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Essays on Exchange Rate Dynamics and Currency Crises in Asia

Sweta C. Saxena

A dissertation submitted in partial fulfillment of requirements for the degree of

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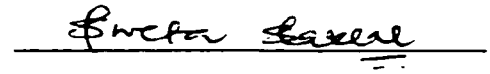
Signature 

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Abstract

Essays in Exchange Rate Dynamics and Currency Crises in Asia

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Chairperson of the Supervisory Committee
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This dissertation studies theoretical models of causes of and arguments about remedies for currency crises, and empirically examines movements in exchange rates and episodes of crises. In the first chapter, various theoretical models of currency crises are evaluated and issues in capital account convertibility are discussed. The second chapter analyzes the currency crisis in Indonesia to determine if domestic fundamentals, monsoons or contagion caused the 1997 crisis. Using Markov-switching models, this chapter finds that including exchange pressure from neighboring countries in the transitional probabilities improves the conditional probability of a crisis in Indonesia. In the third chapter, the dynamics of Indonesia's exchange rate are examined using different theoretical and empirical models. In particular, in-sample and out-of-sample forecasts are shown for VAR, cointegration, and unobserved components models. The last chapter is a case study that investigates India's 1991 currency crisis. The chapter constructs an estimate of the equilibrium real exchange rate to determine if it was overvalued at the time of the crisis and also looks at short run factors that may have contributed to misalignment.

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Acknowledgements

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In Loving Memory

of my Sister

Late Smt. Seema Kulshreshtha

(September 12, 1961-August 24, 1998)

and my Brother-in-Law

Late Shri Yogesh Chandra Nigam

(August 18, 1954-January 19, 1997)

INTRODUCTION

This dissertation investigates exchange rate dynamics and currency crises in developing countries, with special reference to the Asian crisis in 1997. The first chapter is a survey that discusses theoretical models of speculative attack and currency crises, and reviews the empirical evidence. The chapter outlines the correspondence of the models to different cases of crisis (e.g. Latin American crises, the ERM breakdown, and the recent Asian crisis), and points to gaps in the theoretical literature for explaining the Asian crisis. The large economic costs resulting from the severe depreciation of Asian currencies and general problems with macroeconomic management in the presence of large capital flows has recently led to proposals for limiting capital flows. The chapter reviews the arguments and empirical results for and against capital controls.

The second chapter studies the case of Indonesia in the recent Asian currency crisis. The objective is to investigate empirically whether the crisis can be attributed to domestic fundamentals, common external shocks (monsoons), or contagion from neighboring countries. The evidence from Big-Mac parity suggests that the Indonesian Rupiah was 30% undervalued before the crisis. In the absence of any kind of overvaluation of the currency, it is puzzling to see the severity of the recent devaluation.

A Market Pressure Index (MPI) as a measure of the degree of speculative pressure on the exchange rate is constructed. This measure includes actual changes in the exchange rate as well as increases in interest rates or loss of foreign exchange reserves required to defend the value of the currency. Results from OLS and Probit estimations suggest that domestic political and financial sector factors played a role in the crisis, as did contagion from speculative pressures in Thailand and Korea. However, probit models have some drawbacks. First, there is a loss of information resulting from the formation of a discrete measure of crisis. More importantly, the definition of a crisis as speculative pressure above an arbitrary threshold level leads to an exclusion of episodes of moderate speculative pressure, which biases the sample against those episodes that could be partly anticipated from the behavior of economic fundamentals. Therefore, Markov Switching

Models are estimated to use the full information contained in the continuous dependent variable and endogenously determine the switch in regime. The results from a Time Varying Transitional Probability Markov Switching Model show that inclusion of exchange rate pressures from Thailand and Korea in the transitional probability improves the conditional probabilities of crisis in Indonesia. We also find evidence of contagion in the stock market.

The third chapter explains the real exchange rate movements in Indonesia over the period 1980-98 using different economic and time series models and compares the forecasting ability of these methods. First, the paper develops an intertemporal optimization model and estimates it using the cointegrating approach. This model shows that the government expenditures (consumption and investment), openness, terms of trade and productivity growth explain the real exchange rate movements in the long run. Then, in order to examine the movements in the real exchange rate and the trade balance, an unobserved component model is estimated that shows that the cycles in the real exchange rate are associated with the cycles in trade balance—whenever the exchange rate depreciates, the trade balance improves. Lastly, the impact of various shocks on the real exchange rate is examined through the structural vector auto regression (*VAR*). The bivariate *VAR* shows that the real shocks in the economy explain much of the variation in the real exchange rate. The results from the trivariate *VAR* suggest demand shocks are important in explaining most of the variation. The results from forecasting show that the trivariate structural VAR, the cointegration approach and the unobserved component model beat the random walk model in case of in-sample forecasting, while only the unobserved component model performs better than the random walk in one-step ahead out-of-sample forecasting. The random walk model, however, triumphs over all the models in out-of-sample forecasting 4-period ahead.

The fourth chapter investigates the 1991 currency crisis in India by determining whether real exchange rate of the Indian Rupee was overvalued at the time of the crisis relative to its long run equilibrium level. According to analysis in intertemporal theoretical models,

the long run equilibrium real exchange rate depends on a number of real fundamental factors (i.e. there are real reasons why PPP does not hold). The equilibrium exchange rate for India is estimated in this paper using an error correction model. The paper then applies a technique developed by Gonzalo-Granger (1995)—which uses joint information from the error correction model to decompose each endogenous variable into permanent and temporary components—to the case of the real exchange rate. The results support the hypothesis that the Rupee real exchange rate was overvalued at the time of crisis in 1991. The econometric evidence also indicates that current account deficits played a significant role in the crisis. Moreover, dynamic forecasts from the ECM models outperform random walk models.

Chapter 1: Currency Crises and Capital Controls: A Selective Survey[1]

1.1. INTRODUCTION

The recent history of the international financial markets is characterized by numerous currency crises. Various countries around the world have come under pressure or faced a crisis at different points in time. Recent cases include the crises in Mexico in 1976 and Argentina, Brazil, Peru and Mexico in the early and mid-80s, Chile and Argentina in 1980s, ERM in 1992, and Mexico in 1995. Now, starting from 1997, a major part of Asia is under a financial crisis.

Economists, who are doing some catching-up work, are trying to provide analysis of these crises. Roughly speaking, this work focuses mainly on three related areas:

(a) Theoretical analysis of the causes and effects of currency crises

Undoubtedly, most of the work on currency crises focuses on explaining their causes and effects. Earlier papers by Salant and Henderson (1978), Krugman (1979), and Flood and Garber (1984), which often are referred to as the first-generation models, painstakingly point out how persistent government budget deficits may lead to capital flight and currency crisis. The crises in Chile and Argentina in the 1980s and ERM in 1992 led to the development of second-generation models, which emphasize the existence of multiple equilibria in the foreign exchange markets and the possibility of crises as self-fulfilling outcomes.

The current crisis in Asia, however, has some features that either were not present or were not so obvious in previous episodes. For example, these Asian countries had been

[1] Thanks are due to Charles Engel for constructive comments.

adopting responsible fiscal policies, and their economies exhibited other solid macroeconomic fundamentals. Another feature of these economies is that they had impressive growth rates for a long period of time. Prior to the Asian crisis, many economists regarded these countries as models of growth for developing countries. Suddenly, they faced unexpected problems in the financial markets. It is, therefore, interesting to investigate any possible links between growth and crisis.

(b) Empirical Studies of Crises

Two types of empirical work can be identified. First, there are studies of the nature and features of these crises. For example, are there contagion effects? Have the exchange rates of various countries before a crisis been overvalued? How have the crises affected various parts of the economies? Second, efforts have been made to try to determine whether crises can be predicted. In particular, there has been interest in finding whether good leading indicators of a crisis exist.

(c) Policy Recommendations

As the analysis of various crises is being developed, a question that easily pops up in people's mind is what a government should do to avoid a crisis, and what the government should do after a crisis has happened. Two approaches to policy analysis can be suggested. First, one can focus on a particular crisis, determine its causes, and try to see whether some of these causes can be eliminated through a change in certain government policies. For example, if one looks at the crises in Latin America, one can simply suggest that lowering the government deficits could avoid a crisis down the road. Second, one can examine the similarities between various crises and determine whether there are some government policies that could diminish the chance of a crisis in the future.

In the second approach, one can note that while all crises can be distinguished in terms of their causes and effects, they do share two common features: (i) a fixed exchange rate

regime, and (ii) capital flight and speculative attacks. Corresponding to these two features, two proposal have been suggested: (i) give up the fixed exchange rate regime; (ii) exercise capital control, i.e., impose strict constraints on the inflow and/or outflow of capital across the borders of a country.

In this paper, we survey some of the more important issues related to currency crises. Our discussion will be based on the three areas described above: the analysis of causes and effects of crises, empirical studies, and policy recommendation.

In analyzing the causes and effects of crises, we begin with the two main areas emphasized in earlier work: the existence of persistent fiscal deficits, and existence of multiple equilibria and self-fulfilling crises. These are discussed respectively in Sections 1.2 and 1.3.

We then turn to the more recent work that examines other issues: (a) simultaneous existence of a banking crisis and a currency crisis, so called the twin crises (Section 1.4); (b) herd behavior and its relationship to capital flight and speculative attacks (Section 1.5); and (c) moral hazard and currency crises (Section 1.6).

Next, in Section 1.7, we turn to the work that examines the predictability of crises.

In Sections 1.8 to 1.13, we choose to discuss one policy recommendation to avoid a currency crisis that has been proposed before: capital control. We will not mention about the other policy suggestion: the floating of a local currency. It is because a fixed exchange rate versus a flexible exchange rate has long been an important issue in the literature, and we decided not to cover this area.

In Section 1.8, we provide some basic material about capital account control, including a brief history of capital control. In Section 1.9, we present some traditional arguments for and against capital control, while Section 1.10 focuses on more recent arguments. Section

1.11 explains an alternative recommendation: Instead of liberalizing the capital account in a single step, as some of Asian countries did prior to the crisis, it has been suggested that the capital account should be liberalized in several steps. We will present some of these arguments. Section 1.12 discusses several measures to discourage capital inflow and outflow, so that an economy may not be so risky under the threat of capital flight. Section 1.13 presents some empirical studies related to capital control, while the last section concludes.

1.2. DOMESTIC CREDIT CREATION AND CURRENCY CRISES

For an economy under a fixed exchange rate regime, a currency crisis usually refers to a situation in which the government is under severe pressure to give up either the prevailing exchange rate or the regime. For the former, the economy in crisis reluctantly devalues its currency by a substantial amount,[2] and the exchange rate then moves to a new, but at least temporarily fixed level. For the latter, the alternative regime is a flexible exchange rate one.

In the literature, many models and theories have been suggested to explain the causes and occurrence of a currency crisis. In this section, we focus on the impacts of domestic credit creation on the exchange rate pegged by the government. Models that use these impacts to explain the existence of a currency crisis are sometimes called the *first-generation* models.

1.2.1. A Simple Model of Exchange Rate Determination

To introduce the main features of the first-generation models, it is more convenient to begin with a simple model of exchange rate determination. Consider a one-sector, small, open economy. To focus on the monetary side of the economy, we assume that its real

---

[2] Devaluation and appreciation of a currency are usually treated asymmetrically. While an involuntary devaluation is considered as a crisis, an involuntary appreciation is usually not.

side is characterized by full employment, with constant factor endowments and technology. The following conditions describes the monetary side of the economy:

(1.1) $M_t / P_t = a - bi_t$

(1.2) $M_t = S_t R_t + D_t$

(1.3) $P_t = P_t^* S_t$

(1.4) $i_t = i_t^* + \dot{S}_t / S_t$

where M_t, P_t, i_t, are the quantity of (high-powered) money, the general price level, and the interest rate, respectively. Equation (1.1) is the money demand equation, with the output always at a fixed level. The two coefficients, a and b, are positive numbers. Equation (1.2) gives the money supply, which consists of foreign reserves (in foreign currency) held by the government/central bank, R_t, plus domestic credit, D_t. Variable S_t is the spot exchange rate, defined as the domestic currency price of foreign currency. Equation (1.3) is the purchasing power parity, where an asterisk represents a foreign variable, while equation (1.4) is the interest parity condition, where a dot above a variable represents the rate of change of that variable with respect to time. Assuming perfect foresight, expected rate of depreciation is equal to the actual rate of depreciation. Since we are considering a small economy, foreign variables are treated as given exogenously. This allows us to normalize $P_t^* = 1$ and $i_t^* = 0$.

In this subsection, we assume that the spot exchange rate always adjusts to its equilibrium level instantaneously and costlessly. With no government intervention, the amount of foreign reserve is fixed and is denoted by $R_0 > 0$. The domestic credit is assumed to be increasing at an exogenously given rate of $\mu > 0$, i.e., $\dot{D}_t = \mu$.

The increase in domestic credit is the main feature of most currency crisis models. Several reasons can be used to explain why it increases, but the most common one is that

the government is running continuous deficits, and that these deficits are financed by printing money (increase in domestic credit).[3]

Combining equations (1.1), (1.3) and (1.4) together, we have

(1.5) $M_t = aS_t - b\dot{S}_t$.

The solution to equation (1.5) can be found to be

(1.6) $S_t = \alpha + \beta M_t$,

where $\alpha = b\mu\phi / a$, $\beta = 1/a$ and $\phi = 1/(a - R_0)$.[4] Substitute (1.2) into (1.6) to give

(1.7) $S_t = b\mu\phi^2 + \phi D_t$.

Two points about equation (1.7) can be mentioned. First, from the definition of ϕ, the exchange rate depends on the initial amount of foreign reserve. For any given value of D_t, S_t is an increasing function of R_0. Second, for a particular value of R_0, S_t is an increasing function of D_t. The latter point is illustrated graphically by line ABCE in Figure 1.1, which has a slope of $\phi \equiv 1/(a - R_0)$. The vertical intercept of the line, point A, equals $b\mu\,\phi^2$.[5] Suppose that initially at time $t = t_0$, the quantity of domestic credit is D_0. The corresponding exchange rate is represented by point B. As the domestic credit increases, the currency is devalued and the exchange rate moves up along the line BCE.

---

[3] This is what was observed in many Latin American countries, which experienced currency crises of various degrees in the seventies and eighties.

[4] To derive the solution, we conjecture that the solution of the following form: $S_t = \alpha + \beta M_t$, where α and β are constants over time. Differentiating both sides gives $\dot{S}_t = \beta\dot{M}_t$, which is combined with (1.2), after differentiation. Using the rate of domestic creation to simplify (1.5), and comparing this with the assumed solution form gives $\beta = 1/a$ and $\alpha = b\mu\phi / a$.

[5] Since the money supply is positive, $a - R_0 > 0$.

Note that because of the constant rate of increase in D_t, Figure 1.1 is a diagram showing the change in S_t with respect to time, with t represented by the horizontal axis.

Because D_t is changing at a rate of μ, the value of D_t at time t can be written as $D_t = D_0 + \mu(t - t_0)$. Using this equation, the exchange rate will change according to the following equation:

$$(1.8) \quad S_t = b\mu\phi^2 + \phi D_0 + \mu\phi(t - t_0).$$

Because the exchange rate given in (1.8) depends on the initial value of foreign reserve, we can consider an alternative rate that corresponds to another reserve level such as zero, i.e., $R_0 = 0$. Denote the corresponding rate by $\tilde{S}_t$, which is described by

$$(1.9) \quad \tilde{S}_t = \frac{b\mu}{a^2} + \frac{D_0}{a} + \frac{\mu}{a}(t - t_0).$$

The exchange rate in (1.9) is represented by line GHJ in Figure 1.1, which is below and less steep than line ABCE.

Suppose now that at time $t = t_0$, in an unanticipated move, the government raises the exchange rate from the prevailing level to a higher level and then fixes it there. In Figure 1.1, this policy can be represented by a jump of the exchange rate from point B to F instantaneously. As the domestic credit is increased, the movement of the exchange rate can be represented by the horizontal line $\overline{S}$ FCH.

When the exchange rate is fixed, $\dot{S}_t = 0$. Equation (1.4) implies that $i = i^* = 0$, so that equation (1.1) reduces to

(1.10) $M_t = a\bar{S}$,

i.e., the equilibrium stock of money is proportional to the given exchange rate. Therefore at the time when the government pegs the exchange rate, the economy accumulates foreign reserve and thus money by running a balance of payments surplus.

1.2.2. Domestic Credit Creation and Currency Crisis

Mexico in 1976 and Argentina, Brazil, Peru and Mexico in the early and mid-80s experienced various degrees of currency crises. These countries chose to peg their currencies against foreign ones. At some points they observed capital flight and speculative attacks on their currencies, which resulted in enormous pressure on the central bank to devalue their currencies.

Continuous government fiscal deficits had been attributed as one major factor of these currency crises. These deficits were financed mainly by printing money, i.e., through an increase in the domestic credit held by the central banks. As Salant and Henderson (1978), Krugman (1979), and Flood and Garber (1984) pointed out, there is an inconsistency between deficit financing policy and the policy of a fixed exchange rate. In the model described above, the money supply that equilibrates the money market is given exogenously.[6] An increase in the central bank's domestic credit will be matched by a drop in foreign reserve. Because the amount of foreign reserve held by the central bank is finite, the government cannot maintain a fixed exchange rate regime indefinitely. Krugman went on to argue that a crisis occurs when the central bank's foreign reserve reaches a minimum level. At this point, the government will have to devalue its currency or give up its fixed exchange rate policy.

---

[6] This feature is an important one in the Mundell-Fleming models of a small open economy with a fixed exchange rate and perfect capital mobility.

Let us make use of the simple model of exchange rate introduced earlier to explain such an inconsistency.[7] Let us assume that at some point, the economy is represented by point F in Figure 1.1, with the exchange rate fixed at $\bar{S}$, while domestic credit is increasing at a rate of $\mu > 0$. The increase in domestic credit means that point F shifts to the right along horizontal line FCH. However, by equation (1.10), the equilibrium money stock is fixed, meaning that as the economy is creating domestic credit, it is losing foreign reserve by running balance of payments deficits. In other words, because $\dot{M}_t = 0$, we have

$$(1.11)\quad \dot{R}_t = -\dot{D}_t / \bar{S} = -\mu / \bar{S} < 0.$$

Equation (1.11) suggests that the amount of foreign reserve at any time t is given by

$$(1.12)\quad R_t = R_0 - \bar{\mu}(t - t_0),$$

where $\bar{\mu} = \mu / \bar{S}$. The change in the foreign reserve over time as described by (1.12) is illustrated by line ABC in Figure 1.2.

If the foreign reserve changes over time according to (1.12), the central bank will run out of foreign reserve at time $t = t_z$, where t_z is obtained from the equation by setting $R_t = 0$:

$$(1.13)\quad t_z = t_0 + R_0 / \bar{\mu}.$$

At $t = t_z$, the value of domestic credit is

$$(1.14)\quad D_z = D_0 + \mu(t_z - t_0).$$

---

[7] The following model is based on Flood and Garber (1984).

In the present regime, the exchange rate is fixed, while the exchange rate function given by equation (1.9) can be interpreted as the "shadow" exchange rate corresponding to a given foreign reserve; for example, corresponding to R_0 the shadow exchange rate is illustrated by line ABCE in Figure 1.1. However, because the foreign reserve held by the central bank is declining over time, we can imagine that as the central bank loses foreign reserve, the shadow exchange rate line shifts to the right. When the foreign reserve drops down to zero, the shadow exchange rate line is GHJ, representing $\tilde{S}_t$.

For the time being, let us focus on the shadow exchange rate, $\tilde{S}_t$, that corresponds to zero foreign reserve. Using equation (1.9), $\tilde{S}_t = \bar{S}_t$ when $t = t_y$, where

$$(1.15)\quad t_y = t_0 + \frac{a^2\bar{S} - b\mu - aD_0}{a\mu}.$$

It is straightforward to show that $t_y < t_z$, as

$$t_z - t_y = \frac{\bar{S}R_0}{\mu} - \frac{a^2\bar{S} - b\mu - aD_0}{a\mu} = \frac{b}{a},$$

where equations (1.1) and (1.2) have been used. At $t = t_y$, the value of domestic credit is equal to

$$(1.16)\quad D_y = D_0 + \mu(t_y - t_0) = a\bar{S} - b\mu/a,$$

while the corresponding value of foreign reserve is

$$(1.17)\quad R_y = \frac{b\mu}{a\bar{S}}.$$

Obviously, because the amount of foreign reserve held by the central bank is limited, the present situation cannot continue indefinitely. Suppose that the government decides that this situation terminates when foreign reserve hits a minimum level such as zero, and that it gives up its fixed exchange rate policy and lets the currency float.[8] When the constraint is removed, the exchange rate becomes the same as the shadow rate.

If the floating of the exchange rate occurs when $t = t_z$, Figure 1.1 shows that the exchange rate will jump instantaneously up to S_z. By the assumption of a small open economy and the purchasing power parity, there will also be a corresponding jump in the domestic price level.

However, the discrete devaluation of the local currency represents a windfall capital loss for those people holding the local currency. If the devaluation is expected, as it is in the present model, investors will try to avoid it by acting earlier. Therefore, as Krugman (1979) and Flood and Garber (1984) point out, a currency crisis will occur before $t = t_z$, as investors are trying to sell the local currency to the central bank. In fact, as long as the shadow exchange rate corresponding to zero foreign reserve is higher than the pegged exchange rate, investors will have an incentive to sell local currency earlier to avoid the capital loss. This means that a crisis will actually occur when $t = t_y$, the time when the shadow exchange rate is equal to the pegged exchange rate. At this point, everyone is trying to sell the local currency for foreign reserve, until the central bank runs out of foreign reserve.

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[8] The same analysis applies even if the minimum level is positive, but it is usually assumed that this amount is less than R_y, meaning that the government will not consider giving up the regime before $t = t_z$.

This situation can also be illustrated in Figure 1.2. Line ABC, which represents equation (1.12), shows the change in foreign reserve in the absence of any speculative attacks. The foreign reserve drops down to zero at $t = t_z$. Speculative attacks at $t = t_y$ could cause a sudden depletion of the foreign reserve held by the central bank. The adjustment path of R_t could be ABE in Figure 1.2. Because devaluation occurs at $t = t_y$, the exchange rate will adjust along line FCH in Figure 1.1 and then up line HJ.

The above analysis is based on the assumption that the government will give up the fixed exchange rate regime when the foreign reserve becomes zero. A similar analysis can be provided if the government decides to give up defending the exchange rate at another reserve level, R^*, where $R_0 > R^* > 0$. Corresponding to R^*, there exists a shadow exchange rate, which can be represented by a positively sloped line (not shown) that lies between ABCE and GHJ in Figure 1.1. The above analysis shows that speculative attacks and a crisis occur at $t = t' < t_y$. Since the same analysis holds for all foreign reserve levels $R < R_0$, there exist multiple equilibria, as Sen (1998) argues, in the sense that a crisis can occur any time between t_0 and t_y, depending on what the minimum foreign exchange people think the government must have before giving up the fixed exchange rate regime. In this case, what matters is what people think about the minimum foreign reserve the government would want to have, not what the government actually wants to have. This means that the currency crisis can be self-fulfilling.

One of the weak points of the above theory is that the government is treated in an ad hoc way. First, the rule of deficit financing assumed is too rigid, even though it cannot be sustained in the long run. Second, while investors actively try to maximize the returns to the assets they hold, the government is too passive, even though it is clear that the central bank is going to lose all its foreign reserve at $t = t_y$. For example, what prevents the government from giving up the fixed exchange rate regime just a short time before t_y? If the government does that, it can save the remaining foreign reserve.

One of the implications of the above theory is that the exchange rate will adjust smoothly when the exchange rate regime shifts from a fixed to a flexible one. However, in practice, many countries that were hit by a financial crisis experienced a quick, unexpected, and sufficient devaluation of their currency.

The ruling out of discrete jumps in the exchange rate in the above models is partly due to perfect information, but introducing uncertainty may not be sufficient to explain why countries that let go their exchange rates during a currency crisis face big devaluation of their currencies in a short time. Krugman (1979) and Flood and Garber (1984) considered two models with uncertainty. In the former, the local government may want to spend a fraction of its foreign reserve on defending the currency with certainty, while spending the rest of the reserve on defending the currency has a positive probability less than unity. The investors will then purchase all the reserve that is committed to defending the currency with certainty at the time when the pegged exchange rate is equal to shadow exchange rate corresponding to the remaining reserve. They then wait and see whether the government spends the rest of the reserve. If it does not, the exchange rate becomes flexible and follows continuously the path of the shadow exchange rate. If it does, the confidence of the investors returns, and they will sell the reserve back to the government, and hold the local currency. The fixed exchange rate regime is maintained, until the next crisis occurs, when the pegged exchange rate is equal to the shadow exchange rate corresponding to zero reserve.

In the uncertainty model of Flood and Garber (1984), the domestic credit creation rule is uncertain, and the investors do not know with certainty whether in the next period the shadow exchange rate will be higher or lower than the pegged exchange rate. However, since the cost of holding foreign reserve is zero, investors can simply purchase foreign reserve from the government just before each period, wait and see whether the exchange rate will become flexible. If it does not, investors can simply sell the foreign reserve they hold back to the government.

1.3. SPECULATIVE EXPECTATIONS AND SELF-FULFILLING CRISES

While the model of currency crisis presented in the previous subsection shows the inconsistency between continuous creation of domestic credit and a fixed exchange rate, it has been pointed out that a currency crisis can also occur without the financing of fiscal deficit through domestic credit creation. The crisis that appeared to be strange is the experience of certain European countries in 1992 – 1993. During this period of time, while maintaining fixed exchange rates, these countries faced severe speculative attacks on their currencies. In August 1993 member countries of the European Monetary System gave in and allowed more flexibility in their exchange rates, permitting their currencies to move within a band of ± 15 percent instead of ± 2.25 percent for most Exchange Rate Mechanism (ERM) rates. However, it is interesting to note that two years later the prices of some of these currencies were at a level approximately the same as before. This means that these European countries were not having any obvious macroeconomic troubles and that currency crises can arise even when economies have sound macroeconomic fundamentals. In other words, these countries do not have the features that are described by the first-generation models.

Looking at the breakdown of the ERM, Obstfeld (1994) suggests the following features of the crises experienced by these European countries:

1. There are reasons why the government wants to abandon the peg (to inflate away the debt burden denominated in domestic currency, and to follow expansionary monetary policies in case of unemployment, etc).

2. There are reasons why the government wants to defend the peg, hence a conflict between the two (to facilitate international trade and investment, to gain credibility if has a history of high inflation, and as a source of national pride or commitment to an international cooperation).

3. The cost of defending the peg rises when people expect the peg would be abandoned, because people *in the past* expected that the exchange rate would be depreciated *now*. Hence, anticipation of devaluation makes the debt-holders and worker unions in the past demand higher interest rate and wages, making debt-burden too high and industries uncompetitive at the current exchange rate level.

The important trigger of a crisis is the expectation of people. If they expect that the currency is going to be devalued in the near future, they could expect enormous pressure on the central bank even though the conditions of the economy are solid. Such expectations may lead them to convert their domestic currency to foreign currency before the devaluation. If sufficient number of people do that with large sums of domestic currency, the central bank could run out of foreign reserve and has to devalue the currency. In this case, the crisis is self-fulfilling. Often the models that emphasize the above characteristics are called the *second-generation* models.

Suppose that the central bank currently owns foreign reserve $R_0 > 0$, and the exchange rate is pegged at $\overline{S}$. Suppose now that currency speculators believe that there is a positive probability that the government will devalue the currency in the near future. Specifically, suppose that the government will let the currency go if the foreign reserve runs down to a minimum level, such as zero, and that the flexible exchange rate will then be equal to the shadow rate.[9]

If the speculators have the resources and choose to purchase all the foreign reserve held by the central bank, the government will give up its fixed exchange rate policy, and the exchange rate will jump up to $S_1 > \overline{S}$.

[9] When the exchange rate is expected to devalue, the domestic interest rate will rise.

In terms of the resources held by the speculators, Obstfeld (1996)[10] identifies three different cases: (a) when the total resources of the speculators are less than R_0; (b) when the resource of each speculator is greater than R_0; (c) when none of the speculators has resources greater than R_0, but when two or more of them combined will have resources greater than R_0. In case (a), devaluation will not occur. In case (b), devaluation will occur when any one of the speculators purchases R_0 from the central bank, causing devaluation. In fact, all of them will try to be the first to do so. The total profit accruing to the speculators is $(S_1 - \overline{S})R_0$.[11]

Case (c) is the most interesting one. If people believe that the government is going to keep the prevailing exchange rate and if they believe that there are not enough speculators attacking the exchange rate, then none of them will choose to purchase foreign reserve from the government. If, however, for some reasons they believe that the exchange rate is going to collapse, they will sell the local currency, putting pressure on the government, which will eventually be forced to give up defending the exchange rate.[12]

The above model and the type of crises described in case (c) have two important features. First, the outcome depends very much on people's expectation: If they believe that the government will keep the prevailing exchange rate, they will take no speculative actions and the exchange rate regime will survive indefinitely; if, however, they believe that the government is going to devalue, they will acquire foreign reserve from the government,

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[10] In this model, Obstfeld assumes that there is a transaction cost involved in converting domestic currency into foreign currency.

[11] In the above model, the government has no choice but to give up the initial fixed exchange rate regime when it runs out of foreign reserve, while it is able and will choose to defend the initial exchange rate regime if it has at least some reserves. In a more sophisticated model used in Obstfeld (1994, 1996a), the loss function of a government is stated, which depends on people's expectation, the prevailing fixed exchange rate, the chosen exchange rate, and the cost of giving up the regime in terms of the loss of credibility. In such a model, foreign reserve is not stated explicitly, and the government chooses the exchange rate to minimize the loss function. See also Krugman (1996), Kehoe (1996) and Obstfeld (1996b).

which eventually will not be able to resist the pressure and have to devalue. In this sense, the crisis is said to be self-fulfilling.

Another feature of the above type of crisis is that the time when a crisis occurs is indeterminate because it all depends on the expectation of the people. So it can occur now or sometime in the future.

Krugman (1996) challenges the indeterminacy feature of the model. He considers a model with deteriorating fundamentals in the economy, and argues that the timing of devaluation can be predicted and multiple equilibria can be removed. To illustrate his idea, we can make use of the model analyzed in the previous two sections. In the small, open economy considered, suppose again that the government runs continuous deficits, which are financed with domestic credit creation. As explained above, this fiscal policy is inconsistent with the policy of a fixed exchange rate.

Suppose that for time t, $t_y < t < t_z$, the government holds a foreign reserve of R_t given by,

(1.18) $0 < R_t < R_y$,

where $R_y = b\mu / a\bar{S}$ is the amount of foreign reserve of the government when the shadow exchange rate $\tilde{S}$ (corresponding to zero foreign reserve) is equal to the prevailing fixed exchange rate. (Refer to Figure 1.2.) As explained earlier, the fixed exchange rate regime is defeatable in this period. In fact, as every speculator is aware of the fact the currency is overvalued, they will purchase foreign currency until the government runs out of foreign reserve, and devaluation follows. In the terminology of the second-generation models, the crisis is self-fulfilling: If the speculators do not purchase foreign reserve from the government, the fixed exchange rate regime can be maintained, but since they all expect

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[12] If the speculators can collude, the fixed exchange rate regime will not survive, but this will reduce to

that the currency will devalue and buy foreign reserve, the government is forced to devalue.

Krugman (1996) makes two points. First, the above type of self-fulfilling crises occurs only for certain values of parameters, not for all of them. For example, if at time t the government has a sufficient amount of foreign reserve, say, $R_t > R_y$, then no crisis occurs because the currency is undervalued. Krugman also challenges the indeterminacy of timing of a crisis in the self-fulfilling model. The crisis will occur at $t = t_y$.

In responding to Krugman's criticism, Kehoe (1996) and Obstfeld (1996b) point that the new crisis models do not assert that every fixed exchange rate regime must be subject to a self-fulfilling crisis, and that while it is argued that a self-fulfilling crisis can occur even though a fixed exchange rate can be sustained in the absence of speculation, there is no denial that deteriorating fundamentals can lead to a crisis and can eliminate multiple equilibria and indeterminacy of timing of a crisis. Furthermore, speculative attacks can take advantage of some temporary problems faced by an economy, causing a crisis that has nothing to do with the long-run sustainability of a fixed exchange rate regime.

Despite these differing views of a currency crisis, the second-generation models do draw people's attention to the importance of speculative attacks and their pressure on the government in trying to maintain a fixed exchange rate regime. One message brought by Krugman is that in many cases speculative attacks do not appear out of the blue, and can in fact be traced to some deteriorating fundamentals of an economy.

On the empirical side, when given a crisis it is difficult to say whether the crisis is mainly due to some fundamental problems in the economy or whether the crisis should not have occurred if speculative attacks are absent.

1.4. TWIN CRISES: BANKING AND EXCHANGE RATE CRISES

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case (b). For the present analysis, we ignore this possibility.

The new generation models emphasize the importance of financial sector and capital flows in currency crises. Hence, the term **"twin crises"**. The frequent occurrence of twin crises (Nordic countries in 1990s, Turkey in 1994, Venezuela, Argentina and Mexico in 1994, Bulgaria in 1996, and Asian countries in 1997) has been a result of banking crisis precipitating a currency crisis, either by an increase in money supply, or by a large scale withdrawal leading to a decrease in money demand. The causation between the balance of payments and banking crises is, however, debatable. Stoker (1995) and Mishkin (1996) argue that ***balance of payments crisis leads to banking crisis***. According to Stoker, an external shock, coupled with commitment to fixed exchange rate, leads to loss of reserves. If this loss of reserves is not sterilized, then a speculative attack is followed by a period of abnormally high interest rates leading to credit crunch, increased bankruptcies and financial crisis. Mishkin argues that devaluation could weaken the position of the banks if they have a large share of their liabilities denominated in foreign currency. However, Diaz-Alejandro (1985), Velasco (1987), Calvo (1995) and Miller (1995) argue that ***banking crises lead to balance of payments crises***. The argument is that central banks bailout financial institutions by printing money, and this erodes their ability to maintain the prevailing exchange rate commitment. But Reinhart and Vegh (1996) suggest that the ***two crises have some common causes***—an example of "perverse" dynamics of an exchange rate based inflation stabilization plan. Since prices are slow to converge to international levels, exchange rate appreciates markedly. Initially, there is a boom in imports and economic activity, which is financed by borrowing abroad. This leads to a widening of current account deficits and financial markets infer that stabilization program is unsustainable, hence the currency is attacked. The increase in bank credit during the boom is financed by foreign borrowings, when capital flows out and asset market crashes, it leads to the collapse of the banking system as well. McKinnon and Pill (1996) show that financial liberalization along with some microeconomic distortions—like implicit insurance deposits—can make boom-bust cycles more pronounced as they lead to lending boom that leads to the eventual collapse of banking system. Goldfajn and Valdes (1997) show that changes in international

interest rates and capital inflows are amplified by the intermediating role of banks and how these swings may produce business cycles that ends in bank runs and financial and currency crashes.

However, the stylized facts that these models tend to explain are: (Goldfajn and Valdes, 1997 and Kaminsky and Reinhart, 1996)

1. Banking crises are highly correlated to currency crises.
2. Capital inflows increase steadily before the crisis and fall sharply during the crisis.
3. Banking activity (intermediation) increases some time before the collapse.

Goldfajn and Valdes (1997) model the interaction of liquidity creation by financial intermediaries with capital flows and exchange rate collapses in a two time-period framework, hence focussing on the role of the financial intermediaries in the currency crises. These intermediaries provide liquidity, which is attractive to foreign investors with short-term incentives for investment, hence helping in capital inflows. However, due to any exogenous shocks, when the foreign investors want to withdraw their deposits, these intermediaries, being locked in illiquid assets, face the risk of failure. Hence, a bank run leads to capital outflows and currency collapse. Their model provides role for the banking system in magnifying the shocks to fundamentals (productivity and interest rates), but does not assume any kind of inconsistency in policy making, like the first and second generation models.

Some of the important results from their model are:

1. Under intermediation, the probability of a run will be positive and non-decreasing with respect to international interest rate.
2. There are proportionally more capital outflows with intermediaries in period 1.
3. There is a trade-off in the sense that intermediation may generate larger inflows, but, at the same time, a higher probability of a run against the country.
4. If devaluations are expected, runs against the intermediary are more likely.

5. The intermediation process generates a transmission and amplification mechanism in which small shocks translate into larger effects.

Chang and Velasco (1998b) dwell on an open economy version of Diamond-Dybvig (1983) model—where banks transform maturities, i.e., accept liquid deposits and invest in illiquid assets. This risk pooling enhances welfare, but also makes self-fulfilling bank runs possible. In their model, international illiquidity is the root cause of the financial crisis. Their story is more relevant for emerging markets as banks play a much larger role in emerging markets than in mature economies, and banks in emerging economies have limited access to world capital markets. Hence, illiquidity plays a much bigger role in emerging market crises. The main arguments from their paper are summarized below:

1. Capital flows from abroad can magnify the illiquidity problem, especially when these foreign loans are of short maturity.
2. Financial liberalization accompanies mismatch between assets and liabilities, which makes illiquidity problem even worse.
3. There is a rise in price of assets that are in inelastic supply (land, real estate) as foreign capital flows are intermediated by the financial system, and the prices fall in case of a bank collapse.
4. Unsound policies—like government guarantees, subsidies, etc—increase the fragility of the banking system.
5. A twin crisis is observed—central bank could either keep rates of interest low or provide lender of last resort funds to prevent a bank crisis. However, agents use these additional funds to buy reserves, leading to the collapse of the fixed exchange rate.

Chang and Velasco (1998c) again extend the Diamond-Dybvig model to an open economy to study financial fragility, exchange rate crises and monetary policy. In particular, they consider three exchange rate regimes—currency boards, fixed exchange rates with Central bank credit to commercial banks and flexible exchange rates. Their main results can be summarized as:

1. Self-fulfilling bank runs (rather than currency runs) are more likely under a currency board.
2. However, a fixed exchange rate with positive central bank credit to commercial banks is more prone to bank runs than a currency board. (Intuition: with exchange rate being fixed, the liabilities of the banking system are denominated in foreign currency. If the banking system's liabilities are greater than its international liquid assets, a bank run is likely. When the central bank gives credit to commercial banks, the gap between the assets and liabilities of the banks is greater than under a currency board; hence bank runs become more likely.)
3. If the central bank fixes the exchange rate **and** acts as a lender of last resort, then balance of payments crises become more likely (as the central bank prevents bank runs at the cost of losing reserves in the event of bank runs).
4. The combination of flexible exchange rate and a lender of last resort rules out self-fulfilling bank runs. (Intuition: Under fixed exchange rate, people run to withdraw domestic currency to buy dollars at the central bank. If a depositor expects that in the event the central bank would run out of reserves, then she will run as well, and hence the pessimistic expectations become self-fulfilling. However, under a flexible exchange rate regime, with the central bank acting as a lender of last resort, commercial banks always have enough domestic currency for those who want to withdraw. Since the central bank has no compulsion to sell all the available reserves, those who run face a depreciation, while those who don't run know that they could buy dollars at a later date. Hence, bank run doesn't occur, pessimistic expectations don't become self-fulfilling and depreciation of the currency does not happen.)
5. However, the benefits of the flexible exchange rate regime vanish if deposits are dollarized—as the central bank can no longer act as a lender of last resort.
6. An increase in capital inflows increases the likelihood of run equilibrium under fixed exchange rate regime.

1.5. HERDING AND CAPITAL FLIGHT

In this section, we turn to another explanation of the existence of currency crisis: herd behavior. Herding, which is an example of information cascade, is said to exist when individuals tend to choose actions similar to previous actions chosen by other individuals. In other words, with herding effects, individuals tend to move in conformity, and a small shock to society could lead to a mass shift in the actions of people. In some special cases, people can choose to give up the private information or signals they possess and follow the actions of others, even though the private information or signals they have would suggest them to act otherwise.

A famous example is Keynes' beauty contest example.[13] Earlier work includes the papers by Leibenstein (1950) on the bandwagon effects. Recently, more rigorous models have been suggested to explain herd behavior.[14] Several models that have been introduced to explain investment behavior are mentioned here.

Froot, et al (1992) show that speculators with short horizons may herd on the same information, trying to learn what the other informed traders know. These could lead to multiple equilibria, and herding speculators may even choose to study information that is completely unrelated to fundamentals. So, the large perceived penalty for missing a bull market leads managers to follow the pack even if fundamentals do not warrant it; conversely, the penalty of losses during the bear market are lower as all other managers are losing money as well.[15]

Krugman (1998a) suggests similar reasons why herding might occur. First, there is a bandwagon effect, which is driven by the awareness that investors have private information—where investors ignore their own information and thrive on the information of other investors. It has been argued that bandwagon effects in markets with private information create a sort of "hot money" that at least sometimes causes foreign exchange

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[13] In a beauty pageant, a judge picks up the girl who he thinks others would pick, rather than who he considers to be the most beautiful.

[14] See, for example, Banerjee (1992), Bikhchandani, et al (1992), and Froot, et al (1992).

markets to overreact to news about national economic prospects. Second, much of the money invested in crisis-prone countries is managed by agents rather than directly by principals—where the principal-agent problems arise.

Chari and Kehoe (1997) link debt-default actions of the governments to herding behavior. In their model, investors have private information about the state of the economy and have priors about the competence of the government. The credibility of the government is built on its ability to pay its debts—the government is competent if it could repay foreign debt in a crisis state. If the prior that the government is competent is either very high or very low, then the investors ignore their private information and either lend or not lend, respectively. If the prior is in the intermediate range, the possibility of herding arises. In this range, capital flows are very sensitive to small pieces of information and hence volatile.

The above models usually assume sequential actions by individuals, so that those who take actions later will observe what actions others have taken previously. Calvo and Mendoza (1998) introduce a model in which herding can exist even when individuals have simultaneous decision making. They find that with informational frictions, herding behavior may become more prevalent as the world capital market grows. With globalization, the cost of collecting country-specific information to discredit rumors increases and managers, facing reputational costs, choose to mimic the market portfolio.[16] Hence, small rumors can induce herding behavior and move the economy from a no attack to an attack equilibrium.

Herding is a type of distortion in the economy in the sense that the actions of some individuals can produce externality. This has two implications, both are important in

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[15] As Krugman (1998a) puts it: "I feel worse if I lose money in a Thai devaluation when others don't, than I will if I lose the same in the general rout."

[16] The details in country credit ratings (CCRs) are assumed to be costly. They find an empirical regularity about the CCRs that new information changes the perceptions of investment conditions significantly in emerging markets than in developed and least developed countries. Also, information gathering requires

explaining the occurrence of a crisis. First, the actions of a limited number of individuals may produce at best some limiting adverse effect on an economy. The same action of a large number of individuals can make a possible damage unbearable. For example, Obstfeld (1996) argues that in some cases, the attacks by a limited number of speculators on the local currency will not do much harm, as the central bank has enough foreign reserves to defend the peg. However, if a large number of speculators launch similar attacks, the central bank could run out of reserve and the country could face a crisis. Another example is the current crisis in Asia. For countries like Thailand or South Korea, failure of firms in the economy is nothing strange, and as long as the number of failures during any period of time is limited, the economy usually has the capacity to absorb these losses. However, if widespread failures exist at about the same time, huge bad loans can be created, and financial institutions could face repayment problems if the money originally comes from abroad.[17] Furthermore, if the values of bad loans were not high, these financial institutions can borrow more to ease the cash flow problem, but if the bad loans are high, it is difficult to borrow such large amounts in a short time.

Another externality created by herding is that while certain massive actions may hurt the economy, these actions could be entirely rational from individuals' point of view.[18] Such rational behaviors occur when there are payoff externalities (payoffs to an agent adopting an action increases as the number of agents adopting that action increases) or principal-agent problems (managers have an incentive to hide in the herd so that their actions cannot be evaluated).

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larger adjustments in mean and variance of the returns on assets in emerging markets than in OECD countries.

[17] For example, Thailand passed the Bangkok International Banking Facility in 1992, allowing domestic banks and financial institutions to borrow from abroad to finance local investment projects. As capital was available in other countries at very low interest rates, the new policy of Thailand led to huge inflow of foreign capital. Much of this money went to the housing/real estate sector, creating big jumps in supply. When these investments went sour, bad loans were created and these banks and financial institutions did not have the money to repay the loans they borrowed from aboard. The worst part was that most of these foreign loans were denominated in foreign currency such as the yen or the dollar, and usually no hedging against currency depreciation had been made. When the Thai baht was devalued, these financial institutions suffered double hits.

[18] Interested readers are referred to Devenow and Welch (1996) for a summary on rational herding literature.

Of course, as Flood and Marion (1998) argue, in many cases, herding could explain some part of the currency crises in Asia, but not the whole. First, individuals are less likely to ignore their own or new information in a world where they can adjust their strategies continuously to new information. Second, in case strategic interactions are important, then the cascade story is unsatisfactory, because the potential capital gains arising from the action of one agent does not depend on actions chosen by others.

Wong (1998) applies herding behavior to provide a theory of the formation of bubbles in the housing market in case of Thailand, and explains how the bubbles had caused some of the troubles in the economy. When the growth in the economy creates rising demand for housing, investors respond with higher supply. Consecutive periods of high growth reward the more optimistic and aggressive investors with huge profits. These profits and successes prompt pessimistic investors to revise upward their beliefs of the future and become more aggressive. More firms enter the market and ride the bandwagon. Bubbles are then formed when (a) investors get too optimistic; or (b) a widespread failure and bankruptcy of firms in the housing market creates big losses to financial institutions, which in turn could not repay their foreign debts; or (c) a widespread failure and bankruptcy of firms in the housing market creates pessimism and panics in the economy, prompting capital flight and speculative attacks on the domestic currency.

Backus, Foresi and Wu (1998) argue that liquidity crunch is the main cause for contagion in financial markets. Periods of high growth, high savings rate and huge capital inflows lead to excessive investments in illiquid sectors (such as real estate), and hence reduce the liquidity of the banking sector. When these investment decisions turn sour, the most inefficient banks first go bankrupt. These bankrupt banks, along with capital flight, generate a liquidity crunch, and contagion spreads to the otherwise healthy banks.

1.6. MORAL HAZARD AND FINANCIAL CRISES

Moral hazard can occur under asymmetric information because borrowers can alter their behavior after the transaction has taken place in ways that the lender regards as undesirable. In financial markets, however, moral hazard could occur in the absence of asymmetric information; i.e., moral hazard arises from the possibility that investor behavior will be altered by the extension of government guarantees that relieve investors of some of the consequences of risk taking.

Krugman (1998b) and Corsetti, et al (1998) have proposed moral hazard as a possible explanation for currency crises, especially the Asian crisis of 1997. Krugman considers a case of over-guaranteed and under-regulated financial intermediaries. Since these institutions do not have to put any capital up-front, and have the liberty to walk away at no personal cost in case of bankruptcy, the economy engages in excessive investment. This economy is made worse off by globalization. If it did not have access to world capital market, then excessive investment demand by these intermediaries would show up as high rates of interest, and not as excessive investment. But access to world market allows the moral hazard in the financial sector to translate into real excess capital accumulation.

Corsetti, et al (1998) also recognize moral hazard as a source of over-investment, excessive external borrowing and current account deficits. Unprofitable projects and cash shortfalls are re-financed through external borrowing as long as foreign creditors lend to domestic agents against future bail-out revenue from the government. The government deficits need not be high before the crisis, but refusal of foreign creditors to re-finance the debt forces the government to step in and guarantee the outstanding stock of external liabilities. The government might recourse to seigniorage revenues. Expectations of inflationary financing thus cause a collapse of the currency and anticipate the event of a financial crisis.

In fact, the argument of moral hazard is not only applicable to the intermediaries, but also to the governments. Proponents of moral hazard argue that IMF creates bailout for the governments or investors in the event of a crisis.

However, Radelet and Sachs (1998) do not see the current Asian crisis as a result of carelessness on the part of the investors because they were sure to be bailed out in a crisis. First of all, only state-owned enterprises can be bailed out in a crisis. According to Radelet and Sachs, if the creditors feared a risk of a crisis in Asia, then spread on Asian bonds should have increased, but it did not. If the creditors felt an increasing risk of government-led bailout, then ratings of long term government bonds should have gone down, but they did not either. A large part of the investment went into the risky equity market, and bank loans went to non-financial corporate sector, where the direct government bailout was least possible. Creditors have been aware of weak bankruptcy laws and ineffective judicial systems in Asia. Hence, the foreign investors lent because they anticipated these economies to perform well, and not because they believed that they would be bailed out.

1.7. PREDICTABILITY OF CRISES[19]

There are different definitions of crisis that have been used in empirical literature. Some papers use a narrow definition of crisis as a ***devaluation of exchange rate***.[20] Other papers use the term crisis in a broader sense, i.e., as ***an increase in Market Pressure Index (MPI)***[21]. It is constructed as follows:

$$(1.19)\quad MPI_{i,t} = \frac{(\%\Delta e_{i,t})}{\sigma_{\Delta e_{i,t}}} + \frac{(\Delta i_{i,t})}{\sigma_{\Delta i_{i,t}}} - \frac{(\%\Delta r_{i,t})}{\sigma_{\Delta r_{i,t}}}$$

[19] For a comprehensive review on empirical literature, see Kaminsky, Lizondo and Reinhart (1997).

[20] Edwards (1989), Edwards and Montiel (1989), Edwards and Santaella (1993) and Frankel and Rose (1996)

where e is the bilateral exchange rate of country "i" with US or Germany; i is the interest rate in country "i" and r is the non-gold international reserves that the central bank has; the changes in exchange rate, interest rate and reserves are weighted by their respective standard deviations. This index is high when there is pressure on the currency and low otherwise. The intuition is that if there is an attack on the currency, either the exchange rate would depreciate, or interest rate would be raised to ward off the attack, or the central bank would sell foreign currency to support the exchange rate. Most papers use probit or logit analysis, where the dependent variable is a discrete measure of crisis, which is also the probability of a crisis. For example, Eichengreen, Rose and Wyplosz (1996a) define the dependent variable as:

$$(1.20)\quad DUMMPI_x = 1 \; if \; MPI_x > \mu_{MPI_x} + 1.5 * \sigma_{MPI_x}$$

where μ is the mean of the MPI in country x, and σ is the standard deviation of MPI.

Kaminsky and Reinhart (1996) construct the MPI as a weighted average of exchange rate changes and reserve changes, and define crisis as:

$$(1.21)\quad DUMMPIx = 1 \; if \; MPIx > \mu_{MPIx} + 3 * \sigma_{MPIx}, \; 0 \text{ otherwise}$$

The exclusion of incidents of speculative pressure on the exchange rate below the arbitrary threshold value has the disadvantage of introducing sample bias into the estimation procedure. Flood and Marion (1998) argue that many models of speculative attack indicate that unanticipated devaluations produce the largest jump in the MPI. The size of jumps in the MPI at the time of attack is reduced by the extent to which the attack is anticipated. Thus, selection of only extreme values of the MPI (as in construction of the dependent variable for probit models) may reduce the share of predictable crises in the sample and reduce the number of crises that are likely to be correlated with

[21] See Eichengreen, Rose and Wyplosz (1996), Sachs, Tornell and Velasco (1996), Kaminsky, Lizondo and Reinhart (1997) and Cerra and Saxena (1998) for construction of this variable.

fundamental economic determinants. Cerra and Saxena (1998) use Markov Switching Models (MSMs), which make the probability of a crisis continuous and endogenous.

Radelet and Sachs (1998b) define a financial crisis as a ***sharp shift from capital inflow to capital outflow between year t-1 and year t.***

A banking crisis could be defined in either of the two ways: financial distress meaning a situation of insolvency of banks, or financial panic referring to illiquidity in the banking sector. A run on the bank occurs when individual depositors withdraw money from the bank because they fear that "other depositors" are withdrawing money, and not because banks have made bad investments. This immediate withdrawal of funds by all depositors makes the banks illiquid, and the bank run a success.

Kaminsky, Lizondo and Reinhart (1997), Kaminsky and Reinhart (1996) and Kaminsky (1998) use the signals approach, where the idea is that economy behaves differently during crisis and tranquil times. The events that start a crisis will be present in "the leading indicators" before the actual crises and thus will help predict currency crises. This approach involves monitoring the evolution of a number of economic variables to find whether the variables are behaving in an anomalous way and thus are "signaling" a future crisis. This approach involves specifying a "threshold", beyond which the variable sends a "signal" of future crisis—the signal could be an accurate one or give a "false alarm". The 24-month before the crisis erupts is defined as "crisis" times, while the rest of the months are defined as "tranquil" times. The choice of threshold determination involves striking a balance between Type I (Rejecting H_0 when H_0 is true) and Type II (Accepting H_0 when H_0 is false) errors. The sizes of the errors are α and β, respectively. If α is 0 (the threshold is too lax), then the indicator will catch all the crises, but will give lots of false signals (noise). If β is 0 (the threshold is too tight), the indicator will never issue a false signal, but it will miss all the crises. Hence, for each variable, the critical region is selected so as to minimize the noise-to-signal ratio:

(1.22) Noise-to-signal ratio = $\frac{\beta}{1-\alpha}$

where $(1-\alpha) = \frac{\text{number of months with good signals}}{\text{number of months in the crisis window}}$

$$\beta = \frac{\text{number of months with bad signals}}{\text{number of months outside the crisis window}}$$

where goods signals are the signals inside the crisis window and bad signals are the signals that are outside the crisis window, and the crisis window is the 24-months preceding the crises.

The most common leading indicators used in the literature are:

1. Over-borrowing cycles: M2 multiplier, domestic credit/GDP, financial liberalization;
2. Bank runs: Bank deposits;
3. Monetary Policy: "excess" M1 balances;
4. Balance of Payments problems: exports, imports, terms of trade, real exchange rate, reserves, M2/reserves, real interest rate differential, world real interest rate, foreign debt, capital flight (deposits of domestic residents in BIS banks) and short-term foreign debt/total foreign debt;
5. Growth slowdown: output, domestic real interest rate, lending /deposit rate ratio, stock prices.

The following shocks signal vulnerability to a crisis:

1. Since crises are preceded by over-lending cycles, signals are associated with large positive shocks to the M2 multiplier, the domestic credit /GDP ratio, excess real M1 balances, M2/reserves, and high levels of foreign debt.
2. Problems in the capital account can worsen if foreign debt is concentrated at short maturities and there is capital flight. So large positive shocks to these indicators are associated with possible future crises.

3. Large positive shocks to the lending/deposit interest rate ratio and to real interest rates are taken as signals of crises.
4. Large negative shocks to deposits warn of future financial fragility.
5. The weak external sector is captured by large negative shocks to exports, the terms of trade, the real exchange rate and reserves and large positive shocks to imports, the real interest rate differential, and the world real interest rate.
6. The recessions are captured by large negative shocks to output and to the stock market.

1.8. CAPITAL CONTROL: A REMEDY?

The current crisis in Asia has renewed an old debate on whether a country, especially the emerging economies like Thailand, Malaysia, and Indonesia, should limit the inflow and outflow of capital as its economy is growing. People are alarmed by the size of the speculative attacks on local currencies of these countries and the possible damages caused by a sudden outflow of capital on the central bank's foreign reserve stock and the financial and real sides of the economy. All these countries, after months of attacks on their currencies and massive depletion of the reserve stocks, eventually gave up their fixed exchange rate regimes. In the nineties, while these countries were growing impressively, they attracted large amounts of capital from investors all over the world. In 1997, as the prospect of devaluation became more and more likely, everyone tried to move his/her capital out of these countries as soon as possible. That created a huge swing in the direction of movement of capital. While in 1996, the 5-Asian economies (South Korea, Indonesia, Malaysia, Thailand and the Philippines) received net private capital inflows amounting to $93billion, in 1997, they experienced an estimated outflow of $12.1billion, a turnaround in a single year of $105billion, amounting to more than 10% combined GDP of these economies (Rodrik 1998).

The ease of capital movement across the borders of the countries, which was at a time regarded as the main reason for attracting capital which is used for domestic investment

and growth, allowed foreign investors to move their capital out in 1997, and facilitated speculative attacks. It was therefore straightforward to blame these currency speculators and question the wisdom of allowing capital movement in the first place. In fact, Malaysia was the first country in the current crisis (and the only one so far) to turn to a strict control on inflow and outflow of capital.[22]

In the following sections, we will present several issues about capital control and arguments for and against capital control. Before we do that, let us present some background material.

1.8.1. Capital Account Liberalization and Currency Crises[23]

As mentioned above, in the Mundell-Fleming model for a small open economy with a fixed exchange rate and perfect capital mobility, the money supply that equilibrates the money market is given exogenously. This means that such an economy has no independent monetary policy. Any attempt by the central bank to raise the domestic interest rate above the world rate (plus a risk premium) will invite foreign capital inflow while any attempt to lower the domestic rate below the world rate will lead to capital outflow. On the other hand, if there is a change in the world interest rate, the domestic rate has to change accordingly. As a result, it is argued that there is inconsistency between the policy of simultaneous currency pegging and capital account liberalization for small open economies.

As a matter of fact, all the Asian and Latin American countries that experienced currency crises had various degree of capital account liberalization prior to the crises. A good example is Thailand. The passage of the Bangkok International Banking Facility in 1992 had resulted in a surge in foreign debts, a significant percentage of which went to the

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[22] Malaysia adopted this new policy on September 1, 1998.

[23] IMF (1998) provides further discussion of the theoretical links between capital account liberalization and financial crises.

housing market. The eventual collapse of the housing market has contributed to the crisis in 1997.[24]

In trying to apply the Mundell-Fleming model to explain the link between capital account liberalization and currency crises for these Asian and Latin American countries, three related points can be noted. First, for most countries, capital mobility is far from perfect: There are transactions costs, information asymmetry, heterogeneity between domestic and foreign assets, and administrative requirements. Because of the friction caused by these factors, domestic monetary policy can be effective, and domestic interest rates can deviate from foreign interest rates.

Second, not all currency crises reflect inconsistent domestic policies. As the second-generation models emphasis, crises can be self-fulfilling. This seems to be what the ERM breakdown of 1992 suggests.

Self-fulfilling currency crises can be due solely to the actions of speculators, but the existence of domestic difficulties and huge external debts can also trigger self-fulfilling crises. In particular, when an economy is showing signs of difficulties, investors would want to move their capital out of the country and foreign lenders would refuse to provide more loans.

Third, most of these countries experienced not only a currency crisis but also a bank crisis. With the imperfection of and lack of sufficient supervision in the domestic banking system, the ability of domestic banks and financial institutions to borrow from abroad makes the economy vulnerable. Both overborrowing (from abroad) and overlending (to domestic investors) could occur, and any widespread failure of some important sectors could trigger loss of investors' confidence, bank run, and financial crisis. On the other hand, if the problems of the domestic financial institutions are confined to the domestic economy so that foreign lenders regard these problems as short term, domestic financial

[24] See Wong (1998) for a theoretical model.

institutions could raise new capital from abroad to help them solve the illiquidity problems.

1.8.2. A Historical Look at the Capital Account Liberalization

Exchange rate restrictions were unheard of in the period before World War I. Even during the war, pressures on exchange rate were easily avoided by official reserve holdings and credit operations. The stabilization of exchange rate was relatively easier as there were no historical memories of wars leading to severe realignments. The most memorable war was Franco-German war of 1870, which did not affect the currency of victorious nation, while leaving the currency of the defeated country depreciated by a mere 3½ %.

The failure to establish international monetary stability during the inter-war period led to trade restrictions and capital controls. The sentiments did not change even after World War II. Controls in the post World War II were generally targeted to achieve balance of payments objectives or as a part of broader economic development strategies (in addition, there were restrictions on current international transactions). The exchange controls in the UK were designed to protect sterling in the face of a weak balance of payments problem. The controls in the US in the 1960s were aimed at improving a weak balance of payments by preventing capital transfers abroad. The controls in Japan and France ensured that savings were invested at home than abroad, while those in Germany and Switzerland were aimed at restricting capital inflows to prevent the exchange rate from appreciating. These restrictions were consistent with members' obligations under the IMF's Articles of Agreement. For example, Article IV, Section 3, states that "Members may exercise such controls as necessary to regulate international capital movement." The rationale was to prevent short-term equilibrating capital movements rather than long-term ones.

However, by 1958, the current account restrictions were removed in Western Europe and industrial countries waited until the end of 1970s to remove the capital controls. The UK

suspended all exchange controls in 1979, while Japan dismantled restrictions on capital movements in 1980, Australia and New Zealand in 1983, the Netherlands in 1985, France Sweden and Denmark in 1989, Norway, Belgium and Luxembourg in 1990, Finland and Austria in 1991, Portugal and Ireland in 1993 and Iceland in 1994.

Some of the developing nations have been liberal on capital account, like the Middle East oil exporting countries, Singapore, Hong Kong, Panama and Liberia. Indonesia opened its capital account in 1970, while Uruguay maintained a liberal capital account for a number of years.

1.9. CAPITAL ACCOUNT CONTROL: SOME CONVENTIONAL ARGUMENTS AND COUNTER-ARGUMENTS

Capital account control or liberalization is an old issue. Many arguments have been suggested to support capital account control, but many have also been made to argue for capital account liberalization.[25] We present some of the more traditional ones here. In the next sections, we will focus on those that are more relevant to the current Asian crisis.

1.9.1. Volatility of Short-Term Capital

Proponents of capital controls argue that ***controls help limit volatile short-term capital flows*** (avoiding balance of payments crises, exchange rate volatility, etc) and provide greater independence of interest rate policy. Financial markets are very liquid and react quickly to shocks, while the real economy is slow to react due to price and wage rigidities and investment irreversibility. Tobin (1978) and Dornbusch (1986) argue that this differential speed of adjustment, together with exogenous excess volatility in financial markets, may induce excess exchange rate volatility (over shooting, bubbles, etc) with negative effects on real economic activity. While Tobin proposes "throwing sand in the

[25] Some more discussions can be found in Mathieson and Rojas-Suarez (1992), Johnston and Ryan (1994), and Grilli and Milesi-Ferretti (1995).

wheels" of short-run capital flows by imposing a uniform tax on all foreign exchange transactions, which would discourage very short-term capital flows, but with negligible effects on long run ones, Dornbusch suggests adoption of measures such as dual exchange rate systems, which would partially protect the real economy from fluctuations in the financial markets.

Opponents of capital controls argue that controls are particularly ineffective in preventing short-term movements, and the degree of insulation of monetary policy is therefore very limited. Large capital movements tend to occur when interest rates and exchange rates are out of line with fundamentals and therefore indicate the need for more timely adjustments in exchange rates and interest rates. Since it is difficult to distinguish between short-term and long-term investment and also between direct and portfolio investment, hence imposing controls on short-term inflows could crowd out the long-term foreign investment.

1.9.2. Protection of Foreign Reserves

Proponents of capital controls argue that ***controls support the balance of payments by protecting the foreign exchange reserves by preventing outflows of domestic savings and capital flight.*** Unstable macroeconomic and political environment in many developing economies can reduce the expected private returns from holding domestic financial instruments, and hence risk averse savers may prefer to hold a significant portion of their wealth in foreign assets that are perceived to yield higher or more certain real returns. Controls help retain domestic savings by reducing the return on foreign assets through interest equalization tax or by raising the costs of moving funds abroad and by limiting access to foreign funds.

Opponents of capital controls argue that because of the scope for avoidance through trade and other channels, capital controls are ineffective in preventing outflows, but can discourage inflows and may not necessarily protect the balance of payments. In addition,

even if capital controls limit the acquisition of foreign assets, they may still be ineffective in increasing and sustaining the availability of savings for domestic capital formation. If domestic financial instruments carry relatively uncertain and low real rates of return and residents cannot acquire foreign assets, they often respond by reducing their overall savings or by holding their savings in inflation hedges such as real estate or inventories.

1.9.3. Limitations on Foreign Ownership of Domestic Assets

Proponents of capital controls argue that ***controls limit foreign ownership of domestic factors of production.*** These controls prevent either unwarranted depletion of a country's natural resources or the emergence of a monopoly in a particular industry. Equity and income distribution considerations are often cited as justifications for limiting ownership of domestic factors of production and real estate.

Opponents of capital controls view controls as discouraging foreign direct investment. FDI may be an important source of external finance and the acquisition of new technologies.

1.9.4. Taxation of Domestic Financial Activities, Income and Wealth

Proponents of capital controls argue that ***controls are needed to maintain the authorities' ability to tax financial activities, income and wealth***. Since domestic residents have an incentive to shift some portion of their financial activities and portfolio holdings abroad to avoid taxes on income from interest and dividends, controls are viewed as limiting holdings of foreign assets or to gaining information on the scale of residents' external asset holdings so that these holdings can be taxed.

Opponents of capital controls argue that governments can impose measures such as high reserve requirements that raise the demand for money and, hence, the inflation tax base.

But this is detrimental in the long run as it raises rates of interest and hence discourage capital accumulation. Also, restricting foreign investment could slow market development, domestic investment and growth. Controls often breed bribery and rent seeking activities; this mentality could spill over to tax system and provide avenues for expansion of underground economies[26].

1.9.5. Insulation of Domestic Structural Reform Programs from Foreign Shocks

Proponents of capital controls argue that ***controls help in stabilization and structural reform programs.*** An early opening of capital account can cause a real appreciation, because of high interest rates typically associated with a stabilization plan and increased real exchange rate volatility. These would make trade liberalization more problematic. The credibility of the stabilization program plays a key role in determining the consequences of free capital mobility. For example, if a stabilization program lacks credibility, the liberalization of the capital account could lead to currency substitution and capital flight, which could trigger a balance of payments crisis, devaluation and inflation. If the plan is credible, the high interest rates associated with a stabilization program may cause temporary large capital inflows. Sterilization of capital flows makes the interest rates remain high, encouraging further inflows and hence imposing a quasi-fiscal cost on the central bank. In the absence of sterilization, increase in money supply could jeopardize control of inflation. If nominal exchange rate is allowed to appreciate, it may deter trade reforms aiming at lower barriers to imports. Even if there was uncertainty about the likely success of the reform program, a capital inflow could occur if residents temporarily repatriate funds abroad to take advantage of the high real rates of interest.

Opponents of capital controls feel that there are advantages in liberalizing the capital account simultaneously with domestic financial sector reforms. Capital account

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[26] There is a huge body of literature (e.g. Calvo, Leiderman and Reinhart, 1995, and Johnston and Ryan, 1994) that provides support for the argument that controls breed corruption and that they are easy to get around with, e.g. Tax on short term borrowing is effective only in the short run, as private sector

liberalization will reinforce policies to liberalize domestic interest rates and the domestic economy more generally and to help create a competitive and efficient financial system. The increase in net private capital inflows, which tend to accompany the capital account liberalization, will help to support balance of payments during the period of domestic financial sector liberalization. In addition, capital controls reduce the credibility of government promises that international investors will be able to repatriate their funds.

An open capital account, with a threat for capital outflows, and of short-term capital flows in either direction, could have a disciplining effect, making the authorities careful in their macroeconomic management.

1.9.6. Short-term Relief from Speculative Attacks

While proponents of capital controls argue that ***control program may help government buy time to move the fundamentals to a region where self-fulfilling speculative attacks are less likely***, the opponents hold the view that the possibility that controls might be introduced in the future can generate attacks where none would be observed otherwise.

1.9.7. Lowering Local Interest Rates

Proponents of capital controls argue that ***controls help reduce the local interest rates without allowing capital outflows***, so that investment could be encouraged. The opponents feel that capital controls are perceived as an additional risk factor by the investors. Hence, instead of reducing interest rates and limiting outflows, controls would require higher risk premia, and so would lead to higher interest rates to compensate for higher risk.

1.10. THE CURRENT DEBATE ON CAPITAL ACCOUNT LIBERALIZATION

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quickly finds ways to dodge those taxes through over- and under-invoicing of imports and exports and increasing reliance on parallel financial and foreign exchange markets.

Some argue that controls have played an important role in virtually all systems of pegged exchange rates since WW II[27]. The controls give authorities some autonomy to preserve the peg, some space to organize orderly realignments and make it easier to ward off the speculative attacks. Others argue that capital controls were always easy to evade and never played an important role in limiting exchange rate flexibility[28]. Dooley (1995) argues that controls have influenced yield differentials across countries, but there is no evidence that controls have helped governments achieve policy objectives, such as avoiding real appreciation, or that controls have enhanced welfare as the theory suggests. In addition, Johnston and Ryan (1994) and Grilli and Milesti-Ferretti (1995) find empirically that controls do not affect economic variables, like volume and composition of private flows, changes in foreign reserves or level of exchange rate. In fact, controls are associated with higher inflation and lower real interest rates.

Eichengreen et al (1996b) show that capital controls make a difference. Using data for 20 countries[29] over the period 1962-92, they show that capital controls have been associated with significant differences in the behavior of macroeconomic variables such as budget deficits and money growth rates, but not in case of interest rates and foreign exchange reserves. However, Vinals (1996) argues that this is an evidence of controls being ineffective. In fact, Eichengreen, et al (1996b) find that periods when capital controls are effective are associated with inflation and high trade deficits. This leads Vinals (1996) to argue that capital controls help authorities follow expansionary polices. Since such polices are associated with fundamental imbalances, capital controls eventually lead to exchange market turbulence and to unavoidable devaluations. Hence, controls make "self-fulfilling" attacks justified.

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[27] See Wyplosz (1986) and Giovannini (1989)

[28] See Gros (1987), Gros and Thygesen (1992). However, Johnston and Ryan (1994) argue that they have been effective in developed nations, vis-à-vis developing countries.

[29] The countries included are: US, UK, Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, Canada, Japan, Finland, Greece, Ireland, Portugal, Spain, Australia, South Africa, India and South Korea. However, their study is concentrated on EMU.

In short, Vinals (1996) believes that "capital controls do not seem to facilitate the defense of exchange rate stability in the short-run but continue to undermine it in the medium term through relaxation of policy discipline and coordination."

Reinhart and Smith (1997) argue that capital controls of the 1990s are asymmetric (they are imposed to discourage inflows) and are temporary. The temporariness is either pre-announced or the market rightly perceives them to be temporary as they are counter-cyclical. Even if they are intended to be permanent, they end up being temporary as investors find ways to circumvent the controls, making them ineffective. They study the welfare consequences of taxes on capital inflows, and study the shock to the world interest rate that generates a surge in capital inflows. They find that if countries allow the controls in effect for longer time period than the world interest rate is in effect, then it becomes costly because it causes the domestic real interest rate to rise once the temporary shock disappears, offsetting the benefits associated with smoothing the shock.

Stiglitz (1998) argues that increase in capital flows to developing countries increased the vulnerability of these economies to crises. He suggests some necessary, but not sufficient, conditions to deal with the capital flow problems. First, there should be more information and greater disclosure, which would avoid triggering and exacerbation of crises. But the caveat is that markets don't fully incorporate all the information as the world is dominated by private-to-private capital flows. Second, emerging markets could create more robust financial markets, more transparent systems of corporate governance, and less error-prone macroeconomic policy. But again, developing countries have less capacity for financial regulation and greater vulnerability to shocks. Third, intervention in case of short term flows, which bring no ancillary benefits, besides trade credits, in an economy where saving rates are already high, but increase the vulnerability of an economy.

Krugman (1998c) also suggests that temporary capital controls could bring a respite for the suffering Asian countries. To maintain an appreciated exchange rate, the Asian

economies were asked by the IMF to maintain high rates of interest, which led the economies further into a recession. According to Krugman, this link between domestic interest rates and exchange rate could be broken by imposing temporary capital controls. Controls would avoid capital flight, while lower interest rates would boost the economy and help rebuild the confidence. However, Friedman (1998) thinks that this is the worst possible choice, as the emerging countries need external capital (and the discipline and knowledge that comes with it) to make the best use of their capacities. He suggests either a currency board arrangement or a floating exchange rate. Under the former, a balance of payments deficit automatically shows up in a decrease in high-powered money, and hence the discipline of external transactions is maintained, which is not possible under a pegged exchange rate system. Under the latter, changes in exchange rate absorb the pressures that would otherwise lead to a crisis in a pegged exchange rate while maintaining domestic monetary independence. According to Friedman, the present crisis is not a result of market failure, but that of governments intervening in or seeking to supercede the market both internally via loans, subsidies or taxes and other handicaps, and externally via the IMF, the World Bank and other international agencies.

While Rodrik (1998) advocates capital controls because governments otherwise have to carry out policy based on "what 20 or 30 foreign exchange dealers in London, New York and Frankfurt" think, Henderson (1998) is of the opinion that "foreign exchange markets are a continuing, minute-by-minute election in which everyone with wealth at stake, including residents of the country, gets to vote, an election in which the winners are those countries whose governments have the most pro-growth policies". In his opinion, capital controls allow governments to hide the damage their policies do, which leads them to even-more-damaging policies.

Rodrik (1998) and Bhagwati (1998b) argue that free trade is not the same thing as free capital flows. Rodrik thinks that financial markets are different from goods and services markets in that the former are prone to market failures arising from asymmetric information, incompleteness of contingent markets and bounded rationality. In fact,

Bhagwati suggests that countries like India and China, which still haven't shed their controls on capital should not do that until they have attained political stability, sustained prosperity and substantial macroeconomic expertise. They should instead concentrate on internal reforms like privatization and external reforms like freer trade. They should allow targeted convertibility for dividends, profits and invested capital for direct foreign investment, as this brings in capital and skill and is more stable than short-term capital flows.

Unlike Stiglitz and Krugman[30], Bhagwati feels that the free capital economies, which are currently afflicted by panic-driven outflows, should not jump into capital controls. These countries need to restore the confidence. Capital controls, such as in Malaysia, can help lower interest rates to boost the economy, but if diffidence increases, who will borrow to invest?

Like Rodrik, Bhagwati (1998a) feels that the pro-capital free movement has dominated because of the self-interest of Wall Street financial firms, which see the free capital mobility world as an arena to make money. "Wall Street has an exceptional clout with Washington because of networking of like-minded luminaries among the powerful institutions—Wall Street (Altman went from Wall Street to Treasury and bank), the Treasury Department (Secretary Rubin is from Wall Street), the State Department, the IMF and the World Bank (James Wolfensohn, President of the World Bank, was as investment banker; Ernest Stern, managing director of J.P. Morgan, served as an acting president of the World Bank) most prominent among them".

1.11. SEQUENCING CAPITAL ACCOUNT LIBERALIZATION[31]

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[30] Soon after Krugman's article in Fortune supporting temporary capital controls, Malaysia imposed them. Krugman (1998d) points out why Malaysia seemed to have gone overboard—e.g., while controls should aim to disrupt ordinary business as little as possible, initial announcements seemed to suggest that Malaysians travelling abroad would be restricted to carry unreasonable small quantities of currency. In this open letter, Krugman also suggests that controls should serve as an aid to reform, and not an alternative.

[31] This section draws mainly from Johnston (1998), Johnston, et al (1997), IMF (1998), Johnston and Ryan (1994).

It is widely accepted that capital account liberalization benefits economic growth: by improving the ability to tap savings globally at lower costs; enhancing the domestic agents' portfolio choices; improving resource allocation through increased competition for financial resources; and increasing the availability of resources to support investment, and to finance trade and other activities. Michel Camdessus, Managing Director of the IMF, believes that "the trend towards capital account convertibility is "irreversible", and all countries have an important stake in seeing that the process takes place in an orderly way." Since the benefits from free capital markets are undeniable, hence the costs and risks need to be minimized. Stanley Fisher, IMF First Deputy Managing Director, feels that there is a consensus that "liberalization without a necessary set of preconditions in place may be extremely risky." These preconditions are (IMF Survey 1998):

- a sound macroeconomic policy framework; in particular, monetary and fiscal policies that are consistent with the choice of exchange rate regime;
- a strong domestic financial system, including improved supervision and prudential regulations covering capital adequacy, lending standards, asset valuation, effective loan recovery mechanisms, transparency, disclosure, and accountability standards, and provisions ensuring that insolvent institutions are dealt with promptly;
- a strong and autonomous central bank; and
- timely, accurate and comprehensive data disclosure, including information on central bank reserves and forward operations.

The optimal sequencing of capital account liberalization is complicated. Since all countries are different—in their levels of economic and financial development, in their existing institutional structures, in their legal systems and business practices, and in their capacity to manage the liberalization process—there is no single rule for sequence of steps to undertake in financial and capital account liberalization and no guideline for how the process should take place. There have been differing views, however, about the sequencing issue. While some believe that capital account should be liberalized following

the liberalization of the current account and the domestic financial system, others hold the opinion that there should be simultaneous liberalization of the current and capital accounts. Liberalization of direct investment is seen as a significant part of the real sector reforms, while liberalization of portfolio investment flows is coordinated with financial sector reforms and the development of financial markets and instruments. However, there are certain advantages in coordinating the liberalization in the financial sector and capital accounts:

- The freedom of international capital flows reinforces the policies to liberalize domestic interest rates and helps create a competitive and efficient domestic financial system. The institutional reforms required could be mutually beneficial to both; e.g., creation of efficient money and foreign exchange markets.
- Since capital account liberalization encourages the return of flight capital and eliminates impediments to inflows of foreign investment, it could support the balance of payments during periods of financial sector liberalization, when lifting of domestic credit controls initially leads to rapid increase in bank credit than deposits, increasing domestic resource pressures as banks run down holdings of excess liquidity, and weaken the balance of payments.
- Many developing and transition economies already have a de facto high degree of currency convertibility, and openness of these economies means that even small changes in the invoicing or timing of exports and imports can result in movements of foreign exchange relative to GDP. Maintaining controls under these circumstances results in pronounced balance of payments statistical discrepancies, which complicate the interpretation of underlying economic trends, and obscures the interrelationships between the domestic and external financial conditions.
- Since the preconditions for capital account liberalization do not seem more onerous than those for domestic financial liberalization, hence the two should take place simultaneously. The direct controls on interest rates and credits need to be replaced by indirect controls, as there is scope for avoidance of direct controls through capital movements. Hence, the adoption of indirect monetary controls should either precede

or occur simultaneously with liberalization of capital account. In fact, these reforms should take place early in domestic financial liberalization, as interest rates need to be market determined, and opening of capital account may have little impact on interest rate policy.

If the sequencing is not followed appropriately, then there are potential risks from opening the capital account. Continued reliance on credit controls or high non-interest bearing reserve requirements for monetary controls, and failure to address properly inefficiencies in domestic financial markets resulting in wide spreads between deposit and lending rates, may encourage borrowing abroad rather than domestically. Inappropriate incentives for foreign borrowing may also be provided by the tax system, leading to an overvalued exchange rate and excessive external debt burden.

Even if domestic financial and capital account liberalization do not proceed simultaneously, one should clearly recognize that there is a danger of removing most restrictions on capital account transactions before major problems have been addressed in domestic financial system. The problems include: inadequate accounting, auditing and disclosure practices in the financial and corporate sectors, which weaken market discipline; implicit government guarantees, which encourage excessive, unsustainable capital inflows; and inadequate prudential supervision and regulation of domestic financial institutions and markets, which create scope for corruption, connected lending and gambling for redemption. If these problems are severe, and still countries open their capital accounts, they run the risk of a crisis. Hence, countries should work towards removing these distortions, when they open their capital accounts. Reliance on temporary selective controls is recommended as a part of the financial regulatory framework. Given the destabilizing effects of short term flows, there may be a case for liberalizing longer term flows, particularly, foreign direct investment, ahead of short term capital inflows. Foreign direct investment has its own economic benefits, including transfer of technology and of efficient business practices.

Hence, capital account liberalization is not an "all or nothing" affair. A comprehensive liberalization of capital transactions and transfers does not mean an abandonment of all rules and regulations connected to foreign exchange transactions. In fact, the individual components of the capital account can be, and usually are, liberalized selectively. Certain areas need to be regulated and strengthened:

1. Prudential regulations related to nonresidents and foreign exchange transactions and transfers.
2. Measures designed to prevent tax evasion and money laundering
3. Reporting by market participants ensuring the timely and accurate compilation of monetary, external debt and balance of payments data.
4. Strengthening the banking sector: Banks are the major intermediaries and channel for capital flows in many developing countries. Their interest rates and credit policies may influence the structure of domestic interest rates and financial markets, and hence the composition of capital flows. For example, wide bank deposit/lending spreads may promote foreign corporate borrowing; or the underpricing by banks of credit and maturity transformation risks may distort the yield curve, and thus the composition of flows. As a result, banking systems may not only be faced with problems of insolvency and illiquidity, but the underpricing of credit and maturity risks can hinder the development of longer term markets due to an underpricing of longer term risks in the economy. Allowing weak banks to expand their balance sheets will lead to banking crises. The reforms for weak banks should focus on capital adequacy, loan loss provisioning, credit assessment, liquidity management, and increasing foreign participation.

1.12. MEASURES TO DISCOURAGE CAPITAL INFLOWS

Latin America and the Asian countries have been the biggest recipients of capital flows in the 1990s. This does not mean that these countries had an open capital account. They all had some kind of intervention at some point or the other. All the monetary authorities met

these inflows by intervening in the foreign exchange market. This would be evident from Table 1.1. The table clearly shows that in response to the capital flows, the monetary authorities intervened in the foreign exchange markets to sterilize the inflows. This sterilization process has been discussed below.

Notwithstanding the desire to have capital inflows into the country, they have been a source of concern for most countries that have experienced huge inflows. They have some destabilizing side effects, like appreciation of local currency may lead to a loss of competitiveness for exports, hence giving rise to inflation; lack of proper intermediation of capital flows could lead to resource misallocation; short-term "hot money" flows could lead to reversal at short notice causing a financial crisis. The usual step taken by the central banks to avoid currency appreciation and inflation is to "***sterilize***" the capital inflows. To look at the sterilization process, let's look at the balance sheet of the central bank.

Assets : Domestic Credit (DC) plus Foreign Currency (FC)
Liabilities : Monetary Base (MB)

In the event of capital inflows, there would be a high demand for domestic currency, which would lead to appreciation of domestic currency and loss of competitiveness of exports. To prevent this appreciation, the central bank buys foreign currency (FC), increasing the monetary base (MB) in the economy. Higher money supply in the economy would lead to higher inflation. To prevent this, the central bank wants to sterilize these inflows by keeping the MB constant. This is done by decreasing the domestic credit (DC) through the classical form of open market operation (OMO), i.e., selling treasury securities. But the problem is that this leads to an increase in rate of interest, which leads to further increase in capital inflows[32]. Unfortunately, most developing countries lack the tools to run this OMO or find it too costly, since the

[32] This assumes that capital is perfectly mobile and that domestic and foreign bonds are perfectly substitutable. But OMO is often considered a temporary means of sterilization, which often fails in the presence of persistent inflows.

financial system is not fully liberalized and issuing securities to mop up the inflowing liquidity places a heavy debt-service burden on the government or central bank. The central bank loses when it raises its funds by investing in foreign assets, which has lower interest rates compared to what it has to pay on the bills that it sells. This could require re-capitalization of the central bank. The risks increase when much of the capital inflows are in the form of short-term portfolio investment, which is more likely to reverse in case of change of sentiments compared to foreign direct investment.

The impact of freedom of capital movements on monetary and exchange rate policy can be seen through the covered interest parity, which is the consequence of arbitrage between short-term domestic and foreign interest rates, and the discount on the currency in the forward exchange market. The covered interest parity is:

(1.23) $i_d = i_f + F_d$

where $F_d = \frac{e^f - e^s}{e^s} \times 100$, i_d is the domestic interest, i_f the foreign interest rate of the same maturity and F_d the forward discount for that maturity, e^s is the rate of exchange (units of domestic currency in terms of foreign currency) in the spot exchange market, and e^f the forward exchange rate on the date of maturity of the interest rate contracts. Hence, where the foreign interest rate and forward exchange rate are predetermined, a country could determine the domestic interest rate or the spot exchange rate, but not both.

With greater capital mobility, short-term interest rates will be determined by the covered interest rate parity condition. If both interest rates and exchange rates are inconsistent with this condition, then there would be incentives for significant short-term capital flows. Hence, monetary and exchange policies are constrained to achieve different macroeconomic targets, when the capital account is open. On the one hand, if monetary policy targets inflation, then exchange rate is not free to be used as an expenditure-switching instrument to achieve current account balance objectives; fiscal policy could be

used to achieve savings/investment balance. On the other hand, if exchange rate is targeted to achieve current account balance, or if exchange rate is fixed, monetary policy would have little autonomy to achieve domestic stabilization objectives or to manage the consequences of short-term capital inflows.

Hence countries turn to less conventional measures, like widening the exchange rate bands, intervening in forward exchange markets, or imposing capital controls like variable deposit requirements and interest equalization taxes on foreign borrowings. Then, there are "belt-and-braces" strategy, where indirect monetary policy instruments are combined with some capital controls, and "sand-in-the-wheel" policies, where controls have targeted short-term capital flows, which have often been perceived by authorities as volatile and destabilizing.

Supplementary Sterilization Measures[33]: There are several measures that could be used instead of the OMO to control the money supply. Each has its own advantage and disadvantage, as discussed below.

- ***Discount Policy and Directed Lending***: This measure increases the cost or restricts the use of central bank credit. But this policy tool loses its flexibility when rediscounts and loans granted by the central bank are often automatic tools for priority lending in the developing nations. The rediscount ratio cannot be adjusted often, as it would be counterproductive to the goal of providing cheap credit to targeted sectors. Hence, to make this tool more effective, subsidies through the discount windows need to be eliminated.

  Advantages: The changes in discount rates entail a smaller fiscal cost, because the discount rates are lower than the market rates. These changes don't impact the local money markets; hence, the sterilization objective can be achieved without raising the market rates (which prevents further inflows of capital).

[33] This section draws from Lee (1996)

- ***Reserve Requirements***: Credit expansion can be curtailed through an increase in the statutory reserve requirement, e.g., Columbia followed in 1991.These reserves can either be remunerated (where the central bank pays interest on the deposits) or non-remunerated (where commercial banks don't get any return). If the interest paid is close to the market rates, then the cost is similar to open market sales of interest-bearing instruments.

  Limitations: It could be ineffective when banks already hold excess reserves, when banks are weak or when statutory reserve requirement is already at a high level (in response to sterilizing the flows previously as in Korea and Columbia). Frequent changes could disrupt the efficient management of bank portfolios and send a wrong signal about the banking system. They are considered a tax on banks, and hence could lead to disintermediation, which could weaken the control of central bank.

- ***Government Deposits***: The public sector deposits could be shifted from commercial banks to the central bank, especially when they form a large part of banks' deposits as in Malaysia and Thailand.

  Advantage: As long as the interest paid on government's deposits is lower at the central bank, this measure does not impose fiscal or quasi-fiscal costs[34].

  Limitation: Frequent and unpredictable transfers can make it difficult for banks to manage their portfolios efficiently. This tool is limited if the government deposits are already held at the central bank by law.

- ***Foreign Exchange Swaps***: In the foreign exchange swap, the central bank agrees to sell the foreign exchange against the domestic currency and simultaneously agrees to

buy it back at a specified date in the future, using forward exchange rate. Banks that buy the foreign currency can lend it to domestic residents or invest abroad, but the domestic monetary base gets reduced. It gives the banks an incentive to "export" the funds, hence leading to capital outflow to offset the inflow. This is done by pricing the swap in such a way that the difference between the spot and the forward rate is bigger than the interest rate differential between foreign and domestic markets.

Advantages: Swaps are highly flexible, and can be varied in length reflecting expectations about duration of capital inflows and the time period for which they need to be offset. Unlike the OMO, they can be executed with out government securities, which helps countries that have budget surpluses.

Limitations: Swaps can cause losses for the central bank when the bank gives favorable margins on interest rate differentials. The effect can be nullified if the foreign exchange sold by central bank is sold back against the local currency. Commercial banks can take advantage of this kind, but this activity can be avoided if monitoring and supervision is strengthened, or there are restrictions on how banks can trade the swap proceeds.

- ***Wider Exchange Rate Bands***: Widening exchange rate bands in response to capital inflows allows the exchange rate to appreciate, and import prices to fall, putting downward pressure on inflation, which reduces the need to sterilize all the capital inflows. The possibility of appreciation of exchange rate reduces speculation on domestic currency. A wider band gives central bank some flexibility for intervention, especially when there is a reversal in market sentiments.

  Limitations: A wider exchange rate band can wrongly signal that the central bank wants to devalue the currency to make exports competitive instead of controlling

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[34] When the central bank sterilizes, it issues high yielding government securities and acquires low yielding international reserves (e.g. U.S. Treasury Bills). This operation imposes a cost, which is often termed as quasi-fiscal cost.

inflation. Also, if wide changes in exchange rate are well anticipated, then they could provoke large inflows and outflows of capital.

- ***Intervention in Forward Exchange Market***: Through this facility, the central bank allows the domestic investors to "hedge" the value of their foreign investments by locking in a forward exchange rate. This could encourage offsetting capital outflows.

  Limitations: This facility requires a well-developed forward market. This could be risky and might entail fiscal costs if the central bank offers excessively favorable premiums above the existing interest differentials and hence incurs financial losses.

- ***Easing Restrictions of Capital Outflows***: The restrictions on capital outflows can be eased by easing surrender requirement on foreign exchange earnings, allowing local institutions to make investments abroad, or letting non domestic entities to issue local currency bonds in the domestic market. These measures would work if the restrictions had been effective to begin with. This can increase the overall efficiency of the investments made by local institutions, who diversify their portfolios internationally. Exporters can manage their foreign assets efficiently by being able to retain their foreign earnings. The local financial market develops if international organizations issue bonds. Remittance of profits and income is simplified, which is a positive signal, meaning that capital can be moved in and out easily, thereby lowering the risk premium on financial assets.

  Limitation: Easing of capital outflows in practice has encouraged inflows as it increases the confidence in the exchange system.

- ***Variable Deposit Requirements***: This measure requires that a certain percentage of foreign currency borrowed by the domestic residents has to be kept with the central bank in interest free, non assignable deposits for a fixed period. This is like a tax on foreign borrowing. It is like the non-remunerated requirement, but it is paid in foreign

currency. It does not affect the rate of interest like the OMO, hence does not lead to further inflows.

Advantage: It penalizes the short-term borrowings more severely, which are mostly perceived as destabilizing. The requirement could be higher on short-term borrowings, hence targeting the "hot money inflows" that are seeking short-term gains. Since the deposits are non-remunerated, hence there is no fiscal cost involved.

Limitations: Borrowers find ways to circumvent these controls. It can lead to resource misallocation. Since the deposit requirement is like a cost, borrowers can't take advantage of lower interest rates in international markets; hence, firms engaged in international trade are penalized. It not only hurts "speculative" investment, but also "genuine" investment.

- ***Interest Equalization Taxes***: Unlike variable deposit requirements, this measure can directly affect both inflows and outflows of capital. This measure is used to level the yields between foreign and domestic securities, discouraging domestic investors to buy foreign assets. Hence, it is tax on capital outflows. But, if it is imposed on capital inflows, then it could be referred to as "capital import tax". It decreases the return on local assets for the foreign investors, while increases the cost of borrowing for domestic companies.

  Advantages: It can influence the exchange rate without changing interest rates or intervention in the currency markets. There is a debate about what the tax should be, i.e. should it be higher for short-term transactions than for long-term transfers, or whether public debts should be exempt. This measure has been used by a lot of countries, including the U.S.. However, it should only be used as a temporary measure, otherwise, as with most control measures, investors find ways to circumvent it.

Limitation: It raises administrative costs of implementation, raises cost of capital and has the tendency to distort allocation of resources.

Causes and Policy Responses to Capital Inflows[35]**:** Since the real exchange rate appreciates and economy gets overheated in response to large capital inflows, appropriate and timely decisions need to be taken to avoid these consequences. The economic impact and the policy response to capital inflows depend on the forces driving them, as well as the recipient country's exchange rate regime. If the *exchange rate is fully flexible*, then capital inflows do not lead to inflationary pressures—as the exchange rate appreciates and the relative price of imported goods falls shifting consumption away from non-tradables—all of which tend to alleviate inflationary pressures. Under a *managed float or a fixed exchange rate*, the cause of capital inflows determines whether or not there would be inflationary pressure.

Causes of Capital Inflows: Haque, et al categorize the causes of capital inflows as:

1. autonomous increase in the domestic money demand function
2. increases in the domestic productivity of capital
3. external factors, such as falling international interest rates

Capital inflows due to an increase in money demand function do not lead to inflationary pressures. But if they increase due to other reasons, then foreign reserves will accumulate, which, in the absence of sterilization, would expand the monetary base, increase inflationary pressures and deteriorate external position. The policymakers could get an idea about the cause of inflows from the financial indicators listed in the Table 1.2.

Policy Response: The appropriate policy responses depend on the causes of inflows, as well as degree of flexibility allowed by the domestic institutional structure and the existing policy stance. It is easier to deal with disruptions caused by the inflows when countries follow relatively balanced macroeconomic policies (unbalanced policy refers to

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[35] This sub-section draws from Haque, Mathieson and Sharma (1997)

loose fiscal policy compensated by tight monetary policy). The upward pressure on exchange rate can be partly offset by accelerating the pace of trade and exchange liberalization, including easing controls on capital outflows. There are three other ways of dealing with the possible effects of large capital inflows: sterilized intervention, fiscal tightening and exchange rate appreciation. The optimal mix of instruments depends on the country's institutional structure and past policies. For example, non-availability of suitable instruments or insufficient development of financial markets could limit sterilized intervention. Fiscal policy is unwieldy for short-term demand management because of the associated formulation and implementation lags. Temporary capital controls could be used to deal with huge capital inflows, especially when other instruments are limited in their use or effectiveness.

The appropriate use of each instrument for countries with *balanced macroeconomic policies* is shown in Table 1.3.

When inflows are induced by increase in money demand function (say, due to financial deregulation), no policy response is required, as expansion of monetary base will not be inflationary. However, sterilization may be required to smooth fluctuations in exchange rate and interest rates. Measures might be needed to restrict bank intermediation because increase in money balances is likely to expand bank credit, which could lead to excessive risky lending if the banking system is weak and poorly supervised.

If there is a sustained increase in inflows, say, due to increased productivity of domestic capital, then appreciation of the equilibrium real effective exchange rate (REER) should be achieved through adjustments in goods, factor and asset prices. Over the medium run, a tight fiscal policy may be needed to control increases in domestic absorption, to prevent an excessive appreciation of the REER and to contain the external deficit.

Sterilization is the most recommended response to temporary inflows, say, due to falling international interest rates. However, the ability to sterilize inflows is likely to be limited

and short lived if the substitutability between domestic and international assets is high or exchange rate is pegged. Fiscal adjustment is not recommended unless sterilization is severely constrained, as it involves frequent changes in tax and government spending structure, which could lead to additional adjustment costs.

In countries with unbalanced financial policies, short term inflows are likely to be influenced by domestic interest rates and expected changes in exchange rate movements, due to loose fiscal and tight monetary polices. Hence, appropriate mix of fiscal and monetary policies is the best response. But reducing interest rates to decrease speculative inflows could stimulate domestic demand and lead to overheating.

1.13. EMPIRICAL EVIDENCE ON CAPITAL CONTROLS

Empirical work links capital account liberalization and performance of macroeconomic variables. However, the work has been limited by the absence of a clear measure of the degree of liberalization and the intensity of controls. The usual measure is to construct a dummy variable from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. However, this variable doesn't measure the intensity of controls, and captures restrictions on capital outflows (since it refers to resident-owned funds only). To account for intensity, some studies have used information on multiple currency practices and/or surrender of export proceeds to form a single index. Then others have used country-by-country descriptions of foreign exchange restrictions. Still others, who use high frequency data, have used onshore-offshore interest differentials, the size of the black market premium and deviations from covered interest rate parity to infer the effectiveness and intensity of controls.

Using a dummy variable for controls from Annual Report on Exchange Arrangements and Exchange Restrictions for OECD countries, Epstein and Schor (1992) find that countries with strong left-wing parties and non-independent central banks tend to impose restrictions on capital account transactions. Grilli and Milesi-Ferretti (1995) use a panel

of 61 countries and three different measures of controls (restrictions on payments of capital transactions, multiple currency practices, and restrictions on payments for current transactions). They find that countries with low per capita income, a large government, fixed or managed exchange rate, unbalanced current accounts and a central bank with limited independence are more likely to impose capital controls.[36] Using the onshore-offshore interest differentials for 11 OECD countries, Lemman and Eijffinger (1996) show that controls are positively related to domestic inflation, degree of political stability and the level of investment (as controls keep domestic rates of interest low, boosting domestic investment).

Using data for 20 countries[37] over the period 1962-92, Eichengreen, et al (1996b) show that capital controls have been associated with significant differences in the behavior of macroeconomic variables such as budget deficits, trade deficits and money growth rates, but not in case of interest rates and foreign exchange reserves. These differences are more noticeable for the observations from tranquil periods.

Johnston and Ryan (1994) study the impact of controls on capital movements on the private capital accounts of countries' balance of payments using data from 52 countries for the period 1985-92. They find that exchange controls significantly alter the structure of industrial countries' capital accounts, especially by restricting outflows of recorded direct and portfolio investment. However, for developing countries, capital controls do not effectively prevent the outflows, and misinvoicing[38] may be used to circumvent the exchange controls.

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[36] Similar results are found by Alesina and Milesi-Ferretti (1995) and Quinn and Inclan (1997), where the former use a broader measure of restrictions, including multiple exchange rates, surrender of export proceeds and current account restrictions, and the latter construct measures of financial openness that combine proxies for current and capital account restrictions.

[37] The countries included are: US, UK, Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, Canada, Japan, Finland, Greece, Ireland, Portugal, Spain, Australia, South Africa, India and South Korea. However, their study is concentrated on EMU.

[38] Misinvoicing of trade transactions measures the extent to which the imports and exports recorded in the balance of payments misrepresent the value of goods shipped. Such mis-invoicing can be an important channel for the circumvention of controls on capital movements; e.g., a company seeking to export capital outside the exchange control regulations might over-invoice its imports and under-invoice its exports.

Bartolini and Drazen (1997) construct an index of capital controls similar to Epstein and Schor (1992) and Grilli and Milesi-Ferretti (1995) for 74 developing countries from 1970 to 1994. The policies of free capital mobility signal governments' future policies. They find that the industrial countries' rates of interest are the main determinants of developing countries' liberalization decisions. When world interest rates are low, emerging markets experience an inflow and engage in a widespread policy of free capital mobility; when interest rates are high, only sufficiently committed countries allow free capital mobility, whereas others impose controls to trap capital onshore, thus signaling future policies affecting capital mobility.

Grilli and Milesi-Ferretti (1995) find that capital controls are associated with higher inflation and lower real interest rates, while there is no correlation between controls and economic growth. In a sample of 23 countries over a period 1975-89 and after controlling for initial per capita GDP, initial secondary enrollment rate, an index of quality of governmental institutions and regional dummies for East Asia, Latin America and sub-Saharan Africa, Rodrik (1998) finds that capital account liberalization does not lead to higher per capita GDP growth, higher investment as a share of GDP or lower inflation.

Quinn (1997) constructs an index of financial and capital account openness for 64 countries to capture the intensity of controls. Controlling for initial income, education and political instability, he finds a positive correlation between capital account liberalization and economic growth. Tamarisa (1998) finds that for 1996, capital controls have acted as a deterrent to trade in developing and transition economies.

Dooley (1996) reviews theoretical and empirical work on controls over international capital movements. The empirical literature suggests that controls have been "effective" in the narrow sense of influencing yield differentials. There is little evidence that controls have helped the governments meet policy objectives, except reducing governments' debt-service costs, and controls don't even enhance economic welfare.

Mathieson and Rojas-Suarez (1992) test the relationship between programs to control capital flight and other fundamental determinants of capital flight. They find that, during episodes of capital outflows in response to increased risk from inflation and default risk, countries with capital controls did not prevent capital flight; at the same time, the private sector's reaction to a deterioration of the fundamentals was delayed.

Cardoso and Goldfjan (1998) study the case of Brazil, by accounting for the endogeniety of capital controls by considering a government that sets controls in response to capital flows. They find that the government reacts strongly to capital flows by increasing controls on inflows during booms and relaxing them during times of distress. They also find that controls temporarily alter levels and composition of capital flows, but have no sustained effects in the long run.

1.14. CONCLUSION

In this paper, we survey some of the more important issues related to currency crises and capital control. It is hoped that this paper will help the reader get a good idea of the features of various financial crises.

The literature on currency crises and capital control, however, is huge, and this survey is not meant to be exhaustive. There are some issues not covered here because of space constraint, and more issues are constantly arising. The survey is to provide a snap shot of what is currently available.

Table 1.1: Indicator of Sterilization

Year	Balance of Goods Services, and Private Transfers1/ $ billion	Balance on Capital Account plus Net Errors & Omissions2/ $ billion	Changes in Reserves3/ $ billion
		Latin America	
1985	-5.5	6.5	-1.0
1986	-19.8	13.2	6.6
1987	-11.8	15.0	-3.2
1988	-13.4	5.7	7.7
1989	-10.2	12.7	-2.6
1990	-8.5	23.6	-15.1
1991	-20.5	38.9	-18.4
1992	-34.6	53.4	-18.8
		Asia	
1985	-18.7	22.7	-4.0
1986	-1.1	25.5	-24.4
1987	14.8	24.7	-39.5
1988	2.6	8.7	-11.3
1989	-8.1	17.1	-9.0
1990	-10.0	31.7	-21.7
1991	-10.2	48.9	-38.7
1992	-25.2	46.3	-21.1

1/ Data for Western Hemisphere and Asia from IMF's World Economic Outlook

2/ A minus sign indicates a deficit in the pertinent account. Balance on goods, services and private transfers is equal to the current account balance less official transfers. The latter are treated in this table as external financing and are included in the capital account.

3/ A minus sign indicates an increase.

Source: Table 1 from Calvo, Leiderman and Reinhart, 1995.

Table 1.2: How financial indicators could shed light on capital inflows

Indicator	Upward shift of money Demand curve	Increase in productivity of domestic capital (sustained inflows)	External factors;e.g. falling international interest rates (temporary inflows)
Asset Prices			
Interest rates	Increase	Increase	Decrease
Yield Curve	Flattens	?	Becomes steeper
Exchange rate	Appreciates	Appreciates	Appreciates
Equity prices	Decrease	Increase	Increase
Real estate prices	Decrease	Increase	Increase
Inflation	Decreases	Increases	Increases
Monetary and credit aggregates			
Real money balances	Increase	Likely to decrease	Increase
Base money	Increases	Increases	Increases
International reserves	Increase	Increase	Increase
Bank credit	Likely to increase	Increases	Likely to increase
Foreign currency deposits	Decrease	?	May decrease
Balance of payments			
FDI	?	Increases	?
Portfolio investment	Increases, especially in Short-term flows	Increases, in both short and long-term flows	Increases, especially in short term flows

? indicates that the effect is uncertain.

Source: Table 1 from Haque, Mathieson & Sharma, 1997.

Table 1.3: Instruments for managing capital inflows
A matrix for countries with balanced macroeconomic policies

	Upward shift of domestic Money demand curve	**Increase in productivity of domestic capital (sustained flows)**	**External factors-e.g. falling international interest rates (temporary inflows)**
Sterilization	May be needed to smooth Fluctuations.	May be needed to smooth Fluctuations	Is appropriate
Exchange rate Appreciation	Equilibrium real effective exchange rate does not change	The warranted appreciation of the equilibrium real effective exchange rate can be achieved partly through nominal appreciation and partly though increases in the prices of non-traded goods.	Equilibrium real exchange rate need not change. Temporary nominal appreciation of the exchange rate may be warranted if there are constraints on sterilization.
Fiscal policy	No policy response is required	Fiscal policy tightening is required, especially if the absorptive capacity of the economy is limited relative to the size of the inflows.	If the constraints on sterilization are too severe and the external competitive position is weak, then some fiscal tightening may have to be considered.

Source: Table 2 in Haque, Mathieson & Sharma, 1997.

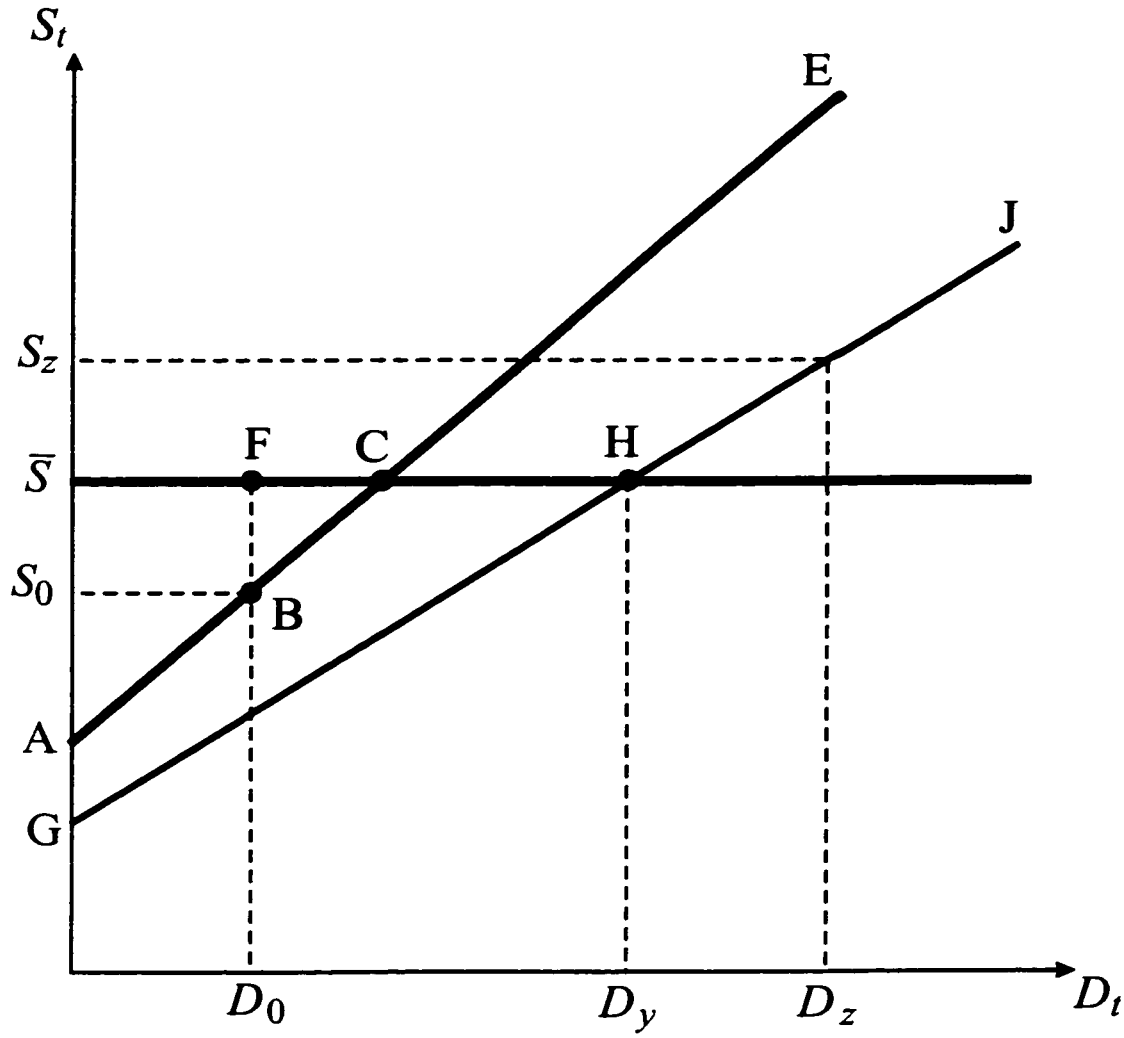

Figure 1.1

Domestic Credit Creation and Devaluation

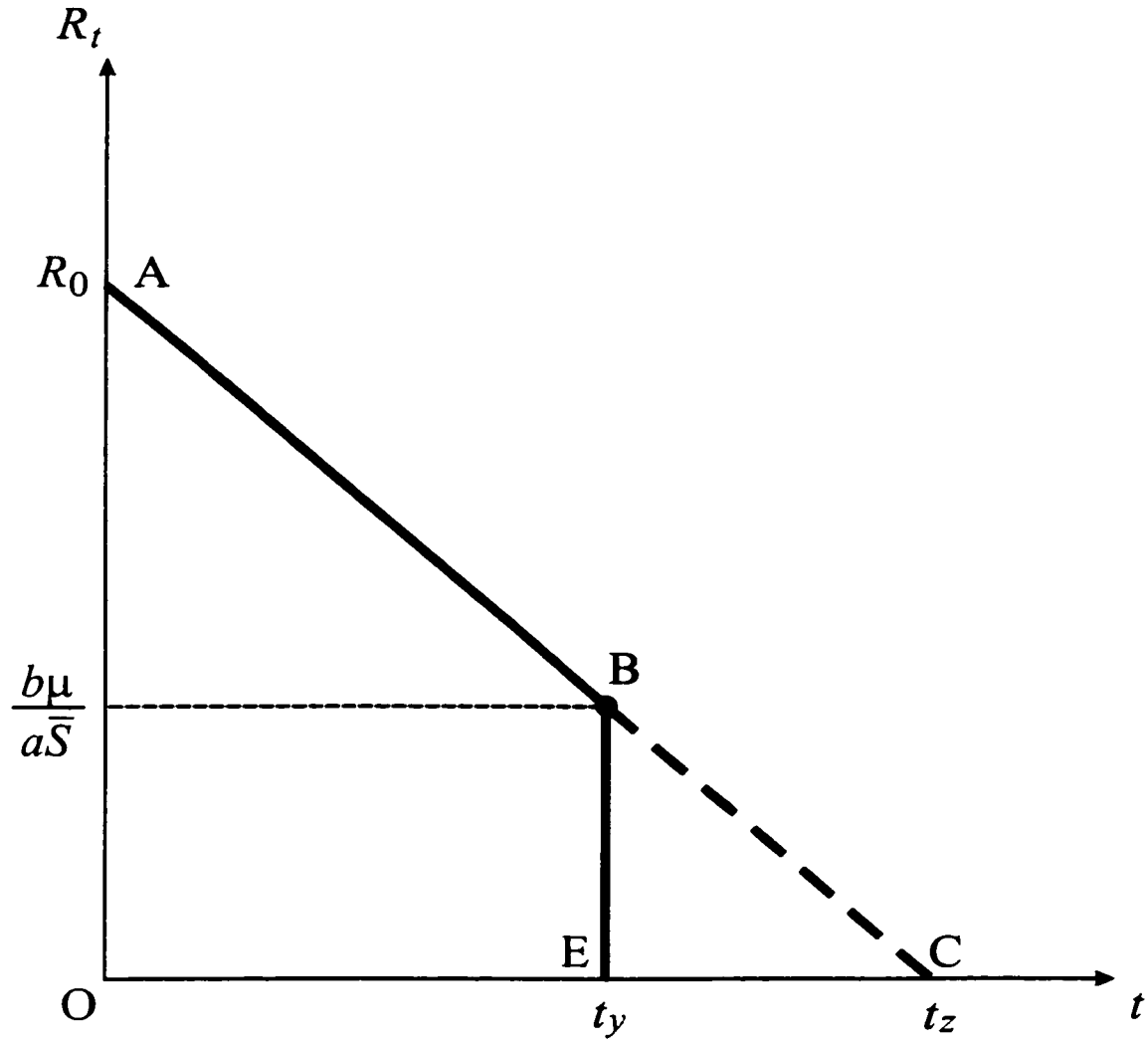

Figure 1.2

Speculative Attacks and Foreign Reserve Depletion

Chapter 2: Contagion, Monsoons, and Domestic Turmoil in Indonesia: A Case Study in the Asian Currency Crisis[1]

2.1. INTRODUCTION

This decade has witnessed a currency crisis in Asia as well as other parts of the world. The decade began with the ERM breakdown in 1992, followed by the Mexican Peso crisis in 1994, which spread to Latin America, and then the latest 1997 crisis in South East Asia, which engulfed countries like Thailand, Indonesia, Malaysia, South Korea and the Philippines. The magnitude of the crisis in Asia was unexpected by most observers—Asia had been praised as a miracle for its outstanding growth performance since the late 1980s and early 1990s; some of the economies involved in the crisis had earned the title of "Asian Tiger". These Asian economies were consistently praised for their openness, and the economies prospered as liberalization drives led to large inflows of capital.

Following the crisis that began in July 1997, economists have begun to look more closely at the underlying fundamentals. High growth rates of the Asian economies contributed to an underestimation of risks from weak financial systems, questionable political governance, and an over-reliance on external debt. In addition to these domestic factors, some economists argue that there were common external shocks that contributed to the crisis. In particular, slow growth in Japan and low world interest rates are believed to have been responsible for the magnitude of capital inflows that left these countries vulnerable to reversals of sentiment. In addition, swings in the dollar-yen exchange rate may have affected export competitiveness of countries pegged to the dollar. Finally, there

[1] Thanks to Simeon Djankov for providing the data on the political risk variable. Helpful comments from Stijn Claessens, Simeon Djankov, Charles Engel, Cheng Hsiao, Keon Lee, Paul Masson, Kar-yiu Wong and Eric Zivot are acknowledged. Thanks are due to Chang-Jin Kim for assistance with econometric issues and programs.

are new models of currency crises, which emphasize contagion through multiple equilibria or a "wake-up call" to investors.[2]

This paper focuses on the case of Indonesia, and tries to separate the contributions of domestic and external fundamentals from contagion in the development of events. Indonesia has been selected as the country of interest because it has suffered the most severe economic consequences in the year following the onset of the crisis as measured by the magnitude of currency depreciation and contraction of economic activity. This outcome occurred despite macroeconomic fundamentals leading up to the crisis that are believed to have been among the strongest of the crisis countries. Indonesia could be arguably one of the clearest cases of contagion from neighboring countries.[3] The rest of the paper is structured as follows. Section 2.1 provides a longer-term perspective on economic trends and policy reforms in Indonesia. Section 2.3 focuses on events leading up to and following the onset of the crisis. Had fragility increased? What were the triggering events domestically and from the region? Section 2.4 discusses some models of currency crises and outlines the characteristics of the Asian crisis. Section 2.5 presents the econometric analysis to identify the roles of domestic and external factors in the crisis. A market pressure index is constructed for Indonesia as well as Thailand and Korea. Markov-Switching Models are estimated to determine the factors that are responsible for an increase in the average speculative pressure. Section 2.6 discusses the out-of-sample forecasting performance of the Probit and Markov Switching Models. Finally, section 2.7 concludes.

2.2. INDONESIA: ECONOMIC BACKGROUND[4]

[2] Corsetti, Pesenti, and Roubini (1998a) propose these arguments. Masson (1998) provides a framework for grouping causes of a crisis into common shocks, spillover effects, and (pure) contagion. We employ his terminology of "monsoons" to refer to common external shocks.

[3] Radelet and Sachs (1998a) support this view.

[4] This section draws from discussion in EIU (1997), IMF (1997a), IMF (1997b), Johnston, et al (1997), and Kochhar, et al (1998).

Indonesian economic reforms began in the mid-1980s. Over the next decade, reforms were aimed at opening the real economy by promoting the direct investment flows and rationalizing the tariff system. In addition to the investment and trade reforms, measures were taken to liberalize the financial sector, increase competition, and promote growth of capital markets including through capital account liberalization. To foster economic growth through increased openness, the payment and transfer system for current international transactions was liberalized. Foreign exchange spot and swap markets were developed. The government also aimed to support these reforms with improved macroeconomic management, including through an attempt to maintain a competitive and stable exchange rate.

2.2.1. Macroeconomic conditions and management

Over the two and a half decades beginning in 1970, the Indonesian economy sustained high real GDP growth rates averaging about 7 percent annually, while the rate of inflation was held consistently below 10 percent annually. This performance reflected prudent macroeconomic policies, high investment and saving rates, and liberalization efforts. According to official data, the incidence of poverty declined from 60 percent in 1970 to 11 percent of the population in recent years.

Agricultural production grew strongly and Indonesia benefited from rising oil prices during the 1970s. However, the decline of oil prices in the 1980s led to a slowdown in growth, an increase in fiscal deficits, and a rise in external debt. The government took steps to reduce the budget deficit through tax reforms and cuts in current expenditures as well as scaling down or canceling large investment projects. Export competitiveness was supported by major devaluations of the Rupiah in 1983 and 1986. The adoption of a market-oriented development strategy spurred rapid growth from the mid-1980s, led by non-oil manufacturing exports. Macroeconomic policies were tightened promptly to counteract occasional bouts of excess demand and to relieve strains on the current account from rapid import growth. However, the authorities were not able to contain

inflation to the stated 5 percent target on an enduring basis and external debt indicators remained high.

The central government's financial position strengthened over the past decade, primarily as a result of firm expenditure control. Fiscal discipline benefited from the balanced budget rule, which had been in effect since 1968. It requires that total budgetary expenditure should be equal to budgeted revenue including external loans and grants. The rule also requires domestic revenue to cover current expenditure, including amortization of government debt and a portion of development expenditure. These rules prevent domestic private bank and nonbank financing of the central government. To the extent that development expenditure exceeds public saving, the gap can normally be filled only by external borrowing.

Monetary policy, conducted in the context of an open capital account since 1970, has been complicated during the 1990s by large private capital inflows and the long-standing exchange rate policy of gradually depreciating the Rupiah against the U.S. dollar with a view to maintaining external competitiveness. Since capital markets in Indonesia have not been deep enough to support sustained sterilized intervention, this strategy has resulted in monetary and credit growth well in excess of pre-announced targets. Bank Indonesia accumulated substantial foreign exchange reserves, partly as a result of the interventions to limit nominal exchange rate appreciation.

External developments, particularly the cyclical downturn in economic activity and the associated decline in interest rates in the industrial countries during the early 1990s, played a role in the initial surge in capital flows to many emerging market countries. Although Indonesia was not at first a major recipient of these flows, over more recent years, stock price movements in Indonesia have been more closely related to changes in industrial country interest rates and developments in other emerging markets.

2.2.2. Recent macroeconomic developments

Overheating in the Indonesian economy, which had characterized developments in 1995, subsided in 1996, after the central bank raised interest rates and again raised the minimum reserve requirement. Real GDP growth eased slightly to 7.8 percent and inflation declined to under 7 percent. To maintain the competitiveness of exports, the central bank accelerated the depreciation of the Rupiah, and widened the Rupiah's trading band. Nonetheless, the current account deficit remained over 3 percent of GDP, mostly financed by short-term inflows of portfolio capital.

After inflation moderated, Bank Indonesia lowered interest rates in December 1996 and again in March 1997. These actions were meant to reduce upward pressure on the Rupiah to maintain export competitiveness, and moderate capital inflows to lessen the debt burden on Indonesian firms. Yet, Indonesian firms continued to borrow heavily in international capital markets. The offshore borrowing was not reported correctly, hence there was an underestimation of foreign borrowing.

Foreign investment inflows continued in the first half of 1997. Consequently, the central bank took steps to prevent credit growth through sterilization from sales of central bank certificates, increase in reserve requirements, and reduction in subsidized credit to private enterprises.

2.2.3. Investment and FDI inflows

Liberalization of direct investment inflows involved expanding the number of permitted industries, liberalizing equity ownership rules in certain sectors, and increasing the length of time after which a company was required to revert to domestic ownership. Foreign direct investors were also allowed to sell foreign exchange directly to commercial banks. As a result of the improved climate for foreign direct investment, foreign investment approvals have increased rapidly since 1989. Recent investment projects were widespread across sectors, although the largest increases by value were concentrated in

resource-based manufacturing, services, and infrastructure. Infrastructure investment was also encouraged through tax incentives; in 1996, the government announced a 10-year tax holiday for investment in infrastructure development to compete against neighboring countries, which were providing these incentives. The tax holiday applied to investment projects that would be completed within 5-7 years of obtaining a license.

2.2.4. The financial sector

Financial sector reforms began with liberalization of interest rates and removal of direct credit controls on banks in 1983. In 1987, reforms concentrated on strengthening the capital markets and introducing new capital market instruments. In 1988, reforms emphasized improving the functioning of the banking system and developing the money markets. The role of private sector banks relative to state banks was enhanced and foreign participation in the financial sector was encouraged through the licensing of new foreign banks and branches. The scope and coverage of directed credit schemes was greatly reduced, although some limits were put on banks' other financial business activities and lending requirements to small businesses and the export sector were introduced.

Functioning of the capital market was improved by increasing the role of the market in raising funds for investments, increasing the maturity of money market instruments, and broadening the range of market makers. Portfolio capital inflows were liberalized in 1989 by removing the quantitative limits on borrowing from non-residents by banks. Foreigners could invest in the stock market, up to 49 percent of ownership of listed stocks.

Despite some backtracking in reforms in 1991 to stem the interference of capital inflows with macroeconomic management, development of financial markets continued through the mid-1990s. Banking reforms were codified in the banking law of 1992, which unified and replaced the 1967-68 banking acts. In addition to describing the more liberal framework, the new banking law officially removed the traditional functional

specialization between various types of banks and the major areas of specialization for state-owned banks.

In capital markets, middle class Indonesians were increasingly attracted to stock market investment, but the government also tried to attract foreign investors through public relations efforts. In recent years, Indonesia's equity markets, particularly the Jakarta Stock Exchange, has been bolstered by the surge in portfolio capital inflows. Inflows have contributed to strong increases in market capitalization, trading volumes, and share prices. Market activity was also boosted by improvements in clearing and settlement systems, and the growth of mutual funds. By around 1995, the government aimed to implement a coherent strategy for privatizing the state-owned enterprises, first by floating shares of some large state-owned enterprises and then by privatization of the largest state-owned commercial bank, Bank Negara Indonesia (BNI). However, this had the unintentional effect of making public the extent of bad debt in the banking sector, most of which was held by the state banks.

The Indonesian domestic bond market remained relatively small in comparison with the equity market, although mutual funds grew rapidly following deregulation introduced in the Capital Market Law of 1995. The legislation permitted these institutions to be wholly foreign owned and granted them income tax exemptions for investments in the domestic bond market.

The relatively fast pace of banking sector liberalization over the past decade and a half was not matched by increased prudential oversight. As liberalization progressed, the number of banks and the increased complexity of their business activities led to several episodes of banking distress, such as the collapse and closure of Bank Summa in 1992. Although Bank Indonesia responded by redesigning the prudential framework, attempts to deal with identified problem banks have been slower. Violations of prudential regulation have sometimes been met with regulatory forbearance, and few banks have been closed or merged. In recent years, the banking sector showed signs of weakness

including a high share of non-performing loans, increased exposure to foreign exchange risk, concentrated bank ownership, connected lending, and weak compliance with prudential requirements. In addition, exposure of banks to the property sector rose to around 20 percent in early 1997 from around 12 percent three years earlier.

2.2.5. The Political Environment

Strong linkages between the government, businesses, and the banks, what is generally referred to as "crony capitalism" in the press, has contributed to economic distortions and misallocation of resources. Policies taken to benefit politically well-connected monopolies have created controversy and mistrust of the government. For example, one stated initiative on the part of the government was to improve the efficiency and competitiveness of the export sector. However, the specific measures were highly controversial since they were devised to benefit the family and friends of President Suharto.

- The Asri Petroleum Group (established under Suharto's son Bambang Trihatmojo) received heavy tariff support, and there were worries that this might increase the costs for downstream producers.

- Despite the AFTA trade liberalization date being moved to 2003, in December 1995, Suharto insisted on a list of exemptions on goods such as cloves, rice, wheat flour, and sugar, which were the monopolies owned by Suharto's family or close friends.

- In February 1996, the National Car policy specified that qualified "pioneer" firms would be exempt from sales tax and tariffs on imported components. The only firm that received these benefits was the firm of Suharto's youngest son (Hutomo Tommy Mandala Putra), which collaborated with a Korean firm to initially import cars duty-free and then start to manufacture them at home. This treatment was not extended to any other firm even if it demonstrated the expertise needed for another three years.

The controversy was heightened when the EU, Japan and the USA lodged a complaint with the World Trade Organization (WTO) for violating certain WTO rules.

- Nepotism also cast suspicion on efforts to privatize a state-owned bank--shares were considered to be under-priced and half of the issue went to people linked to the first family.

- In April 1997, the inspection of all commercial cargoes entering Indonesia was handed back to the country's customs service--a step viewed as breeding inefficiency, red-tape and corruption.

These initiatives demonstrated the lack of government commitment to seriously address the economic problems pressing the country. They also helped Indonesia earn the title of the "most corrupt country in Asia" in March 1997, according to the private Hong Kong-based Political and Economic Risk Consultancy survey of expatriate businessmen operating in various Asian countries.

In addition to economic distortions caused by political nepotism, Indonesia has suffered from concerns about political stability and election fairness. There were several recent incidents of political sabotage, media tampering, and clashes between protestors and the military.[5] Allegations of electoral fraud and the limitation of political competition had also led to public riots, mainly by Indonesian youth. Episodes of political unrest have often been associated with declines in the stock market.

Regarding political developments in the period leading up to the crisis, in May 1997, Golkar (the majority party) had an unprecedented victory in the DPR (the national legislature) elections. Since Suharto belonged to Golkar and the president is elected by the DPR plus appointees who reflect the composition of the DPR, this overwhelming

[5] For specific examples, see Saxena (1998).

victory ensured a smooth re-election of Suharto for his seventh term in 1998. This incident of political stability brought with it the up trend in the stock market. During the Asian crisis, various reports of Suharto's ill health again brought uncertainty and declines in asset and exchange markets.

2.3. THE CRISIS UNFOLDS

The first country to come under attack in the Asian crisis was Thailand. The defense of its peg to the US dollar was difficult--with a weak and vulnerable financial system, high interest rates could not be used to prevent capital outflows. Adding to the pressure, speculators short-sold baht. The peg was defended until July 2, 1997 after which the Baht was permitted to float. Thereafter, Thailand sought help from the international community.

Indonesia withstood the initial contagion from Thailand mainly because of its strong fundamentals. Measures were also taken to resist pressure on asset markets. In July 1997, banks were banned from making loans to property developers for land purchases and land developments, and to prevent speculation, Indonesia widened the trading band for exchange rate against US dollar to 12 percent from 8 percent. The government also limited nonresidents' transactions in the forward market, and banks' net open positions. Despite a vigorous initial defense of the exchange rate from severe speculative pressure, the Rupiah was allowed to float on August 14, 1997, owing to government concerns about the adverse impact of high interest rates on the stability of the banking system. Soon after this move, the currency underwent a massive depreciation and Indonesia sought assistance from the IMF in October. The financial contagion from Thailand also spread to Singapore, Korea, Malaysia, Taiwan, the Philippines and Hong Kong.

When Indonesia signed its IMF program in October 1997, the Rupiah initially strengthened. However, the abrupt bank closures and concomitant bank runs, and the government's initial lack of commitment to implement the agreed IMF policy measures

led to a severe depreciation of Rupiah and decline in stock market values. This was heightened by the closure of a bank belonging to Suharto's son who publicly balked and threatened to take legal action. The government further lost credibility when it first cancelled 150 investment projects to gain international confidence, and then a few days later reversed its decision.

In December, a drought led to high food prices and food shortages. It was becoming increasingly difficult to manage the situation as food imports became expensive with the exchange rate crisis, and displaced urban day laborers could not return to rural areas to find work. Simultaneously, the fall in petroleum prices decreased Indonesia's export earnings, which further added to the pressure on exchange rate.

Uncertainty in the region grew when Korea signed its IMF program in December 1997. It was revealed that Korea had very little usable foreign reserves, and fear mounted that low debt rollover rates would lead to corporate defaults. The illness of Suharto, without a successor in sight, added to the panic. In January 1998, the Rupiah depreciated severely after Indonesia announced its fiscal budget, which contained economic assumptions that were seen as unrealistic. The budget also was viewed as reneging on several structural reforms that had been agreed to in the IMF program.

The crisis was then both political and economic. Especially in Indonesia's case, lack of commitment to implement structural reforms prevented recovery. Political and social unrest continued through the first half of 1998, eventually leading to the resignation of Suharto.

2.4. MODELS OF CURRENCY CRISIS AND THE ASIAN EXPERIENCE

Previous episodes of currency crises tended to stem from unsustainable fiscal deficits financed by seigniorage or were induced by trade-off between short-run macroeconomic flexibility and longer-term credibility. The first generation of currency crisis models such

as Krugman (1979) and Flood and Garber (1984) fit the experience of Latin American crises in response to monetization of debt from unsustainable fiscal imbalances. In these models, the central bank attempts to maintain a fixed exchange rate with limited foreign exchange reserves and high monetary growth and inflation resulting from growth of domestic credit. Anticipation of future devaluation leads to an accelerated draw down of reserves as speculators attack the currency. In the Asian crisis countries, however, fiscal budgets were generally in surplus and as a result, inflation was low.

The second generation models explained the crises as self-fulfilling outcomes. While Diamond and Dybvig (1983) present a stylized model of financial intermediation in which there are two equilibria: one in which agents have confidence in the solvency of financial intermediaries; and the one in which lack of confidence leads to a bank run, Obstfeld (1986) emphasized the tension between the government's motives to defend and abandon an exchange rate peg. Modeled largely on the experience of European countries, the focus is on the desire of the government to use expansionary monetary policy to reduce unemployment. Even if reserves are sufficient to defend a fixed exchange rate, market confidence in the commitment of the government to defend the peg may weaken if the costs are believed to be higher than the benefits. However, this explanation also does not appear to be relevant for the Asian case, as cyclical weakness did not emerge until after the crisis was well underway.

New generation models of currency crisis emphasize financial sector weaknesses, and investor behaviors. Goldfjan and Valdes (1997) focus on the role of financial intermediaries in currency crises. These intermediaries provide liquidity, which is attractive to foreign investors with short-term incentives for investment, hence aiding capital inflows. However, due to exogenous shocks, when the foreign investors want to withdraw their deposits, these intermediaries, being locked in illiquid assets, face the risk of failure. Hence, a bank run leads to the capital outflows and exchange rate collapse. Their model provides role for the banking system in magnifying the shocks to

fundamentals (productivity and international interest rates), but does not assume any kind of inconsistency in the policy making, like the first and second generation models.

While Goldfjan and Valdes (1997) capture the illiquidity in domestic financial markets, leading to a panic and crisis, Agenor and Aizenman (1997) analyze the transmission process of contagious shocks by capturing the imperfections on both world capital markets and domestic credit markets.

Other models emphasize rational herding or multiple equilibria resulting from imperfect information and moral hazard. Froot, Scharfstein and Stein (1992) show that speculators with short horizons may herd on the same information, trying to learn what the other informed traders know. These could lead to multiple equilibria, and herding speculators may even choose to study information that is completely unrelated to fundamentals. So the large perceived penalty of missing a bull market leads managers to follow the pack even if fundamentals do not warrant it; conversely, the penalty of losses during a bear market is lower as all managers are losing money as well.

Krugman (1998) and Corsetti, et al (1998b) explain the Asian crisis using moral hazard models. Krugman (1998) analyzes the case of over-guaranteed and under-regulated financial intermediaries, that encourage excessive investment in the economy. If the economy does not have access to the world financial market, then excessive investment demand by intermediaries would show up in higher interest rates rather than excessive investment. The access to the world market allows moral hazard in the financial sector to translate into real excess capital accumulation. Corsetti, et al (1998b) also consider the case of moral hazard fueling over-investment, excessive borrowing, and current account deficits. Unprofitable projects and cash shortfalls are re-financed through external borrowing as long as foreign creditors lend to domestic agents against future bail-out revenue from the government. The government deficits need not be high before the crisis, but refusal of foreign creditors to re-finance the debt forces the government to step in and guarantee the outstanding stock of external liabilities. The government also might have

recourse to seigniorage revenues. In this case, expectations of inflationary financing thus cause a collapse of the currency.

The Asian crisis exhibited no signs of predictability based on the traditional crisis models. The government deficits and inflation were low, unemployment was not a problem, capital inflows continued, and credit ratings were high from all agencies. Indeed, the current crisis in Asia is thought to have different characteristics from previous episodes. The crisis is attributed mainly to the excesses in the financial sector, which--combined with poor supervision and lax accounting standards--have led to the collapse of a speculative bubble. The prolonged maintenance of pegged exchange rates and record of high economic growth rates encouraged massive inflows of capital. Poor financial sector supervision and weak prudential regulations allowed excessive lending, much of it directed toward real estate, construction, stock purchase and consumer loans. The ratio of short-term debt to foreign exchange reserves rose to high levels prior to the crisis. While this indicated vulnerability to a crisis, it did not guarantee the onset of one. Furthermore, these vulnerability indicators were ignored since the economies had sustained high rates of economic growth. When investors lost confidence in the economy and currency, the ensuing depreciation and rise in interest rates led to bankruptcies of banks and finance companies as loans soured.

In short, proposed causes for the Asian financial crisis include the following:[6]

- They all suffered from real appreciation of currencies. Since they all had de-facto exchange rate pegs to the US dollar or to currency baskets that gave a high weight to the US dollar, these currencies became overvalued when the US dollar appreciated relative to other major currencies (especially the yen). All these countries gained from the appreciation of Japanese yen in 1993-95, but lost their competitive edge when the Japanese yen depreciated against the US dollar in 1996.

- Prolonged maintenance of fixed exchange rates weakened the ability of central banks to use monetary policy to react to overheating pressures.

- The implicit guarantee of exchange value encouraged over-borrowing in foreign debt. Since much of this was short-term, banks and private companies were vulnerable to refusals of creditors to rollover the debt.

- Weak prudential regulations and poor financial supervision permitted a deterioration in bank loan portfolios.

- The severity of the crisis owed to a "competitive devaluation" game, as devaluation in one country decreased the export competitiveness of other currencies, leading to further rounds of exchange rate adjustments.

- An investment boom led to current account imbalances and huge foreign debt. Investment rose sharpest in the non-traded sectors (non-traded goods, real estate, speculative asset purchases). Since borrowing and lending was directed toward speculative assets, there was a price bubble, which burst in 1997 and the simultaneous currency fall aggravated the debt problem as the burden increased in real terms.

- Implicit government bailout guarantees created "moral hazard" problems, whereby banks borrowed too much and financed marginal projects, which turned out to be unprofitable later.

- The governments were weak, lacked credibility and were not committed to structural reforms. Corrupt and nepotistic governments created distortions in the economy, which came under increased scrutiny after the crisis began.

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[6] See Berg (1998), IMF (1997), Kochhar, et al (1998), Corsetti, et al (1998a), and Radelet and Sachs (1998a) for overviews of the origins, onset, and spread of the Asian crisis.

- Political uncertainty reduced investor confidence and increased reluctance to roll over short-term debt.

- In 1995-96, there was a drop in demand for semi-conductors, the major export of these Asian countries. Also, economic stagnation in Japan in 1990s was another factor responsible for decrease in exports (roughly one-third of exports went to Japan).

- Low international interest rates (especially in Japan) led to elevated capital flows to developing countries in search of higher returns.

- Limited availability of economic data and lack of transparency increased vulnerability to capital flow reversals (and contagion) when problems became evident.

2.4.1. Contagion, Panic and Crisis in Indonesia

Despite Indonesia's own internal problems, which included under-supervised banks, extensive crony capitalism, corruption, monopoly power and growing short-term debt, this country has been viewed as the clearest case of contagion, as it had the least severe macroeconomic imbalances.[7] Indonesia's current account deficit was the lowest of the Asian-5 and export growth in 1996 was the second highest. The budget surplus averaged over one percent in the previous four years, while credit growth was modest. Foreign liabilities of commercial banks were below the other affected economies (although corporate foreign debts were high) and there were no major corporate bankruptcies. The stock market continued to rise through early 1997 until the onset of the crisis in Thailand.

In short, the crisis in Indonesia does not appear to have been caused by poor traditional economic fundamentals. The crisis appears to relate to a weak financial sector and political uncertainty, combined with contagion from economies in the region.

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[7] See Radelet and Sachs (1998a) for detailed arguments supporting this view.

2.5. ECONOMETRIC EVIDENCE OF CONTAGION IN INDONESIA

Since the measure of equilibrium real exchange rate from Big-Mac parity[8] suggests that the Indonesian Rupiah had been 30% under-valued before the crisis, the severe depreciation that took place in the wake of the Asian crisis looks puzzling. This section decomposes the causes of the pressure on the domestic currency into domestic and external fundamentals and contagion. The domestic fundamentals are of three kinds; financial, non-financial and political.

2.5.1. Data and Linear Estimation

The term "crisis" in this paper refers to an intense increase in speculative pressure on the country's currency. Therefore, we construct a measure of exchange rate pressure termed the Market Pressure Index (MPI) as follows:

$$(2.1) \qquad MPI_{i,t} = \frac{(\%\Delta e_{i,t})}{\sigma_{\Delta e_{i,t}}} + \frac{(\Delta i_{i,t})}{\sigma_{\Delta i_{i,t}}} - \frac{(\%\Delta r_{i,t})}{\sigma_{\Delta r_{i,t}}}$$

where e is the U.S. dollar exchange rate (domestic currency/US$) and the changes in the exchange rate, interest rate and reserves are weighted by their respective standard deviations.[9]

This index is high when there is pressure on the currency and low otherwise. The intuition is that if there is an attack on the currency, either the exchange rate would depreciate, or interest rates would be raised to prevent the attack, or the central bank would sell foreign currency to support the exchange rate. Figure 2.1 shows the MPI for Indonesia, Korea and Thailand. Thailand and Korea were chosen for comparison since

[8] This figure has been taken from the Economist web site.
[9] See e.g. Eichengreen, Rose, and Wyplosz (1996), Sachs, Tornell, and Velasco (1996), Frankel and Rose (1996) and Kaminsky, Lizondo, and Reinhart (1997) for similar constructions of exchange rate pressure.

they experienced macroeconomic problems, which forced them to seek IMF programs in 1997. It is clear from the figure that the MPI increased for all the three countries in 1997. There are two substantial spikes in the MPI in 1997. The first one is around mid-1997, when a large increase in the MPI for Thailand was followed by a larger increase in the MPI in Indonesia. The second spike is towards the end of 1997, when an increase in the Indonesian MPI follows an increase in the Korean MPI. Hence, both times Indonesia experienced pressure on its currency after Thailand and Korea.

To decompose the causes of the severe crisis in Indonesia, a number of domestic and foreign fundamentals are investigated. It is clear from the background section that Indonesia had some severe financial and political problems. Since Indonesia is an oil-based country, it is likely to have been affected by some terms of trade shocks as well. In addition, the crisis could have precipitated due to some external shocks (captured by financial conditions in the U.S. and Japan). Hence, all these variables are considered in contributing to the crisis. The domestic variables considered in this study are of three kinds: financial (private claims to GDP, domestic credit to GDP, foreign liabilities to GDP, foreign assets to M1 and interest rate spread)[10], non-financial (trade balance and terms of trade) and political (political confidence).

- Private claims to GDP and domestic credit to GDP are a proxy for how extended the banking system is.[11] An increase in these ratios signifies growing strain in the banking system.[12] These variables were intended to account for a possible boom and

[10] IMF (1997a) and IMF (1997b) outlined concerns about the soundness of the banking sector just prior to the onset of the crisis.

[11] Hardy and Pazarbasioglu (1998) find a persistent tendency for credit to the private sector to follow a boom and bust pattern in advance of banking crises, with a further decline in credit growth during the crisis. Sachs, Tornell, and Velasco (1996), Radelet and Sachs (1998b) and Corsetti, Pesenti, and Roubini (1998b) also use this variable as a measure of a bank lending boom, arguing that this measure proxies for financial fragility, as the quality of bank loans is likely to deteriorate significantly when bank lending grows at a rapid pace in a relatively short period of time. Kaminsky and Reinhart (1996) find that the growth in domestic credit to GDP accelerates steadily and markedly as the crisis approaches, peaking at the time the crisis erupts.

[12] Domestic credit to GDP consists mainly of claims on the private sector. Net claims on the government are negative, indicating that the government was a net creditor. The inclusion of the central bank may be important in Indonesia's case since the central bank was a source of subsidized credit to the agricultural sector and public enterprises. For some Latin American country studies, net domestic credit of the central bank may be the most useful variable, as it would reflect the financing of government expenditure similar

bust lending cycle in the crisis countries. Moreover, financial inflows in previous years had been channeled into the property market, stock market, and the corporate sector with decreasing profitability.[13]

- We also included variables intended to measure foreign exchange exposure risks in the financial sector. The ratio of foreign liabilities to GDP measures the extent to which the banking system relies on foreign capital to fund its operations; hence, it proxies for the banking system's vulnerability to a sudden reversal of capital inflows. The ratio of foreign assets to M1 measures the degree to which the M1 money supply is backed by foreign assets of the banking system.
- The interest rate spread is the difference between bank lending and deposit rates. It is an indicator of the profitability of the banking system.
- A deterioration of the trade balance may indicate an overvalued exchange rate leading to slow export growth and increased import growth.
- An adverse terms of trade shock may affect the competitiveness of the economy, and lead to deterioration of corporate sector profitability.
- The political confidence index is a measure of investors' confidence in the political stability of the economy. An increase reflects greater confidence, which may encourage capital inflows.

The external fundamentals consist of U.S. and Japanese rates of interest. The U.S. rate of interest is a proxy for the world interest rate. Lower world interest rates reduce pressure on the exchange rate as capital flows out of industrial countries to developing countries in search of relatively higher returns. In addition to the US interest rate, the Japanese interest rate is used, since monetary conditions in Japan are believed to have contributed to the Asian crisis.

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to the first generation speculative attack models. However, it is less relevant for Indonesia since it did not have budget problems in recent years. The total domestic credit from the central bank and deposit money banks gives an overall measure of lending activity of the entire banking system to the domestic economy.

[13] Claessens, Djankov, and Lang (1998) find that while investment rates were high, corporate profitability in most East and Southeast Asian countries declined sharply in the years 1994-1996 while leverage increased. In Indonesia, profitability measured by real Return on Assets (ROA) declined from 12.8 percent in 1990 to 4.9 percent in 1996. This data, while instructive, is unfortunately annual. We are not aware of high frequency data on corporate profitability for Indonesia.

The sources and construction of all variables are provided in the Appendix 1.

Table 2.1 shows the trends in the explanatory variables from 1991-1998 Q1. Although Indonesia had a current account deficit in 1990s, the merchandise trade balance was in surplus. The trade surplus more than doubled in US dollar terms between 1991 and 1994, after which it declined in 1995 and 1996. The trade balance increased to 11.7 billion US dollars in 1997, mainly in response to import compression from the depreciation in August. The terms of trade index improved over the period 1991-96. However, it deteriorated in 1997, affecting the competitiveness of the economy. Domestic credit to GDP and private claims to GDP rose from around 46 percent to 58 percent between 1991 and 1997. The ratio of foreign liabilities to GDP increased from 4.5 to 6.5 percent between 1991 and 1994, and further increased to 11.3 and 15 percent in 1997 and 1998 Q1, respectively. The ratio of foreign assets to M1 remained between 30 and 40 in 1991-96, but increased to 68 and 108 percent in 1997 and 1998 Q1, respectively, mainly reflecting the exchange rate effect[14]. The interest rate spread peaked in 1993 at 6 percent. Since then it has fallen to a low of 1.8 and 1.6 percent in 1997 and 1998 Q1, respectively, indicating disintermediation of banks. The political confidence index shows an increase from 1989 through early 1997 (Figure 2.2). According to the definition of political confidence, Indonesia moved from a high risk to moderate risk country in 1993. But it again became a high-risk country beginning in the latter half of 1997, and the index experienced a sharp decline in 1998 Q1.

To find out which of the above variables best explain the pressures on Indonesian currency, an Ordinary Least Square (OLS) equation is estimated. The MPI for Indonesia is regressed on all the lagged domestic and foreign fundamentals.[15] The OLS results are shown in Table 2.2. Three variables are found to be significant (foreign liabilities to

[14] The domestic currency equivalent of foreign currency denominated assets rises as domestic currency falls.

[15] Contemporaneous fundamentals could lead to endogeneity problems. For example, movements in the explanatory variables may result from valuation effects related to exchange rate changes, or may reflect the economic consequences of a major devaluation

GDP, political confidence and private claims to GDP). To arrive at the most important fundamentals, the insignificant variables were dropped from this equation one by one. The final specification has foreign liabilities to GDP, political confidence and private claims to GDP. The positive sign on foreign liabilities to GDP means that an increase in this variable makes the banking system more vulnerable to capital outflows that put pressure on the currency. Likewise, the negative sign on the political confidence variable means that as investors lose confidence in the economy, there is an outflow of funds and hence pressure on the currency. The sign on private claims to GDP is significant and negative. This unexpected sign prevails despite positive sample correlations between this variable and the MPIIDN on a contemporaneous and lagged basis.[16]

2.5.2. Probit Models

Following the methodology used in the literature (especially Eichengreen, Rose and Wyplosz (ERW) (1996)), we estimate a probit model. *The probit model is presented mainly as a benchmark against which to compare the later Markov Switching estimations*, which we argue have theoretical advantages over the probit model. The probit model uses a discrete dependent variable, and permits estimation of the probability of a speculative attack. The discrete dependent variable is constructed as follows (using the definition of the crisis or speculative attack that ERW (1996) use):

$$(2.2) \quad DUMMPI_x = 1 \; if \; MPI_x > \mu_{MPI_x} + 1.5 * \sigma_{MPI_x}$$

where x denotes IDN, KOR and THA for Indonesia, Korea and Thailand, respectively, μ denotes the mean, and σ denotes the standard deviation. According to this definition, there were only four time periods when Indonesia faced a crisis.

[16] We are indebted to Charles Engel for pointing out that an increase in private sector claims to GDP may represent a strengthening of the banking sector on the basis that if increased confidence in the banking sector leads to more deposits, there could be correspondingly higher lending activity.

Table 2.3 shows the results from the probit models. The dummy for crisis in Indonesia (DUMMPIIDN) is estimated using lagged (model 1) domestic fundamentals (foreign liabilities, political risk and private claims to GDP). There are two significant variables: the ratio of foreign liabilities to GDP and the ratio of private claims to GDP; however, the latter has the wrong sign as in the OLS estimation. Figure 2.3 shows the actual and fitted probabilities of crises for this model. The fitted value series peaks in early 1998, although with a one period delay compared to the actual. It misses the crisis in 1986 and mid-1997. The model also indicates periods of pressure in 1989-93 (especially in 1991), when there is no actual crisis according to this definition.

Model 2 is estimated with lagged probabilities of crises, respectively, in Korea and Thailand and with the domestic fundamentals. The coefficients on the probability of a crisis in Thailand and private claims to GDP are significant. The sign on the latter variable is again incorrect while the sign on the former suggests that pressure in Thailand leads to pressure in Indonesia. Figure 2.4 shows the actual and fitted probabilities of crises for this model. The fitted value is a slight improvement compared to model 1, since it peaks simultaneously with the actual data in early 1998 and had a smaller probability of a crisis in 1991.

In order to see if the external fundamentals (probability of crises in Korea and Thailand) are significant in predicting a crisis in Indonesia, a Likelihood Ratio Test was performed. The result is in Table 2.5. The test indicates the joint significance (at 5 percent level) of the two variables in the probit model. This is an indication of some kind of contagion from the neighboring countries into Indonesia.

2.5.3. Markov Switching Models[17]

Although the probit model results showed weak signs of contagion, there are limitations to the use of probit models. The creation of a discrete dependent variable involves an

[17] For details about estimating these models, see Kim and Nelson (1998)

arbitrary cut-off in the underlying MPI in defining a period of crisis. In the Indonesian data, the conversion of the MPI to a discrete measure of crisis for the probit models results in only four cases of crisis. Also, making the probability a discrete variable leads to a loss of information on the magnitude of speculative attack (e.g. the data shows numerous incidents of pressure on the currency of varying degree). The exclusion of incidents of speculative pressure on the exchange rate below the arbitrary threshold value has the further disadvantage of introducing sample bias into the estimation procedure. Flood and Marion (1998) argue that many models of speculative attack indicate that unanticipated devaluations produce the largest jump in the MPI. The size of jumps in the MPI at the time of attack is reduced by the extent to which the attack is anticipated. Thus, selection of only extreme values of the MPI (as in construction of the dependent variable for probit models) may reduce the share of predictable crises in the sample and reduce the number of crises that are likely to be correlated with fundamental economic determinants. We turn to a model that makes the probability of a crisis in Indonesia continuous and endogenous. Estimation of Markov Switching Models (MSMs) permits full use of the continuous dependent variable while endogenously determining the probability of a switch in regime.

Fixed Transitional Probability Model: The Fixed Transitional Probability (FTP) MSM estimates the switch in mean of the MPI of Indonesia in the two states (high pressure indicating a crisis state and low pressure a non-crisis state). The model filters the data into states of high and low pressures and estimates the probabilities accordingly. The estimated model consists of a measurement equation with mean switching, and fixed transitional probabilities:

$$(2.3) \quad MPI_t - \mu_{s_t} = \phi [MPI_{t-1} - \mu_{s_{t-1}}] + \sum_{i=1}^{3} \beta_i DV_{i,t-1} + e_t$$

$$(2.4) \quad e_t \sim iidN(0, \sigma^2)$$

(2.5) $\mu_{s_t} = (1 - s_t)\mu_0 + s_t\mu_1$

(2.6) $\Pr(s_t = 0 / s_{t-1} = 0) = q$

(2.7) $\Pr(s_t = 1 / s_{t-1} = 1) = p$

where the MPI follows an AR(1) process and has two means (μ_0 low pressure and μ_1 high pressure); DV_i consist of the predetermined variables found to be significant in the OLS regressions: political conf, forliabgdp, and pvtclaimgdp; p is the probability of remaining in a crisis state between times *t-1* and *t*; q is the probability of remaining in a no-crisis state; and s_t is the unobserved state.[18]

There are two types of figures shown for the Markov Switching Models. The figures containing the probability of a crisis compare the actual data at time t, $MPIIDN_t$, and the one step ahead probability of a crisis ($\Pr(S_t = 1 / MPIIDN_{t-1})$). The figures containing the forecasted values compare the actual data, $MPIIDN_t$, and the conditional expectation at time t-1, ($E_{t-1} MPIIDN_t$). Construction of forecasted values is described in Appendix 2. The forecasted values of MPIIDN are constructed using the parameters estimated over the entire sample, the predetermined explanatory variables and one step ahead probability of switching to the high state in the next period.

Figures 2.5 and 2.6 show the MPI for Indonesia, one-step ahead probability of a crisis in Indonesia, and the forecasted MPI for Indonesia. Figure 2.5 shows that the dependent variable (Indonesia's MPI) indicates the occurrence of crises in 1997 and early 1998, but does not indicate incidents of significant pressure on the currency in any earlier periods. The spikes in the one step ahead probabilities occur one period after the crisis. Figure 2.6 shows the forecasted MPI for Indonesia from FTP MSM. The values are concentrated

[18] As a sensitivity test, we attempted to put the three domestic variables into the transitional probabilities, and separately tried using the entire original set of fundamental variables in the measurement equation, but convergence was not achieved in either case.

around zero, as the probability of going to a high state (*1-q*) is very low. Also, the spikes in the forecasted values occur one period after the actual data.

The coefficient estimates are summarized in the first column of Table 2.4. The estimate of q, ϕ, variance, μ_1 and political confidence are significant. The high value of q depicts a lot of persistence in the no-crisis state. The negative coefficient on political confidence indicates that decreasing confidence in the political environment is associated with an increase in speculative pressure. The coefficients on forliabgdp and pvtclaimgdp have the correct sign, although insignificant.

Time-Varying Transitional Probability Model with regional contagion: To see if the exchange market pressures in Indonesia could be explained by movements in MPIs of Thailand and Korea, a time varying transitional probability (TVTP) Markov Switching Model[19] is estimated. In this model, the probability of a crisis varies in the high and low states according to one period lags of the MPIs of Thailand and Korea. The transitional probabilities are given by:

$$(2.8)\quad \Pr(s_t = 1 / s_{t-1} = 1) = p_t = \frac{\exp[p_0 + p_1 MPI_{j,t-1} + p_2 MPI_{k,t-1}]}{(1 + \exp[p_0 + p_1 MPI_{j,t-1} + p_2 MPI_{k,t-1}])}$$

$$(2.9)\quad \Pr(s_t = 0 / s_{t-1} = 0) = q_t = \frac{\exp[q_0 + q_1 MPI_{j,t-1} + q_2 MPI_{k,t-1}]}{(1 + \exp[q_0 + q_1 MPI_{j,t-1} + q_2 MPI_{k,t-1}])}$$

where $MPI_{j,t-1}$ and $MPI_{k,t-1}$ is the lagged MPI for Thailand and Korea; respectively and p and q are varying over time in response to movements in these MPIs.

Figure 2.7 shows the actual MPI and one-step ahead probability of a crisis in Indonesia when the probability is a function of lagged Thai and Korean MPIs. It is clear from these figures that when the neighboring countries' market pressure indexes are accounted for, there is considerably more variation in the estimated probabilities. In addition, the crises

are picked up with much greater accuracy in a TVTP model and without delays. The probability of a crisis peaks very close to one at the same time as the actual data in autumn 1997 and again early 1998. The simultaneous peaking is prediction because the comparison at each point in time is between the actual data at time t, $MPIIDN_t$, and the one step ahead probability of a crisis ($\Pr(S_t = 1 / MPIIDN_{t-1})$). In contrast, analogous probit models had relatively poor results in predicting these crises. Figure 2.8 shows the forecasted values from this model. The forecasted values overestimate the actual data during the earlier "tranquil" periods. This could be attributed to the higher probability of switching to the higher (crisis) state.

The second column of Table 2.4 shows the parameter estimated from this model. In addition to the same significant parameters as in the FTP model, μ_0, $q1$ and $q2$ are significant. The negative signs on $q1$ and $q2$ show that as the pressure on Thai and Korean currency rises, the probability of remaining in a no-crisis state decreases and hence there is increased likelihood of a move to a crisis state in Indonesia. The likelihood ratio test (Table 2.5) shows the joint significance of p's and q's at 1 percent level of significance, suggesting the importance of Thai and Korean MPIs in predicting a crisis in Indonesia. Thus, there is evidence of contagion from the crisis in Thailand and Korea.

Attention should be drawn to one additional point regarding the MSM results. The MSMs predict state shifts in the mean of the MPI. Although these state dependent means were not specified a priori, they are endogenously estimated by the model. In all of these MSMs, the estimates for the low state mean is slightly below the simple mean of the *MPIIDN* over the sample, while the estimated value of the high state means are very high, ranging from 8 ½ to 10 ½. The actual data on *MPIIDN* only attains these high values in 1997, during the time when any reasonable definition would indicate that a crisis occurred. Therefore, the probability of having the high state mean could be reinterpreted as the probability of having mean so high as to be equivalent to "crisis".

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[19] These models have been used by Diebold, et al (1994) and Filardo (1994) to examine the business cycles.

2.5.4. Contagion in Stock Market

The currency crisis in Indonesia was accompanied by a massive drop in the stock market. Figure 2.9 shows the daily co-movement of the Nominal Effective Exchange Rate (NEER) and stock market index (SMI) in Indonesia. There was a sharp drop in exchange rate and SMI in August 1997 and since then they have moved together. This observation is consistent with a movement out of Indonesian financial and Rupiah-denominated assets. Figure 2.10 shows the daily movements in SMIs in Indonesia, Korea and Thailand. It is evident that the three stock markets have been moving together since mid-1997. Thailand's SMI has been declining continuously since the beginning of 1996.

To look for contagion in stock market, similar FTP and TVTP models are estimated on SMIs. Figures 2.11 and 2.12 show results from FTP models, while Figures 2.13 and 2.14 show those for TVTP models.

The estimates of p, ϕ, variance and μ_0 are significant in both models, while μ_1 is significant only in TVTP model. Although the p's and q's are individually insignificant, the LR test shows a joint significance of SMIs for Korea and Thailand at 5 percent level. Thus, there is some evidence of contagion in stock market.

2.6. OUT-OF-SAMPLE FORECASTING OF MARKET PRESSURE INDEX

In order to gauge the performance of the Markov Switching Models vis-a-vis the probit models, this section estimates the out-of-sample forecasts of the market pressure index to see if the 1997 crisis could have been predicted.

For the purpose of out-of-sample forecasting, the Markov Switching Models are estimated over the time period 1985:1 through 1996:8. The parameters from this estimation are used to estimate the probability of a crisis[20] as well as the market pressure

[20] For the derivation of the filter to estimate the probability of a crisis, refer to Kim and Nelson (1998).

indices out-of-sample[21]. However, the sample period over which the models are estimated doesn't have any major crisis peak in the market pressure indices. Hence, the difference in means in the two states is not much. This leads to an under-prediction of the market pressure index in 1997. This is by no means a limitation of the models. However, this is the limitation of the data. Indonesia doesn't have crises on the order of magnitude of the 1997 one in its entire sample period from 1985:1 to 1998:4. In the absence of a crisis like the recent one, the Markov Switching Models cannot distinguish between the high and the low states really well, so the estimated means excluding the recent crisis are very low and close together. This shows up in the forecasts of the market pressure index—although the out-of-sample probabilities are very good, the switch is from a low mean to a negligibly higher one. On the other hand, forecasts were at least possible with the MS models. The probit models—the standard models used in the prior literature—could not even be estimated over the sample period 1985:1 to 1996:8 due to the lack of any overlapping crisis observations between Indonesia and the other countries.

The results from the out-of-sample forecasting are shown in Figures 2.15-2.18. The prefix IS refers to in-sample (one step ahead) probabilities and forecasts, while OS refers to out-of-sample. For both the models, the out-of-sample forecast of the market pressure index is really low. As mentioned earlier, it has been the case because of the absence of crises on the order of magnitude of the 1997 one.

The out-of-sample one step ahead probability of a crisis performs similar to the in-sample probability for the fixed transitional probability model (Figures 2.15), except that the out-of-sample probability has higher magnitude. However, it peaks at the same time in 1998:1. The out-of-sample forecast of the market pressure index is very low (Figure 2.16). As mentioned earlier, it is a result of very close means.

[21] The out-of-sample forecasts of the market pressure index are constructed as described in Appendix 2, except that the parameters are estimated over the restricted sample and the probabilities are out-of-sample probabilities.

In case of the time-varying transitional probability model, the out-of-sample one-step ahead probability of a crisis starts to rise in 1997:4, when the crisis was starting to emerge in Thailand (Figure 2.17). The out-of-sample probability peaks again when the market pressure peaks in early 1998. The out-of-sample forecast of the market pressure index (Figure 2.18) is low as mentioned, since the means in the two states are not very different.

Although the out-of-sample forecasts of the market pressure index are very low compared to the actual one, the out-of-sample one-step ahead probability of a crisis are pretty good. While the markov switching models can be estimated over the restricted sample for out-of-sample forecasting, the probit models could not even be estimated due to the lack of any overlapping crisis observations between Indonesia and the other countries.

2.7. CONCLUSIONS

The chief objective of this paper has been to examine the causes of the exchange rate crisis in Indonesia. The estimate of "equilibrium" level of real exchange rate for Indonesia from the Big-Mac parity shows that the Indonesian Rupiah was 30% undervalued before the crisis. This suggests that overvaluation was not the cause of the severe depreciation that took place in 1997. Additional causes are explored, which fall into three broad categories: (i) domestic factors, including non-financial and financial fundamentals, and political confidence; (ii) external shocks common to the Asian countries, and (iii) contagion from crises in the region. The latter factor is meant to gauge shifts in market sentiment that is unexplained by other macroeconomic fundamentals.

There may be some difficulty in distinguishing pure contagion from unobserved spillovers from neighboring countries or unobserved common global shocks. The two most likely spillovers include either trade linkages or financial linkages. If a neighboring country has a devaluation, the home country's exports may slow due to slackening demand from the neighbor or third countries (due to export competition with the

neighbor); likewise, imports from the neighbor may increase owing to the price effect. These trade linkages may lead to deterioration of the home country's trade balance. There could also be direct financial linkages between the countries. Financial institutions in the home country may have a credit exposure or equity stakes in corporations, financial institutions, or real estate in the neighboring country. A crisis in the neighbor country could then spillover by causing weakness in the home country's financial sector. While this paper does not control for direct spillovers from Thailand and Korea, it includes variables such as Indonesia's trade balance, and various financial indicators which should respond to linkages with neighbors, among other things. An attempt was also made to control for common global shocks by including international variables such as U.S. and Japanese interest rates.

Results from OLS, Probit, and Markov-Switching models suggest that domestic financial conditions, loss of political confidence, and contagion from the region were all instrumental in causing the crisis. In particular, exchange pressure in Thailand and Korea helped predict subsequent exchange pressure in Indonesia.

Table 2.1: Trends in Explanatory Variables

	1991	1992	1993	1994	1995	1996	1997	1998, Q1
Trade Balance (millions of US dollars)	3273	6687	8495	8072	4787	6885	11750	6300 1/
Terms of Trade (Index)	128.8	131.6	131.4	135.9	150.5	170.6	145.8	133.7
			(in percent)					
Domestic Credit to GDP	45.6	46.0	47.7	50.6	51.8	54.2	58.1	62.4
Private Claims to GDP	45.8	45.5	48.9	51.9	53.5	55.4	61.1	59.8
Foreign Liabilities to GDP	4.8	5.7	6.2	6.5	5.9	5.6	11.3	14.8
Foreign Assets to M1	41.5	47.3	33.6	31.1	36.3	40.3	68.1	108.1
Interest Rate Spread	2.2	4.4	6.0	5.2	2.1	2.0	1.8	1.6
Japanese Discount Rate	4.5	3.3	1.8	1.8	0.5	0.5	0.5	0.5
US three-monthT-bill rate	5.4	3.5	3.0	4.3	5.5	5.0	5.1	5.1
Political Confidence (Index)	56.6	56.9	60.7	62.0	62.7	65.9	65.0	52.0

1/ The figure for 1998 represents quarterly trade balance and is not annualized

Table 2.2: Results from Ordinary Least Squares

	MPIIDN	MPIIDN Final Specification
Constant	0.559	0.170
	2.288 **	1.260
AR(1)	-0.093	-0.034
	-0.870	-0.358
DOMCRGDP(-1)	-7.933	
	-1.566	
FORLIABGDP(-1)	12.532	12.153
	3.669 **	3.898 **
FA2M1(-1)	-1.198	
	-0.655	
POLCONF(-1)	-0.582	-0.351
	-3.638 **	-2.973 **
PVTCLAIMGDP(-1)	-4.400	-4.893
	-2.302 **	-2.940 **
RTSPREAD(-1)	0.317	
	1.068	
TB(-1)	-0.341	
	-0.654	
TOT(-1)	0.001	
	0.080	
JPNRROI(-1)	0.832	
	1.108	
USRROI(-1)	0.502	
	0.651	
R-squared	0.212	0.157
Sample Period	86:7 to 98:3	85:1 to 98:3
No. of Observations	141	159

Note: The figures below the coefficients are t-statistics.
** and * denote the significance at 5 and 10%, respectively.

Table 2.3: Results from the Probit Model
The dependent variable is DUMMPIIDN

	Model 1	Model 2
CONSTANT	-2.408	-2.613
	-6.631 **	-5.915 **
DUMMPIKOR(-1)		1.870
		0.638
DUMMPITHA(-1)		1.621
		2.047 **
FORLIABGDP(-1)	1.555	0.935
	3.006 **	1.319
POLCONF(-1)	-0.156	0.004
	-0.943	0.015
PVTCLAIMGDP(-1)	-8.459	-6.543
	-2.992 **	-1.798 *
LOGLIKELIHOOD	-11.478	-7.938
Obs. With Dep=1	4	4
Obs. With Dep=0	156	155

Note: The figures below the coefficients are t-statistics. ** and * denote significance at 5 and 10%, respectively.

Table 2.4: Results from Markov Switching Models

	MPIIDN		SMIIDN	
	FTP	TVTP	FTP	TVTP
p	0.331	0.000	0.951	1.000
	1.225	0.000	55.400 **	348.42 **
q	0.987	1.000	0.188	0.000
	107.99 **	11111 **	1.500	0.017
phi	-0.167	-0.284	0.413	0.247
	-2.100 **	-2.930 **	5.820 **	3.660 **
variance	1.087	1.062	2.267	2.678
	17.660 **	17.510 **	18.280 **	18.460 **
mu0	-0.104	-0.135	-7.118	-1.406
	-1.325	-1.920 *	-9.280 **	-2.760 **
mu1	9.816	8.515	0.252	0.542
	14.480 **	15.830 **	1.012	1.700 *
mpithap(-1)	-	-0.740	-	0.019
	-	-1.057	-	0.196
mpithaq(-1)	-	-0.195	-	0.344
	-	-1.709 *	-	0.584
mpikorp(-1)	-	0.410	-	0.435
	-	0.727	-	1.255
mpikorq(-1)	-	-0.148	-	-0.363
	-	-3.093 **	-	-1.179
fliabgdp(-1)	11.427	20.227	-	-
	0.554	1.004	-	-
polconf(-1)	-0.184	-0.243	-	-
	-2.284 **	-3.099 **	-	-
ptclmgdp(-1)	9.919	8.848	-	-
	0.882	0.806	-	-
Likfn.Val	246.98	281.78	636.63	642.45

Note: The figures below the coefficients are the t-statistics. ** and * denote the significance of the coefficients at the 5 and 10% level of significance, respectively.

Table 2.5: Likelihood Ratio Tests 1/

Model 2/	Likelihood Value	Critical Values	Likelihood Ratio
Probit models with MPI Idn:			
DVs	-11.48		
DVs and MPIs	-7.94		
		4.6, 6.0, 9.2	7.1 **
Markov Switching Models with MPI Idn:			
FTP; DVs in measurement eqn.	246.98		
TVTP with MPIs; DVs in measurement eqn.	281.78		
		7.8, 9.5, 13.3	69.6 ***
Markov Switching Models with SMI Idn:			
FTP	636.63		
TVTP with SMIs	642.45		
		7.8, 9.5, 13.3	11.6 **

1/ $2^{*}(LR_{UR} - LR_{R}) \sim \chi^{2}_{d.f.}$ where d.f. is the number of restrictions.

2/ DVs denote domestic variables; MPIs denote the MPI for Thailand and Korea; SMI denotes stock market indices; FTP is fixed transition probability model while TVTP indicates a time-varying transition probability model.

3/ At the 10, 5, and 1 percent levels, respectively.

Note: Significance at the 10, 5, and 1 percent level is denoted by *, **, and ***, respectively.

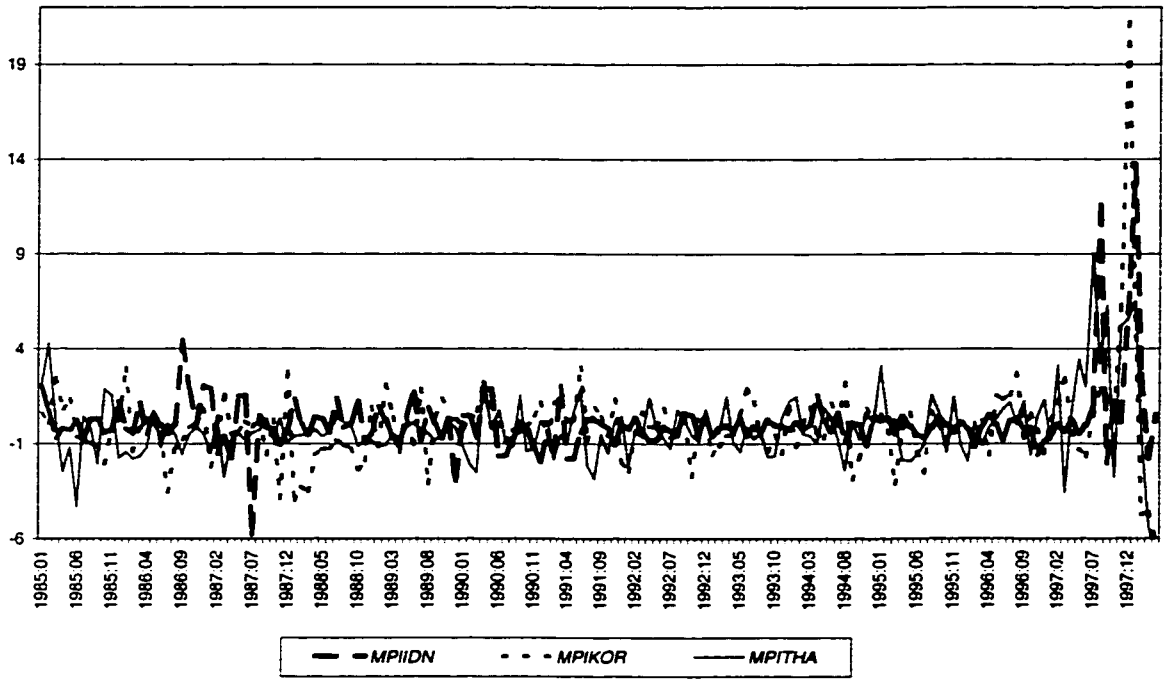

Figure 2.1: MPI for Indonesia, Korea and Thailand

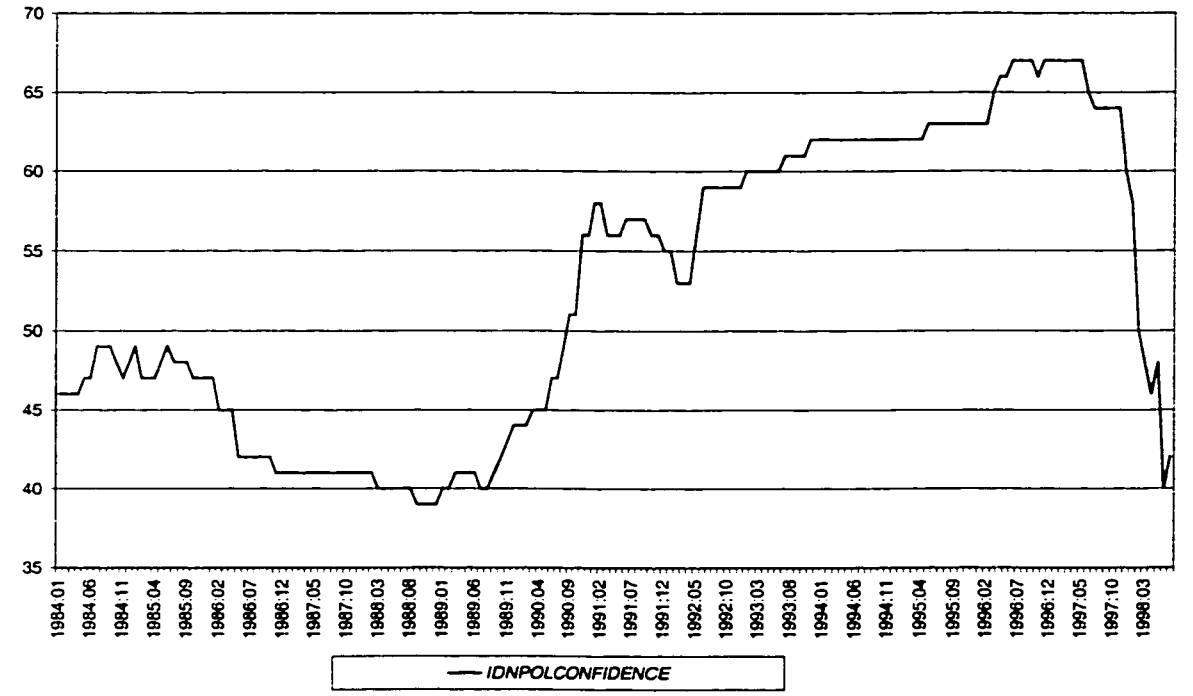

Figure 2.2: Political Confidence Index for Indonesia

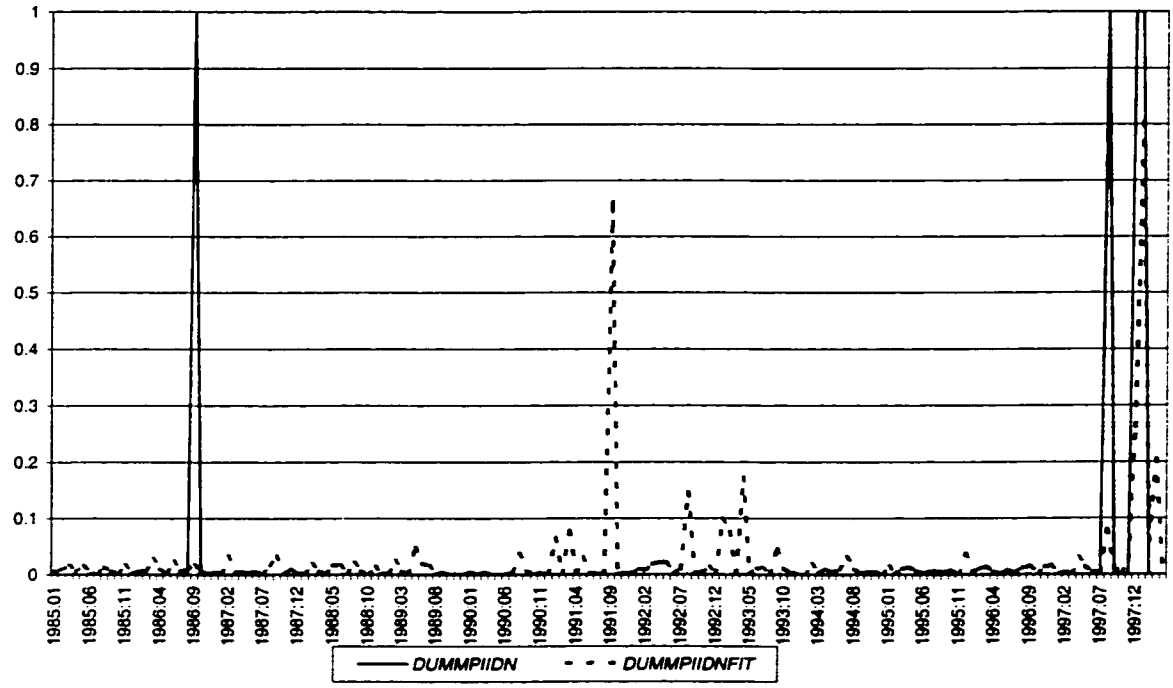

Figure 2.3: Actual and Fitted Values from Probit Model with Lagged Domestic Variables

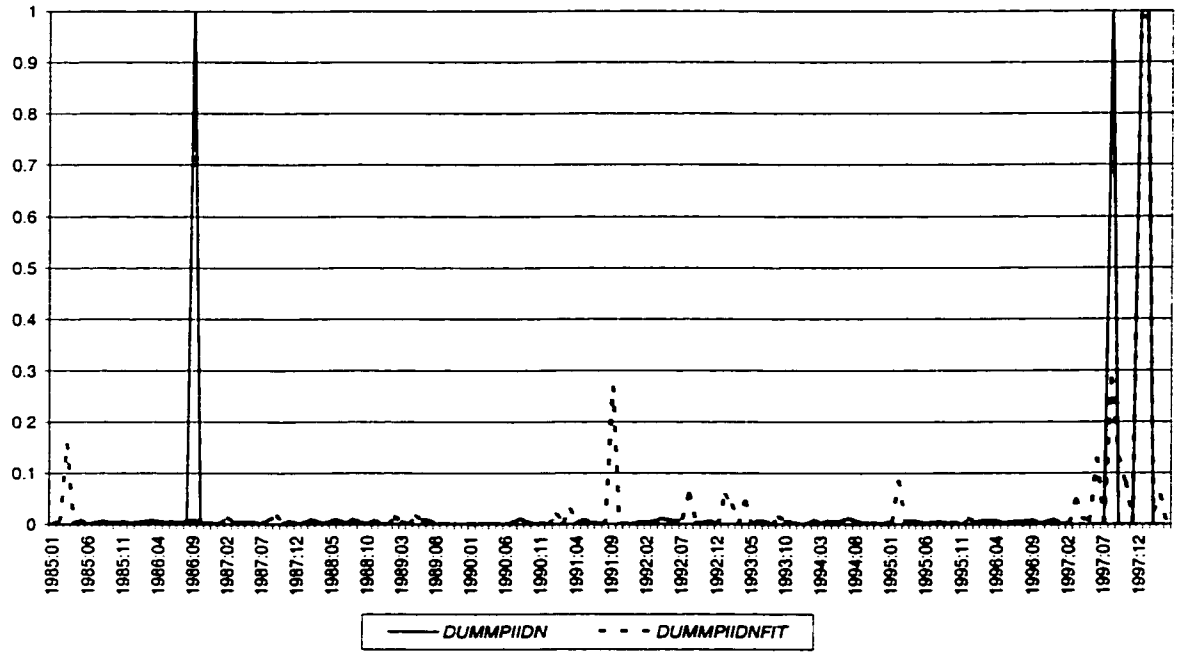

Figure 2.4: Actual and Fitted Values from Probit Model with Lagged Crisis in Thailand and Korea and Lagged Domestic Variables

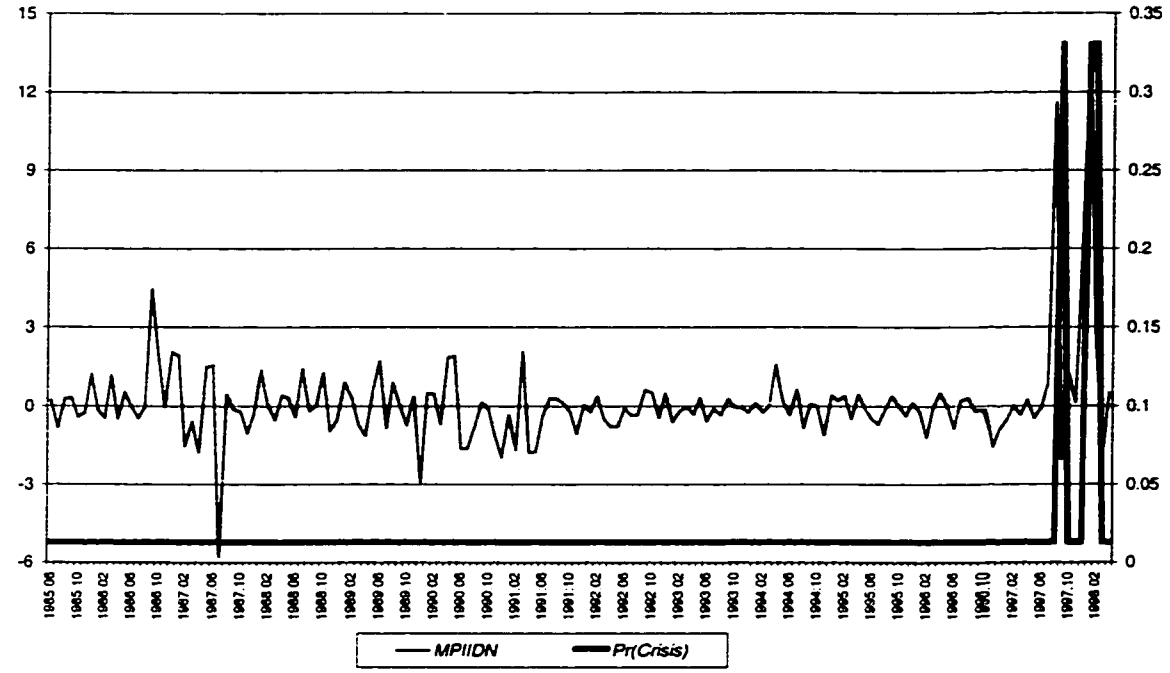

Figure 2.5: One-Step Ahead Probability of a Crisis
Fixed Transition Probability Markov Switching Model

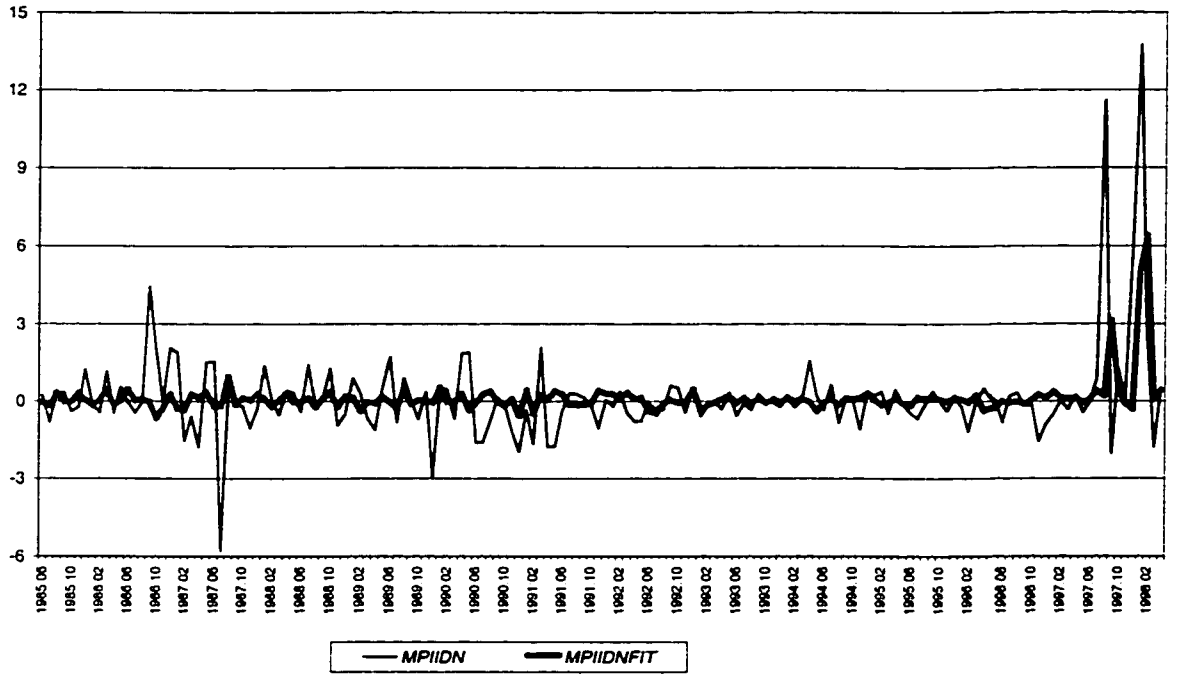

Figure 2.6: Actual and Forecasted MPI for Indonesia
Fixed Transition Probability Markov Switching Model

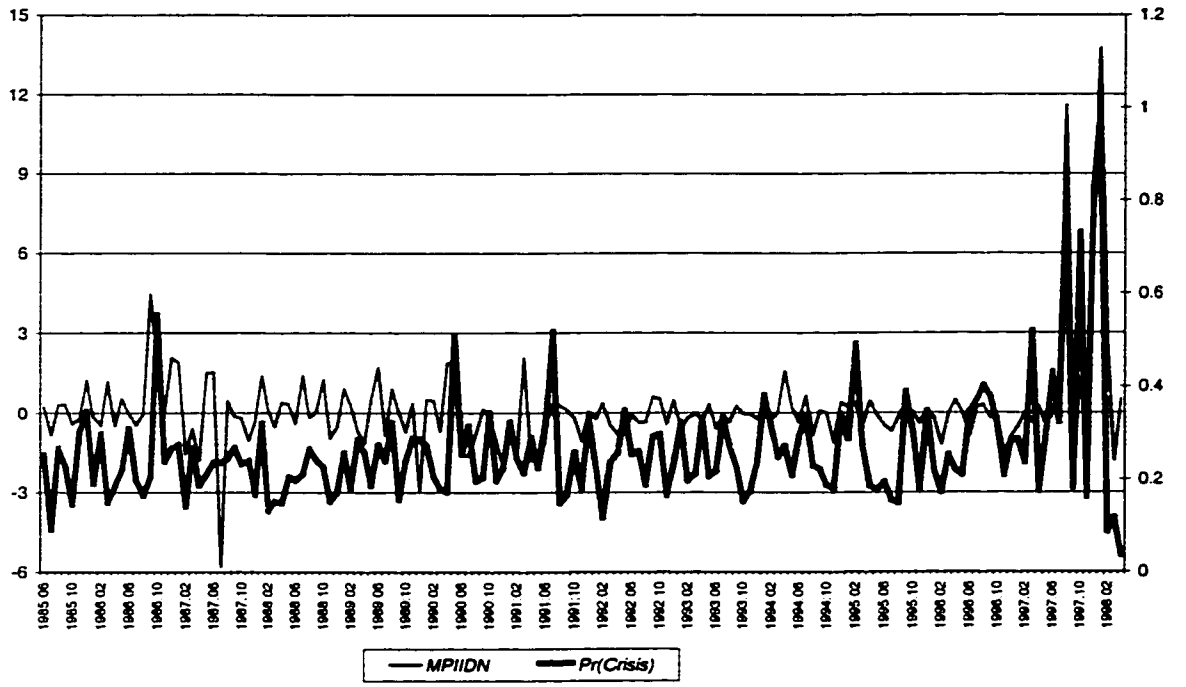

Figure 2.7: One-Step Ahead Probability of a Crisis
Time Varying Transition Probability Markov Switching Model

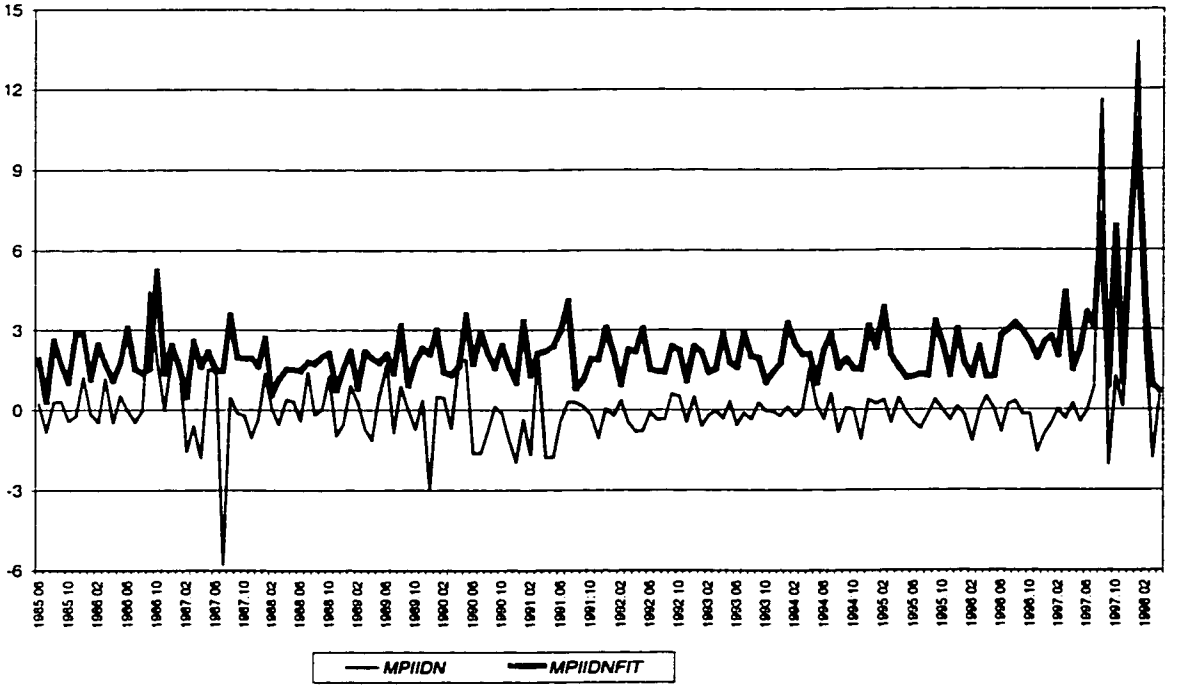

Figure 2.8: Actual and Forecasted MPI for Indonesia
Time Varying Transition Probability Markov Switching Model

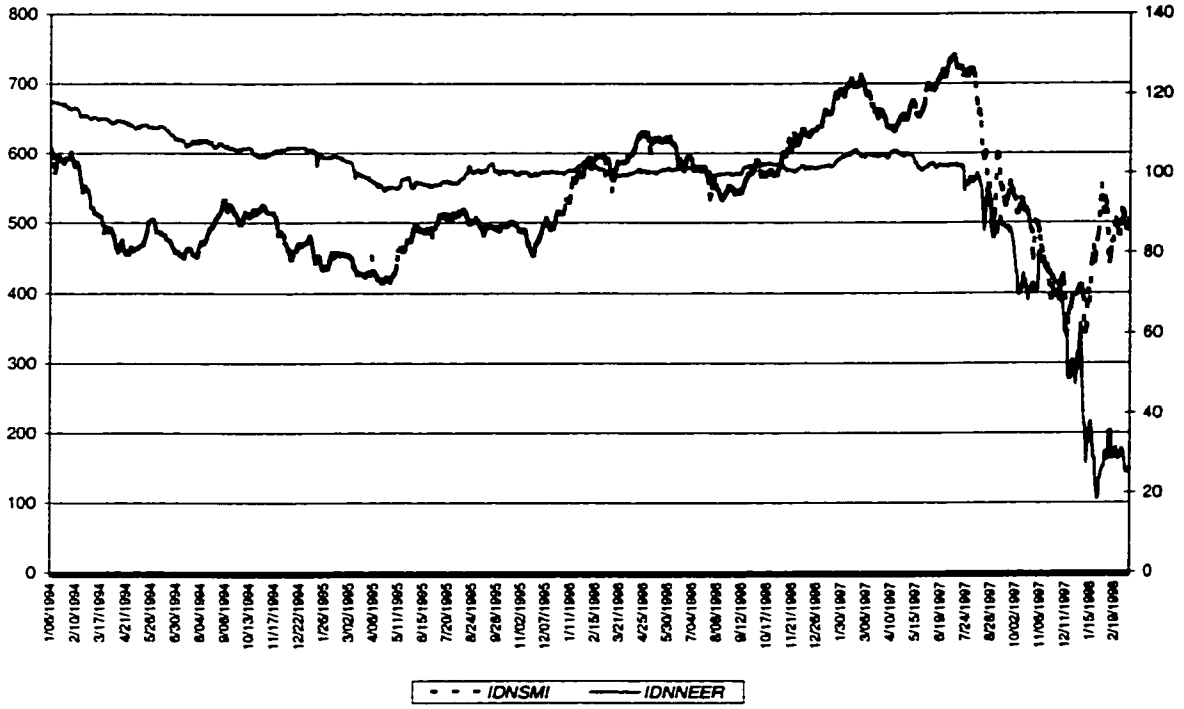

Figure 2.9: Daily NEER and Stock Market Index for Indonesia, 1/4/94-3/13/98

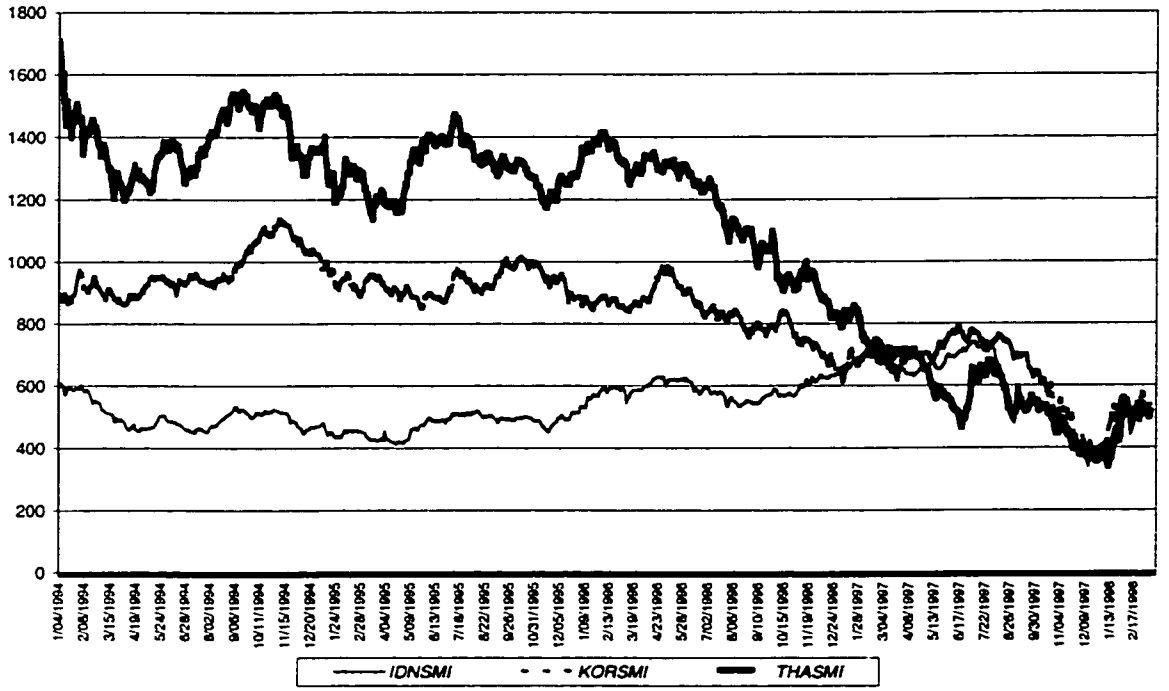

Figure 2.10: Daily Stock Market Indices for Indonesia, Korea and Thailand, 1/4/94-3/12/98

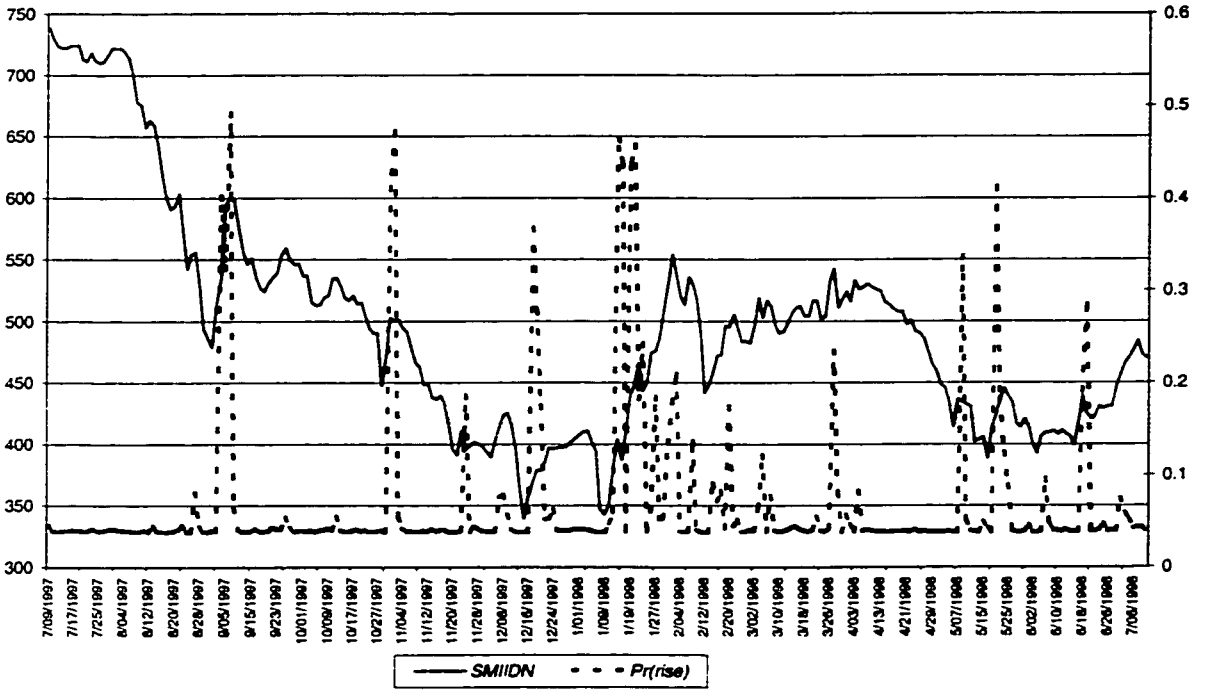

Figure 2.11: Probability of a Rise in the Daily Stock Market Index
Fixed Transitional Probability Markov Switching Model

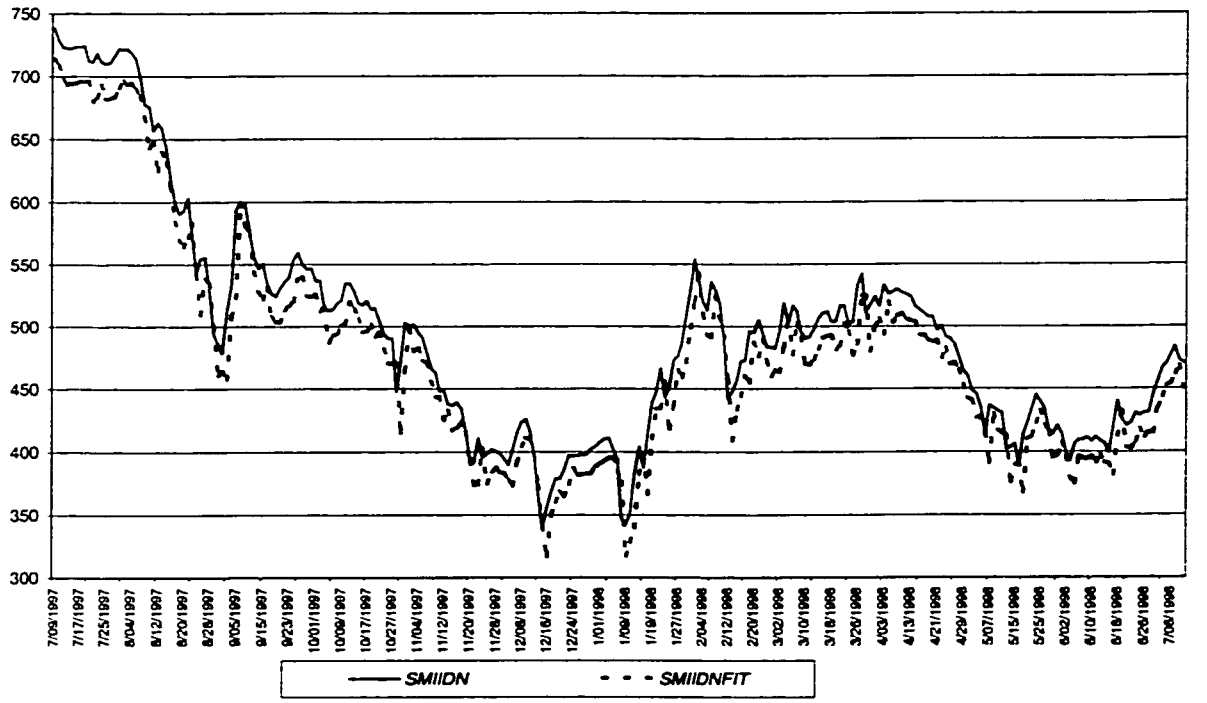

Figure 2.12: Actual and Forecasted Daily Stock Market Index for Indonesia
Fixed Transitional Probability Markov Switching Model

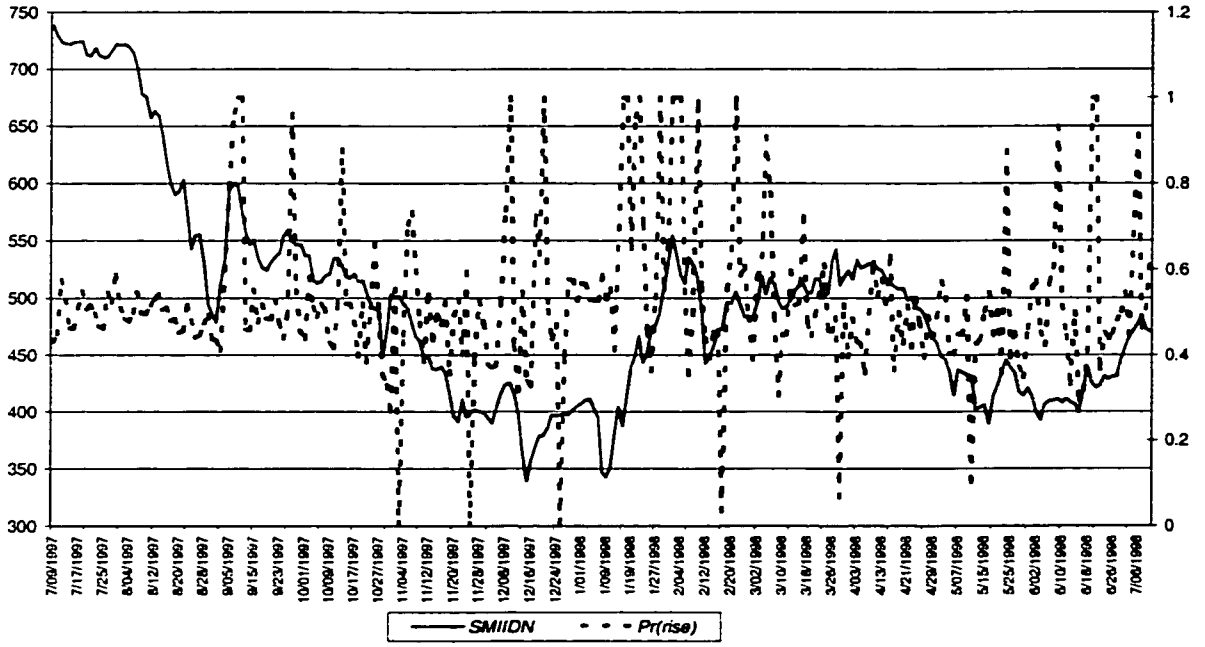

Figure 2.13: Probability of a Rise in the Daily Stock Market Index Time Varying Transitional Probability Markov Switching Model

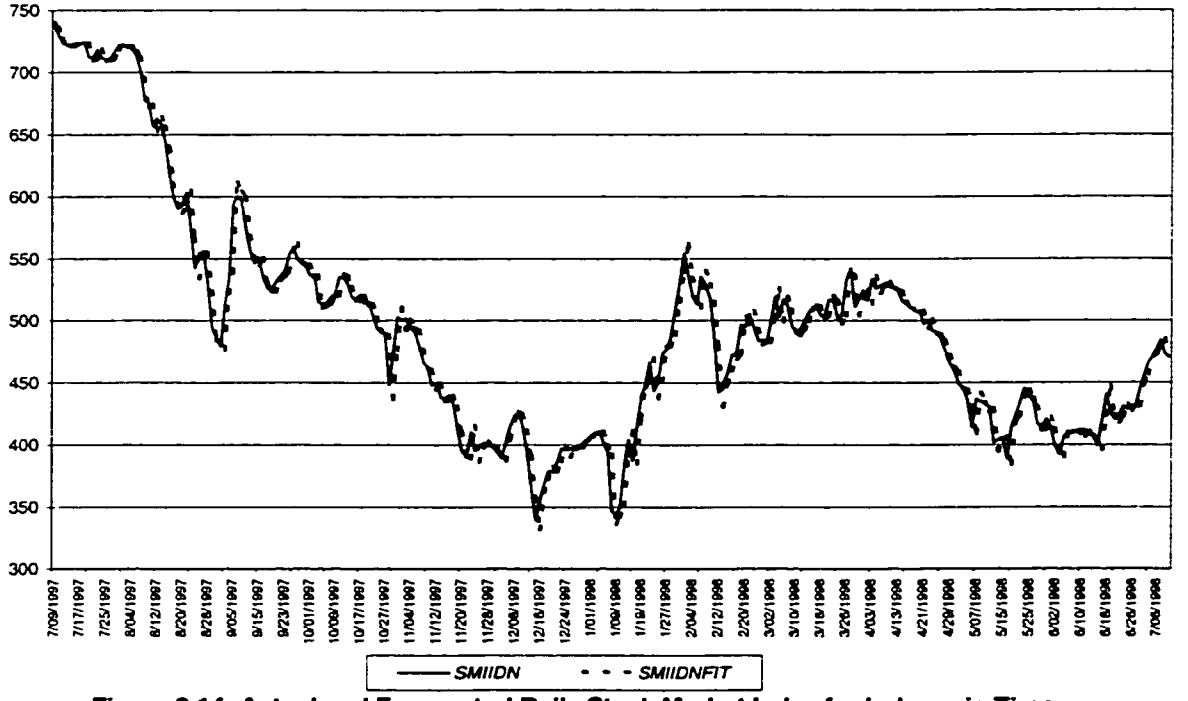

Figure 2.14: Actual and Forecasted Daily Stock Market Index for Indonesia Time Varying Transitional Probability Markov Switching Model

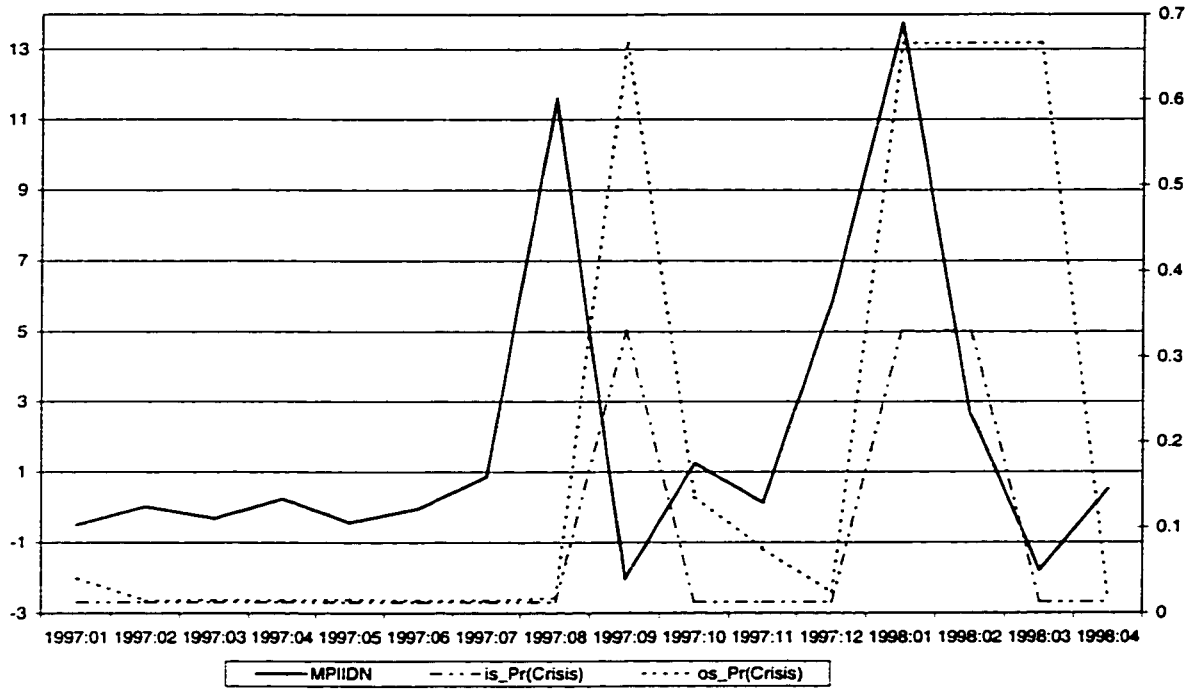

Figure 2.15: Forecasted One-Step Ahead Probability of a Crisis
Fixed Transitional Probability Markov Switching Model

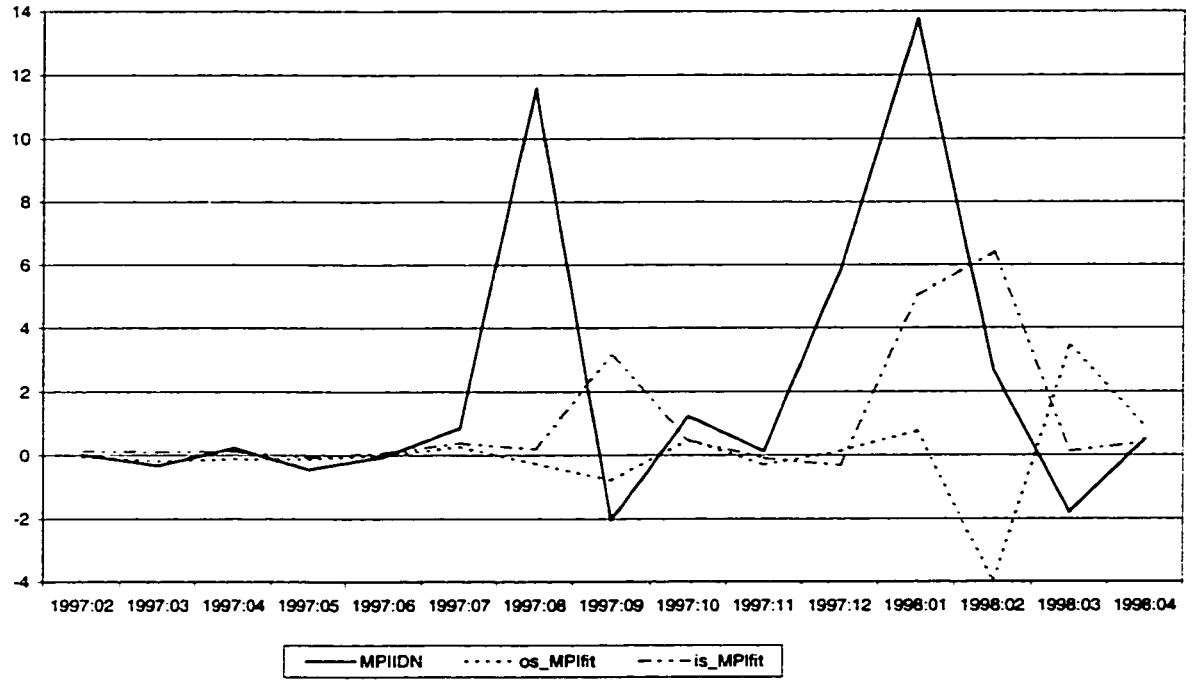

Figure 2.16: Actual and Forecasted MPI for Indonesia, 1997-1998
Fixed Transitional Probability Markov Switching Models

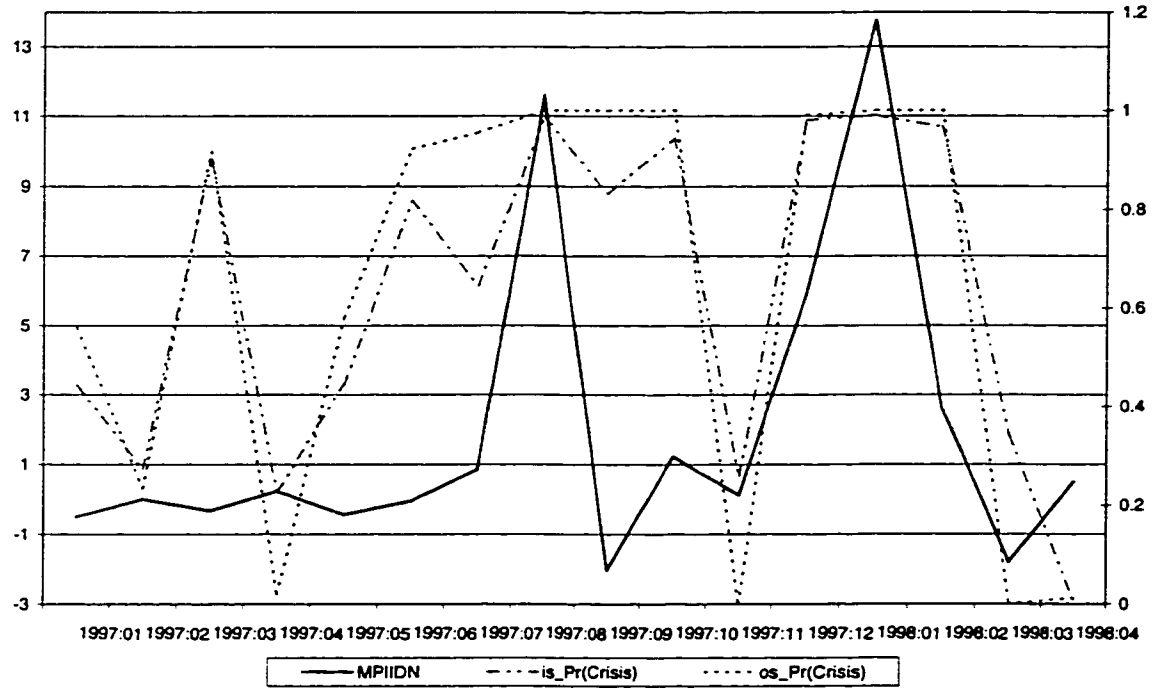

Figure 2.17: Forecasted One-Step Ahead Probability of a Crisis
Time Varying Transitional Probability Markov Switching Model

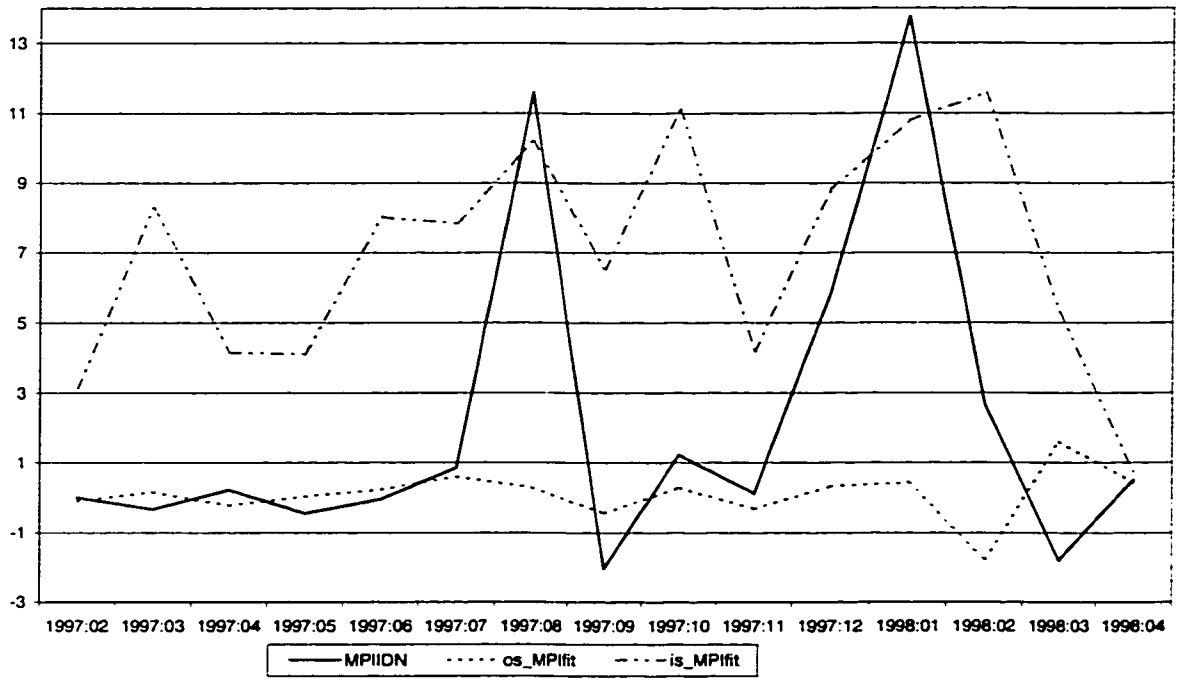

Figure 2.18: Actual and Forecasted MPI for Indonesia, 1997-1998
Time Varying Transitional Probability Markov Switching Model

Chapter 3: Exchange Rate Dynamics in Indonesia: 1980-1998[1]

3.1. INTRODUCTION

Indonesian economic reforms began in the mid-1980s[2]. Over the next decade, reforms were aimed at opening the real economy by promoting the direct investment flows and liberalizing the financial sector, increasing competition, and promoting growth of capital markets including through capital account liberalization. To foster economic growth through increased openness, the payment and transfer system for current international transactions was liberalized. Foreign exchange spot and swap markets were developed. The government also aimed to support these reforms with improved macroeconomic management, including through an attempt to maintain a competitive and stable exchange rate.

The aim of this paper is to explain the real exchange rate movements in Indonesia over the period 1980-98. The rest of the paper is organized as follows. Section 3.2 analyzes the real exchange rate movements in Indonesia, using various economic and time series models. First, an intertemporal optimization of model is developed and its econometric implications are derived. This model is estimated using the cointegration technique (3.2.1). Then, the movements in the real exchange rate and trade balance are examined using an Unobserved Components Model (3.2.2). Finally, the impact of various shocks on the real exchange rate is examined through the estimation of a structural vector autoregression (3.2.3). Section 3.3 investigates the forecasting ability of the time series models estimated in section 3.2. Section 3.4 concludes.

3.2. ANALYSIS OF THE REAL EXCHANGE RATE MOVEMENTS IN INDONESIA

[1] The author acknowledges helpful suggestions from Charles Engel.

The real exchange rate movements can be analyzed in terms of the real factors or real shocks affecting the economy. First, the paper outlines an intertemporal optimization model of real exchange rate, where changes in government spending, terms of trade, productivity and openness lead to changes in the real exchange rate in the long run. The econometric implications of this model are derived and the model is estimated using the cointegration approach. Secondly, the movements in the real exchange rate and trade balance are examined using a bivariate unobserved component model. Lastly, the movements in the real exchange rate are analyzed in terms of the shocks affecting the economy. This is accomplished by estimating a structural Vector Auto Regression.

3.2.1. Cointegration Approach

Intertemporal Optimization Model of Exchange Rate Determination[3]

This model derives the level of real exchange rate that is consistent with both internal and external balance. Consider a small open (representative developing) economy with flexible domestic wages and prices. There are two sectors producing two goods—Traded (y_T) and Non-Traded (y_N) goods[4]—each good being produced with fixed, specific factor and perfectly mobile capital. This economy is financially open—with imperfect substitutability between domestic and foreign financial assets.

Let w = nominal wage measured in terms of traded goods

e = real exchange rate (measured as relative price of traded goods in terms of non-traded goods)

$y_T^{\cdot}(L_T) = w$ and $y_N^{\cdot}(L_N) = we$ determine the employment in the two sectors.

Equilibrium in labor market: $L_T(w) + L_N(we) = L$ = fixed labor supply.

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[2] For details on the economic reforms that took place in Indonesia, refer to Cerra and Saxena (1998) and Saxena (1998).

[3] This model has been adapted from Montiel (1997a), Edwards (1994), Montiel (1986), Khan and Montiel (1987).

[4] To analyze the terms of trade shocks later, traded goods would be distinguished between exports and imports.

The equilibrium real wage is a decreasing function of the real exchange rate, $w=w(e)$

Aggregate output in the economy (in terms of traded goods) is given by:

$$y(e) = y_T[L_T(w(e))] + y_N[L_N(w(e))]/e, \quad y'<0$$

At each point in time, the representative agent allocates her net wealth to net foreign bonds f_H (that pay r real interest rate). The accumulation of net wealth over time is given by:

$$\dot{f}_h = y + rf_h - t - c \tag{3.1}$$

where t is a real lump-sum tax and c is an aggregate of consumption expenditure at a point in time (in terms of traded goods).

The agent maximizes an additively separable constant-relative-risk-aversion type of utility function over an infinite horizon. She derives utility from consuming traded and non-traded goods, c_T and c_N respectively. The utility function is assumed Cobb-Douglas in consumption of traded and non-traded goods.

$$u(c_T, c_N) = \frac{[c_T^{\theta} c_N^{1-\theta}]^{1-\sigma}}{1-\sigma} \tag{3.2}$$

where θ is the share of traded goods consumption in total consumption and σ is the inverse of the intertemporal rate of substitution. From the utility function specification, it is clear that:

$$\begin{aligned} c_T &= \theta c \\ c_N &= (1-\theta)ec \end{aligned} \tag{3.3}$$

Substitute (3.3) in (3.2) to derive the indirect utility function:

$$(3.4) \quad u(c_T, c_N) = v(e,c) = \frac{\kappa[e^{1-\theta}c]^{1-\sigma}}{1-\sigma}$$

The problem of the agent is: she chooses path for consumption expenditure so as to:

$$Max \int_0^{\infty} \frac{\kappa[\, e^{1-\theta}c]^{1-\sigma}}{1-\sigma} \exp(-\rho t)dt$$

$$(3.5) \quad s.t.\ \dot{f}_h = y - t + rf_h - c$$

$$\lim f_h \exp(-\int r dt) \geq 0$$

Setting up the Lagrangian as:

$$(3.6) \quad L = \frac{\kappa[\, e^{1-\theta}c]^{1-\sigma}}{1-\sigma} \exp(-\rho t) + \lambda \exp(-\rho t)[y - t + rf_h - c - \dot{f}_h]$$

The first order conditions are:

$$(3.7a) \quad \kappa e^{\gamma} c^{-\sigma} - \lambda = 0$$

$$(3.7b) \quad \rho - \frac{\dot{\lambda}}{\lambda} = r$$

$$(3.7c) \quad \dot{f}_h = y - t + rf_h - c$$

$$(3.7d) \quad \lim f_h \exp(-\int r dt) = 0$$

where $\gamma=(1-\theta)(1-\sigma)$. Equation (3.7a) states that the marginal utility of consumption is equal to the marginal utility of wealth. Equation (3.7b) is the intertemporal arbitrage relationship—stating that the rate of return on the bonds equals the rate of return on consumption. Since this is a representative agent model, she allocates her wealth taking the rate of interest as given. Equation (3.7c) is the budget constraint, while equation

(3.7d) is the transversality condition. To derive the time path for consumption, differentiate (3.7a) with respect to time, substitute (3.7b) to get:

$$(3.8) \quad \dot{c} = \sigma^{-1}[r - \rho + \gamma\frac{\dot{e}}{e}]c$$

This economy has a government and a central bank, where the latter maintains the exchange rate parity and lends to the government. The government receives lump-sum taxes from private sector, consumes both traded and non-traded goods (g_T and g_N respectively). The consolidated budget constraint of the public sector is:

$$(3.9) \quad \dot{f}_c = t + rf_c - g_T - g_N/e$$

where f_c is stock of foreign exchange reserves held by central bank. The government maintains its intertemporal budget constraint by levying taxes to keep $\dot{f}_c = 0$.

Since this economy's financial liabilities are not perfect substitutes for foreign ones, hence its residents have to pay a risk premium on their foreign borrowing, which is an increasing function of the share of the country's liabilities held in world financial portfolios. The domestic residents face r, the external real interest rate, which is the sum of world interest rate (r_w) and a risk-premium p:

$$(3.10) \quad r = r_w + p(f), \; p(0) > 0, \; p' < 0$$

where f is the aggregate stock of foreign bonds held by all the households in the economy and the stock of foreign exchange held by the central bank.

The **equilibrium in the non-traded goods (internal balance) market** is given by:

(3.11) $y_N(e) = c_N + g_N = (1-\theta)ec + g_N$

This equation can be solved for short-run equilibrium exchange rate—one that clears non-traded goods market, given c and g_N.

$$e = e(c, g_N)$$

(3.12) $$e_c = \frac{(1-\theta)e}{y_N - (1-\theta)c} < 0$$

$$e_{g_N} = \frac{1}{y_N - (1-\theta)c} < 0$$

To derive the level of exchange rate that is consistent with internal and external balance, the long-run restrictions: $\dot{c} = \dot{e} = 0$ are imposed in equation 3.8, which gives the steady state value:

(3.13) $\rho = r = r_w + p(f)$

Since r_w and ρ are exogenous, equation 3.13 establishes the long run equilibrium value of net international creditor position for this economy, $\bar{f}$.

Setting $\dot{f}_h = \dot{f}_c = 0$ and using equations (3.1,3.9,3.11 and 3.13), **the external balance condition** is given by the following equation:

(3.14) $0 = y_T(e) - \theta c - g_T + r\bar{f}$

The aggregate demand in the traded goods sector is given by $(\theta c + g_T)$ and aggregate supply by y_T. The excess of aggregate supply of traded goods represents the real trade balance surplus, and adding the real interest payments from abroad yields the current account (measured in terms of traded good—RHS of equation 3.14). Hence, equation 3.14 implies that in the long run equilibrium, the current account must be in balance.

From equation 3.11, it is clear that the locus of combinations of e and c that are consistent with internal balance is negatively sloping (IB), while from 3.14, the locus of combinations of e and c that are consistent with external balance is positively sloping (EB). The long-run equilibrium real exchange rate is one that is simultaneously consistent with external and internal balance in the long run—point A (Figure 3.1).

This long-run equilibrium real exchange rate ($\bar{e}$) changes when there is a permanent change in the policy variables and other parameters:

1. *Change in government spending on traded goods*: An increase in g_T does not affect the internal balance locus, but creates a trade deficit, and hence shifts the locus EB up. This requires an exchange rate depreciation to maintain external balance. This can be seen from equation 3.14. For a given level of consumption: $\frac{de}{dg_T} = \frac{1}{\dot{y}_T} > 0$. Hence, EB locus moves up, and the equilibrium real exchange rate depreciates.

2. *Change in government spending on non-traded goods*: An increase in g_N affects the internal balance. Increased demand requires an increase in the relative price of non-traded goods to maintain internal equilibrium—hence IB locus moves down and exchange rate appreciation is required. From equation 3.11, for a given level of real consumption: $\frac{de}{dg_N} = \frac{1}{\dot{y}_N - (1-\theta)c} < 0$. Hence IB locus moves down and the equilibrium real exchange rate appreciates.

3. *The Balassa-Samuelson effect*: Consider the following production function for the traded goods sector:

(3.15) $y_T = y_T(L_T, \alpha),\ y_{T1} > 0,\ y_{T2} > 0$

where α is the measure of productivity. Now, the equilibrium in the labor market would be given by:

$$(3.16)\quad L_T(w,\alpha) + L_N(we) = L$$

The equilibrium real wage would be:

$$w = w(e,\alpha)$$

$$(3.17)\quad w_2 = -\frac{L_{T2}}{L_{T1} + L_N{}'e} > 0$$

The output in the traded and non-traded goods sector would be given by:

$$y_T = y_T[L_T(w(e,\alpha),\alpha),\alpha]$$

$$(3.18)\quad \frac{dy_T}{d\alpha} = y_{T1}L_{T2}\frac{L_N{}'e}{L_{T1} + L_N{}'e} + y_{T2} > 0$$

$$y_N = y_N[L_N(w(e,\alpha))]$$

$$(3.19)\quad \frac{dy_N}{d\alpha} = y_N{}'L_N{}'w_2 < 0$$

An increase in productivity in the traded goods sector increases the demand for labor in that sector, which increases the real wage. This shifts labor from non-traded goods sector to traded goods sector, which leads to the expansion of the latter at the expense of the former. The productivity parameter α enters both the internal and external balance equations through the effect on y_T and y_N. Equation 3.19 implies that an increase in α causes a decrease in y_N, hence creates an excess demand in that sector, which moves the IB locus down and hence an appreciation is required to bring internal balance. This shock also leads to an increase in production of traded goods, which gives rise to trade surplus, the EB locus shifts down and an appreciation is required to maintain external balance.

4. *Changes in terms of trade*: To study the effect of terms of trade on equilibrium real exchange rate, traded goods need to be distinguished between exportables and importables, y_x and y_z respectively. They are produced using sector specific factor and mobile labor. Let ϕ be the terms of trade, defined as the price of exportables in terms of importables, and define the real exchange rate e as the relative price of importables in terms of non traded goods. For simplicity, assume exportable goods are not consumed at home. Now, the labor market equilibrium will be given by:

$$L_x(w/\phi) + L_z(w) + L_N(we) = L \tag{3.20}$$

where w is the real wage in terms of importables. The equilibrium real wage is:

$$w = w(e, \phi)$$

$$w_2 = \frac{L_x' w/\phi^2}{L_x'/\phi + L_z' + L_N' e} > 0 \tag{3.21}$$

An improvement in the terms of trade increases real wage as labor moves from importables and non-traded sectors to the expanding exportables sector.

$$y_x = y_x[L_x(w(e,\phi)/\phi)]$$

$$\frac{dy_x}{d\phi} = y_x' L_x'(w_2/\phi - w/\phi^2) > 0 \tag{3.22}$$

$$y_z = y_z[L_z(w(e,\phi))]$$

$$\frac{dy_z}{d\phi} = y_z' L_z' w_2 < 0 \tag{3.23}$$

$$y_N = y_N[L_N(w(e,\phi)e)]$$

$$\frac{dy_N}{d\phi} = y_N' L_N' w_2 e < 0 \tag{3.24}$$

The internal balance condition does not change, but external balance (3.14) can be written as:

$$(3.25)\quad 0 = \phi y_x(e,\phi) + y_z(e,\phi) + r\bar{f} - \theta c - g_z$$

An improvement in terms of trade decreases the output in the non-traded goods sector, which leads to excess demand in that sector, IB locus shifts down and real exchange rate appreciation is required to bring internal balance. The effect on external balance depends on the value of total traded goods output:

$$(3.26)\quad \frac{\partial(\phi y_x + y_z)}{\partial \phi} = y_x - \phi y_x \dot{L}_N e w_2 > 0$$

The value in traded goods increases through two channels: income effect resulting from the higher price of exportables, and output effect from movement of labor from non-traded to exportables sector. Hence, the EB locus moves down, leading to an appreciation of real exchange rate to keep trade balance at sustainable level.

5. *Openness:* Consider two tradables—exportables and importables, but the household consumes only the importable (c_M) and non-tradables, and only exportables are produced at home. There is a tariff on importables--δ. The budget constraint of the agent now would be given by:

$$(3.1a)\quad \dot{f}_h = y + rf_h - t - c_N / e - (1+\delta)c_M$$

The consumption of traded and non-traded goods would be:

(3.3a) $$c_M = \frac{\theta c}{1+\delta}$$
$$c_N = (1-\theta)ec$$

Substituting in the Cobb-Douglas utility function (3.2), the indirect utility function is derived as:

(3.4a) $$u(c_M, c_N) = v(e,c) = \frac{\kappa[e^{1-\theta}c]^{1-\sigma}}{[1+\delta]^{\theta}[1-\sigma]}$$

The problem of the agent is to choose path for consumption so as to:

$$Max \int_0^{\infty} \frac{\kappa[e^{1-\theta}c]^{1-\sigma}}{[1+\delta]^{\theta}[1-\sigma]} \exp(-\rho t)dt$$

(3.7a) $$s.t.\ \dot{f}_h = y + rf_h - t - c_N / e - (1+\delta)c_M$$
$$\lim f_h \exp(-\int rdt) = 0$$

Setting up the Lagrangian, the first order condition for c from the above maximization would be:

(3.7a') $$\frac{\kappa e^{\gamma} c^{-\sigma}}{[1+\delta]^{\theta}} = \lambda$$

Differentiating equation 3.7a', substituting 3.7b and 3.1a would give:

(3.8) $$\dot{c} = \sigma^{-1}[r - \rho + \gamma\frac{\dot{e}}{e}]c$$

The consolidated public sector budget constraint would now be given by:

(3.9a) $\dot{f}_c = t + rf_c + \delta c_M - g_M - g_N / e$

Setting $\dot{f}_h = \dot{f}_c = 0$ and using equations (3.1a, 3.9a, 3.11 and 3.13), the **external balance condition** would be given as:

(3.15a) $0 = \phi y_x(e,\phi) + r\bar{f} - \frac{\theta c}{1+\delta} - g_M$

Now, as the economy opens up, the tariff would decrease, which would lead to more imports and a trade deficit. In the process, the EB locus moves up and real exchange rate depreciation would be required to bring about external balance. It can be seen from equation 3.15a that for a given level of consumption, $\frac{de}{d\delta} = -\frac{\theta c}{[1+\delta]^2 \phi \dot{y}_x} < 0$. Hence, real exchange rate depreciates with an increase in the openness.

Testable Implications of Dynamic Optimizing Models—An Illustration

This sub-section presents a simple illustration of how theoretical dynamic optimizing models could be tied to current methods used in time series econometrics (in particular, cointegration analysis). Most dynamic optimizing models have some jumping variables such as consumption, the exchange rate, asset prices, and other sluggish variables such as the capital stock, the stock of net wealth, etc. Let j be a jumping variable and let S be a sluggish variable. In the long run, i.e. when $\dot{j} = \dot{S} = 0$, the steady states of j and S are functions of policy variables and exogenous shocks. That is, $j^* = j(\theta_1, \theta_2, ...)$ and $S^* = S(\theta_1, \theta_2, ...)$. For simplicity, suppose there is one policy variable θ, and the steady state of j is given by $j^* = \beta\theta$. Next consider the dynamics when the equilibrium (that is, steady state) j adjusts to a change in θ. Suppose for illustration that the stable adjustment arm has a steeper slope than the slope of the change in steady states (Figure 3.2). At time $t=1$, assume j is resting at some initial steady state.

Let $j_1 = j_0^* = \beta\ \theta_0$. Then assume the policy is changed to θ_1. The new steady state will be at point D. In the next period, there will be two components of adjustment of j to its new equilibrium. First, there is a vertical jump from point A to B on the new stable adjustment arm. This jump is a constant ϕ times the change in steady state: $\phi(j_1^* - j_0^*) = \phi(\beta\theta_1 - \beta\theta_0)$. The constant ϕ is a function of the slope of the stable arm relative to the slope of the change in steady state, and could be positive or negative. In this diagram it is shown to be negative. Over a discrete interval of time in which the data is measured, the sluggish variable will move slightly toward its equilibrium at point D. Therefore, the second component of adjustment involves movement to point C along the stable arm in the direction of the new equilibrium. This movement will be some fraction of the distance between point B and point D. In terms of j, this will be measured as $j_1^* - [j_1 + \phi(j_1^* - j_0^*)]$. Combining these two movements, j will end up at point C in period 2, as given by equation (3.27).

(3.27) $j_2 = j_1 + \phi(j_1^* - j_0^*) + \gamma(j_1^* - [j_1 + \phi(j_1^* - j_0^*)])$

Collecting terms,

(3.28) $j_2 = j_1 + \phi(1-\gamma)(j_1^* - j_0^*) + \gamma(j_1^* - j_1)$

or expressing (3.28) in terms of changes.

(3.29) $\Delta j_2 = \phi(1-\gamma)\Delta j_1^* - \gamma(j_1 - j_1^*)$

The change in j will consist of a jump reflecting the change in steady state, and movement toward the new steady state. If there are no further changes in policy θ, j will eventually end up at point D. On the other hand, additional unexpected changes in θ will generate additional jumps. Nonetheless, there is a long run relationship between j and θ. In equation (3.29) we can see the similarity of adjustment to equations estimated using

cointegration/ error correction analysis. The first term on the right hand side is the usual lagged difference in the policy variable. The second term is the long run relationship between j and θ as given by a cointegrating vector. The divergence of the actual j from its equilibrium level is the equilibrium error, which gets corrected over time in accordance with the speed of adjustment coefficient. Of course, in most cointegration studies there is more than one policy variable and also richer short-run dynamics given by multiple lags which can capture temporary shocks, but the basic concept is as illustrated. In the long run, the endogenous variables such as j move toward their steady state, a dynamic estimated by the cointegrating vector. In the simple example above, the cointegrating vector would be $[1 \ -\beta]$.

The exchange rate model presented earlier contains several policy variables and external shocks that can lead to a change in steady state. As described above, the equilibrium exchange rate depends on government consumption of traded and non-traded goods, productivity, terms of trade and commercial policy, $e^* = e(g_T, g_N, \alpha, \phi, \delta)$. The cointegrating vector would contain all of these variables and the error correction equation would contain lagged differences of each of these variables.

Empirical Estimation[5] of the Intertemporal Optimizing Model

Time Series Properties of the Data

Quarterly data from 1980:3 to 1997:4 is used. Prior to estimating the cointegrating vector, the time-series properties of the REER (in logs, LREER) and the explanatory variables are checked using standard unit root tests. The results from the Unit Root testing are described in the Table 3.1.

Based on the results of the ADF tests, all the variables are non-stationary in levels, but stationary in their first differences (I(1)), except LTOT, for which the unit root hypothesis

[5] Data source and construction for all empirical work are provided in Appendix 3.

can be rejected at the 5 percent level. All variables are nonstationary according to the Phillip-Perron tests.[6]

The Johansen Test reveals that the variables LREER, GCONGDP, GINVGDP, OPEN, LTOT, and a time trend are cointegrated with one cointegrating vector (there is one linear combination of the variables that is stationary). The results from the Johansen Cointegration Test are presented in Table 3.2.

Thus the long-run REER depends on the factors government consumption, government investment, openness of the economy, the terms of trade and differential productivity growth rates.

Since one cointegrating vector is found, it is estimated via the Johansen reduced rank VAR MLE in ECM form by imposing one cointegrating vector. The lag length of the ECM is determined by backward selection, beginning at a lag length of four to economize on degrees of freedom. The Likelihood Ratio Test indicates that ECM(1) is the most appropriate. The results are presented below.

Cointegrating Equation:

LREER = 3.52*GCONGDP + 22.38*GINVGDP + 0.69*LTOT – 5.03*OPEN + 0.01*TREND – 1.35

(0.99) (3.61***) (2.88***) (-2.00**) (1.37)

Note: T-stats are in parentheses. Asterisk *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

It can be seen from the above results that GINVGDP, LTOT and OPEN are highly significant in the cointegrating equation, while GCONGDP and TREND are not. All

[6] In addition to the notorious low power of unit root tests, some of these variables are bounded (at least from below) by construction and possibly stationary by construction. However, the author believes that there could be a range in which the variables move as a random walk even if there is some threshold beyond which the variables would return to the range.

variables have the expected signs except the GINVGDP. The latter result suggests that government investment expenditures may be directed toward non-tradables. In fact, IMF (1997) states that in fiscal year 1996/97, increases in government investment (development expenditure) could be attributed primarily to increases in spending on health, education, and social welfare. These are generally non-tradable items. Government infrastructure investment (which may rely on imported inputs) had apparently become less important in recent years as these activities had been transferred in part to the private sector. The trend, used as a proxy for total factor productivity growth, is positive, although insignificant in the cointegrating equation.

3.2.2. Bivariate Unobserved Component Model

This section examines movements in the real exchange rate and the trade balance. Following Clarke (1989)[7], the cyclical movement in the real exchange rate is measured using a bivariate Unobserved Components model, where the exchange rate and the trade balance each have their own trend components, but the cyclical component is common to the two series. Assume that the exchange rate y_t follows a stochastic trend, n_t and a stationary cyclical component, x_t. The trade balance z_t has a trend component, L_t and a stationary component, C_t. The model is:

(3.30) $y_t = n_t + x_t$

(3.31) $n_t = \delta + n_{t-1} + v_t, \quad v_t \sim i.i.d.N(0,\sigma_v^2)$

(3.32) $x_t = \phi_1 x_{t-1} + \phi_2 x_{t-2} + e_t, \quad e_t \sim i.i.d.N(0,\sigma_e^2)$

(3.33) $z_t = L_t + C_t$

(3.34) $L_t = L_{t-1} + v_{lt}, \quad v_{lt} \sim i.i.d.N.(0,\sigma_{vl}^2)$

(3.35) $C_t = \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + e_{ct}, \quad e_{ct} \sim i.i.d.N(0,\sigma_{ec}^2)$

[7] Clarke (1989) estimates similar model on output and unemployment.

All errors are white noise. The cyclical component of trade balance, C_t, is assumed to be a function of the current and the past transitory component of the real exchange rate.

Treating all the variables in the above model as unobserved, the model could be represented in the state-space form as follows:

$$(3.36)\quad \begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 \\ 0 & \alpha_0 & \alpha_1 & \alpha_2 & 1 \end{bmatrix} \begin{bmatrix} n_t \\ x_t \\ x_{t-1} \\ x_{t-2} \\ L_t \end{bmatrix} + \begin{bmatrix} 0 \\ e_{at} \end{bmatrix}$$

$$(3.37)\quad \begin{bmatrix} n_t \\ x_t \\ x_{t-1} \\ x_{t-2} \\ L_t \end{bmatrix} = \begin{bmatrix} \delta \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & \phi_1 & \phi_2 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} n_{t-1} \\ x_{t-1} \\ x_{t-2} \\ x_{t-3} \\ L_{t-1} \end{bmatrix} + \begin{bmatrix} v_t \\ e_t \\ 0 \\ 0 \\ v_{lt} \end{bmatrix}$$

This model is estimated using a Kalman filter[8]. Quarterly data is used for REER and trade balance (1980:1 to 1998:2). Figure 3.3 shows the cyclical components from this model. The cycles in the exchange rate and trade balance move in the opposite directions; i.e., whenever the exchange rate appreciates, the trade balance deteriorates. The cyclical component of the exchange rate shows depreciation in 1983 and 1986—both these times, the exchange rate was devalued to maintain the competitiveness of exports, and the trade balance improved in response.

3.2.3. Structural Vector Auto Regression (VAR)

[8] Refer to Kim and Nelson (1998) for derivation of Kalman Filter.

The purpose of this section is to gauge the importance of various shocks in explaining the movements in the real exchange rate. Instead of decomposing a series into its permanent and temporary components using Beveridge Nelson decomposition, Blanchard-Quah (1989) developed a macroeconomic model in which real GNP is affected by demand and supply-side disturbances. However, due to natural rate hypothesis, demand side shocks have no long run effect, while productivity shocks have permanent effect on output. Since there is no unique way to decompose the series in a univariate framework, Blanchard and Quah use a bivariate framework to decompose real GNP. Clarida and Gali (1994) use this approach to estimate the effects of demand, supply and nominal shocks on relative output, real exchange rate and relative prices.

The basic framework is as follows[9]. Let there be two series, x_t and y_t. Ignoring the intercept, and assuming that both variables are difference stationary, the changes in x and y have a structural representation as:

$$(3.38)\quad \begin{bmatrix}\Delta x_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}C_{11}(L) & C_{12}(L) \\ C_{21}(L) & C_{22}(L)\end{bmatrix}\begin{bmatrix}\varepsilon_{1t} \\ \varepsilon_{2t}\end{bmatrix}$$

where ε_{1t} and ε_{2t} are independent white-noise disturbances, each with constant variance, and $C_{ij}(L)$ are polynomials in the lag operator L such that individual coefficients of $C_{ij}(L)$ are denoted by $c_{ij}(k)$. It can be compactly written as:

$$(3.39)\quad X_t = C(L)\varepsilon_t$$

The variance-covariance matrix of innovations is:

$$(3.40)\quad \Sigma_\varepsilon = \begin{bmatrix}\text{var}(\varepsilon_1) & \text{cov}(\varepsilon_1,\varepsilon_2) \\ \text{cov}(\varepsilon_1,\varepsilon_2) & \text{var}(\varepsilon_2)\end{bmatrix} = \begin{bmatrix}1 & 0 \\ 0 & 1\end{bmatrix}$$

[9] This follows Enders (1995).

The shocks ε_{1t} and ε_{2t} are not directly associated with x_t and y_t. Instead, the x_t and y_t are endogenous variables and the ε_{1t} and ε_{2t} sequences represent exogenous variables—in their example, Blanchard and Quah consider the two shocks as aggregate supply and demand shocks, respectively. However, the structural shocks are unobservable. Thus, ε_t is recovered from estimating the moving average representation:

(3.41) $X_t = A(L)X_{t-1} + e_t$

where X_t is the column vector $(\Delta x_t, \Delta y_t)'$

e_t is the column vector $(\Delta e_{1t}, \Delta e_{2t})'$

$A(L)$ is the 2x2 matrix with elements equal to polynomials $A_{ij}(L)$, and the coefficients of $A_{ij}(L)$ are denoted by $a_{ij}(k)$.

The residuals from the reduced form VAR above are composites of the pure innovations, ε_{1t} and ε_{2t}. Since the two representations are equivalent, hence the one-step ahead forecast error of x and y can be given by:

(3.42) $e_{1t} = c_{11}(0)\varepsilon_{1t} + c_{12}(0)\varepsilon_{2t}$

(3.43) $e_{2t} = c_{21}(0)\varepsilon_{1t} + c_{22}(0)\varepsilon_{2t}$

or in matrix form:

(3.44) $$\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \begin{bmatrix} c_{11}(0) & c_{12}(0) \\ c_{21}(0) & c_{22}(0) \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

Now, if $c_{ij}(0)$, i,j=1,2 were all known, then ε_t could be recovered from residuals, e_{1t} and e_{2t}. However, Blanchard and Quah show that the relationship between equations 3.39 and 3.41, and a restriction on the long run multiplier could help identify the four coefficients.

Restriction 1&2: Since ε_{1t} and ε_{2t} are uncorrelated, equation 3.40, 3.42 and 3.43 imply that:

(3.45) $Var(e_1) = c_{11}(0)^2 + c_{12}(0)^2$

(3.46) $Var(e_2) = c_{21}(0)^2 + c_{22}(0)^2$

Restriction 3: The product of e_{1t} and e_{2t} is given by:

(3.47) $e_{1t}e_{2t} = [c_{11}(0)\varepsilon_{1t} + c_{12}(0)\varepsilon_{2t}]\,[c_{21}(0)\varepsilon_{1t} + c_{22}(0)\varepsilon_{2t}]$

Taking the expectations, the covariance of residuals from the reduced form *VAR* is given by:

(3.48) $Ee_{1t}e_{2t} = c_{11}(0)c_{21}(0) + c_{12}(0)c_{22}(0)$

Equations 3.45, 3.46 and 3.48 have four unknowns, hence an additional restriction is required to identify the four elements of *C(L)*.

Restriction 4: Equation 3.39 could be re-written as:

(3.49) $X_t = [1\text{-}A(L)L]^{-1} e_t$

$$(3.50)\quad \begin{bmatrix}\Delta x_t \\ \Delta y_t\end{bmatrix} = (1/[I - A(L)L])\begin{bmatrix}1 - A_{22}(L)L & A_{12}(L)L \\ A_{21}(L)L & 1 - A_{11}(L)L\end{bmatrix}\begin{bmatrix}e_{1t} \\ e_{2t}\end{bmatrix}$$

which is equivalent to:

$$(3.51)\quad \begin{bmatrix}\Delta x_t\\ \Delta y_t\end{bmatrix} = (1/[I - A(L)L])\begin{bmatrix}1-\Sigma a_{22}(k)L^{K+1} & \Sigma a_{12}(k)L^{k+1}\\ \Sigma a_{21}(k)L^{k+1} & 1-\Sigma a_{11}(k)L^{k+1}\end{bmatrix}\begin{bmatrix}e_{1t}\\ e_{2t}\end{bmatrix}$$

Replacing e_{1t} and e_{2t} from 3.42 and 3.43 into 3.51 and imposing the long run restriction that ε_{2t} has no effect on x_t gives us the following condition:

$$(3.52)\quad [1-\sum_{k=0}^{\infty} a_{22}(k)L^{k+1}]c_{12}(0) + \sum_{k=0}^{\infty} a_{12}(k)c_{22}(0) = 0$$

So now we have four equations (3.45, 3.46, 3.48, 3.52) in four unknowns (c_{ij} *(0)*, i,j=1,2), hence the structural shocks can be fully identified.

The above model has been used in this paper to study the impact of real and nominal shocks on the real effective exchange rate (REER) and the nominal effective exchange rate (NEER)[10]. To explain the deviations from PPP, it is assumed that there are two types of shocks: a real shock and a nominal shock. In theory, only real shocks affect real exchange rate in the long run, while nominal shocks have only a temporary effect—increase in money supply, increases prices, while exchange rate depreciates. So the basic model is:

$$(3.53)\quad \begin{bmatrix}\Delta r_t\\ \Delta e_t\end{bmatrix} = \begin{bmatrix}C_{11}(L) & C_{12}(L)\\ C_{21}(L) & C_{22}(L)\end{bmatrix}\begin{bmatrix}\varepsilon_{rt}\\ \varepsilon_{nt}\end{bmatrix}$$

where ε_{rt} and ε_{nt} represent mutually uncorrelated real and nominal shocks, respectively. Since nominal shocks do not affect real exchange rate in the long run, the restriction is:

$$(3.54)\quad C_{12}(L) = \sum_{k=0}^{\infty} c_{12}(k) = 0$$

The above model is estimated using quarterly data for REER and NEER (1981:2 to 1998:2). The lag length for the *VAR* is selected by backward selection using the Likelihood Ratio test. The *VAR* of 4 lags is found to be the most appropriate. Figures 3.4 and 3.5 show the responses of REER and NEER to real and nominal shocks. A positive real shock leads to an initial appreciation of REER, and the real exchange rate stabilizes at a new appreciated long run value after 20 quarters. On the other hand, a positive nominal shock depreciates the REER initially and the effect dies out completely after 20 quarters, as expected. The response of the NEER to real and nominal shocks is similar to that of the REER, with the difference that the nominal shock, instead of vanishing after 20 quarters, stabilizes the nominal exchange rate at a new depreciated level. Hence, the nominal exchange rate overshoots its long run value in response to a nominal shock, as in the Dornbusch overshooting model.

Table 3.3 shows the variance decomposition of the REER and the NEER. It is clear that almost all the variation in the REER is explained by real shocks at all horizons (beyond two quarters), while nominal shocks have no role to play. For the NEER, about 80 to 95% of the variation is explained by real shocks at all horizons beyond three quarters. This suggests that real shocks are important in explaining both the real and the nominal exchange rates.

However, there are many types of shocks but this approach can identify at most only as many different shocks as there are variables. Hence, Clarida and Gali (1994) make an attempt to use three variables to identify three shocks. They use relative output, real exchange rate and relative prices, and through a flexible price model, they derive the restrictions that are needed to identify the structural shocks in the Blanchard and Quah decomposition[11]. The restrictions on the long-run multipliers are: only supply shocks affect output in the long run, while real exchange rate is affected by both supply and demand shocks. Hence, nominal shocks have only temporary effect on real exchange

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[10] See Lee and Enders (1993) for details.

[11] Refer to Clarida and Gali (1994) for the derivation of the model—which is based on the standard Mundell-Fleming-Dornbusch models.

rate. In this 3-variable case, C would be a 3x3 matrix, and if $X_t = (\Delta y_t, \Delta q_t, \Delta p_t)'$, where y, q, and p are relative output, REER and relative prices (in logs), and if $\varepsilon_t = (\varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{nt})'$, where the 3 shocks are supply, demand and nominal, respectively, then the restrictions would be $C_{12} = C_{13} = C_{23} = 0$.

Intuitively, we expect that:

1. A positive supply shock leads to an excess supply of home goods, which depreciates the real exchange rate. Over time, output increases to its long run level, while exchange rate remains depreciated.
2. A positive demand shock creates an excess demand for home goods that appreciates the real exchange rate and increases the output in the short run. Over time, output returns to its long run value, while the real exchange rate remains appreciated.
3. A positive nominal shock decreases the home interest rate, which depreciates the real exchange rate and increases the output in the short-run. However, over time, both the real exchange rate and the output return to their initial levels.

To proceed with the analysis described above, the lag length is estimated for the *VAR* using likelihood ratio test. A *VAR* of 8 lags is found to be the most appropriate for capturing the dynamics in the data. Using quarterly data on relative output, REER and relative prices (1982:2 to 1997:4), the impulse responses and variance decompositions for the three variables are estimated. Figures 3.6 through 3.8 show the responses of REER, relative output and relative prices to supply, demand and nominal shocks. A positive supply shock necessarily leads to a permanent increase in output. However, instead of the REER depreciating and the prices going down, the impulse response function in Figures 3.7 and 3.8 show that the REER appreciates while the relative price level rises in response to a positive supply shock. Now it is not clear from this methodology what exactly constitutes a supply shock. Hence, following are some of the interpretations of a supply shock to explain the behavior of exchange rate and price levels.

1. Since the economy opened up during the period under consideration, and the exports increased faster than imports as a percentage of GDP, then the output definitely would increase as a result of openness. However, this would lead to a trade balance surplus, which would require appreciation of the REER to bring external balance.

2. If the supply shock is interpreted as a productivity shock in the traded goods sector, then it would increase output, while the exchange rate would appreciate due to the Balassa-Samuelson effect. In fact, according to Harrod-Samuelson effect, there is a tendency for countries with higher productivity in tradables compared to non-tradables to have higher price levels.

3. If the supply shock is interpreted as an increase in capital inflows, the borrowing constraint in the economy would ease and hence output would increase. This would lead to inflationary pressures and an appreciation of the real exchange rate.

4. If the government spending moves from tradables to non-tradables, then it would lead to an appreciation of the REER. Since the price of non-traded goods increase, the general price level would increase as well.

The relative output increases in response to a positive demand shock (although there is a slight decrease initially) and the effect wears off over time, as expected (Figure 3.6). A positive demand shock leads to a permanent appreciation of the real exchange rate (Figure 3.7). The demand shock, however, is not properly identified for relative price level.

Due to a positive nominal shock, the real exchange rate depreciates in the short run, but as expected, returns to its initial level in the long run. On the other hand, a positive nominal shock leads to an increase in the relative prices in the long run. The nominal

shock is not properly identified for the relative output—as the output decreases. However, the effect dissipates in the long run, as expected.

Supply shocks explain most of the variability in relative output at all horizons (Table 3.4), while nominal shocks contribute to the variability up to 4 quarters. Almost all the variation in real exchange rate is explained by demand shocks. Nominal shocks do not account for any variation in the real exchange rate. All shocks are important in explaining the variation in relative prices.

Limitations of structural VAR: As mentioned above, this approach is limited by its ability to identify *at most* only as many types of shocks as there are variables. Since there are many types of shocks, some shocks may not be well identified by the model.

The structural *VAR* approach assumes that there are only three types of shocks—which are interpreted as supply, demand and monetary shocks by Clarida and Gali. This implicitly assumes that all temporary shocks are monetary, which may not be the case; e.g., oil price change, fiscal policy, strikes, weather, etc.

Another assumption of the model that structural shocks for demand and supply are uncorrelated is unbelievable. For example, an increase in demand, increases investment and capital stock, which in turn increases output. Another example is that a technological advancement increases demand because of higher wealth and marginal productivity of capital.

3.3. FORECASTING ABILITY OF THE TIME SERIES MODELS

The purpose of this section is to see how each time series model is capable of forecasting exchange rates—in and out of sample. For the purpose of in-sample forecasting, the models are estimated over the entire sample, and the parameters from this estimate are used for in-sample prediction of the REER. For out-of-sample forecasting, each model is

estimated over the sample period (1980:1 through 1992:4). The estimated parameters from this sample are taken to form 1-period ahead and dynamic 4-period-ahead out-of-sample forecasts of the REER. These forecasts are shown in Figures 3.9 through 3.12.

3.3.1. Cointegration Approach

For in-sample prediction, the cointegrating vector is estimated over the entire sample period (1980:3 to 1997:4). These estimated parameters are used for in-sample prediction:

$$(3.55)\quad \Delta LREER_t^f = \hat{\alpha} + \hat{\lambda}(\hat{A}y_{t-1}) + \sum \hat{\beta}\Delta y_{t-1} + \hat{\gamma} trend$$

where y is a 5x1 vector containing the *LREER, LGCONGDP, LGINVGDP, LTOT and OPEN*, $\hat{A}$ is the cointegrating vector and $\hat{\lambda}$ is the speed of adjustment coefficient.

For out-of-sample forecasting, the cointegrating vector is estimated over the sample period 1980:3 to 1992:4. The parameter estimates from this sample period are used to construct the one- and 4-step ahead out-of-sample forecasts for the remaining sample period.

The forecasts are shown in Figure 3.9. The in-sample forecast of the REER tracks the actual REER closely. The out-of-sample forecasts of the REER show under-prediction of the actual exchange rate—except that the one-step ahead forecast over-predicts in 1993:1 while the 4-period ahead forecast shows over-prediction in 1993:4 and 1995:4.

3.3.2. Unobserved Components Model

The Unobserved Component Model is also estimated over the entire sample (1980:1 to 1998:2) for in-sample prediction. The parameters from this estimation are used to construct the in-sample forecast as follows:

(3.56) $LREER_t^f = \hat{\delta} + n_{t-1} + \hat{\phi}_1 x_{t-1} + \hat{\phi}_2 x_{t-2}$

For out-of-sample forecasting, the model is estimated over the sample 1980:1 to 1992:4. The parameters from this estimation are used to estimate the hyper-parameters (n and x) and these hyper-parameters are used to construct the one- and 4-step ahead out-of-sample forecasts.

The forecasts are shown in Figure 3.10. The in-sample prediction of the REER shows a slight over-prediction of the actual REER whenever the actual REER falls—i.e., the predicted REER falls after the fall in the actual REER. The out-of-sample forecasts of the REER are similar to the in-sample forecast—they show a fall in the REER after the fall in the actual REER. However, the under- and over-prediction is greater for the 4-step ahead forecast.

3.3.3. Structural Vector Auto Regression

For the structural VAR, the first step is to run an equation-by-equation ordinary least square (OLS) regression. The forecasts for the structural VAR are constructed from this first step OLS regression. The equation that is estimated is:

(3.57) $\Delta LREER_t^f = \hat{\alpha} + \sum_{i,j} \hat{\beta}_i y_{i,t-j}$

where y is {*ΔLREER, ΔLNEER*} for the bivariate *VAR*, and {*ΔLREER, ΔRELOUTPUT, ΔRELPRICES*} for the trivariate VAR, j is the number of lags in the VAR.

For the in-sample forecast for the bivariate structural *VAR*, the regression is estimated over the time period 1981:2 to 1998:2 and the parameter estimates are used to construct the forecasts. For the out-of-sample forecast, the regression is estimated over the sample period 1981:2 to 1992:4. The parameters from this regression are used for the one- and 4-

step ahead out-of-sample forecasting over the period 1993:1 to 1998:2 and 1993:4 to 1998:2, respectively.

The forecasts for the bivariate case are shown in Figure 3.11. The in-sample forecasts track the actual REER from 1983 to 1986, after which the forecasts over-predict the actual REER through 1991. After this there is a consistent under-prediction. The out-of-sample forecasts also under-predict the actual REER in the later period, but the extent of under-prediction is less for 4-step ahead out-of-sample forecast compared to the other two.

For the forecasts from the trivariate model, the regression is estimated over the period 1982:2 to 1997:4 and 1982:2 to 1992:4 for the in-sample and the one- and 4-step ahead out-of-sample forecasts, respectively. The forecasts are presented in Figure 3.12. The in-sample forecasts under-predict with a lag whenever the actual REER falls. However, the out-of-sample forecasts under-predict the actual REER through 1996:1, after which there is over-prediction. The extent of over- and under-prediction is larger for 4-step ahead forecast as compared to one-step ahead forecasts.

To gauge the forecasting performance of the models, the mean squared error (MSE) is estimated for all these models, and compared against the standard random walk model. The results are reported in Table 3.5[12]. For the in-sample forecasts, the trivariate structural VAR performs the best, followed by the cointegration approach and the unobserved component model, respectively. All these models beat the random walk model. The unobserved component model performs the best in one-step ahead out-of-sample forecasting, beating the random walk model again. The random walk model turns out to be the best in terms of forecasting 4-period ahead, followed by the cointegration approach.

[12] To make the estimates comparable, the MSE for the in-sample forecasts is taken over 66 common observations, while the one- and 4-period ahead out-of-sample forecasts are estimated over 20 and 17 common observations, respectively.

3.4. CONCLUSION

This paper explains the real exchange rate movements over the period 1980-98 using different economic and time series models and compares the forecasting ability of these methods. First, the paper develops an intertemporal optimization model and estimates it using the cointegrating approach. This model shows that the government expenditures (consumption and investment), openness, terms of trade and productivity growth explain the real exchange rate movements in the long run. Then, in order to examine the movements in the real exchange rate and the trade balance, an unobserved component model is estimated that shows that the cycles in the real exchange rate are associated with the cycles in trade balance—whenever the exchange rate depreciates, the trade balance improves. Lastly, the impact of various shocks on the real exchange rate is examined through the structural vector auto regression (*VAR*). The bivariate *VAR* shows that the real shocks in the economy explain much of the variation in the real exchange rate. The results from the trivariate *VAR* suggest that demand shocks are important in explaining most of the variation.

These models are used for in-sample and out-of-sample forecasting. Their performance is compared in terms of mean squared errors. The results from forecasting show that the trivariate structural VAR, the cointegration approach and the unobserved components model beat even the random walk model in case of in-sample forecasting, while only the unobserved component model performs better than the random walk model in the one-step ahead out-of-sample forecasting. The random walk model beats all the models in terms of forecasting 4-period ahead.

Table 3.1: Unit Root Test for Cointegration

		ADF Test	PP Test
	K	Test Statistic	Test Statistic
LREER	1	-0.638606	-0.654257
LTOT	3	-3.115713**	-2.397927
OPEN	4	-2.442619	-2.559876
GCONGDP	3	-0.151235	-2.066636
GINVGDP	2	-0.761226	-2.400429

Note: Variables are as defined in Appendix 1. Estimation period is 1980:1-1997:4. The lag length for ADF test is determined by a backward selection criterion (starting at 5 lags). The value of k corresponds to the highest-order lag for which the corresponding t-statistic in the regression is significant. The truncation lag for PP test was 3 for all the series. Asterisks *, **, and *** denote rejection of null hypothesis of a unit root in levels at 10 percent, 5 percent, and 1 percent significance levels, respectively. Critical values are from MacKinnon. All series are stationary in first differences.

Table 3.2: Johansen Cointegration Test

Eigenvalue	Likelihood Ratio	5% Critical Value	1% Critical Value	Hypothesized No. of CE (s)
0.56	118.48	87.31	96.58	None**
0.36	61.73	62.99	70.05	At most 1

Note: *(**) denotes rejection of the hypothesis at 5% (1%) level. L.R. Test indicates 1 cointegrating equation(s) at 1% significance level.

Table 3.3: Variance Decomposition of REER and NEER

Variance due to Real Shocks (%)		
Horizon	REER	NEER
1	49.76	35.77
2	60.48	45.93
3	90.23	70.97
4	94.50	97.44
8	98.31	93.10
12	97.39	79.18
40	100.00	87.29

Variance due to Nominal Shocks (%)		
Horizon	REER	NEER
1	50.24	64.23
2	39.52	54.07
3	9.77	29.03
4	5.50	2.56
8	1.69	6.90
12	2.61	20.82
40	0.00	12.71

Table 3.4: Variance Decomposition of Relative Output, REER and Relative Prices

Variance due to Supply Shocks (%)			
Horizon	Output	REER	Prices
1	79.61	5.29	11.45
2	65.06	4.03	15.99
3	53.72	4.27	10.54
4	52.03	2.53	8.68
8	78.90	1.85	12.08
12	92.18	1.24	12.07
40	99.75	16.62	34.95

Variance due to Demand Shocks (%)			
Horizon	Output	REER	Prices
1	1.66	93.69	38.60
2	5.95	95.58	42.83
3	8.33	95.67	52.59
4	10.59	96.38	55.15
8	6.90	97.88	36.99
12	0.03	94.07	16.63
40	0.01	83.24	15.17

Variance due to Nominal Shocks (%)			
Horizon	Output	REER	Prices
1	18.73	1.02	49.96
2	28.99	0.39	41.18
3	37.95	0.06	36.86
4	37.38	1.09	36.18
8	14.21	0.28	50.94
12	7.80	4.69	71.30
40	0.24	0.14	49.87

Table 3.5: Forecasting Performance of the Time Series Models using Mean Squared Errors

In-Sample Forecasts	
Random Walk	0.0044
Cointegration Approach	0.0032
Unobserved Component Model	0.0041
Structural VAR: Bivariate	0.0910
Trivariate	0.0027
Out-of-Sample Forecasts--1 period ahead	
Random Walk	0.0046
Cointegration Approach	0.0104
Unobserved Component Model	0.0034
Structural VAR: Bivariate	0.0605
Trivariate	0.0089
Out-of-Sample Forecasts--4 period ahead	
Random Walk	0.0088
Cointegration Approach	0.0141
Unobserved Component Model	0.0168
Structural VAR: Bivariate	0.0150
Trivariate	0.0416

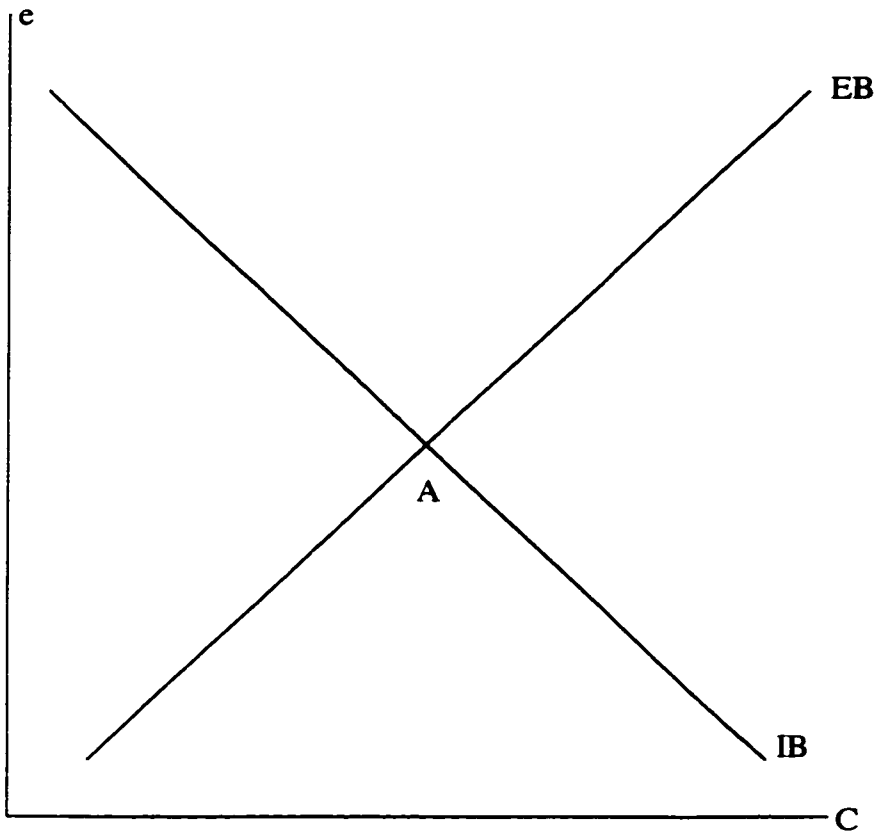

Figure 3.1

Equilibrium Real Exchange Rate

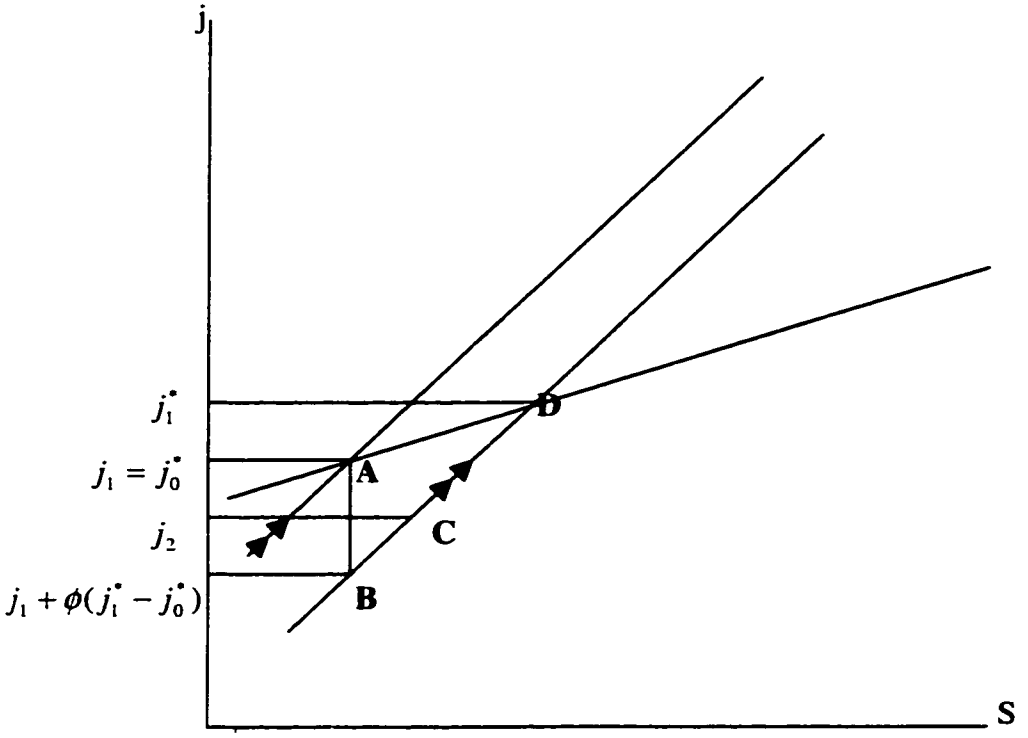

Figure 3.2

Testable Implications of Dynamic Optimizing Model

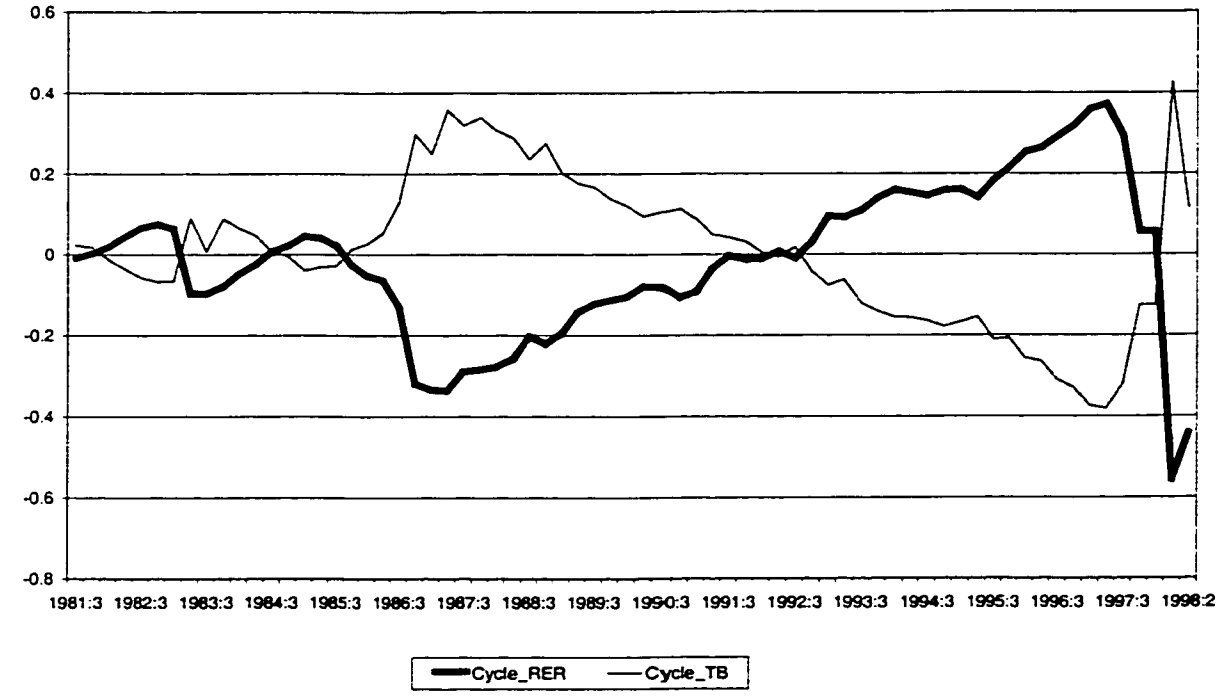

Figure 3.3: Cycles in Real Exchange Rate and Trade Balance
Unobserved Component Model

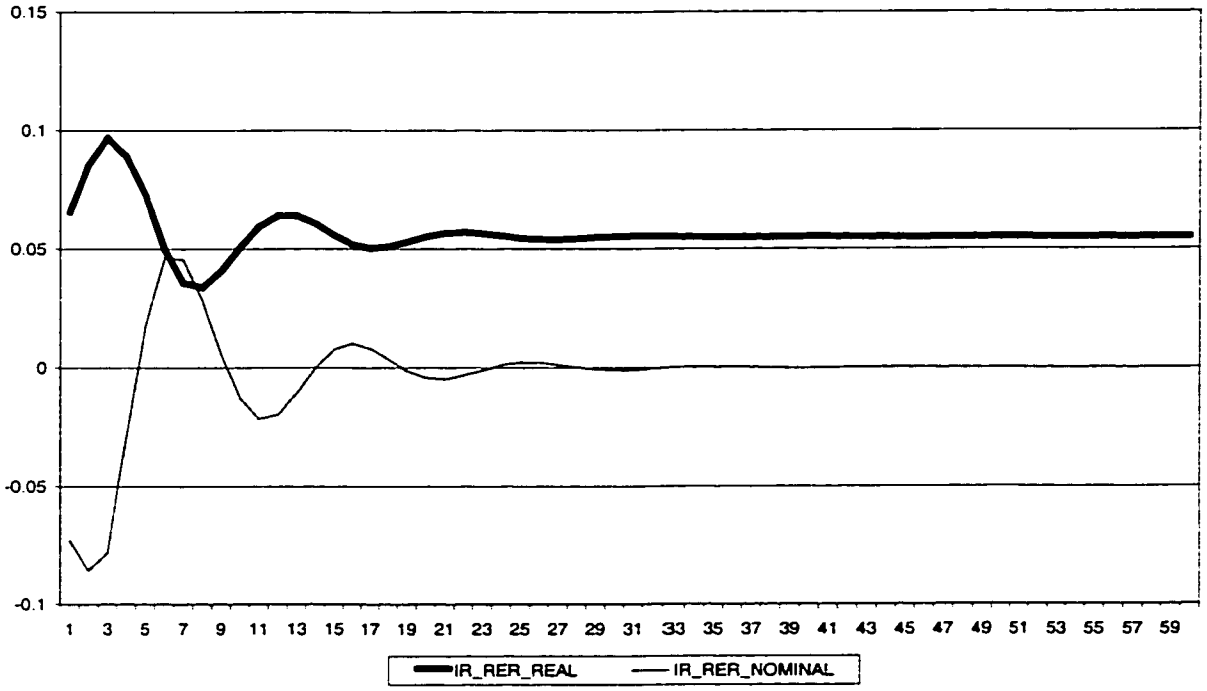

Figure 3.4: Response of Real Exchange Rate to Real and Nominal Shocks
Bivariate Structural Vector Auto Regression

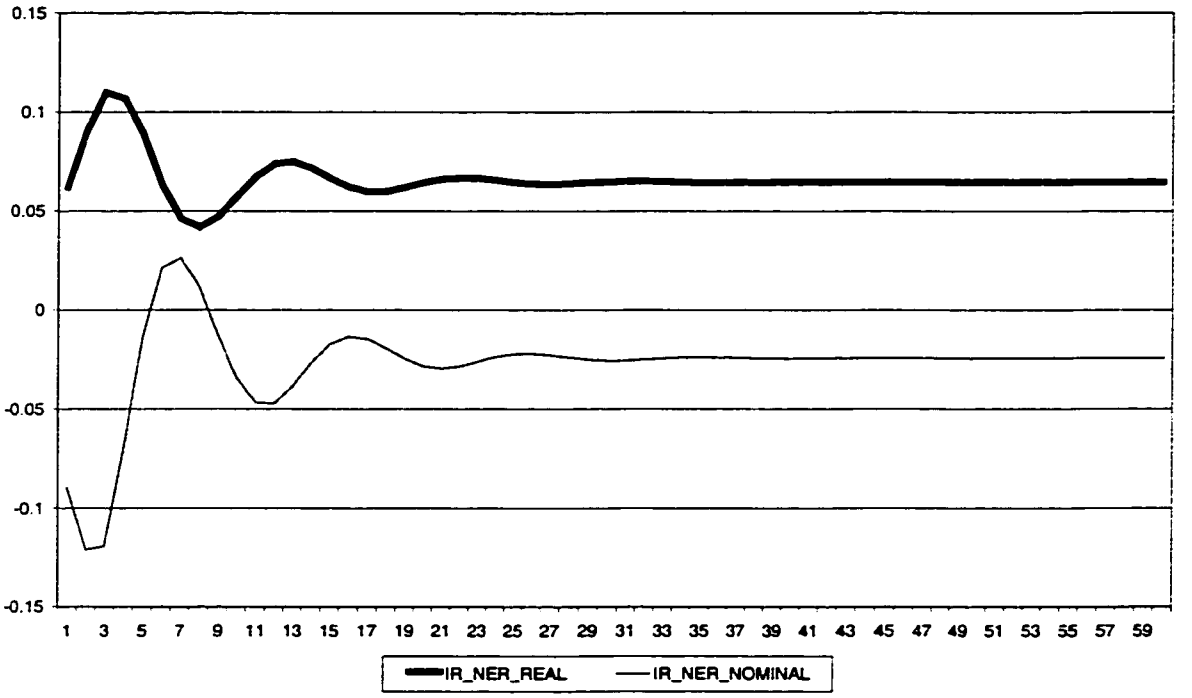

Figure 3.5: Response of Nominal Exchange Rate to Real & Nominal Shocks
Bivariate Structural Vector Auto Regression

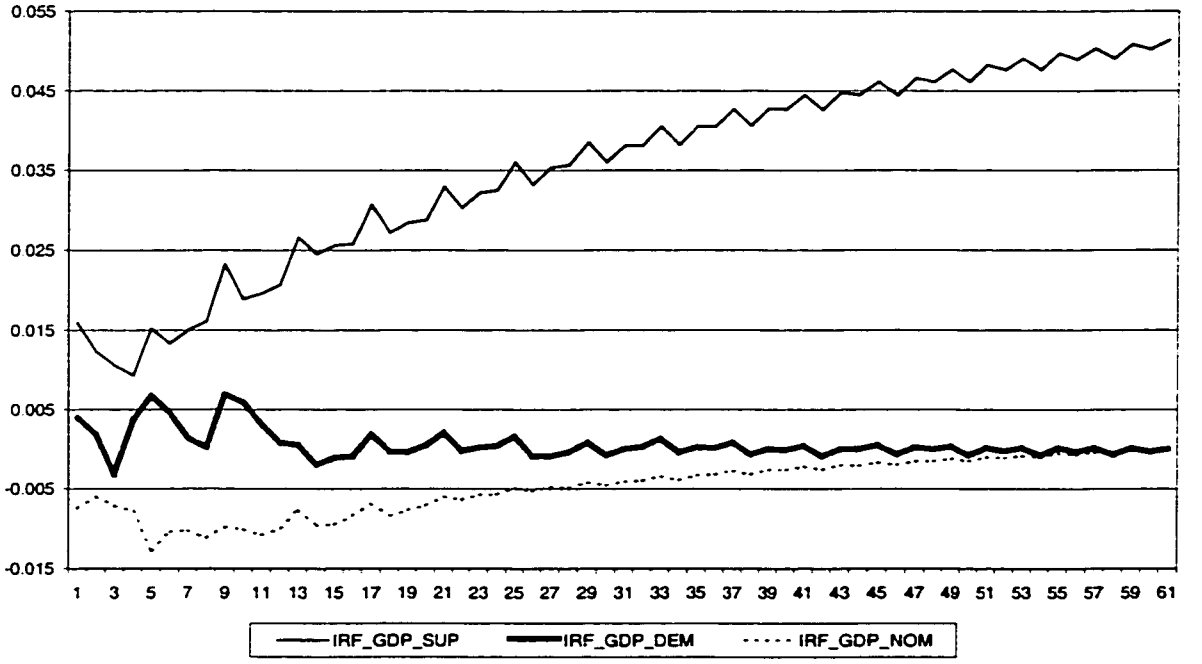

Figure 3.6: Response of Relative Output to Supply, Demand & Nominal Shocks
Trivariate Structural Vector Auto Regression

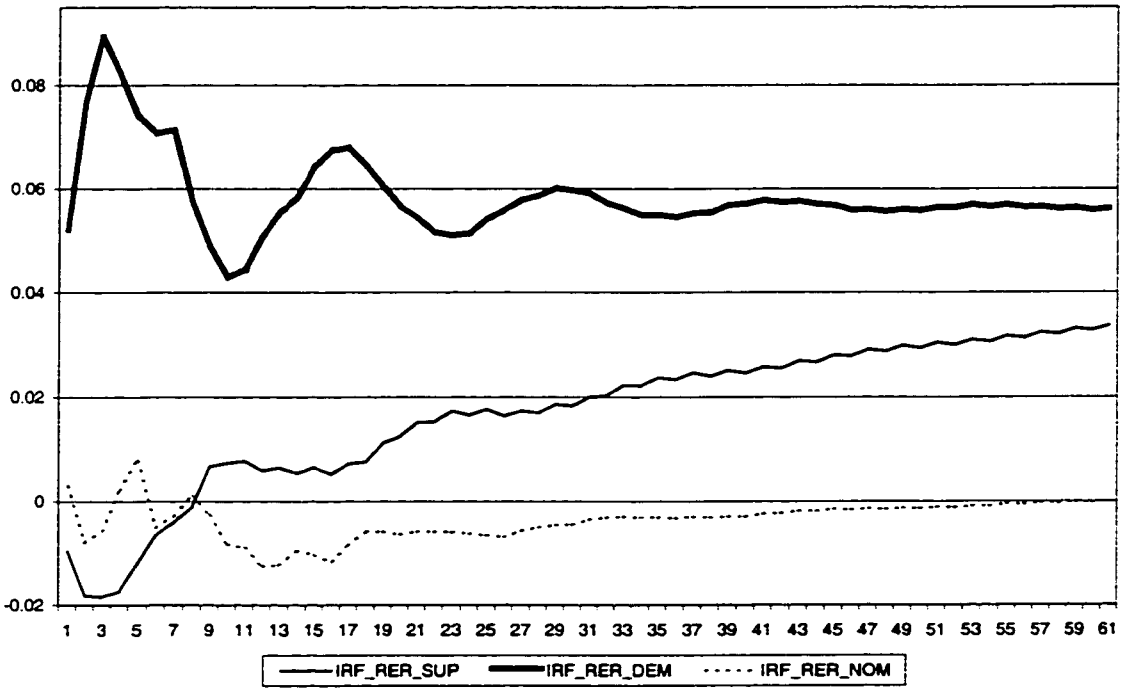

Figure 3.7: Response of REER to Supply, Demand and Nominal Shocks
Trivariate Structural Vector Auto Regression

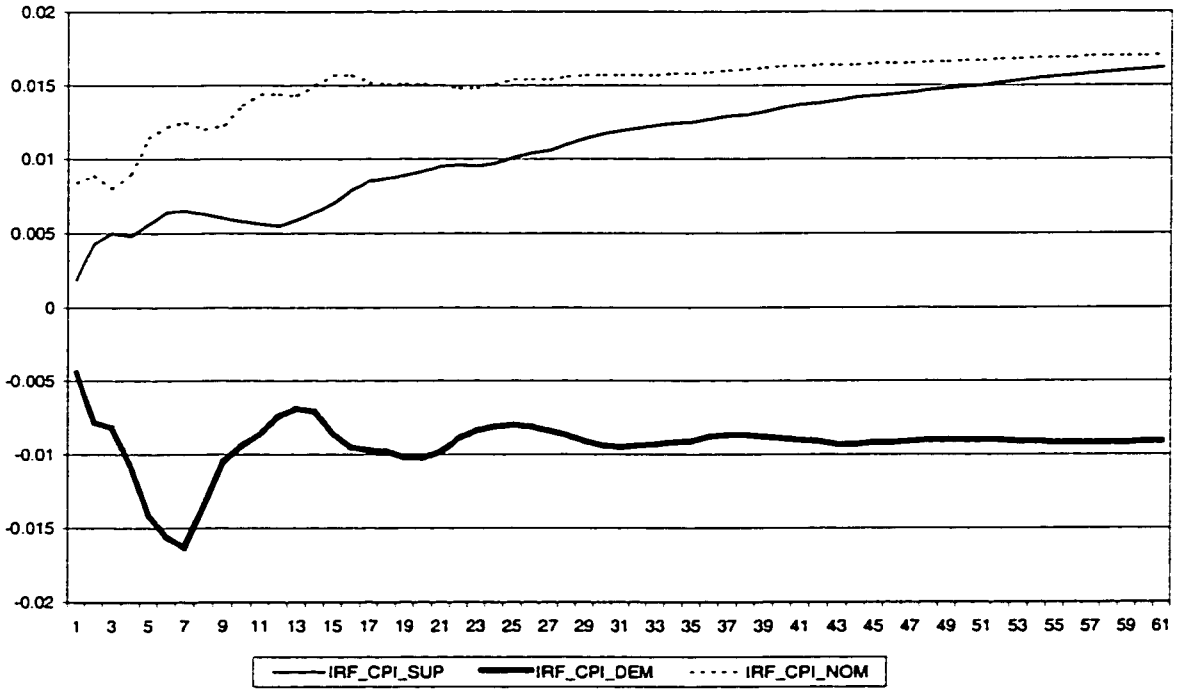

Figure 3.8: Response of Relative Prices to Supply, Demand & Nominal Shocks
Trivariate Structural Vector Auto Regression

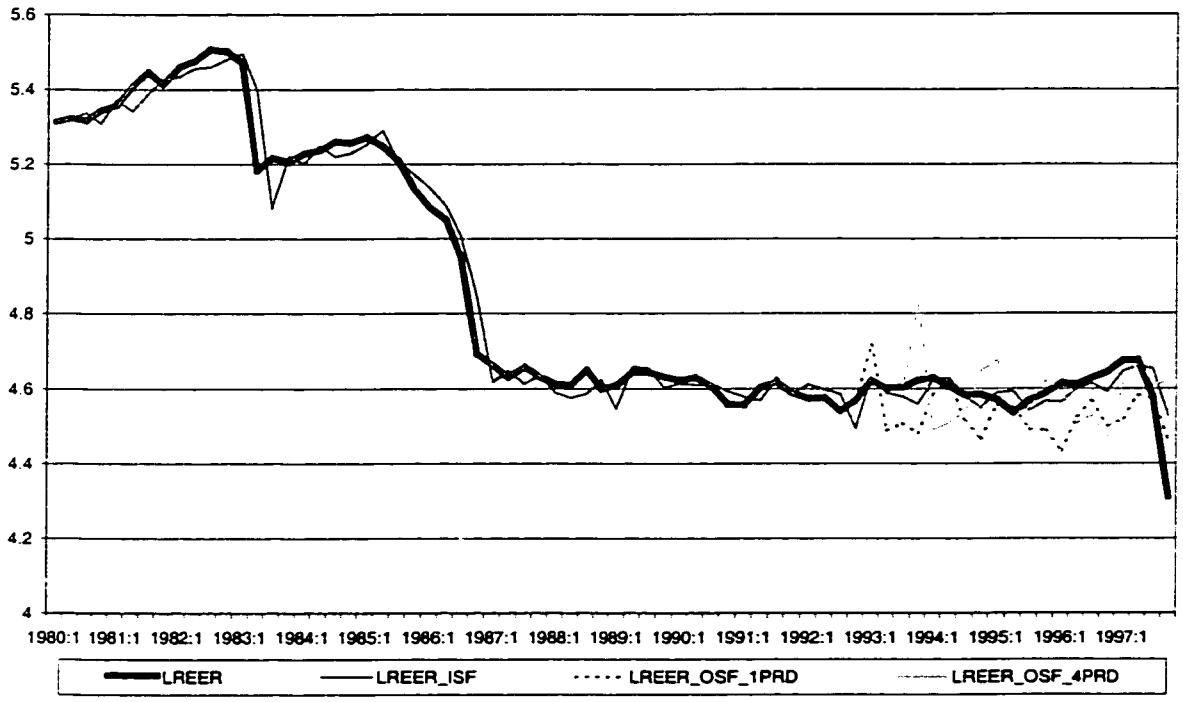

Figure 3.9: Actual and Forecasted REER for Indonesia
Cointegrating Vector Approach

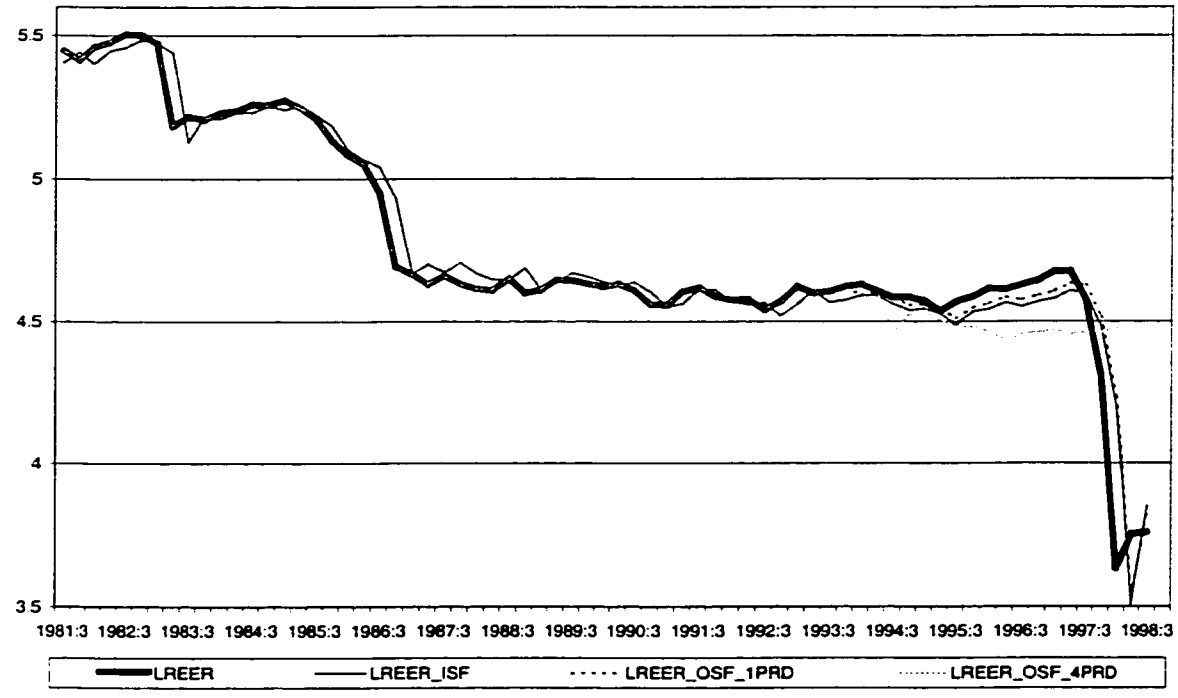

Figure 3.10: Actual and Forecasted REER for Indonesia
Unobserved Component Model

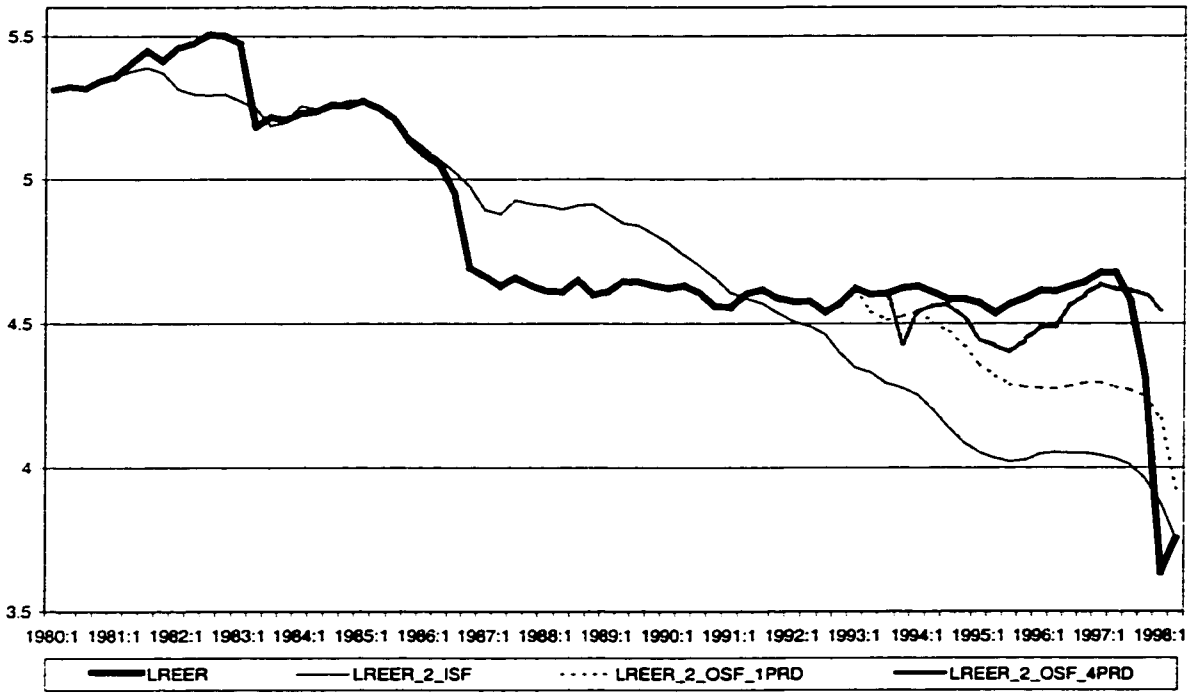

Figure 3.11: Actual and Forecasted REER for Indonesia
Bivariate Structural Vector Auto Regression

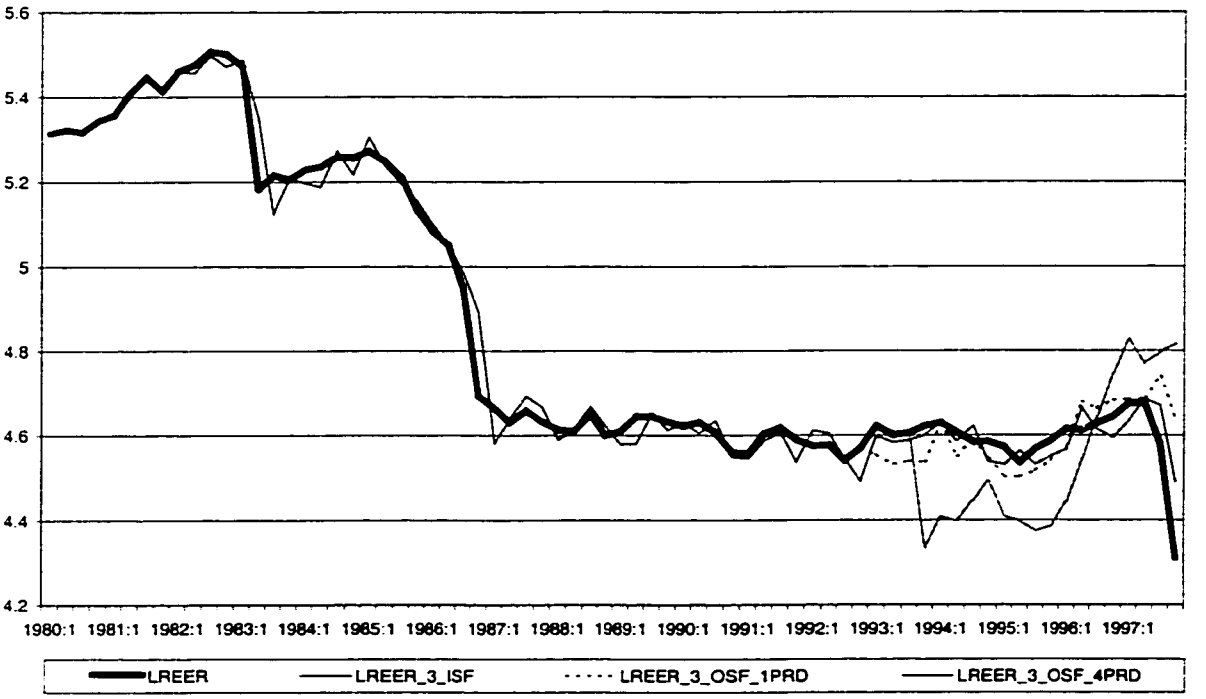

Figure 3.12: Actual and Forecasted REER for Indonesia
Trivariate Structural Vector Auto Regression

Chapter 4: What Caused the 1991 Currency Crisis in India? A Case Study[1]

4.1. INTRODUCTION

India's post-Independence development strategy was both inward-looking and highly interventionist, consisting of import protection, complex industrial licensing requirements, financial repression, and substantial public ownership of heavy industry. However, macroeconomic policy strived for stability through low monetary growth and moderate public sector deficits. Consequently, inflation remained generally low except in response to unfavorable supply shocks (e.g. from oil price increases or poor weather conditions). The current account was in surplus for most years until 1980, and there was a reasonable cushion of official reserves. Official aid dominated capital inflows.

During the first half of the 1980s, the current account deficit averaged about $2¼ billion. While export growth was slow, the trade deficit was kept in check as a rapid increase in domestic petroleum production permitted savings on energy imports. At the same time, the high proportion of concessional external financing kept debt service down.

In the second half of the 1980s, the policy emphasis shifted from import substitution toward export-led growth, supported by measures to promote exports and liberalize imports for exporters. The government began a process of gradual liberalization of trade, investment, and financial markets. Import and industrial licensing requirements were eased, and tariffs replaced some quantitative restrictions. Export growth was rapid, due to the initial measures of deregulation and improved competitiveness associated with the real depreciation of the rupee. However, the value of imports increased at a faster clip. The volume of petroleum imports increased by over 40 percent from 1986/87 to 1989/90 with the growth of domestic petroleum production slowing and consumption growth

[1] Helpful suggestions from Charles Engel are acknowledged.

remaining strong. A deterioration of the fiscal position stemming from rising expenditures contributed to the wider current account deficits. For instance, imports of aircraft and defense capital equipment rose sharply. The balance on invisibles also deteriorated as debt service payments increased.

Current account deficits in the second half of the 1980s exceeded the availability of aid financing on concessional terms and consequently other sources of financing were tapped to an increasing extent. In particular, the rising current account deficits were increasingly financed by borrowing on commercial terms and remittances of nonresident workers—which meant greater dependence on higher cost short maturity financing and increased sensitivity to shifts in creditor confidence. India's external debt increased from some $35 billion at the end of 1984/85 to $69 billion by the end of 1990/91. Medium- and long-term commercial debt increased from $3 billion at the end of 1984/85 to $13 billion at the end of 1990/91 and the stock of nonresident deposits rose from $3 billion to $10.5 billion over the same period. Short-term external debt rose sharply to $6 billion and the ratio of debt service payments to current receipts increased to close to 30 percent.

By 1990/91, India was increasingly vulnerable to shocks as a result of its rising current account deficits and increased reliance on commercial external financing. Events in the Middle East in 1990 and the consequent run-up in world oil prices helped precipitate the crisis in India that followed. In 1990/91, the value of petroleum imports increased by $2 billion to $5.7 billion as a result both of the spike in world prices associated with the Middle East crisis and increased oil import volume as domestic crude oil production was impaired by supply difficulties. In comparison, non-oil imports rose by only 5 percent in value (1 percent in volume terms). The rise in oil imports led to a sharp deterioration in the trade account, worsened further by a partial loss of export markets (as the Middle East crisis disturbed conditions in the Soviet Union). The Gulf crisis also resulted in a decline in workers' remittances as well as additional burden on repatriating and rehabilitating non-resident Indians from the affected zones.

The deterioration of the current account was also induced by slow growth in important trading partners. Export markets were weak in the period leading up to India's crisis as world growth declined steadily from 4½ percent in 1988 to 2.3 percent in 1991. The decline in growth was even greater for the US, India's single largest export destination. US growth fell from 3.9 percent in 1988 to 0.8 percent in 1990 and –1.0 percent in 1991. Consequently, India's export volume growth slowed to 4 percent in 1990/91. In short, the Middle East crisis and slow growth in major trading partners were the main factors behind the large current account deficit in 1990/91.

In addition to adverse shocks from external factors, there had been rising political uncertainty, which peaked in 1990 and 1991. After a dismal performance in the 1989 elections, the previous ruling party (Congress), chaired by Rajiv Gandhi (the son of former Prime Minister Indira Gandhi), refused to form a coalition government. Instead, the next largest party, Janata Dal, formed a coalition government, headed by V.P.Singh. However, due to Mr. Singh's unpopular social policies, especially the move to provide "blanket reservations" to some deprived castes in jobs and education, riots spread throughout the country and Singh's government fell immediately after his forced resignation in December 1990. A caretaker government was set up until the new elections that were scheduled for May 1991. These events heightened political uncertainty, which came to a head when Rajiv Gandhi was assassinated on May 21st 1991, while campaigning for elections.

Therefore, in addition to the deterioration of the current account, India's balance of payments in 1990/91 suffered from capital account problems due to a loss of investor confidence. The rising current account imbalances and reserve losses contributed to the low investor confidence that was further weakened by the political uncertainties and finally a downgrade of India's credit rating by the credit rating agencies. The result was that commercial bank financing became hard to obtain, and outflows began to take place on short-term external debt, as creditors became reluctant to roll over maturing loans.

Moreover, the previously strong inflows on nonresident Indian deposits shifted to net outflows.

As a consequence of these balance of payments pressures, India's exchange rate was subjected to a severe adjustment in mid-1991. Leading up to mid-1991, the value of the rupee began to slide. The authorities at the Reserve Bank of India took partial action, defending the currency by expending international reserves and slowing the decline in value. Finally, in mid-1991, with foreign reserves nearly depleted, the Indian government permitted a sharp depreciation that took place in two steps within three days (July 1 and July 3, 1991) against major foreign currencies: for example, 9½ percent and 23 percent against the US dollar. With assistance from the IMF, the government then embarked on an adjustment program featuring stabilization and structural reforms. After an initial stage of stabilization through administrative controls, the government focused on monetary tightening and fiscal consolidation. Structural measures initially emphasized accelerating the process of industrial and import delicensing and then shifted to further trade liberalization, financial sector reform, and tax reform. However, despite progress in liberalizing trade and capital flows, India is still relatively closed and capital inflows have been well below those in other Asian economies. In this respect, India's 1991 currency crisis provides an interesting case study, contrasting against the recent Asian crisis, which mostly affected the very open Asian countries.

In official descriptions of the event as outlined above, India's exchange rate crisis has been attributed to the continued current account deficits leading up to the crisis, made worse by problems related to the Middle East crisis; high fiscal deficits; and a loss of confidence in the government. Edwards (1989) presents an extensive analysis of exchange rate misalignments and crises in developing countries, including those with restricted external regimes. He attributes crises to a correction of real exchange rate appreciation following expansive macroeconomic policies.

The paper will investigate the causes of India's crisis, attempting to verify if Edwards' framework or the official explanations for the crisis can be supported by the econometric evidence. The paper proceeds by estimating the long run (equilibrium) real exchange rate for India in order to determine if the Indian Rupee was overvalued at the time of the crisis in 1991. The aim is to see what macroeconomic factors led to a misaligned exchange rate—if at all there was a misalignment. Section 4.2 discusses the determinants of the equilibrium real exchange rate in the light of some theoretical models. Section 4.3 presents the econometric results from the estimation of error correction models and verifies how close the results adhere to predictions of the theoretical models. Section 4.4 uses information from the econometric estimation to decompose the real exchange rate into its temporary and permanent (equilibrium) components. The forecasting performance of our model is contrasted against the random walk in section 4.5. Section 4.6 concludes.

4.2. THEORETICAL EXPLANATIONS OF THE REAL EXCHANGE RATE

Theoretical models that suggest real fundamentals impacting the long run real exchange rate are presented by Montiel (1997) and Edwards (1989). They both use intertemporal optimization techniques to determine how the equilibrium real exchange rate is affected by real variables. While Montiel's model is an infinite horizon one, Edwards uses a two-period optimization model. Intuitively, the equilibrium real exchange rate—associated with the steady state in Montiel and the second period in Edwards—is consistent with simultaneous internal and external balance. The predictions from the two models can be summarized as follows:[2]

- Changes in the **composition of government spending** affect the long run equilibrium REER in different ways depending on whether the spending is directed toward traded or non-traded goods. If government spending is directed mainly toward traded goods and services, the trade balance deteriorates. To bring the external balance in equilibrium, the REER must depreciate. The expected sign on the coefficient is

negative. Conversely, spending directed mainly toward non-traded goods and services generate excess demand in the non-traded sector. To restore the sectoral balance, there must be an appreciation of the REER, which can be defined as the relative price of non-tradables to tradables (since we use an increase in the ratio as an appreciation). The expected sign on the coefficient is positive.

- As the **terms of trade** improve, there is an increase in the real wage in the export sector, due to which labor from the non-tradable sector moves to the tradable sector, which leads to a trade surplus. To restore external balance, the REER must appreciate. Hence, a positive coefficient is expected.

- As **exchange and trade controls** in the economy decrease, the demand for imports leads to external and internal imbalance which require real depreciation to correct them. The expected sign depends on the proxy used for exchange controls. Montiel uses the proxy openness (exports+imports/gdp) for a reduction in exchange controls arguing that as trade barriers are reduced (including price and quantity controls), the total amount of trade will increase. Accordingly, an increase in openness should be associated with real depreciation, and the expected sign is negative. However, Edwards uses other proxies for exchange controls—import tariffs as a ratio of tariff revenues to imports and the spread between the parallel and official rates in the foreign exchange market. If these proxies are used, then the expected sign is positive, since a reduction in the values of each of these proxies implies a reduction in controls and depreciation.[3] Edwards stresses the limitations of his two proxies. While import tariffs ignore the role of non-tariff barriers, the spread between the parallel and official rates captures some other forces besides the trade controls.

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[2] Following the convention used by the IMF, an increase in the real effective exchange rate (REER) is an appreciation.

[3] In this case, the parallel and official rates are in rupees per dollar and the spread is the difference between them. Therefore, a positive spread reflects a more depreciated parallel rate compared to the official rate.

- As **capital controls** decrease, private capital flows in[4] and both the intertemporal substitution effect and the income effect operate to increase present consumption. There is pressure on the real exchange rate to appreciate in the short run in order to induce greater production in the nontraded sector and to shift some of the increased consumption toward imports. However, the long run effect of a reduction in capital controls is ambiguous. The reduction in capital controls is equivalent to a decrease in the tax on foreign borrowing that generates a positive wealth effect, which increases consumption in all periods. Hence, an appreciation is required (positive sign) for equilibrium to hold. On the other hand, by the intertemporal substitution effect, future consumption is lower than present consumption, which exerts a downward pressure on the future (long-run) price of non-tradables, hence a depreciation of REER is required (negative sign). The overall sign of the equilibrium depends on which effect dominates.

- The **Balassa-Samuelson effect—technological progress**: Higher differential **productivity growth** in the traded goods sector leads to increased demand and higher real wages for labor in that sector. The traded goods sector expands, leading to an incipient trade surplus. To restore both internal and external balance, the relative price of non-traded goods must rise (REER appreciation).

- **Investment** in the economy: According to Edwards, when investment is included in the theoretical model, the intertemporal analysis includes supply side effects that depend on the relative ordering of factor intensities across sectors. Therefore, the sign on the exchange rate in response to increased investment is ambiguous.

Permanent changes in the fundamentals above lead to changes in the long run equilibrium real exchange rate. In other words, strict purchasing power parity does not hold as the

[4] The lifting of capital controls is typically associated with inflows of capital in developing countries as foreign investors seek new investment opportunities and as domestic industries resort to borrowing abroad. The reduction of capital controls could also conceivably lead to an outflow of capital, although this would most likely occur in response to a temporary loss in confidence of domestic policies or economic prospects.

equilibrium real exchange rate is time-varying. The real exchange rate therefore fluctuates around a time-varying equilibrium defined by its relationship with the long-run fundamental determinants.

In addition to the long-run relationship, Edwards considers macroeconomic policies that lead to overvaluation of the domestic currency, that is, short-run misalignments. He uses excess supply of domestic credit and a measure of fiscal policy (ratio of fiscal deficit to lagged high-powered money) as proxies of "inconsistent" macroeconomic policies. As macroeconomic polices become highly expansive, the real exchange rate appreciates—reflecting a mounting dis-equilibrium or real exchange rate overvaluation. However, we must keep in mind that his analysis is based on a fixed exchange rate regime: inconsistent macroeconomic policies generate a higher domestic price level which, with a fixed nominal exchange rate, leads to an appreciation of the real exchange rate. India did not have a fixed exchange rate regime in the period under analysis, although the authorities did intervene to manage the exchange rate and partially resist depreciation, especially in the period leading up to the crisis. Since the regime can be thought of as a managed float, it is not likely that the conditions assumed by Edwards—fixed exchange rate with price adjustment—were met. Instead, nominal exchange rate adjustment likely outpaced adjustment through the price level.

In connection with Edwards' theory of misalignment, we include his variables for inconsistent macroeconomic policies in the short run part of the specification. In addition, the 1991 crisis in India is believed to have been caused mainly by high fiscal deficits, the loss of confidence in the government, and mounting current account deficits. We will verify these assertions also. We now proceed to the econometric investigation.

4.3. ECONOMETRIC EVIDENCE

The intertemporal model discussed above is estimated using an Error Correction Model (ECM).[5] Before the cointegration technique was developed, researchers used partial adjustment or auto-regressive models. These models assume that the variables are stationary and try to capture the serial correlation in the endogenous variable by including lags of it or including ARMA terms. These techniques do not account for tendency of many economic variables to be integrated and therefore also do not account for the possibility that the economic variables share a common stochastic trend. Any equilibrium relationship among a set of non-stationary variables implies that their stochastic trends must be linked. Then, since these variables are linked in the long-run, their dynamic paths should also depend on their current deviations from their equilibrium paths. The ECM has the advantage of capturing the common stochastic trend among the non-stationary series and the deviations of each variable from its equilibrium.

Data source and construction are provided in Appendix 4.

In order to estimate the error correction model, all of the fundamentals are examined for unit roots. Unit test results are reported in Table 4.1. Standard unit root tests reveal that the null hypothesis of a unit root cannot be rejected for any of the long-run fundamentals, but can be rejected for the current account, excess credit and the fiscal balance to high powered money.[6] The unit root test cannot be rejected for the index of political confidence, but can be rejected for its first difference. The lag length for the error correction model is determined by backward selection, beginning at a lag length of four to economize on degrees of freedom. The Likelihood Ratio Test indicates that ECM(2) is the most appropriate.

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[5] For testable implications of the intertemporal model, refer to Saxena (1999).

[6] Of course, much research has shown that unit root tests of economic variables suffer from lack of power. That is, when a series is stationary, but highly autocorrelated, rejection of the unit root hypothesis requires a considerably longer sample period than the sample typically available. Nonetheless, the consequences of assuming variables are stationary when they are not includes finding spurious relationships. Hence, it is more conservative to assume the variables are nonstationary even if they are not.

To estimate the error correction model (ECM), the series are tested for cointegration. The results from Johansen Cointegration tests are reported in Table 4.2, including the number of cointegrating vectors. The results reported in Table 4.3 are obtained by estimating the ECM by imposing one cointegrating vector for ease of interpretation.[7] (However, the equilibrium real exchange rate and forecasting analysis discussed below are estimated with the number of cointegrating vectors stipulated from the cointegration test.)

We first estimate the ECM with all of the potential fundamental long-run variables suggested from the theory (Model 1). The results indicate that all the fundamentals are significant, except openness. The same model was estimated with Edwards' proxies for openness, namely parallel market spread and exchange controls. However, they were insignificant as well. Government consumption leads to a real depreciation, consistent with a higher proportion of government consumption directed towards traded goods relative to private consumption. An improvement in the terms of trade leads to an appreciation of the real exchange rate, while increases in openness and increases in investment lead to real depreciation. A decrease in capital controls leads to higher capital inflows, which appreciates the real exchange rate in the long run—indicating that the income effect dominates over the intertemporal substitution effect. Technological progress leads to an appreciated real exchange rate—a result consistent with the Balassa Samuelson effect.

Next, a general to specific modeling procedure is employed. The insignificant variables from Model 1 are eliminated sequentially to arrive at the parsimonious specification, Model 2. The results remain the same as Model 1 in terms of signs, although the magnitudes change slightly.

Having arrived at a parsimonious specification involving significant fundamentals that affect the equilibrium exchange rate, we now examine the impact of short-run factors that

can cause the exchange rate to temporarily deviate from equilibrium.[8] Model 3 is estimated with the same long run fundamentals as in Model 2, with proxies for inconsistent macroeconomic policies as used by Edwards (1989). The results indicate that the signs on the long run fundamentals remain the same as before and are significant. The coefficients on the policy variables are insignificant—indicating that the empirical evidence does not provide support for Edwards' description of misalignment in the case of India.[9] Moreover, the signs of our results are inconsistent with Edward's explanation of real exchange rate misalignment in response to lax macroeconomic policy. Our (insignificant) results indicate that an improvement in the government fiscal balance leads to an appreciation in the real exchange rate and conversely, fiscal deficits correspond to a depreciation of the real exchange rate. Excessive domestic credit creation leads to a depreciation of the real exchange rate. In Edwards' model, the nominal exchange rate is fixed and higher government deficits that are monetized lead to a higher domestic price level and a corresponding appreciation of the real exchange rate. Given these assumptions, the lack of support for Edwards' model for India is not surprising: since the rupee exchange rate was mostly flexible, nominal depreciation could partly offset any domestic price pressures arising from monetary expansion. In addition, the data do not indicate that India monetized its deficits to any significant extent. The increasing fiscal deficits in the years leading up to the crisis were financed by borrowing, including from foreign sources. The effect of this was a misalignment in the external sector as a result of fiscal deficits which, at the prevailing levels, was inconsistent with an intertemporal budget constraint. Instead of Edwards' framework, the exchange rate depreciation resulting from fiscal deficits or high domestic credit creation is consistent with the classical Mundell-Fleming framework. Expansive fiscal or monetary policy, in the case of a country such as India with limited capital mobility, leads to a balance of

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[7] Note that this one cointegrating vector can also be obtained as a linear combination of the estimated multiple cointegrating vectors.

[8] Sensitivity tests indicated that there was no advantage in using the full specification of Model 1 when analyzing the effects of the exogenous variables, since the results were not significantly different from those reported from the parsimonious specification while several degrees of freedom were lost in the process of dragging around the insignificant variables and their lags.

[9] The table shows the results for the most significant lag. The coefficients on other lags have the same sign as the third lag, with one negligible exception.

payments deficit and nominal exchange rate depreciation. With sluggish prices, the real exchange rate also depreciates.

Having found that the Edwards model does not fit well for India, we now investigate whether the evidence supports the descriptions of the causes of India's balance of payments crisis: namely high current account deficits, fiscal deficits, and loss of confidence in the government. Hence, to Model 2, we add the short run factors: the current account balance, the government fiscal balance to high powered money (as above), and changes in political confidence.[10] The results are shown in column 4 (Model 4) of Tables 4.3 and 4.4. The long run results do not change much as the fundamentals have the usual (significant) signs. Regarding the exogenous variables, both the current account and the change in political confidence are significant,[11] with positive signs. This indicates that as the current account balance improves and confidence in the government increases, the real exchange rate appreciates. The sign and significance of the political confidence indicator can be expected since this variable proxies for the confidence of India's creditors and their willingness to rollover debt or maintain deposits. Similar to the result reported in Model 3, the government balance is positive but insignificant. The insignificance of the fiscal variable here may be due to collinearity. Confidence in the government is likely to decline as fiscal deficits grow and appear unsustainable. Moreover, the inclusion of the current account deficit in the equation would, according to the Mundell-Fleming model described above, capture the external effects of the expansionary fiscal policy.

Through elimination of the insignificant fiscal variable, we arrive at the parsimonious Model 5. However, one difficulty with using this model for the analysis in the next sections is that data is available for political confidence only from 1985. The loss of several years of data in the early 1980s leads to the problem that there are not enough degrees of freedom to estimate a restricted sample for the out-of-sample forecasting

[10] Since we could not reject the hypothesis of a unit root for the level of political confidence, its first difference was taken in the specification.
[11] The insignificant lags were eliminated.

exercise discussed below. Therefore, for purposes of the remaining analysis, the political confidence variable is dropped and the **baseline specification** is shown as **Model 6**—which consists of the long-run variables from the parsimonious specification (Model 2) and the current account balance as the exogenous short run variable.

As a sensitivity analysis, we estimate Model 7, where Edwards' variables for capital control and investment are ignored but openness and terms of trade are restored, consistent with Montiel's specification. The results from Model 1 still hold—increases in government consumption and openness lead to a depreciation of the real exchange rate, while an improvement in the terms of trade results in an appreciation of the real exchange rate. An improvement in the current account balance results in real exchange rate appreciation. The coefficient on technological progress, however, becomes insignificant.

One result that emerges very clearly from the econometric investigation is that the current account plays a very significant role in explaining short-run movements in the real exchange rate for India during the period of analysis. This variable is robust to all specifications (a significant positive sign). This result is corroborated by Callen and Cashin (1999) which examines the sustainability of India's current account during the period 1952/53-1998/99 using three methods. They find that in the period prior to 1990/91, India's intertemporal budget constraint was not satisfied and the return to smaller current account deficits following the crisis was needed to reestablish solvency.

In this section, the current account has been discussed as an exogenous short-run explanatory variable. In general, however, the real effective exchange rate could be expected to influence the current account. Indeed, the decline in the real exchange rate in the latter half of the 1980s was likely a contributing factor to rapid export growth in particular, although the initial liberalization measures implemented to spur export-led growth is also thought to have been important. However, since the key feature of the current account from the mid-1980s through the crisis in mid-1991 was its sharp deterioration, it seems that the simultaneous rapid decline in the real exchange rate over

this same period had at most a mitigating influence. There were many other factors that jointly overwhelmed any beneficial influence of the real exchange rate and produced the substantial deterioration in the current account. As mentioned in the introductory section, some of these factors included: the increasing dependence on foreign oil imports and consequently the increased vulnerability to oil price shocks; strong domestic demand as a result of both the initial liberalization efforts and deteriorating fiscal balances, but weak foreign demand in the years leading up to and including 1991; shocks to worker's remittances; and higher interest payments on external debt due to its higher cost structure and rising size.

Moreover, these observations on the relationship between the real exchange rate and the current account in this period are borne out by evidence from Granger causation tests. The results of Granger causation tests (Table 4.5) lend support to the idea that movements in the current account had a strong impact on the real exchange rate, but opposite did not hold.

The null hypothesis that the current account does *not* Granger cause changes in the real effective exchange rate *can be rejected* at the 10 percent confidence level for 4 and 8 quarter lags and (marginally) at the 5 percent confidence level for 12 quarter lags. In the other direction of causality, the hypothesis that changes in the real effective exchange rate do *not* Granger cause the current account *cannot be rejected* for 8 and 12 lags. This hypothesis *can* be (marginally) rejected at the 10 percent confidence level for 4 lags. However, this latter result is more likely spurious because the sum of the lagged exchange rate coefficients in the current account equation is positive, counter to theoretical predictions that decreases in the real exchange rate should lead to improved current account balances. This evidence is in line with the discussion above that the current account balances were deteriorating at the same time as the real exchange rate was declining substantially. Therefore, we cannot look to real exchange rate movements to explain India's current account problems in this sample, but we can feel confident that

the deteriorating current account was an important factor in India's currency crisis in 1991.

4.4. ESTIMATING THE EQUILIBRIUM REAL EXCHANGE RATE

In order to determine if the Indian Rupee was overvalued prior to the crisis in 1991, we estimate the equilibrium real exchange rate using the error correction model estimated in section III.[12] Frequently, researchers construct the equilibrium real exchange rate by multiplying the cointegrating vector with the *actual* values of the fundamentals. However, the fundamentals may have their own temporary components and by using the *actual* values of the fundamentals, the construction of the equilibrium real exchange rate depends on these temporary components, when it should not. Edwards (1989) recognizes the problem with using actual values of the fundamentals to construct the equilibrium exchange rate. He tries to solve this using two methods. He does a Beveridge-Nelson decomposition of each fundamental series or alternatively he uses moving averages of each fundamental series. He then uses the constructed permanent component of each variable in his equilibrium equation. These are potential suggestions for finding the equilibrium fundamentals as would be other methods of univariate decomposition into permanent and temporary components.

This section estimates the equilibrium real effective exchange rate using three different methods. First, the permanent components of the fundamentals are constructed using a Hodrick-Prescott filter and a 13-quarter (centered) moving average process as representative smoothing methods.[13] These methods are used for illustrative purposes only. While these methods produce smooth fundamental series that are appealing to the eye, there is no sound theoretical basis for these procedures. If simple smoothing processes were enough to arrive at the equilibrium values for the fundamental series, then

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[12] We report only the equilibrium exchange rate estimated from the baseline ECM (Model 6).

[13] Previous work with the Beveridge-Nelson decomposition has shown that since the method assumes that the permanent component is a random walk, the filtered series tends to closely replicate the actual data; very little smoothing tends to occur.

the same smoothing processes could be employed on the real exchange rate series to estimate the equilibrium real exchange rate. But doing so would be devoid of economic theory such as that which describes a relationship between the exchange rate and other economic variables, a relationship that is estimated through an error correction model in this paper. In addition, independently smoothing the fundamentals does not take advantage of information arising from the interaction of the variables.

Gonzalo and Granger (1995) propose a more appealing way of solving this econometric problem so that the permanent (equilibrium) component of the endogenous variable of interest—in our case the exchange rate—could be constructed using the permanent components rather than the actual values of the fundamental determinants. It is done using the joint information in the error correction system rather than pre-constructing the fundamental variables the way Edwards and some other researchers do. Other procedures advanced in the literature to address this issue include Quah (1992) and Kasa (1992). A transitory component can be characterized as having limited memory such that shocks to this component die out over time. However, if the transitory component Granger causes the permanent component, the shock can have permanent effects on the actual aggregated series. Therefore, the economic interpretation of the components can be misleading since a shock to the "temporary" component may nonetheless have permanent effects. The latter two decomposition methods present this undesirable property. However, Gonzalo and Granger derive a P-T decomposition such that the transitory component does not Granger cause the permanent component in the long-run. Their procedure is outlined below.[14]

Let X_t be a (pxl) vector of $I(1)$ time series with mean 0. Assume that the rank of cointegration is r (there exists a matrix α_{pxr} of rank r such that $\alpha' X_t$ is I(0)). Hence, the vector X_t has the following ECM representation:

[14] This is drawn from Gonzalo and Granger (1995). This procedure was also used by Alberola et al (1999) in their study of euro area exchange rates.

$$(4.1) \qquad \underset{pxr}{\Delta X} = \underset{rxp}{\gamma\ \alpha'} X_{t-1} + \sum_{i=1}^{\infty} \Gamma_i \Delta X_{t-i} + \varepsilon_t$$

where Δ is the lag operator. The elements of X_t consist of $(p\text{-}r)$ *I(1)* variables, f_t, known as the common factors plus some *I(0)* components.

$$(4.2) \qquad \underset{px1}{X_t} = \underset{pxk}{A_1}\ \underset{kx1}{f_t} + \underset{px1}{\tilde{X}_t}$$

where $k = p\text{-}r$.

In order to construct the common factors, f_t, from a linear combination of X_t, the following definition is employed such that $A_1 f_t$ and $\tilde{X}_t$ form the permanent and temporary components of X_t, respectively:

Definition: Let X_t be a difference stationary sequence. A *P-T* decomposition for X_t is a pair of stochastic processes, P_t and T_t such that

1. P_t is difference stationary and T_t is covariance stationary
2. var(ΔP_t) and var(T_t) >0
3. $X_t = P_t + T_t$
4. Let

$$(4.3) \qquad \underset{pxp}{H^*(L)} \begin{bmatrix} \Delta P_t \\ T_t \end{bmatrix} = \begin{bmatrix} u_{P_t} \\ u_{T_t} \end{bmatrix}$$

be the autoregressive (AR) representation of $(\Delta P_t, T_t)$, with u_{P_t} and u_{T_t} uncorrelated, then

(4.3a) $$\lim_{h\to\infty}\frac{\partial E_t(X_{t+h})}{\partial u_{P_t}} \neq 0$$

(4.3b) $$\lim_{h\to\infty}\frac{\partial E_t(X_{t+h})}{\partial u_{T_t}} = 0$$

where E_t is the conditional expectation with respect to the past history. This means that the only shocks that can affect the long run forecast of X_t are those that come from the innovation term u_{P_t} of the permanent component P_t. Innovations to the temporary components of all of the endogenous variables including the fundamental determinants do not affect the long run, i.e. "equilibrium", forecast of X_t. So, for our purposes, cyclical deviations of the fundamentals will be removed in the construction of the equilibrium exchange rate. In addition, the conditions for identifying the common factor permit the contemporaneous observations to contain all of the necessary information to extract the permanent component.

The only linear combination of X_t such that $\tilde{X}_t$ has no long run impact on X (which constitute the conditions sufficient to identify the common factor f_t) is given by:

(4.4) $$\underset{kxp}{f_t} = \underset{kxp}{\gamma_\perp'}\ \underset{px1}{X_t}$$

where $\gamma_\perp$ is the orthogonal complement of γ (i.e, $\gamma_\perp'\gamma = 0$) and $k = p\text{-}r$. Once the common factors f_t are identified, the matrix $(\gamma_\perp, \alpha)'$ can be inverted to obtain the *P-T* decomposition as follows:

(4.5) $$\underset{px1}{X_t} = \underset{pxk}{A_1}\ \underset{kxp}{\gamma_\perp'}\ X_t + \underset{pxr}{A_2}\ \underset{rxp}{\alpha'}\ X_t$$

where $A_1 = (\gamma \dot{}_\perp \alpha_\perp)^{-1}$ and $A_2 = \gamma\,(\alpha'\gamma)^{-1}$. The first term on the right hand side provides the permanent component at each point in time, t, for the vector of endogenous variables (in our case, the real exchange rate and all of its fundamental long-run determinants).

The equilibrium exchange rate is estimated for the baseline model (Model 6) using the three methods—the Hodrick-Prescott filter and moving average process for illustrative purposes (Figure 4.1) and the theoretically attractive Gonzalo-Granger method (Figure 4.2). The equilibrium exchange rate constructed using the Hodrick-Prescott filtered series shows an overvalued exchange rate from 1985:2 through 1995:5, while the one estimated by smoothing the series using moving average shows an overvaluation of the exchange rate from 1986:3 through 1994:4. As mentioned above, these results carry no theoretical value. In order to estimate the exchange rate consistent with the fundamentals, we construct the equilibrium using the method described by Gonzalo-Granger (1995). Figure 4.2 shows the result—the real effective exchange rate was overvalued for several years prior to and through the crisis (from 1985:3 through 1993:1). Indeed, the equilibrium path was below the actual path of the exchange rate for several years of a downward trend, suggesting that the actual depreciation was moving in the direction of restoring equilibrium although the equilibrium itself continued to move to lower levels. In 1993, the equilibrium comes in line with the actual data for the first time since the mid-1980s. Thereafter, the equilibrium is periodically above or below the actual, but there is no clear trend. In summary, a strong result that emerges from all of these estimations is that the real exchange rate for India was overvalued at the time of crisis in 1991.

4.5. FORECASTING THE REAL EXCHANGE RATE

In order to test the forecasting performance of the baseline model (Model 6), we make dynamic as well as static forecasts of the real exchange rate. For both types of forecasts, the model is estimated for the full sample period (through 1997:1) and for a restricted

sample period that ends at a point sufficiently earlier than the crisis such that there would be time for adjustment (1989:4 is chosen as the end point). The parameters from the error correction model estimated over each of these two sample periods are used to form forecasts for the period 1990:1 through 1997:1. While the static forecasts for the exchange rate are formed using actual data for the lagged endogenous variables on the right hand side of the ECM, dynamic forecasts use actual data for the endogenous variables only up to 1989:4 and thereafter use forecasted data for all of the RHS endogenous variables.

The series of real exchange rate forecasts are shown in Figures 4.3 (dynamic) and 4.4 (static). The static forecasts from full and restricted sample parameters follow the actual exchange rate exceptionally closely. More surprisingly, the dynamic forecasts also display similar trends and cycles as the actual data. The dynamic forecast using parameters from the restricted sample does a better job in prediction than the forecast using the full sample parameters in the initial part of the forecast period, but the latter provides a better forecast for the end of the period.

Dynamic forecasts are also constructed for Model 2 in Figure 4.5 (which is the same as the baseline Model 6, but without the current account). The exchange rate forecasts show a linear downward trend. Compared to this, the forecasts from Model 6 shows a similar downward trend, but also show cyclical movements that mirror the actual exchange rate. The better comparative performance of the model containing the current account adds to the evidence that the current account has been an important determinant of short-run exchange rate movements for India.

The forecasting performance of our baseline model is compared with the forecasting performance of different random walk models—in terms of their respective Mean Squared Errors (MSE). The static random walk model is estimated as the usual random walk—the forecast for time t is the actual value of the exchange rate prevailing at

time t-1. These forecasts are comparable to the static forecasts from the ECM, as they both use the actual data from the period immediately preceding the forecast.

Some "dynamic" random walk models are also estimated so that they can be compared with our dynamic forecasts—which do not use any new information after the period of estimation.[15] A simple dynamic random walk model forms a forecast for all future exchange rates based on the value of the exchange rate at the end of the estimation period (1989:4). The two dynamic random walk with trend models are comparable to our dynamic forecasts, where the trend is estimated over the full and the restricted sample periods. These trends are combined with the value of the exchange rate prevailing in 1989:4 to construct the dynamic random walk forecasts.

The MSE results from forecasting are reported in Table 4.6. It is very evident from the results that the forecasts from the ECM perform better than the random walk models. The static forecasts from the ECM models outperform the static random walk while the dynamic forecasts from the ECM models, including those using parameters from the restricted sample, outperform all of the dynamic random walk models.

4.6. CONCLUSIONS

This paper estimates the long run equilibrium real exchange rate for India in order to determine if the currency crisis in 1991 was caused due to the overvaluation of the Indian Rupee. First, the fundamentals that affect the long run equilibrium exchange rate are explained as predictions from intertemporal theoretical models. Then, the predictions of the theoretical models are estimated empirically using error correction models. The results show that the Indian rupee appreciates in the long run in response to an improvement in terms of trade, technological progress, and a relaxation of capital controls. The real exchange rate depreciates when government spending (on tradable

[15] Except for the exogenous variable for which there is no forecast model in the ECM method and the parameters of the full sample model that rely on the complete data set.

goods) increases, the economy opens up and investment increases. The short run variable, current account, is found to be significantly positive and robust to all specifications.

The equilibrium real exchange rate is constructed using the smoothing techniques for the fundamentals—Hodrick-Prescott filter and moving average processes. Since these smoothing processes do not have any theoretical basis, the joint information from the error correction model is used to construct the equilibrium values of the fundamentals using the technique illustrated by Gonzalo-Granger (1995). The estimates of the equilibrium real exchange rate show an overvaluation at the time of crisis in 1991. The econometric evidence supports that the current account deficits played a significant role in the crisis. Moreover, the forecasts from our ECM model outperform random walk models.

Table 4.1: Unit Root Tests

Variable	K	ADF Statistic	PP Statistic
LREER	3	-0.70 *	-0.10 *
LTOT	5	-1.84 *	-1.12 *
LGCONGDP	5	-0.62 *	-3.02 *
LOPEN	4	-0.24 *	-0.61 *
TECHPRO	4	-1.00 *	-2.04 *
LINVGDP	1	-1.19 *	-0.44 *
CAPCONTROL	4	-1.76 *	-1.47 *
EXCHCONTROL	2	-1.24 *	-1.87 *
LPARALLEL	2	-2.42 *	-2.09 *
GBALHPM	2	-3.45	-6.73
EXCREDIT	3	-3.80	-12.47
CURRENTACC	0	-5.23	-5.16
POLCONF	1	-1.44 *	-1.38 *
DPOLCONF	1	-4.58	-5.32

Note: Variables are as defined above in Appendix 1. The value of k corresponds to the highest-order lag for which the corresponding t-statistic in the regression is significant. Asterisks * denote non-rejection of null hypothesis of a unit root at 1% significance level. Critical values are from MacKinnon. These are the results from Unit Root testing in levels. However, all non-stationary series were stationary in first differences.

Table 4.2: Johansen Cointegration Test

Model	Eigenvalue	Likelihood Ratio	Critical Value 5%	Critical Value 1%	Hypothesized No. of CE(s)
Model 1	0.50	172.23	124.24	133.57	None **
	0.43	124.18	94.15	103.18	At Most 1 **
	0.37	84.56	68.52	76.07	At Most 2 **
	0.26	51.68	47.21	54.46	At Most 3 *
	0.23	31.02	29.68	35.65	At Most 4 *
	0.13	13.16	15.41	20.04	At Most 5
Model 2	0.43	97.87	68.52	76.07	None **
	0.34	58.60	47.21	54.46	At Most 1 **
	0.19	29.21	29.68	35.65	At Most 2
Model 3	0.43	96.53	68.52	76.07	None **
	0.36	58.71	47.21	54.46	At Most 1 **
	0.19	27.98	29.68	35.65	At Most 2
Model 4	0.71	98.24	68.52	76.07	None **
	0.41	39.25	47.21	54.46	At Most 1
Model 5	0.73	115.20	68.52	76.07	None **
	0.42	50.67	47.21	54.46	At Most 1 *
	0.22	23.59	29.68	35.65	At Most 2
Model 6	0.41	95.92	68.52	76.07	None **
	0.38	59.55	47.21	54.46	At Most 1 **
	0.19	26.39	29.68	35.65	At Most 2
Model 7	0.41	94.25	68.52	76.07	None **
	0.29	55.27	47.21	54.46	At Most 1 **
	0.19	29.88	29.68	35.65	At Most 2 *
	0.10	14.14	15.41	20.04	At Most 3

Note: *(**) denotes rejection of the null hypothesis of cointegration at 5%(1%) level of significance

Table 4.3: Results from Cointegrating Equation 1/2/

VARIABLE	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
LGCONGDP	-3.586 ***	-4.859 ***	-2.895 ***	-4.842 **	-4.641 ***	-6.011 **	-6.423 ***
LTOT	0.771 ***						2.291 ***
LOPEN	-0.174						-0.967 ***
TECHPRO	3.909 ***	6.167 ***	6.378 ***	3.183 **	4.119 ***	5.703 ***	-1.475
CAPCONTROL	16.180 ***	41.084 ***	21.754 ***	108.910 ***	95.502 ***	56.969 **	
LINVGDP	-3.859 ***	-6.259 ***	-5.482 ***	-5.112 ***	-5.739 ***	-6.816 ***	
Exogenous Variables: 3/							
EXCREDIT(-3)			-0.193				
GBALHPM(-3)			0.297	0.187			
DPOLCONF(-3)				0.003 *	0.003 **		
CURRENTACC(-4)				0.00002 ***	0.00002 ***	0.00002 ***	0.00002 ***

1/ The models differ in terms of long run and short run variables that are included in each.

2/ Astensks ***, **, * denote significance of the variable at 1, 5 and 10 percent level of significance, respectively.

3/ These variables are included in the short run part of the error correction models.

Table 4.4: Results from Error Correction Models 1/

VARIABLE	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
CointEq	-0.111 ***	-0.057 ***	-0.067 ***	-0.061 ***	-0.079 ***	-0.037 ***	-0.077 ***
d(LREER(-1))	0.165	0.104	0.074	-0.256 **	-0.204 *	-0.012	0.104
d(LREER(-2))	-0.155	-0.217 *	-0.180	-0.360 ***	-0.350 ***	-0.254 ***	-0.234 **
d(GCONGDP(-1))	-1.593 **	-1.520 **	-1.313 **	-2.632 **	-3.014 ***	-1.420 **	-1.031
d(GCONGDP(-2))	1.386 ***	1.167 **	1.143 **	1.010	1.332	0.876 *	0.582
d(LTOT(-1))	-0.211						0.069
d(LTOT(-2))	0.258						-0.327
d(LOPEN(-1))	0.112 *						0.106 *
d(LOPEN(-2))	0.059						0.048
d(TECHPRO(-1))	0.051	0.065	0.065	0.084	-0.030	0.143	0.301 ***
d(TECHPRO(-2))	-0.190	-0.257 *	-0.208	-0.219 *	-0.308 **	-0.216	-0.109
d(CAPCONTROL(-1))	3.913	5.473 **	5.866 **	5.846 *	6.922 **	5.279 **	
d(CAPCONTROL(-2))	-1.807	-1.623	-0.210	1.480	0.402	-0.956	
d(LINVGDP(-1))	-1.177 *	-1.078 *	-0.900	-1.425 ***	-1.470 ***	-1.415 ***	
d(LINVGDP(-2))	1.399 **	1.670 **	1.838 ***	2.342 ***	2.405 ***	1.564 **	
EXCREDIT(-3)			-0.193				
GBALHPM(-3)			0.297	0.187			
DPOLCONF(-3)				0.003 *	0.003 **		
CURRENTACC(-4)				0.00002 ***	0.00002 ***	0.00002 ***	0.00002 ***
Adjusted R-Squared	0.343	0.326	0.354	0.687	0.675	0.420	0.346

1/ The dependent variable is d(LREER)

Note. Asterisks ***, ** and * denote the significance of the variables at 1, 5 and 10 percent level of significance, respectively.

Table 4.5: Granger Causality Tests

Pairwise Granger Causality Tests for the period 1979:1 to 1997:1			
Null Hypothesis:	Lags	F-Statistic	Probability
CA does not Granger cause D(LREER)	4	2.43485	0.05713
D(LREER) does not Granger cause CA	4	2.07426	0.09561
CA does not Granger cause D(LREER)	8	2.06296	0.05895
D(LREER) does not Granger cause CA	8	1.53289	0.17160
CA does not Granger cause D(LREER)	12	2.04197	0.04990
D(LREER) does not Granger cause CA	12	1.22957	0.30279

Table 4.6: Mean Squared Forecasting Errors

Model	Mean Squared Error
Dynamic_Random Walk	0.1277
Dynamic_Random Walk with Drift_Full Sample	0.0183
Dynamic_Random Walk with Drift_Restricted Sample	0.0409
Dynamic_ECM_Full Sample	0.0057
Dynamic_ECM_Restricted Sample	0.0063
Static_Random Walk	0.0025
Static_ECM_Full Sample	0.0008
Static_ECM_Restricted Sample	0.0022

Note: The forecasts for the ECM are from Model 6. All MSEs are estimated over a common sample (1990:1 to 1997:1) with 29 observations.

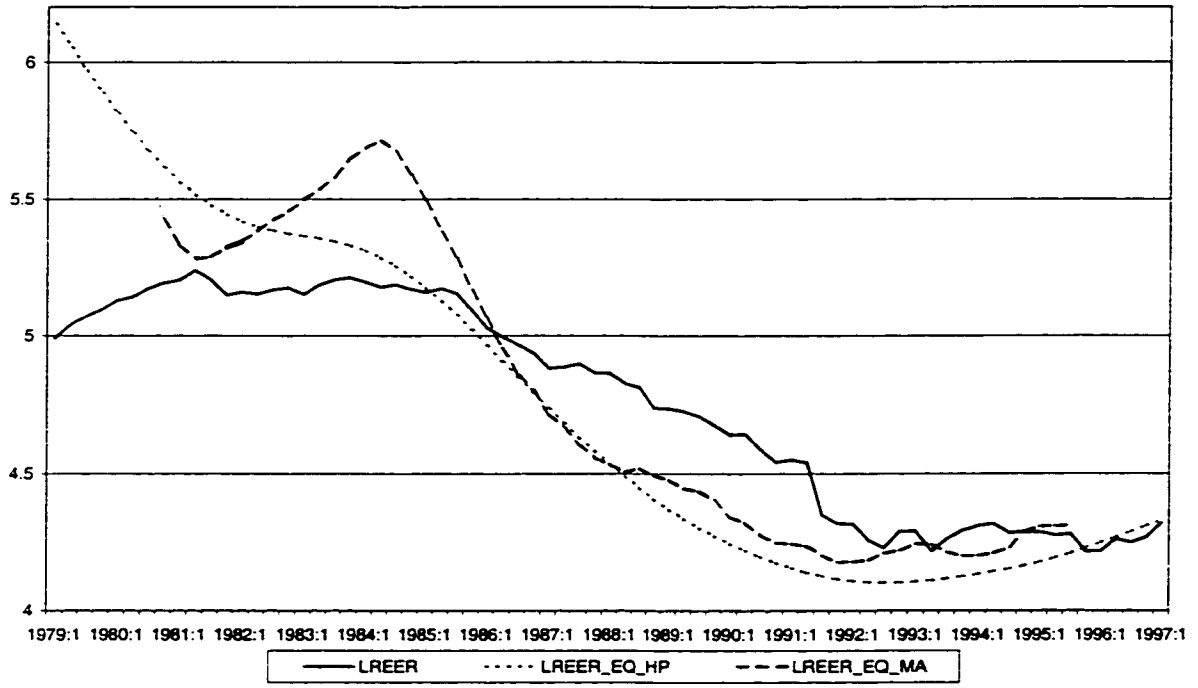

Figure 4.1: Actual and Equilibrium Real Effective Exchange Rate for India using Hodrick Prescott Filter and Moving Average Method

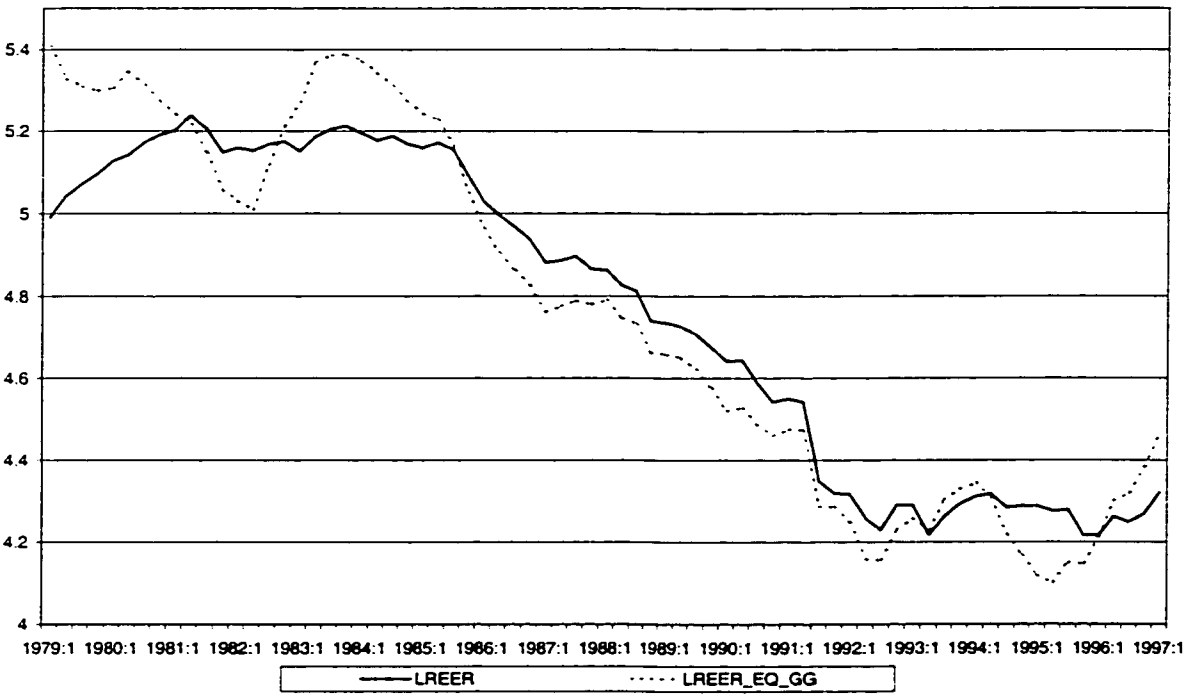

Figure 4.2: Actual and Equilibrium Real Effective Exchange Rate for India using Gonzalo-Granger Method

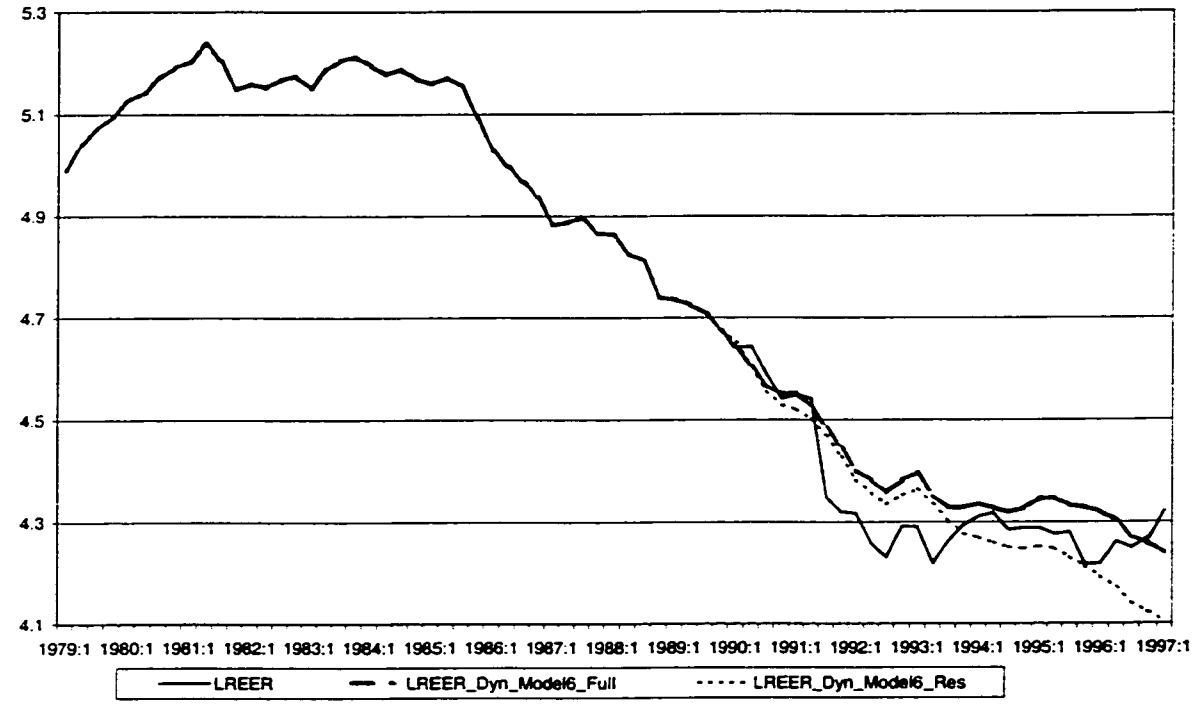

Figure 4.3: Dynamic Forecast of Real Effective Exchange Rate for India: Model 6

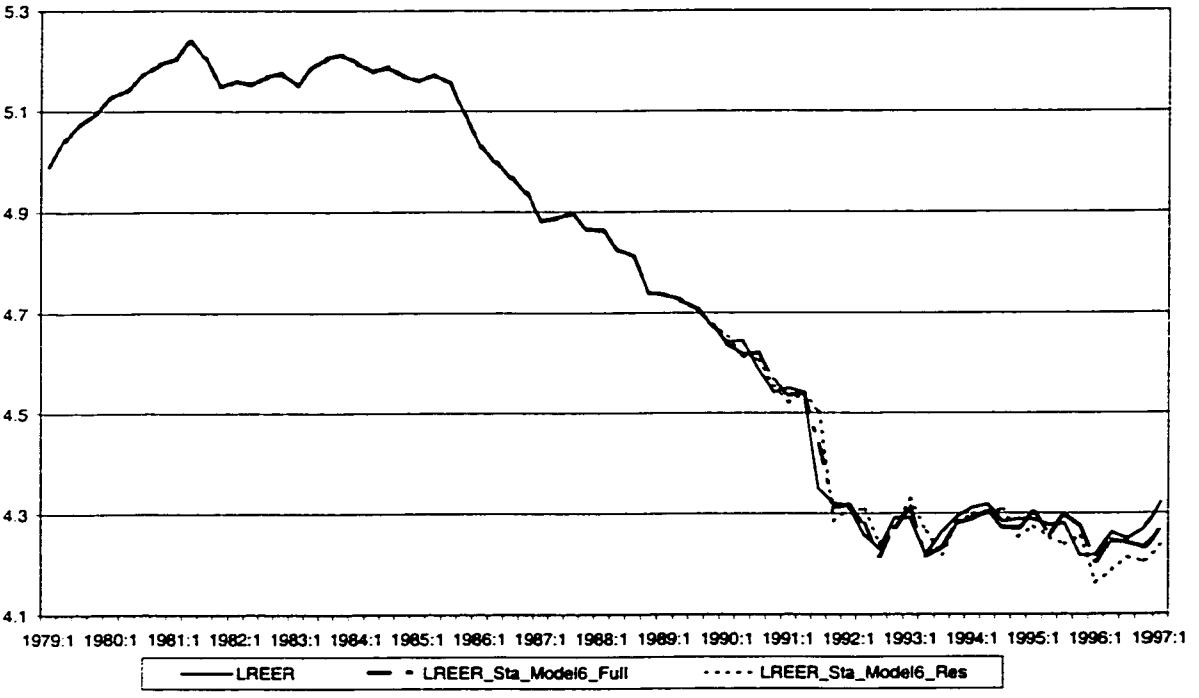

Figure 4.4: Static Forecast of Real Effective Exchange Rate for India: Model 6

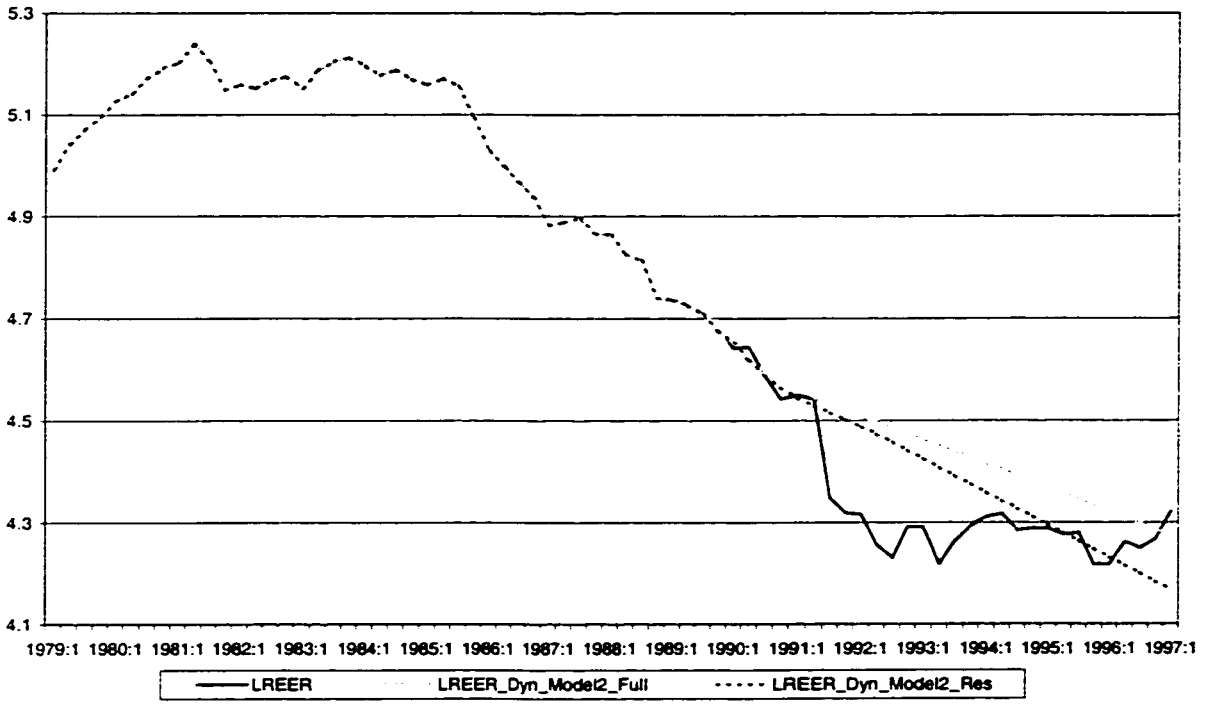

Figure 4.5: Dynamic Forecast of Real Effective Exchange Rate for India: Model 2

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Appendix 1: Data Source and Construction for Chapter 2

Date Sources:

Variable	Description of the Variable	Source
e	Average-period exchange rate	IFS line rf
i	Discount-rate or money market rate	IFS line 60 or 60b
r	Non-gold international reserves	IFS line 1ld
REER	Real Effective Exchange Rate	IMF calculation
gdp	Gross Domestic Product	Indonesian Financial Statistics, BI Publication
forliab	Deposit money banks' gross foreign liabilities	IFS line 26c
pvtcredit	Deposit money banks' credit to private sector	IFS line 22d
domcr	Domestic Credit	IFS line 32
depliab	Real bank deposit liabilities	IFS line 24 + 25
M1	M1 measure of money supply	IFS line 34
forasset	Deposit money banks' gross foreign assets	IFS line 21
rtspread	Difference between lend rate and deposit rate	IFS line 60P minus 60L
polconf	Political Risk Measure	International Country Risk Guide
exports	Exports	IFS line 70d
imports	Imports	IFS line 71d
xvalue	Unit price of export	IFS line 76 (updated from Indonesian Financial Statistics, BI Publication)
mvalue	Unit Value of import	Indonesian Financial Statistics &Import Statistika
gcon	Government consumption expenditures	Indonesian Financial Statistics
ginv	Government investment expenditures	Indonesian Financial Statistics
jpndisctrt	Japanese discount rate	IFS line 60
jpncpi	Japanese Consumer Price Index	IFS line 60
uscpi	U.S. Consumer price Index	IFS line 64
ustbillrt	U.S. 3-month treasury bill rate	IFS line 60

Data Construction:

1. Market Pressure Index (MPI) for Indonesia, Korea and Thailand was constructed as:

   $$MPI_{i,t} = (\%\Delta e_{i,t})/\sigma_{\Delta e_{i,t}} + (\Delta i_{i,t})/\sigma_{\Delta i_{i,t}} - (\%\Delta r_{i,t})/\sigma_{\Delta r_{i,t}}$$

   where e is the U.S. dollar exchange rate (domestic currency/US$);

i is the discount rate;

r is the non-gold international reserves;

σ is the standard deviation of the respective series

2. forliabgdp = forliab/gdp

3. pvtclaimgdp = pvtcredit/gdp = private claims to GDP

4. forasset2m1 = fa2m1=forasset/m1

5. domcrgdp = domcr/gdp

6. tradebalance=tb = exports-imports

7. TOT = (xvalue/mvalue)*100

8. usrroi = ustbillrt – usinflation

9. jpnrroi = jpndisctrt - jpninflation

10. The measure on political risk (polconf) was taken from ratings compiled every month by the PRS Group in the International Country Risk Guide. This indicator is weighted by each component as (%):

a. Government Stability (12)
b. Socio-Economic Conditions (12)
c. Investment Profile (12)
d. Internal Conflict (12)
e. External Conflict (12)
f. Corruption (6)
g. Military in Politics (6)
h. Religion in Politics (6)
i. Law and Order (6)
j. Ethnic Tensions (6)
k. Democratic Accountability (6)
l. Bureaucracy Quality (4)

Overall, political confidence rating is as follows:

00-49.9% indicates Very High Risk;

50-59.9% indicates High Risk;

60-69.9% indicates Moderate Risk;

70-79.9% indicates Low Risk;

80% or more indicates Very Low Risk.

Appendix 2: Construction of "Forecasted Values" for the Markov Switching Models

The measurement equation for the simple Fixed Transitional Probability Model is given by equation (A.2.1).

$$(A.2.1)\quad Y_t = \mu_t + \phi(Y_{t-1} - \mu_{t-1}) + \sum_{j=1}^{3} \beta_j X_{j,t-1} + e_t$$

where

$$(A.2.2)\quad Y_t = MPIIDN_t$$

$$(A.2.3)\quad \mu_t = \mu_0(1 - S_t) + \mu_1 S_t$$

The expected value of Y_t at time (t-1) can be found by taking the expectation of both sides of (A.2.1), conditional on information at (t-1).

$$(A.2.4)\quad \begin{aligned} E_{t-1}Y_t = {} & E_{t-1}[\mu_0 - \mu_0 S_t + \mu_1 S_t] + E_{t-1}[\phi Y_{t-1}] - \\ & E_{t-1}[\phi\mu_0 - \phi\mu_0 S_{t-1} + \phi\mu_1 S_{t-1}] + E_{t-1}[\sum_{j=1}^{3} \beta_j X_{j,t-1}] + E_{t-1}[e_t] \end{aligned}$$

The parameters μ_0, μ_1 and ϕ are constants. They are, therefore, independent of the state. We have the following conditional expectations:

$$(A.2.5)\quad E_{t-1}[\mu_i] = \hat{\mu}_i \quad i = 0,1$$

$$(A.2.6)\quad E_{t-1}[\mu_i S_t] = \hat{\mu}_i E_{t-1}[S_t] \quad i = 0,1$$

$$(A.2.7)\quad E_{t-1}[\phi\mu_i] = \hat{\phi}\hat{\mu}_i + C\hat{o}v(\phi, \mu_i) \quad i = 0,1$$

$$(A.2.8)\quad E_{t-1}[e_t] = 0$$

We can also find the conditional expectations of the state.

$$\text{(A.2.9)}\quad E_{t-1}S_{t-1} = \sum_{0,1} S_{t-1}\,\Pr(S_{t-1} / Y_{t-1}) = \Pr(S_{t-1} = 1 / Y_{t-1})$$

$$\text{(A 2.10)}\quad E_{t-1}S_{t} = \sum_{0,1} S_{t}\,\Pr(S_{t} / Y_{t-1}) = \Pr(S_{t} = 1 / Y_{t-1})$$

Since the explanatory variables are pre-determined, we can find the conditional expectations by using actual values of the lagged explanatory variables.

$$\text{(A.2.11)}\quad E_{t-1}[\sum_{j=1}^{3} \beta_j X_{j,t-1}] = \sum_{j=1}^{3} \hat{\beta}_j X_{j,t-1}$$

Substituting (A.2.5) through (A.2.10) into (A.2.4), we can get an expression for $E_{t-1}Y_t$ in terms of the parameter estimates μ_0, μ_1 and ϕ, the off-diagonal elements of the parameter covariance matrix $Cov(\phi,\mu_0)$ and $Cov(\phi,\mu_1)$, the conditional probabilities in (A.2.9) and (A.2.10), and the lagged dependent variable Y_{t-1}.

$$\begin{aligned}\text{(A.2.12)}\quad E_{t-1}Y_t &= \hat{\mu}_0 + (\hat{\mu}_1 - \hat{\mu}_0) * \Pr(S_t = 1 / Y_{t-1}) + \hat{\phi} Y_{t-1} - (\hat{\phi}\hat{\mu}_0 + \hat{Cov}(\phi, \mu_0)) \\ &\quad + [\hat{\phi}\hat{\mu}_0 + \hat{Cov}(\phi, \mu_0) - \hat{\phi}\hat{\mu}_1 - \hat{Cov}(\phi, \mu_1)] * \Pr(S_{t-1} = 1 / Y_{t-1}) + \sum_{j=1}^{3} \hat{\beta}_j X_{j,t-1}\end{aligned}$$

Construction of forecasted values for the Time Varying Transitional Probability Markov Switching Model in Chart 8 are similar to above, except that the transitional probabilities are affected by lagged values of MPIs in Thailand and Korea.

Appendix 3: Data Source and Construction for Chapter 3

Data Source:

Variable	Description of the Variable	Source
REER	Real Effective Exchange Rate	IMF Calculation
NEER	Nominal Effective Exchange Rate	IMF Calculation
Idngdp	Indonesia's Gross Domestic Product	Indonesian Financial Statistics, BI Publication
Idnexports	Indonesia's Exports	IFS line 70d
Idnimports	Indonesia's Imports	IFS line 71d
Xvalue	Unit price of export	IFS line 76 (updated from Indonesian Financial Statistics, BI Publication)
Mvalue	Unit price of import	Indonesian Financial Statistics & Import Statistika
Gcon	Government Consumption Expenditures	Indonesian Financial Statistics
Ginv	Government Investment Expenditures	Indonesian Financial Statistics
Usgdp	U.S. Gross Domestic Product	IFS line
Jpngdp	Japanese Gross Domestic Product	IFS line
Relprice	Relative Price Index for Indonesia	IMF calculation—I536PRPI

Data construction:

1. GCONGDP = Gcon/Idngdp
2. GINVGDP = Ginv/Idngdp
3. OPEN = (Idnexport + Idnimport)/Idngdp
4. TOT = (Xvalue/Mvalue)*100
5. Trade balance = Idnexport – Idnimport
6. Relative Output = Log (Idngdp) – (0.6232)*Log (Jpngdp) – (0.3768)Log (Usgdp)
7. Due to the lack of available data on sectoral productivities, a simple trend is used as a proxy for the differential productivity.

Appendix 4: Data Source and Construction for Chapter 4

Data Source:

Variable	Description of the Variable	Source
REER	Real Effective Exchange Rate	IMF Calculation
Rupper$	Period average nominal exchange rate	IFS line rf
GCON	Government consumption expenditure	IFS line 91
XVAL	Unit value of exports	IFS line 74
MVAL	Unit value of imports	IFS line 75
X	Exports	IFS line 70
M	Imports	IFS line 71
GDP	Gross Domestic Product	IFS line 99b
CAPINFLOW	Capital Inflows	IFS line 78bjd + 78cad
PARALLEL	Black market rate	
IPI	Industrial Production Index	IFS line 64
INV	Gross Fixed Capital Formation	IFS line 93e
CURRENTACC	Current account balance	IFS line 78aldzf
POLCONF	Political Confidence	Ratings compiled by PRS group in the International Country Risk Guide
HPMONEY	High Powered Money	IFS line 14
DOMCREDIT	Domestic Credit	IFS line 32
CUSTREV	Custom revenues	Monthly Statistical Abstract of India, GOI Publication
GBAL	Government balance	Monthly Statistical Abstract of India, Revenue-Expenditure

Data Construction:

1. LREER = Ln(REER)
2. LGCONGDP = Ln(GCON/GDP)
3. LTOT = Ln(XVAL/MVAL)
4. LOPEN = Ln (X + M/ GDP)
5. LINVGDP = Ln(INV/GDP)
6. TECHPRO = Ln(IPI/IPI $_{-4}$)
7. LEXCHCONTROL = Ln(CUSTREV/M)

8. LPARALLEL = Ln(PARALLEL-Rupper$)
9. CAPCONTROL = $(\text{CAPINFLOW/GDP})_{-1}$
10. GBALHPM = GBAL/HPMONEY_{-1}
11. EXCREDIT = $\Delta Ln(DOMCREDIT) - \Delta Ln(GDP)_{-1}$
12. DPOLCONF = $\text{POLCONF} - \text{POLCONF}_{-1}$

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