

Financial Liberalization and Banking Crises in Emerging Economies*

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Abstract

Financial liberalization often leads to financial crises. This link has usually been attributed to poorly designed banking systems, an explanation that is largely static. In this paper we develop a dynamic explanation, by modelling the evolution of a newly-liberalized bank's opportunities and incentives to take on risk over time. The model reveals that even if a banking system is well-designed, in the sense of having good long-run properties, many countries will enjoy an initial period of rapid, low-risk growth and then enter a period with an elevated risk of banking crisis. This transition emerges because of the way in which the degree of foreign competition, the marginal product of capital, and the bank's own net worth simultaneously evolve.

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1 Introduction

Many banking crises have been preceded by financial liberalization. This link was noted as early as 1985 in a paper by Diaz-Alejandro. More recently, Kaminsky and Reinhart (1999) find that in 18 of the 26 banking crises they study, the financial sector had recently been liberalized. Caprio and Klingebiel (1996), Niimi (2000), and Gruben, Koo and Moore (2003) conclude that banks are much more likely to fail in a liberalized regime than under financial repression. Financial liberalization has also been cited as a possible culprit in the Asian financial crisis by Corsetti, Pesenti and Roubini (1999) and Furman and Stiglitz (1998).

In explaining this link, the existing literature has focussed on the institutional structure of newly liberalized banking systems. For example, many analysts have stressed that implicit or explicit promises of government bailouts expose many newly liberalized banking systems to severe problems of moral hazard. When banks are under-capitalized, bailouts cut off the lower portion of their return distribution, encouraging them to assemble loan portfolios that are riskier than would be socially optimal.¹ Responding to these ideas, policy discussions have emphasized greater transparency, better bank supervision, and the costs and benefits of bailouts. Another important institutional concern has been the extent of competition. Hellman, Murdock and Stiglitz (2000) argue that increased competition erodes a bank's franchise value, reducing its incentive to avoid risk.

¹ The seminal paper on this topic is Stiglitz and Weiss (1981). Recent applications to banking crises include Dekle and Kletzer (2001) and Tornell, Westermann and Martinez (2004). Allen and Gale (2000) argue that limited liability increases the prices investors will pay for risky assets, leading to asset price bubbles and financial crises. Dooley (2000) claims that deposit insurance makes depositors less willing to monitor banks that can "appropriate" their deposits.

It is indeed likely that newly liberalized banking systems will have major institutional flaws. This explanation, however, is static in nature. It applies to all liberalized banking sectors, whether recently liberalized or not; competition and moral hazard explain the American Savings and Loan crisis as well as they explain the banking crises in East Asia.

We believe that the crises that follow liberalization involve more than poor design. Building on this belief, we develop a dynamic, small-open-economy, general-equilibrium model of the transition period following financial liberalization. The model illustrates how financial liberalization affects the evolution of a bank's franchise value, its net worth, its returns to risk-taking, and the aggregate capital stock. We show that the period shortly—but not immediately—after liberalization can be especially risky, a result consistent with the stylized fact, emphasized by Gaytan and Ranciere (2003), that “middle income” economies are most vulnerable to banking crises.² This occurs even if the banking system is well-designed, in the sense that banks are relatively safe in the economy's long-run equilibrium. Moreover, we show that banks can be riskier in the transition period even if competition is fiercer in the long-run. Our results in no way imply that poor design of banking systems does not contribute to banking crises, for surely it does. Our results do imply, however, that financial liberalization, in and of itself, contributes as well.³

The starting point for our analysis is the immediate aftermath of financial repression.

We assume that an economy emerging from financial repression is characterized by a small

² To explain this stylized fact, Gaytan and Ranciere (2003) develop a closed-economy model where banks face risk from sunspot-triggered bank runs. Aghion, Bacchetta and Banerjee (2004) use the interaction between net worth, investment and the price of a fixed domestic factor to show that countries at “an intermediate level of financial development” are most vulnerable.

³ Our model is also complementary to the enormous literature exploring the links between banking crises and currency crises. If currency crises are a risk facing banks (e.g., Cook, 2004), our model explains why newly-liberalized banks willingly expose themselves to such risks. Conversely, if weak banking sectors trigger currency crises (e.g., Burnside, Eichenbaum and Rebelo, 2001), our model provides an explanation of why newly-liberalized banks might become weak.

capital stock—this, presumably, is why it liberalizes—and limited bank net worth. Because foreign finance is most expensive in a small market, and because a small capital stock has a high marginal product, the bank can charge high interest rates on its loans. The same high returns to capital that make lending desirable also imply that the bank faces little default risk. Banks thus lend up to their regulatory limits, retain most of their earnings, and see their net worth grow. But as the economy’s capital stock grows, its marginal productivity falls. Moreover, foreign debt becomes cheaper, as foreign lenders acquire more experience in the market. Loan interest rates begin to fall. It is at this point, when the bank’s profit margin has fallen, but is expected to fall even further, that risky behavior and banking crises are most likely. The bank’s costs of default—foregone future profits—are low, but the returns to gambling—depending on current profits—are high. If the bank can weather this period, it can enter a regime of more conservative behavior and lower leverage.

This paper is organized as follows. Section 2 contains a description of firm and household behavior, and section 3 provides a description of the financial sector. In section 4, we describe the transition from financial repression to financial liberalization for the emerging market economy. Conclusions are in section 5. Additional results and discussion, including technical appendices, are available in Daniel and Jones (2006).

2 The Non-Financial Sector

2.1 Firms

Output is produced by a unit mass of price-taking firms. Although these firms are ex-ante identical, they receive idiosyncratic productivity shocks, and firms with particularly bad shocks will be unable to repay their bank loans. Each firm lives two periods; across time,

output is produced by overlapping generations of these firms. In the first period of their lives, before they observe their productivity, firms procure capital and labor. In the second, firms realize their idiosyncratic productivity levels, produce, and repay their financiers. As is standard, we assume that capital must be installed in advance, which forces firms to finance their capital purchases through either the domestic bank or foreign creditors. Labor expenses, on the other hand, are concurrent with production, and are paid out of output.

2.1.1 Technologies

The output of firm i at time t is given by

$$Y_{it} = z_{it} K_{it}^\alpha H_{it}^{1-\alpha}, \quad 0 < \alpha < 1,$$

where z_{it} is firm i 's realized productivity, and K_{it} and H_{it} represent firm-specific capital and labor, respectively. Each firm's productivity is drawn independently from a common aggregate distribution. The aggregate distribution is stochastic over time, however, so that firms face aggregate as well as idiosyncratic risk. In particular, the distribution of z_{it} is fully characterized by the variable a_t , with

$$F(z_{it} | a_t = a_0) > F(z_{it} | a_t = a_1), \quad \forall z_{it} \in \mathbf{S}(a_0, a_1), \quad a_0 < a_1, \quad (1)$$

$$\mathbf{S}(a_0, a_1) \equiv \{z : F(z | a_0) > 0, F(z | a_1) < 1\},$$

so that conditional distributions with higher values of a_t are stochastically dominant—higher values of a_t increase the probability of higher values of z_{it} . We also assume that a_t itself follows a stationary Markov process. Many stochastic environments fit this description.⁴

⁴ A familiar example occurs when z_{it} is the sum of the aggregate shock a_t and the idiosyncratic shock e_{it} , with a_t following an AR(1) process. A second example appears in the numerical exercises below, where we assume that z_{it} takes on the value z_H with probability a_t and the value $z_L < z_H$ with probability $(1 - a_t)$, with a_t a bounded transformation of an AR(1) process.

2.1.2 The Firm's Problem

A firm born at time t chooses capital, labor, and the financing portfolio of bank loans L_{it} and foreign loans $(K_{it+1} - L_{it})$ that maximizes its expected profits at time $t + 1$. The firm's capital depreciates at the rate $\delta_{it+1} = \delta(z_{it+1})$, with $\delta'(z) \leq 0$. This reflects the notion that capital is site-specific, and that capital devoted to unproductive uses (low values of z_{it+1}) has a lower resale value. The firm's objective is

$$\begin{aligned} \max_{K_{t+1} \geq 0, 0 \leq L_t \leq K_{t+1}, H_{t+1} \geq 0} \int & [z_{it+1} K_{it+1}^\alpha H_{it+1}^{1-\alpha} + (1 - \delta(z_{it+1})) K_{it+1} - w_{t+1} H_{it+1}] dF(z_{it+1} | a_t) \\ & - (1 + \lambda_{t+1}^e) (K_{it+1} - L_{it}) - (1 + r_{t+1}^e) L_{it}, \end{aligned} \quad (2)$$

where r_{t+1}^e denotes the average interest rate on bank loans, and λ_{t+1}^e denotes the average interest rate on foreign loans required by the competitive loan market. The superscript “e” on these rates signifies one-period-ahead conditional expectations:

$$x_{t+1}^e \equiv E(x_{it+1} | a_t), \quad x \in (\lambda, r).$$

While the firm's lenders require average returns of r_{t+1}^e and λ_{t+1}^e , the actual returns will vary with the realized value of z_{it+1} . To simplify the exposition, we assume that the process for z_{it} is such that in equilibrium firms will always be able to meet their wage obligations, implying that w_{t+1} is known at time t .⁵

As discussed below, we assume that households inelastically supply one unit of labor.

Imposing this quantity, the first-order conditions for an interior solution are standard and

⁵ A firm with a particularly high (out-of-equilibrium) value of employment and a low realized value of z_t could use bankruptcy protection to avoid its full wage obligation. In the numerical exercises presented below, we assume that workers facing this possibility would require the firm to provide state-contingent wages with an expected value equal to the one given in equation (3).

are given by

$$w_{t+1} = (1 - \alpha) z_{t+1}^e K_{it+1}^\alpha, \quad (3)$$

$$K_{it+1} = \left(\frac{\alpha z_{t+1}^e}{\lambda_{t+1}^e + \delta_{t+1}^e} \right)^{\frac{1}{1-\alpha}} \quad (4)$$

$$r_{t+1}^e = \lambda_{t+1}^e. \quad (5)$$

Since all firms in a cohort are identical when they make decisions, they all procure the same inputs. Averaging across the unit mass of firms, aggregate output is given by.⁶

$$Y_{t+1} = z_{t+1} K_{t+1}^\alpha, \quad z_{t+1} \equiv E(z_{it+1} | a_{t+1}),$$

The firms' loan contracts take the form of standard debt. We assume that domestic and foreign creditors share equitably in the firm's assets when bankruptcy occurs, so that equality of expected loan rates in equation (5) implies equality of contractual loan rates. The firm agrees to pay the contractual rate of return $(1 + i_{t+1}^l)$ on loans when solvent, that is when: $z_{it+1} K_{t+1}^\alpha - w_{t+1} + (1 - \delta(z_{it+1})) K_{t+1} \geq (1 + i_{t+1}^l) K_{t+1}$. When z_{it+1} is sufficiently low, the firm defaults, and its creditors seize its resources, in fractions proportional to their loans. Integrating across firms, and imposing the equilibrium wage, the contractual rate i_{t+1}^l and the expected rate r_{t+1}^e are linked by

$$\begin{aligned} 1 + r_{t+1}^e &= 1 + \lambda_{t+1}^e & (6) \\ &= \int_{z_{it+1} \geq z^{\text{sol}}(K_{it+1}, i_{t+1}^l, a_t)} (1 + i_{t+1}^l) dF(z_{it+1} | a_t) \\ &\quad + \int_{z_{it+1} < z^{\text{sol}}(K_{it+1}, i_{t+1}^l, a_t)} [(z_{it+1} - (1 - \alpha) z_{t+1}^e) K_{t+1}^{\alpha-1} + 1 - \delta(z_{it+1})] dF(z_{it+1} | a_t), \end{aligned}$$

with the solvency threshold $z^{\text{sol}}(K_{t+1}, i_{t+1}^l, a_t)$ given by

$$z^{\text{sol}} = K_{t+1}^{1-\alpha} [i_{t+1}^l + \delta(z^{\text{sol}})] + (1 - \alpha) z_{t+1}^e. \quad (7)$$

⁶ Note that z_{t+1} is *not* the same as z_{t+1}^e : $z_{t+1} = E(z_{it+1} | a_{t+1})$, while $z_{t+1}^e = E(z_{it+1} | a_t) = E(z_{t+1} | a_t)$.

Let $R(z_{it+1}, K_{t+1}, i_{t+1}^l, a_t)$ denote the realized gross returns on loans to firm i . Integrating across firms, the return lenders realize on their entire loan portfolio, r_{t+1} , is given by

$$1 + r_{t+1} = E \left(R(z_{it+1}, K_{t+1}, i_{t+1}^l, a_t) \mid a_{t+1} \right). \quad (8)$$

2.2 Households

The economy contains a representative, infinitely-lived household that inelastically supplies one unit of labor. Given the small-open-economy assumptions described below, asset prices, which are determined in world markets, are independent of the household's saving decision. The only aspect of the household's problem that affects the dynamics of banking crises is its inelastic supply of labor. Therefore, in the interest of brevity, we omit an explicit description of the household sector.⁷

3 The Financial Sector

The financial sector consists of foreign creditors and a single domestic bank. The domestic bank has lower screening and monitoring costs than its foreign competitors, due to its superior local knowledge. Together the domestic bank's monopoly status and its cost advantage give it franchise value, which it has an incentive to protect. The bank's franchise value declines, however, as foreign creditors gain experience.

3.1 Foreign Debt

To model the cost of foreign debt, we assume that the expected return demanded by foreign investors exceeds the risk-free international rate of θ , with the premium a function of the investors' "experience" with a country's idiosyncratic economic and institutional features.

⁷ A detailed model of the household sector would be necessary, however, for welfare analyses.

This is a reduced-form way of introducing the domestic bank to foreign competition that starts off weak but builds up over time.⁸

Letting X_t denote experience, the expected return is characterized by:

$$\lambda_{t+1}^e = \lambda(X_t), \quad (9)$$

where

$$\lambda'(X) < 0, \quad \lim_{X \rightarrow \infty} \lambda(X) \geq \theta, \quad \lim_{X \rightarrow 0} \lambda(X) > \theta.$$

Experience can thus be interpreted as the organizational capital (e.g., Hall, 2000) of foreign banks. The law of motion for experience is assumed to be

$$X_{t+1} = (1 - \gamma) X_t + \gamma K_{t+1}, \quad 0 < \gamma < 1, \quad (10)$$

so that experience is increasing in its own lag and in the capital stock of the emerging market.

This captures the notion that experience grows more quickly in larger markets.

Substituting equation (9) into equation (4) and using the definition of z_{t+1}^e implies that

$$K_{t+1} = \tilde{\kappa}(X_t, a_t). \quad (11)$$

Substituting equation (11) into equation (10) yields an expression for experience as a function of its own lag and the stochastic productivity shock:

$$X_{t+1} = \kappa(X_t, a_t). \quad (12)$$

with $\kappa(\cdot)$ increasing in both arguments.

⁸ The effects of the experience premium are in some ways similar to those of standard capital adjustment costs, in that both slow the expansion of the capital stock. The experience premium, however, also allows banks to receive short-run rents after liberalization, while adjustment costs do not.

Equations (11), (6) and (9) allow us to express the contractual rate on bank loans, i_{t+1}^l , as a function of current experience, X_t , and productivity, a_t . Similarly, we can use equation (11) to substitute for K_{t+1} , to express the realized return in equation (8) as:

$$1 + r_{t+1} = R(a_{t+1}, a_t, X_t). \quad (13)$$

Equation (1) can be used to show that the return on bank loans is increasing in a_{t+1} —higher values of a_{t+1} imply that fewer firms default⁹—and decreasing in experience. Note that future productivity, a_{t+1} , is the only term not known at time t .

As long as firms use foreign debt as their marginal source of finance (equation (5) holds), interest rates, given by equation (13), and the capital stock, given by equation (11), evolve as a function of the state of experience and the exogenous technology parameter.¹⁰ Capital does not immediately jump to equate its marginal product with the international rate θ , as a lack of experience limits international financial flows.

3.2 The Domestic Bank

The bank accepts deposits and makes loans in order to maximize the expected discounted value of its dividend stream.¹¹ Since the bank must issue its loans before it observes the aggregate productivity level, the return on these loans, given by equation (13), is stochastic.

This uncertainty, combined with two finance constraints described below, implies that the bank must consider the possibility of bankruptcy. Bankruptcy is undesirable because the bank will lose its charter and the corresponding monopoly rents.

⁹ Following standard arguments (for example, Green, Mas-Collel and Whinston, 1995, proposition 6.D.1), one can see that r_{t+1} is increasing in a_{t+1} by noting that $1 + r_{t+1} = E(R(z_{it+1}, K_{t+1}, a_t, i_{t+1}^l) | a_{t+1})$, the expectation of a function that is increasing in z_{it+1} .

¹⁰In the numerical exercises presented below, we allow banks to set r_{t+1}^e below λ_{t+1}^e and capture the entire lending market. In practice, banks never exploit this option.

¹¹We accept as a stylized fact that banks are financed primarily by debt contracts (deposits) rather than with equity. We consider equity financing in a sensitivity analysis.

3.2.1 The Bank's Budget Constraints

The bank accepts deposits (B) from domestic and foreign agents. The bank lends its deposits, along with any post-dividend net worth ($Q - d$), so that its loans are given by

$$L_t = Q_t - d_t + B_t, \quad (14)$$

while Q_t , the bank's pre-dividend net worth, follows

$$\begin{aligned} Q_{t+1} &= \max \{0, (1 + r_{t+1}) L_t - (1 + i_{t+1}^b) B_t\} \\ &= \max \{0, (r_{t+1} - i_{t+1}^b) L_t + (1 + i_{t+1}^b) (Q_t - d_t)\}, \end{aligned}$$

where i_{t+1}^b is the interest rate on deposits. Defining the leverage ratio ψ_t by

$$L_t = \psi_t (Q_t - d_t), \quad (15)$$

the accumulation equation for net worth becomes

$$Q_{t+1} = \max \{0, (Q_t - d_t) [(r_{t+1} - i_{t+1}^b) \psi_t + (1 + i_{t+1}^b)]\}. \quad (16)$$

Note that the lowest return on loans that allows the bank to avoid bankruptcy is

$$1 + r_{t+1}^{\min} = \frac{\psi_t - 1}{\psi_t} (1 + i_{t+1}^b). \quad (17)$$

This implies that $r_{t+1}^{\min} < i_{t+1}^b$; even if loans do not earn enough to pay back depositors, when losses are sufficiently small, banks can bridge the difference out of their net worth. Let a_{t+1}^{\min} denote the lowest value of aggregate productivity consistent with bank solvency. Using equation (13), a_{t+1}^{\min} is implicitly given by

$$R(a_{t+1}^{\min}, a_t, X_t) = \frac{\psi_t - 1}{\psi_t} (1 + i_{t+1}^b), \quad (18)$$

with a_{t+1}^{\min} defined to be $-\infty$ when the bank is solvent under all realizations of a_{t+1} .

The bank faces two finance constraints. The first is that there is a fixed cost to issuing negative dividends, i.e., to raising new equity.¹² We assume that this cost is so high that the bank will not issue negative dividends. This requires that dividends be non-negative, prohibiting banks from issuing new net worth to avoid bankruptcy.¹³ In addition, dividends cannot exceed net worth, so that

$$0 \leq d_t \leq Q_t. \quad (19)$$

We assume that in equilibrium the upper constraint binds only in bankruptcy.¹⁴

The second finance constraint is a capitalization requirement. The ratio of loans relative to retained net worth must not exceed an upper bound:

$$0 \leq L_t \leq \bar{\psi} \times (Q_t - d_t), \quad 1 < \bar{\psi} < \infty. \quad (20)$$

This leverage restriction is common in the literature, in large part because it has been imposed internationally through the Basle Accord, but also because there are a number of papers suggesting that enforceability problems lead to collateral constraints.¹⁵ A capitalization requirement both limits a bank's ability to take on risk, by forcing it to hold a buffer of net worth, and discourages risk-taking, by requiring the bank's owners to put some of their own funds at risk.

¹²The usual explanation of why firms raise so few funds by selling stock is that equity markets suffer from extreme problems of asymmetric information. Greenwald and Stiglitz (1993) provide a nice discussion. Gomes (2001) provides an estimate of issuance costs.

¹³If the value of continuing the bank's franchise were to exceed the fixed cost of raising equity, banks with sufficiently bad finances would issue new stock. Cooley and Quadrini (2001) analyze this sort of behavior in their study of firm dynamics.

¹⁴Note that the no-new-net worth constraint could be circumvented if the government revoked the bank's monopoly franchise, and allowed new banks to enter the market.

¹⁵These include Kiyotaki and Moore (1997), Albuquerque and Hopenhayn (2004), Mendoza and Smith (2006) and Mendoza (2005). Note that in those models the leverage constraint depends on the borrower's market value, which in our case would be the market value of the bank's stock. Our leverage constraint depends on the book value of the bank's net worth, Q_t , which can be much less sensitive to aggregate shocks.

These two constraints imply that a bank with non-positive net worth can neither make loans nor raise new equity, but must instead shut down: $d_{t+j} = L_{t+j} = Q_{t+j} = 0, \forall j > 0$.

3.2.2 The Bank's Cost of Deposits

We assume that financial liberalization implies free and open international capital markets. This means that the interest rate on deposits, i_{t+1}^b , must ensure that the expected return on bank deposits, accounting for the prospect of default, equals the world interest rate θ . Assuming that investors have full information about the bank's riskiness, this condition implies that for $\psi > 1$,

$$1 + \theta = \int_{a_{t+1} > a_{t+1}^{\min}} [1 + i_{t+1}^b] dF(a_{t+1} | a_t) + \int_{a_{t+1} \leq a_{t+1}^{\min}} \frac{\psi_t}{\psi_t - 1} R(a_{t+1}, a_t, X_t) dF(a_{t+1} | a_t). \quad (21)$$

where the second term in the brackets is the average return on deposits.¹⁶ Comparative statics calculations in Appendix A of Daniel and Jones (2006) show that the equilibrium deposit rate, i_{t+1}^b , is increasing in leverage, since the depositors' returns from an insolvent bank are decreasing in leverage.

3.2.3 The Bank's Problem

In recursive form, the bank's problem is

$$V(Q_t, a_t, X_t) = \max_{0 \leq \psi_t \leq \bar{\psi}, 0 \leq d_t \leq Q_t} d_t + \frac{1}{\varpi(1 + \theta)} E(V(Q_{t+1}, a_{t+1}, X_{t+1}) | I_t), \quad (22)$$

subject to the law of motion for net worth given by equation (16) and the arbitrage condition on the deposit rate given by equation (21). $V(Q_t, a_t, X_t)$ is the market value of the bank,

¹⁶It follows from equation (14) that the the average (gross) return on deposits is given by $L_t(1 + r_{t+1}) / [L_t - (Q_t - d_t)]$.

defined over non-negative net worth, with $V(0, a_t, X_t) = 0$. $\varpi > 1$ is the bank's "discount premium;" setting $\varpi > 1$ ensures that the bank does not accumulate net worth indefinitely.¹⁷

The first order conditions are derived in Appendix A of Daniel and Jones (2006). The marginal value of net worth is

$$\frac{\partial V_t}{\partial Q_t} = \left(\frac{\psi_t}{Q_t - d_t} \right) \frac{\partial V_t}{\partial \psi_t} + \frac{1}{\varpi} E \left(\left. \frac{\partial V_{t+1}}{\partial Q_{t+1}} \right| a_{t+1} > a_{t+1}^{\min}, I_t \right) \geq 1, \quad (23)$$

where, in an abuse of notation, $\frac{\partial V_t}{\partial \psi_t}$ denotes the marginal return from increased leverage. The lower bound of unity on the marginal value of net worth reflects the bank's ability to pay dividends; an additional unit of net worth will at a minimum generate an additional unit of dividend income.

The first order condition for dividends can be expressed as

$$1 - \left(\frac{\psi_t}{Q_t - d_t} \right) \frac{\partial V_t}{\partial \psi_t} - \frac{1}{\varpi} E \left(\left. \frac{\partial V_{t+1}}{\partial Q_{t+1}} \right| a_{t+1} > a_{t+1}^{\min}, I_t \right) = 1 - \frac{\partial V_t}{\partial Q_t} \leq 0, \quad (24)$$

with the bank paying dividends only when the condition holds at equality. The dividend rule given by equation (24) can be interpreted as a comparison between the external value of net worth, given by 1, and its internal value to the bank as retained earnings, $\frac{\partial V_t}{\partial Q_t}$, given by equation (23).

Note that solving equation (23) forward yields

$$\frac{\partial V_t}{\partial Q_t} = \sum_{j=0}^{\infty} \left(\frac{1}{\varpi} \right)^j E \left(\left(\frac{\psi_{t+j}}{Q_{t+j} - d_{t+j}} \right) \frac{\partial V_{t+j}}{\partial \psi_{t+j}} \Big| a_{t+j} > a_{t+j}^{\min}, I_t \right). \quad (25)$$

Even when the bank is not leverage-constrained today ($\frac{\partial V_t}{\partial \psi_t} = 0$), if the leverage constraint binds in enough feasible future states ($\frac{\partial V_{t+j}}{\partial \psi_{t+j}} > 0$ for enough j), then the internal value of

¹⁷This sort of discount premium appears frequently in the literature on constrained corporate finance. Gross (1994) justifies this assumption by appealing to such works as Jensen and Meckling (1976), where shareholders fear that firms with too much cash will spend it on management perquisites. Milne and Robertson (1996) provide a similar justification.

retained earnings will be high enough to rule out current dividends $\left(\frac{\partial V_t}{\partial Q_t} > 1\right)$.

Proposition 1 *The bank will always be leverage-constrained either at present or in some solvent future state. $\left(\frac{\partial V_{t+j}}{\partial \psi_{t+j}} > 0\right)$ for some j .*

To prove this, note that, as shown in equation (24), the ability to pay dividends implies that $\frac{\partial V_t}{\partial Q_t} \geq 1$. With $\varpi > 1$, equation (25) shows that $\frac{\partial V_t}{\partial Q_t} \geq 1$ only if some values of $\frac{\partial V_{t+j}}{\partial \psi_{t+j}}$ are positive.

One implication of this trade-off between current and future leverage is that:

Corollary 2 *When the expected value of internal funds in the future is relatively low (high), the bank will (not) be fully levered today.*

To prove this, note that equation (24) implies that

$$\frac{\partial V_t}{\partial \psi_t} \geq \frac{Q_t - d_t}{\psi_t} \left[1 - \frac{1}{\varpi} E \left(\frac{\partial V_{t+1}}{\partial Q_{t+1}} \middle| a_{t+1} > a_{t+1}^{\min}, I_t \right) \right]. \quad (26)$$

Suppose that the bank's future prospects are relatively bleak, so that the expected marginal value of net worth in the future is unity. Then the term in the square brackets in equation (26) will be positive, implying that the current marginal value of leverage is positive, which in turn implies that the bank is fully levered. This reflects a situation where the bank's franchise value has deteriorated so much that it is willing to gamble, paying dividends and leveraging fully. Alternatively, when the expected value of future internal funds is high, the term in the square brackets will be negative, and $\frac{\partial V_t}{\partial \psi_t}$ can equal zero. It is in this situation that the bank is most likely to restrict current dividends and or current leverage in order to avoid future leverage constraints.

The exact behavior of $\frac{\partial V_t}{\partial \psi_t}$, and thus the exact shape of the value function, is harder to establish analytically. Limited liability implies that $V(Q, a, X) = 0$ for $Q \leq 0$, making

the value function convex around the default point of $Q_t = 0$. On the other hand, the numerical simulations described below show that the value function is concave over non-negative net worth, implying that solvent banks face diminishing returns in their net worth. Figure 1 illustrates these conflicting incentives. Figure 1 shows that, holding experience fixed, increasing a bank's net worth makes it more risk averse; as net worth increases, the outcomes of any lending "gamble" move rightward into the concave region of the domain.¹⁸ In contrast, increasing foreign experience (X_t) flattens the value function for solvent banks and rotates it downward, as stronger competition reduces the bank's lending spreads and profits. This strengthens the convexity produced by bankruptcy, causing the bank to become less risk-averse.

4 Equilibrium

Given the initial values (Q_0, X_0) and the exogenous process $\{a_t\}_{t=0}^{\infty}$, an equilibrium is a collection of stochastic processes for quantities, $\{K_{t+1}, H_{t+1}, L_t, Q_{t+1}, \psi_t, d_t, X_t\}_{t=0}^{\infty}$, and prices, $\{w_{t+1}, \lambda_{t+1}^e, r_{t+1}^e, i_{t+1}^l, r_{t+1}, i_{t+1}^b\}$ such that: (i) given $\{w_{t+1}, \lambda_{t+1}^e\}$, $\{K_{t+1}, H_{t+1}\}$ satisfy the optimality conditions for the firm given by equations (3) and (4); (ii) given $\{K_{t+1}, H_{t+1}, w_{t+1}, \lambda_{t+1}^e\}$, $\{r_{t+1}^e, i_{t+1}^l, r_{t+1}\}$ satisfy the arbitrage conditions given by equations (5), (6) and (8), and $0 \leq L_t \leq K_{t+1}, \forall t$; (iii) given $\{r_{t+1}\}$, $\{Q_{t+1}, \psi_t, d_t, L_t, i_{t+1}^b\}$ satisfy the optimality conditions for the bank given by equations (22), (24), (16), (20), (19) and (21), and $\{L_t\}$ obeys equation (15); (iv) $\{\lambda_t^e\}$ obeys equation (9) and $\{X_{t+1}\}$ obeys equation (10); (v) the markets for labor ($H_{t+1} = 1$), bank loans (L_t), foreign loans ($K_{t+1} - L_t$), and international deposits

¹⁸Because bank deposits must offer an expected return of θ , the bank cannot use bankruptcy to reduce its expected deposit expenses. This means the bank views choices over risk as choices over mean-preserving spreads in its expenses.

$(L_t - Q_t + d_t)$ all clear.¹⁹

5 The Transition from Repression to Liberalization

Consider the evolution of the bank from financial repression to a long-run stochastic equilibrium under financial liberalization. Because the model lacks a closed form solution, we rely on numerical analysis, and use the theoretical results derived above to interpret our findings.

5.1 Calibration and Numerical Methodology

We assume that at time t , a firm's productivity, z_{it} , takes on the high value z_H with frequency a_t and the low value z_L with frequency $1 - a_t$, with $z_L < z_H$. Similarly, we assume that $\delta(z_H) = \delta_H$ and $\delta(z_L) = \delta_L$, with $\delta_L > \delta_H$. Let z_t denote aggregate productivity:

$$z_t = E(z_{it} | a_t) = a_t z_H + (1 - a_t) z_L.$$

We assume that a_t is a logistic transformation of the underlying variable v_t , i.e.,

$$a_t = \frac{\exp(v_t)}{1 + \exp(v_t)},$$

where v_t follows an AR(1) process with uniformly-distributed innovations:

$$v_{t+1} - \mu_v = \phi(v_t - \mu_v) + \varepsilon_{t+1}, \quad \varepsilon_{t+1} \sim U(-\varepsilon_D, \varepsilon_D) \quad \phi \in [0, 1),$$

An important feature of this specification is that when the support of v_t is positive (the support of a_t lies above 50 percent), the distribution of a_t will have a fatter lower tail than the distribution of v_t . This captures the significant downside risks faced by banks in

¹⁹Equilibrium also requires that the household behave optimally, and that the market for goods clears. In the small open economy considered here, however, this imposes no restrictions on the variables important in bank crisis dynamics.

developing countries. Moreover, the conditional variance of a_t is higher when a_t takes on a low value, implying that recessions increase bank risk.

We specialize the cost of foreign debt, λ_{t+1}^e , as

$$\lambda_{t+1}^e = \theta + \kappa_0 + [X_t + \kappa_1]^{-\kappa_2}, \quad \kappa_0, \kappa_1, \kappa_2 > 0. \quad (27)$$

The parameter κ_1 bounds λ_{t+1}^e from above, so that even in small markets, foreign debt can be the marginal source of funds. The constant κ_0 provides a lower bound on the experience premium, ensuring that the bank always has some franchise value.

The model is calibrated at an annual frequency. Where possible, we base our parameter values on data for countries involved in the Southeast Asian crises of 1997, or on general studies of emerging markets. Table 1 presents the parameter values.

We normalize z_H to 1, and z_L to 0, which ensures that low-productivity firms fail, and implies that $z_t = a_t$. The process for v_t (and thus a_t and z_t), is calibrated with estimates of linear, trend-stationary AR(1) processes for industrial output in Malaysia and Korea over 1985-2004. The two countries have an average autocorrelation coefficient of 0.5 and an average innovation standard deviation of 5 percent. We set ϕ and ε_D so that the AR(1) process fit to $\ln(z_t)$ has the same properties.²⁰ These estimates are consistent with those drawn from a larger sample of developing countries (Agénor, McDermott and Prasad, 2000).

We set α to 0.4, a fairly standard value for developing countries (e.g., Barro and Sala-i-Martin, 1995). Following Mendoza (1991), we set δ_H to 0.1. We set δ_L to 35 percent. The

²⁰Agénor, McDermott and Prasad (2000) argue that industrial output provides a good measure of business cycle volatility in emerging markets. Because the mapping between the volatility of industrial output and the volatility of z_t is unclear, we assume the two are equal. Although output is usually more volatile than productivity, the total industrial sector is probably less volatile than the sectors financed by bank loans. In addition, if one expands the definition of z_t to include sources of volatility—for example, exchange rate shocks—not formally included in the model, the standard measure of TFP will understate loan risk. By way of comparison, Meza and Quintin (2005, page 5) find that in Mexico, South Korea and Thailand, conventional economy-wide TFP fell by 8.6%, 7.1% and 15.1%, respectively, during financial crises.

gap $\delta_L - \delta_H$ represents the reduction in asset value that occurs when a firm fails. The gap of 25 percent used here is the same one used by Carlstrom and Fuerst (1997), who survey a number of studies. This value lies between the loss rate of 50 percent cited by Hellman, et al. (2000) and the “financial distress costs” of 10 to 20 percent estimated by Andrade and Kaplan (1998). We set the leverage bound, $\bar{\psi}$, to 20. While this exceeds the standards set by the Basle Accord, it is consistent with the post-liberalization experience in countries such as Thailand, Indonesia, and Malaysia, where asset/capital ratios reached 18, 19, and 21, respectively, shortly after liberalization.

We set initial bank net worth, Q_1 , low to reflect weak bank balance sheets under financial repression (Kaminsky and Schmukler, 2003, and Hanson, 2003). The value we choose is low enough to expose banks to significant default risk, yet high enough to let banks capture a significant portion of the lending market. The end result is a value of Q_1 equal to about 10% of average output, a ratio similar but somewhat higher than those observed in the Southeast Asian economies in the year prior to liberalization;²¹ given that we are assuming complete bank financing, a higher value is not unreasonable, and is arguably conservative.

To calibrate the parameters determining the evolution of experience (the depreciation rate γ and the initial value X_1) and the resulting interest rates (the parameters $\kappa_0, \kappa_1, \kappa_2$ in equation (27)), we would need lending interest rate data for at least one country (and preferably many) that unexpectedly liberalized both its current and capital accounts, and remained liberalized over time without crisis. Since no country followed this experiment, we set parameters to yield paths consistent with evidence that market lending rates tend

²¹In the year of liberalization, the bank capital/output ratio (Q_1/Y_1 where Q_1 is measured in the data as the stock at the end of the previous period) varies from a low of 2.4% in Indonesia to a high of 6.3% in the Phillipines. Korea, Malaysia, and Thailand have intermediate values of 3.1%, 5.1%, and 5.1%, respectively. The liberalization dates are given below in footnote 24.

to increase with financial liberalization, and that real interest rates in recently liberalized emerging markets are higher than those in industrialized countries (Honohan, 2001). Two features of the interest rate path we use are particularly important: (1) interest rates immediately after liberalization are high enough to support rapid, low-risk growth in lending and bank capital; and (2) interest rates fall quickly enough to expose “mid-transition” economies to significant default risk.

Details on the numerical solutions for decision rules and equilibrium interest rates are contained in Daniel and Jones (2006).

5.2 The Transition

Consider the behavior of a bank in an emerging market that has just experienced financial liberalization. The initial conditions in this market are determined by financial repression, under which both the aggregate capital stock and the experience of foreign investors are low. Liberalization allows the bank the freedom to choose its own interest rate. Although the bank faces competition from the foreign lenders newly admitted to its market, low initial experience implies that the foreign lenders will require a high lending rate. Therefore, immediately following liberalization, the marginal product of capital and the cost of foreign debt will both be high. This implies that the domestic bank will choose a high loan interest rate and high leverage. The high returns to lending that lead the bank to high leverage also make default unlikely. Even when bad productivity shocks occur, the marginal product of capital is sufficiently high to keep the bank sound. Moreover, equation (24) implies that the bank retains all of its earnings; the high returns to lending imply that the internal value of retained earnings exceeds their market value. With high and relatively safe returns to

lending, and a policy of fully retaining earnings, the newly-liberalized bank will see its net worth grow.

These effects are shown in Figure 2. To construct Figure 2, we simulate the transition paths of 40,000 artificial economies, drop the economies whose banks have defaulted, and take averages over the remaining, solvent, banking sectors. The transition paths shown in Figure 2 start with year 1, where the economy inherits the values Q_1 and X_1 from the repressed regime. (Recall that these two stocks are measured at the beginning of the period.) Panel A shows that upon liberalization, the market rate of return, $r_{t+1}^e = \lambda_{t+1}^e$, exceeds 8 percent, well above the international rate of 4 percent. Average leverage is high, with a value for ψ in excess of 19, close to the model's regulatory limit of 20. As shown in Panel B, lending rates are high relative to deposit rates, and banks issue very few dividends. Panel A reveals that in the first 3 years, average net worth—expressed as a fraction of K^* , the average capital stock that firms would hold at the risk-free international interest rate θ —more than doubles.

But as net worth accumulates, the economy's capital stock increases as well, and its marginal product falls. Moreover, as the market grows, so does foreign experience, and this increased competition lowers the cost of foreign debt. Loan interest rates fall, reducing the bank's intermediation spreads, and increasing the probability of low returns on their loan portfolios. Holding leverage fixed, these changes mechanically imply that bank-level default is more likely.

The bank responds to these changes by adjusting its leverage. The possibility of default generates conflicting incentives. On the one hand, bankruptcy cuts off the tail of the bank's return distribution, encouraging risk-taking behavior. On the other hand, bankruptcy ends

the bank's stream of monopoly rents, and thus encourages risk-averse behavior. The key to determining how bank risk evolves is whether the lending gambles available to the bank lie in the convex or in the concave region of the value function, as illustrated in Figure 1. As the bank's net worth increases, indicated by a rightward movement of Q_t along the horizontal axis, the gambles drift into the concave region. But as experience and the aggregate capital stock increase, the return to bank loans, r_{t+1}^e , falls. The fall in return reduces the bank's franchise value, flattening and shifting the value function down, making convexity more important. In the simulations shown in Figure 2, the effects of increased convexity initially dominate. Even though leverage declines, it remains high enough for the exit rate, signifying the probability of a crisis, to increase rapidly. Panel A shows that although only 1 percent of the banks alive in year 1 default at the beginning of year 2, the exit rates after years 2 and 3 are 2.6 and 2.9 percent, respectively. The probability of a crisis is highest several years after liberalization.

Panel C allows us to compare the book value (net worth, Q) of solvent banks to their market value (franchise value, $V(Q)$). Although net worth grows rapidly, the bank's market value does not increase nearly as much, as falling intermediation spreads and increasing default risk depress market value. A somewhat different pattern emerges when we consider the banks with the highest default risk. Panel D shows market and book value for banks that experience a crisis within 9 years of liberalization, the period of highest risk.²² Because failing banks have unusually bad productivity draws, their market value steadily declines, and, after an initial increase, their net worth declines as well. The behavior is consistent with Burnside, Eichenbaum and Rebelo (2001), who found that values for bank stocks in

²²As before, banks are removed from the simulations once they fail.

Thailand, Korea, Malaysia and the Philippines had been falling prior to the 1997 crises.

Panel B shows that banks initially pay little in dividends. At first, interest rate spreads are high enough to justify net worth growth, but as the spreads decline, banks increase dividends, letting their net worth decline. The long-run status of these banks depends on their long-run franchise value, which in turn depends on the long-run level of foreign lending rates. If λ_{t+1}^e declines sufficiently as capital and experience approach their stationary distributions, banks will lose all franchise value and be indifferent about staying in business. Banks then choose maximum leverage and thus maximum risk, a point emphasized by Hellman, et al. (2000). This is stated in the Corollary, which shows that banks will fully lever when the expected value of retained earnings, $E\left(\frac{\partial V_{t+1}}{\partial Q_{t+1}} \mid a_{t+1} > a_{t+1}^{\min}, I_t\right)$, is low. In contrast, if banks retain a significant informational advantage in the long-run, they will adopt more conservative policies to protect their franchise value.

In the simulations shown in Figure 2, the economy settles down into a regime of lower leverage and lower risk. Even though the bank's franchise value is lowest in the long run, the bank becomes more risk averse. This is because the returns to gambling, given by the current interest rate spread, are lowest in the long run as well. In contrast, the high-risk period is characterized by franchise values that, due to low *future* interest rate spreads, are low relative to current interest rate spreads. In the high risk period, the potential gains to gambling exceed the potential costs. In the long-run, the potential gains and costs are both low. In summary, the bank's long-run conservative behavior is due to an interest rate spread that is high enough to yield positive franchise value, but low enough to limit the returns to gambling.

It is useful to compare the predictions of the model to experiences of liberalizing coun-

tries. The model implies that bank capital should grow and leverage should fall following liberalization. Additionally, crises should develop a few years after liberalization instead of immediately. However, comparing the simulations to the transition paths actually observed is not simple. No country has engaged in the exact experiment considered in this paper, namely an unexpected complete and simultaneous liberalization of the capital account and the banking sector. Instead, liberalization has tended to proceed slowly, and has sometimes been reversed. The liberalizations most similar to those in the model occurred in Asia during the late 1980's and early 1990's.²³

To compare the predictions of the model with data for these countries, we compute time paths for bank capital and leverage for Indonesia, Thailand, Philippines, Malaysia, and Korea, following financial liberalization using IFS data. We define liberalization as the latest date for either interest rate or capital account liberalization, using Kaminsky and Schmukler (2003).²⁴ For example, the liberalization date for the Philippines is the date on which capital markets were opened, 1994, with interest ceilings having been lifted much earlier, in 1982.

The model predicts that bank capital will grow following liberalization, due to its high internal value, and that leverage will fall over time as profit opportunities shrink and the bank chooses to take on less risk. Figure 3 contains paths for bank capital and leverage which begin with the year of liberalization for each country and end prior to the 1997 crisis. Data for the crisis year of 1997 are not comparable to our simulation results, which are averages over the simulated transitions for countries (banks) that have *not* suffered a crisis.

²³The Latin interest rate liberalizations in the 1970's were typically accompanied by capital controls. Even so, bank capital grew following the interest rate liberalizations, although the response of leverage was inconsistent. The Latin liberalizations in the late 1980's were confounded with the policy changes, including bank recapitalization, that followed the 1982 debt crisis, and by the Argentine crisis in the early 1990's.

²⁴The liberalization dates we used are Indonesia - 1988, Korea - 1988, Malaysia - 1991, Philippines - 1994, Thailand - 1992.

In all of these countries, the 1997 crisis developed several years after liberalization. Panel A of Figure 3 shows bank capital deflated by the CPI and normalized by its initial value in the year of liberalization.²⁵ Note the strong growth in bank capital following liberalization. In all cases except the Philippines, for which we have only three years of post-liberalization data, pre-crisis data, bank capital doubles within two to five years. Panel B plots leverage for the same countries beginning in the year of liberalization.²⁶ In four of the five countries, leverage falls, as predicted by the model. Leverage does not fall in the Philippines, perhaps reflecting the fact that interest liberalization occurred twelve years earlier and that leverage is already low in the year in which the capital account is finally liberalized.

5.3 Sensitivity Analyses

We performed several sensitivity analyses on the simulated transition paths. In the interest of space, we provide only a summary; a detailed description is available in Daniel and Jones (2006). We introduced deposit insurance, by setting the deposit rate, i^b , equal to the risk-free rate, θ . We considered “true bailouts,” where the owners are protected as well as the depositors, by allowing failing banks to be recapitalized with a small (0.12% of K^*) amount of capital. We allowed foreign finance (for firms) to take the form of equity instead of debt. We increased the degree of firm impatience by setting $\varpi = 1.005$, reduced the upper bound on leverage ($\bar{\psi}$), to 12.5 (the inverse of the Basle capitalization ratio of 8 percent), doubled initial bank net worth (Q_1), reduced the additional depreciation suffered by failing firms

²⁵The first observation is bank capital at the beginning of the year of liberalization (in the data this is the end-of-the-year stock the year prior to liberalization) deflated by the price index during the year of liberalization. Therefore, if liberalization occurs in 1988, the first observation is bank capital at the end of 1987 deflated by the CPI for 1988. All values for real bank capital are normalized by this initial value.

²⁶Bank leverage is computed as the sum of all bank assets in a particular year divided by bank capital at the end of the previous year. This corresponds to the dating in the model where stocks (bank capital) are measured at beginning of the period values, and flows (in the model bank assets have a single period duration and hence behave like flows) are measured as values over the period.

$(\delta_L - \delta_H)$ to 15 percent (following Andrade and Kaplan, 1998), and increased the shock persistence parameter ϕ from 0.515 to 0.85.²⁷ Results are summarized in Table 2.

In all cases, bank net worth rises sharply after liberalization, and leverage falls. In addition, the highest exit rate (default probability) occurs several years after liberalization. Changing the parameter values does affect magnitudes, sometimes in interesting ways. In particular, both deposit insurance and bailouts have little effect on exit rates in the years immediately following liberalization. Although either change reduces the cost of taking on risk, when interest rate spreads are very high the bank still has a strong incentive to stay in business. Even with a small recapitalization, a failing bank would lose much of its franchise value, because it would be low on capital—and loans—over the period when loan profits are highest. Reducing the cost of risk has much more of an effect in the long run, when interest rate spreads are low. Long-run exit rates are much higher than in the baseline case, particularly with recapitalization. An increase in firm impatience has similar effects. This acts like a long-term decrease in the interest rate spread, reducing the bank's long-term franchise value and raising the long-run probability of default, but having little effect on the firm's willingness to take on risk in the short-run, when spreads are higher.

Other parameter changes reduce the magnitude of the spike in risk following financial liberalization, but they do not eliminate it. These include reducing the upper bound on leverage, increasing initial net worth, letting banks finance loans with equity instead of deposits and reducing the depreciation cost of firm bankruptcy. The way in which lowering $\overline{\psi}$ reduces exit rates is especially interesting. As Hellman, et al. (2000) point out, increasing a bank's capitalization requirements in this fashion affects the bank's attitudes toward risk in

²⁷This implies an increase in the autocorrelation of $\ln(z_t)$ from 0.5 to 0.82.

two ways. The first effect is the standard one: holding everything else constant, reducing the bank's ability to lever reduces its ability to take on risk. The second effect is that leverage restrictions reduce the bank's profitability and hence its franchise value.²⁸ This reduces the penalty to failed gambles, and encourages banks to take on more risk. For the specification considered here, the first effect dominates; at a leverage ratio of 12.5 it is mechanically difficult for banks to take on risk.

6 Conclusion

Financial liberalization often leads to financial crises. This link has usually been attributed to moral hazard from promised bailouts, or to pressure from increased competition. Neither mechanism, however, is unique to financial liberalization. In this paper we develop a dynamic model that shows that financial liberalization, in and of itself, contributes to banking crises. The model shows that between an initial period of rapid, low-risk growth and a long-run outcome of a safe banking system, banking systems of emerging markets will experience a transitional period with an increased risk of banking crisis. This transition emerges because of the way in which the degree of foreign competition, the marginal product of capital in a rapidly-growing economy, and the bank's own net worth simultaneously evolve.

Immediately following liberalization, the capital stock is low, so that the marginal product of capital is high even when productivity is bad. The bank's foreign competitors lack experience with the emerging market and lend only at high interest rates. As a result, returns on bank loans are high, and even though banks choose high leverage, they face very little risk. Newly-liberalized banks enjoy high profits and see their net worth grow rapidly. But

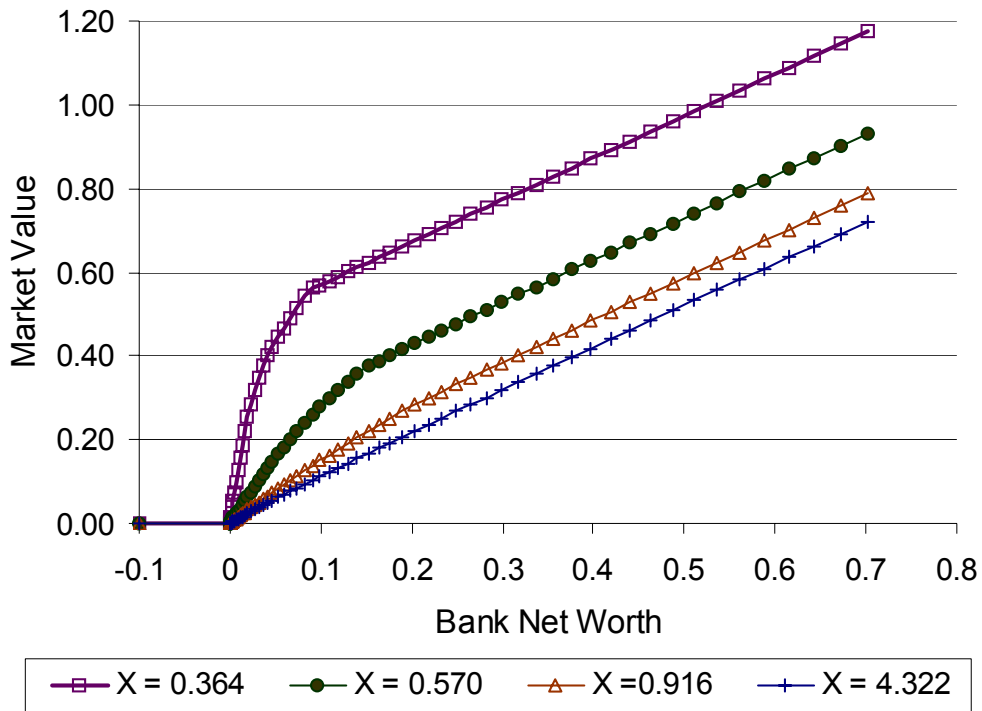
²⁸The underlying results show that franchise value (the market to book ratio) does in fact fall when $\bar{\psi}$ is lowered to 12.5, and it rises when deposit insurance is introduced.

the capital stock grows as well, and becomes less productive. Foreign debt becomes cheaper as foreign lenders acquire more experience in the market. Loan interest rates begin to fall. It is at the point, when the bank's competitive advantage is still significant but declining, that risky behavior and banking crises are most likely. If the bank can weather this period, and retain a sufficiently large cost advantage over international lenders, it can enter a regime of more conservative behavior and lower risk.

What are the policy implications of our analysis? The model implies that a period of increased bankruptcy risk is inherent in an emerging economy's transition from repression to liberalization. This occurs in the absence of any implicit or explicit bailouts—in our model defaulting banks lose their franchise—implying that reducing such bailouts need not eliminate the risk of crises following financial repression. The sensitivity analyses suggest that by reducing the upper bound on leverage, that is, by increasing the bank capitalization requirement as in the Basle Accord, the risk of bankruptcy can be reduced. The sensitivity analyses also suggest the probability of a crisis can be reduced by capitalizing the bank prior to liberalization. Neither of these policies necessarily increase welfare. A higher capitalization requirement comes at the cost of lower returns for the bank, and capitalizing emerging banks diverts resources from other uses. Alternatively, postponing liberalization until banks have capitalized could reduce the pace of economic growth. Evaluating the welfare impact of these policy actions requires us to model the aggregate costs of banking crises, a topic we leave for future research.

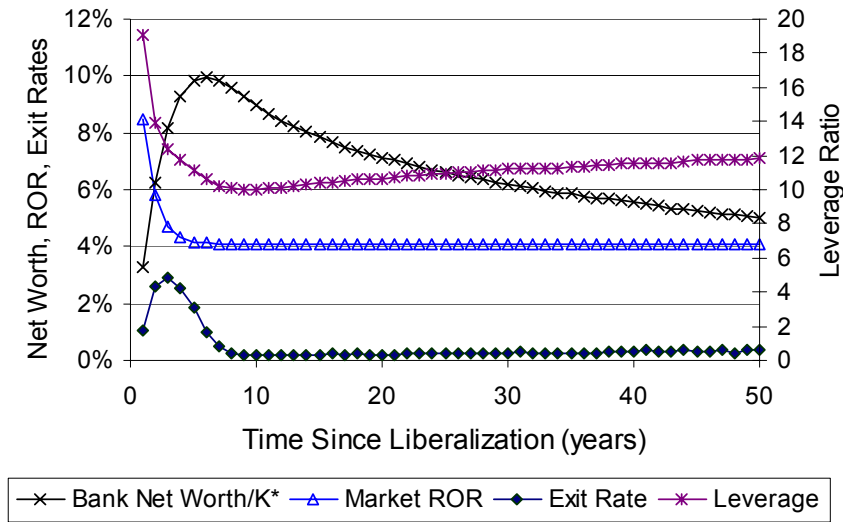
Figure 1

Value Functions at Different Levels of Experience (X)

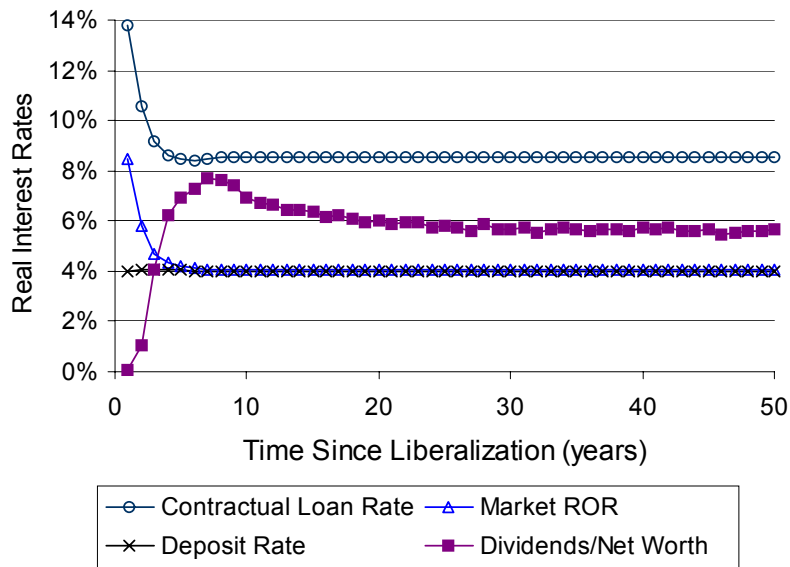


Note: Value functions calculated as part of the numerical exercises for the baseline specification. All the value functions shown here are based on a success rate (a_t) of 0.95.

Figure 2
Simulation Results: Baseline Specification



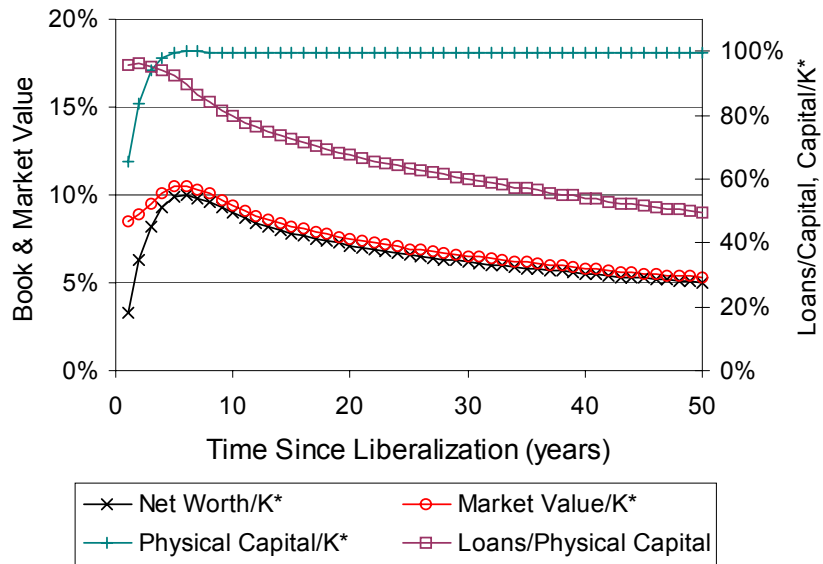
Panel A



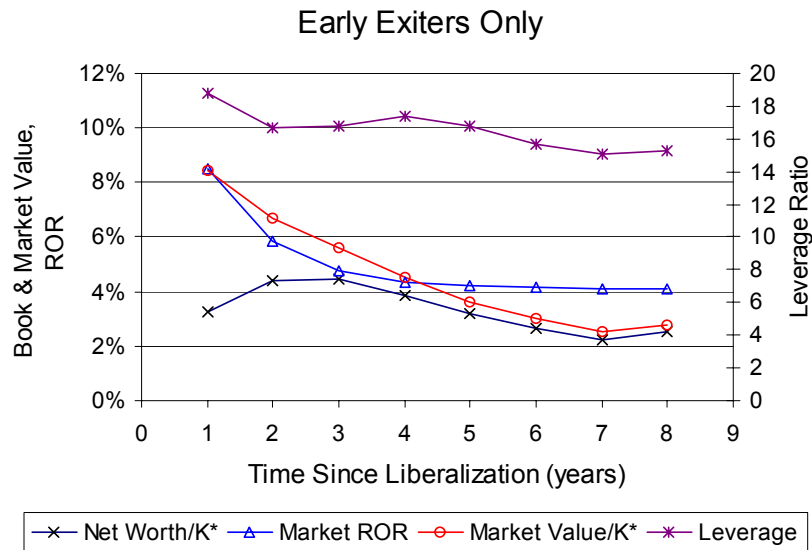
Panel B

Figure 2 (continued)

Simulation Results: Baseline Specification



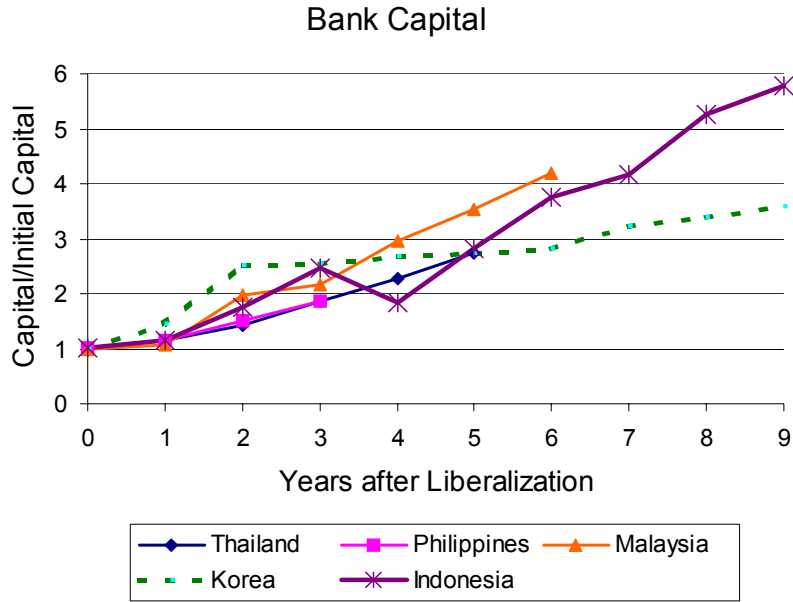
Panel C



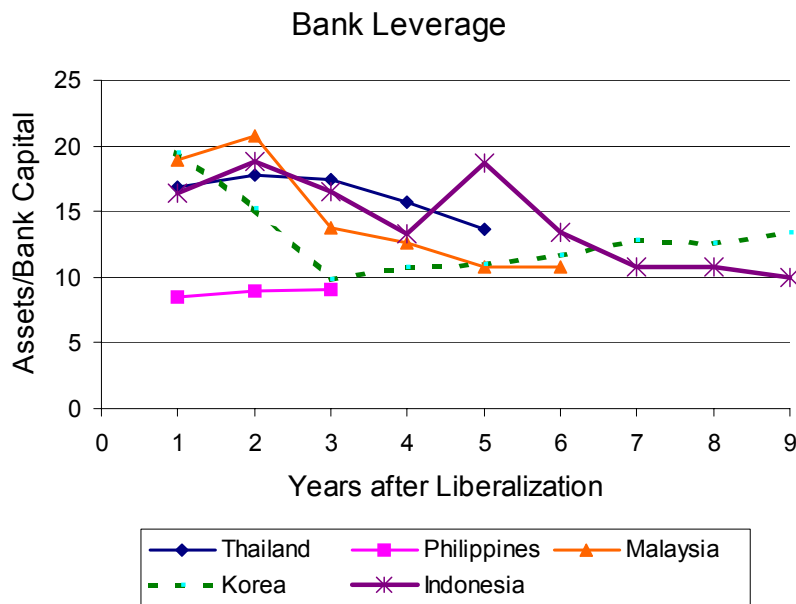
Panel D

Figure 3

Post-Liberalization Bank Capital and Leverage in Southeast Asia



Panel A



Panel B

Table 1
Calibrated Parameter Values

α (Returns to Capital)	0.4
δ_H (Capital Depreciation Rate for High-Productivity Firms)	0.1
δ_L (Capital Depreciation Rate for Low-Productivity Firms)	0.35
γ (Depreciation Rate for Experience)	0.1
θ (Global Interest Rate)	0.04
ϖ (Discount Premium)	1.002
$\bar{\psi}$ (Leverage Bound)	20
z_L (Low Productivity Value)	0.0
z_H (High Productivity Value)	1.0
z_t ($= a_t$) Aggregate Productivity (Success Rate)	
Median Value	0.95
Mean Value	0.934
φ (First autocorrelation of $\ln(z_t)$)	0.5
$\widehat{V}(\ln(z_t) \ln(z_{t-1}))$ (“Innovation Variance”)	0.05^2
κ_0 (Shift Parameter in $\lambda(X)$, per Equation (27))	0.0006
κ_1 (Curvature Parameter in $\lambda(X)$, per Equation (27))	1
κ_2 (Exponent in $\lambda(X)$, per Equation (27))	7.0
Q_1 (Initial Bank Equity for Simulations)	0.1407
X_1 (Initial Foreign Experience)	0.5626

Table 2
Sensitivity Analyses

Year (t)	Q_t (% of K^*)			ψ_t (Leverage)			Exit Rate (%)			
	1	3	10	1	3	10	1	3	10	30
Benchmark	3.3	8.2	9.0	19.1	12.4	10.0	1.1	2.9	0.2	0.3
Deposit Insurance	3.3	8.2	8.8	19.1	12.4	10.8	1.0	2.7	2.3	2.3
Bailouts	3.3	8.1	6.4	19.1	13.2	16.5	1.2	3.2	5.4	7.1
$\varpi = 1.005$	3.3	7.7	4.5	19.1	14.6	17.8	1.1	3.1	3.2	2.7
$\bar{\psi} = 12.5$	3.3	6.7	8.1	12.5	11.9	9.5	0.2	1.0	0.1	0.0
$Q'_1 = 2Q_1$	6.6	11.5	9.7	10.0	9.2	9.6	0.0	1.4	0.2	0.2
Foreign Equity	3.3	8.1	6.1	19.1	12.6	14.1	1.1	1.1	0.0	0.0
$\delta_L - \delta_H = 0.15$	3.2	7.5	8.5	19.6	13.3	10.7	0.5	2.2	0.1	0.1
$\phi = 0.85$	3.3	7.9	6.6	18.1	13.7	15.2	0.8	2.1	1.0	0.7

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