Discussion Paper
No. 0601

Exchange Market Intervention and Evidence of Post-Crisis Flexible Exchange Rate Regimes in Selected East Asian Economies

Victor Pontines and Reza Y. Siregar

April 2006

International Macro and Finance Program

University of Adelaide
Adelaide 5005 Australia

CENTRE FOR INTERNATIONAL ECONOMIC STUDIES

The Centre was established in 1989 by the Economics Department of the Adelaide University to strengthen teaching and research in the field of international economics and closely related disciplines. Its specific objectives are:

- to promote individual and group research by scholars within and outside the Adelaide University
- to strengthen undergraduate and post-graduate education in this field
- to provide shorter training programs in Australia and elsewhere
- to conduct seminars, workshops and conferences for academics and for the wider community
- to publish and promote research results
- to provide specialised consulting services
- to improve public understanding of international economic issues, especially among policy makers and shapers

Both theoretical and empirical, policy-oriented studies are emphasised, with a particular focus on developments within, or of relevance to, the Asia-Pacific region. The Centre's Director is Reza Y. Siregar (reza.siregar@adelaide.edu.au).

Further details and a list of publications are available from:

Executive Assistant
CIES
School of Economics
Adelaide University
SA 5005 AUSTRALIA
Telephone: (+61 8) 8303 5672
Facsimile: (+61 8) 8223 1460
Email: cies@adelaide.edu.au

Most publications can be downloaded from our Home page: http://www.adelaide.edu.au/cies/

ISSN 1445-3746 series, electronic publication

Exchange Market Intervention and Evidence of Post-Crisis Flexible Exchange Rate Regimes in Selected East Asian Economies

Victor Pontines[1] and Reza Y. Siregar[2]

School of Economics
University of Adelaide
Adelaide, SA 5005

Draft: April 2006

---

[1]/ E-mail: victor.pontines@adelaide.edu.au
[2]/ (Corresponding Author): E-mail: reza.siregar@adelaide.edu.au, Phone: (61-8)-8303-5908, and Fax: (61-8) 8223-1460.

*This study is funded by a Research Grant from the School of Economics, University of Adelaide. Various parts of the paper were completed during the second author's visit to the Asia Pacific Division-4, the International Monetary Fund, Washington, D.C. The authors thank Peter B. Clark, Masahiko Takeda, and participants at the 11th Australasian Macroeconomics Workshop, in particular, Jeffrey Sheen, John McDermott, Olan Henry and Mark Crosby. The usual disclaimers apply.

Exchange Market Intervention and Evidence of Post-Crisis Flexible Exchange Rate Regimes in Selected East Asian Economies

Abstract:

By examining exchange market intervention activities of the monetary authority of each country, we revisit an old debate on whether crisis-effected countries in East Asia, namely Indonesia, Korea, Singapore and Thailand, have gone back to their pre-1997 rigid exchange rate policies, or, instead, have they actually moved to a more flexible regime? More importantly, if indeed there has been a shift from a rigid to a more flexible one, was the move a voluntary one, or mainly due to the presence of high market pressures on the currency? Given the absence of publicly available information on intervention in the foreign exchange market during the observation period, we propose an index of central bank intervention activity in the exchange market that also includes overnight market rates. Apart from applying the markov-switching ARCH and the extreme value theory methodologies to the construction of the index, thresholds of exchange rate regimes are also generated and utilized to systematically classify the types of exchange rate regimes that these East Asian countries adopted during the post-1997 financial crisis.

JEL Classifications: F31, F41

Key Words: Exchange Market Intervention; Exchange Rate Regimes; East Asian Countries

1. Introduction

In the September 2005 World Economic Outlook (WEO) report, the International Monetary Fund forecasted that the global economy for 2005 will grow by 4.3 percent, slower than in 2004, but still at a relatively healthy pace (IMF, 2005). Despite a generally positive outlook, the WEO report has however drawn attention to excessive dependence of global growth on unsustainable current account deficits in the United States and in order to finance these deficits, the United States needs to pull in 70 percent of total global capital flows. This phenomenon is referred to as the global imbalances problem.

In addition to a number of potential root causes, a few policy recommendations have also been put forward in that report to commence and establish an orderly adjustment of the imbalances in the global economy. Among the policies prescribed for emerging markets in Asia is an adoption of a more flexible exchange rate policy, which should allow regional currencies in Asia to appreciate against the major world currencies, including against the US dollar. The stronger currencies in Asia should in turn provide a catalyst for a stronger demand for imported products, which includes those coming from the United States, a key trading partner in the region.

The debates on the appropriate exchange rate policy actually resurfaced at the outbreak of the 1997 East Asian financial crises, and remained as one of the pinnacle challenges facing monetary authorities around the globe. Despite official announcements of a policy shift toward either the adoption of inflation targeting in countries such as Indonesia, Thailand and Korea and the abandonment of a fixed regime in China and (the gradual relaxation of controls in) Malaysia in recent years, uncertainties over the de-facto exchange rate policies adopted by most emerging markets in East Asia remained high.

The rapid stockpiling of the foreign exchange reserves since late 2000 by most economies in this region has, in particular, been at the centre of the exchange

rate policy debate (Table 1). A number of important views on this issue have emerged. One of them is the mercantilist argument. This view claims that aside from the desire to maintain exchange rate predictability, the reserve growth has been primarily motivated by desires of these countries to preserve an undervalued local currency and to enhance the international competitiveness of the newly emerging industries (Dean and Rajan (2004)). In the context of China, Dooley, Folkerts-Landau, and Garber (2003) interpret the reserve accumulation as largely motivated by the country's export promotion strategy.

Another view translates the high accumulation of foreign exchange reserves as an insurance policy held against the future uncertainty of balance of payment position. Fischer (2001) nicely summarizes this point:

> "Reserves matters because they are a key determinant of a country's ability to avoid economic and financial crisis. This is true for all countries, but especially of emerging markets open to volatile international capital flows… (pp. 1).

A number of recent papers have examined and compared the importance of precautionary and mercantilist motives in the hoarding of the international reserves by developing countries (Aizenman and Lee (2005) and Dean and Rajan (2004)). The distinguishing objective of our paper is to contribute further on this debate on exchange rate policy, but without looking-through the perspectives of precautionary view versus mercantilist view. We, instead, revisit one of the old debate on evaluating the *de-facto* exchange rate regimes adopted by a number of East Asian economies, namely Indonesia, Thailand, Singapore and South-Korea from January 1985 to December 2003.

There has been a great deal of efforts expended on developing behavioural classifications of exchange rate regimes by either looking exclusively at the behaviour of nominal exchange rates, or considering fluctuations in both the nominal exchange rates and foreign exchange reserves (Reinhart and Rogoff (2004) and

Levy-Yeyati and Sturzenegger (2004)). These considerable efforts in developing so-called *de-facto* classifications were mainly motivated by a crucial recognition that, until late 1990s, the Annual Report on Exchange Rate Arrangements and Exchange Restrictions of the International Monetary Fund (IMF), which is usually the primary source of information about the official or *de-jure* exchange rate policies pursued by member countries, takes at face value what countries announce.[1]

Despite the numerous efforts, however, we have not seen conclusive and consistent findings among them (Table 2). For instance, Kawai and Akiyama (2000) cannot conclusively classify the regime adopted in Indonesia in 1999. In contrast, Bubula and Otker-Robe (2002) categorize the exchange rate regime in Indonesia for that same year as independently floating. There are also a number of limitations and criticisms against previous studies, particularly on the shortcomings associated with the methodologies used and the primary statistical assumptions of the empirical testing.[2]

In this study, our approach will be to verify the type of exchange rate regimes adopted by those four East Asian countries through the examination of the exchange market intervention activities of the monetary authorities of each country. Given the absence of publicly available information on the timing and size of the intervention in the foreign exchange market during the observation period, we will have to first construct an index of central bank exchange market intervention by borrowing relevant concepts originally introduced by the seminal work of Girton-Roper (1977).

To trace how volatilities of each component of the intervention index evolve overtime, we apply the Markov-Switching ARCH (SWARCH) procedure. This empirical approach significantly departs from previous works that have also attempted to construct measures of indices of intervention (see for instance:

[1] In view of this, the IMF moved to a *de-facto* classification in 1999, and aimed to describe what member countries actually do rather than what they say that they do (Genberg and Swoboda (2004)).

[2] Refer to section 2 on the Literature Reviews.

Weymark (1997) and Bayoumi and Eichengreen (1998)). Unlike the traditional ARCH model, the SWARCH model can successfully capture the structural shift in the data without the need to distinguish or create arbitrarily sub-samples (for instance the pre-1997 financial crisis period and the post-1997 period). Furthermore, for the intervention index we employ the smoothed probabilities of the conditional variances instead. This helps us to avoid the problem with using a parametric measure of volatility such as variance or standard deviation where these measures are prone to outliers and structural breaks.

Once we have generated the intervention index for each country case, the next task is to calculate regime thresholds for each currency. The idea here is to estimate a threshold where we can systematically categorize a regime characterized by excessive intervention activities of the monetary authority and separate it from that of low exchange market intervention regime. Given potential diversities between the behaviours of the four currencies and the activities of the monetary authorities of these countries, it is imperative that we avoid imposing a "common regional set" of thresholds for all currencies.

Due to the non-normality of the statistical distribution of the intervention index series, we have to avoid relying on parametric assumptions in identifying the threshold levels. Accordingly, our study will apply the Extreme Value Theory (EVT) and adopt a modified estimator proposed by Huisman, Koedijk, Kool, and Palm (2001) ---henceforth HKKP. The application of HKKP enables us to generate more consistent analyses even with relatively small sample sizes.

Given the construction of the intervention index and the carefully done statistical classification of the regimes, a number of insightful and relevant policy concerns can be addressed by the paper. Instead of just asking whether these crisis-effected countries in East Asia have moved to a more flexible regime during the post-1997 period, more important questions that can be posed are: has the shift from a rigid policy to a flexible one been a "voluntary" policy decision? Or, has it mostly been

driven by the strong market pressures on the local currency which potentially could result in a very expensive cost toward managing a fairly rigid exchange rate regime? These two questions are clearly important and crucial research questions, which we find, until now, hardly any study has systematically tried to address[3].

The outline of the paper is as follows. A brief overview of the literature will be presented in section 2. The next section discusses the basic concepts behind the construction of the intervention index. The two key empirical tools, namely, the SWARCH and the EVT, are briefly introduced in section 4. Data and empirical test results are presented in section 5. Based on the findings reported in section 5, we evaluate the exchange regimes of the four East Asian economies in section 6. A brief concluding section ends the paper.

2. Literature Reviews

Previous studies that have examined the actual or *de-facto* exchange rate arrangements in place in most of the countries in East Asia have proceeded in two ways. One approach is to test if the countries assigned weights either to a specific currency or to a basket of currencies using a simple regression model. Originally developed and applied by Frankel and Wei in a series of studies (1993, 1994, 1995), the regression model estimates an equation of the form:

$$\Delta e_t^j = \alpha + \beta_1 \Delta e_t^{USD} + \beta_2 \Delta e_t^{DM} + \beta_3 \Delta e_t^{JY} + \beta_4 \Delta e_t^{FF} + \beta_5 \Delta e_t^{UKP} + u_t \qquad (1)$$

where Δe_t^j is the monthly change in the log exchange rate of currency *j* in month *t*, α is a constant term, β_k (k = 1, 2, .., 5) is the coefficient on the monthly change in the log exchange rate of currency *k*, and u_t is the residual term. The superscripts *USD*, *DM*, *JY*, *FF*, and *UKP* refer to the dollar, the deutschemark, the yen, the French

[3] See also, for instance, (Reinhart and Rogoff (2004)) that posed a research question similar to the one above.

franc, and the U.K. pound, respectively.[4] All exchange rates are expressed in terms of a certain numeraire currency, usually the Swiss franc.

The intuition behind the model is that the coefficient estimates can be interpreted as the weights assigned by the respective authorities to the corresponding currencies in their exchange rate policies (Kawai and Akiyama, 2000). In doing so, one can then identify to which specific currency or to a basket of currencies that monetary authorities have tended to stabilise their exchange rates.

The Frankel-Wei model does not come without its criticisms. First, McCauley (2001) pointed out that the high estimated coefficients (weights) for the U.S. dollar does not follow that these currencies were pegging to the U.S. dollar. The conclusion that does follow is that the East Asian currencies belong and remain to the U.S. dollar bloc, "or at least that they have not slipped from the dollar bloc into the euro bloc" (McCauley, p. 47). McCauley's basis for this distinction between bloc membership and de-facto pegging (the latter being the preferred interpretation of McKinnon and among others) is that "currencies can float freely and yet belong to a bloc" (p.46). The paper further argues that "if belonging to the dollar bloc is taken to be the same as being pegged to the dollar, then the Canadian and Australian dollars must be considered pegged to the U.S. dollar" (p. 46).

The second criticism has something to do with the choice of the numeraire currency. The problem with this empirical strategy is that the numeraire currency should not be linked to any of the currencies in the basket (Benassy-Quere and Coeure, 2000)[5]. For instance in Equation 1, the Swiss franc, as the numeraire currency, is linked to the DM/euro and the U.S. dollar.

[4] Alternatively, in order to assess the roles of the tripolar currencies (U.S. dollar, Japanese yen, and the euro) in East Asian exchange rates, the deutschemark (DM), French franc (FF), and the U.K. pound (UKP), can be collectively replaced in the right-hand side of the equation by the euro.

[5] In one of the earlier Frankel-Wei (1995) paper, they also used the Swiss franc as the numeraire, but this was all right as they only had the U.S. dollar and the Japanese yen as the exogenous variables.

The other alternative approach is to assess the degree of commitment by countries to exchange rate stabilisation by arriving at a statistical descriptive measure of observed volatilities in exchange rates, stock of foreign exchange reserves and interest rates. The basic idea behind this approach is that exchange rate stabilisation is not observed through movements alone (or the lack of it) in the nominal exchange rate, but also through interventions in the foreign exchange market and monetary policy actions which moderate or suppressed supposed movements in the nominal exchange rate. There is a scant of studies (e.g., Baig (2001) and Hernandez and Montiel (2003)) that have directly used this approach.[6] However, the two studies also have their own limitations.

First, these studies used as their measurements of volatility, the standard deviation, which is the commonly used parametric measure of volatility. However, any standard deviation measure is a form of averaging and is only as appropriate with the underlying conformity of the data to a conventional parametric assumption of normal distribution needed to employ such a method.[7] In fact, as early as the 1960s, the non-normality of any speculative price series such as the exchange rate and the interest rates has already been clearly recognised.[8]

Second, it is customary practice of these studies to compare the observed volatility outcomes of the East Asian countries' exchange rates, stock of foreign exchange reserves, and interest rates across a benchmark or comparator set of acknowledged 'clean' floaters, which are also mostly developed countries with more advanced and well-developed financial markets. However, this approach rests on the

[6] McKinnon and Schnabl (2002) can also be added to these two studies, however, they only looked at exchange rate volatility.
[7] Hernandez and Montiel (2003) used, aside from the standard deviation, the range and mean absolute change of the respective changes in exchange rate, stock of foreign exchange reserves and interest rate, while, Baig (2001) used only the standard deviation of the changes of the same three series.
[8] See, for example, the collection of papers by Mandelbrot (1963, 1964, 1967), Fama (1965, 1970) among others.

strong implicit assumption that the shocks experienced by all these countries were uniform over time and across countries, which may not most likely to be the case.[9]

As will be elaborated further in the next section, our approach will also involve examining three key indicators, namely the foreign exchange reserve, the interest rate, and the nominal exchange rate. Instead of looking at those indicators individually however, we will employ them to construct an intervention index of the central bank for each individual country case. Then, a number of empirical methodologies will be applied to address the shortcomings of previous studies.

3. Intervention Index

In their seminal work, Girton-Roper (1977) show that any excess demand for foreign exchange can be fulfilled through non-mutually exclusive conduits. If market pressures on a particular currency, or often referred to as speculative pressures, have successfully targeted a currency, then there would likely be a sharp depreciation of the domestic currency. However, at other times, the attack can be repelled or warded off through raising interest rates and/or running down on the foreign exchange reserves.

Therefore, volatility alone in the nominal exchange rate understates the magnitude of speculative attacks as this excludes episodes of unsuccessful attacks. Government policies manifested through interest rate policy actions in the money market and purchase or sell of international reserves in the foreign exchange market, moderate supposed large movements in exchange rates. In the same manner, considering in isolation, movements in reserves and interest rate aside from exchange rates also offer only a partial view of the severity of shocks in the economy.

[9] Nonetheless, this argument was also recognized by Hernandez and Montiel. In cases, where the said assumption appears not to hold, they also examined the relative volatilities of the three variables (exchange rates, foreign exchange reserves, and interest rates). They believe that, in principle, by looking at their relative volatilities it will be independent of the environment (p. 345).

Based on that seminal idea of Girton-Roper (1977), we can generate two sets of measures or proxies. First, by combining the information gathered from the foreign exchange reserve position of the central bank and its key policy interest rate, one can generate a measure of the monetary authority's propensity to intervene and manage the fluctuations of the local currency. Second, we can also add the information on the exchange rate fluctuations of the local currency to the monetary authority's intervention objectives in order to construct a reasonable estimate of the extent of currency attacks on the market, or commonly referred to as the index of exchange market pressure (EMP).[10]

It is important to note however that the definition of EMP in our study is more closely in line with that of Weymark (1997), whereby the exchange market pressure measures the total excess demand for the domestic currency in the international market as the exchange rate change that would have been required to remove the excess demand in the absence of market intervention by the monetary authority. Girton-Ropter (1977) instead defines its EMP as a measure of excess demand for money in the domestic money market, hence focusing solely on pressures arising from the domestic economy.

To construct the intervention index, we first estimate the "smoothed" probabilities of each key indicator (interest rate, reserve, and exchange rate) to be in the high-volatility state by adopting the markov-regime switching ARCH (as will be elaborated further in the next section). A large (small) value for the smoothed probability of high-volatilty state of the exchange rate at time t, for instance, suggests that there is a high (low) probability that the exchange rate is volatile during that specific period (t). As will be discussed further, this is a useful measure as it conveys information about the nature of the market and the policy stance.

[10] This general idea of exchange market pressure index has been well developed by early studies such as Eichengreen, B., Rose, A., and Wyplosz (1995), Kaminsky, Lizondo, and Reinhart (1998) and Weymark (1998).

Next, taking the ratio of the smoothed probabilities of high volatility state of the monetary authority intervention and the exchange market pressure, we arrive at the intervention index of the monetary authority (Equation 2):

$$\text{Index of Intervention } (INTV) = \frac{p_{reserves}^{H} + p_{\text{int}\,r}^{H}}{p_{exr}^{H} + p_{reserves}^{H} + p_{\text{int}\,r}^{H}} \qquad (2)$$

Where: $p_{exr}^{H}, p_{reserves}^{H}, p_{\text{int}\,r}^{H}$ are the smoothed probabilities that the conditional variance of the changes in exchange rate, reserves, and interest rates, respectively, are in a high-volatility state at date (t). The denominator ($p_{exr}^{H} + p_{reserves}^{H} + p_{\text{int}\,r}^{H}$) is interpreted as the smoothed probability of a high exchange market pressure on the currency. It captures the probability of the 'total' pressure place upon by market shocks on the exchange rate, and is given as the sum of the smoothed probabilities of the high variability in exchange rate (p_{exr}^{H}) and the smoothed probabilities of the high variability of the monetary policy actions in the exchange markets ($p_{reserves}^{H} + p_{\text{int}\,r}^{H}$) (Glick and Wihlbourg, 1997).

In the absence of publicly available information on intervention in the foreign exchange market, we follow Calvo and Reinhart (2002) in using changes in reserves as the imperfect measure of foreign exchange intervention, while intervention in money markets is measured by changes in interest rates.[11] These indicators are imperfect measure as we recognize that not all movements or changes in reserve or interest rate are due to or associated with interventions to defend or smooth the fluctuations of the local currency.

[11] As will be discussed in section 5, line 11 of the IMF-IFS is used as the measure of the stock of foreign exchange reserves instead of line 1Ld (international reserves data). The advantage of using line 11 is that it includes borrowed money, which can be used for foreign exchange intervention, while, line 1Ld may change due to a host of other reasons not entirely connected to intervention such as, fluctuations in valuations, accrual of interest earnings, and money in the IMF that can or cannot be used. We thank Charles Wyplosz for pointing this out.

Our INTV index denotes that when analysing exchange rate policy, examining alone the behaviour of the exchange rate offers us a partial picture, as exchange rate volatility can be low because of government policy actions manifested through monetary policy and interventions in the foreign exchange market $\left(p^{H}_{reserves} + p^{H}_{\text{int}\,r}\right)$, or because there are relatively few shocks or modest exchange market pressures $\left(p^{H}_{exr} + p^{H}_{reserves} + p^{H}_{\text{int}\,r}\right)$. Thus, at the minimum, to produce an appropriate description of a country's exchange rate policy, we need to look both at the information conveyed by exchange rate changes and intervention (Willett, 2004). As will be shown in the empirical section, the INTV index is in fact constrained between 0 and 1. An INTV index closes to one (zero) should suggest that there is a high (low) propensity to intervene, and thus suggesting a rigid (flexible) exchange rate regime. To be noted here, that our INTV index focuses on the degree of flexibility or rigidity of the regime, but it does not necessarily convey any discussion on the policy direction of the intervention: i.e. "leaning against or with the wind".

There are a number of advantages of adopting the INTV index. First, the inclusion of the interest rate variable in the INTV index extends earlier models, such as that of Bayoumi and Eichengreen (1998) and Weymark (1997). Given the importance and the evidence of frequent use of interest rate adjustments to defend the local currency, most especially during times of heavy market pressures against the local currency, it is vital that we include this policy instrument in our INTV index.[12]

Second, early studies constructed their indices of exchange market pressure and intervention index by including actual percentage changes of the key relevant variables. Since the volatility of one variable may potentially completely dominate the others, for instance the monthly changes in the exchange rate could double during the crisis period, early indices place a strong emphasis on the weights of the three

[12] Kaminsky and Reinhart (1996) did not include the interest rate component in their application due to the lack of complete interest data for the countries that they examined. Eichengreen, Rose and Wyplosz (1995), on the other hand, include the level of domestic interest rate in their index of exchange market pressure.

variables/ components of the index. Each of the previous studies has a slightly different set of weighting schemes. Our INTV index relies on the probability of each variable to be in its high volatile state. The probability of each series is equally ranged from 0 to 1 at any point of time, including the crisis period. Hence, the INTV index is simpler to construct since it does not need to rely on any arbitrary weighting scheme.

Thirdly, the application of time-varying smoothed probabilities of the markov-regime switching ARCH means that our index does not require a priori dating of crisis, speculative attack periods or the abrupt shift from one type of exchange rate regime to another. The dynamics of the smoothed probabilities of each variable means that the INTV index will endogenously capture the trends and signal the timing of the following (if any): a significant rise in the market pressure (i.e. the speculative attack periods); a rise in the intervention activities of the monetary authority; and more importantly a shift to a different regime of exchange rate (if indeed there is one).

Lastly, given the construction of the INTV index, different possible scenarios on the regime classifications can be conveniently derived, as will be shown in the empirical section of the paper. In the next section, however, we will first briefly discuss the two key econometric /statistical tools adopted in this study.

4. SWARCH and Extreme Value Theory

4.1 Markov-Regime Switching ARCH (SWARCH)

Hamilton and Susmel (1994) proposed an extension of the standard ARCH model which can incorporate regime shifts. In their model, the parameters of the ARCH process are allowed to switch between discrete number of states, with the transitions between states governed by a finite-order Markov process. Hamilton and Susmel called this the switching ARCH or, simply, SWARCH model. The SWARCH model can be described by the following system of equations:

$$\Delta r_t = \phi_0 + \phi_1 \Delta r_{t-1} + \varepsilon_t, \qquad \varepsilon_t \mid I_{t-1} \sim N(0, h_t) \tag{3}$$

$$\varepsilon_t = u_t \sqrt{g(s_t)} \qquad s = 1,....,K \tag{4}$$

$$u_t = \sigma_t v_t; \qquad v_t \sim N(0,1) \tag{5}$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i u_{t-i}^2 \tag{6}$$

Equation (3) assumes that the return (r_t) follows a first-order autoregressive scheme. The returns innovations (ε_t) are assumed to follow an ARCH process with conditional variance σ_t^2 where σ_t^2 depends linearly on *q* past squared errors, i.e., u_{t-i}^2. In standard ARCH models, the parameters are constant across regimes. In the SWARCH model, however, the ARCH parameters are allowed to switch endogenously between a set of discrete states (K). The move from one state to another represents a change in the scale of the volatility process. This is represented above by $g(s_t)$ as the constant switching or variance factor, which depends on the state variable, $s_t = 1,....,K$. In this representation, a normalization is imposed such that $g(1) = 1$ and $g(s_t) \geq 1$ for $s_t = 1,....,K$. Hence, State 1 may be viewed as the low volatility state. For $s_t \neq 1$, $g(s_t)$ therefore indicates the magnitude of volatility at s_t relative to the low volatility state.

Following Hamilton and Susmel (1994), s_t is assumed to follow an unobserved first-order *K*-Markov process, which can be described by transition probabilities, $P(s_t = j / s_{t-1} = i) = p_{ij}$. Each probability number, (p_{ij}), is the probability that State i is followed by State j. For the purpose of this paper, it is assumed here that there are only two volatility states: low volatility (State 1) and high volatility state (State 2). Hence, for the two state case, the transition probabilities are:

$$p[s_t = 1 \mid s_{t-1} = 1] = p$$

$$p[s_t = 2 \mid s_{t-1} = 1] = 1 - p \qquad (7)$$

$$p[s_t = 2 \mid s_{t-1} = 2] = q$$

$$p[s_t = 1 \mid s_{t-1} = 2] = 1 - q$$

One of the objectives of the SWARCH model is to predict the probability of occurrence of a state for each period, where it was shown by Hamilton and Susmel (1994) to be a by-product of a non-linear Markov-switching filter. For example, the inference that is based on information available or observed at time (t) is called the 'filter probability'. Alternatively, the inference using all sample observations is called the 'smoothed probability'. The full sample smoothed probability represents the probability that the conditional variance was in state s_t at date (t), given all sample of observations. Since the basis for the construction of the INTV index (Equation 2) is expressed through the smoothed probabilities of the conditional variance being at State 2 (the high-volatility state), the index is in effect constrained between 0 and 1.

4.2 Intervention Threshold: Application of Extreme Value Theory

The next empirical challenge is to compare and contrast the pre-1997 exchange regime with that of the post-1997 regime. The challenge here is to calculate the levels of INTV index that can be considered as High and Low INTV, suggesting less and more flexible exchange rate regimes, respectively. Without properly generating thresholds of High and Low levels of INTV index, the classification of the regimes based on the intervention index will be done in an ad-hoc manner.

The conventional approach of generating these thresholds is by simply employing the mean and the standard deviations of the INTV index. Studies such as Baig (2001) and Hernandez and Montiel (2003) employed thresholds using the mean and standard deviations in their own definition of an INTV index. Moreover, early studies such as Eichengreen, Rose and Wyplosz (1995) and Kaminsky, Lizondo and

Reinhart (1998) also apply the mean and standard deviation measures to examine thresholds for the index of exchange market pressure. One principal assumption that must hold for the use of the mean and standard deviation to be appropriate is that the relevant series are normally distributed. However, as earlier mentioned, studies have shown that exchange rates, interest rates and foreign exchange reserves are not normally distributed.[13]

To generate thresholds that are statistically consistent with the underlying INTV series, we adopt the Extreme Value Theory (EVT) approach. Given the relatively small observation size that we have for this study, we apply the modified tail index estimator proposed by Huisman, Koedijk, Kool, and Palm (2001) ---henceforth HKKP---, which is unbiased in small sample cases. The HKKP methodology starts with the Hill (1975) estimator:

$$\gamma(k) = \frac{1}{k}\sum_{j=1}^{k} \ln(x(n-j+1) - \ln(x(n-k)) \qquad (8)$$

where: we assume that there is a sample of n positive independent observations drawn from some unknown fat-tailed distribution. Let the parameter γ be the tail-index of the distribution, and $x(i)$ be the ith-order statistic such that $x(i-1) \le x(i)$ for $i = 2,.....,n.$ k is the pre-specified number of tail observations. Note by ordering the observation by its size and not by the original dates, the sample observations are arguably becoming independently distributed. Naturally, the choice of k is crucial to obtain an unbiased estimate of the tail-index.

HKKP (2001) shows that for a general class of distribution functions the asymptotic expected value of the conventional hill estimator to be biased and increasing monotonically with k. Similarly, the asymptotic variance of the Hill

[13] Refer to Footnote 7 and Pontines and Siregar (2005).

estimator to be proportional to $\left(\frac{1}{k}\right)$. Generally, this problem will only be resolved when the sample size goes to infinity for given k.

For our small sample observations, HKKP (2001) introduces an estimator that overcomes the problem of the need to select a "single" optimal k in small sample observations. HKKP (2001) proposes that for values of k smaller than some threshold value κ, the bias of the conventional Hill estimate of γ increases almost linearly in k and can be approximated by:

$$\gamma(k) = \beta_0 + \beta_1 k + \varepsilon(k), \qquad k = 1, 2, ..., \kappa \tag{9}$$

where: β_0 and β_1 are the intercept and the estimate coefficient. $\varepsilon(k)$ is a disturbance term. HKKP (2001) also shows that the modified Hill estimator is quite robust with the choice of κ to be around $\left(\frac{n}{2}\right)$. Accordingly, for our empirics, we propose to compute $\gamma(k)$ for a range value of k from 1 to κ (roughly equal to $\left(\frac{n}{2}\right)$).

Given our need to calculate the "high" and "low" thresholds of INTV index, our choice of κ for the high threshold will contain the high or large observations of γ, associated with the large/high INTV index. Conversely, the low threshold will be the group of observation with the lower set of γ.

To estimate Equation (9), HKKP (2001) adopted the Weighted Least Squares (WLS), instead of the Ordinary Least Squares (OLS), to deal with the potential heteroscedasticity in the error term $(\varepsilon(k))$ of Equation (9). The weight has $\left(\sqrt{1}, \sqrt{2}, ...\sqrt{k}\right)$ as diagonal elements and zeros elsewhere. The estimate of γ from the WLS regression is an approximately unbiased estimate of the tail-index.

5. Empirics

5.1 Data

The data consist of monthly time series of nominal exchange rate expressed in local currency per U.S. dollar, overnight money market rates as the measure of domestic interest rates, and foreign assets of monetary authorities as the measure of foreign exchange reserves for Indonesia, Korea, Singapore and Thailand. The sample covers the period from January 1985 to December 2003. The data were gathered from the IMF International Financial Statistics. In Table 3, summary statistics are presented for the monthly percentage changes of exchange rates and foreign exchange reserves, and first-differences of the interest rates. As discussed before, the changes in reserve and interest rate are only imperfect measures of intervention in the foreign exchange market and money market, respectively.

In addition, Table 3 also contains information on the mean, standard deviation, skewness coefficient, kurtosis coefficient, Jarque-Bera normality test (JB), and Ljung-Box (LB) test. All three series for the four countries show non-normality (note the JB test results), and the kurtosis coefficient indicates fat-tailedness, which is also behind the rejection of normality. The Ljung-Box (LB) statistics suggest significant autocorrelation with the exceptions of Indonesia (reserves) and Korea (reserves). The Ljung-Box (LBS) statistics, for the squared levels, are also significant, with the exceptions of Indonesia (exchange rate, reserves), Korea (exchange rate) and Singapore (reserves). This is largely taken as evidence for an ARCH-type process for the conditional variance.

5.2 SWARCH Test Results and INTV Index

Next we proceed in using the (SWARCH) model of Hamilton and Susmel (1994) and the results of the SWARCH model for each of the three series for the individual countries are shown in Tables 4-6. A number of interesting results can be noted from the tables. First, the coefficient estimates are statistically significant with the exceptions of the Singapore dollar and reserves (α_1) (Tables 4 and 5). Second,

the estimated transition probabilities, i.e., p_{11} and p_{22}, are statistically significant and are close to one. These estimates imply that the states are highly persistent. More specifically, from the estimates, one can compute for the expected duration of each volatility state as $\left(\frac{1}{1-p_{ii}}\right)$. For example, state 1 (the low volatility state) for the Indonesian rupiah in Table 4 is expected to last on average for $(1 - 0.95)^{-1} = 20$ months, while state 2 (the high volatility state) can be expected to last on average for 14 months.

Third, the estimated switching parameters (the variance factors), $g(s_t)$, are significantly different than one in all series. That is, for each of the three individual series and for each of the five countries, it is possible to distinguish a 'low' and a 'high' volatility state. Taking again the example of the Indonesian rupiah in Table 4, the second state is 787 times more volatile than state 1. The magnitude of this difference alone for the case of the Indonesian rupiah and for the rest of the results of the switching parameters in Tables 4-6 underscores the need for a model of conditional variance that allows for regime switches. Fourth, conventional likelihood ratio test suggest that the null hypothesis of no regime switching can, indeed, be rejected. For example, the estimated SWARCH(2,2) in the case of the Indonesian rupiah in Table 4 would have as its nested model an ARCH(2). The usual likelihood ratio test is then computed as: $-2(292.67 - 599.83) = 614.32$, which rejects the ARCH(2) model in favour of the SWARCH model.[14] Finally, as a diagnostic test, Ljung-Box *Q*-statistics were tested for the standardised residuals, LB(24), and for the squared standardised residuals, LBS(24). Noticed that by using the SWARCH model, evidence of autocorrelation were either clearly reduced or eliminated.

[14] A word of caution is necessary in interpreting this result. In Markov switching models, the usual regularity conditions justifying the use of classical tests such as the likelihood ratio test are violated. This is because, under the null hypothesis of only one state, the transition probabilities are not identified, implying that the sample likelihood function is flat with respect to these parameters. As in Hamilton and Susmel (1994), the likelihood ratio test results mentioned here should be treated more as a descriptive summary than formal statistical tests.

5.3 The EVT Thresholds and the Scenarios

Based on the SWARCH test results, we can compute the estimated probabilities of high variability in exchange rate, reserve and interest rate during the observation period. From these estimated probabilities (Figures 1-4), the intervention (INTV) index can be accordingly constructed for each country (Figures 1b-4b). As discussed, a high INTV (i.e. close to one) implies a high propensity to intervene and thus a rigid exchange rate regime. However, the question now is at what level of INTV index can be considered as high (or low).

Employing the concept of the extreme value theory discussed earlier, we are able to calculate the "extreme maximum and minimum" of the INTV index for each country. From the set of high extreme values selected we pick the smallest one. The numbers in Table 7 suggest that the threshold for a high INTV index is at least around 90 percent for Indonesia, 91 percent for Korea, 98 percent for Singapore and close to 99 percent for Thailand. In addition, from the set of minimum extreme values, we pick the highest level. The threshold for a low INTV index is found to be around 15 percent for Thailand and Korea, 18 percent for Indonesia and 89 percent for Singapore. The wide ranges of thresholds, especially in the low thresholds, underscore the importance of imposing individual thresholds, instead of introducing a regional threshold in an *ad-hoc* manner. As will be elaborated further in the next section, the small gap between the maximum and minimum thresholds and the considerably high value of the minimum threshold for Singapore dollar clearly suggests that the currency had in general been under a rigid exchange rate policy.

Based on these classifications, a set of possible scenarios may emerge from the High and Low INTV classifications.

(a). Scenario #1: High and Successful Intervention Efforts. A high $(INTV)$ index, created by the high value of $\left(p^{H}_{reserves} + p^{H}_{\text{int}\,r}\right)$, leads to a stable local currency

(low $\left(p_{exr}^{H}\right)$). Here, we can conclusively argue that there is an attempt by the monetary authority to intervene and offset 'market forces' and hence, successfully keeping a limited exchange rate flexibility.

(b). Scenario #2: Inconclusive case. A high $(INTV)$ Index due to low values for both $\left(p_{reserves}^{H} + p_{\text{int}\,r}^{H}\right)$ and $\left(p_{exr}^{H} + p_{reserves}^{H} + p_{\text{int}\,r}^{H}\right)$. Under this circumstance, it is hardly anything conclusive that can be argued about the commitment of the monetary authority. The situation may prevail when for instance there is no significant shock in the foreign exchange market, and also no significant activities taken by the monetary authority. One cannot say anything much about the policy as the low $\left(p_{reserves}^{H} + p_{\text{int}\,r}^{H}\right)$, or the lack of intervention policies, occurs because there is no need to intervene due to relatively calm market condition, reflected by low $\left(p_{exr}^{H} + p_{reserves}^{H} + p_{\text{int}\,r}^{H}\right)$.

(c). Scenario #3: When Intervention Index (INTV) is low due to a low value of $\left(p_{reserves}^{H} + p_{\text{int}\,r}^{H}\right)$, and a high $\left(p_{exr}^{H} + p_{reserves}^{H} + p_{\text{int}\,r}^{H}\right)$, we can confidently conclude that the monetary authority is not adopting a rigid exchange rate policy. However, we have to add a caveat here. Under few circumstances, we may not be able to conclusively assert that the central bank has voluntarily adopted the policy stance. For instance, under the situation when there is a high probability of a very volatile local currency and a low probability of a successful exchange market intervention, the policy maker may reluctantly keep their foreign exchange market intervention activities to a minimum level, and thus avoiding the high cost of intervention. Hence, we need to carefully examine the probabilities of each component of the index to squeeze as much as information about the natures of the market and the monetary policy stance.

(d). Scenario #4. In addition to the earlier three possibilities, we can also add one more Scenario to be called as the period of high foreign exchange market pressures where the currency crises periods are included as well. Under this

scenario, the INTV index is going to fall between the low and the high ranges, $(High > INTV > Low)$. This situation appears when at least two of the three components of the INTV index $\left(p^{H}_{exr}, p^{H}_{reserves}, p^{H}_{\text{int}\,r}\right)$ are relatively high. During the crisis period, the monetary authorities are often found to be very active in trying to keep the local currency stable (thus high $\left(p^{H}_{reserves} + p^{H}_{\text{int}\,r}\right)$). However, the attacks on the local currency are very severe, reflected by the persistently volatile exchange rate --- high $\left(p^{H}_{exr}\right)$, hence keeping the INTV index between the low and the high ranges.

6. Evaluating the Exchange Rate Regime

6.1 Indonesia

The persistently high $(INTV)$ index, well above (0.90), from 1991 to1995, seems to suggest that the monetary authority had adopted an active intervention strategy to keep rupiah stable (Figures 1 and 1b, and Table 8). However, when we decompose the Intervention index into its three key components, it becomes less definite what one can conclude for most part of that period. With the exception of 1991 with the relatively high levels of $\left(p^{H}_{\text{int}\,r}\right)$ and $\left(p^{H}_{reserves}\right)$, the rest of the period saw very little evidences of interventions, either via the foreign exchange reserve or the interest rate policy. That is we find the characteristics of Scenario #2.

We do know however that all the way until 1995, the intervention spread for the rupiah of Bank Indonesia was only 3 percent at the most from the central parity, suggesting a fairly rigid exchange rate regime adopted by the monetary authority during this period. Hence we can conclude that up to 1995, the exchange rate policy in Indonesia has largely been a rigid one. However, from 1992 to 1995 in particular, the market pressure against the rupiah has largely been moderate, and thus requiring little intervention policies by Bank Indonesia (the central bank).

Since 1996, rupiah has undoubtedly become more volatile. The intervention spread band was widened three times in that year, from 3 percent in December 1995 to 5 percent in June 1996, and to 8 percent in September 1996 (Djiwandono (2000)). The central bank allowed rupiah to move more freely again in July 1997 by further extending the intervention band to 12 percent. During the period of January 1998 until December 1998, Indonesian went through the worst stage of the 1997 East Asian financial and currency crises. The $(INTV)$ averaged around (0.67), with each of all three components of the $(INTV)$ index, $\left(p^H_{exr}, p^H_{reserves}, p^H_{\text{int}\,r}\right)$, was extremely high, anywhere between (0.96) and (0.99). We classify this condition as the Crisis Scenario (#4), where despite the active intervention of the monetary authority, high value of $\left(p^H_{reserves} + p^H_{\text{int}\,r}\right)$, the domestic currency continued to be very volatile. The Crisis Scenario in fact continued until 1999, where rupiah remained volatile despite the active intervention policies in both the foreign exchange market (reserve) and the money market (the interest rate).

The clear evidence of a shift to a more flexible policy (Scenario #3) can be detected since 2000, with the $(INTV)$ index hovering around 10 percent (except for 2001). Despite the persistently high smoothed probability of rupiah, intervention activities of the central bank were kept to significantly less than their efforts in previous years, but still at a rather moderate average rate of intervention activities in 2001 and 2002. The evidences seem to capture initial moves to a more flexible rate, but one cannot conclude that the monetary authority has voluntarily fully adopted the new regime. Moreover, political uncertainty was arguably the primary underlying cause of selling pressures against the rupiah in 2001 and early 2002 (Siregar and Pontines (2005)). No evidence of market interventions is reported only in 2003 (Table 8).

In general, our findings are consistent with a number of early studies, in particular those of Bubula and Otker-Robe (2002) and Kim, Kim and Wang (2004).

For instance, Bubula and Otker-Robe (2002) classified the exchange rate regime in Indonesia for the period of 1999 to early 2001 as an independent float. The IMF defines an independent float as an arrangement where "the exchange rate is market-determined, with any foreign exchange intervention aimed at moderating the rate of change and preventing undue fluctuations in the exchange rate, rather than establishing a level for it". Whereas, from April 2001 until end of 2003, Indonesia is classified as "managed floating" (Bubula and Otker-Robe (2002)). However, the distinction between an independent float and a managed float according to the IMF classifications is rather unclear.[15]

6.2 Korea

Looking at Table 9 and Figures 2 and 2b, the high smoothed probability for interest rate component of the INTV index for the period from January 1990 to July 1994 suggests that the monetary policy authority had always been active in the money market in managing the won. The role of interest rate policy was very dominant during this period, as suggested by the high $\left(p_{\text{int}\,r}^{H}\right)$**.** Starting in 1990, the monetary authority in Korea also adopted the so-called market-average system (MARS) where the won/U.S. dollar nominal exchange rate was allowed to fluctuate within a specified band of the basic rate which was revised daily (Dornbusch and Park (1999)). When this system was first introduced, the won/U.S. dollar was allowed to vary within a very narrow $\pm$ 0.4 percent of the basic rate. In the mid-1990s, the band was widened to ± 2.25 percent. With the INTV index averaging around 99 percent level and the average smoothed probability of the won around 0 percent, the Bank of Korea (BOK) was indeed successful in tightly managing the won rate against the US dollar during the early to mid-1990s.

[15] The IMF defines a managed float as "the authorities influence exchange rate arrangements through interventions to counter the long-term trend of the exchange rate, without specifying a predetermined path, or without having a specific exchange rate target.

Starting in 1995, the won had become significantly more volatile, despite the continued effort of the monetary authority to manage it by actively adjusting the interest rate. On November 20th, 1997, clearly feeling the rising pressures of the early stages of the 1997 East Asia currency crisis, widened the MARS band to about ± 10 percent. In addition to the interest rate policy, BOK began to actively conduct open market operation by selling its foreign exchange reserve. From a persistently low level up to 1996, the smoothed probability of the reserve $\left(p^{H}_{reserves}\right)$ jumped significantly in 1997 to around 46 percent. The band was finally abolished on the 16th of December 1997, when Korea was officially in a crisis. We would categorize 1996 and 1997 under Scenario #4.

At the height of the crisis, January 1998 until December 1998, the $(INTV)$ index was averaging around (0.60), with two of the components of the $(INTV)$ index, $\left(p^{H}_{exr}, p^{H}_{\text{int}\,r}\right)$**,** were extremely high between (0.99) to (1.00). It also became obvious that the monetary authority had started to directly intervene in the foreign exchange market, as suggested by a significant rise in the smoothed probability of reserves from around (0.06) for the period of July 1995-July 1997 to about (0.55) for the period of January 1998 to December 1998. The levels of the smoothed probabilities for all three components of the INTV index are consistent with the Crisis Scenario (Scenario #4).

In 1999, Korea began the recovery process, and returned to a more stable macroeconomic environment. Despite the presence of persistently high volatility in the foreign exchange market $\left(p^{H}_{exr} > 99\right)$, the intervention of the BOK was clearly reduced as compared from the levels reported during 1996-1998. The $(INTV)$ index is still close to 14 percent, driven mostly by $\left(p^{H}_{\text{int}\,r}\right)$. Based on the previous definitions of different regime scenarios, we would place this period as Scenario 3. However, we cannot still consider this period as the period of pure/ voluntary flexible regime, as the

BOK was still actively adjusting its interest rate policy to manage the money market and influence the fluctuations of the won in that year.

The post-2000 exchange rate regime can clearly be characterized as the flexible / floating period with no evidences of government interventions reported from the smoothed probabilities ---low values for both $\left(p^{H}_{reserves}\right)$ and $\left(p^{H}_{\text{int}\,r}\right)$. The INTV index was averaging less than 1 percent, while clearly the won continued to remain very volatile during the period of January 2000 – December 2003. This leads us to conclude that Korea has voluntarily moved to a *de-facto* flexible regime (Scenario #3). Annual Report publication of the BOK from 2000 to 2003 describes its exchange rate regime to the effect that while it stands ready to undertake appropriate measures to avoid abrupt fluctuations in its exchange rate, the won, in principle, is allowed to fluctuate freely according to its demand and supply in the foreign exchange market.

6.3 Singapore

It is clear from these statistics that the rigid management of the exchange rate policy continued to be the centrepiece of the monetary policy in the country until 2003. With the exception of the crisis period of 1997-1998 and 2001, the INTV index for Singapore was persistently well above 90 percent and remained very close to 98 percent “high-threshold” for a number of years (Table 10 and Figures 3 and 3b). These statistics are consistent with a number of official reports and studies conducted at Monetary Authority of Singapore (MAS), which all suggest that the MAS periodically intervened in the foreign exchange market with the extent of the foreign exchange intervention determined by the exchange rate target bounded by an undisclosed band (MAS 1999, 2000, 2001 and 2003).

From the average smoothed probabilities posted in Table 10, we can also construe that the MAS actively employed both the reserve and the interest rate policy to manage the exchange rate of the local currency for the large part of the past two

decades. It is also interesting to note here that during the pre-1997 financial crisis, the interest rate was the main instrument of the monetary authority, reflected by the high smoothed probability. A different practice emerged from January 2000 to December 2003. During this period, the reserve has clearly become the primary instrument to manage the Singapore dollar to maintain the rigid exchange rate policy. To illustrate this point, between 2000 to 2003, the foreign exchange reserve of the country (minus gold) has increased by about US$15 billion to reach a total of around US$95 billion in 2003.

6.4 Thailand

In general, our test results suggest that the case of Thailand is very similar to that of Korea, where there has indeed been a *de-facto* shift from a rigid exchange policy (Scenario 1) during the pre-1997 period to a high-degree of floating / flexible regime (Scenario 3) during the post-1999 period. The average INTV index dropped from a level close to 100 percent from 1991 to 1996 to an average of less than 5 percent for the period from 1999 to 2003.

Another similarity can be found on the importance of the interest rate policy, relative to reserves, in the management of a stable baht during the pre-1997 crisis period. For the period between 1991 and 1996, the smoothed probabilities (Figure 4 and 4b and Table 11) of the interest rate $\left(p_{\text{int}\,r}^{H}\right)$ have been well over 99 percent, while the smoothed probabilities of the reserve $\left(p_{reserves}^{H}\right)$ were close to zero percent.

From the empirical findings, we can also conclude that the exchange rate regime was under Scenario #4 (the Crisis case) during 1997 and 1998. Both years saw the full efforts of the central bank to defend the local currency by employing both an interest rate policy and the selling off of foreign exchange reserves. Despite the massive intervention efforts in 1997, as suggested by the high smoothed probabilities

of interest rate and reserve, the baht lost its value substantially against the US dollar and was very volatile.

7. Brief Concluding Remarks

Frankel, et.al. (2001) nails it right at the very heart of the challenge when they argued that credibility and transparency are the core of the current debate about exchange rate regimes. Like many other papers in the past, they also emphasize the difficulties facing the efforts to verify the de-facto exchange rate regime being adopted by a country.

This paper revisited the debate on the de-facto versus de-jure exchange rate regimes adopted by four countries in East Asia, namely Indonesia, Thailand, Singapore and South-Korea. By constructing an intervention index of the monetary authorities of each country and carefully categorizing the threshold regimes, the study is able to conclusively conclude that, with the exception of Singapore, the other three economies have adopted a de-facto flexible exchange rate regime during the post-1997 period, in particular since 2000.

As briefly mentioned, Indonesia, Thailand and South-Korea have officially announced their intentions to adopt the inflation targeting strategy as the anchor of their monetary policies during the post-1997 financial crisis. The move to focus on the fluctuations in the price level has allowed, as illustrated by our empirical evidences, the rupiah, the baht and the won to move more freely. The more flexible regime, as reflected by the less interventionist strategy of each central banks, should, in due course, help address the global imbalance phenomenon discussed in the September 2005 WEO report of the IMF.

Going back to the debate between the mercantilist view versus the precautionary view on rapid accumulation of international reserve, our findings, in

general, implicitly reject that of the mercantilist view.[16] There is no evidence of commitments by the monetary authorities of these three countries, namely Indonesia, Thailand and South-Korea, to either pursue a specific target of bilateral nominal exchange rate against the US dollar, or preserve an undervalued local currency against the US dollar by actively intervening in both foreign exchange and money markets in these countries since 2000.[17]

[16] Given the coverage of the paper, we cannot however make any general remarks on the precautionary view.

[17] This overall finding is, in general, consistent with the message conveyed in Aizenman and Lee (2005).

References:

Aizenman, J. and Lee, J. 2005, "International Reserves: Precautionary vs. Mercantilist Views, Theory and Evidence", IMF Working Paper, WP/05/198, October.

Baig, T. 2001, 'Characterizing Exchange Rate Regimes in Post-Crisis East Asia', *IMF Working Paper WP/01/152*, IMF, Washington, D.C.

Bank of Korea (BOK). 1998-2003 Annual Reports.

Bayoumi, T. and Eichengreen, B. 1998, 'Exchange rate Volatility and Intervention: Implications of the Theory of Optimum Currency Areas', *Journal of International Economics*, vol. 45, pp. 191-209.

Benassy-Quere, A. and Coeure, B. 2000, 'Big and Small Currencies: The Regional Connection' *CEPII Working Paper 2000-10*.

Bubula, A. and Otker-Robe, I. 2002, 'The Evolution of Exchange Rate Regimes Since 1990: Evidence from De Facto Policies', *IMF Working Paper No. 02/155,* IMF, Washinton, D.C.

Calvo, G., and Reinhart, C. 2002, 'Fear of Floating', *The Quarterly Journal of Economics*, vol. CXVII, pp. 379-407.

Dean, J.W., and Rajan, R.S. 2004, "Why and Whither China's Reserves? Motives, Cost, Consequences and Putative Policies", mimeo, University of Adelaide.

Djiwandono, J.S. 2000, 'Policy Reponses Facing Financial Crisis', mimeo.

Dooley, M., Folkerts-Landau, D. and Garber, P. 2003, "An Essay on the Revived Bretton Woods System", NBER Working Paper No. 9971.

Dornbusch, R. and Park, Y.C. 1999, 'Flexibility or Nominal Anchors', in S. Collignon, J. Pisani-Ferry and Y.C. Park (eds.), *Exchange Rate Policies in Emerging Asian Countries*, Routledge, London, U.K.

Eichengreen, B., Rose, A., and Wyplosz, C. (1995), "Exchange Markey Mayhem: The Antecedents and Aftermaths of Speculative Attacks", *Economic Policy*, 21 (October), pp. 249-312.

Fama, E. F. (1965). "The behavior of stock market prices." *Journal of Business* 38: 34-105.

Fama, E. F. (1970). "Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance* 25: 383-417.

Fischer, S. 2001, "Opening Remarks. IMF/World Bank International Reserves: Policy Issues Forum", Washington D.C., April 28.

Frankel, J.A., Fajnzylber, E., Schmukler, S.L., and Serven, L. (2001), 'Verifying Exchange Rate RegimeS', *Journal of Development Economics*, Vol. 66, pp. 351-386.

Frankel, J. and Wei, S. 1993, 'Is There a Currency Bloc in the Pacific?', in A. Blundell-Wingnall and S. Grenville (eds.), *Exchange Rates, International Trade and Monetary Policy,* Sydney: Reserve bank of Australia, pp. 275-307.

Frankel, J. and Wei, S. 1994, 'Yen Bloc or Dollar Bloc?: Exchange Rate Policies of the East Asian Economies', in T. Ito and A. Krueger (eds), *Macroeconomic Linkage: Savings, Exchange Rates, and Capital Flows*, University of Chicago Press, Chicago.

Frankel, J. and Wei, S. 1995, 'Emerging Currency Blocs', in H. Genberg (ed.), *The International Monetary System,* pp. 111-170.

Gan, W.B. 2000, 'Exchange-rate Policy in East Asia after the fall: How much have things changed?', *Journal of Asian Economics*, vol. 11, pp. 403-430.

Genberg, H. and Swoboda, A. 2004, 'Exchange Rate Regimes: Does What Countries Say Matter?' mimeo.

Girton, L. and Roper, D. 1977, 'A Monetary Model of Exchange Market Pressure Applied to the post-war Canadian experience', *The American Economic Review*, vol. 67, no. 4, pp. 537-547.

Glick, R. and Wihlborg, C. 1997, 'Exchange Rate Regimes and International Trade', in P. Kenen and B. Cohen (eds), *International Trade and Finance: New Frontiers for Research*, Cambridge University Press, Cambridge.

Glick, R., Kretzmer, P., and Wihlborg C. 1995, 'Real Exchange Rate Effects of Monetary Disturbances under Different Degrees of Exchange Rate Flexibility: An Empirical Analysis, *Journal of International Economics*, vol. 38, pp. 249-273.

Hamilton, J. 1989, 'A new approach to the economic analysis of nonstationary time series and the business cycle', *Econometrica*, vol. 57, pp. 357-84.

Hamilton, J. and Susmel, R. 1994, 'Autoregressive conditional heteroscedasticity and changes in regime', *Journal of Econometrics*, vol. 64, pp. 307-333.

Hernandez, L. and Montiel, P. 2003, 'Post-Crisis Exchange Rate Policy in Five Asian Countries: Filling in the 'Hollow Middle'?', *Journal of the Japanese and International Economies*, vol. 17, pp. 336-369.

Huisman, R., K. G. Koedijk, et al. 2001. "Tail-index Estimates in Small Samples." *Journal of Business and Economic Statistics* 19(1): 208-216.

IMF (2005), Word Economic Outlook, September.

Kaminsky, G., and Reinhart, C.M. (1996), "The Twin Crises: The Causes of Banking and Balance of Payment Problems", *International Finance Discussion Paper,* No. 544, Board Governors of the Federal Reserve System; (March), Washington.

Kaminsky, G., Lizondo, S., and Reinhart, C. (1998), "Lending Indicators of Currency Crises", *IMF Staff Paper*, 45, 1 (March), pp. 1-48.

Kawai, M. and Akiyama, S. 1998, 'Roles of the World's Major Currencies in Exchange Rate Arrangements', *Journal of the Japanese and International Economies*, 12, pp. 334-387.

Kawai, M. and Akiyama, S. 2000, 'Implications of Currency Crisis for Exchange Rate Arrangements in Emerging East Asia', *Policy Research Working Paper No. 2502*, World Bank, Washington, D.C.

Kawai, M. 2002, 'Exchange Rate Arrangements in East Asia: Lessons from the 1997-98 *Currency Crisis', Monetary and Economic Studies (Special Edition)*, Bank of Japan.

Kawai, M. 2004, 'The case for a tri-polar currency basket for emerging East Asia', in G. de Brouwer and M. Kawai (eds.), *Exchange Rate Regimes in East Asia*, RoutledgeCurzon, London, U.K.

Kim, S, Kim, S.H. and Wang, Y. 2004, "Fear of Floating in East Asia", mimeo.

Levy-Yeyati, E. and Sturzenegger, F. 2004, 'Classifying Exchange Rate Regimes: Deeds vs. Words', forthcoming, *European Economic Review.*

Mandelbrot, B. (1963). "The Variation of Certain Speculative Prices." *Journal of Business* XXXVI: 392-417.

Mandelbrot, B. (1964). "New Methods in Statistical Economics." *Journal of Political Economy* LXXI: 421-440.

Mandelbrot, B. (1967). "The Variation of some other specualtive prices." *Journal of Business* 36: 394-419.

McCauley, R. 2001, 'Setting Monetary Policy in East Asia: Goals, Developments and Institutions', in D. Gruen and J. Simon (eds.), *Future Directions for Monetary Policies in East Asia*, Economic Group, Reserve Bank of Australia (RBA).

McKinnon, R. 2000, 'The East Asian Dollar Standard: Life after Death?', *Economic Notes*, vol. 29, pp. 31-82.

McKinnon, R. 2001, 'After the Crisis, the East Asian Dollar Standard Resurrected', paper presented at the International Conference on "Monetary Outlook on East Asia in an Integrating World Economy" at Chulalongkorn University, Bangkok, on September 5-6, 2001.

McKinnon, R. and Schnabl G. 2002, 'Synchronized Business Cycles in East Asia: Fluctuations in the Yen/Dollar Exchange Rate and China's Stabilizing Role', *Institute for Monetary and Economic Studies (IMES) Discussion Paper No. 2002-E-13*, Bank of Japan.

Monetary Authority of Singapore (MAS). 1999, 'Capital Account and Exchange Rate Management in a Surplus Economy: The Case of Singapore', *Occasional Paper No. 11*.

Monetary Authority of Singapore (MAS). 1999-2000 Annual Report.

Monetary Authority of Singapore (MAS). 1999, 'Monetary Policy Operating Procedures in Singapore', mimeo.

Monetary Authority of Singapore (MAS). 2000, 'A Survey of Singapore's Monetary History', Occasional Paper No. 18.

Monetary Authority of Singapore (MAS). 2001, 'Singapore's Exchange Rate Policy'.

Monetary Authority of Singapore (MAS). 2003, 'Monetary Policy Operations in Singapore'.

Monetary Authority of Singapore (MAS). 2003, *Macroeconomic Review*.

Monetary Authority of Singapore (MAS). 2004, 'Singapore's Balance of Payments 1965 to 2003: An Analysis', *MAS Staff Paper No. 33*.

Ogawa, E. 2001, 'Beyond De Facto Dollar Pegs: Exchange Rate Regimes for Asia', mimeo.

Ogawa, E. 2002, 'Economic Interdependence and International Coordination in East Asia', mimeo, Department of Commerce and Management, Hitotsubashi University.

Ohno, K. 1999, 'Exchange Rate Management in Developing Asia: Reassessment of the Pre-Crisis Soft Dollar Zone', *ADBI Working Paper, 1*, Asian Development Bank Institute, Tokyo.

Pontines, V., and Siregar, R. (2005), "The Yen, the U.S. dollar, and the Trade Weighted Basket of Currencies: Does the choice of anchor currencies matter in identifying incidences of speculative attacks?", *Japan and the World Economy*, (forthcoming).

Rajan, R. 2001, 'Adopting an Appropriate Exchange Rate Regime: Fixed or Floating?', *Centre for International Economic Studies (CIES) Discussion Paper No. 0137*, Adelaide University, Adelaide, Australia.

Rajan, R. 2002, 'Exchange Rate Policy Options for Post-crisis Southeast Asia: Is there a Case for Currency Baskets?', *World Economy*, vol. 25 (1), pp. 137-63.

Rajan, R. and Siregar, R. 2002, 'Choice of Exchange Rate Regime: Currency Board (Hong Kong) or Monitoring Band (Singapore)?' *Australian Economic Papers*, vol. 41 (4), pp. 538-556.

Rajan, R. Siregar, R, and Bird, G. , "Examining the Case for Reserve Pooling in East Asia" , *Asia Pacific Journal of Economic and Business* (forthcoming).

Reinhart, C. and Rogoff, K. 2004, 'The Modern History of Exchange Rate Arrangements: A Reinterpretation, *The Quarterly Journal of Economics*, vol. CXIX, 1, pp. 1-48.

Rogoff, K. et al. 2003, 'Evolution and Performance of Exchange Rate Regimes', *IMF Working Paper 03/243*.

Weymark, D. 1997, 'Measuring the Degree of Exchange Market Intervention in a Small Open Economy', *Journal of International Money and Finance*, vol. 16, pp. 55-79.

Weymark, D. 1998, " A General Approach to Measuring Exchange Market Pressure", *Oxford Economic Papers*, Vol. 50, pp. 106-121.

Willett, T. 2004, ‘Assessing Korea’s Post-Crisis Managed Float’, mimeo.

Table 1:
Reserves as Proportion of Imports (months),
GDP (in percent) and Average Amount (in US$ millions)

Country	1992	1995	1998	2001	2004
Indonesia					
Imports[a]	3.0	2.7	7.1	9.6	11.9
GDP	8	7	15.9	17.2	13.9
Average[b]	10376.7	13022.5	19020.8	27863.5	34523.9
Malaysia					
Imports[a]	4.2	3.0	5.1	4.6	N/A
GDP	30	27	34	35	46.7
Average[b]	15082.8	25063.0	21441.8	28071.3	55017.6
Philippines					
Imports[a]	2.8	2.1	3.6	4.8	3.5
GDP	8	9	13	19	15.5
Average[b]	3941.9	6199.4	8771.2	12771.5	13068.97
Singapore					
Imports[a]	5.7	5.7	7.3	7.8	9.1
GDP	82	82	90	91	92.9
Average[b]	38028.3	65798.9	73170.9	75687.8	102704.7
Thailand					
Imports[a]	4.9	4.9	6.2	6.4	6.1
GDP	18	22	23	28	25.7
Average[b]	19574.5	33455.7	27020.1	31734.4	43355.9
Hong Kong					
Imports[a]	3.0	3.1	6.1	6.8	5.4
GDP	35	40	55	66	74.1
Average[b]	N/A	53283.5	92826.8	113307	121103.3
China					
Imports[a]	3.1	5.9	9.5	9.0	N/A
GDP	4.6	10.7	15.5	15.9	30
Average[b]	33875.2	67595.4	145535.8	194410.2	494608.2
Korea					
Imports[a]	2.2	2.5	5.6	8.5	9.4
GDP	5.0	4.0	5.0	20.6	22.9
Average[b]	15365.3	29679.9	42351.3	97834.1	171948.0
Japan					
Imports[a]	2.1	3.9	10.2	14.3	23.8
GDP	2.0	4.0	5.0	8.5	16.6
Average[b]	71408.6	166451.2	213459.8	374028.8	806165

Notes: a) Ratio to average monthly imports of Merchandise goods; b) Monthly average of total foreign exchange reserves minus gold. Source: Rajan, R. Siregar, R, and Bird, G. (forthcoming).

Table 2: Summary of Findings of Studies (*with exclusive focus on East Asia alone*) Regarding the Post-crisis Exchange Rate Regimes In Some East Asian Countries

Studies	Observation Period	Method(s)	Indonesia	Korea	Singapore	Thailand
Kawai and Akiyama (2000)	January 1999-December 1999	Frankel-Wei	Inconclusive	U.S.Dollar-peg reversion	U.S. Dollar-peg reversion	U.S.Dollar-peg reversion
Gan Wee Beng (2000)	July 2, 1997 – September 30, 1999	Simplified and Modified Version of Frankel-Wei	Greater Flexibility	Greater Flexibility	Greater Flexibility	Greater Flexibility
Baig (2001)	1999-2000	Standard Deviation and Frankel-Wei	Inconclusive	U.S. Dollar-peg reversion	Not Included	Increased Flexibility
McKinnon (2001)	1999-May 2000	Frankel-Wei	Still in quasi-crisis mode	High-frequency dollar-peg reversion	High-frequency dollar-peg reversion	High-frequency dollar-peg reversion
Ogawa (2001)	Various sub-periods from July 1998 – September 2000	Frankel-Wei	U.S. Dollar-peg reversion	U.S. Dollar-peg reversion	U.S. Dollar-peg reversion	U.S. Dollar-peg reversion
McKinnon and Schnabl (2002)	January 1, 1999 – April 22, 2002	Standard Deviation and Frankel-Wei	Floating	High-frequency U.S. dollar- peg reversion	High-frequency U.S. dollar- peg reversion	High-frequency U.S. dollar- peg reversion
Kawai (2002)	1999-June 2002	Frankel-Wei	Floating	Managed Floating	Managed Float	Managed Floating
Hernandez and Montiel (2003)	1999-2001	Standard Deviation	Managed Float	Managed Float	Not Included	Managed Float
Fukuda and Ohno (2003)	Various sub-periods from February 2, 1998 – September 5, 2002	Frankel-Wei	Not Included	U.S. Dollar- peg reversion	U.S. Dollar- peg reversion	U.S. Dollar- peg reversion
Kim, Kim, and Wang (2004)	Two sample periods: January 1999-June 2001; January 1999-December 2003	Structural VAR (SVAR)	Increased Flexibility	Increased Flexibility	Increased Flexibility	Increased Flexibility

Table: 2 (cont'd)
Summary of Findings of Studies (*Non- exclusive focus on East Asia*)
Regarding the Post-crisis Exchange Rate Regimes In Some East Asian Countries

	IMF Classification based on Bubula and Otker-Robe (2002)				
	1999	**2000**	**2001**	**2002**	**2003**
Indonesia	Independently Floating	Independently Floating	Managed Floating	Managed Floating	Managed Floating
Korea	Independently Floating	Independently Floating	Independently Floating	Independently Floating	Independently Floating
Singapore	Managed Floating	Managed Floating	Managed Floating	Managed Floating	Managed Floating
Thailand	Managed Floating	Managed Floating	Managed Floating	Managed Floating	Managed Floating
	Levy-Yeyati and Sturzenegger Classification (2005)				
	1999	**2000**	**2001**	**2002**	**2003**
Indonesia	Intermediate Dirty/Crawling Peg	Intermediate Dirty/Crawling Peg	--------	--------	---------
Korea	Fix	Fix	--------	--------	---------
Singapore	Fix	Fix	--------	--------	---------
Thailand	Float	Float	-------	--------	---------
	Reinhart-Rogoff Classification (2004)				
	Indonesia		**Korea**	**Singapore**	**Thailand**
Periods	**August 1997-March 1999**	**April 1999-December 2001**	**July 1998-December 2001**	**December 1998-December 2001**	**January 1998-December 2001**
	Freely Falling/Freely Floating	Freely Floating	Freely Floating	Managed Floating	Managed Floating

Table 3:
Univariate Statistics on Exchange Rates (EXR), Reserves, and Interest Rates (INT)

	Mean	Std. Dev.	Skewness	Kurtosis	JB Normality Test	LB(24)	LBS(24)
Indonesia							
EXR	1.202	8.723	6.563	68.593	42323.16**	53.36**	15.16
Reserves	2.071	10.644	4.257	37.329	11831.79**	30.15	11.36
INT	-0.02	5.246	2.715	42.83	15283.63**	43.12**	41.88**
Korea							
EXR	0.214	3.606	8.573	105.007	101197.8**	70.43**	6.68
Reserves	2.274	7.296	0.833	8.161	278.215**	27.97	87.24**
INT	-0.02	1.156	1.122	11.878	793.152**	38.94*	37.06*
Singapore							
EXR	-0.10	1.334	0.252	7.042	156.954**	35.70*	126.73**
Reserves	0.868	1.06	0.118	4.061	11.172**	79.0**	26.34
INT	-0.02	0.571	0.216	16.898	1828.664**	27.47**	58.45**
Thailand							
EXR	0.202	2.815	2.602	24.63	4681.083**	54.12**	222.35**
Reserves	1.517	4.552	0.085	12.291	816.69**	111.6**	315.41**
INT	-0.05	2.155	0.35	12.728	899.658**	61.72**	104.58**

Notes: EXR and Reserves in percentage changes and INT in first-difference.

JB-normality test: Jarque-Bera test, which is distributed χ^2_2.

LB(24): Ljung-Box test for EXR, Reserves and INT with 24 lags, which is distributed χ^2_{24}.

LBS(24): Ljung-Box test for squared of EXR, Reserves and INT with 24 lags, which is distributed χ^2_{24}.

**, * significant at the 1 and 5 percent level, respectively.

Table 4:
2-state regime switching ARCH regressions for percentage changes in exchange rates

	Rupiah **Normal** **SWARCH (2,2)**	**Won** **Student *t*** **SWARCH (2,1)**	**Singapore dollar** **Normal** **SWARCH (2,1)**	**Thailand baht** **Normal** **SWARCH (2,2)**
ϕ_0	0.21** (0.01)	-0.0003 (0.04)	-0.13* (0.06)	-0.01 (0.04)
ϕ_1	0.34** (0.02)	0.58** (0.06)	0.3** (0.07)	0.24** (0.07)
α_0	0.01** (0.002)	0.20** (0.07)	0.64** (0.10)	0.15** (0.03)
α_1	1.22** (0.29)	0.58** (0.25)	0.16 (0.12)	0.36** (0.12)
α_2	0.32* (0.16)	---	---	0.3** (0.11)
p_{11}	0.95** (0.02)	0.99** (0.006)	0.97** (0.02)	0.99** (0.008)
p_{22}	0.93** (0.03)	0.99** (0.006)	0.81** (0.1)	0.97** (0.03)
g_2	787.33++(283.10)	19.92++ (0.96)	9.69++ (3.63)	64.15++ (18.53)
Log-likelihood	-292.67	-316.7	-333.66	-316.04
Log-likelihood (no regime switching)	-599.83	-339.38	-353.77	-417.76
LR test	614.32**	45.36**	40.22**	203.44**
df	---	3.61** (0.96)	---	---
LB(24)	7.27	27.49	15.92	11.75
LBS(24)	0.22	31.73	9.25	0.31

Notes: Standard errors in parentheses.

LR test: Likelihood ratio test which test the null hypothesis if no regime switching, which is distributed χ_r^2.

LB(24): Ljung-Box test for EXR, Reserves and INT with 24 lags, which is distributed χ_{24}^2.

LBS(24): Ljung-Box test for squared of EXR, Reserves and INT with 24 lags, which is distributed χ_{24}^2.

**, * significant at the 1 and 5 percent level, respectively.

++, + significantly different than 1 at the 1 and 5 percent level, respectively.

Table 5:
2-state regime switching ARCH regressions for percentage changes in reserves

	Indonesia Normal SWARCH (2,1)	**Korea Normal SWARCH (2,1)**	**Singapore Normal SWARCH (2,1)**	**Thailand Normal SWARCH (2,1)**
ϕ_0	1.22** (0.33)	1.68** (0.33)	0.69** (0.09)	1.34** (0.19)
ϕ_1	0.04 (0.07)	-0.04 (0.08)	0.20** (0.07)	0.01 (0.06)
α_0	13.91** (2.4)	12.72** (1.83)	0.58** (0.10)	4.57** (0.64)
α_1	0.44** (0.13)	0.2* (0.1)	0.14 (0.10)	0.22* (0.10)
p_{11}	0.97** (0.02)	0.99** (0.01)	0.98** (0.03)	0.99** (0.008)
p_{22}	0.85** (0.09)	0.97** (0.03)	0.95** (0.06)	0.92** (0.07)
g_2	18.19++ (5.17)	9.01++ (2.45)	3.09+ (0.89)	24.17+ (11.03)
Log-likelihood	-741.17	-697.78	-316.72	-559.30
Log-likelihood (no regime switching)	-816.97	-739.22	-325.86	-576.12
LR test	151.6**	82.88**	18.28**	33.64**
LB(24)	30.04	21.88	43.3**	42.43**
LBS(24)	34.19	26.66	22.72	13.29

Notes: Standard errors in parentheses.

LR test: Likelihood ratio test which test the null hypothesis if no regime switching, which is distributed χ_r^2.

LB(24): Ljung-Box test for EXR, Reserves and INT with 24 lags, which is distributed χ_{24}^2.

LBS(24): Ljung-Box test for squared of EXR, Reserves and INT with 24 lags, which is distributed χ_{24}^2.

**, * significant at the 1 and 5 percent level, respectively.

++, + significantly different than 1 at the 1 and 5 percent level, respectively.

Table 6:
2-state regime switching ARCH regressions for first-difference in interest rates

	Indonesia Normal SWARCH (2,1)	**Korea Normal SWARCH (2,1)**	**Singapore Normal SWARCH (2,1)**	**Thailand Normal SWARCH (2,2)**
ϕ_0	0.02 (0.07)	-0.001 (0.01)	0.0006 (0.01)	-0.04 (0.03)
ϕ_1	-0.05 (0.06)	0.22** (0.05)	0.08** (0.02)	0.09 (0.07)
α_0	0.82** (0.19)	0.007** (0.001)	0.006** (0.002)	0.06** (0.02)
α_1	0.48** (0.19)	0.38** (0.11)	0.62** (0.21)	0.63** (0.22)
α_2	---	---	---	0.24* (0.11)
p_{11}	0.96** (0.02)	0.91** (0.03)	0.66** (0.09)	0.99** (0.01)
p_{22}	0.84** (0.07)	0.95** (0.02)	0.83** (0.06)	0.92** (0.01)
g_2	87.92++ (25.06)	174.31++ (42.48)	36.81++ (10.08)	51.38++ (18.12)
Log-likelihood	-480.76	-210.15	-135.83	-347.38
Log-likelihood (no regime switching)	-587.39	-338.49	-192.99	-423.63
LR test	213.26**	256.68**	114.32**	152.5**
LB(24)	23.72	21.14	21.80	18.21
LBS(24)	5.52	1.51	48.68**	31.76

Notes: Standard errors in parentheses.

LR test: Likelihood ratio test which test the null hypothesis if no regime switching, which is distributed χ_r^2.

LB(24): Ljung-Box test for EXR, Reserves and INT with 24 lags, which is distributed χ_{24}^2.

LBS(24): Ljung-Box test for squared of EXR, Reserves and INT with 24 lags, which is distributed χ_{24}^2.

**, * significant at the 1 and 5 percent level, respectively.

++, + significantly different than 1 at the 1 and 5 percent level, respectively.

Table 7: EVT Thresholds of INTV Index

Country	Maximum	Minimum
Indonesia	0.90	0.18
Korea	0.91	0.15
Thailand	0.99	0.15
Singapore	0.98	0.89

Source: Authors' own calculation

Table 8: Smoothed Probabilities and INTV Index for Indonesia

	Intervention $(INTV)$	**Interest Rate** $p_{\text{int}\,r}^{H}$	**Rupiah** p_{exr}^{H}	**Foreign Exchange Reserve** $p_{reserves}^{H}$
1991	0.9844	0.4256	0.0071	0.2299
1992	0.9206	0.0010	0.0004	0.0054
1993	0.9195	0.0138	0.0007	0.0045
1994	0.9593	0.0046	0.0003	0.0093
1995	0.9735	0.0056	0.0002	0.0049
1996	0.3586	0.0077	0.4349	0.0159
1997	0.5234	0.3621	0.5062	0.0119
1998	0.6709	0.9943	0.9650	0.9635
1999	0.5181	0.5338	0.9943	0.6961
2000	0.0292	0.0085	0.9819	0.0227
2001	0.3209	0.1947	0.9919	0.3478
2002	0.1008	0.1758	0.9997	0.0091
2003	0.0219	0.0088	0.7452	0.0033

Table 9: Smoothed Probabilities and INTV Index for Korea

	Intervention $(INTV)$	**Interest Rate** $p^{H}_{\text{int}\,r}$	**Won** p^{H}_{exr}	**Foreign Exchange Reserve** $p^{H}_{reserves}$
1991	0.9999	0.9982	0.0001	0.0023
1992	0.9893	0.5161	0.0001	0.0010
1993	0.9999	0.9992	0.0001	0.0007
1994	0.9985	0.9996	0.0015	0.0006
1995	0.6793	0.9901	0.5314	0.0042
1996	0.5128	0.9999	0.9542	0.0045
1997	0.5615	0.9993	0.9862	0.4652
1998	0.5966	0.9895	0.9999	0.5522
1999	0.1367	0.2459	0.9998	0.0117
2000	0.0066	0.0050	0.9982	0.0017
2001	0.0052	0.0021	0.9999	0.0032
2002	0.0046	0.0040	0.9999	0.0007
2003	0.0260	0.0021	0.9955	0.0248

Table 10: Smoothed Probabilities and INTV Index for Singapore

	Intervention $(INTV)$	**Interest Rate** $p_{\text{int}\,r}^{H}$	**Singapore Dollar** p_{exr}^{H}	**Foreign Exchange Reserve** $p_{reserves}^{H}$
1991	0.9183	0.8944	0.0873	0.1101
1992	0.9889	0.7619	0.0091	0.1045
1993	0.9715	0.6019	0.0153	0.0317
1994	0.9925	0.8519	0.0061	0.0169
1995	0.9677	0.7628	0.0226	0.0247
1996	0.9937	0.7162	0.0039	0.0181
1997	0.6889	0.8574	0.4873	0.0530
1998	0.4915	0.8122	0.9019	0.1302
1999	0.9496	0.8304	0.0683	0.6737
2000	0.9891	0.5073	0.0152	0.9356
2001	0.8419	0.6139	0.3568	0.9497
2002	0.9885	0.4433	0.0143	0.8459
2003	0.9239	0.1144	0.0580	0.5354

Table 11: Smoothed Probabilities and INTV Index for Thailand

	Intervention $(INTV)$	**Interest Rate** $p^{H}_{\text{int}\,r}$	**Baht** p^{H}_{exr}	**Foreign Exchange Reserve** $p^{H}_{reserves}$
1991	0.9969	0.9999	0.0031	0.0007
1992	0.9998	0.9993	0.0002	0.0006
1993	0.9999	0.9997	0.0001	0.0006
1994	0.9999	0.9995	0.0001	0.0004
1995	0.9997	0.9991	0.0003	0.0008
1996	0.9999	0.9994	0.0001	0.0017
1997	0.8295	0.9989	0.5075	0.7196
1998	0.4730	0.6482	0.9890	0.3520
1999	0.0511	0.0279	0.9654	0.0251
2000	0.0183	0.0001	0.9957	0.0206
2001	0.0131	0.0001	0.3752	0.0005
2002	0.1485	0.0000	0.0035	0.0005
2003	0.0285	0.0002	0.5939	0.0013

Figure 1: Smoothed Probabilities for Indonesia

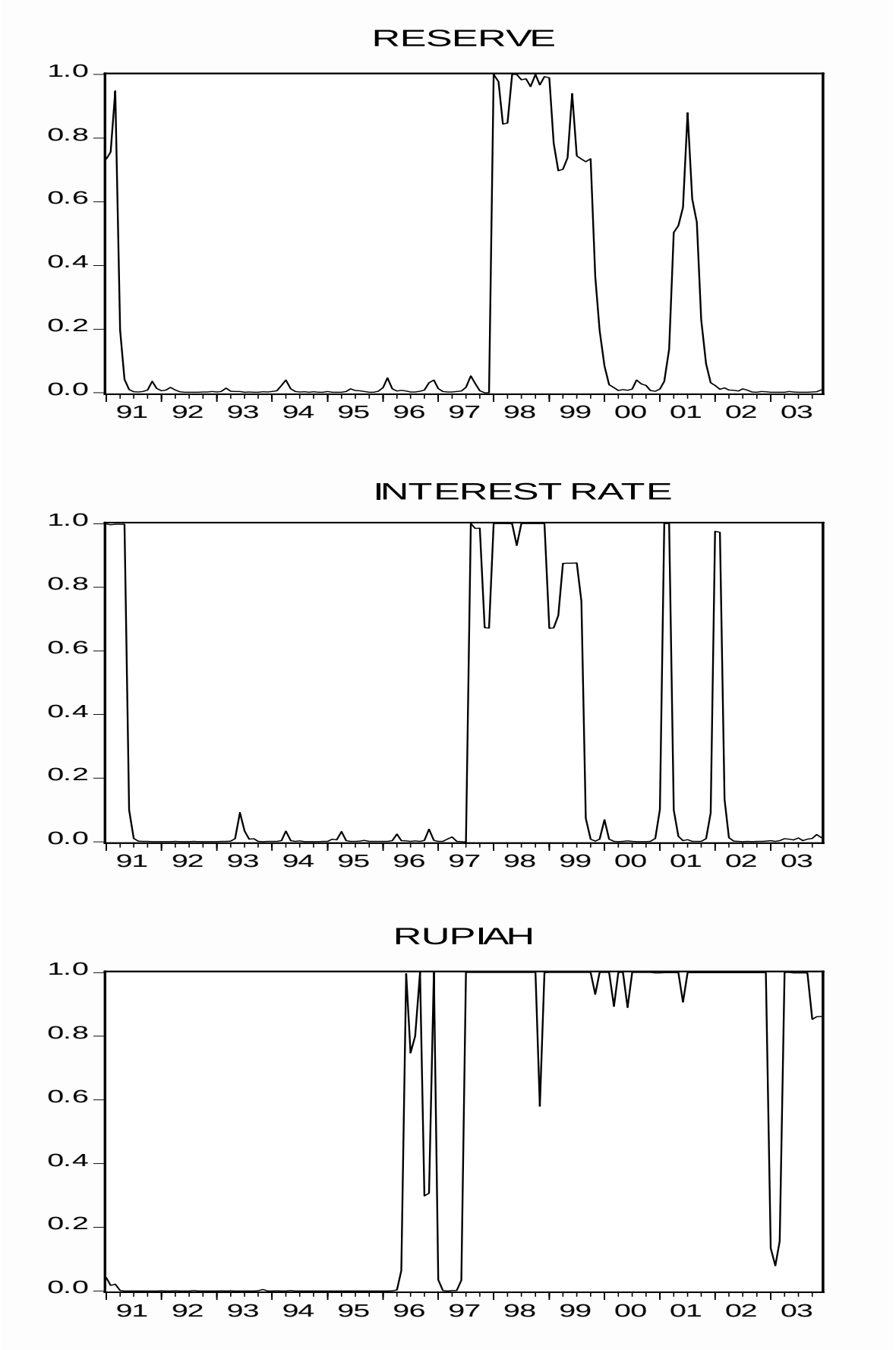


Figure 1b:
Probability of Intervention Estimates for Indonesia

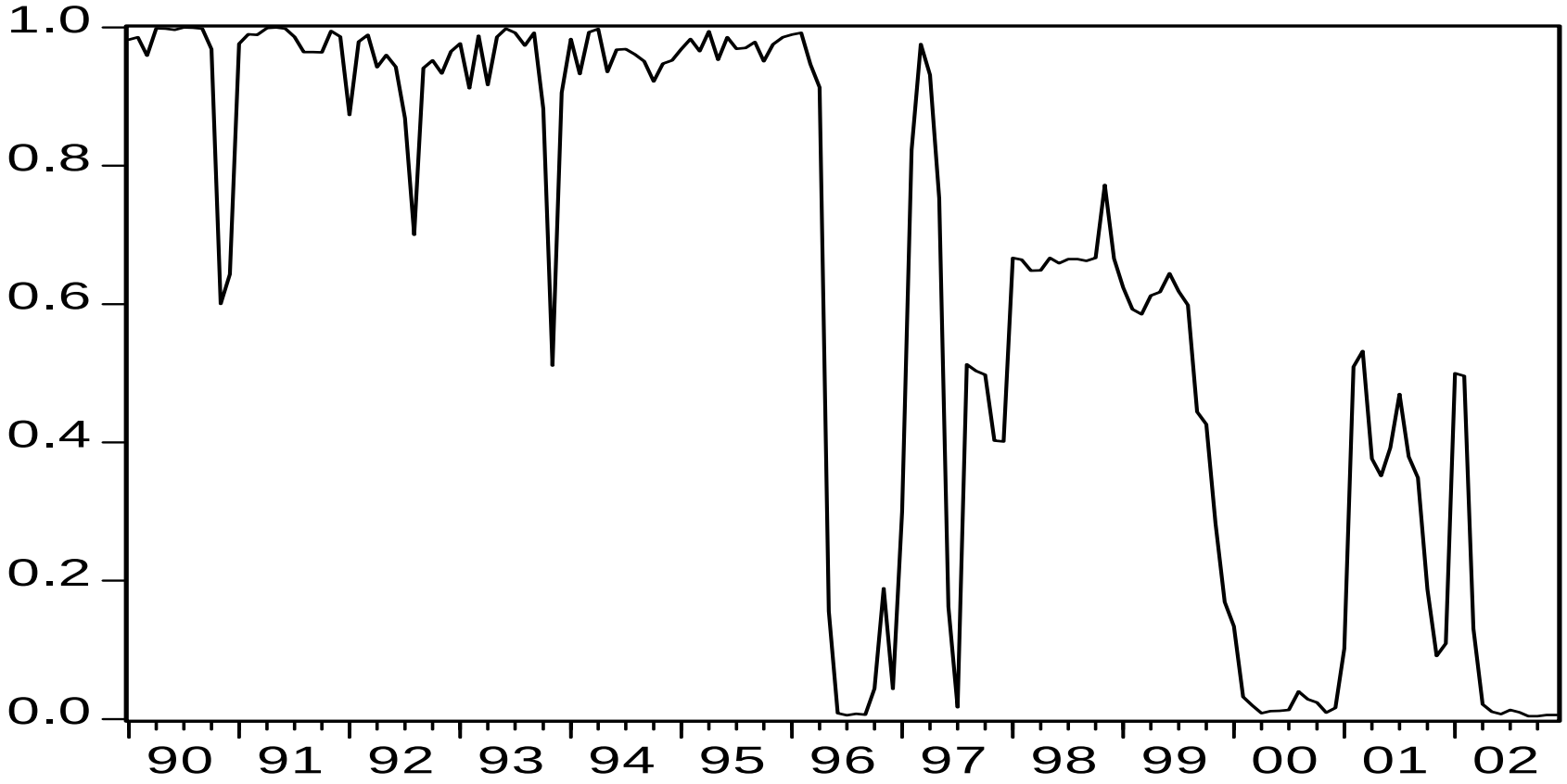


Figure 2: Smoothed Probabilities for Korea

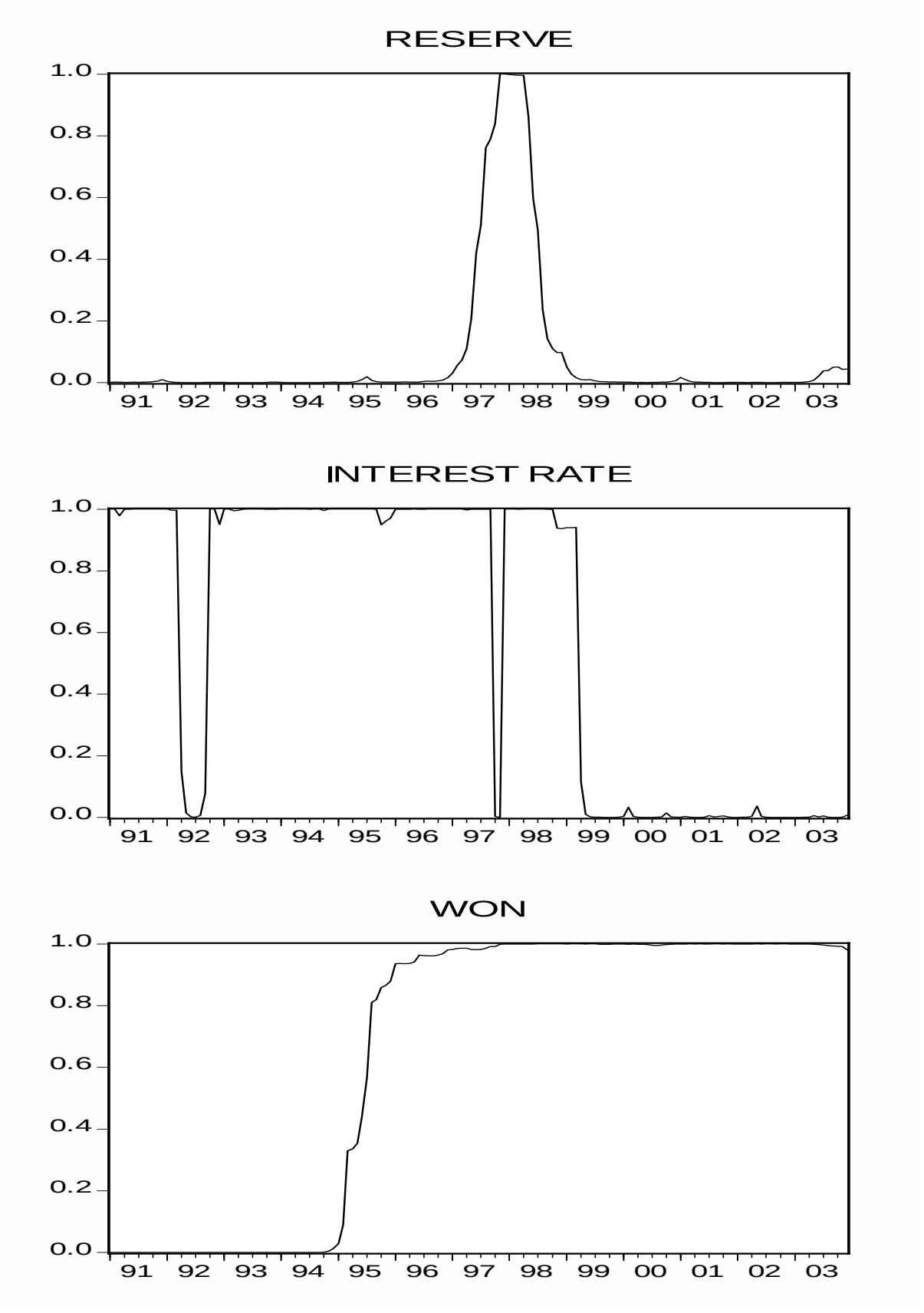


Figure 2b:
Probability of Intervention Estimates for Korea

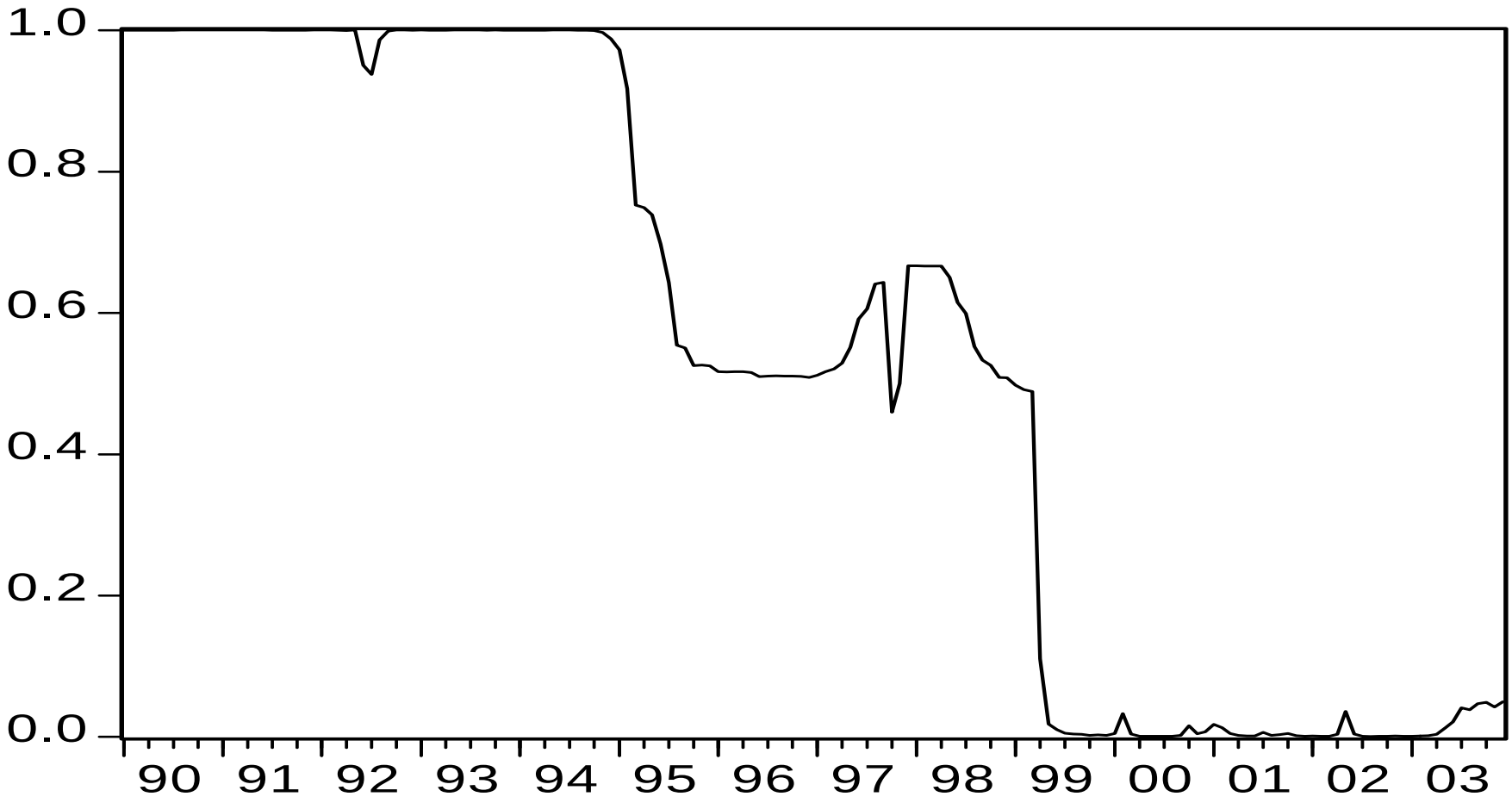


Figure 3: Smoothed Probabilities for Singapore

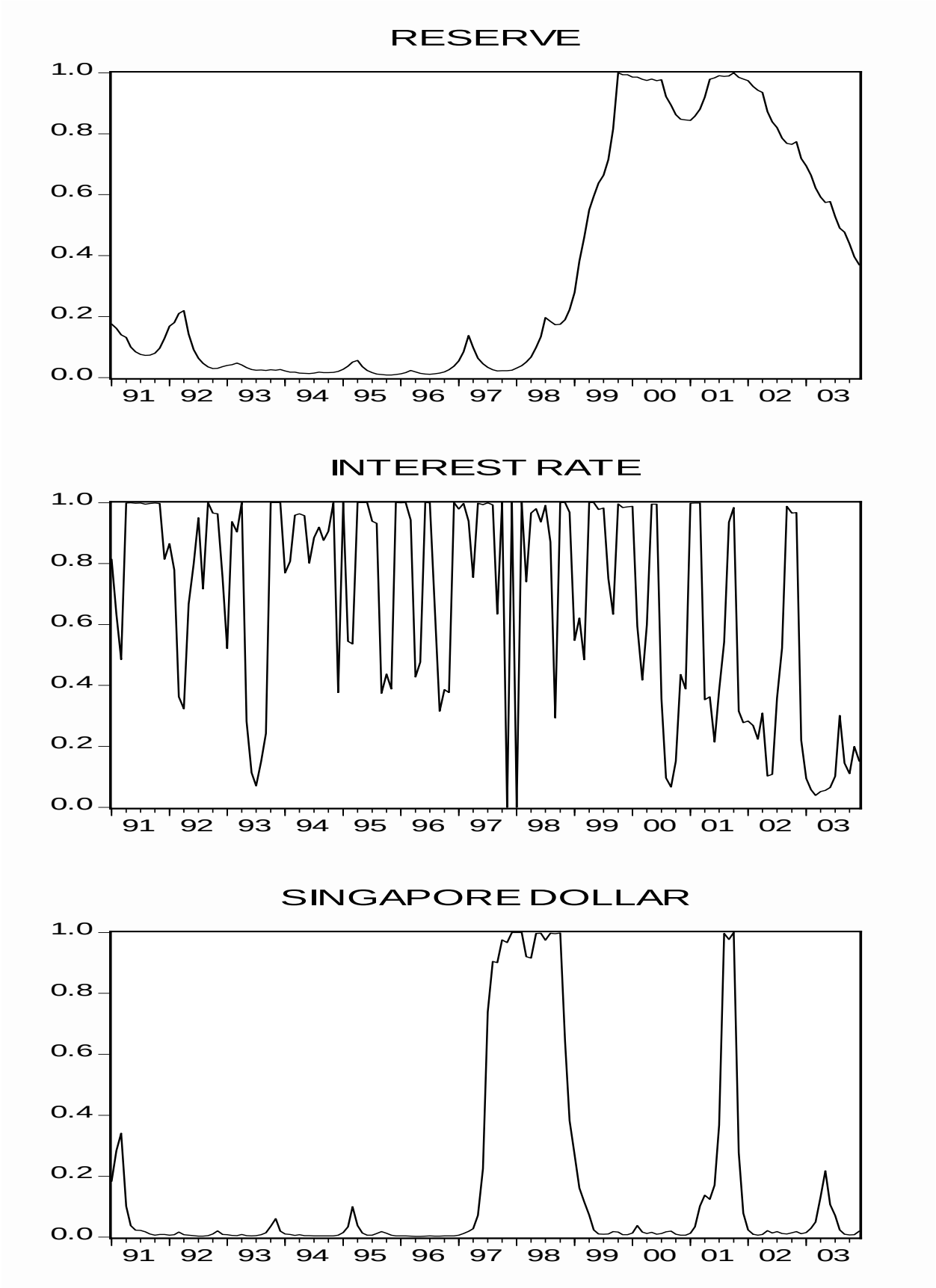


Figure 3b:
Probability of Intervention Estimates for Singapore

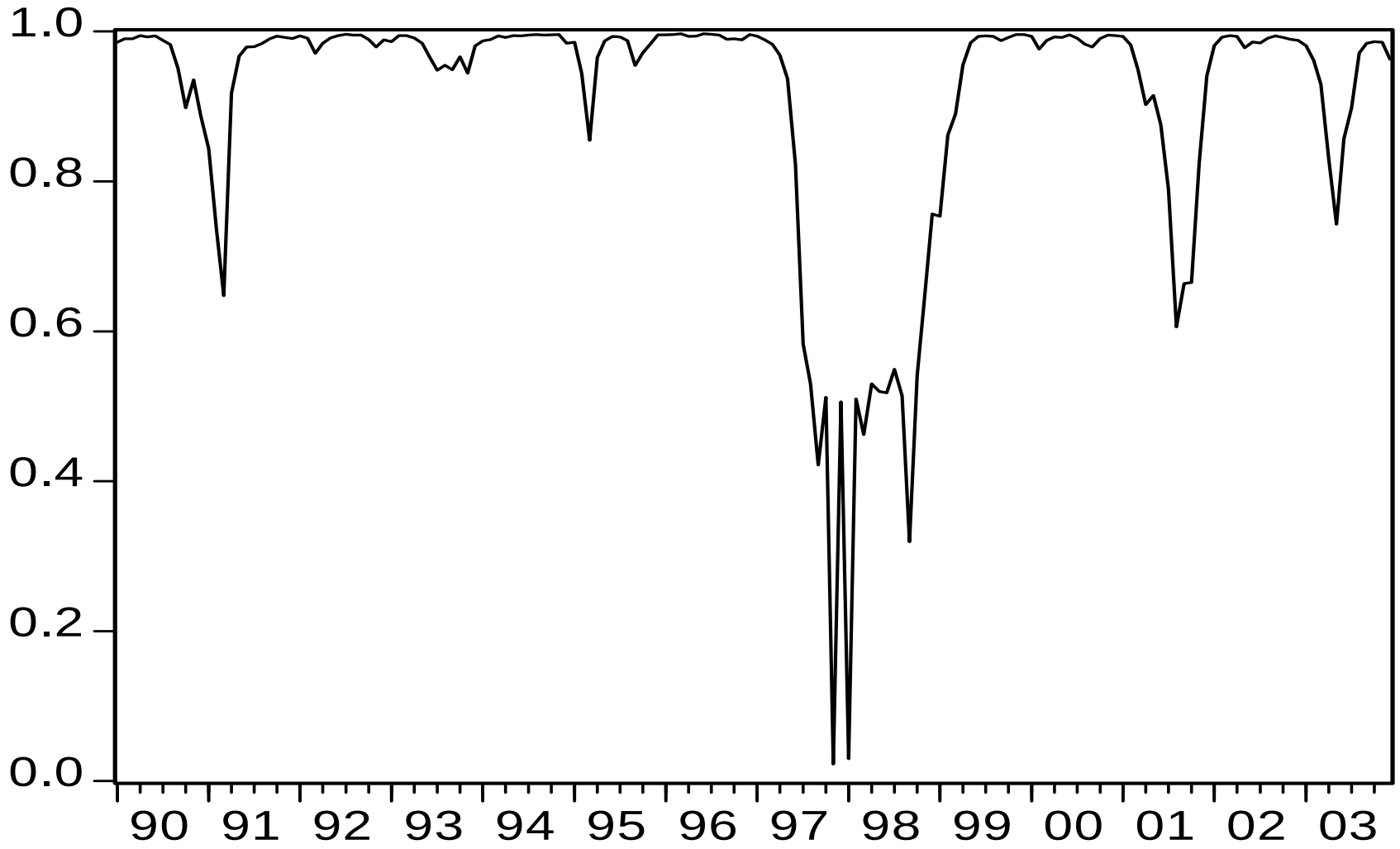


Figure 4: Smoothed Probabilities for Thailand

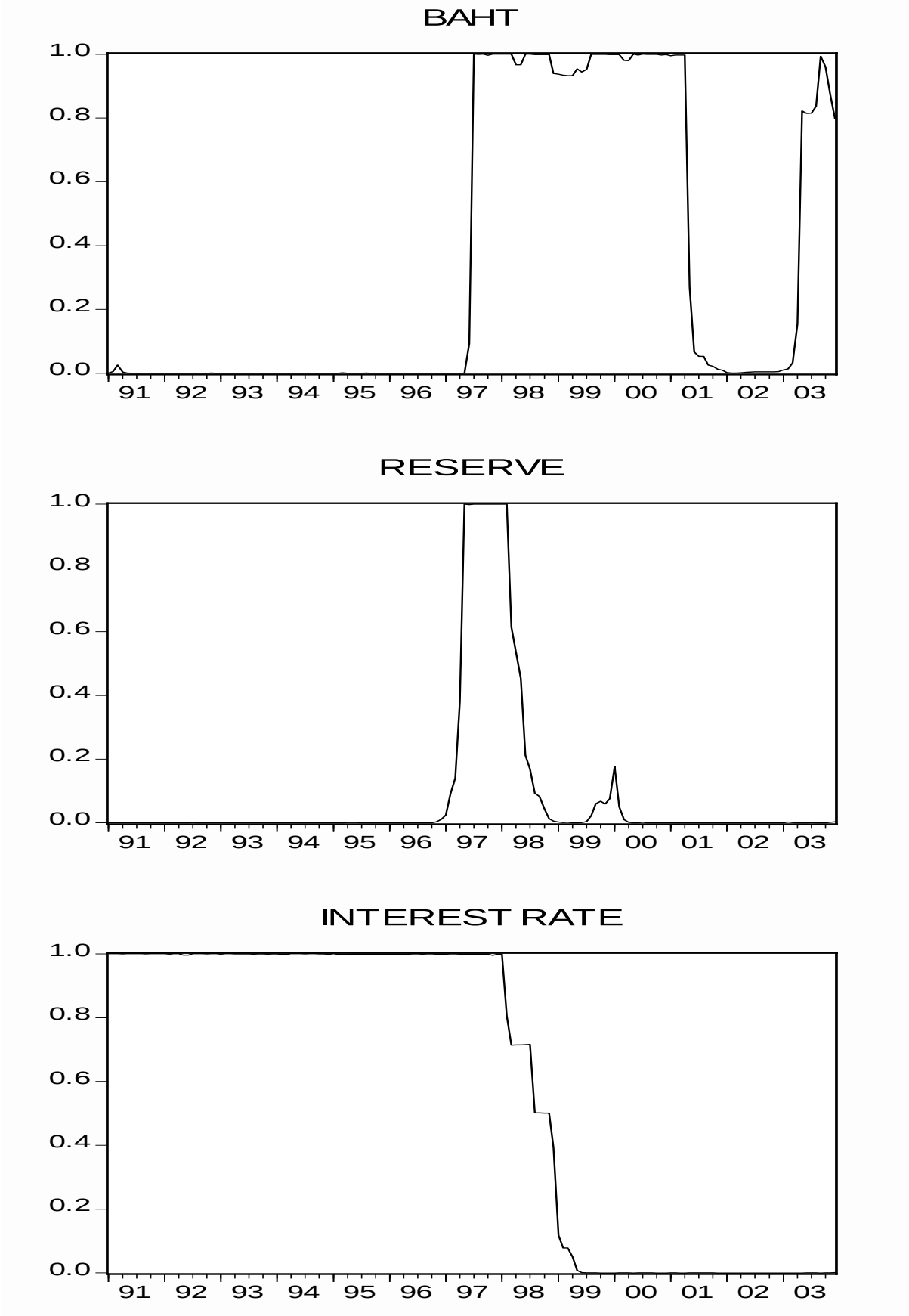
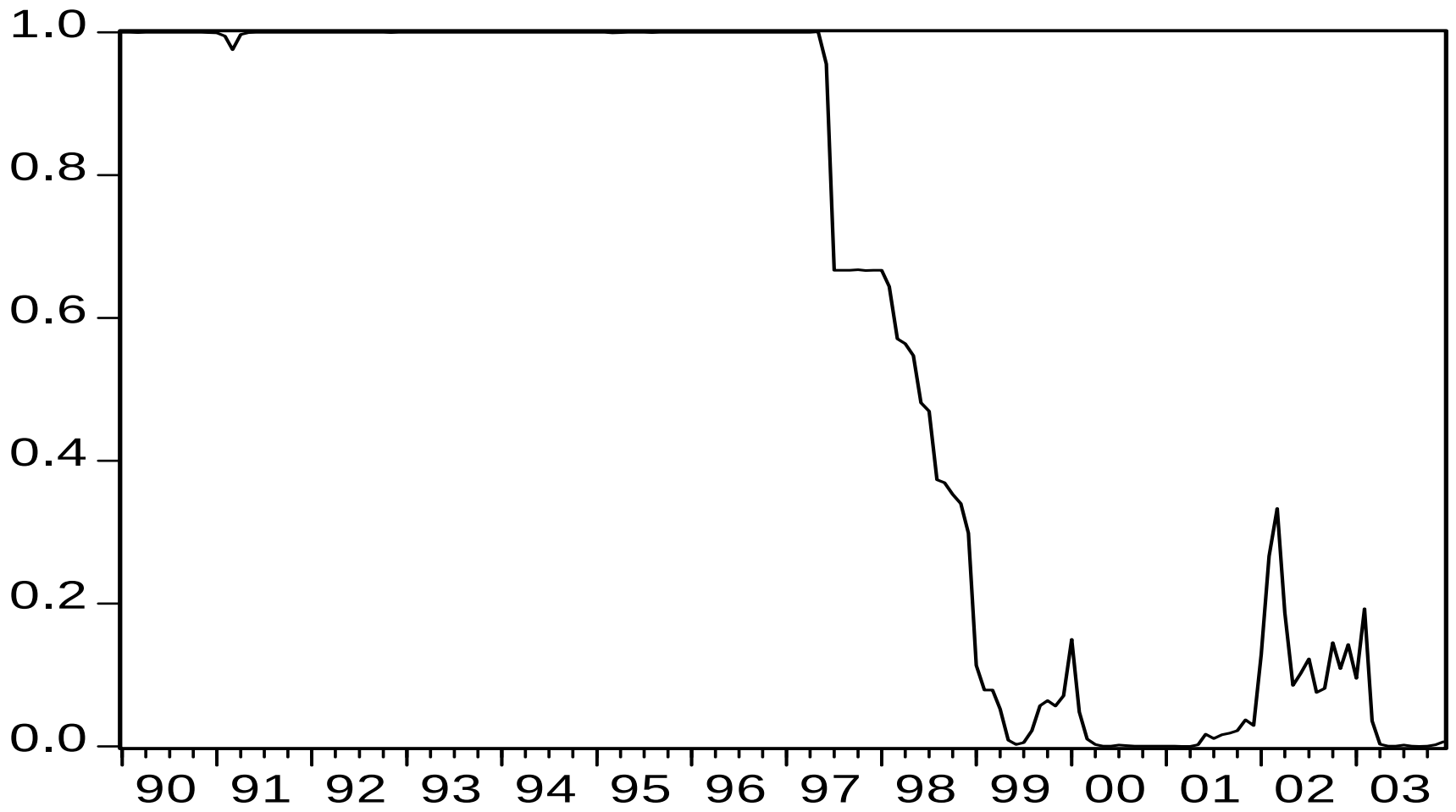


Figure 4b:
Probability of Intervention Estimates for Thailand



CIES DISCUSSION PAPER SERIES

The CIES Discussion Paper series provides a means of circulating promptly papers of interest to the research and policy communities and written by staff and visitors associated with the Centre for International Economic Studies (CIES) at the Adelaide University. Its purpose is to stimulate discussion of issues of contemporary policy relevance among non-economists as well as economists. To that end the papers are non-technical in nature and more widely accessible than papers published in specialist academic journals and books. (Prior to April 1999 this was called the CIES Policy Discussion Paper series. Since then the former CIES Seminar Paper series has been merged with this series.)

Copies of CIES Policy Discussion Papers may be downloaded from our Web site at http://www.adelaide.edu.au/cies/ or are available by contacting the Executive Assistant, CIES, School of Economics, Adelaide University, SA 5005 AUSTRALIA. Tel: (+61 8) 8303 5672, Fax: (+61 8) 8223 1460, Email: cies@adelaide.edu.au. Single copies are free on request; the cost to institutions is US$5.00 overseas or A$5.50 (incl. GST) in Australia each including postage and handling.

For a full list of CIES publications, visit our Web site at http://www.adelaide.edu.au/cies/ or write, email or fax to the above address for our *List of Publications by CIES Researchers, 1989 to 1999* plus updates.

0601 Pontines, Victor and Siregar, Reza Y., "Exchange Market Intervention and Evidence of Post-Crisis Flexible Exchange Rate Regimes in Selected East Asian Economies", April 2006

0520 Siregar, Reza Y. and Pontines, Victor, "External Debt and Exchange Rate Overshooting: The Case of Selected East Asian Countries", October 2005

0519 Anderson, Kym, Martin, Will and van der Mensbrugghe, Dominique, "Distortions to world trade: impacts on agricultural markets and farm incomes", August 2005

0518 Anderson, Kym, Martin, Will and van der Mensbrugghe, Dominique, "Would Multilateral Trade Reform Benefit Sub-Saharan Africans?", August 2005

0517 Anderson, Kym and Martin, Will, "Agricultural Trade Reform and the Doha Development Agenda", August 2005

0516 Anderson, Kym, Martin, Will and van der Mensbrugghe, Dominique, "Doha Merchandise Trade Reform: What's at Stake for Developing Countries?", August 2005

0515 Anderson, Kym, "On the Virtues of Multilateral Trade Negotiations", August 2005

0514 Anderson, Kym, "Interactions Between Trade Policies and GM Food Regulations", August 2005

0513 Anderson, Kym, "Setting the Trade Policy Agenda: What Roles for Economists?", August 2005

0512 Stein, Jerome L., "Optimal debt and equilibrium exchange rates in a Stochastic Environment: An Overview", July 2005

0511 Bayer, Ralph C. and Binenbaum, Eran, "The Hay and the Carrot: A Model of Corporate Sponsoring of Academic Research", July 2005

0510 Binenbaum, Eran, "Grants, Contracts, and the Division of Labor in Academic Research", July 2005

0509 Li, Jie and Rajan, Ramkishen S., "Can High Reserves Offset Weak Fundamentals? A Simple Model of Precautionary Demand for Reserves", June 2005

0508 Sugema, Iman, "The Determinants of Trade Balance and Adjustment to the Crisis in Indonesia", June 2005

0507 Ouyang, Alice Y. and Rajan, Ramkishen S., "Monetary Sterilization in China Since the 1990s: How Much and How Effective?", June 2005

0506 Sugema, Iman and Chowdhury, Anis, “Aid and Fiscal Behaviour in Indonesia: The Case of a lazy Government”, May 2005

0505 Chowdhury, Anis and Sugema, Iman, “How Significant and Effective has Foreign Aid to Indonesia been?”, May 2005

0504 Siregar, Reza Y. and Pontines, Victor, “Incidences of Speculative Attacks on Rupiah During The Pre- and Post-1997 Financial Crisis”, May 2005

0503 Cavoli, Tony and Rajan, Ramkishen S., “Have Exchange Rate Regimes in Asia Become More Flexible Post Crisis? Re-visiting the evidence.” January 2005

0502 Cavoli, Tony, “Sterilisation, Capital Mobility and Interest Rate Determination for East Asia” February 2005

0501 Marrewijk, Charles Van, “Basic Exchange Rate Theories” February 2005

0415 Griffiths, William and Webster, Elizabeth. “The Determinants of Research and Development and Intellectual Property Usage among Australian Companies, 1989 to 2002” December 2004

0414 Marrewijk, Charles Van and Koen G. Berden, “On the static and dynamic costs of trade restrictions” November2004

0413 Anderson, Kym , Lee Ann Jackson and Chantal Pohl Nielsen “Genetically Modified Rice Adoption” November 2004

0412 Anderson, Kym , “The Challenge of Reducing Subsidies and Trade Barriers” November 2004

0411 Anderson, Kym and Lee Ann Jackson, “Standards, Trade and Protection: the case of GMOs”, November 2004

0410 Anderson, Kym, Richard Damania and Lee Ann Jackson, “Trade, Standards, and the Political Economy of Genetically Modified Food”, November 2004

0409 Anderson, Kym and Lee Ann Jackson, “Some Implications of GM Food Technology Policies for Sub-Saharan Africa”, November 2004

0408 Anderson, Kym and Lee Ann Jackson, “GM Food Crop Technology and Trade Measures: Some economic Implications for Australia and New Zealand” November 2004

0407 Marrewijk, Charles Van, “An Introduction to International Money and Foreign Exchange Markets”, October 2004

0406 Pontines, Victor and Reza Y. Siregar, “The Yen, The US dollar and
The Speculative Attacks Against The Thailand Baht”, October 2004

0405 Siregar, Reza and William E. James, “Designing an Integrated Financial Supervision Agency: Selected Lessons and Challenges for Indonesia”, October 2004

0404 Pontines, Victor and Reza Y. Siregar, “Successful and Unsuccessful Attacks:Evaluating the Stability of the East Asian Currencies”, August 2004

0403 Siregar, Reza and Ramkishen S. Rajan “Exchange Rate Policy and Reserve Management in Indonesia in the Context of East Asian Monetary Regionalism “, August 2004

0402 Siregar, Reza “Interest Spreads and Mandatory Credit Allocations:
Implications on Bank Loans to Small Businesses in Indonesia”, January 2004.

0401 Cavoli, Tony., Ramkishen S. Rajan, and Reza Siregar “A Survey of Financial Integration in East Asia: How Far? How Much Further to Go?”, January 2004.

0323 Rajan, Ramkishen., Reza Siregar and, Graham Bird “Examining the Case for Reserve Pooling in East Asia: Empirical Analysis”, September 2003.

0322 Chantal Pohl Nielsen and Kym Anderson “Golden Rice and the Looming GMO Trade Debate: Implication for the Poor”, July 2003.

0321 Anderson, Kym “How Can Agricultural Trade Reform Reduce Poverty?” July 2003.

0320 Damania, Richard and Erwin Bulte “Resources for Sale: Corruption, Democracy and the Natural Resource Curse”, July 2003.