Prospective Deficits and the Asian Currency Crisis*

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Abstract

This paper argues that a principal cause of the 1997 Asian currency crisis was large *prospective* deficits associated with implicit bailout guarantees to failing banking systems. The expectation that these future deficits would be at least partly financed by seigniorage revenues or an inflation tax on outstanding nominal debt led to a collapse of the fixed exchange rate regimes in Asia. We articulate this view using a simple dynamic general equilibrium model whose key feature is that a speculative attack is inevitable once the present value of future government deficits rises. While the government cannot prevent a speculative attack, it can affect its timing. The longer the delay, the higher inflation will be under the subsequent flexible exchange rate regime. We present empirical evidence in support of the four key assumptions in our interpretation of the crisis: (i) the currency crises could not have been predicted on the basis of standard macroeconomic indicators; (ii) the exchange rate crises were preceded by publicly available signs of imminent banking crises; (iii) failing financial sectors were associated with large prospective government deficits; and (iv) governments were either unwilling or unable to raise the resources required to pay for bank bailouts via fiscal reforms.

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1. Introduction

Recent events in Asia have renewed interest in the causes and consequences of speculative attacks on fixed exchange rate regimes. The explanation preferred by policy makers in Asia is that the currency crisis was a self-fulfilling prophecy: it happened because speculators thought it was going to happen.[1] Not surprisingly, proponents of this view argue that the International Monetary Fund (IMF) should provide resources to fend off such predatory attacks and help countries recover from them. Multiple equilibrium models of currency crises can be used to rationalize this interpretation of recent events in Asia.[2]

The most natural alternative explanation of the Asian currency crisis is that it reflected profligate fiscal policy: ongoing fiscal deficits led to sustained reserve losses and to the eventual abandonment of fixed exchange rates. This is the standard view of speculative attacks in 'first generation' models of currency crises. In the these models the collapse of a fixed exchange rate is preceded by ongoing deficits and rising debt levels.[3]

The standard explanation for speculative attacks has an obvious shortcoming when applied to Asia: governments of the crisis countries (Indonesia, Korea, Malaysia, the Philippines, and Thailand) were running either surpluses or small deficits. This evidence notwithstanding, we argue that the Asian currency crisis was caused by fundamentals: large *prospective* deficits associated with implicit bailout guarantees to failing banks. The expectation that these future deficits would (at least in part) be financed by seigniorage revenues or an inflation tax on outstanding nominal debt led to the collapse of the fixed exchange rate regimes in Asia.[4] Of course market participants could have believed that governments would fund their obligations by raising taxes or lowering expenditures. But would such beliefs be reasonable? In our view they would not. The state of the world in which financial intermediaries would suffer grievous losses is exactly the state of the world in which current and prospective real output and tax revenues would fall. While not modeled in this paper, rais-

[1] Radelet and Sachs (1998) also take this perspective in addition to arguing that the actions of the IMF exacerbated the crisis.

[2] See for example Obstfeld (1986a, 1996), Sachs, Tornell and Velasco (1996), and Chang and Velasco (1997).

[3] See for example Krugman (1979), Flood and Garber (1984), Obstfeld (1986b), Calvo (1987), Wijnbergen (1991), and Calvo and Végh (1998).

[4] Corsetti, Pesenti and Roubini (1999a) also discuss the possible role played by expectations of future seignorage revenues in the Asian currency crises. They do so under the assumption that the affected countries faced a limit on the ratio of total private foreign debt to government reserves. Dooley (2000) considers the role that bank bailouts play in emerging market currency crises.

ing distortionary taxes or lowering government purchases under those circumstances could well be politically unacceptable or socially undesirable relative to the alternatives: collecting seigniorage or imposing an inflation tax on outstanding nominal government debt. But these alternatives are incompatible with maintaining fixed exchange rates.

Section 2 provides empirical evidence in favor of the four key assumptions underlying our interpretation of the crisis. First, the currency crises could not have been predicted on the basis of standard macroeconomic indicators. Since this fact has already been extensively documented, we limit ourselves to a discussion of governments' fiscal deficits. Second, the exchange rate crises were preceded by publicly available signs of imminent banking crises. Here we analyze stock market based measures of the value of the banking and nonfinancial sectors in the crisis countries. We find strong evidence that in Korea, Thailand, and to a lesser extent Malaysia and the Philippines, the values of the banking sectors had been declining, in both absolute and relative terms, well before their currency crises. Third, failing financial sectors were associated with large prospective government deficits. Here we use information on pre and post-currency crisis loan default rates to generate rough estimates of governments' implicit liabilities to the financial sector. Fourth, governments were either unwilling or unable to raise the resources required to pay for bank bailouts via fiscal reforms. Here we examine the ex-post budget deficits of the crisis governments as well as the international aid packages they received.

Sections 3 and 4 present a model that articulates our interpretation of the Asian currency crisis. Specifically, we study the dynamics of a speculative attack in a variant of the perfect foresight small open economy models considered by Calvo (1987) and Drazen and Helpman (1987). The key difference between our analysis and theirs is the nature of the monetary experiment that we analyze. To capture the effect of a prospective deficit on a fixed exchange rate regime we assume that at time zero agents receive information that future deficits will be larger than they originally believed. For reasons that might be anticipated from Sargent and Wallace's (1981) classic analysis of monetary policy in a closed economy context, the government's intertemporal budget constraint implies that a speculative attack is inevitable.

We analyze the date of a speculative attack, i.e. the date at which the economy switches from a fixed to a floating exchange rate regime, under two assumptions. First, we assume that the government follows a threshold rule according to which the fixed exchange rate regime is abandoned in the first period in which net government debt reaches some exogenous upper bound. Second, we consider the case in which the only constraint faced by the government is its intertemporal budget constraint. In both cases we depart from the speculative attack literature by distinguishing between the time of the speculative attack and the time at which the government implements the new monetary policy required to balance its intertemporal budget constraint. Disentangling these two events considerably enriches the dynamic implications of the model.

Section 5 analyzes a version of our model calibrated to Thai data. The key properties of the model are: (i) the speculative attack occurs after new information about higher future government deficits arrives but before the government begins to monetize a portion of the deficit; and (ii) the collapse of the fixed exchange rate regime is followed by a burst of inflation but only by a small increase in the steady state rate of inflation.

Property (i) implies that an econometrician looking at data from our model economy would see an exchange rate crisis–but he would not see large deficits, high growth rates of money or high rates of inflation prior to the speculative attack. The econometrician could well conclude that the attack was a multiple equilibrium phenomenon. In fact the attack would reflect fundamentals: high prospective deficits. Property (ii) implies that an econometrician might conclude that seignorage was not a particularly important source of revenue in these economies. This would ignore a key fact. The present value of the resources raised by reducing the real value of outstanding debt and engineering a small but highly persistent increase in inflation can be substantial.

While the government cannot prevent a speculative attack in our model, it can affect its timing by borrowing. The cost of delaying is higher inflation after the speculative attack. This raises the issue of what monetary policy the government should pursue. We conclude section 5 by showing that in our simple model, the optimal policy is to abandon fixed exchange rates as soon as information about higher prospective deficits arrives. Since this result reflects, in part, the absence of nominal rigidities in our model, it serves primarily to highlight the costs of delaying a speculative attack. In reality, these costs must be counterbalanced against the benefits (if any) of delaying.

Section 6 discusses the evolution of money growth, inflation and interest rates in Asia with an eye towards assessing the empirical plausibility of properties (i) and (ii) above. Finally, Section 7 presents concluding remarks and discusses some shortcomings of our analysis.

2. Empirical Motivation: Background to the Crises

Figure 1 plots exchange rates of various Asian countries from January 1997 through December 1999. It is evident that Indonesia, Malaysia, Thailand, Korea and the Philippines experienced severe currency crises in the latter part of 1997. By severe, we mean that the currencies of these countries underwent large depreciations in a short period of time. In our view these currency crises were principally caused by large anticipated deficits associated with implicit bailout guarantees to failing banking systems. The model that we use to formalize our argument rests upon four key assumptions:

(1) The currency crises could not have been predicted on the basis of standard macroeconomic indicators such as high ongoing government deficits or rates of inflation.

(2) The exchange rate crises were preceded by publicly available signs of banking crises.

(3) Failing financial sectors were associated with large prospective government deficits.

(4) Governments were either unwilling or unable to raise the resources required to pay for bank bailouts by cuts in government expenditures or increases in taxes.

In this section we offer evidence to substantiate the empirical plausibility of these assumptions.

Government Deficits

Table 1 presents data on the fiscal surpluses for various Asian countries and the U.S. over the period 1995–99. Consistent with Assumption 1, there are no dramatic differences between the crisis and noncrisis countries (Hong Kong, Singapore, Taiwan). Notice that the crisis countries were running either surpluses or very modest deficits. The crises certainly could not have been predicted on the basis of large and/or growing pre-crisis fiscal deficits. For now we note that the crises were also unpredictable on the basis of other standard indicators like money growth, inflation or real GDP growth (see Corsetti, Pesenti and Roubini (1999b) and Park and Rhee (2000)). In section 6 we discuss the pre and post-crisis behavior of money growth and inflation in light of the predictions of our theoretical model.

The Banking Crises

Consistent with Assumption 2, Korea, Thailand, and to a lesser extent Indonesia, Malaysia and the Philippines experienced severe banking/financial sector crises that began *before* their currency crises. Corsetti, Pesenti and Roubini (1999b) and Peregrine (1997) provide estimates of loan default rates in Asia as of the end of 1996 and 1997, respectively. These are summarized in Table 2. Note that according to both sets of estimates, nonperforming loan rates were substantially higher in the crisis countries.

Were the Banking Crises Public Information?

We now consider whether private agents understood the precarious state of the crises countries' banking systems prior to the speculative attacks. Corsetti, Pesenti and Roubini (1999b), IMF (1998), Lane et al (1999), and Park and Rhee (2000) provide several examples of bank failures and reorganizations that occurred before the crises. Presumably these were public information. These papers leave open the question of how markets aggregated the information contained in these episodes. To investigate this issue we obtained data on stock market indices of the value of the banking and nonfinancial sectors in the crisis countries. These are presented in Figure 2 and summarized in Table 3. A number of features of this table are worth noting.

First, in Korea and Thailand and to a lesser extent the Philippines and Malaysia, the value of the banking sectors had been declining well *before* the currency crises. For example, by July 1 1997 and December 31 1997 the stock market value of the Korean banking sector had declined by roughly 52 percent and 70 percent, respectively, relative to its previous peak value (see Table 3). Second, with the exception of Indonesia and possibly Malaysia (depending on which of the end dates we used) the value of the banking sectors in the crises countries declined substantially relative to the value of the nonfinancial sectors. Evidently markets seemed particularly concerned about banking sectors in the crisis countries.

We conclude that, consistent with Assumption 2, private agents in Korea, Thailand, the Philippines and Malaysia, and to a lesser extent Indonesia, understood the fragile nature of their banking systems. Consistent with Assumption 3, the sharp decline in the stock market value of the banks suggests that markets anticipated that the government would bail out only depositors and creditors of the banks. Had they anticipated that the banks would be fully insured by the government, the equity value of banks would not have changed, other things being equal.

The Size of the Prospective Deficits

Using the average of nonperforming loan rates estimated by Corsetti, Pesenti and Roubini (1999b) and Peregrine (1997) (see Table 2) and data on total credit to domestic enterprises and financial institutions, we can generate a rough estimate of the government's total implicit liabilities stemming from guarantees to the financial sector. Columns 5 and 6 of Table 4 report total nonperforming loans as a percentage of real output and central government revenue, respectively. Note that Korea, Malaysia and Thailand exhibit high levels of total implicit liabilities. For example, in Korea, the ratio of total nonperforming loans to real GDP is roughly 26 percent.

The previous table pertains to total implicit liabilities prior to the onset of the crises. J.P.Morgan (1998) has estimated nonperforming loans as a percentage of total loans and GDP in Indonesia, Korea, Malaysia and Thailand, as of June 1998.[5] Presumably these estimates, summarized in Table 5, incorporate the impact of the currency crises on economic activity. In addition they provide estimates of the amount of capital, as a percent of GDP, needed to restore bank capital to the 8 percent Bank of International Settlement's Capital Adequacy Requirement level.[6] More recently Standard and Poor's has estimated the cost of restructuring the financial sectors in the crisis countries as of the end of 1999. These are reported in Table 6.

With the exception of Indonesia, the estimates in Tables 5 and 6 are roughly consistent. The large increase in the Indonesia case may reflect ongoing political turmoil in that country associated with the collapse of the Suharto regime. Taken as a whole, the estimates summarized in Tables 5 and 6 are consistent with Assumption 4, namely that the banking crises were associated with large prospective government deficits.

It is worth noting that while large, the magnitudes of the Asian banking crises were not unprecedented relative to other twin crisis episodes. For example, Caprio and Klingebiel (1996) estimate that the banking crises in Argentina (1980), Chile (1981), Uruguay (1981) and Israel (1977) cost 55, 41, 31 and 30 percent of GDP respectively.[7] In contrast, the fiscal costs of banking crises in the U.S. were much smaller. According to Caprio and Klingebiel (1996), the fiscal cost of the 1980's U.S. savings and loans crisis was roughly 3 percent of GDP.

[5] See Goldstein (1998) for other estimates of non-performing loans in selected countries as of the end of 1998. These are similar in magnitude to the J.P. Morgan estimates.

[6] These estimates assume 60 percent recovery rates on non-performing loans and no losses to depositors.

[7] See Frydl (1999) for a review of the literature on the fiscal costs of banking crises.

Calomiris (1998) estimates that losses from bank failures during the Great Depression years of 1930–33 equaled roughly 4 percent of U.S. GDP. It is not surprising that these relatively small banking crises could have been financed without significant changes in monetary policy.

Fiscal Reform and the Banking Crises

Various studies have concluded that the crisis governments will bear the burden of the recapitalization. For example J.P. Morgan (1998, page 12) which argues that "... the burden of absorbing banks' bad loans will increasingly fall on governments. To some extent, this has already happened in countries where the central bank's lender of last resort activities have effectively put the government in control of a large number of banks–notably in Indonesia, Korea and Thailand."

Burnside, Eichenbaum and Rebelo (1998) summarize the plans of the different countries as of the last quarter of 1998 to finance the costs associated with their failing bank systems. Consistent with J.P. Morgan (1998, page 12) they conclude that the crisis governments had little room left to cut spending or raise taxes, at least in the near term.

Consistent with Assumption 4, Table 1 indicates that after the crises, the fiscal situations of the affected governments deteriorated. No doubt this reflected sharp declines in revenue associated with post-crises recessions. For example, Korea went from a balanced budget at the end of 1996 to a fiscal deficit of 4.6 percent of GDP by the end of 1999. So there is little evidence that the crisis governments moved to raise the resources to fund bank bailouts via fiscal reforms.

Finally, what about foreign aid packages? Table 7 summarizes the assistance given to the crisis countries by the international community. As can be seen, the countries where the crises were most severe, Indonesia, Korea and Thailand, received large aid packages. However, it is important to understand that this aid took the form of loans, not transfers. Granted, these loans were issued at below market interest rates–but according to Jeanne and Zettlemeyer (2000) the values of the associated subsidies were very small.

3. The Model

In order to articulate our explanation of the Asian currency crisis, we describe a continuous time, perfect foresight endowment economy populated by an infinitely lived representative agent and a government. All agents, including the government, can borrow and lend in international capital markets at a constant real interest rate r.

There is a single consumption good in the economy and no barriers to trade, so that purchasing power parity holds:

$$P_t = S_t P_t^*. \tag{3.1}$$

Here P_t and P_t^* denote, respectively, the domestic and foreign price levels, while S_t denotes the exchange rate (defined as units of domestic currency per unit of foreign currency). For convenience we assume that $P_t^* = 1$.

Consider an economy which is operating under a fixed exchange rate so that $S_t = S$. At time zero news arrives that the government's future liabilities will be higher than previously anticipated. We interpret the rise in liabilities as reflecting transfer payments associated with bank bailouts. There are three ways in which the government can satisfy its revised intertemporal budget constraint: (i) implement a fiscal reform by raising taxes or reducing spending; (ii) print money in order to generate seigniorage revenues; or (iii) deflate the real value of nonindexed nominal debt issued prior to time zero.[8]

The only way to maintain the fixed exchange rate regime is to rely exclusively on the first strategy, i.e. the government must implement a fiscal reform which completely covers the cost of the new future liabilities. The alternatives—generating seigniorage revenues or deflating the value of pre-existing nominal debt—require inflation. But, as we will show, these alternatives are inconsistent with maintaining a fixed exchange rate. With this in mind, we now describe the government's intertemporal budget constraint.

3.1. The Government's Budget Constraint and the Inevitability of a Currency Crises

In each period the government purchases g units of output, levies real lump sum taxes, τ, and transfers v_t units of output to the representative agent. In addition the government can print money.

Before time zero, agents assumed that v_t was constant ($v_t = v$). At time zero, they learn that these transfers will increase permanently after date T':

$$\begin{cases} v_t = v & \text{for } 0 \leq t < T', \\ v_t \geq v & \text{for } t \geq T'. \end{cases}$$

where T' is a positive scalar. We use ϕ to denote the present value of the increase in transfers:

$$\phi = \int_{T'}^{\infty} e^{-rt}(v_t - v)dt.$$

[8] A devaluation may also reduce other government liabilities such as outlays that are fixed, at least temporarily, in nominal terms (e.g. civil servant wages or programs like social security).

Before agents received information about the rise in transfers ($t = 0$), the government issued nonindexed government consols with a face value of B units of local currency and coupon rate r. Since there was zero expected inflation before $t = 0$, the nominal value of these consols was B. To simplify, we assume that no new consols are issued after time zero. The government also issued dollar denominated bonds whose real value at time zero is b_0. We denote by b_t the stock of dollar denominated debt at time t.

The government's flow budget constraint is:

$$\begin{array}{ll} \Delta f_t - \Delta b_t = \Delta m_t & \text{if } t \in I \\ \dot{f}_t - \dot{b}_t = r(f_t - b_t) + \tau - g - v_t - rB/S_t + \dot{m}_t + \pi_t m_t & \text{if } t \notin I. \end{array} \tag{3.2}$$

Throughout the paper $\dot{x}_t$ denotes dx/dt. Here f_t denotes the real value of government's net foreign assets and π_t is the inflation rate, $\dot{P}_t/P_t$. The variable m_t represents real money balances, defined as $m_t = M_t/P_t$, where M_t denotes nominal money holdings. Note that $\dot{m}_t + \pi_t m_t$ is equal to the seignorage flow, $\dot{M}_t/P_t$. As in Drazen and Helpman (1987), equation (3.2) takes into account the possibility of discrete changes in m_t, b_t, and f_t at a finite set of points in time, I. Below we discuss the points in time in which these discrete changes occur.

The flow budget constraint, together with the conditions $\lim_{t\to\infty} e^{-rt} b_t = \lim_{t\to\infty} e^{-rt} f_t = 0$, implies the following intertemporal budget constraint:

$$\begin{aligned} b_0 - f_0 \quad = \quad & \int_0^\infty (\tau - g - v_t) e^{-rt} dt + \\ & \int_0^\infty (\dot{m}_t + \pi_t m_t) e^{-rt} dt + \sum_{i \in I} e^{-ri} \Delta m_i \\ & - \int_0^\infty \frac{rB}{S_t} e^{-rt} dt. \end{aligned} \tag{3.3}$$

We assume that before time zero the fixed exchange rate regime was sustainable. In such a regime, the exchange rate is constant and seignorage revenues are equal to zero.[9] Thus, the government's intertemporal budget constraint reduces to:

$$b_0 + \frac{B}{S} - f_0 = \frac{\tau - g - v}{r}. \tag{3.4}$$

Equation (3.4) requires that the present value of current and future real surpluses equals the initial real net liabilities of the government.

[9] If there were growth in P^* or in consumption, the government would collect some seignorage revenue under fixed exchange rates.

To see the impact of the new information about prospective deficits on the government's budget constraint we use (3.4) to rewrite (3.3) as:

$$\begin{aligned}\phi \;=\; & \int_0^\infty (\dot{m}_t + \pi_t m_t) e^{-rt} dt + \sum_{i \in I} e^{-ri} \Delta m_i \\ & + \left[\frac{B}{S} - \int_0^\infty \frac{rB}{S_t} e^{-rt} dt \right] \end{aligned} \qquad (3.5)$$

According to (3.5), the present value of the prospective deficits, ϕ, must be financed by seignorage revenues ($\int_0^\infty (\dot{m}_t + \pi_t m_t) e^{-rt} dt + \sum_{i \in I} e^{-ri} \Delta m_i$) or by a reduction in the real value of the nonindexed debt ($B/S - \int_0^\infty (rB/S_t) e^{-rt} dt$).

Our interpretation of the Asian currency crises follows directly from (3.5). The crisis governments did not have a credible commitment to finance the bank bailouts with a fiscal reform. The remaining possibilities for balancing the government's intertemporal budget constraint—raising seignorage or deflating the value of outstanding nominal debt—require abandoning the fixed exchange rate regime. In this sense the currency crises were inevitable.

The particular characteristics of the crises depend on the nature of government policy and on the magnitude of nonindexed government liabilities. For example, the government could pay for the bulk of the bank bailout by reducing the real value of outstanding nominal debt with a devaluation at time zero. Under these circumstances, the currency crises would be associated with little future money growth or ongoing inflation. This scenario is closely related to the work of Cochrane (2000), Sims (1994) and Woodford (1995) on the fiscal theory of the price level.[10] In contrast if the government does not have any nonindexed liabilities, then the bank bailout would have to financed entirely via seignorage revenues. This would have potentially very different implications for money growth, inflation and exchange rate depreciation.

It follows that to fully characterize the response of our model economy to new information about prospective deficits, we must make additional assumptions about government policy and the behavior of private agents. In the following subsections we do so.

[10] See Dupor (2000) and Corsetti and Mackowiak (2000) for applications of the fiscal theory to open economies.

3.2. The Representative Agent

The representative agent maximizes lifetime utility, defined as:

$$U = \int_0^{\infty} \frac{c_t^{1-\sigma} - 1}{1-\sigma} e^{-\rho t} dt. \tag{3.6}$$

Here c_t denotes consumption, $\rho > 0$ is the discount factor, and $\sigma > 0$ is the inverse of the elasticity of intertemporal substitution. The representative agent can borrow and lend in international capital markets at a constant real interest rate r. To eliminate trends in the current account we assume that $r = \rho$. The representative agent's flow budget constraint for $t \geq 0$ is given by:

$$\begin{array}{lll} \Delta b_t + \Delta d_t = -\Delta m_t & & \text{if } t \in I, \\ \dot{b}_t + \dot{d}_t = & y + r(b_t + d_t) + rB/S_t + v_t - c_t - \tau - \pi_t m_t - \dot{m}_t & \text{if } t \notin I. \end{array} \tag{3.7}$$

Here d_t denotes the net foreign assets held by the representative agent, and y denotes the constant endowment of output. As with the government, the household's budget constraint (3.7) takes into account the possibility of discrete changes in m_t, d_t, and b_t at a finite set of points in time, I. The flow budget constraint, together with the conditions $\lim_{t\to\infty} e^{-rt} b_t = \lim_{t\to\infty} e^{-rt} d_t = 0$, implies the following intertemporal budget constraint for the household:

$$b_0 + d_0 + \int_0^{\infty} e^{-rt}[y + v_t + rB/S_t]dt = \int_0^{\infty} e^{-rt}[c_t + \tau + \pi_t m_t + \dot{m}_t]dt + \sum_{i \in I} e^{-ri} \Delta m_i. \tag{3.8}$$

According to (3.8), the present value of the representative agent's endowment plus asset income must equal the present value of real expenditures inclusive of taxes and money purchases.

Finally, the representative agent faces the following continuous time analogue to a cash-in-advance constraint on consumption purchases:

$$c_t \leq m_t. \tag{3.9}$$

Since the nominal interest rate is positive in all the scenarios that we consider, (3.9) holds with strict equality.[11]

[11] This continuous time cash-in-advance model is the limit, as the length of the period, n, goes to zero of a discrete time economy in which preferences are given by $U = \sum_{t=0}^{\infty}(1+n\rho)^{-t/n} n (c_t^{1-\sigma} - 1)/(1-\sigma)$, the resource constraint is $b_t - b_{t-n} = ny + nrb_{t-n} - nc_t + M_{t-n}/P_t - M_t/P_t$ and the cash-in-advance constraint is $M_t/P_t \geq c_t$. Note that if the cash-in-advance constraint was of the form $M_t/P_t \geq nc_t$ then money would be neutral as $n \to 0$ since, in the limit, transactions could be carried out without using money. See Feenstra (1985) for a discussion of cash-in-advance constraints in continuous time models.

The problem of the representative household is to maximize (3.6) subject to (3.7) and (3.9) by choice of time paths for c_t, m_t, b_t and d_t, subject to a known time path for P_t. In the Appendix, we show that the first order conditions for this problem imply:

$$c_t^{-\sigma} = \lambda(1 + r + \pi_t), \tag{3.10}$$

where λ is the current-valued Lagrange multiplier associated with (3.7). Equation (3.10) will play a central role in our subsequent derivations.

3.3. A Competitive Equilibrium

A competitive perfect foresight equilibrium for this economy is a set of allocations c_t, m_t, and $b_t + d_t$, a set of prices P_t and S_t, and a set of paths for the fiscal variables, τ_t, g_t and v_t, such that the following conditions hold: (i) c_t, m_t, and $b_t + d_t$ solve the household's problem given the paths for P_t, S_t, τ_t and v_t (ii) the government's intertemporal budget constraint (3.5) holds; and (iii) $S_t = P_t$ for all t. Note that this definition applies to both fixed and flexible exchange rate equilibria.

3.4. The Pre-Crisis Economy

Prior to time zero, agents anticipate zero inflation and (3.10) reduces to:

$$c^{-\sigma} = \lambda(1 + r), \tag{3.11}$$

implying that consumption is constant over time. The budget constraint (3.8) implies that:

$$c = r(b_0 + d_0 + B/S) + y + v - \tau. \tag{3.12}$$

The economy is in a fixed exchange rate regime so the money supply is endogenous. Purchasing power parity (3.1), and the cash-in-advance constraint (3.9) imply that the equilibrium level of the money supply is:

$$M = Sc. \tag{3.13}$$

In sum, prior to time zero the money supply is constant, seignorage revenues are zero, and the government's intertemporal budget constraint is given by (3.4).[12]

[12] To see that the government cannot collect seignorage revenues under a fixed exchange rate regime note that expected inflation is zero and the demand for real balances is constant over time. What happens if the government prints money? Since there is no demand for this money, agents will simply trade it for a different asset. Regardless of whether this asset is domestic bonds, foreign bonds or foreign reserves, the nominal money supply will revert to its initial value. This means that no seignorage revenue has been raised by the government.

4. The Exchange Rate Crisis

In this section we characterize the time at which the fixed exchange rate regime collapses, and the post-crisis behavior of the economy. We do so under particular assumptions about government policy, which has two components: (i) the rule for abandoning the fixed exchange rate and (ii) the post-crisis monetary policy.

Abandoning Fixed Exchange Rates

In our benchmark analysis we assume that the government adopts the following threshold rule: it abandons the fixed exchange rate regime in the first period t^* when net real government debt, $b_t + B/S - f_t$, reaches Ψ. Note that the threshold rule refers to the real face value of nominal debt, B/S.[13] A special case of this rule emerges under the additional assumption (which we do not make) that the only component of the government's portfolio that changes over time is the central bank's foreign reserves. Given this assumption, a threshold rule on net government debt is transformed into the threshold rule for reserves that is often used in the speculative attack literature.[14]

In section 5 we consider an alternative rule for abandoning the fixed exchange rate regime. In particular, taking as given the parameters of post-crisis monetary policy, the government delays abandoning fixed exchange rates for as long as possible subject to the constraint that its intertemporal budget constraint holds. We show that the key properties of our benchmark analysis continue to hold under this alternative specification of government policy.

Post-Crisis Monetary Policy

For simplicity, we assume that the government will raise seignorage revenues by a combination of a one time increase in the stock of money at time T to M_T and growth in the money supply at rate μ from period T on:

$$M_t = M_T e^{\mu(t-T)}, \text{ for } t \geq T. \tag{4.1}$$

Given T, the pair (M_T, μ) must be such that the government's budget constraint (3.3) is satisfied.

[13] An alternative would be to make the rule a function of the real market value of the nominal debt. We chose the former because we only have data on the face value of the debt.

[14] See for example Krugman (1978) and Obstfeld and Rogoff (1996). Exceptions to this assumption include Drazen and Helpman (1987, 1988) and Wijnbergen (1993) who use the present value rule which we discuss below.

4.1. Timing

To analyze how the economy reacts to the information about higher prospective deficits it is useful to distinguish between four intervals of time.

Time Interval 1: $0 < t < t^*$. This is the time interval after information about the higher future deficits has arrived but before the collapse of the fixed exchange rate regime. We denote the values of consumption, real balances and nominal money supply in this interval of time by $\bar{c}$, $\bar{m}$, and $\bar{M}$, respectively.

Time Interval 2: $t^* \leq t < T$. This is the time interval between the collapse of the fixed exchange rate regime and the new steady state flexible exchange rate equilibrium. We denote all variables that are time varying during this regime with a subscript t (e.g. c_t is consumption). Variables which are constant during this time interval are denoted with a superscript asterisk ($*$).

Time Interval 3: $T \leq t < T'$. This is the interval of time after the new monetary policy has been implemented but before the new level of transfers has been adopted. We denote all variables that are constant during this time interval with a lower bar, e.g. $\underline{c}$.

Time Interval 4: $t \geq T'$. This is the time interval after which the new transfer policy is implemented. As with time interval 3, we represent all variables that are constant during this interval with a lower bar. Note, consistent with our notation the precise value of T' is irrelevant as long as $T' > T$.

4.2. Computing the Time of the Speculative Attack

In order to solve for the time of the speculative attack, we must compute the dynamic, perfect foresight equilibrium. Our procedure is as follows. First, we fix the parameters of monetary policy (M_T and μ). Second, we derive the equilibrium paths of consumption, inflation, and exchange rates as a function of M_T and μ. Third, we check whether the government's intertemporal budget constraint is satisfied. If not, we adjust (M_T, μ) and recompute the equilibrium. We repeat this procedure until we have converged upon a solution.

Solving for Consumption Given Inflation and t^*

At time zero, when information about the new fiscal deficit arrives, the representative agent reoptimizes his consumption plan. The value of the Lagrange multiplier associated with his intertemporal budget constraint changes from λ to $\tilde{\lambda}$. The optimal plan for consumption during time interval 1 satisfies,

$$(\bar{c})^{-\sigma} = \tilde{\lambda}(1+r), \text{ for } 0 < t < t^*. \tag{4.2}$$

Here we have used the fact that inflation is zero in the fixed exchange rate regime.

The government raises revenues by printing money and by deflating the value of outstanding nominal debt. Since these revenues are rebated in the form of lump sum transfers, the present value of the resources available to the consumer does not change with the arrival of new information at time zero. However, since inflation is not constant, consumption at time zero will, in general, be different from c. The cash-in-advance constraint is binding, so the time zero value of real balances must also jump from $m = c$ to $\bar{m} = \bar{c}$. Since $P_t = S$ before t^* the change in real balances is accomplished by a change in the nominal money supply from M to $\bar{M}$, where $\bar{M}$ is given by:

$$\bar{M} = S\bar{c}. \tag{4.3}$$

The change in the money supply occurs as private agents adjust the amount of domestic money, government debt and foreign reserves that they hold. For example if $\bar{M} > M$, agents increase real balances by selling government bonds, b_t, or foreign assets, d_t for domestic money.

The optimal plan for consumption during time interval 2 satisfies:

$$c_t^{-\sigma} = \tilde{\lambda}(1 + r + \frac{\dot{P}_t}{P_t}), \text{ for } t^* \leq t < T. \tag{4.4}$$

Since inflation changes discretely at t^*, so does consumption. The path for S_t must be continuous, so that $P_{t^*} = S$. Otherwise, given our assumption of perfect foresight, there would be arbitrage opportunities associated with trading the currency just before and after t^*. At t^* the demand for money is given by:

$$M^* = Sc_{t^*}. \tag{4.5}$$

so agents adjust their money balances from $\bar{M}$ to M^*. For the remainder of time interval 2 the money supply is equal to M^* and the exchange rate is determined by:

$$S_t = M^*/c_t. \tag{4.6}$$

The level of consumption $\underline{c}$ in the third and fourth time intervals, is determined by the consumption Euler equation:

$$\underline{c}^{-\sigma} = \tilde{\lambda}(1 + r + \mu), \text{ for } t \geq T. \tag{4.7}$$

Here we have used the fact that the rate of inflation is μ for $t \geq T$. The cash-in-advance for this time period is:

$$M_t = S_t \underline{c}.$$

Note that the path for M_t is exogenous in this time period and given by (4.1).

Given a path for inflation and a value for t^*, we can solve for the consumption path as follows. Substitute equations (4.2), (4.4), and (4.7) into the household's intertemporal budget constraint, (3.8). This yields one equation in one unknown, $\bar{c}$.

Solving for Inflation Given t^*

Equations (4.2) and (4.4) together with the cash-in-advance constraint (4.5) imply:

$$\left(\frac{M^*}{P_t}\right)^{-\sigma} = \frac{\bar{c}^{-\sigma}}{1+r}(1 + r + \frac{dP_t}{dt}\frac{1}{P_t}). \tag{4.8}$$

This differential equation in P_t can be written as:

$$\begin{aligned} \frac{dP_t}{dt} &= aP_t^{1+\sigma} - bP_t, \\ a &= (M^*)^{-\sigma}(1+r)\bar{c}^{\sigma}, \\ b &= (1+r). \end{aligned} \tag{4.9}$$

The solution to (4.9) is:

$$P_t = \left[\frac{b}{a - e^{(t-\gamma)\sigma b}}\right]^{1/\sigma}. \tag{4.10}$$

Here γ is a constant of integration determined by the condition that P_t must be continuous at t^*. This requires that $P_{t^*} = S$ so (4.10) can be used to express γ as a function of t^*:

$$\gamma = t^* - \frac{1}{\sigma b}\ln(a - bS^{-\sigma}). \tag{4.11}$$

Equation (4.10), the cash-in-advance constraint at time T, and the continuity of the price level at T (required to prevent arbitrage opportunities) imply that:

$$P_T = M_T/\underline{c} = \left[\frac{b}{a - e^{(T-\gamma)\sigma b}}\right]^{1/\sigma}. \tag{4.12}$$

Solving for t^*

By definition, t^* is the point in time at which net government debt rises to Ψ. Therefore,

$$\Psi = b_{t^*} + B/S - f_{t^*}.$$

Using the government flow budget constraint, (3.2), we have that

$$\begin{aligned}\Psi &= (b_0 + B/S - f_0)\, e^{rt^*} + \int_0^{t^*} (g + v - \tau)e^{rt}dt + \\ &\quad \frac{(\bar{M} - M^*)}{S} + \frac{M - \bar{M}}{S} e^{rt^*}. \qquad (4.13)\end{aligned}$$

Relation (4.13) decomposes government debt at t^* into four terms. The first is the value at t^* of the government's initial debt. The second is the value of new debt issued between time zero and t^* to finance the government's primary deficit. The third term $(M - \bar{M})/S$ represents the jump in the value of the debt that takes place at time zero. The fourth term $(\bar{M} - M^*)/S$ represents the discrete, positive increase in government debt that takes place at t^*. This increase reflects the fact that agents trade domestic money, at the exchange rate S, for either government bonds or foreign assets.

Solving for the Parameters of Monetary Policy

The final step in computing the competitive equilibrium is to ensure that the government's budget constraint holds. It is evident from (3.3) that there is a continuum of (M_T, μ) combinations that do so. If we fix M_T, then we can then solve for the value of μ that solves (3.3). Alternatively, we can fix μ and solve for M_T.

4.3. The Determinants of t^*

The key determinants of t^* are: (i) the magnitude of the deficit being financed (ϕ); (ii) the monetary policy used to finance it; (iii) the government's threshold rule (Ψ); and (iv) the demand for domestic money which is tied to agents' optimal consumption path.

To obtain intuition about the timing of the speculative attack it is useful to combine equations (4.11) and (4.12) to express t^* as a function of P_T:[15]

$$t^* = T - \frac{1}{\sigma b} \ln \frac{a - bP_T^{-\sigma}}{a - bS^{-\sigma}}. \qquad (4.14)$$

[15] Equation (4.14) is only valid when $0 < t^* < T$.

Since the government increases the money supply at time T, P_T will, in general, be greater than S. So equation (4.14) suggests that the attack will take place before the new monetary policy is implemented ($t^* < T$). In fact this is what happens in the calibrated versions of our model economy.

Why doesn't the attack happen at time zero? This would be the case if the demand for real balances at time zero fell by enough to drive government debt to a value greater than or equal to Ψ. Such a situation might occur if M_T was so large that the rate of inflation at time zero was higher than μ. The relatively high rate of inflation at time zero would induce agents to lower their consumption, creating a fall in money demand and a rise in government debt. If the rise in debt were large enough to trigger the threshold rule then a speculative attack would occur at time zero and there would be an instantaneous depreciation.[16]

5. Properties of the Model

In this section of the paper we accomplish two tasks. First, we study the determinants of speculative attacks in a version of the model calibrated to the Thai economy. Second, we analyze the nature of optimal monetary policy in our model.

5.1. Model Calibration

Table 8 summarizes the parameter values of our benchmark model. Throughout we normalize both output and the time zero exchange rate, S, to be one.

It is useful to associate $t = 0$, the time at which agents learn that the government intends to bailout the failing banking system, with a calendar date. This is difficult to do because the relevant information was almost surely revealed over time. Still, data on offshore forward premia for the Thai baht contain useful information for calibrating $t = 0$. Figure 3 displays data on these premia for baht-dollar forward contracts of different maturities. Note that these premia began to rise significantly around mid-May 1997. So we tentatively identify $t = 0$ with mid-May 1997 and assess the sensitivity of our main results to this choice.

Next we turn to the parameters characterizing monetary policy: T and M_T/M. Figure

[16] Note that for large values of Ψ it is possible that $t^* > T$. In this scenario, the exhange rate is fixed at time T and the time T money supply is not under the effective control of the government - it must equal $\bar{M}$. When the government prints money and buys back government bonds at time T, private agents simply reverse the effects of the open market operation by trading money for bonds. The money supply only changes at t^*, when it drops to $M^* = \underline{c}S$. Thereafter the money grows at the rate μ. The time of the speculative attack is determined by the requirement that the government's intertemporal budget constraint (3.3) holds.

4, which displays data on the monetary base in Thailand, indicates that a significant remonetization of the Thai economy took place in the latter half of 1999. Hence we choose $T = 2$ where we measure time in years. Because there are significant movements in the Thai monetary base from one month to the next (see Figure 4) we calibrate M_T/M to the ratio of the average monetary base in the second half of 1999 to the average monetary base in the period January–May 1997. This yields a value for M_T/M equal to 1.207.

The next step in our calibration is to determine the initial values of public sector domestic debt, $b_0 + B/S$, public sector net foreign assets f_0, and private net foreign debt d_0. Since we identify $t = 0$ with mid-May 1997, we use Bank of Thailand (BOT) data on various asset positions as of the end of May 1997 to determine these parameters. We assume that all domestic debt was denominated in local currency and was issued prior to $t = 0$. This yields the following values: $b_0 = 0$, $B/S = 0.052$, $f_0 = 0.091$ and $d_0 = -0.449$.[17]

Next we turn to Ψ which governs the threshold rule. This parameter was chosen to match the decline in consolidated government assets that occurred in the period leading up to the end of June 1997. Using Bank of Thailand data, we estimate that, as of this date, net assets of the consolidated public sector fell to 3.4 percent of GDP. So in our benchmark calibration we set $\Psi = -0.034$. Later we will assess the sensitivity of our results to the choice of Ψ. In Section 2 we argued that the fiscal cost of the banking bailout was roughly 30 percent of GDP, so we set $\phi = 0.30$.

The average money market interest rate in Thailand in the period January 1993–April 1997 was 8.66 percent. The average year-on-year CPI inflation rate over the same period was 4.96 percent.[18] Hence, we set the real interest rate, r, to 0.037.

Our model implies that in the initial steady state, the level of private consumption is

[17] We use end-of-May figures since data on external and public sector debt positions are reported on an end-of-month basis. To measure the ratio of debt to GDP on a monthly frequency we used data from the BOT website, (www.bot.or.th). The "Databank" section, Table 1.16, of that website provides quarterly data on nominal GDP at quarterly rates. We converted these data to annual rates, and set the February, May, August and November monthly values equal to the 1st, 2nd, 3rd and 4th quarter values, respectively. For the other months we used linear interpolation. To measure private and public sector external debt we referred to the "Economic Data, External Debt Data" section of the BOT website. The BOT figures are provided in US dollars. We converted these to baht using the end-of-period dollar-baht exchange rate from the IMF *International Financial Statistics* (*IFS*) (..AE.ZF). To measure public sector domestic debt we referred to Tables 7.4 and 7.5 in the "Databank" section of the BOT website. We took the gross measure of public sector debt to be equal to the sum of all government and state enterprise domestic debt. To obtain net domestic debt of the public sector we subtracted, from our measure of gross debt, any of this debt held by the BOT, the Government Savings Bank, or the Exchange Equalization Fund.

[18] We obtained monthly data from the *IFS* database on money market interest rates (60B..ZF) and the CPI (64...ZF).

given by $c = r(b_0 + d_0 + B/S) + y - (\tau - v)$. Given our assumptions about b_0, B/S, f_0, r and y we choose $\tau - v = 0.438$ so that the ratio of consumption to output in the steady state equals the sample average for Thailand in the period 1993Q1–1997Q2, i.e. $c = 0.547$.[19]

5.2. Results

Figure 5 depicts the dynamic equilibrium paths of c_t (which coincides with m_t), π_t, M_t, $b_t + B/S_t - f_t$ and S_t (which coincides with P_t). Two key features of Figure 5 are worth noting. First, the speculative attack occurs at $t^* = 0.12$ or roughly 1.4 months after agents receive information about the higher prospective deficits. Second, inflation begins to increase at t^*, well before the change in monetary policy. This is reminiscent of Sargent and Wallace's (1981) classic results according to which future monetary policy affects current inflation.

We now turn to the behavior of consumption. In the benchmark model consumption increases discretely at time zero to a level that is higher than both the old steady state ($\bar{c} > c$) and the new steady state reached after T ($\bar{c} > \underline{c}$). The fact that $\bar{c} > c$ results from two features of the equilibrium. First, since seignorage revenues are rebated to the household, the present value of resources available to private agents is the same before and after the increase in the government deficit. Second, since inflation is at its lowest value before t^*, the effective price of consuming during time interval 1 is lower than in all other periods. Figure 5 indicates that during time interval 2 consumption declines. This reflects the rise in inflation relative to time interval 1. During time intervals 3 and 4 consumption is constant because inflation is constant. Notice that $\bar{c} > \underline{c}$ because inflation is zero during time interval 1 but positive during time intervals 3 and 4.

Consider next the behavior of the money supply and government debt. In the initial steady state, the level of the money supply is determined by the cash-in-advance constraint $c = M/S$. At time zero, consumption jumps from c to $\bar{c}$, while the exchange rate remains constant. It follows that the money supply must jump from M to $\bar{M} = S\bar{c}$. Agents obtain the additional money needed for consumption transactions by trading in foreign reserves or government bonds. Consequently, government debt drops discontinuously at time zero. For the remainder of time interval 1 all model variables remain constant except for government debt.

At time t^* there is a discontinuous decrease in consumption which reflects the jump in

[19] We obtained quarterly data on private consumption and GDP from the BOT website, www.bot.or.th, "Databank" section, Table 1.17.

inflation that occurs at the onset of the floating exchange rate regime. Since the exchange rate is still fixed at t^* the cash-in-advance constraint implies that the money supply falls discontinuously at the time of the attack. Agents exchange domestic money for foreign reserves or government debt, raising total government liabilities to Ψ. It is this decline in domestic money holdings that is often described as a speculative attack.

At time T, the new monetary policy is implemented so that there is a policy induced jump in M_T after which the money supply grows at rate μ. The government engineers the increase in M_T by retiring government debt. Before the new transfer policy is implemented at T' the government is running a surplus, so that government debt is declining.

5.3. Sensitivity Analysis

Table 9 describes the effect of perturbations to the benchmark parameter values on the timing of a speculative attack and the present value of the resources raised via monetary policy. The latter include seignorage revenues plus the reduction in the real value of initial nominal debt. Five key results emerge here. First, if the increase in the deficit reflects a rise in government purchases rather than an increase in transfers, then t^* falls. The reason for this is as follows. In the benchmark model, time zero consumption rises by 2 percent relative to its initial steady state level. Correspondingly, there is an increase in the demand for money and a reduction in the government's debt. Other things equal, the reduction in $b_0 - f_0$ delays the time at which $b_t + B/S - f_t$ reaches its threshold level, Ψ. Now suppose the 10% of the rise in the prospective deficit reflects an increase in government expenditures. Then, the rise in the deficit is associated with a fall in the household's wealth. Consequently time zero consumption does not rise by as much as in the benchmark model and $b_t + B/S - f_t$ reaches Ψ more quickly. Note that the amount of resources raised by monetary policy also falls relative to the benchmark case. This occurs primarily because the fall in the household's wealth leads to a decline in $\underline{c}$ which reduces the flow of seignorage revenues ($\mu\underline{c}$) after T.

Second, a decrease in the elasticity of intertemporal substitution to 1/2 ($\sigma = 2$) increases t^*. This reflects a greater desire on the part of the household to have a smooth consumption path. There is also a small decline in the amount of resources raised by monetary policy. This results from a lower level of $\underline{c}$ which leads to a decline in seignorage revenues. Third, a rise in T increases t^* and reduces the resources raised by monetary policy. The latter happens because positive seignorage revenues are generated only when the new monetary policy is implemented. Fourth, an increase in Ψ increases t^* and reduces the present value of resources raised by monetary policy. The basic reason for the rise in t^* is that it takes longer for government debt to hit the threshold level associated with abandoning fixed exchange rates. The impact on seignorage revenues is more subtle. Recall that no seignorage revenues are collected between t^* and T, so that the increase in t^* has no direct impact on the present value of seignorage revenues. The decline in seignorage is caused by the fall in money demand, $\bar{M} - M^*$, that occurs when the government debt jumps to its threshold level Ψ at t^*. The higher is Ψ, the larger is the decline in money demand and the greater is the loss in seignorage revenue at t^*.[20] Finally, note that assuming all government debt is dollar denominated ($B = 0$ and $b_0 = 0.052$), raises t^* and lowers the amount of resources raised by monetary policy. To understand this note that our experiment does not hold household wealth constant. In the benchmark case, households receive transfers of ϕ from the government, which just offsets the resources raised by monetary policy. In contrast, when $B = 0$ and $b_0 = 0.052$, the resources raised by monetary policy is equal to 0.28. So there is an increase in household wealth relative to the benchmark case. This leads to higher time zero consumption and lower initial government debt, thus raising t^*.

The experiments reported in Table 9 do not hold seignorage revenues constant. We now consider the results of experiments in which monetary policy is adjusted to ensure that the government's intertemporal budget constraint is satisfied. Table 10 reports results when monetary policy is adjusted via changes in M_T or in μ. Two results are worth noting. First, adjusting μ to balance the government's intertemporal budget constraint has virtually no effect on t^*. This is because only small adjustments in μ are required to balance the budget. Second, when the adjustment occurs via changes in M_T, t^* changes noticeably. To understand the effect on t^*, note that, in all of the experiments, M_T must rise to balance the government's budget. Other things equal, this leads to a higher value of P_T and from (4.14) a decline in t^*.

We now study the sensitivity of our results to the threshold parameter Ψ. Regardless of the particular threshold rule that the government adopts, its intertemporal budget constraint must hold. As discussed above, an increase in Ψ reduces seignorage revenues. The government must compensate for the loss of these revenues by either raising M_T or μ. Figure

[20] There are two offsetting effects associated with higher values of Ψ: (i) t^* is increasing in Ψ so that the loss of seignorage revenue at t^* is discounted more heavily, and (ii) a higher value of Ψ is associated with a larger jump in money demand at T. In addition changes in t^* affect the present value of the resources raised by deflating outstanding nominal debt. In our benchmark model, these effects are small relative to the effect discussed in the text.

6 depicts the time of the attack and the adjustment in monetary policy as Ψ varies from -0.034 to 0.0. Panel A pertains to the case where M_T is fixed and the adjustment occurs via μ. Panel B refers to the case where μ is held fixed and the adjustment occurs via M_T. The key points to note are as follows. First, regardless of how monetary policy is adjusted, t^* is an increasing function of Ψ. Basically, this reflects the fact that the government can delay the date of the speculative attack by borrowing more resources. Second, both M_T and μ are increasing functions of Ψ. As M_T increases, the peak rate of inflation in time interval 2 also increases. In this case, the cost of delaying the attack is higher inflation during the transition to the new steady state of the economy. As μ increases, the steady state rate of inflation rises. We conclude that the price for delaying a speculative attack is a higher rate of inflation in the future. This suggests that the key issue is not whether governments can borrow to delay speculative attacks, but whether they should. To examine this issue we proceed in two steps. First, we briefly consider the equilibrium of our model when the only constraint faced by the government is (3.3), its intertemporal budget constraint. We then discuss the optimal government policy.

5.4. The Present Value Rule

We now consider the equilibrium of the model when the government operates under a present value rule, i.e. (3.3) is the only constraint that the government faces. We proceed by asking the question: what is the maximal value of Ψ consistent with (3.3)? In one sense we have already answered this question. Given the parameters of monetary policy (M_T and μ), there is a unique Ψ such that (3.3) holds, so that the present value rule can always be described *ex post* as a threshold rule on government debt.

Suppose that we fix one of the monetary policy parameters, say μ. For every value of M_T there exists a value of Ψ such that (3.3) holds. What is the value of M_T that maximizes Ψ? For our benchmark case it is roughly $M_T = 100M$.[21] The associated values of Ψ and t^* are 0.40 and 1.89, respectively. Alternatively, we can fix M_T and find the value of μ that maximizes Ψ. We did not pursue this experiment because it yields extreme results in our model: at the cost of hyperinflation the government could delay the attack for a very long (but finite) period of time. This is because the government can seize all private wealth by generating sufficiently high inflation. Its ability to do so is an artifact of two assumptions

[21] This is the value of Ψ that satisfies (3.3) when $M_T = 100M$. Further increases in M_T lead to very small changes in Ψ.

which we make in our model: the cash-in-advance constraint applies only to consumption, and output is exogenous.

Figure 6 and the results of this section convey a common message: changes in the threshold rule, Ψ, do not affect the inevitability of the speculative attack, only its timing and how much monetary policy must be adjusted to balance the government's budget. A government can substantially delay the collapse of a fixed exchange rate regime by borrowing but only at the cost of higher future inflation.

5.5. Optimal Monetary Policy

We have seen that a government can substantially delay the collapse of a fixed exchange rate regime by borrowing but only at the cost of higher future inflation. Because of this, it is not obvious that a government should borrow to delay an attack, even if it can. In this section we demonstrate that the optimal monetary policy in our model economy is to abandon the fixed exchange rate regime as soon as new information about the deficit arrives. The required seignorage revenues should be raised by an increase in M_0 and/or setting the growth rate of money to a constant, μ. This monetary policy succeeds in balancing the government's intertemporal budget constraint without introducing distortions into the economy.[22] This result follows from three features of our model: output is exogenous, the cash-in-advance constraint applies only to consumption, and seignorage is rebated to the households.

To demonstrate the optimality of the proposed policy, suppose that the government could finance the increase in the present value of the deficit using lump sum taxes. The equilibrium under this financing strategy cannot be improved upon: the fixed exchange rate could be maintained and inflation would continue to be zero. Note that since tax revenues are rebated lump sum to households, consumption will remain at its initial steady state level, c.

We now prove the optimality of our candidate monetary policy by showing that it supports the same allocation as that which obtains when the government raises lump sum taxes. Recall that the optimal behavior of consumption is dictated by equation (3.10). It follows that if π_t is constant, consumption will also be constant. Since seignorage revenues are rebated to the household, the intertemporal budget constraint is unaffected and consumption will still equal c. To finance the increase in the present value of the deficit, it must be the

[22] Koenig (1987) and Rebelo and Xie (1999) prove analogous results for a closed economy model.

case that:

$$\frac{c}{M_0}(M_0 - M) + \int_0^\infty e^{-rt}(\pi_t m_t + \dot{m}_t)dt + \left[\frac{B}{S} - \int_0^\infty \frac{rB}{S_t} e^{-rt} dt\right] = \phi. \tag{5.1}$$

The first term represents seignorage collected from increasing the money supply to M_0 at time zero. The integral term reflects seignorage obtained from the future growth rate of money. The third term is the revenue associated with deflating the value of existing nominal debt. Relation (5.1) implies that M_0 and μ must satisfy:

$$c\left\{\frac{M_0 - M}{M_0} + \frac{\mu}{r} + \left[\frac{B}{M} - \frac{1}{M_0}\frac{rB}{r+\mu}\right]\right\} = \phi.$$

Since it is feasible to choose (M_0, μ) to satisfy (5.1), the proposed policy supports the optimal equilibrium allocation.

An important caveat to the preceding discussion is that it abstracts from nominal rigidities in prices and wages as well as unhedged loans denominated in foreign currency. These aspects can clearly affect optimal monetary policy and the optimal time to abandon fixed exchange rates. The key point of our discussion is to emphasize that there are clear costs to delaying the adjustment of monetary policy. In our model, the cost is the distortion of consumption decisions induced by the fact that lower inflation now is purchased at the price of higher inflation in the future. The more a government borrows to delay a speculative attack, i.e. the higher is Ψ, the higher is this cost. In this sense, the ability to borrow from abroad to delay a speculative attack actually *reduces* welfare.

6. Assessing Some Predictions of the Model

In the previous section we used a simple perfect foresight model to show how prospective deficits could lead to the collapse of a fixed exchange rate regime. The key properties of the model can be summarized as follows. First, the speculative attack occurs after new information about higher future government deficits arrives but before the government begins to monetize a portion of the deficit. Second, the collapse of the fixed exchange rate regime is followed by a burst of inflation but only a very small increase in the steady state rate of inflation. In this section we discuss the evolution of money growth, inflation and interest rates in Asia with an eye towards assessing the empirical plausibility of these properties.

Figure 4 presents data on the evolution of the base, M1 and M2 in the crisis countries.[23] Each aggregate is reported relative to a benchmark value of 100 in June 1997. Table 11

[23] We were unable to obtain consistent data on the base for Hong Kong and Taiwan.

reports the ratio of the average value of the base, M1 and M2 in the second half of 1999 to the average value of the corresponding monetary aggregate in the period January–May 1997.

Two features of Figure 4 and Table 11 are worth noting. First, there is substantial diversity in the behavior of the monetary aggregates across the crisis countries. Thailand comes closest to the stylized pattern of monetary policy embodied in our model: the base and M1 remained virtually unchanged for roughly two years after the crisis, but then began to grow rapidly. Second, in all crisis countries, base money grew relative to its pre-crisis value, with the highest growth rates occurring in Indonesia and Thailand. Viewed as a whole, the evidence on monetary growth is consistent with a basic prediction of our model: partial monetization of the debt occurred with a lag after the currency crises.

Figure 7 presents data on the evolution of different price indices in the crisis countries. For Indonesia, Korea and Thailand, we display data on the CPI, the wholesale price index, and export and import unit prices. For the Philippines and Malaysia only the first two price measures are available. Note that price indices within each country responded very differently to the currency crises. While there are relatively modest movements in the CPI and wholesale price indices, there are large increases in export and import prices. Our theoretical model, which assumes only one good and purchasing power parity, clearly cannot account for these patterns.[24] But it does account for: (i) the rapid rise in tradable goods prices before monetization begins ($t = T$); and (ii) the low rates of inflation roughly two years after the crises.

We conclude by turning to the issue of whether agents anticipated the attack. In principle, nominal interest rate movements prior to a crisis are useful for assessing private agents' expectations about the timing of the speculative attack. Our model predicts that nominal yields on bonds of maturity greater than t^* ought to rise once agents receive information about the increase in prospective deficits.[25] In pursuing this implication of the model, we face two serious problems: (i) as far as we can tell, interest rate data on debt denominated

[24] Burstein, Neves and Rebelo (2000) show that a model which incorporates nontraded goods and distribution costs for traded goods can account for different responses of wholesale, retail, and CPI inflation to exchange rate fluctuations.

[25] Cline and Barnes (1997) analyze trends in spreads on U.S. dollar denominated Eurobonds. They conclude that these spreads fell in emerging markets, including Southeast Asia, between mid-1995 and mid-1997. While useful this information does not bear directly on the issues raised in this paper. Since the bonds in question are dollar denominated, the spreads reflect default risk rather than expected depreciation. Similar comments apply to Park and Rhee's (1998) analysis of the yield spread on Korean Development Bank global bonds.

in units of domestic currency pertain primarily to short term loans; and (ii) there was active government intervention in the crisis countries, including capital controls, aimed at affecting short term interest rates.[26] With this caveat, Figure 8 presents different measures of three month interest rates in the crisis countries. The basic prediction of our model is that these interest rates should have gone up within three months of the crises. Figure 8 indicates that the evidence on this prediction is mixed. On the positive side, interest rates in Thailand and Korea did rise prior to the major movements in the baht and the won. But the evidence for the other crisis countries is much weaker, with measured interest rates beginning to rise around the time of the crises. An open question is whether these interest rates reflected market participants expectations or government controls.

7. Conclusions

In this paper, we focused on the role played by large prospective deficits in the Asian currency crisis. Our basic argument was simple: absent the political will to raise taxes or cut spending, governments have to raise seignorage revenues or deflate the value of outstanding nominal debt to pay for the bailout of the banking system. In a world of forward looking agents this makes a currency crisis inevitable. In a version of our model calibrated to the Thai economy, the collapse of the fixed exchange rate happens *after* agents learn that future deficits will rise but *before* the government implements its new monetary policy. Under this scenario standard macroeconomic aggregates such as past inflation and fiscal deficits are not useful in predicting currency crises. In this limited sense our model rationalizes claims that the Asian crises were hard to predict.

Our model suggests that we focus our empirical analysis on information useful for forecasting prospective deficits.[27] This is why we studied the state of the Asian banking system prior to the crisis. We found evidence consistent with the view that agents knew that banks were in trouble before the crisis and that the size of the financial sector bailout would be large. This evidence does not rule out the possibility that the Asian currency crises were multiple equilibrium phenomena. But it does suggest a simple explanation based on fundamentals.

We conclude by highlighting some important shortcomings of our analysis. First, in our model the state of the banking system is costlessly revealed to agents at a particular

[26] For example see Park and Rhee's (2000) discussion of the Korean case.

[27] Standard and Poor's began, at the end of 1997, to report estimates of contingent government liabilities stemming from implicit guarantees to financial sectors.

point in time. In reality, obtaining this information took time and resources. Moreover, information about banking problems in one country may have conveyed information about banking systems in other countries. We suspect that understanding the precise timing and sequencing of speculative attacks will require an analysis of these information dynamics. Second, we used a perfect foresight model. This implies, among other things, that (i) the timing of the speculative attack is perfectly forecastable; and (ii) the equilibrium path for the exchange rate is continuous. Both of these implications are counterfactual. After all the precise timing of a currency crisis is difficult to predict, and discrete devaluations do occur. It is well known that both of these problems can be solved by incorporating stochastic elements into the model (see for example Flood and Garber (1984) and Drazen and Helpman (1988)). Allowing for uncertainty would considerably complicate our model. But it would not affect our main message: the Asian currency crises were primarily caused by governments' prospective deficits.

Third, we modeled the decision of when to abandon fixed exchange rates with a simple threshold rule on government debt. In reality this decision is shaped by political considerations. Modeling these political aspects is likely to lead to insights regarding the timing of speculative attacks. Fourth, to isolate the role of prospective deficits we abstracted from nominal rigidities. These rigidities will almost surely have an impact on the nature of optimal monetary policy. Finally, we did not address the issue of how the collapse of financial intermediaries affects future output and tax revenues. We took as given that in the state of the world where banks collapsed, governments would find it difficult to raise tax revenues. In future work we intend to study in detail the role played by the financial sector in generating the persistent recessions that are often associated with currency collapses.

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Appendix A

The problem of the representative household is to maximize (3.6) subject to (3.7)–(3.9) by choice of time paths for c_t, m_t, b_t and d_t, given a known time path for π_t. The current-valued Hamiltonian associated with this problem is:

$$\begin{aligned}\mathcal{H} &= \frac{c_t^{1-\sigma}-1}{1-\sigma} + \lambda_t[y + r(b_t + d_t + B/S_t) + v - c_t - \tau - \pi_t m_t - z_t] + \\ &\quad \theta_t z_t + \omega_t(m_t - c_t)\end{aligned}$$

where $z_t = \dot{m}_t$.

The first order conditions to the problem are given by:

$$\begin{aligned}c_t^{-\sigma} &= \lambda_t + \omega_t, \\ \lambda_t &= \theta_t, \\ \dot{\lambda}_t &= (\rho - r)\lambda_t = 0, \\ \dot{\theta}_t &= \theta_t \rho + \lambda_t \pi_t - \omega_t.\end{aligned}$$

These equations imply (3.10) in the main text.

Appendix B

Detailed Data Sources

Table 1. The data are taken from the IMF World Economic Outlook database. The fiscal surplus in local currency units is the General Government Balance (EDSS): mnemonic GGB. GDP is Gross Domestic Product (current prices): mnemonic N*xxx*GDP, where *xxx* is the country code.

Table 3. All series are from Datastream. Banks: BANKS*xx*, Nonfinancial: TOTLI*xx*, where *xx* is ID (Indonesia), KO (Korea), MY (Malaysia), PH (Philippines), TH (Thailand).

Table 4. We construct domestic lending to the private sector from the *IFS*. Our measure captures, to the extent possible, all lending by banks and other financial intermediaries to all domestic sectors other than the government. It varies by country depending on the availability of data. We net out, where possible, any lending among financial intermediaries. When the data limit us to the lending activities of deposit money banks, we include loans to other financial intermediaries in our measure. Mnemonics: "Deposit Money Bank (DMB) Claims on Nonfinancial Public Enterprises (NPEs)" (22C..ZF), "DMB Claims on the Private Sector (PS)" (22D..ZF), "Other Banking Institution (OBI) Claims on the Private Sector" (42D..ZF), "Nonbank Financial Institution Claims on the PS" (42D.SZF). Indonesia: (22C..ZF) plus (22D..ZF) plus "DMB Claims on OBIs" (22F..ZF) plus "DMB Claims on Nonbank Financial Institutions" (22G..ZF). Korea: (22D..ZF) plus (42D..ZF) plus "Trust Account Claims on the PS" (42D.GZF) plus (42D.SZF) minus "OBI Credit from DMBs" (46H..ZF). Malaysia: (22D..ZF) plus (42D..ZF). Philippines: (22C..ZF) plus (22D..ZF) plus (42D..ZF). Thailand: (22C..ZF) plus (22D..ZF) plus "Finance and Security Company Claims on NPEs" (42C.FZF) plus "Finance and Security Company Claims on the PS" (42D.FZF). Hong Kong: (22D..ZF). Singapore: (22D..ZF) plus (42D..ZF) plus (42D.SZF). Taiwan: "DMB Claims on the PS" (22D..ZF) plus (22D.GZF), plus "OBI Claims on the PS" (42D.KZF) plus (42D.SZF).

We construct private nonbank foreign borrowing from the BIS *International Banking and Financial Market Developments* data. Table 5B of that publication reports the "External Positions of Reporting Banks vis-a-vis Individual Countries (vis-a-vis the nonbank sector)" in millions of U.S. dollars. We converted these to local currency using the *IFS* end of month exchange rate (..AE.ZF).

Ratios to GDP were computed using GDP figures as in Table 1. Central government revenue figures were obtained from the IMF World Economic Outlook database: mnemonic GCRG.

Table 11. All series are from the *IFS*. MB: 14...ZF. M1: 34...ZF. M2: 35L..ZF.

Figure 1. All series are from Datastream. Indonesia: USINDON. Korea: KOUSDSP. Malaysia: BBMYRSP. Philippines: USPHILP. Thailand: USTHAIB. Hong Kong: USHK-DOL. Singapore: SGUSDSP. Taiwan: U$NTDSP.

Figure 2. All series are from Datastream. Banks: BANKS*xx*, Nonfinancial: TOTLI*xx*, where *xx* is ID (Indonesia), KO (Korea), MY (Malaysia), PH (Philippines), TH (Thailand), HK (Hong Kong), SG (Singapore), TA (Taiwan).

Figure 3. Offshore Thai baht interest rate: Bank of Thailand website www.bot.or.th, English-Financial Markets-Yield Curve & Financial Markets Interest rates-Thai Baht Implied Interest Rate. US Fed Funds rate: Bloomberg.

Figure 4. MB: *IFS*, 14...ZF. M1 (all except Taiwan): *IFS*, 34...ZF. M1 (Taiwan): Datastream, TWM1AAVEA. M2 (all except Taiwan): *IFS*, 35L..ZF. M2 (Taiwan): Datastream, TWM2AVE.A.

Figure 7. CPI: *IFS*, 64...ZF. PPI: *IFS*, 63...ZF. EUV: *IFS*, 74...ZF. IUV: *IFS*, 75...ZF. EWPI (Indonesia): Datastream, IDEXPP83F and IDEXPPRCF, spliced. EPI (Korea and Singapore): *IFS*, 76...ZF. EPI (Taiwan): Datastream, TWEXPPRCF. IWPI (Indonesia): Datastream, IDIMPP83F and IDIMPPRCF, spliced. IPI (Korea and Singapore): *IFS*, 76.X.ZF. IPI (Taiwan): Datastream, TWIMPPRCF.

Figure 8. Indonesia: Interbank (Bloomberg JIIN3M). Korea: Factoring and Bill Discounting Rate (Datastream KOFB91D) Commercial Paper (Datastream KOCP91D). Malaysia: Interbank (Bloomberg KLIM3M), Offshore (Datastream MYOFS3M). Philippines: Interbank (Bloomberg PHINBR3M), T-bill (Datastream PHTBL3M). Thailand: both rates (Bank of Thailand website www.bot.or.th, English-Financial Markets-Yield Curve & Financial Markets Interest rates-Thai Baht Implied Interest Rate). Hong Kong: Interbank (Datastream HKIBK3M). Singapore: Interbank (Datastream SNGIB3M). Taiwan: Commercial Paper (Bloomberg NTCPP90), Money Market (Datastream TAMM90D).

TABLE 1

FISCAL SURPLUS (percent of GDP)

	1995	1996	1997	1998	1999
Indonesia	0.0	0.8	1.2	-0.7	-1.9
Korea	1.0	1.3	1.0	-0.9	-4.0
Malaysia	3.3	2.2	2.1	4.0	-1.0
Philippines	-1.8	-1.4	-0.4	–0.8	–2.7
Thailand	1.9	3.0	2.5	–0.9	-2.5
Hong Kong	-0.3	2.2	6.1	-1.8	0.8
Singapore	13.9	12.3	9.3	9.4	3.6
Taiwan	0.2	0.4	-0.7	–0.6	0.9
Japan	-2.3	-3.6	-4.2	-3.4	-4.3
USA	-3.8	-3.3	-2.4	-1.2	-0.1

SOURCES.—See Appendix B.

TABLE 2

ESTIMATED TOTAL NONPERFORMING BANK LOANS (percent of all loans)

	End of 1996*	End of 1997†
Indonesia	13	15
Korea	8	30
Malaysia	10	15
Philippines	14	7
Thailand	13	36
Hong Kong	3	1
Singapore	4	4
Taiwan	4	n.a.

SOURCES.—*Corsetti, Pesenti and Roubini (1999a), †Peregrine (1997).

TABLE 3

CHANGES IN BANKING SECTOR STOCK MARKET VALUES (7/1/97=100)

	Pre 7/1/97 Peak		7/1/97	Peak to 7/1/97 % Change		12/31/97	Peak to 12/31/97 % Change	
	Date	Value	Value	Level	Relative to Nonfinancials	Value	Level	Relative to Nonfinancials
Indonesia	2/28/97	103.2	100.0	-3.1	-3.2	26.3	-74.5	-65.0
Korea	11/7/94	207.3	100.0	-51.8	-34.4	62.5	-69.8	-27.7
Malaysia	2/25/97	121.6	100.0	-17.7	-4.0	36.3	-70.1	-48.0
Philippines	1/31/97	136.8	100.0	-26.9	-13.2	56.4	-58.8	-34.7
Thailand	1/31/96	281.1	100.0	-64.4	-29.6	60.1	-78.6	-48.9

SOURCES.—See Appendix B.

TABLE 4

ESTIMATED NONPERFORMING LOANS (June 1997)

	Domestic Bank Lending*	Private Nonbank Foreign Borrowing†	Total Lending	Nonperforming Credit (as a percentage of)		
	(percent of GDP‡)			a) All Loans	b) GDP‡	c) Government Revenue‡
Indonesia	54.6	14.7	69.3	14	9.7	65.8
Korea	129.9	5.1	135.0	19	25.7	128.0
Malaysia	143.0	6.7	149.7	12.5	18.7	79.9
Philippines	56.4	5.5	61.9	20.5	6.5	33.8
Thailand	135.9	7.3	143.1	24.5	35.1	194.7
Hong Kong	166.1	14.8	180.9	2	3.6	18.3
Singapore	113.9	8.5	122.4	4	4.9	12.5
Taiwan	149.5	1.1	150.5	4	6.0	50.4

SOURCES.—See Appendix B.

NOTES.—*Definition varies though it generally captures all lending by banks and other financial intermediaires to the private sector and to nonfinancial public sector enterprises (see Appendix B). †Lending by BIS banks to the nonbank sector. Total lending is the sum of "domestic bank lending" and "private nonbank foreign borrowing." ‡GDP and government revenue are for the year 1997. Column (a) represents the average of the two nonperforming loan rates in Table 2. Column (b) is the "Total lending" column times the nonperforming loan rate in column (a). Column (c) is the column (b) times the ratio of GDP to central government revenue.

TABLE 5

POST-CRISIS ESTIMATES OF NONPERFORMING LOANS AND RECAPITALIZATION REQUIREMENTS

	Indonesia	Korea	Malaysia	Thailand
Nonperforming Loans				
(percent of all loans)	50	30	25	30
(percent of GDP)	37.5	49.5	41.3	30
Recapitalization Need				
(percent of GDP)	30	30	22	30

SOURCE.—J.P. Morgan (1998).
NOTE.—Figures are for June 1998.

TABLE 6

COSTS OF RESTRUCTURING AND RECAPITALIZING THE BANKING SYSTEM

	(percent of GDP)	Date of Estimate*
Indonesia	65	Nov. 99
Korea	24	Dec. 99
Malaysia	22	Dec. 99
Thailand	35	Jun. 99

SOURCES.—Standard and Poor's Sovereign Ratings Service, various country reports.
NOTES.—*Date of issue of the source country report.

TABLE 7

Assistance from the International Community (percent of GDP)

	IMF	Multilateral*	Bilateral	Total
Indonesia	4.6	3.7	8.7	17.0
Korea	4.5	3.0	5.0	12.4
Phillipines	1.7			1.7
Thailand	2.5	1.7	6.7	10.8

Source.—Garcia (1998).
Notes.—*Includes the World Bank and Asian Development Bank.

TABLE 8

Parameter Values in the Benchmark Example

Parameter	Value	Description
y	1	Real output
S	1	Time 0 exchange rate
σ^{-1}	1	Elasticity of intertemporal substitution
T	2	Time of monetary policy change
b_0	0	Time 0 government indexed domestic debt
B	0.052	Time 0 government nonindexed domestic debt
f_0	0.091	Time 0 government net foreign assets
d_0	-0.449	Time 0 private net foreign assets
Ψ	-0.034	Upper limit on net government debt
M_T/M	1.207	Jump in M_t at time T
ϕ	0.30	Present value of increase in deficit
$r = \rho$	0.037	Real interest rate
$\tau - v$	0.438	Lump-sum taxes net of transfers
μ	0.014	Growth rate of money for $t \geq T$

TABLE 9

SENSITIVITY ANALYSIS, PART 1

	t^*	PVR
Baseline	0.12	0.30
90% transfers	0.04	0.30
$\sigma = 2$	0.93	0.30
$T = 3$	1.14	0.29
$\Psi = 0.0$	1.03	0.29
$B = 0$, $b_0 = 0.052$	0.16	0.28
$M_T/M = 1.1$	0.65	0.26
$\mu = 0.03$	0.04	0.52

NOTES.—Each case changes one assumption (as indicated) relative to the baseline parameterization (indicated by "Baseline" and detailed in Table 8). The "90% transfers" case assumes that 90 percent of the increase in government spending is in the form of transfers, whereas in the baseline case, 100 percent is in the form of transfers. "PVR" represents the present value of resources raised by monetary policy.

TABLE 10

SENSITIVITY ANALYSIS, PART 2

Policy Variable that Adjusts to Keep PVR= ϕ					
a) μ			b) M_T/M		
	t^*	μ		t^*	M_T/M
Baseline	0.12	0.014	Baseline	0.12	1.207
90% Transfers	0.05	0.014	90% Transfers	0.04	1.208
$\sigma = 2$	0.93	0.014	$\sigma = 2$	0.92	1.208
$T = 3$	1.14	0.015	$T = 3$	1.04	1.237
$\Psi = 0$	1.03	0.015	$\Psi = 0$	0.99	1.225
$B = 0$, $b_0 = 0.052$	0.16	0.016	$B = 0$, $b_0 = 0.052$	0.00	1.265
$\phi = 0.25$	0.02	0.011	$\phi = 0.25$	0.63	1.087

NOTES.—Each case changes one assumption (as indicated) relative to the baseline parameterization (indicated by "Baseline" and detailed in Table 8). The "90% transfers" case assumes that 90 percent of the increase in government spending is in the form of transfers, whereas in the baseline case, 100 percent is in the form of transfers. "PVR" represents the present value of resources raised by monetary policy.

TABLE 11

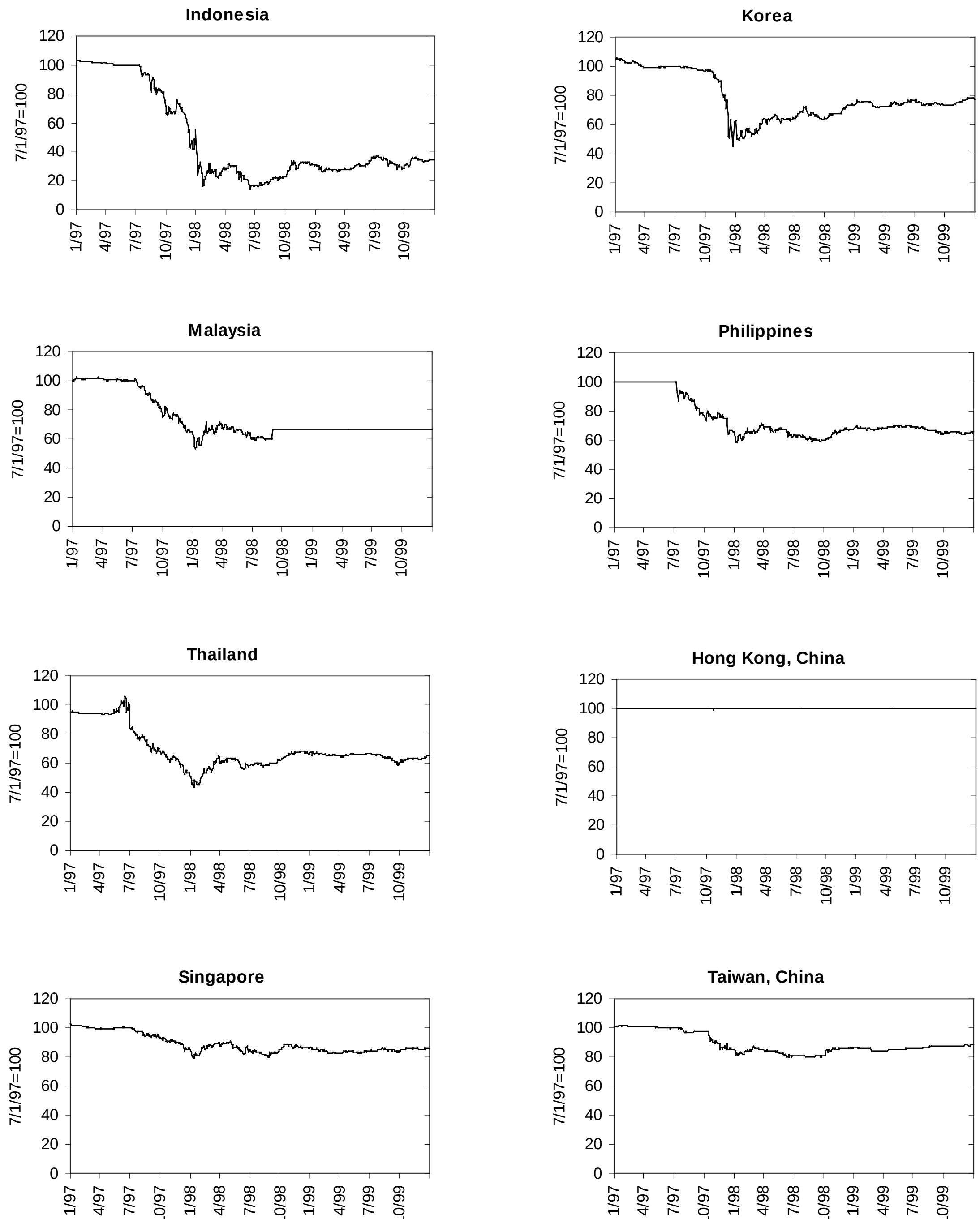
Ratio of Monetary Aggregate in the Second Half of 1999 to its Value in the First Half of 1997

	MB	M1	M2
Indonesia	2.12	1.72	2.16
Korea	1.14	1.02	1.70
Malaysia	1.13	0.86	1.29
Philipines	1.08	1.44	1.43
Thailand	1.21	1.31	1.29

Sources.—See Appendix B.
Note.—MB is the monetary base.

Figure 1

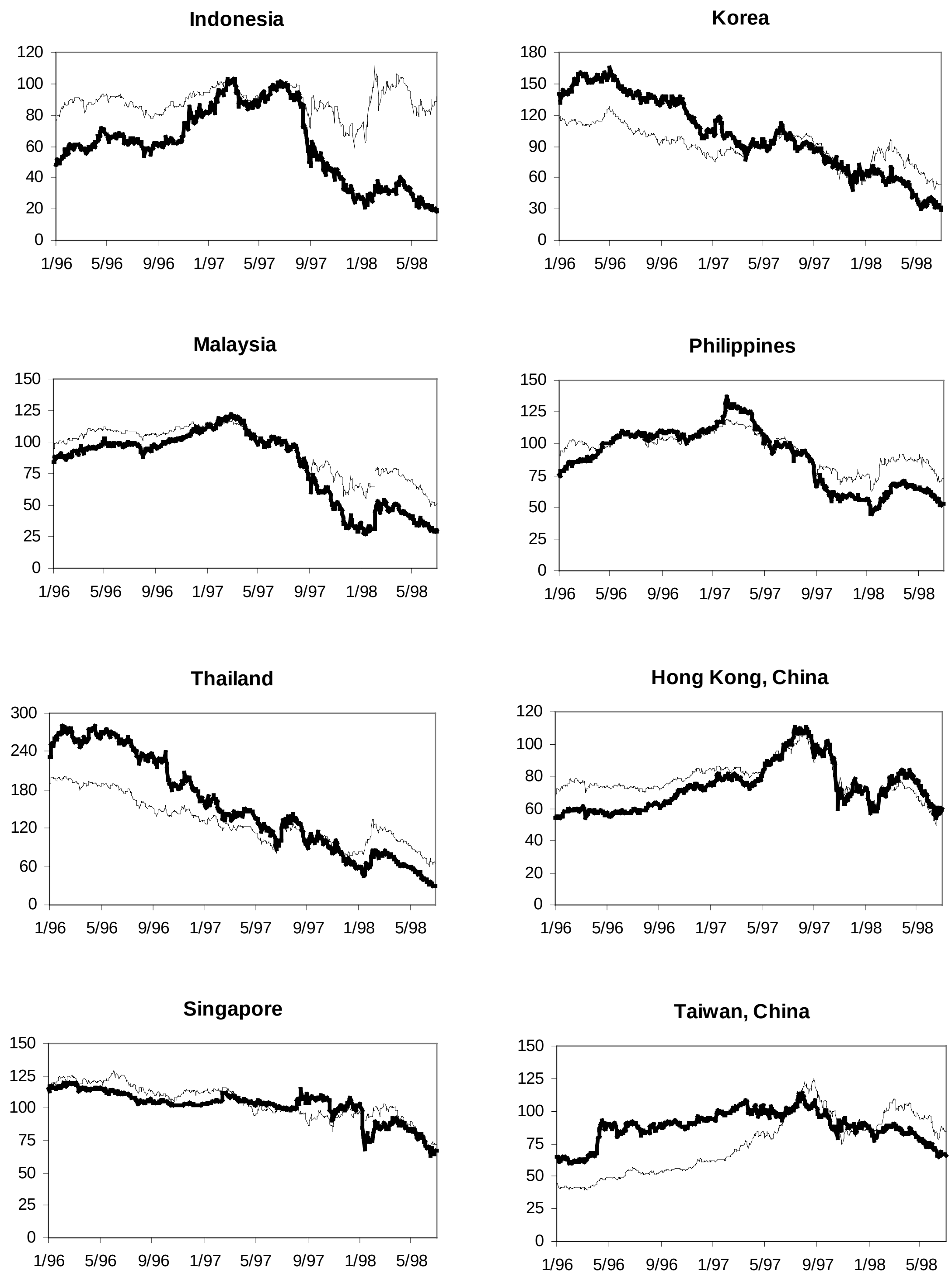
Nominal Exchange Rate Versus the U.S. Dollar
(US$ per Local Currency Unit, 7/1/97=100)



Source: See Appendix B. Notes: Daily observations.

Figure 2

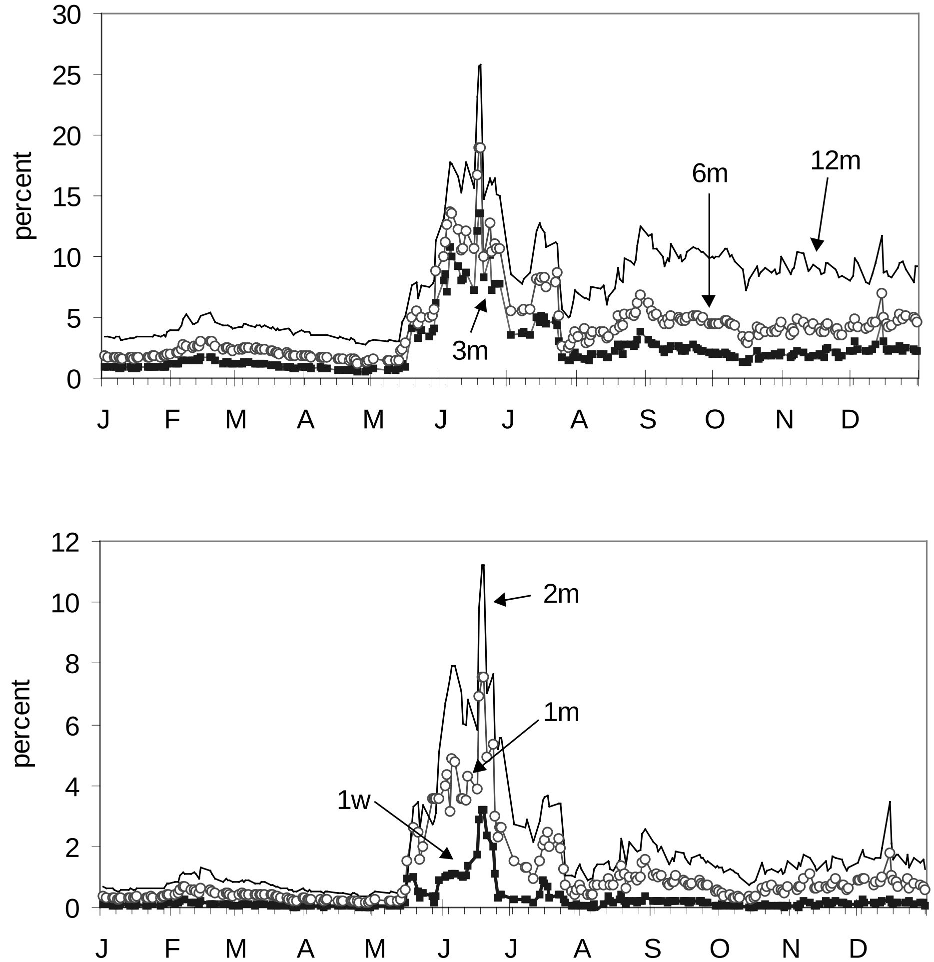
Stock Market Indexes
(Index numbers, 7/1/97=100)



Source: See Appendix B. Notes: Heavy lines–banking index. Thin lines–nonfinancial index. Original data are in local currency units.

Figure 3

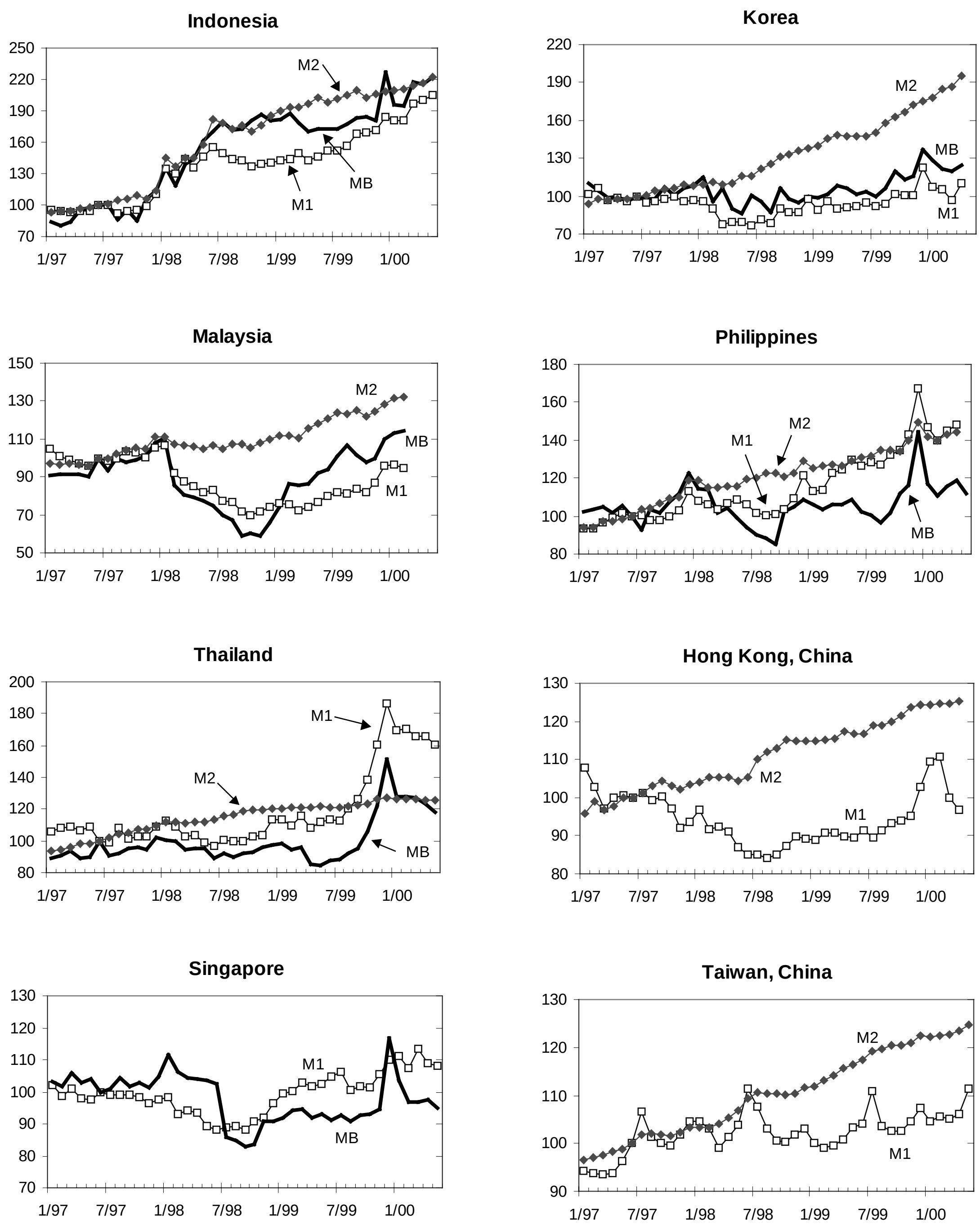
Implied Forward Premia in the Thai Baht Offshore Market, 1997



Sources: See Appendix B. Notes: This figure plots (*F*-*S*)/*S*, measured in percent, for different forward horizons. The forward rate is implicit and is calculated from the covered interest parity condition using baht interest rates and U.S. dollar Fed Funds interest rates.

Figure 4

Money Stocks
(Index numbers, 7/1/97=100)



Sources: See Appendix B. Notes: MB: monetary base. Data are end-of-month values with the last date being the most recent available up to May 2000.

Figure 5

Response to News about an Increase in Prospective Deficits

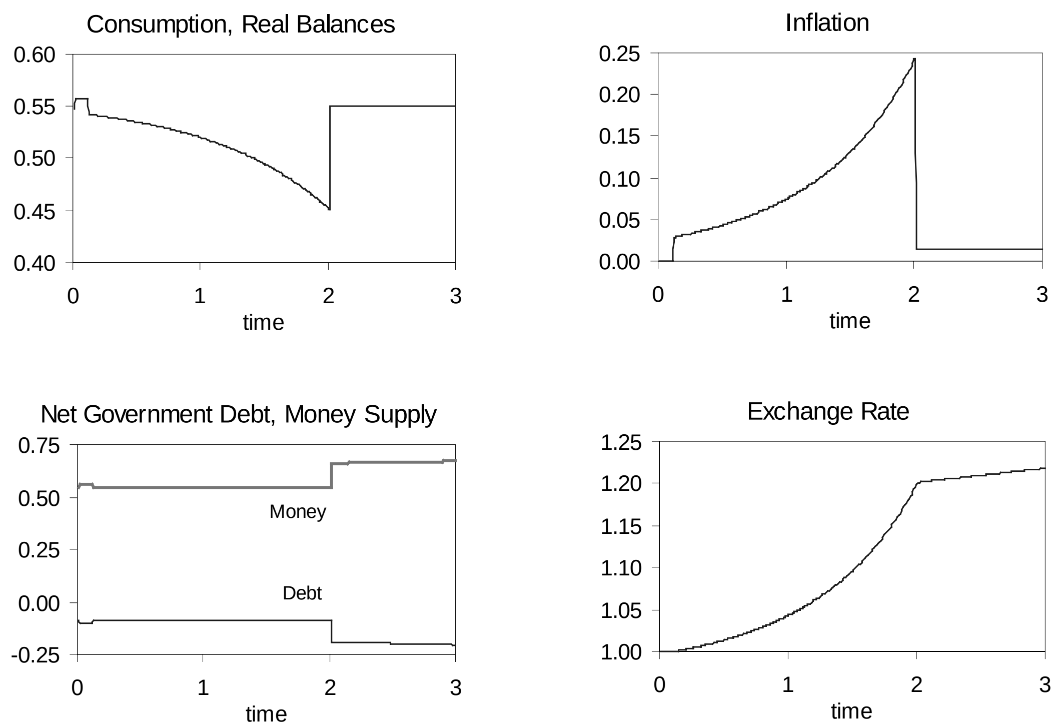
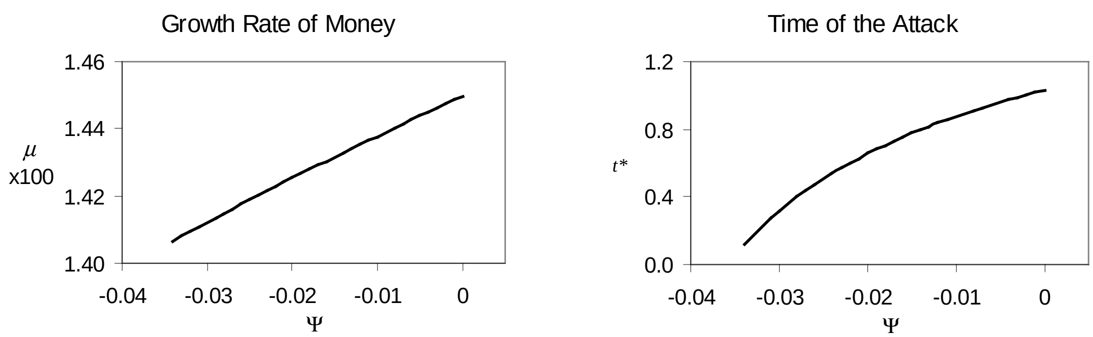


Figure 6

Effects of Varying the Threshold Rule Parameter, Ψ, on the Time of the Attack

a) μ Adjusted to Satisfy the Government's Present Value Budget Constraint



b) M_T/M Adjusted to Satisfy the Government's Present Value Budget Constraint

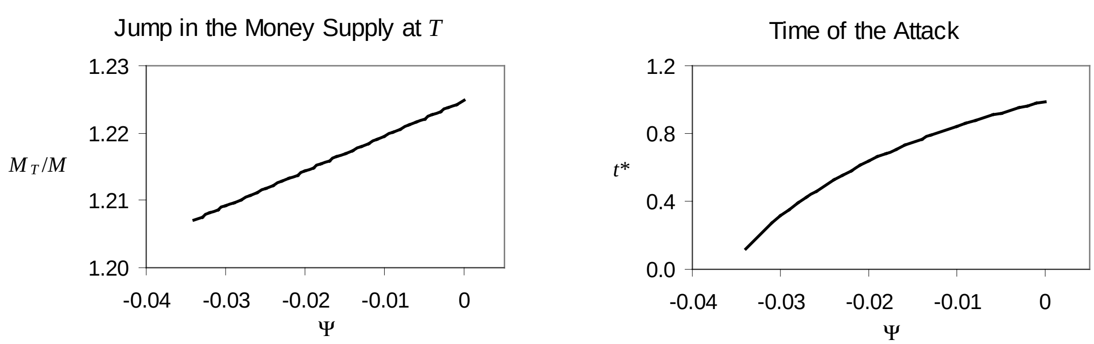
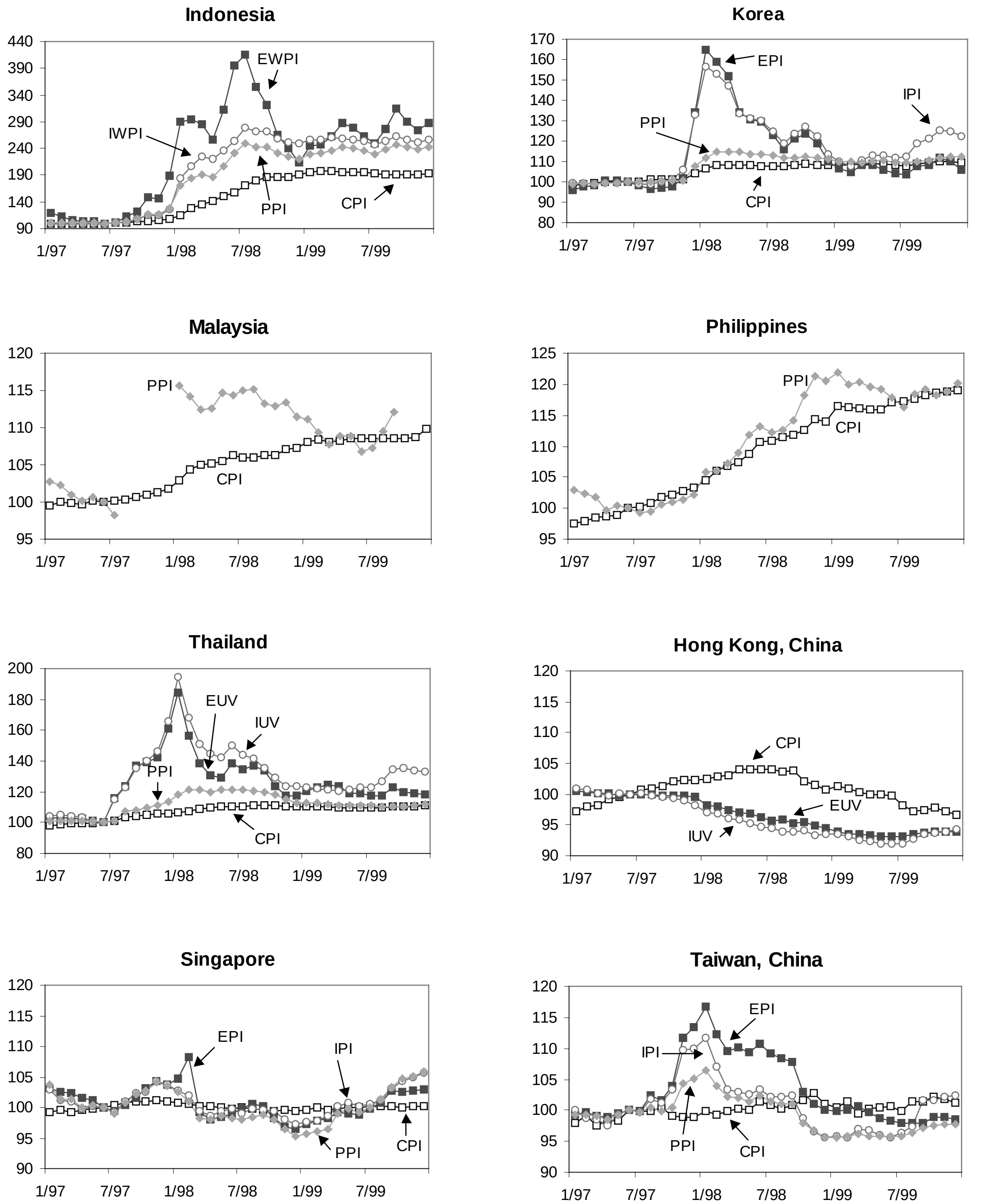


Figure 7

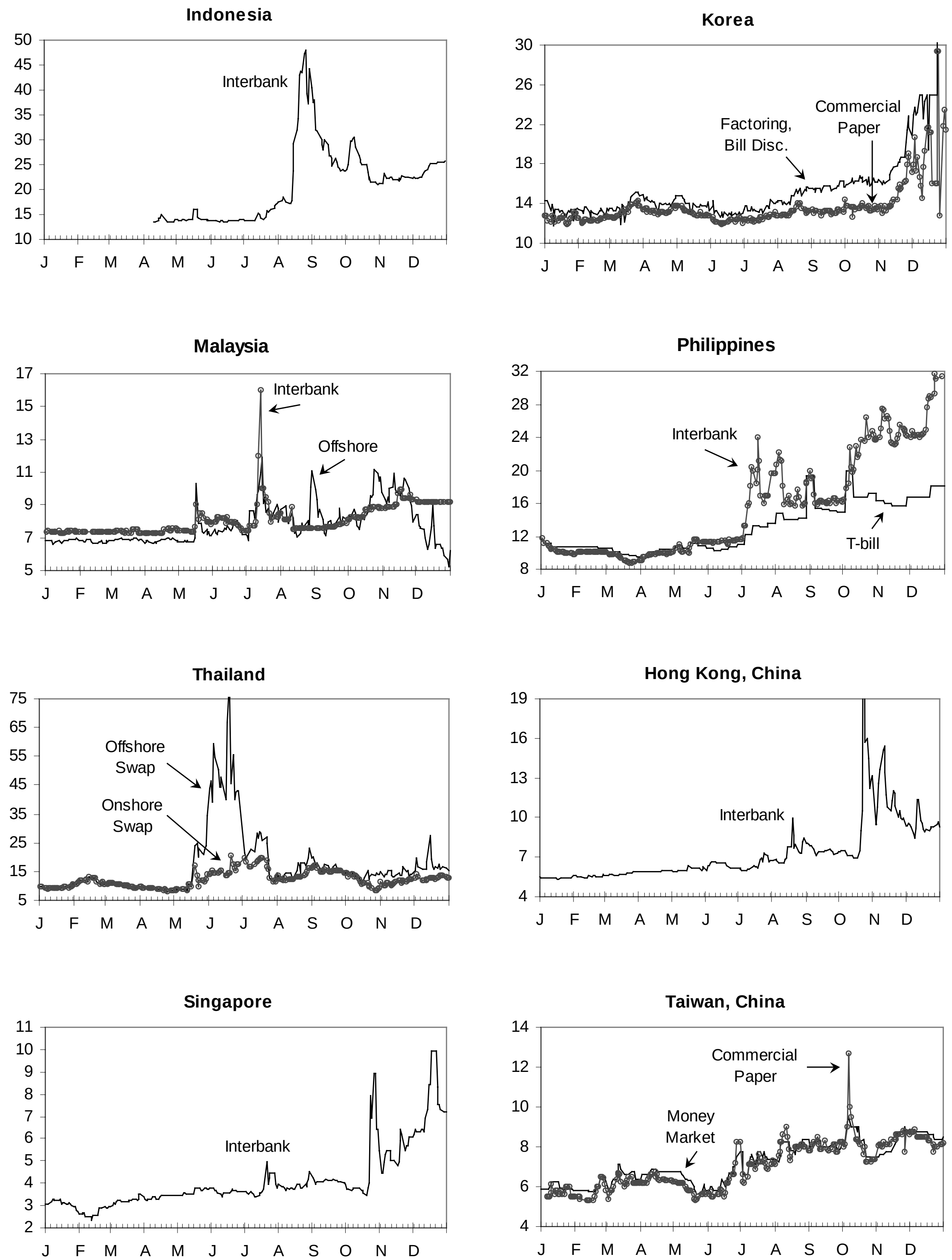
Prices
(Index numbers, 7/1/97=100)



Sources: See Appendix B. Notes: EPI: export price index, EWPI: export wholesale price index, EUV: export unit value, IPI: import price index, IWPI: import wholesale price index, IUV: import unit value, PPI: producer or wholesale price index, CPI: consumer price index. Data are monthly with the last date being the most recent available up to December 1999.

Figure 8

3-Month Interest Rates in 1997



Sources: See Appendix B.