	-2.36***	0.74	-2.53***	-2.28***	0.19	-2.34***
	(0.30)	(1.03)	(0.44)	(0.39)	(1.01)	(0.55)
Log (# firms listed	-0.011	0.077**	-0.044*	-0.007	0.087**	-0.038
on the stock market	(0.020)	(0.039)	(0.023)	(0.021)	(0.040)	(0.025)
Volatility of the U.S.	0.076**	-0.025	0.14***	0.084	-0.016	0.14*
3-year T-bill rate	(0.035)	(0.056)	(0.044)	(0.060)	(0.096)	(0.076)
I(Fixed ER regime)	-0.12***	-0.032	-0.14***	-0.072*	0.032	-0.11**
	(0.036)	(0.061)	(0.045)	(0.039)	(0.062)	(0.049)
Creditor Rights Index	-0.056***	-0.13***	-0.060**	-0.043**	-0.11***	-0.022
	(0.017)	(0.030)	(0.024)	(0.019)	(0.033)	(0.028)
Predicted probability				0.54*	0.53	1.96**
of financial crisis				(0.32)	(0.36)	(0.87)
Constant	2.27***	1.88***	2.44***	2.16***	1.69***	2.24***
	(0.13)	(0.22)	(0.16)	(0.16)	(0.25)	(0.22)
Observations	975	458	517	784	359	425
Number of countries	41	20	23	40	19	23
ρ (AR(1) in errors)	0.41	0.44	0.36	0.39	0.38	0.34
Log likelihood	-483	-270	-194	-387	-213	-147

FGSL. Dependent variable is log of stock return volatility. Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Second stage regressions. Country fixed effects

	Full Sample (1)	non-OECD (2)	OECD (3)	Full Sample (4)	non-OECD (5)	OECD (6)
Growth rate of	-0.26***	-0.53***	-0.015	-0.26**	-0.49***	-0.074
GDP per capita	(0.092)	(0.13)	(0.13)	(0.11)	(0.16)	(0.15)
Log (# firms listed	0.086**	0.055	0.044	0.17***	0.12*	0.17**
on the stock market	(0.035)	(0.052)	(0.043)	(0.046)	(0.067)	(0.069)
Volatility of the U.S.	0.10***	-0.04	0.19***	0.16***	-0.035	0.24***
3-year T-bill rate	(0.033)	(0.052)	(0.043)	(0.060)	(0.097)	(0.076)
Predicted probability				1.05***	1.08***	1.32
of financial crisis				(0.32)	(0.34)	(1.12)
Constant	2.13***	2.39***	1.41***	1.42***	1.76***	0.41
	(0.22)	(0.31)	(0.27)	(0.29)	(0.39)	(0.57)
Observations	1112	551	561	784	359	425
Number of countries	51	29	27	40	19	23
ρ (AR(1) in errors)	0.28	0.30	0.26	0.24	0.23	0.22
Log likelihood	-502	-294	-192	-343	-193	-142

FGLS. Dependent variable is log of stock return volatility. Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%