International Capital Inflows, Domestic Financial Intermediation and Financial Crises under Imperfect Information

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Abstract

A model of financial crises in emerging markets based on agency problems in financial intermediation is developed. Foreign loans and domestic savings flow through domestic banks to investors as a market solution to costly observability of the private information of domestic firms. Banks have an informational advantage over lenders and the domestic government giving rise to moral hazard in intermediation. Financial crises arise endogenously in the model and are induced by implicit government guarantees of loans to the private sector. Currency crises and banking crises are linked when an exchange rate peg implies government guarantees of foreign currency debts. The dynamic implications of the model are compared to the recent empirical experience of financial crises in East Asia with some success.

1. Introduction

Recent financial crises in emerging markets have been preceded by periods of large capital inflows and expansions of the domestic banking sector. These events have also been associated with implicit guarantees of foreign loans by sovereign governments. Emerging market financial crises have also been followed dramatic drops in output making them an important policy concern. Recently several economists, notably Calvo [1998a], have observed that these crises evolve through complicated interactions between domestic financial sectors, international lenders and national governments. Financial crises have often been characterized by coincident currency and banking crises.[1] Recent experience suggests that banking crises are not necessarily just an outcome of a collapsing exchange rate regime. Instead, the source of a financial crisis may be found in the interaction between the microeconomics of private financial intermediation and government macroeconomic policies. Many authors have offered models of varying detail of this interactions and various explanations for the financial crises in East Asia in 1997.[2]

In this paper, we propose a model of the dynamics of bank lending, investment and the accumulation of foreign currency liabilities by the domestic financial intermediaries that ultimately lead to a financial crisis. These dynamics derive from the introduction of an agency problem in domestic financial intermediation that originates in an informational advantage for domestic banks in domestic lending. Government guarantees, implicit or explicit, play a key role in generating growing inflows of financial capital and the eventual banking crisis in our model. When a banking crisis occurs, there will be an output contraction in our model as efficiency-enhancing financial intermediation collapses and foreign capital inflows reverse.

As argued by Calvo [1998a], following the literature on sovereign debt, a sovereign government has an incentive to subsidize foreign capital inflows to overcome the problem of its own moral hazard in setting trade, fiscal and monetary policies. We observe that government guarantees of foreign currency obligations incurred by the private sector are typically associated with the abandonment of an exchange rate peg. Government insurance that at least partially indemnifies foreign investors in the event of devaluation appears to be an implicit part of a pegged exchange rate regime, as noted by Mishkin [1996] and Obstfeld [1998]. Our model links a banking crisis with a currency crisis by assuming this form of contingent government subsidies to foreign lenders. A currency crisis in our specific model occurs as in the basic model of a collapsing exchange rate regime (Krugman [1979] and Flood and Garber [1984]).

In our case, the financial crisis initiates a government bailout, increasing the public sector budget deficit which is ultimately monetized.[3] In the absence of a looming financial crisis, fiscal policies would be consistent with the exchange rate peg in the model economy.

The exchange rate regime and the anticipated policy response to its potential collapse influences the behavior of foreign lenders and contributes to the instability of domestic banking. The rise in foreign capital inflows and eventual crisis in domestic financial intermediation in our model of agency in banking and foreign lending can occur if government intervention is not tied to an exchange rate peg, as long as there is an anticipated bailout. Therefore, ours is a model of credit expansions fueled by international financial capital inflows that end in an eventual crisis and public bailout. We incorporate the exchange rate regime as the source of contingent government liabilities weaving together banking and balance of payments crises. This is similar to other models, for example Calvo [1998a and b], Burnside, Eichenbaum and Rebelo [1999] and Dooley [1999].

In our model, private agents anticipate the government bailout and lend and invest in a stochastic equilibrium under rational expectations. A banking crisis can precede or follow a currency crisis in the basic flexible-price model. Currency crises will bring on immediate banking crises with additional assumptions, such as nominal price rigidity or demand spillovers between sectors.

An important feature of the bailout in our framework is that government is concerned with aggregate domestic output and only responds when the potential fall in output is significant. It does not insure foreign lenders against individual bank failures. It responds to widespread systemic problems. This gives foreign lenders in the asymmetric information environment of the model an incentive to sustain even insolvent banks until the aggregate output cost of pulling out meets the anticipated government threshold. This takes time given the modeled structure of the economy.

The microeconomic model of domestic banking incorporates essential features of the credit market models of Stiglitz and Weiss [1981] and Bernanke and Gertler [1989 and 1990]. Banks operate a technology that allows them to evaluate and monitor projects undertaken by entrepreneurs. There is potential adverse selection in project choice, and an increase in bank evaluation and monitoring effort allows it to influence more the project choice of its client. This is manifested in an increase in the equilibrium value of the bank's objective with its effort; monitoring is not perfect. Domestic banks have an information advantage over foreign financial institutions in that a physical presence in the country allows observation

of investment and production at lower cost. The government faces the same informational disadvantage vis-a-vis private banks as do foreign lenders.

Investments take time to build in the model. This assumption plays a key and interesting role in the dynamics of bank lending because it introduces consequences to sudden increases in the demand for liquidity. It can be used to justify incentives for government intervention. Here, it creates opportunities for renegotiation between a bank and its client that are an interesting part of the dynamics of our model. Our theoretical model contrasts to that of Kiyotaki and Moore [1997] in this respect, among many others. They rule out renegotiations with an assumption. There are incentives to renegotiate loans in our model economy, and renegotiation leads to an accumulation of firm debt and progressively riskier bank portfolios. As lending proceeds in our model, the riskiness of firms' project choices rises (equivalently, a decline in investment quality) and bank portfolios become less diversified as renegotiations take place.

Other models of emerging markets financial crises have adopted a time-to-build assumption adopting the approach of Diamond and Dybvig [1983] to explaining bank runs to the international context (for example, Goldfajn and Valdes [1997] and Chang and Velasco [1998]). We abstract from this issue (for example, we assume the government responds to this problems by providing deposit insurance to domestic savers) since it is modeled in these papers.[4]

Section 2 presents the theoretical model and provides a heuristic analysis of its dynamics. The model implies that capital inflows should be rising in proportion to output before a financial crisis in countries that ultimately experience such a crisis. It also implies that bank debt should be rising (in relation to output) and that investment is becoming riskier over time. After a crisis, there is an expansion in the money supply in the dynamics described. This need not be the case. It is due to a choice of fiscal policy. There is a contraction in output which the model implies can be dramatic (the model is not parameterized and simulated here, though). The agency model of lending implies that equilibrium quantity of credit can be much more responsive to disturbances than the loan rate of interest as in Stiglitz and Weiss for exactly the same reasons. Interest rates need not rise after a crisis, although lending can contract dramatically.[5]

Section 3 compares the predictions of the model to the data. It does reveal capital inflow booms, that for some countries even continue as output growth falls. Countries that suffered eventual crises do have different rates of foreign and domestic loan to GDP growth than do countries that avoided crises. We also consider investment quality as measured by incremental capital to output ratios, again finding some

ambiguous evidence in favor of our model. Output declines are documented, although our model is not novel in generating these, and post-crisis monetary growth is discussed.

2. A Theoretical Model of Financial Crises

We model international capital flows and domestic banking in an infinitely-lived small open economy. Households and firms are represented by entrepreneurs who establish firms, save and consume. A fixed number of these entrepreneurs operate banks. These banks intermediate between domestic and foreign savers and domestic investors. We set up the behavior of each of these agents and of the equilibrium dynamics for the economy in turn.

2.1 The Economy

There is a single good that can be consumed, invested or traded internationally. It is produced using entrepreneurial labor and capital. Capital in this model should be thought of as working capital; it is exhausted in the production process. Production takes time, requiring inputs in each of two periods before a stochastic output is realized at the beginning of the third period.

All residents have identical preferences over infinite-horizon consumption plans and are endowed with a single unit of labor each period. Individuals differ with respect to their financial wealth at date 0. A fixed number of individuals in the economy own banks. The rest are entrepreneurs who combine their one unit of labor with the single good (capital) to produce output. There are increasing returns to entrepreneurial effort in that each entrepreneur can only undertake a single new project in each period. She can at most operate two projects in a period t, one that was started in period $t-1$ and one started in period t. There are constant returns to capital.

The technology is described by the collection of potential projects that can be selected by entrepreneurs. Projects differ with respect to their distributions of output across states of nature. For example, the distribution for one project can be a mean-preserving spread of that for another potential project. Each entrepreneur has access to a set of project choices that does not change over time. These are not the same across entrepreneurs, representing heterogeneity with respect to skills, knowledge or opportunities in a simple way.

Individuals are risk averse and seek to smooth their consumption over time. In this economy, each faces income risk. Potentially, households could form coalitions organizing firms to undertake large

numbers of projects. Alternatively, banks can take deposits from individual entreprenuers and lend to a large number of entrepreneurs partially diversifying individual project risk for savers and diversifying liquidity risk due to gestation lags in production. We assume that banks have a cost advantage monitoring the project choices of entrepreneurs over firms, so that investment and production are undertaken separately from risk diversification and financial intermediation in our model.

International financial capital inflows equal the current account deficit plus the increase in central bank reserve holdings through the balance of payments identity. Private foreign borrowing is intermediated by domestic banks. The current account surplus is given by

$$b_{t+1} - b_t = i_t^* b_t + y_t - c_t - k_t.$$

Investment during period t is

$$k_t = \sum_{j=1}^{n} \left(k_{t-1,t}^j + k_{t,t}^j \right),$$

where $k_{t-1,t}^j$ is entrenpreneur j's period t investment in the project she began in period $t-1$ and $k_{t,t}^j$ is her period t investment in her project undertaken in period t. The current account equation is written in units of foreign currency assuming purchasing power parity and nominal price flexibility.

Individuals seek to maximize utility,

$$U_t = E_t \sum_{s=t}^{\infty} \beta^{s-t} u(c_s),$$

with respect to consumption and saving subject to an intertemporal budget identity given by

$$w_{s+1} - w_s = i_s^d w_s + \pi_s - c_s,$$

given initial financial wealth, w_t, where w indicates deposits held in banks, π represents income from production and i^d is the deposit rate of interest. Money is necessary to make consumption purchases. Demand deposits pay a positive rate of return so that money is held only as demand deposits in equilibrium. Financial markets are assumed to be incomplete. Individuals cannot purchase insurance against income risk (the asymmetries of information in the model could be used to formally justify this assumption). They can only hold bank deposits or invest in their own enterprises. Risk aversion implies that self-finance is dominated by holding bank deposits and borrowing to invest in projects under our assumption that costs favor the establishment of banks.

In equilibrium, the banking sector holds positive monetary reserves against idiosyncratic liquidity

demand by savers. The central bank can also set cash reserve requirements. Allowing banks to acquire internationally tradeable bonds denominated in foreign currency implies uncovered interest parity (risk adjusted). Money demand can be represented using a Cagan equation augmented by a term in output and the differential between the deposit interest rate and the risk-adjusted loan rate.

We consider fiscal policy only in its role of generating a currency crisis under a pegged exchange rate regime. Therefore, there are no public expenditures and all governments revenues are collected through money creation. Any transfers are fully monetized leading to a one-for-one increase in domestic credit. Any transfers will be contingent and paid as government guarantees to creditors.

2.2 Domestic banks and foreign capital inflows

Domestic intermediaries serve to evaluate risky investments proposed by domestic entrepreneurs, diversify the risks of lumpy investments for individual savers and transform long-maturity high-yield investments into short-term liquid liabilities. Domestic banks have a cost advantage evaluating domestic projects over foreign lenders. We simplify this informational advantage by assuming that foreign banks cannot directly observe the riskiness of individual domestic projects at any cost and must rely on domestic banks to do so. This gives rise to a problem of agency between a domestic bank's creditors and its owner-manager.

Banks can borrow from either domestic or foreign savers. Domestic savers will hold demand deposits, but we do not consider bank runs as modelled by Diamond and Dybvig [1983] by assuming they are protected by deposit insurance provided by the home government. Foreign capital inflows to domestic banks are loans from foreign financial institutions. The implicit guarantees provided by the government to foreign creditors play a central role in the dynamics of financial crises in this paper and are discussed below.

Each bank's liability in the event of failure is limited to the value of its assets. The maximum liability of the owners of a bank equals the capital of the bank. This lower bound on losses induces the bank to choose a loan portfolio that is riskier than the one that would be optimal for its creditors (including the government, a co-creditor under deposit insurance). A bank's choice of its loan portfolio is similar to the problem of adverse selection in project choice by a limited liability firm demonstrated by Stiglitz and Weiss [1981]. The profile of returns to the bank as a function of its clients' revenues does not have the same shape as the profile of net returns for the borrower. The firm is the residual claimant to revenues,

and its profile is convex. The bank's profile has both convex and concave segments. When revenues for the entire portfolio of projects funded by a bank equal or exceed the gross interest of its loan portfolio, the bank's return is constant and equals the interest due to its capital. When revenues fall short of the face value of the claims of the bank's creditors, the bank receives nothing. For the interval between these endpoints, the return to the bank is increasing one-for-one with payments from its clients. The objective functions for the creditors of the bank are all concave.

Each project requires one unit of resources each of two successive periods to produce revenues of R, a random variable, in the third period. With constant returns to scale, firm f invests $k^f_{t,t}$ and $k^f_{t,t+1}$ in periods t and $t+1$, respectively, to produce $R^f \min\left\{k^f_{t,t}, k^f_{t,t+1}\right\}$ units of output in period $t+2$, where R^f is the random per unit output for the project chosen by firm f. Despite constant returns to capital and increasing returns to entrepreneurship, firms will be limited in the amount that they can borrow in equilibrium because banks seek to diversify their portfolios.

The bank provides a fraction x of the total loan from its own capital and borrows from foreign creditors at the interest rate i^*. The net return from a project to the firm is given by

$$\pi^f = \max\left\{R^f - (1+i)(2+i)/2, 0\right\}.$$

The bank realizes a return on the loan equal to the gross return,

$$\rho = \min\left\{(1+i)(2+i)/2 - (1-x)(1+i^*)(2+i^*)/2, R^f - (1-x)(1+i^*)(2+i^*)/2\right\}, \quad (1)$$

less the opportunity cost of the bank's capital and expenditures evaluating or monitoring loans (denoted by e),

$$c = x(1+i^*)(2+i^*)/2 + e.$$

This gives the concave portion of the bank's objective in the outcome, R^f. The use of these loan contracts can be justified by adding costly observability (by creditors) of debtor revenues ex post as shown by Diamond [1984]. Note that the loan rate of interest may differ across firms in this economy. The superscript f for the firm is left out for notational simplicity.

The interest paid to foreign loans and domestic deposits is the same for the bank in equation 1. This assumes that banks are competitive in the domestic deposit market, pay a deposit rate of interest that just compensates them for holding non-interest bearing money and are correctly charged the ex ante premium for deposit insurance by the government. Time subscripts have been suppressed in these expressions, but it should be noted that the interest rate charged for the completion of a project could be different from

the interest rate charged in the same period for a new project in a non-stationary equilibrium.

In a three-period economy, the firm goes bankrupt if revenues fall short of the firm's liabilities. The same is true of the bank, so that bank profit equals

$$\pi_b = \max\{\rho, 0\} - c,$$

which is a function of x. This function is first convex then concave as revenues increase from zero.

In this case, there is a single round of lending and the objective of the bank is to choose a portfolio that maximizes its expected return,

$$E\pi_b(e,x) = \int_I^\infty [I - (1-x)I^*]\, dF(R;e) + \int_{(1-x)I^*}^I [R - (1-x)I^*]\, dF(R;e) - xI^* - e,$$

where $I \equiv (1+i)(2+i)/2$ and $I^* \equiv (1+i^*)(2+i^*)/2$. The distribution of returns depends on the choice of projects by the bank's clients which is affected by the level of evaluation and monitoring effort applied to each loan the bank makes. Through evaluation and monitoring, the bank learns the revenue distribution for the investments of its clients. More intense monitoring means that the project chosen is more favorable for the bank. Less intense monitoring leads to a more favorable choice for the borrower. Under the information structure adopted here, the bank can always infer what project its client chooses, and it can exert more influence over this choice by increasing its monitoring effort.

Expected bank revenues are increasing in e, although at an eventually decreasing rate. The optimal level of effort for the bank depends upon x, $I - I^*$ and I^*. The partial effect of an increase in i is a rise in the riskiness of projects undertaken by bank clients. We impose the condition that the collection of projects available to each entrepreneur is such that there is a joint interior solution for i and e for each investment. In this model, an increase in x leads the bank to desire a less risky project, so that an increase in the share of bank capital in the loan increases the optimal level of monitoring effort for any given interest factors, I and I^*. The bank's creditors' desire higher levels of evaluation and monitoring by the bank. But they cannot observe the bank's effort, so they will want to contract on the bank's share, x. The bankowner's share in loans is co-insurance. Domestic depositors are protected by deposit insurance, so only foreign creditors and the government have an interest in monitoring the share of the bank's own capital in assets. This part of the model is a modification of Bernanke and Gertler [1989 and 1990]. In their model, partial self-finance by the firm provides co-insurance for the bank which also evaluates the firm. Here, the bank still evaluates its debtors but private information about its expenditures on

evaluation and monitoring lead its creditors to require self-finance by the bank.

The bank's optimal choice of effort is determined by the first-order condition,

$$\frac{\partial}{\partial e} E\pi_b(e, x) = 0, \tag{2}$$

given I, I^* and x. For a single loan, the bank's foreign creditors seek to maximize their gross return given by

$$E\pi_l(x) = \int_{(1-x)I^*}^{\infty} (1-x)I^* dF(R; e) + \int_0^{(1-x)I^*} R dF(R; e),$$

where e is an implicit function of x and interest rates determined by 2. We assume that the derivative of e with respect to x is sufficiently large for $x = 0$ that an interior optimal choice of x for the bank's foreign creditors exists. The choice of e by the bank for its creditors' optimal x does not generally coincide with the first-best choice of e for those creditors given x. This is due to the conflict between the objectives of the bank and foreign creditors with respect to risk.

With a longer horizon, the bank can choose whether to declare the firm bankrupt or relend it unpaid interest and even provide funds for a new project. Bankruptcy, however, comes at a cost. The firm will have typically undertaken a new investment in period $t-1$ when it is unable to service its debt due in period t on the project initiated in period $t-2$. The bank loses the opportunity to recoup its loan for the newer project if it declares the firm bankrupt. In this economy, firms cannot cheat on loan contracts by concealing revenues, and an adverse investment outcome does not reveal information about entrepreneurial type. Therefore, the bank does not have an incentive to discontinue lending to a firm after its most recently mature project goes bust.

The costs to bankruptcy created by the production lag give the bank an opportunity to renegotiate the unpaid interest obligation with its client. Potentially, the entrepreneur can declare bankruptcy, start a new firm and initiate a new project borrowing from the market. However, she loses any income that could be generated by completing the project she began in period $t-1$. For example, if bankruptcy laws allow her to borrow in period $t+1$ after declaring bankruptcy in period t, then she loses income for periods $t+1$ and $t+2$.

The bank and a client with insufficient current revenues, R, to meet its existing debt-service obligations, I, can reschedule the unmet interest, dividing the surplus created by costly bankruptcy in this economy. Any interest payments that are rolled ahead increase the bank's claim on future revenues generated by the firm's investments. The bank desires to roll forward unpaid interest to the extent that its

expected value increases over forgiving the debt and lending to the firm for new projects in competition with the rest of the market. The firm's current bank can command more surplus from completing the firm's current project and funding its new project (chosen in period t) than can a new lender because the old debts give it an additional claim on future firm revenues.

The bank also has an advantage continuing to lend to its current client over other banks. Suppose that bank and the firm come to an agreement rescheduling interest that cannot be paid in period t and the entrepreneur borrows from another bank for her new project chosen in period t. The entrepreneur chooses her new project given the sum of the debt claims against project revenues. Regardless of whether one debt is senior to another, the entrepreneur chooses a riskier new project than she otherwise would because of the rolled-over debt. That is, the additional debt has the same effect on the firm's net return as increasing the interest rate. As shown by Stiglitz and Weiss, the entrepreneur chooses a riskier project. Even if the new loan were strictly senior to the old loan, a new lender suffers the cost of adverse selection due to the greater claim on firm revenues without realizing the gains from the rolling over of old debts. It would need to expend more on evaluation and monitoring. Further, some of the benefits of its efforts may be reaped by the old bank without compensation. The new lender does not realize gains from the debt rollover and is at a competitive disadvantage with respect to the old bank lending to the firm. Adverse selection and time-to-build give rise to debt renegotiations that bind banks to clients that have realized poor revenue performance.

The division of surplus between the debtor and creditor from renegotiation could be solved analytically using a specific bargaining model. This is unnecessary for the purposes of this paper. All we need is that the current lender gets positive surplus from rolling over debt claims in excess of current revenues. Adverse selection can also limit the surplus that the bank can extract from the firm in rescheduling. There may be an interior solution for maximizing $E\pi_b$ for the new project with respect to the gross interest charged and evaluation effort undertaken that is lower than the cost of bankruptcy. In such instances, the surplus divided in equilibrium is determined by that solution.

Contingent government transfers that are introduced below also complicate matters. Under our assumptions, individual firm revenue histories are observed by the entrepreneur and her banker but not by the bank's creditors. The creditors can observe the bank's balance sheet but verification of the market value of the bank's portfolio is costly (implying the use of standard loan contracts in lending to the

bank). As long as it can service its debts, the bank has an incentive to carry non-performing assets on the balance sheet. Marking to market reduces the bank's capital, reducing the loans it receives due to the agency problem. To keep banks from arbitrarily increasing the reported value of its assets, we assume that government regulation and ultimate penalties are such that banks simply relend unpaid firm debt at the rate of interest for the firm's new loans. The actual amount of repayment (state contingent) anticipated by the bank may be different. These are determined in perfect equilibrium for renegotiation and subsequent lending.

Whenever a firm realizes revenues below its gross interest obligation, the bank wants to continue lending to the firm but increases its claim on future revenues beyond what it would have been if revenues had exceeded debts. Because increasing the debt burden induces a riskier choice of project, the bank first faces a tradeoff between increasing what it expects to be repaid and increasing evaluation and monitoring expenditures. The bank also faces a tradeoff between lending more to this firm because revenues are proportionate to capital inputs (constant returns to capital) and holding a less diversified portfolio. Lending more to the firm reduces the rolled over debt share in revenues reducing the entrepreneur's incentive to choose a riskier project. This increases the expected return to the bank from this loan. However, the amount of resources the bank has to lend is limited (by x in the agency problem between the bank and its creditors). The bank's portfolio becomes less diversified.

Competition between banks determines the equilibrium interest rate charged to firms not in arrears. The number of banks is limited by sunk costs of entry (alternatively, there could be increasing returns to scale in banking each period).

This model can be compared to Kiyotaki and Moore [1997]. Here, the collateral that secures a loan is the revenue realized in the third period of a project. The bank can simply declare a firm in bankruptcy if the revenues are insufficient to fulfill the contract. But, in contrast to the Kiyotaki and Moore model which rules out loan renegotiation, there are incentives to renegotiate here. Time-to-build and the returns to entrepreneurship create the surplus that supports renegotiation. The possibility of renegotiating contracts also relies on the result that default does not reveal information about an entrepreneur's type or actions. In our model, renegotiation is an essential contributor to financial crises.

2.3 The dynamics of lending and investment

The dynamics of capital inflows, lending and production are described beginning in period 0 in which

each bank holds the same positive level of capital and no past-due debts. The number of banks is in equilibrium; the expected present value of a bank is less than or equal to the cost of entry. Bank effort, e, and the riskiness of each bank's portfolio are, respectively, increasing and decreasing functions of x, the individual bank's capital. So far, the model implies that the level of foreign lending is an increasing function of X, total bank capital. We assume further that the financial assets of all entrepreneurs are the same.

There is an equilibrium distribution of projects funded by each bank in the initial period. Borrower heterogeneity, due to access to different techniques of production, and indivisibility of entrepreneurial effort imply that banks' portfolios are imperfectly diversified. Their risks can be imperfectly correlated, although this is not necessarily true. Some projects undertaken in period -1 will generate revenues below the gross interest charged by the lender with positive probablity. As noted above, the bank will continue to lend to the firm and renegotiate the unpaid interest. The expected present value of a bank decreases with defaults by its clients. Conversely, because the bank bears part of the production risk, it charges an interest premium. Good portfolio performance causes a bank's assets to grow. Individual bank expected value follows a Markov chain.

Under the given information structure and institutional environment, bank capital as reported to its creditors also follows a Markov chain. However, unless the bank is unable to service its short-term debts, non-performing assets accumulate without reducing the bank's capital as measured by its balance sheet. As long as they can service their debt, the owners of banks suffer losses as the bank accumulates non-performing assets. The accumulation of non-performing assets on the balance sheet of a particular bank leads the owner-manager of that bank to select a progressively riskier portfolio. The variance of its future value rises. All this implies that overall bank balance-sheet capital is a submartingale.

For example, suppose that there are a large number of entrepreneurs, the distributions of revenues are independent (but not necessarily identical) and the mean output per unit of inputs is identical across all potential projects. The law of large numbers implies that aggregate output beginning in period 0 is constant (at least as long as the banks can service their debt). However, foreign lenders observe rising bank capital. They lend more and capital inflows as a fraction of gross domestic product are rising. More generally, this model implies that the ratio of capital inflows to gross domestic product are a submartingale as long as all banks are liquid. Also, in the general case, the variance of output for the country is

rising stochastically.

2.4 Bank illiquidity and financial crises

To complete the dynamics, we need to know how foreign lenders or the domestic government handle bank illiquidity or insolvency. Consider a bank that has reached the point that it cannot service its total debt on schedule. In contrast with the case of a firm's inability to meet its current debt service, the bank's inability reveals information about its portfolio and future behavior to its creditors. An illiquid bank in this agency model makes risky loans. Therefore, we assume that the government recognizes the problems of moral hazard that arise if they do not close an individual bank that cannot honor domestic depositors' liquidity demands in any period. If a bank becomes illiquid alone, it is closed and insolvent firms shut down. Some output is lost in this process because of time-to-build.

Foreign lenders, ceteris paribus, may be willing to renegotiate with a bank, although they do not necessarily have an incentive to do so. If they anticipate government guarantees of the foreign currency loans they make to domestic banks, then they can have a significant incentive to continue lending to domestic banks that have no capital. We hypothesize that the government does not guarantee foreign lenders against individual bank failure. However, as the number of banks that collapse simultaneously rises, output costs increase proportionately. The government faces a much larger loss of output as foreign lenders choose not to provide the funds needed to complete projects in process. A lender will not provide more funds to a bank to complete its clients' firms as a bank failure becomes more likely. The government may well provide insurance implicitly to foreign lenders against widespread losses that it would not provide against idiosyncratic losses.

Assuming that the government behaves to reduce aggregate output collapses introduces interdependence in foreign lender behavior. When a bank is unable to service its current short-term debt, foreign lenders realize some option value to rescheduling loan payments. As time progresses, more banks will need to negotiate loan extensions with their foreign creditors. Under rational expectations, lenders foresee that the risk of widespread bank insolvency is rising stochastically over time. Once the potential output loss is large enough that the government will make contingent transfers to foreign lenders to avoid the loss of incomplete projects, the foreign banks should stop lending, triggering the implicit government guarantee of a portion of their financial claims. Foreign lenders have an incentive to avoid bankrupting domestic banks too early. They do not need to be fully insured by the government in the event of a wide-

spread domestic financial crisis to rollover loans and lend to complete projects. In fact, it is important that losses are shared by foreign lenders so that they prefer lending to banks with positive capital. These decisions depend on the discount rate for foreign lenders. Clearly, an unanticipated rise in the foreign rate of interest can cause a sudden drop in foreign capital flows short of the magnitude needed to trigger government transfers.

What happens when the eventual financial crisis hits in this model economy? The government suddenly realizes a big increase in its financial obligations. In our model, this implies future monetization. As domestic credit expands, the fixed exchange rate collapse follows exactly as in Krugman [1979].

When can the exchange rate regime collapse? Every foreign lender knows the stochastic process for bank capital, the variance of domestic output and the magnitude of claims against banks that will be collapsed by a pull-out of foreign capital. They can observe the balance-sheet capital for each domestic bank and infer the probability distribution for non-performing foreign loans to these banks. (Even without marking-to-market, reported bank assets grow at different rates for banks realizing positive overall profits and for banks realizing losses under the assumptions made.) This implies that the fixed exchange rate can collapse before or after the financial crisis in this model.

Our assumptions assure that a financial crisis is inevitable with probability one in this economy. The model implies that capital inflows rise a ratio of gross domestic product up to the crisis. Output drops after the crisis and new cycle of expansion can begin.

An eventual financial crisis can occur even under a floating exchange rate. It is a consequence of insufficient monitoring of bank behavior and of government guarantees. The government has an incentive to provide insurance in this model for Diamond and Dybvig reasons, and for reasons of ex post efficiency, it has an incentive to bailout banks. The anticipation of a bank bailout can lead to the same cycle of lending and crisis in the presence of international financial capital inflows without an exchange rate peg and foreign currency guarantees of some sort.

The gap in government policy in this model concerns prudential regulation of the banking sector. The asymmetries of information between the government, foreign lenders and bankers is the source of inefficiency in this model. The government has an incentive to impose bank capitalization requirements and require continuous revaluation of non-performing assets to their correct market values.

After a financial crisis hits, investment and output drop in this economy as noted. Lending contracts

suddenly, and foreign lenders seek to reverse capital flows. There are two further sources of decline in output growth. If banks are allowed to fail, then the economy loses the services of bank entrepreneurs as evaluators of investment projects. They operate a technology that has social value. Reentry is costly, so that the government has an incentive to bailout domestic banks. Anticipating that this occurs in a crisis, but not if one's bank fails idiosyncratically, would contribute to the loan buildup that sows the seeds of the crisis. The second possible contribution to output loss is implicit in the model. Money is held in interest-bearing demand deposits by households. As noted by Calvo [1998a], the loss of bank services can result in a further output contraction by disrupting the payments mechanism.

Things are a bit different if we assume nominal price rigidities. The exchange rate regime collapse causes a sudden change in the real exchange rate. This is manifested as a sudden shift in the distribution of revenues for every potential project for each entrepreneur. The portfolios of liquid banks at the time of the collapse suddenly deteriorate. Because this repercussion for all banks and projects is anticipated under rational expectations, a reduction in lending and investment can occur before the crisis. This is because new loans become unprofitable if they will still be under construction when the crisis hits. It is a reason why the crisis could hit all banks. Hence, price rigidities imply that a financial crisis before or simultaneous to a currency crisis, but not later.

3. Empirical Evidence for the Model

3.1 A First Pass at the Data

Formal testing of the model is hampered by the unavailability of data for many of the variables of interest. Indeed some of the key variables in the model are not directly observable. These are the riskiness of investment, the size of the contingent liabilities and the share of bank capital (as opposed to foreign capital) in domestic investment.

The model, however, can be examined along a number of dimensions using indirect measures of the factors of interest. In this informal examination, we discuss the patterns that can be observed, and whether they conform to the model. The model a number of important assumptions and implies several relationships. The key condition is that increases in capital inflows are intermediated through the banking system and result in increases in lending to the private sector. This is the case to the extent that capital inflows to the domestic banking sector are not sterilized, resulting in reserve accumulations rather than

financing debits on the current account.

The patterns we expect to observe for economies subject to these agency problems include the following:

1. Stochastically increasing foreign and domestic loans as a ratio of output.
2. A rising ratio of capital inflows to GDP for crisis countries; this ratio can be rising even as GDP growth rates decline.
3. Diminishing investment quality.
4. Deterioration of bank portfolios as the share of non-performing assets rises.
5. Post-crisis increases in money supply growth rates.

Each of these factors is examined in turn.

3.1.1 Capital Inflows and Domestic Lending

The model requires that capital inflows are manifested in lending by banks and other financial intermediaries. We do not present a detailed discussion of how effective these countries have been in sterilizing capital inflows; such accounts are provided by Spiegel [1995] and Moreno [1996]. Rather we focus on the broad relations between capital inflows and lending over the pre-crisis period. We measure capital flows using the financial account data reported by the IMF (in US$ converted to domestic currency), while deposit bank lending to the domestic private sector is measured by domestic credit (IFS line 32d). For certain countries, additional lending is provided by non-deposit taking banks and nonbank financial institutions; we will refer to the sum of deposit bank lending and these additional categories as total lending (as opposed to bank lending). In Figures 1-7, scatterplots of the relationship between changes in bank lending and capital inflows (in billions of units of domestic currency) are presented for Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand for the 1985.1-97.1 period (annual data are plotted for Malaysia and Singapore). In all cases, save Singapore and Taiwan, the slope coefficient is positive in a simple regression of bank lending changes and capital inflows. Typically the coefficient is above 0.5, but below 1.00. One might think that some of the effect is omitted since we only allow for contemporaneous effects; however, most of the impact of capital inflows appears to be manifested within one quarter.

Singapore and Taiwan are interesting exceptions. These two economies ran substantial and persistent current account surpluses, and for certain periods Taiwan exports financial capital. Whatever increase

there is in financial intermediation through the banking system, it is not driven by capital inflows.

3.1.2 Surges in Bank Lending

Much has been made of the role of rapidly increasing bank lending in the years leading up to the 1997 crises. More recently, Moreno [1999] has argued that only in certain cases were movements in domestic credit in excess of historical averages in the period immediately preceding the July 1997. Analysis of whether there was a surge in bank lending is complicated by the fact that developing countries typically exhibit rising bank loan to GDP ratios, as the process of financial deepening proceeds.

To examine whether the 1990s were anomalous in their behavior in this respect, we plot in Figures 8-14 the lending to GDP ratios for Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand. The graphs show the trend lines[6] for the 1985.1-89.1 and 1989.2-97.2 subperiods. The 1989.2 break is selected because this represents the last peak in US real interest rates. The subsequent decline marks the beginning of capital surges to the emerging markets.

In all cases, the rate of growth is faster in the later period than the earlier. The acceleration in credit growth is marked, except in the cases of Indonesia and Taiwan. Actually, the Indonesian exception is somewhat misleading: there is a surge of lending in 1989-90 which is not completely captured in the estimated trends. Hence, the one clear exception to the pattern of accelerating growth in the credit-GDP ratio is Taiwan.

3.1.3 The Quality of Investment Projects

Asymmetric information and public insurance of private intermediation in our model imply that bank loans become progressively riskier, equivalently, of lower quality, in the aggregate over time. In general we cannot observe the return on these investment projects directly. A commonly-used aggregate statistic to measure the return to investment is the incremental capital to output ratio (ICOR). This measures the increase in the capital stock needed to produce a unit increase in output. Higher values of the ICOR suggest that the productivity of capital being put into use is low. Figure 15 presents a series of ICORs calculated from national income accounting data, taking account of business cycle factors. What is clear is that Korea, Thailand and Malaysia all exhibit high and rising ICORs, while the ratio for Indonesia is declining from very high levels to match the ICORs of Korea and Thailand. On the other hand, Taiwan once again stands out with by far the lowest ICOR. Singapore's ICOR is comparatively high, but then its

emplaced capital stock per worker exceeds that of the other countries, so Singapore's values are not too surprising.

The aggregate numbers are not terribly illuminating because they confound many other factors that are not held constant in the calculations (ICORs are of the nature of total differentials). To get a less aggregate view of the situation, we also look at firm level data, drawn from two recent World Bank studies (Claessens, Djankov and Lang [1998] and Pomerleano [1998]). The series we examine are the return on assets (ROA) and the pre-tax return on capital employed (ROCE) for nonfinancial firms in the seven East Asian countries. These data are depicted in Figures 16-22.

The median ROA is calculated on the basis of samples ranging from 66 corporations in Korea in 1988 to 3567 corporations in Malaysia in 1996. In the case of sales-weighted mean ROCE, panel data ranging from 16 firms in Taiwan to 211 in Malaysia are used.

The standard caveats apply. The financial institutions and environments differ substantially across the countries, as do the levels of capital per worker. Therefore, cross-country comparisons of the levels of return on assets and return on capital must be viewed with great caution. In contrast, the within-country time series patterns may be very informative with respect to the evolution of firm (and hence investment) profitability.

Indonesia and Thailand, two of the countries that encountered the most severe banking problems, experienced pronounced downward trends in both ROA and ROCE. As shown in Table 1, over the 1990s the ROA declined 2.9 percentage points in Indonesia, and 4.3 percentage points in Thailand. In contrast, the countries that did not experience substantial banking problems also exhibited stable or rising ROAs: Taiwan's ROA rose 1.5 percentage points, while Singapore's was essentially unchanged.

In the case of Korea the ROA only declined one percentage point over the 1990s.[7] However, what is unique about Korea is that its ROA is uniformly low over the entire 1988-96 period. The Korean ROA is even below the US ROA. If we compare Korea to Taiwan, a country of comparable GDP per capita, we find that the gap between the two ROAs widens from about 1 percentage point to 3.5 percentage points over the 1990s. Hence, these statistics validate the anecdotal evidence suggesting that Korean investment expenditures deteriorated markedly in the run-up to the crisis.

3.1.4 Bank capital

Little time-series evidence on bank capital is available on a consistent basis. The evidence does suggest

that the amount of bank capital divided by assets (the capital to asset ratio, or CAR) is inversely related to the severity of financial crisis in East Asia. In Hong Kong, the Philippines, and Singapore, the capital-asset ratios were 15-20, 15-18 and 18-22%, respectively. In contrast, these ratios were 8-10, 6-10 and 6-10 for Indonesia, Korea and Thailand, respectively.

These CAR data are based on accounting conventions; in principle, we need to have the ratio calculated after taking into account the assets that have gone to zero value. In this case, the CARs for the first group are slightly reduced, while those for the last three countries fall to -17, -10, and -11, respectively (Morgan Guaranty [1998], p.6).

3.1.5 Contingent liabilities

The model predicts that, in the presence of government guarantees, lending to GDP will rise; moreover, the size of contingent liabilities will also rise. These contingent liabilities represent the costs of bailing out the banking system. In theory, the share of non-performing loans (NPLs) gives a measure of the proportion of total loans that will have to be assumed by the government. In several studies, the share of NPL multiplied by the loans-to-GDP ratio has been used as a measure of the cost of bailing out the banking sector, expressed as a percentage of GDP (Corsetti, Pesenti and Roubini [1998a] and Burnside, Eichenbaum and Rebelo [1999]). Therefore, we anticipate observing a rising NPL share as the economy approaches the onset of a financial crisis. However, as pointed out by many observers, there are numerous ways in which to circumvent these accounting and regulatory definitions of non-performing bank assets.[8]

Consequently, as illustrated in Figure 23, NPL ratios provide only approximate estimates of the magnitudes of contingent liabilities, both over time and across countries. In the figure, the Thai NPL does rise in the year before the crisis. However, the Korean NPL ratio is both low and declining in the mid-1990s the end-of-year 1996 value of NPL is 0.8%!

3.1.6 Lending before at the Onset of the Crisis

The model allows for the possibility that lending can maintain its momentum even as GDP growth slackens. This is an implication if revenues are correlated within periods across large numbers of firms or across sectors. It may not be the case if firm revenues are serially correlated.

Figures 24-30 depict the various credit ratios and 4 quarter growth rates of GDP (in log difference terms). There is not a clear pattern in the data. However, lending rises as ratio of GDP for Korea even as

the GDP growth rate falls. As output growth declines from 9% to 6% in 1995-96, the lending ratios rise at an accelerating rate. At the other end of the spectrum, Taiwan does not evidence rising lending ratios during the drop in growth rates in 1995-96. The rest of the cases are indefinite.

3.2 Statistical Tests

We report in Column 1 of Table 3 the results of a regression of the capital flow to GDP ratio against a constant and a dummy variable over the 1989.2-1993.4 period. The dummy variable takes a value of unity for those East Asian countries that experienced a financial crisis in 1997 – Indonesia, Korea, Malaysia and Thailand. (We define a country to have suffered a financial crisis if the implied post-bailout capital-to-asset ratio is negative, according to Morgan Guaranty [1998] estimates).

The non-crisis countries averaged capital inflows of 2.8% of GDP over this period, while the crisis countries averaged 6.4%. In the two years leading up to the crisis, as inflows decreased to the non-crisis countries, those to the crisis countries remained roughly the same. In other words, the gap between inflow rates widened in the run-up to July 1997. These differences are statistically significant between the two groups, in both periods.

Lending ratios exhibit similar behavior. In both sets of countries bank lending accelerates from the 1982.1-93.4 period to the 1994.1-97.1 period. If total lending (deposit bank, other bank and nonfinancial institution lending) is considered, then the acceleration in lending is even more marked. While the growth rate in lending to GDP ratios rises from 2.8 percentage points per year to 4.7 percentage points per year in the non-crisis countries, it rises from 4.4 percentage points per year to 7.8 percentage points per year in the crisis countries.

Next we conduct an econometric investigation of the determinants of the timing and location of financial crises. We relate the onset of financial crises in the East Asian countries to corporate returns on assets (ROA) in percentages, the lagged nonperforming loan (NPL) ratios, in percentages, and 4 quarter changes in the bank lending to GDP ratios (in decimal form), over the 1995-97 period (estimating it over a period spanning 1998 only strengthens the results, since the ROA and NPL indicators move very strongly in the expected direction with the continuation of the crisis). The results of various specifications are reported in Table 4; the estimation technique is probit, as the dependent variable is defined as taking a value of zero, except for 1997.3- in Indonesia, Korea, Malaysia and Thailand.

If project quality declines, one should expect that bank liabilities will be increasing relative to assets,

and the banks will find the bankruptcy option more and more attractive. A simple regression involving only ROA yields the correct sign on the variable, but not any statistical significance. Similarly, a regression on only NPL lagged a year also yields correctly signed but statistically insignificant coefficients. Only when the two variables are included does one obtain a significant estimate for ROA.

In many recent studies, the rate of growth of bank lending has been found to be an important determinant of a currency crisis (Kaminsky and Reinhart [1999]; Corsetti, Pesenti and Roubini [1998a]; Chinn, Dooley and Shrestha [1999]). We replace NPL with the change in the bank lending to GDP ratio to see if it proxies for the share of nonperforming loans. This variable has the anticipated (positive) sign when entered contemporaneously into the regression (column 4) or lagged two years (column 5). However, it appears that NPL has independent informational content above what is provided by lagged lending growth, as shown in column 6. In this specification, lower ROA significantly increases the probability of a financial crisis, as does a higher NPL ratio. Lagged bank lending growth has an independent effect above and beyond the NPL variable. This effect is consistent with the model's implication that increasing lending/GDP ratios will occur in economies where the public sector guarantes make bankruptcy an increasingly attractive option.

3.3 Post-Crisis Events

A consequence of financial intermediation with agency is that the model implies that output falls in the wake of the financial crisis. This is a prediction shared by many other models, so it does not differentiate this view of crises from others. The model also implies a sudden increase in the government deficit which is monetized in the wake of a financial crisis, as the government realizes the contingent obligations associated with the bank bailout. Figure 31 shows that this pattern of results is more or less evident in the data. The Korean M2 to GDP ratio grows rapidly in the second and third quarters of 1998; so too does the Thai ratio. In both cases, some of this growth is due to the contraction in the economies. However, even if money stocks alone were examined, a similar pattern would emerge. In contrast, the Taiwanese M2 to GDP ratio remains fairly constant.

4. Conclusion

The theoretical model generates endogenous accumulations of foreign debt by a domestic financial sector that is progressively less stable, leading to an eventual crisis. Essential to this process are the prospect

of government guarantees of foreign loans or bailouts of the domestic banking industry (or both). Also essential is a banking sector that is relatively unregulated or distorted by regulation or corruption. With extended analysis, this model implies an endogenous cycle of foreign financial capital inflows and financial crises that can be sensitive to disturbances to the foreign rate of interest or demands for domestic outputs.

The credit market model shares features with other models of agency in financial intermediation, although there are differences in the informational and institutional assumptions made. Renegotiation plays an important role in the dynamics, motivating the composition of familiar components in the model. Renegotiation is not formally analyzed using an extensive-form game as would be desirable.

An extension of the model that would allow greater parallels to the work of Bernanke and Gertler [1989, 1990] on the role of credit markets in macroeconomic dynamics is natural and tractable. The replacement of a single good with traded and non-traded goods would allow relative price movements in response to interest rates, capital inflows and financial crises. This would introduce the possibility of interdependency between sectors that can alter the timing of a crisis and reduce the magnitude of contingent government guarantees needed to create a financial crisis.

The empirical analysis provides some support for the implications of the model, although formal hypothesis testing was not possible. In particular, countries that underwent a crisis seem to experience higher rates of international capital inflows and domestic bank intermediation. They also tend to have deteriorating investment portfolios, although there can be other reasons for this. Post-crisis events are consistent with this model, but they are also consistent with a variety of models that endogenize output (money expansions are not really a prediction of the model, since they follow from an assumed fiscal policy response).

Data Appendix

Most of the data are from IMF, International Financial Statistics, March 1999 CD-ROM, except for data for Taiwan: Bank of China website.

GDP Income is real GDP, IFS line 99b.r, in 1990 national currency units. The GDP series are seasonally adjusted over the 1975Q1-99Q1 periods, using the X-11 seasonal adjustment additive procedure (except for Japan, in which case the data is adjusted by Japanese statistical agencies). Taiwanese GDP is originally in 1991 New Taiwan dollars, but is rebased to 1990 units. Indonesian data is from the IMF's Indonesia country desk (provided by Ilan Goldfajn). Thai GDP is estimated using the annual relationship between GDP, exports, imports, the real exchange rate and time, and quarterly data on these variables to generate a quarterly GDP series. For post 1992 data, GDP data is actual quarterly GDP obtained from the Bank of Thailand website, in 1988 baht, rescaled to 1990 baht.

ICOR = (INV t + INV t-1)/(GDP t - GDPt-2) where INV is IFS line 93e and GDP is IFS line 99b.r (annual data). (Indonesia INV is IFS line 93).

ICORHP2 = (INV t + INV t-1)/(GDPHP t - GDPHPt-2), where HP superscript denotes HP filtering over 1970-1997 period, using default smoothing parameter for annual data.

ROA Returns to Assets, annual data from Claessens, Djankov and Lang (1998), Table 1. In regressions using quarterly data, annual ROAs are interpolated using a moving average.

OPM Operating margin, annual data from Claessens, Djankov and Lang (1998), Table 3.

ROCE Return on Capital Employed, annual data from Pomerleano (1998), Table 10.

NPL Non performing loan ratios from Bank for International Settlements (1997), Table VI.5. Data for 1997 from Morgan Guaranty (1998) Asian Financial Markets 1998Q2, p.6, except for Taiwan, from Morgan Guaranty (1999) Asian Financial Markets 1999Q1, p. 39. 1996 observation for Singapore and Thailand from Jardine Fleming, as reported in Corsetti, Pesenti, Roubini (1998b) "What caused..." part I, Table 21. In regressions using quarterly data, annual NPLs are arithmetically interpolated by assuming the reported NPLs apply to loan portfolios at year-end. For 1997, end-of-1996 values are assumed form 1997.1-1997.2.

References

Bank for International Settlements [1997], **Annual Report**. Basle, Switzerland: Bank for International Settlements.

Bank for International Settlements [1998], **Annual Report.** Basle, Switzerland: Bank for International Settlements.

Bank for International Settlements [1999], **Annual Report**. Basle, Switzerland: Bank for International Settlements.

Bernanke, Benjamin and Mark Gertler [1990], "Financial Fragility and Economic Performance,"**Quarterly Journal of Economics**, 105, February, pp. 87-114.

Bernanke, Benjamin and Mark Gertler [1989], "Agency Costs, Net Worth and Business Fluctuations," **American Economic Review**, 79, March, pp. 14-31.

Burnside, Craig, Martin Eichenbaum and Sergio Rebelo [1999], "Hedging and Financial Fragility in Fixed Exchange Rate Regimes, "National Bureau of Economic Research Working Paper No. 7143, May.

Caballero, Ricardo and Arvind Krishnamurthy [1998], "Emerging Markets Crises: An Assets Markets Perspective," MIT Working Paper.

Calvo, Guillermo [1998b], "Varieties of Capital-Market Crises," in Calvo, Guillermo and Mervyn King (eds.), **The Debt Burden and its Consequences for Monetary Policy**, London: Macmillan.

Calvo, Guillermo [1998a], "Balance of Payments Crises in Emerging Markets: Large Capital Inflows and Sovereign Governments," NBER Conference on Currency Crises, Cambridge, MA, Febuary.

Chang, Roberto and Andres Velasco [1999], "Illiquidity and Crises in Emerging Markets: Theory and Policy", NewYorkUniversity,Working Paper.

Chinn, Menzie D., Michael P. Dooley and Sona Shrestha [1999], "Latin America and East Asia in the context of an insurance model of currency crises,"**Journal of International Money and Finance**, 18, pp. 659-681.

Claessens, Stijn, S. Djankov and L. Lang, [1998], "East Asian corporates: growth, financing and risks over the last decade," WorldBankPolicy Research Working Paper #2017, World Bank: Washington, DC.

Corsetti, Giancarlo, Paolo Pesenti and Nouriel Roubini [1998a], "Paper Tigers? A preliminary assessment of the Asian crisis," Working Paper no. 6783. National Bureau of Economic Research, Cambridge, MA.

Corsetti, Giancarlo, Paolo Pesenti and Nouriel Roubini [1998b], "What caused the Asian currency

and financial crisis? Part I: a macroeconomic overview," Working Paper no.6833. National Bureau of Economic Research, Cambridge, MA.

Corsetti, Giancarlo, Paolo Pesenti and Nouriel Roubini [1998c], "What caused the Asian currency and financial crisis? Part II: theory and policy responses," Working Paper no. 6834 National Bureau of Economic Research, Cambridge, MA.

Diamond, Douglas [1984], "Financial Intermediation and Delegated Monitoring," **Review of Economic Studies**, 51, pp. 393-414.

Diamond, Douglas and Phillip Dybvig [1983], "Bank Runs, Deposit Insurance and Liquidity," **Journal of Political Economy**, 91, June, pp. 401-419.

Dooley, Michael P. [1999], A model of crises in emerging markets," **Economic Journal**, forthcoming.

Edwards, Sebastian and Carlos Vegh [1997], "Banks and Macroeconomic Disturbances under Predetermined Exchange Rates," **Journal of Macroeconomics**, 40, pp. 239-278.

Eichengreen, Barry and Andrew Rose [1998], "Staying afloat when the wind shifts: External factors and emerging-market banking crises," Working Paper no. 6370. National Bureau of Economic Research, Cambridge, MA.

Flood, Robert and Peter Garber [1984], "Collapsing Exchange Rate Regimes: Some Linear Examples," **Journal of International Economics**, 17, August,

Frankel, Jeffrey and Andrew Rose [1996], "Currency crashes in emerging markets: An empirical treatment," **Journal of International Economics**, 41, pp. 351-368.

Furman, Jason and Joseph Stiglitz [1998], "Economic Crises: Evidence and Insights from East Asia," **Brookings Papers on Economic Activity**, 2, pp. 1-115.

Glick, Reuven and Michael Hutchison [1999], "Banking and Currency Crises: How Common are Twins¿' Federal Reserve Bank of San Francisco, manuscript, June.

Goldfajn, Ilan and Rodrigo Valdes [1997], "Capital Flows and the Twin Crises: The Role of Liquidity," International Monetary Fund, Working Paper WP/97/87.

Hutchison, Michael and Kathleen McDill [1998], "Determinants, costs and duration of banking sector distress: The Japanese experience in international comparison," paper presented at the NBER-TCER Japan Project Meeting, Tokyo, October.

Kaminsky, Graciela and Carmen Reinhart [1998], "Currency and banking crises: The early warnings of distress," International Finance Discussion Paper no. 629, Board of Governors of the Federal Reserve System, Washington, D.C.

Kaminsky, Graciela and Carmen Reinhart [1999], "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems,"**American Economic Review**, forthcoming.

Kiyotaki, Nobuhiro and John Moore [1997], "Credit Cycles," **Journal of Political Economy**, 105, pp. 211-248.

Krugman, Paul [1979], "A Model of Balance-of-Payments Crises," **Journal of Money, Credit and Banking**, 11, August, pp. 311-325.

Krugman, Paul [1998], "Bubble, boom, crash: Theoretical notes on Asia's crisis," MIT, Cambridge, MA. Unpublished.pp. 1-13.

Kumhof, Michael [1998], "Balance of Payments Crises: The Role of Short-Term Debt," manuscript, Stanford University.

McKinnon, Ronald and Huw Pill [1999], "Credible liberalizations and international capital flows: The overborrowing syndrome," in Ito, T., Krueger, A.O. (eds.) **Financial Deregulation and Integration in East Asia**. Chicago: University of Chicago Press.

Miller, Marcus and Joseph Stiglitz [1999], "Bankruptcy Protection Against Macroeconomics Shocks: The case for a 'super Chapter 11'," Centre for the Study of Globalisation and Regionalisation, University of Warwick, manuscript, April.

Mishkin, Frederic [1996], "Understanding Financial Crises: A Developing Country Perspective," in Bruno, Michael and Boris Pleskovic (eds.), **Annual World Bank Conference on Development Economics 1996**, Washington, D.C.: The World Bank, pp. 29-62.

Moreno, Ramon [1996], "Intervention, sterilization, and monetary control in Korea and Taiwan," **Federal Reserve Bank of San Francisco Economic Review** 1996(3), pp. 23-33.

Morgan Guaranty Trust Company [1998], **Asian Financial Markets**, 2nd Qtr., New York: J.P. Morgan.

Morgan Guaranty Trust Company [1999], **Asian Financial Markets**, 1st Qtr., New York: J.P. Morgan.

Obstfeld, Maurice [1998], "The Global Capital Market: Benefactor of Menace?" **Journal of Economic Perspectives**, 12, pp. 9-30.

Pomerleano, M. [1998], "The East Asian crisis and corporate finances: the untold micro story," World Bank Policy Research Working Paper #1990, World Bank: Washington, DC.

Sachs, Jeffrey, Aaron Tornell and Andres Velasco [1996], "Financial crises in emerging markets: The lessons from 1995," **Brookings Papers on Economic Activity**, pp. 147-215.

Spiegel, Mark M. [1995], "Sterilization of capital inflows through the banking sector: evidence from Asia," Federal Reserve Bank of San Francisco, manuscript.

Stiglitz, Joseph and Andrew Weiss[1981], "Credit Rationing in Markets with Imperfect Information," **American Economic Review**, 71, pp. 393-410.

Endnotes

[1]The empirical relationship between these "twin crises" is the subject of Kaminsky and Reinhart [1998 and 1999], Hutchison and McDill [1999] and Glick and Hutchison [1999].

[2]Examples responsive to the Asian Crisis of 1997 include Caballero and Krishnamurthy [1998], Chang and Velasco [1998], Dooley [1999], Eichengreen and Rose [1998], Furman and Stiglitz [1998], Goldfajn and Valdes [1997], Kumhof [1998], Krugman [1998], McKinnon and Pill [1999] and Miller and Stiglitz [1999]. Other recent papers on international capital flows to emerging markets include Edwards and Vegh [1997], Frankel and Rose [1996], Sachs and Tornell and Velasco [1996], among others.

[3]This link between contingent government liabilities and currency crises is also used by Calvo [1998a], Burnside, Eichenbaum and Rebelo [1999], Chinn, Dooley and Shrestha [1999] and Dooley [1999].

[4]Calvo [1998a] also considers the role of time-to-build in his model.

[5]Although not shown, our model implies that raising the nominal rate of interest can have a serious contractionary effect on output, paralleling the argument made by Furman and Stiglitz [1998].

[6]The trend lines are estimated by regressing the first difference of the credit to GDP ratio on a constant and a dummy variable taking on a value of one beginning in 1989.2, and then dynamically forecasting from the beginning of the sample using the estimated equation.

[7]The Korean ROCE actually rose up to 1995 (the last year for which data is available). However, these ROCE statistics are based on a particularly small panel of only 66 corporations; hence we rely more upon the longer, ROA series for inference.

[8]See Morgan Guaranty [1998], p.8 for a table describing the accounting and prudential standards for Indonesia, Japan, Malaysia, Korea and Thailand.

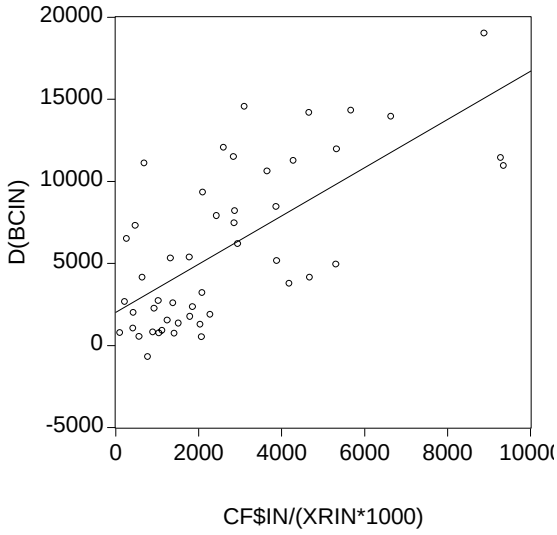

Figure 1: Indonesia, change in deposit bank credit against capital inflows, billions of rupiah.

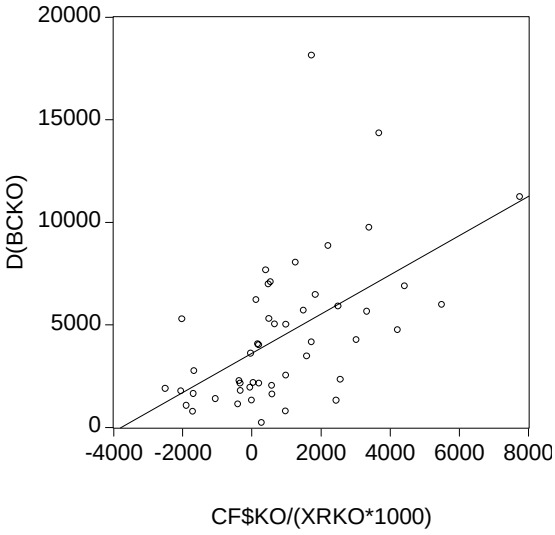

Figure 2: Korea, change in deposit bank credit against capital inflows, billions of won.

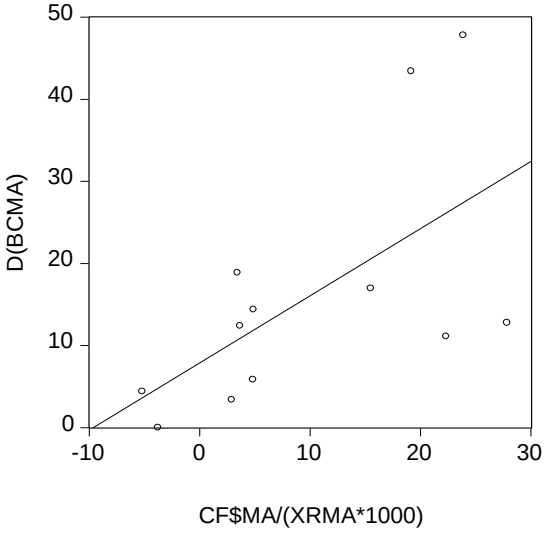

Figure 3: Malaysia, annual change in bank credit against annual capital inflows, in billions of ringgit.

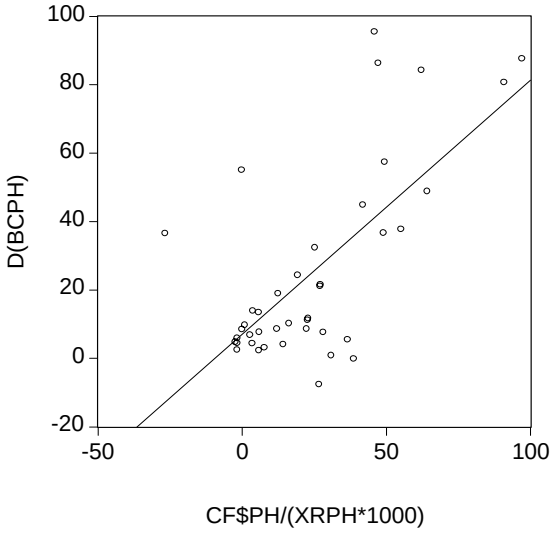

Figure 4: Philippines, change in bank credit against capital inflows, in billions of pesos.

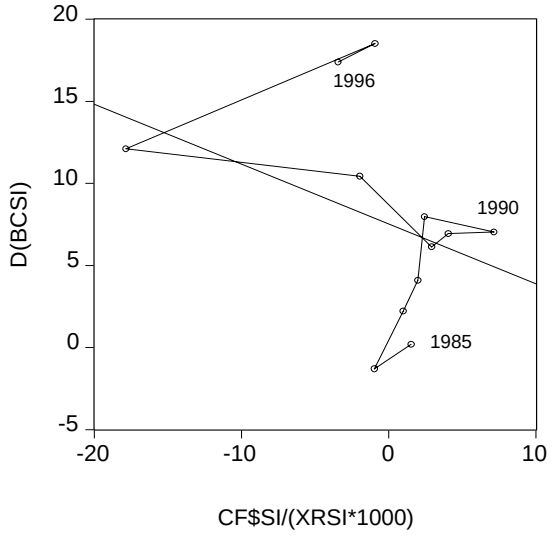

Figure 5: Singapore, annual change in bank credit against annual capital inflows, in billions of Singapore dollars.

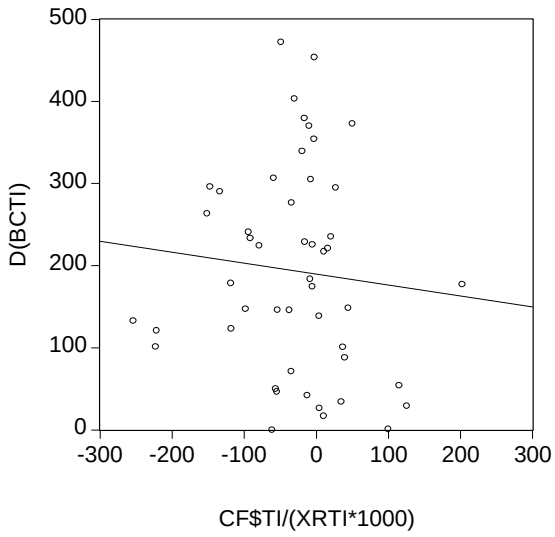

Figure 6: Taiwan, change in bank credit against capital inflows, in billions of New Taiwan dollars.

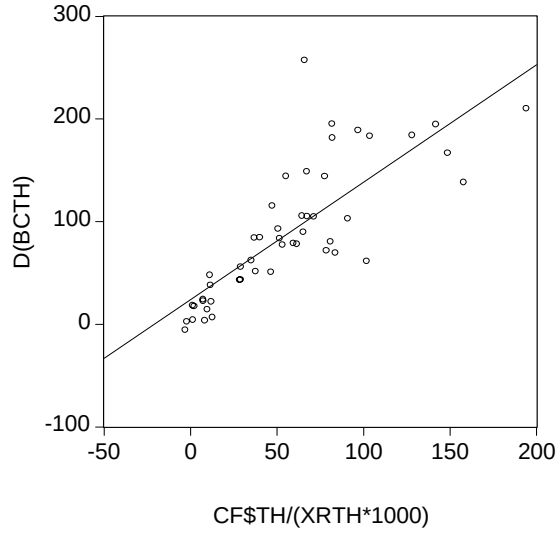

Figure 7: Thailand, change in bank credit against capital inflows, in billions of baht.

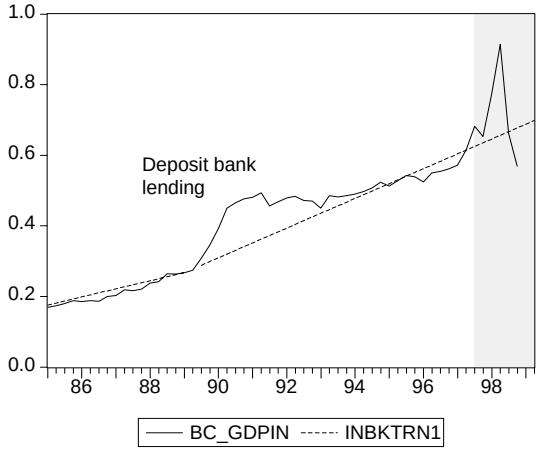

Figure 8: Indonesia, deposit bank lending to GDP ratio and segmented trends.

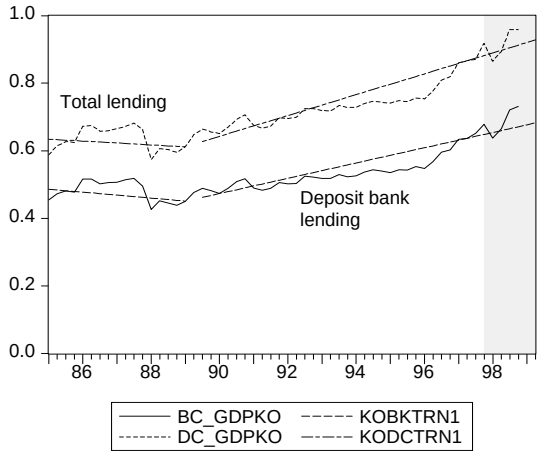

Figure 9: Korea, deposit bank and total lending to GDP ratios, and segmented trends.

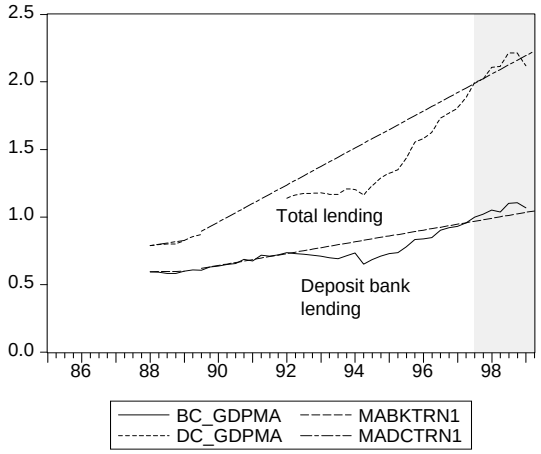

Figure 10: Malaysia, deposit bank and total lending to GDP ratios, and segmented trends.

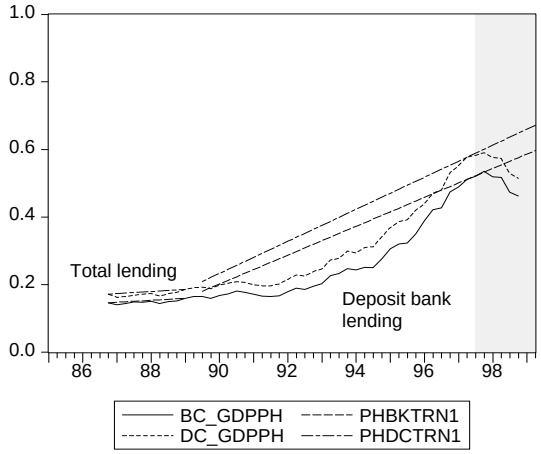

Figure 11: Philippines, deposit bank and total lending to GDP ratios, and segmented trends.

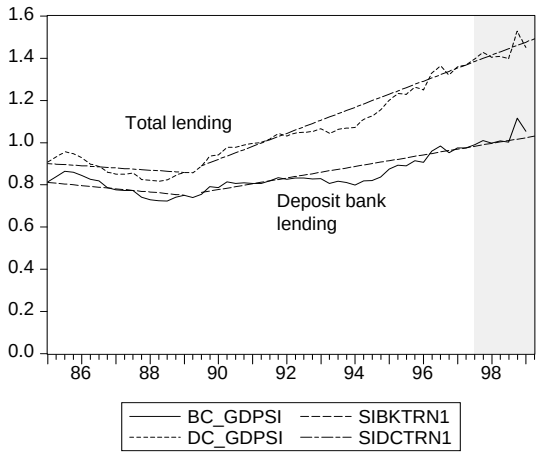

Figure 12: Singapore, deposit bank and total lending to GDP ratios, and segmented trends.

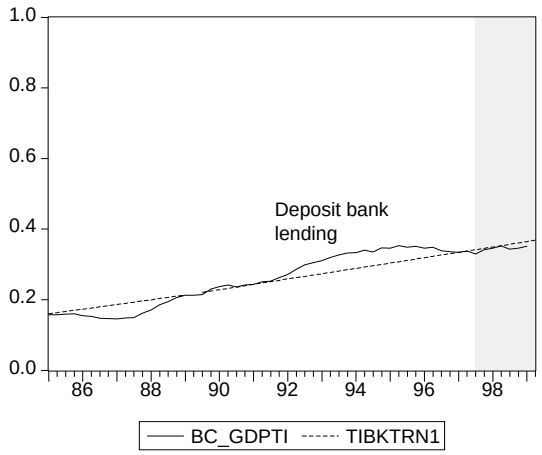

Figure 13: Taiwan, deposit bank lending to GDP ratio and segmented trends.

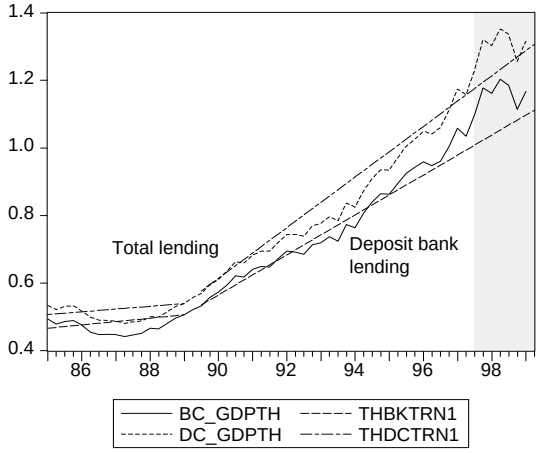

Figure 14: Thailand, deposit bank and total lending to GDP ratios, and segmented trends.

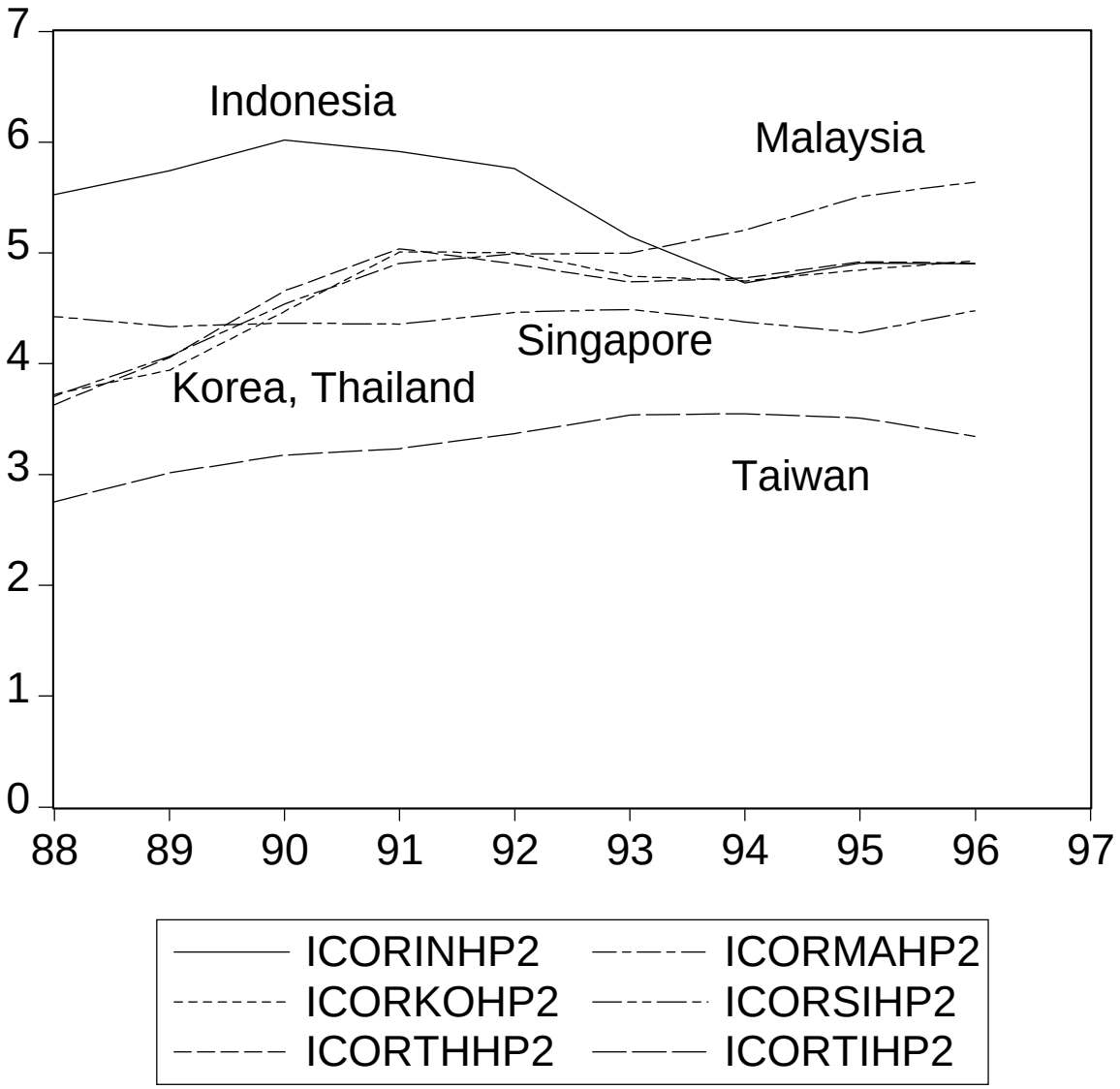

Figure 15: Incremental capital-to-output ratios (ICORs) for Indonesia, Korea, Thailand, Malaysia, Singapore and Taiwan (based on two-year changes and detrended GDP data).

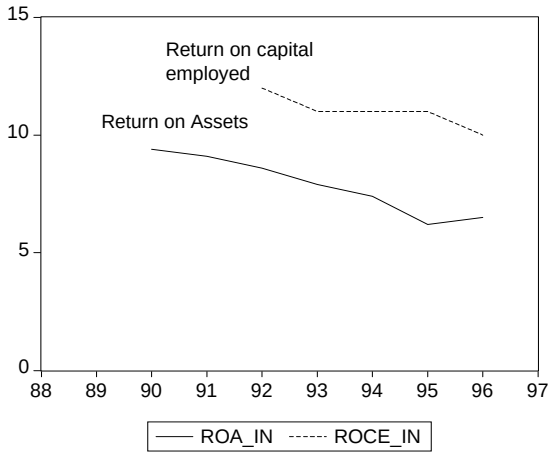

Figure 16: Indonesia, Return on Assets and Return on Capital Employed.

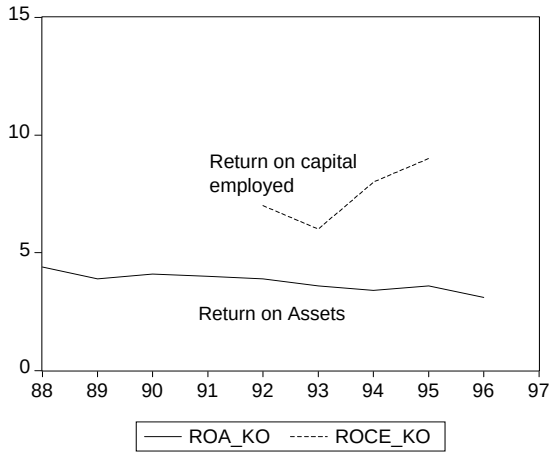

Figure 17: Korea, Return on Assets and Return on Capital Employed.

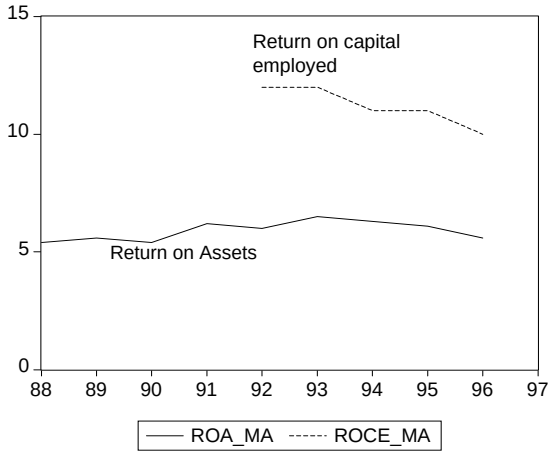

Figure 18: Malaysia, Return on Assets and Return on Capital Employed.

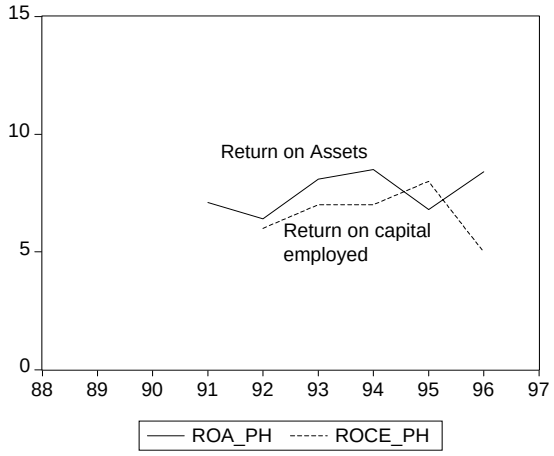

Figure 19: Philippines, Return on Assets and Return on Capital Employed.

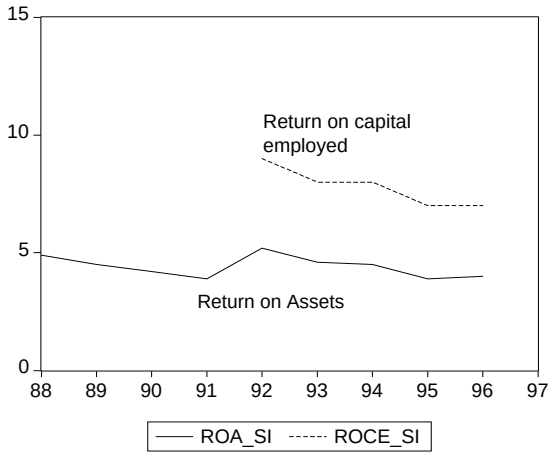

Figure 20: Singapore, Return on Assets and Return on Capital Employed.

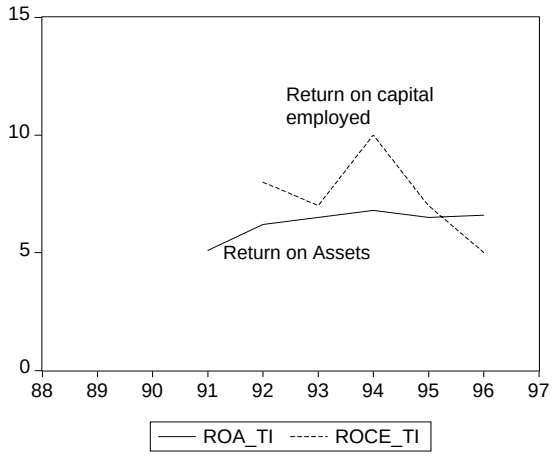

Figure 21: Taiwan, Return on Assets and Return on Capital Employed.

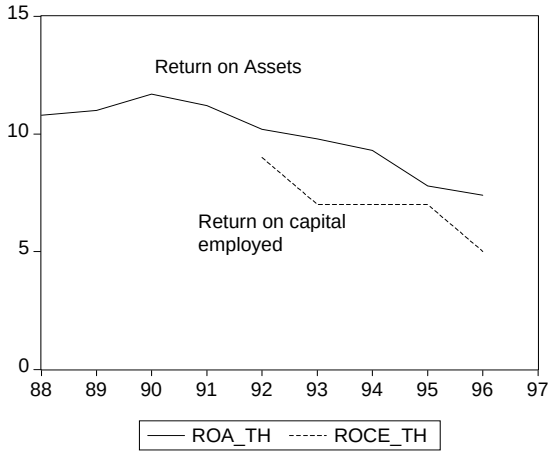

Figure 22: Thailand, Return on Assets and Return on Capital Employed.

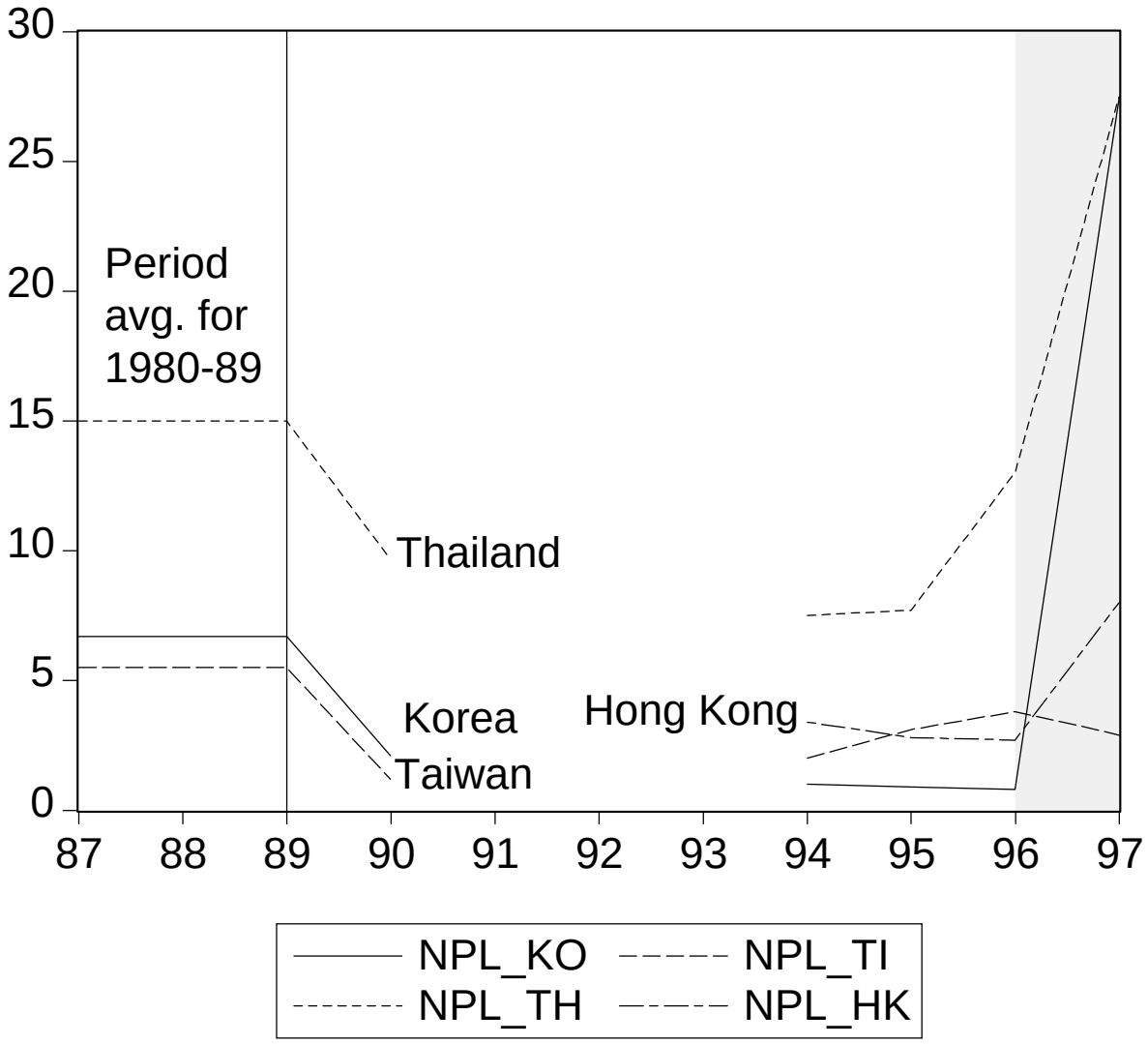

Figure 23: Non-Performing Loan ratios (in percent) for Korea, Thailand, Taiwan and Hong Kong.

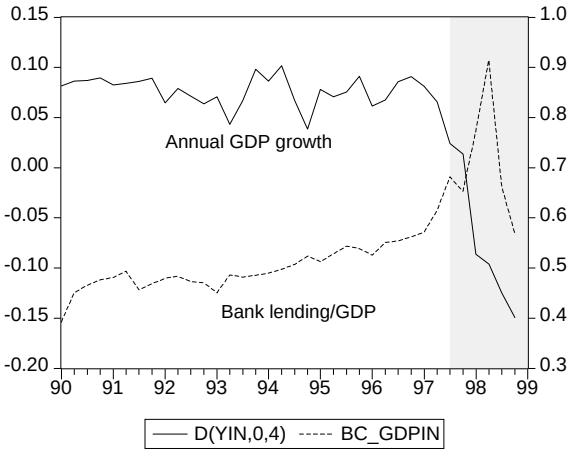

Figure 25: Indonesia, annual GDP growth rate and bank lending to GDP ratio.

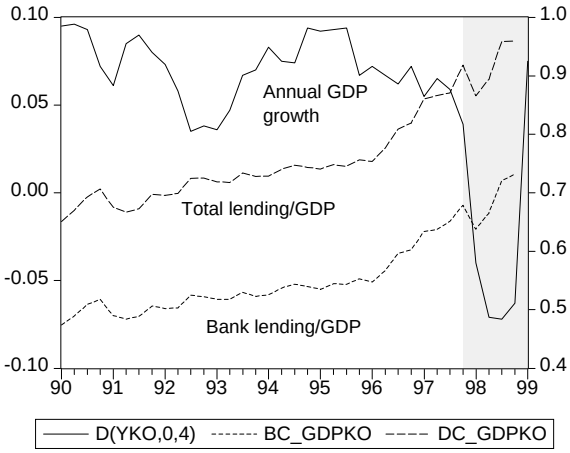

Figure 24: Korea, annual GDP growth rate and deposit bank and total lending to GDP ratios.

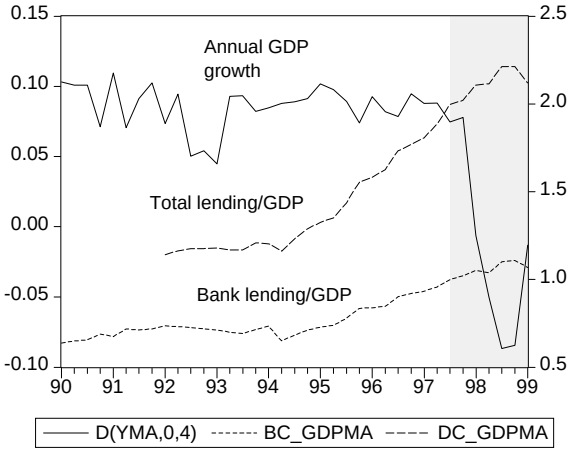

Figure 26: Malaysia, annual GDP growth rate and deposit bank and total lending to GDP ratios.

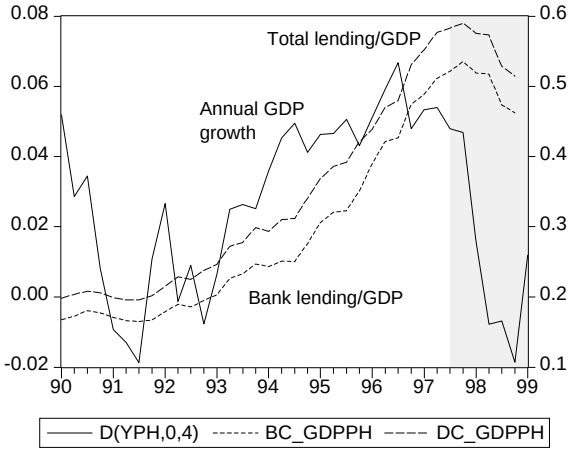

Figure 27: Philippines, annual GDP growth rate and deposit bank and total lending to GDP ratios.

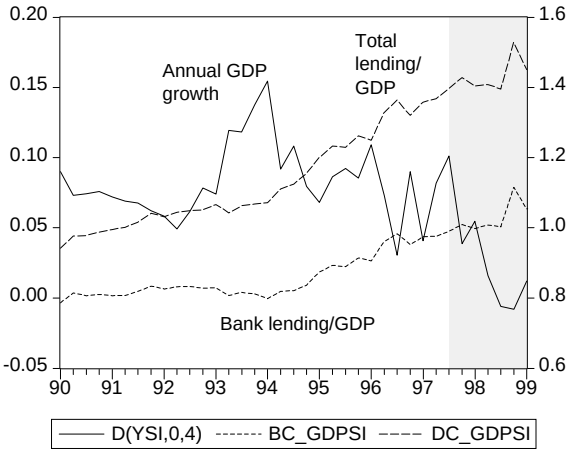

Figure 28: Singapore, annual GDP growth rate and deposit bank and total lending to GDP ratios.

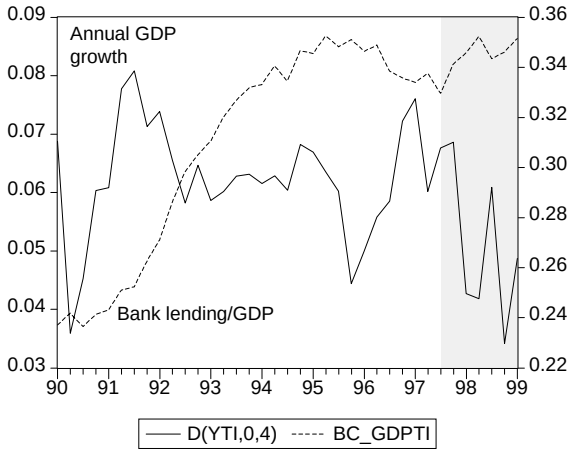

Figure 29: Taiwan, annual GDP growth rate and deposit bank lending to GDP ratio.

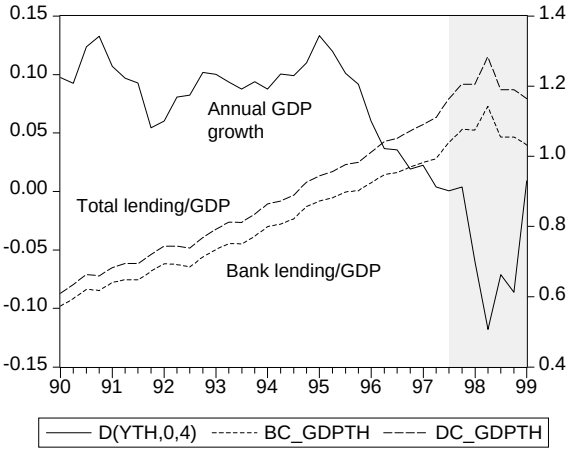

Figure 30: Thailand, annual GDP growth rate and deposit bank and total lending to GDP ratios.

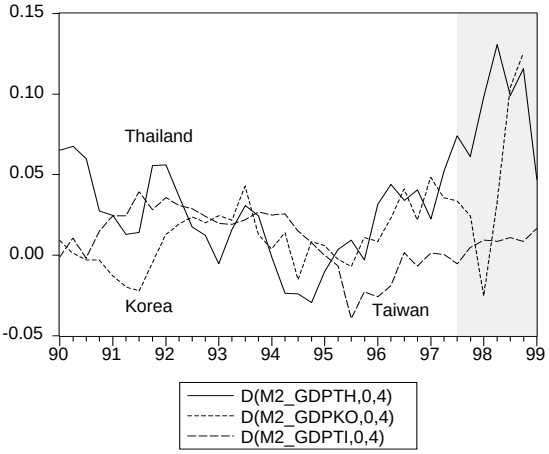

Figure 31: Annual growth rates of the M2 to GDP ratios for Thailand, Korea and Taiwan.

Table 1
Lending to GDP Ratio Growth Rates
1985.1 to 1997.2

SMPL	IN	KO	MA	PH	SI	TI	TH
Deposit Bank Lending							
85Q1 -89Q1	2.29%	-0.89%	0.34%	0.56%	-1.53%	1.33%	0.99%
89Q2 -97Q2	4.20	4.04	4.36	4.27	2.73	1.52	5.91
Total Lending							
85Q1 -89Q1	–	-0.57%	3.84%	0.63%	-1.06%	–	0.82%
89Q2 -97Q2	–	3.09	13.68	4.75	6.17	–	6.93

Notes: Percentage point changes in the lending-to-GDP ratios, calculated by regressing the first difference of the ratios on a constant and a dummy variable. Implied trends depicted in the figures.

Table 2
Return on Assets

obs	ROA_IN	ROA_KO	ROA_MA	ROA_PH	ROA_SI	ROA_TI	ROA_TH
1988	NA	4.40	5.40	NA	4.90	NA	10.80
1989	NA	3.90	5.60	NA	4.50	NA	11.00
1990	**9.40**	**4.10**	**5.40**	NA	**4.20**	NA	**11.70**
1991	9.10	4.00	6.20	**7.10**	3.90	**5.10**	11.20
1992	8.60	3.90	6.00	6.40	5.20	6.20	10.20
1993	7.90	3.60	6.50	8.10	4.60	6.50	9.80
1994	7.40	3.40	6.30	8.50	4.50	6.80	9.30
1995	6.20	3.60	6.10	6.80	3.90	6.50	7.80
1996	**6.50**	**3.10**	**5.60**	**8.40**	**4.00**	**6.60**	**7.40**
change	-2.90	-1.00	0.20	1.30	0.20	1.50	-4.30

Notes: Return on assets, in percent (see text). Source: Claessens, Djankov and Lang (1998), and authors' calculations. "Change" is the change in ROA (in percentage points) between figures in **bold**.

Table 3
Capital Inflows and Lending in Non-Crisis and Crisis Countries
1989.2-1993.4 and 1994.1-1997.1

Dep.Var.	CF/GDP	CF/GDP	△(BC/GDP)	△(BC/GDP)	△(DC/GDP)	△(DC/GDP)
Const.	0.028***	0.008***	0.019***	0.033***	0.028***	0.047***
	(0.003)	(0.003)	(0.003)	(0.007)	(0.007)	(0.008)
CriCtr	0.036***	0.055***	0.019***	0.018*	0.016**	0.031***
	(0.003)	(0.003)	(0.007)	(0.011)	(0.008)	(0.011)
Adj.R^2	0.11	0.15	0.01	-0.01	0.00	0.00
N	133	91	133	91	123	91
Sample	89.2-93.4	94.1-97.1	89.2-93.4	94.1-97.1	89.2-93.4	94.1-97.1

Notes: Point estimates from seemingly unrelated regression (SUR) estimation of the dependent variable (expressed in decimal form) on a constant and a dummy variable. Countries included are Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand. The dummy variable CriCtr takes on a value of unity for Indonesia, Korea, Malaysia and Thailand. △(BC/GDP)is the annualized first difference of the bank lending to GDP ratio. *(**)[***] denotes significance at the 10%(5%)[1%] MSL. Capital flow to GDP ratios for Malaysia and Singapore are annual averages.

Table 4
Determinants of Financial Crises
1995.1-1997.4

Dependent Variable: Financial Crisis

ROA	-0.120 (0.097)	–	-0.407* (0.249)	-0.193 (0.126)	-0.204*** (0.103)	-0.538** (0.243)
NPL_{t-4}		0.041 (0.057)	0.136 (0.088)	–	–	0.152* (0.086)
△(BC/GDP)				18.033*** (5.633)	–	–
$△(BC/GDP)_{t-8}$					10.075** (4.809)	10.281** (4.951)
$Adj.R^2$	0.02	0.32	0.09	0.23	0.10	0.17
N	96	70	70	96	90	67

Notes: Point estimates from probit estimation of the dependent variable (Huber-White robust standard errors in parentheses). Countries included are Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand. ROA is the Return On Assets from Claessens et al. (1998) interpolated. NPL is the Non-Performing Loan ratio (in percent) from BIS (1997) and other sources. △(BC/GDP)is the 4 quarter change in the bank lending to GDP ratio. *(**)[***] denotes significance at the 10%(5%)[1%] MSL.