Exchange Market Pressure and Extreme Value Theory: Incidence of Currency Crises in East Asia and Latin America

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Abstract:

A careful examination of the basic statistical distribution of the measures of exchange market pressure reveals that the conventional method of defining currency crisis is statistically flawed or inaccurate in capturing the 'true' dispersion of any given exchange market pressure series. This study applies an alternative statistical method known as Extreme Value Analysis (EVA) to three different weighting schemes popularly adopted in the literature in constructing exchange market pressure indexes, namely the Eichengreen-Rose-Wyplosz (ERW), the Sachs-Tornell-Velasco (STV) and the Kaminsky-Lizondo-Reinhart (KLR). The application of EVA leads to more incidences of currency crises being identified or 'captured' compared to the conventional methods across a number of countries in East Asia and Latin America from 1985 to 2003.

JEL Classification: F31, F41

Key Words: Currency Crisis; Exchange Market Pressure; Extreme Value Theory; East Asia; Latin America.

I. Introduction

The frequent occurrence and severity of currency crises, particularly in the past decade, have resurrected interest among academics, financial market participants and policy makers in developing an effective early warning device. A good survey of the literatures on the leading indicators of currency crises has shown a wide range of issues and approaches that has been adopted, from basic examinations of stylised facts to full testing / empirical works on various theoretical models (Kaminsky, Lizondo and Reinhart (1998), Chui (2002)).[1]

One of the primary focuses of recent researches in this area has however been on the construction of a single crisis index that expectedly will systematically behave differently prior to a crisis and hence provide a reliable warning of the potential crisis. Studies such as Eichengreen, Rose and Wyplosz (1995, 1996)---henceforth ERW, Sachs, Tornell and Velasco (1996) ---henceforth STV, and Kaminsky, Lizondo and Reinhart (1998, 1999) ---henceforth KLR--- have proposed different constructions of this early warning signal, known as an index of "*exchange market pressure (EMP)*". This index is usually a weighted average of the rate of depreciation of the local currency (mostly against the US dollar in either nominal or real level), the monthly percentage changes in international reserves, and the monthly change in the interest rate. As shown in Figure 1, the EMP index will eventually be either employed directly as an early warning signal or adopted as a dependent variable for empirical models of currency crises.

The appropriate definition of a currency crisis is undoubtedly very crucial here. The literature has usually defined currency crisis occurring when the measure of the exchange market pressure exceeds a certain threshold. The use of a threshold in

[1] A large body of the theoretical literature is along the lines pioneered by Blanco and Garber (1986).

defining currency crisis has, however, largely been of an arbitrary process. Frankel and Rose (1996) for instance apply exchange rate depreciations of 25 percent or more to identify currency crashes. Other papers have also adopted 1, 2 or even more standard deviations as their choices of thresholds. Our paper will show that by a much more careful examination of the basic statistical distribution of the measures of exchange market pressure will reveal that the conventional method of defining currency crisis is statistically flawed or inaccurate in capturing the 'true' dispersion of any given exchange market pressure series.

We will show that due to non-normality of the statistical distribution of the EMP indices in general, we have to avoid relying too much on parametric assumptions in identifying the threshold. Accordingly, our study will apply the Extreme Value Theory (EVT). Hardly any studies have applied this methodology to the study on currency crises leading indicators. A recent one is by Pozo and Dorantes (2003). Their studies apply EVT to identify periods of currency crisis for a broad section of Asian, European and Latin American countries from mid-1960s to 1997.

Our paper investigates the episodes of currency crises in two sets of countries: the Latin American countries (Argentina, Brazil, Chile and Mexico) and the East Asian economies (Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand). We extend Pozo and Dorantes (2003) in several ways. Firstly, our study applies the Extreme Value Analysis to three different weighting schemes popularly adopted in the literature in constructing exchange market pressure indexes, namely the Eichengreen-Rose-Wyplosz (ERW), the Sachs-Tornell-Velasco (STV) and the Kaminsky-Lizondo-Reinhart (KLR). Pozo and Dorantes (2003), on the other hand, only apply the ERW index. Our results will show that it is highly recommended to adopt more than one EMP index to ensure the robustness and conclusiveness of our findings.

Secondly, we extend the period of analyses up to 2003. By doing this, we can also capture the most recent episodes of crises in both regions (East Asia and Latin America).

Thirdly, to avoid the potential problem with the small sample when calculating the tail parameter of the Hill estimate (1975), we adopt the tail index estimator proposed by Huisman, Koedijk, Kool, and Palm (2001) ---henceforth HKKP---, which is unbiased in small sample cases. Pozo and Dorantes (2003) on the other hand opt to pool the countries' EMPs and estimate the regional values of the tail parameter. The pooling of the countries on a regional basis, however, is arguably a statistically inappropriate measure. Even during the pre-1997 financial crisis period that they cover, we can immediately capture the wide divergences of the EMP mean and the standard deviations among the Asian and the Latin American countries, with Indonesia and Paraguay having the total absolute value of mean and one standard deviation of the EMP about twice as much as that of Singapore and Bolivia, respectively.[2] As shown in Table 1, the statistical divergence continues to be quite significant when we include the currency-crisis period of 1998-2003. To generate more consistent analyses, we evaluate country-by-country cases and apply the HKKP methodology to deal with the relatively small number of observations.

The outline of the paper is as follows. Section 2 will briefly review the basic constructions of the three most commonly used exchange market pressure indices (i.e. Eichengreen, Rose and Wyplosz (1995, 1996), Sachs, Tornell and Velasco (1996), and Kaminsky, Lizondo and Reinhart (1998, 1999)). The Extreme Value Theory will be discussed in section 3. The empiric section covering the data and the testing will then follow (section 4). Section 5 analyses the results, and eventually the paper ends with brief concluding remarks (section 6).

2. The Exchange Market Pressure Index.

For our study, It is important to immediately underscore that a currency crisis in the context of an exchange market pressure is not only defined as capturing instances of successful attacks, i.e., when a depreciation of the currency occurs, but as well as instances of unsuccessful attacks (pressure rebuffed by loss in reserves and/or rise in interest rates) (Kaminsky, Lizondo, and Reinhart, 1998; Goldstein, Kaminsky, and Reinhart, 2000). The seminal idea is from the early work of Girton-Roper (1977) that any excess demand for foreign exchange can be fulfilled through non-mutually exclusive conduits. If the speculative attack (currency pressure) is successful, there is 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.

In so doing, a measure of the extent of currency pressure, or, an exchange market pressure (EMP) index can be constructed, which is a weighted average of the changes in exchange rate, in foreign exchange reserves, and in interest rates. The exchange rate is said to be under 'stress' (there is selling pressure) if there is a significant increase in the exchange market pressure index.

The question is how to weigh the three components of the index of speculative pressure. An unweighted index is simpler to construct, but the major drawback is that an unweighted index will be driven or dominated by the most volatile variable, and usually it is the movements in reserves. Next, we will briefly review three recent works on EMP indices that will then be employed for our empirics.

2.1 Eichengreen, Rose and Wyplosz (1995, 1996).

[2] Refer to Table 2 of Pozo and Dorantes (2003), pp. 598.

The exchange market pressure index of Eichengreen, Rose, Wyplosz (ERW) (1995, 1996) is expressed as:

$$EMPI_{i,t} = \frac{1}{\sigma_e}\frac{\Delta e_{i,t}}{e_{i,t}} - \frac{1}{\sigma_r}\left(\frac{\Delta rm_{i,t}}{rm_{i,t}} - \frac{\Delta rm_{US,t}}{rm_{US,t}}\right) + \frac{1}{\sigma_i}(\Delta(i_{i,t} - i_{US,t}) \qquad (1)$$

where $EMPI_{i,t}$ is the exchange rate market pressure index for country *i* in period *t*; $e_{i,t}$ the units of country *i*'s currency per U.S. dollars in period *t*; σ_e the standard deviation of the relative change in the exchange rate ($\frac{\Delta e_{i,t}}{e_{i,t}}$); $rm_{i,t}$ the ratio of gross foreign reserves to money stock or monetary base for country *i* in period *t*; σ_r is the standard deviation of the difference between the relative changes in the ratio of foreign reserves and money(money base) in country *i* and the reference country (US) $\left(\frac{\Delta rm_{i,t}}{rm_{i,t}} - \frac{\Delta rm_{US,t}}{rm_{US,t}}\right)$; $i_{i,t}$ the nominal interest rate for country *i* in period *t*; $i_{US,t}$ the nominal interest rate for the reference country (U.S.) in period *t*; σ_i the standard deviation of the nominal interest rate differential $(\Delta(i_{i,t} - i_{US,t})$.

2.2 Sachs, Tornell and Velasco (1996)

The exchange market pressure index of Sachs, Tornell and Velasco (STV) (1996) is expressed as follows:

$$EMPI_{i,t} = \left(\frac{1/\sigma_e}{((1/\sigma_e)+(1/\sigma_r)+(1/\sigma_i))} \right) \frac{\Delta e_{i,t}}{e_{i,t}} - \left(\frac{1/\sigma_r}{((1/\sigma_e)+(1/\sigma_r)+(1/\sigma_i))} \right) \frac{\Delta r_{i,t}}{r_{i,t}} + \left(\frac{1/\sigma_i}{((1/\sigma_e)+(1/\sigma_r)+(1/\sigma_i))} \right) \Delta i_{i,t} \quad (2)$$

where $EMPI_{i,t}$ is again the exchange rate market pressure index for country *i* in period *t*; $e_{i,t}$ the units of country *i*'s currency per U.S. dollars in period *t*; $r_{i,t}$ gross foreign reserves of country *i* in period *t*; $i_{i,t}$ the nominal interest rate for country *i* in period *t*; σ_e the standard deviation of the rate of change in the exchange rate ($\frac{\Delta e_{i,t}}{e_{i,t}}$), σ_r is the standard deviation of the rate of change in reserves $\left(\frac{\Delta r_{i,t}}{r_{i,t}}\right)$, and σ_i the standard deviation of the change in the nominal interest rate, $\Delta i_{i,t}$.

2.3 Kaminsky, Lizondo and Reinhart (1998, 1999)

The exchange market pressure index of Kaminsky, Lizondo, and Reinhart (KLR) (1998, 1999) is expressed as follows:

$$EMPI_{i,t} = \frac{\Delta e_{i,t}}{e_{i,t}} - \frac{\sigma_e}{\sigma_r} \frac{\Delta r_{i,t}}{r_{i,t}} + \frac{\sigma_e}{\sigma_i} \Delta i_{i,t} \quad (3)$$

where $EMPI_{i,t}$ is again the exchange rate market pressure index for country *i* in period *t*; $e_{i,t}$ the units of country *i*'s currency per U.S. dollars in period *t*; $r_{i,t}$ gross foreign reserves of country *i* in period *t*; $i_{i,t}$ the nominal interest rate for country *i* in period *t*; σ_e the standard deviation of the rate of change in the exchange rate ($\frac{\Delta e_{i,t}}{e_{i,t}}$); σ_r is the standard deviation of the rate of change in reserves $\left(\frac{\Delta r_{i,t}}{r_{i,t}}\right)$; and s $_i$ the standard deviation of the change in the nominal interest rate, $\Delta i_{i,t}$.

3. The Extreme Value Theory

As mentioned earlier, we apply the 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 commonly used Hill (1975) estimator where we assume that there is a sample of n positive independent observations drawn from some unknown fat-tailed distribution. Let the parameter g be the tail-index of the distribution, and $x(i)$ be the ith-order statistic such that $x(i-1) \leq x(i)$ for $i = 2, \ldots\ldots, n.$ Suppose that we opt to include k observations from the right tail in our estimate. Hill (1975) proposed the following estimator for g :

$$\text{g}(k) = \frac{1}{k}\sum_{j=1}^{k} \ln(x(n-j+1) - \ln(x(n-k)) \qquad (4)$$

where: k is the pre-specified number of tail observations. 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 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 k, the bias of the conventional Hill estimate of g increases almost linearly in k and can be approximated by:

$$\mathrm{g}(k) = \mathrm{g} + \mathrm{b}k + \mathrm{e}(k), \qquad k = 1, 2, ..., \mathrm{k} \tag{5}$$

where $\mathrm{e}(k)$ is a disturbance term. HKKP (2001) also shows that the modified Hill estimator is quite robust with the choice of k to be around $\left(\frac{n}{2}\right)$. Accordingly, for our empirics, we propose to compute $\mathrm{g}(k)$ for a range value of k from 1 to k (roughly equal to $\left(\frac{n}{2}\right)$).

To estimate Equation (5), HKKP(2001) adopt the Weighed Least Square (WLS), instead of the Ordinary Least Squares (OLS), to deal with the potential heteroscedasticity in the error term $(\mathrm{e}(k))$ of Equation (5). The weight has $\left(\sqrt{1}, \sqrt{2}, ...\sqrt{k}\right)$ as diagonal elements and zeros elsewhere. The estimate of g from the WLS regression is an approximately unbiased estimate of the tail-index.

4. Data and Empirical Testing

4.1 Data

All data in monthly frequencies were drawn from the IMF International Financial Statistics database covering the period from 1985 to 2003. We considered a number of countries in the two distinct regions of East Asia (Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand) and Latin America (Argentina, Brazil, Chile, Mexico). The exchange rate is expressed in local currency per U.S. dollar. To avoid the issue in some countries of treating separately high-inflation episodes with regard to the construction of the exchange market pressure (EMP) indices, a measure of the real exchange rate is calculated by multiplying the nominal exchange rate by the relative price given as:[3]

$$RER_t^{local/U.S.} = NER_t^{local/U.S.} \frac{P_t^*}{P_t} \tag{6}$$

where P_t is the domestic consumer price index, and P^* is the U.S. consumer price index. An increase in RER_t (real exchange rate) or NER_t (nominal exchange rate) implies an appreciation of the U.S. dollar against the relevant local currency.

The remaining data requirements in the construction of the exchange market pressure indices are as follows. A measure of the interest rate differential is defined as the difference between the domestic interest rate and the U.S. federal fund rate, with the overnight money market rates used as the measure of domestic interest rate, except in the cases of the Philippines (91-day Treasury bill rate) and Chile (deposit rate). Line 11 of the IMF-IFS database (foreign assets of the monetary authorities) was used as the measure of foreign exchange reserves.

4.2 Empirical Testing

4.2.1 Preliminary Testing

Tables 1 and 2 present summary statistics of the individual EMP indices. For one, the mean and standard deviation of the three sets of EMP indices show considerable divergence within each country for each geographic region. For instance, according to Table 1, the ERW index suggests that Indonesia experienced the lightest

[3] Similar results were obtained when the nominal exchange rate is used.

market turbulence. However, both the KLR and STV indices suggest, instead, that Indonesia should experienced the most severe currency pressure compared to the other East Asian countries. Likewise, according to Table 2, the ERW index indicates that Mexico experienced the most severe currency pressure among the four Latin American countries. However, both the KLR and STV indices indicate that Brazil, instead, experienced the most severe currency pressure. Thus, these results show that the potential inconsistencies between different EMP indicators. It is therefore critical that we adopt a number of them.

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TABLES 1 AND 2 HERE

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Tables 1 and 2 also indicate the following observations. First, in almost all of the countries in East Asia and Latin America, the three EMP indices are skewed to the right. Second, all of the three EMP indices exhibit excess kurtosis which reflects fat-tailedness.[4] Third, the Jarque-Bera statistics are highly significant for all countries which further confirms the non-normality of the three EMP indices.[5] This outcome is further substantiated by visual evidence in Figures 2-3 (based on the ERW index), Figures 4-5 (based on the KLR index), Figures 6-7 (based on the STV index) with the histogram of the EMP series for each countries overlaid by its corresponding normal probability density functions. In all cases, it is obvious that the EMP indices depart significantly from the normal distribution—mass of observations in the tails and the observed regularity of a great number of peak observations at the centre of the distribution.

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[4] Excess with respect to the normal distribution which has a kurtosis equal to 3.

FIGURES 2-7 HERE

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A preliminary step in proceeding with extreme value analysis is to examine the unit-root property of the three EMP indices. Tables 3 and 4 present the combined results from the commonly used ADF unit root test as well as from alternative unit root tests—the DF-GLS and the KPSS tests. In all, the three EMP indices for all countries are *I*(*0*) variables at the 1 per cent significance level according to the ADF test. Confirmatory results from the DF-GLS test and the KPSS unit-root test show that the EMP indices are stationary at the 10 percent significance level or even stronger.

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TABLES 3-4 HERE

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4.2.2 The Hill and HKKP Estimators

In order to capture the tail mass or outliers it is mandatory to estimate the so-called tail index (γ), and as earlier mentioned, we use the Hill estimator for this purpose.[6] The Hill estimator requires that the EMP series are rank-ordered from lowest to highest denoted as (x_i), and uses maximum likelihood estimation of the tail index (γ). Although asymptotically unbiased, the Hill estimator is biased in relatively small samples. In a related paper, Pozo and Dorantes (2003) faced with a similar small sample size opted to pool the EMP values in each region and estimate a regional α with the much larger number of observations. However, as emphasised earlier, due to the wide divergence in

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[5] Kolmogorov-Smirnov and Shapiro-Wilk statistics further support this result. The results can be made available upon request.

[6] γ also equals $1/\alpha$, where α refers to the maximum number of existing finite moments. As is customary in the literature, the tail index is either referred to as γ or α, it is used here interchangeably.

the mean and standard deviation of each country's respective EMP indices, it is implausible to assume conformity in the distribution of the EMP indices across the individual countries.

In accordance with the suggestion of HKPP (2001), to deal with the estimation of the tail with a small sample size, we use equation (5) in estimating a weighted least squares (WLS) regression for the individual EMP indices across all countries, after computing the $\gamma(k)$ for a range of values of *k*.[7] Consequently, the essence is to identify the right-tail outliers or 'extreme value' observations since the right-tail distribution of any EMP index ordered distribution will automatically determine the number and incidence of currency pressure episodes that individual countries experienced. Accordingly, Diebold, Schuermann, and Stroughair (DSS) (2000) suggested, similarly employed by Pozo and Dorantes (2003), recursive residuals were derived from the weighted least squares regression to diagnose structural change which will guide us in the selection of the optimal *k*.

Figures 8-13 depict the recursive residuals for the three individual EMP indices across the countries in each region. The recursive residuals are plotted against the bandwith of plus and minus two standard errors, and examination of the recursive residuals in relation to the standard errors show an evident instability, generally, starting at the right-hand side of the plots. When we consider the empirical distribution of the individual ordered EMP indices, the apparent break around the right-hand side of the recursive residual plots appropriately correspond to the optimal choice of *k,* or equivalently, the number of 'extreme' or right-tail observations have now been identified.

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FIGURES 8-13 HERE

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5. Results and Analyses

Prior to identifying the crisis episodes according to EVT, Tables 5-7 report the crisis incidence for each country in each region over the period 1985 to 2003 using the conventional method of selecting an arbitrary threshold or 'cut-off' for the values of the three EMP indices. The choices of three-month and six-month thresholds or exclusion windows are adopted in order to examine the sensitivity of the results and to avoid counting the same crisis more than once, due to the fact that crisis often last for over a month and more crises occur in successive months.

Several key observations can be made from those tables. First, a comparison of the incidence of crisis episodes for each country varies depending on the EMP index that one uses. Second, a comparison of the individual EMP indices indicate that the number and incidence of crises episodes are sensitive to the arbitrary choice of the threshold and to the length of the exclusion window, i.e., a relatively lower threshold and short exclusion window represent higher incidences of crisis episodes, vice-versa.

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TABLES 5-7 HERE

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Tables 8-10 present the identification of crises according to EVT for the individual EMP indices, and for comparative purposes, we also include the result using the conventional method where we include the threshold that has the most number (incidence) of identified crisis episodes from tables 5 to 7 (this is at one and a half standard deviations above the mean). The third column of tables 8 to 10 also report the optimal *k* values which were derived from the recursive residuals discussed earlier, and the reported values clearly show the contrast in the number of extreme right-tail

[7] The WLS results are not reported here, but they can be made available upon request.

observations, or in the number of crises which occurred prior to imposing an exclusion window for individual countries and across each EMP indices.

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TABLES 8 –10

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It is clear that using an alternative approach such as an EVT leads to more incidence of crises episodes identified compared to the standard approach in the literature, notwithstanding the advantage we have accorded to the conventional method. This finding holds across each individual EMP indices for all country-specific cases and at the regional-level irrespective of the length of the exclusion or crisis window used. Another interesting finding is that within the crisis episodes identified by EVT across the individual EMP indices, sensitivity in the results both at the country-specific and regional level are observed.

Once the crisis incidence episodes have been computed, it is now conveniently easy to appropriately date the timing of the currency pressure (crises). Accordingly, tables 11 and 12 summarised the dates of the attack episodes captured by the conventional method and by the EVT, respectively. As expected, the EVT list a more comprehensive dating of actual episodes of currency crises for the countries investigated during the time period covered by the data (1985-2003).

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TABLES 11-12 HERE

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According to table 12, across the three EMP indices, the EVT is able to capture the debt crisis of the 80s in the four Latin American countries. Meanwhile, with respect to the crisis episodes of the 1990s, the three EMP indices are also able to capture the so-called Mexican peso crisis of 1994-1995; the East Asian currency crises of 1997-98 involving Indonesia, Korea, the Philippines, Malaysia, and Thailand; the Brazilian crisis of 1999; and, more recently, the 2001 crisis in Argentina. Furthermore, as is evident in tables 11 and 12, both methods are also able to identify crisis dates other than the ones we mentioned above. For example, according to table 12, Singapore was also 'stressed' during the height of the East Asian currency crisis for all three EMP indices.[8]

For one, this should not come as a surprise since the notion of an EMP index is supposed to capture both successful attacks, i.e., events that have been well recognised and acknowledged as major crises by the relevant economic authorities, market participants and multilateral organisations, and unsuccessful attacks, i.e., those events accompanied by sharp fall (increase) in reserves (interest rates), and may have only been exclusively or privately known by market participants (traders, dealers) and the country's monetary authority. On this aspect, Pozo and Dorantes (2003) argued the following:

> …As is the case for all other approaches used to identify currency crisis periods, our approach may not provide an unambiguous standard that can be used to verify that what we identify as a currency crisis is indeed a currency crisis. There is no formal definition of currency crisis derived from theory, and multilateral organisations do not systematically categorise crisis countries or crisis periods. Hence, there is no way to 'grade' the accuracy of these multiple approaches (pp. 607).

6. Brief Concluding Remarks

Given the magnitudes of both the economic and the social costs of any financial crises, constructing an accurate early warning signal indicator will remain undoubtedly an important research focus in the near future. From this study, two key points are worth noting for any future efforts of formulating crisis indicators.

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[8] Pontines and Siregar (2004) comprehensively list the significant political and economic events that have taken place in these countries that may have served as 'triggering device(s)' for the speculative attacks between mid-1980s and early 2000s.

Firstly, it is always highly recommended that we adopt a range of indices to ensure the robustness and conclusiveness of our results. Our empirical exercise finds that the three sets of EMP indices do vary significantly in size. Based alone on total mean and one standard deviation, the ERW indicator suggests Indonesia experienced the "lightest" exchange market pressure among the East Asian countries. In contrast, the KLR and the STV indices conclude that Indonesia had gone through the "heaviest" pressure during the last 2 decades. As for the Latin American countries, the ERW and KLR indices conclude that it is the Mexican economy that had experienced the largest pressure, but the STV index conclude otherwise that it is the Brazilian economy that came under the largest exchange market pressure.

Lastly, our study also shows that by employing the HKKP-Extreme Value Theory approach which takes into account the basic statistical properties of an EMP index, we can substantially improve the conventional approach in the literature, regardless of whatever standard weighting schemes that one uses in the construction of the EMP index. This statistical rationale stems from several seminal findings that any financial price series do not exhibit distributions that are normal, and this crucial piece of information about speculative price series is, usually, assumed 'away' or takes lesser importance compared to other issues, e.g., search for more powerful econometric methods, in the literature on the early warning signals (EWS) of currency crisis.

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Table 1
Descriptive Statistics of Individual EMP Measures

	Mean	**Standard Deviation**	**Skewness**	**Kurtosis**	**Jarque-Bera Statistic**
East Asia					
Indonesia					
ERW	0.00	1.34	1.08	18.46	2253.828*
KLR	-1.00	9.71	1.17	27.10	5448.91*
STV	0.65	5.56	5.35	50.99	22459.28*
Korea					
ERW	-0.12	1.97	1.98	21.48	3302.40*
KLR	-1.05	6.22	1.66	18.24	2272.20*
STV	0.23	1.64	6.21	66.93	39583.66*
Malaysia					
ERW	0.06	1.97	-1.23	15.71	1550.91*
KLR	-0.45	4.61	-0.78	16.91	1837.17*
STV	0.21	0.81	0.50	10.35	515.47*
Philippines					
ERW	-0.10	2.02	0.14	10.73	552.89*
KLR	-0.43	4.58	-0.22	10.35	508.09*
STV	0.19	1.56	1.45	9.03	419.05*
Singapore					
ERW	-0.07	1.96	0.11	10.37	503.22*
KLR	-1.15	2.83	-0.06	6.75	131.93*
STV	0.24	0.54	-0.42	10.25	499.54*
Thailand					
ERW	-0.06	1.61	1.43	11.17	693.05*
KLR	-0.86	4.17	1.30	11.08	675.49*
STV	0.35	2.07	2.29	24.57	4559.03*

Note: $e_{i,t}$ is measured as the real exchange rate.

*****The null hypothesis of a normally distributed EMP measure is rejected.

Table 2
Descriptive Statistics of Individual EMP Measures

	Mean	Standard Deviation	Skewness	Kurtosis	Jarque-Bera Statistic
Latin America					
Argentina					
ERW	-0.05	1.47	-0.13	48.40	19070.25*
KLR	-4.33	24.45	-1.83	45.22	16836.93*
STV	3.64	20.88	4.31	43.16	15884.13*
Brazil					
ERW	0.04	1.77	3.37	38.93	12364.5*
KLR	-12229	32054.85	0.81	40.70	13351.25*
STV	16.20	32.37	4.36	30.21	7655.06*
Chile					
ERW	-0.04	1.50	0.41	14.91	1317.18*
KLR	-0.87	3.79	0.64	11.10	631.26*
STV	0.52	2.15	1.29	9.30	435.35*
Mexico					
ERW	-0.14	2.15	1.24	18.16	2182.23*
KLR	-0.97	7.74	1.11	19.21	2508.48*
STV	-0.55	4.37	1.11	19.29	2544.13*

Note: $e_{i,t}$ is measured as the real exchange rate.

*****The null hypothesis of a normally distributed EMP measure is rejected.

Table 3
Unit Root tests for the Individual EMP Measures

	ADF test[a] without trend	ADF test[a] with trend	DF-GLS[a] without trend	DF-GLS[a] with trend	KPSS test[b] without trend	KPSS test[b] with trend
East Asia						
Indonesia						
ERW	-14.103***	-14.100***	-3.090***	-13.265***	0.074	0.050
KLR	-14.791***	-14.778***	-2.611***	-13.947***	0.075	0.044
STV	-4.531***	-4.521***	-4.286***	-4.501***	0.076	0.077
Korea						
ERW	-11.300***	-11.276***	-10.784***	-11.111***	0.045	0.038
KLR	-10.107***	-10.087***	-10.100***	-10.113***	0.039	0.035
STV	-11.719***	-11.695***	-11.465***	-11.618***	0.036	0.034
Malaysia						
ERW	-14.190***	-14.165***	-1.439	-2.838*	0.046	0.044
KLR	-12.952***	-12.951***	-1.537	-2.979**	0.062	0.043
STV	-13.228***	-13.203***	-4.871***	-12.188***	0.054	0.040
Philippines						
ERW	-8.877***	-8.943***	-8.722***	-8.952***	0.122	0.047
KLR	-8.879***	-8.560***	-8.727***	-8.791***	0.250	0.049
STV	-12.042***	-12.017***	-1.098	-2.533	0.048	0.047
Singapore						
ERW	-14.768***	-14.761***	-2.383**	-11.997***	0.125	0.092
KLR	-11.821***	-12.040***	-1.400	-9.509***	0.820***	0.172**
STV	-12.236***	-12.236***	-1.432	-11.455***	0.126	0.060
Thailand						
ERW	-15.975***	-16.049***	-1.994**	-3.458**	0.138	0.027
KLR	-9.649***	-10.027***	-0.833	-2.006	0.512**	0.066
STV	-16.406***	-16.389***	-5.254***	-15.432***	0.065	0.033

Notes: $e_{i,t}$ is measured as the real exchange rate.

***, **, * indicate rejection of the null hypothesis at the 1%, 5% and 10%, respectively.

[a] The ADF/DF-GLS procedure test the null that H_0: $y_t \sim I(1)$ against the alternative H_a: $y_t \sim I(0)$.

[b] The KPSS procedure test null that H_0: $y_t \sim I(0)$ against the alternative H_a: $y_t \sim I(1)$.

Table 4
Unit Root tests for the Individual EMP Measures

	ADF test[a] without trend	ADF test[a] with trend	DF-GLS[a] without trend	DF-GLS[a] with trend	KPSS test[b] without trend	KPSS test[b] with trend
Latin America						
Argentina						
ERW	-8.179***	-8.178***	-7.810***	-8.126***	0.092	0.037
KLR	-12.778***	-13.541***	-12.672***	-13.404***	0.856***	0.113
STV	-11.893***	-12.004***	-11.878***	-12.027***	0.361*	0.087
Brazil						
ERW	-15.669***	-15.645***	-9.045***	-15.670***	0.048	0.034
KLR	-12.850***	-13.351***	-12.867***	-13.083***	0.725**	0.194**
STV	-5.990***	-6.304***	-5.879***	-5.985***	0.620**	0.207**
Chile						
ERW	-16.399***	-16.396***	-1.808*	-9.720***	0.215	0.154**
KLR	-14.261***	-14.614***	-9.342***	-10.171***	0.743***	0.136*
STV	-13.716***	-13.826***	-0.976	-2.782*	0.488	0.078
Mexico						
ERW	-14.511***	-14.478***	-14.200***	-14.445***	0.047	0.047
KLR	-14.798***	-14.779***	-8.652***	-14.511***	0.071	0.045
STV	-14.837***	-14.817***	-8.740***	-14.541***	0.068	0.044

Notes: $e_{i,t}$ is measured as the real exchange rate.

***, **, * indicate rejection of the null hypothesis at the 1%, 5% and 10%, respectively.

[a] The ADF/DF-GLS procedure test the null that H_0: $y_t \sim I(1)$ against the alternative H_a: $y_t \sim I(0)$.

[b] The KPSS procedure test null that H_0: $y_t \sim I(0)$ against the alternative H_a: $y_t \sim I(1)$.

Table 5

Number and Proportion of crisis episodes according to the ERW method

		Country-Specific Standard Deviation and Mean															
		• + 1.5•				*• + 2.0•*				*• + 2.5•*				*• + 3.0•*			
	n	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*3-month window*	*Incidence*	*6-month window*	*Incidence*
East Asia																	
Indonesia	222	3	1.4	2	0.9	3	1.4	1	0.5	2	0.9	1	0.5	2	0.9	1	0.5
Korea	222	3	1.4	3	1.4	1	0.5	1	0.5	1	0.5	1	0.5	1	0.5	1	0.5
Malaysia	222	7	3.2	5	2.3	3	1.4	2	0.9	3	1.4	2	0.9	2	0.9	2	0.9
Philippines	222	9	4.1	8	3.6	8	3.6	7	3.2	6	2.7	5	2.3	4	1.8	4	1.8
Singapore	222	5	2.3	5	2.3	3	1.4	3	1.4	2	0.9	2	0.9	1	0.5	1	0.5
Thailand	222	6	2.7	5	2.3	4	1.8	3	1.4	3	1.4	2	0.9	1	0.5	1	0.5
Latin America																	
Argentina	222	2	0.9	2	0.9	2	0.9	2	0.9	2	0.9	2	0.9	1	0.5	1	0.5
Brazil	222	3	1.4	3	1.4	3	1.4	3	1.4	2	0.9	2	0.9	2	0.9	2	0.9
Chile	222	5	2.3	4	1.8	5	2.3	4	1.8	2	0.9	1	0.5	1	0.5	1	0.5
Mexico	222	6	2.7	6	2.7	4	1.8	4	1.8	3	1.4	3	1.4	1	0.5	1	0.5

Note: **$e_{i,t}$ is measured as the real exchange rate.**

Table 6

Number and Proportion of crisis episodes according to the KLR method

		Country-Specific Standard Deviation and Mean															
		• + 1.5•				*• + 2.0•*				*• + 2.5•*				*• + 3.0•*			
	n	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*3-month window*	*Incidence*	*6-month window*	*Incidence*
East Asia																	
Indonesia	223	5	2.2	4	1.8	4	1.8	3	1.3	2	0.9	1	0.4	2	0.9	1	0.4
Korea	224	6	2.7	6	2.7	2	0.9	2	0.9	1	0.4	1	0.4	1	0.4	1	0.4
Malaysia	225	6	2.7	4	1.8	4	1.8	3	1.3	3	1.3	2	0.9	3	1.3	2	0.9
Philippines	225	9	4.0	8	3.6	6	2.7	6	2.7	4	1.8	4	1.8	2	0.9	2	0.9
Singapore	225	4	1.8	4	1.8	3	1.3	3	1.3	2	0.9	2	0.9	1	0.4	1	0.4
Thailand	225	6	2.7	5	2.2	5	2.2	4	1.8	2	0.9	2	0.9	1	0.4	1	0.4
Latin America																	
Argentina	225	2	0.9	2	0.9	2	0.9	2	0.9	1	0.4	1	0.4	1	0.4	1	0.4
Brazil	225	4	1.8	4	1.8	3	1.3	3	1.3	2	0.9	2	0.9	1	0.4	1	0.4
Chile	225	7	3.1	5	2.2	3	1.3	2	0.9	2	0.9	2	0.9	1	0.4	1	0.4
Mexico	225	7	3.1	7	3.1	5	2.2	5	2.2	1	0.4	1	0.4	1	0.4	1	0.4

Note: **$e_{i,t}$ is measured as the real exchange rate.**

Table 7

Number and Proportion of crisis episodes according to the STV method

		Country-Specific Standard Deviation and Mean															
		• + 1.5•				*• + 2.0•*				*• + 2.5•*				*• + 3.0•*			
	n	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*3-month window*	*Incidence*	*6-month window*	*Incidence*
East Asia																	
Indonesia	223	4	1.8	3	1.3	4	1.8	3	1.3	4	1.8	3	1.3	4	1.8	3	1.3
Korea	224	3	1.3	3	1.3	2	0.9	2	0.9	1	0.4	1	0.4	1	0.4	1	0.4
Malaysia	225	9	4.0	6	2.7	5	2.2	3	1.3	2	0.9	2	0.9	2	0.9	2	0.9
Philippines	225	8	3.6	7	3.1	7	3.1	6	2.7	7	3.1	6	2.7	5	2.2	4	1.8
Singapore	225	8	3.6	7	3.1	3	1.3	2	0.9	1	0.4	1	0.4	1	0.4	1	0.4
Thailand	225	5	2.2	4	1.8	3	1.3	2	0.9	2	0.9	1	0.4	2	0.9	1	0.4
Latin America																	
Argentina	226	3	1.3	3	1.3	2	0.9	2	0.9	2	0.9	2	0.9	2	0.9	2	0.9
Brazil	225	3	1.3	3	1.3	3	1.3	3	1.3	3	1.3	3	1.3	3	1.3	3	1.3
Chile	225	9	4.0	8	3.6	6	2.7	5	2.2	4	1.8	3	1.3	4	1.8	3	1.3
Mexico	226	7	3.1	7	3.1	5	2.2	5	2.2	1	0.4	1	0.4	1	0.4	1	0.4

Note: **$e_{i,t}$ is measured as the real exchange rate.**

Table 8

Number of monthly episodes of crises and incidence of crises using the extreme value theory and ERW methods.

		Extreme Value Theory (EVT)					*Conventional Method*			
							Country-Specific Standard Deviation and Mean • + 1.5•			
		Optimal	*No. of Crises Episodes*		*No. of Crises Episodes*		*3-month*		*6-month*	
	n	*k*	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*window*	*Incidence*	*window*	*Incidence*
East Asia	1332		102	7.7	82	6.2	33	2.5	27	2.0
Indonesia	222	19	13	5.9	11	5.0	3	1.4	1	0.5
Korea	222	30	21	9.5	17	7.7	3	1.4	3	1.4
Malaysia	222	25	19	8.6	13	5.9	7	3.2	5	2.3
Philippines	222	21	14	6.3	11	5.0	9	4.1	8	3.6
Singapore	222	25	18	8.1	15	6.8	5	2.3	5	2.3
Thailand	222	25	17	7.7	15	6.8	6	2.7	5	2.3
Latin America	888		66	7.4	51	5.7	16	1.8	15	1.7
Argentina	222	39	21	9.5	15	6.8	2	0.9	2	0.9
Brazil	222	18	12	5.4	10	4.5	3	1.4	3	1.4
Chile	222	20	16	7.2	13	5.9	5	2.3	4	1.8
Mexico	222	25	17	7.7	13	5.9	6	2.7	6	2.7

Note: $e_{i,t}$ **is measured as the real exchange rate.**

Table 9

Number of monthly episodes of crises and incidence of crises using the extreme value theory and KLR methods.

		Extreme Value Theory (EVT)					*Conventional Method*			
							Country-Specific Standard Deviation and Mean • + 1.5•			
		Optimal	*No. of Crises Episodes*		*No. of Crises Episodes*		*3-month*		*6-month*	
	n	*k*	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*window*	*Incidence*	*window*	*Incidence*
East Asia	1347		91	6.8	74	5.5	36	2.7	31	2.3
Indonesia	223	26	16	7.2	13	5.8	5	2.2	4	1.8
Korea	224	14	12	5.4	11	4.9	6	2.7	6	2.7
Malaysia	225	21	15	6.7	12	5.3	6	2.7	4	1.8
Philippines	225	35	21	9.3	15	6.7	9	4.0	8	3.6
Singapore	225	29	18	8.0	16	7.1	4	1.8	4	1.8
Thailand	225	15	9	4.0	7	3.1	6	2.7	5	2.2
Latin America	900		60	6.7	50	5.6	20	2.2	18	2.0
Argentina	225	21	12	5.3	11	4.9	2	0.9	2	0.9
Brazil	225	41	20	8.9	15	6.7	4	1.8	4	1.8
Chile	225	20	15	6.7	13	5.8	7	3.1	5	2.2
Mexico	225	21	13	5.8	11	4.9	7	3.1	7	3.1

Note: $e_{i,t}$ **is measured as the real exchange rate.**

Table 10

Number of monthly episodes of crises and incidence of crises using the extreme value theory and STV methods.

		Extreme Value Theory (EVT)					*Conventional Method*			
							Country-Specific Standard Deviation and Mean • + 1.5•			
		Optimal	*No. of Crises Episodes*		*No. of Crises Episodes*		*3-month*		*6-month*	
	n	*k*	*3-month window*	*Incidence*	*6-month window*	*Incidence*	*window*	*Incidence*	*window*	*Incidence*
East Asia	1347		93	6.9	76	5.6	37	2.7	30	2.2
Indonesia	223	25	15	6.7	13	5.8	4	1.8	3	1.3
Korea	224	31	19	8.5	14	6.3	3	1.3	3	1.3
Malaysia	225	13	8	3.6	6	2.7	9	4.0	6	2.7
Philippines	225	21	12	5.3	10	4.4	8	3.6	7	3.1
Singapore	225	34	22	9.8	19	8.4	8	3.6	7	3.1
Thailand	225	21	17	7.6	14	6.2	5	2.2	4	1.8
Latin America	901		63	7.0	48	5.3	22	2.4	21	2.3
Argentina	226	31	15	6.6	11	4.9	3	1.3	3	1.3
Brazil	225	26	12	5.3	8	3.6	3	1.3	3	1.3
Chile	225	33	23	10.2	18	8.0	9	4.0	8	3.6
Mexico	225	20	13	5.8	11	4.9	7	3.1	7	3.1

Note: $e_{i,t}$ **is measured as the real exchange rate.**

Table 11
Crisis Episodes According to Conventional Method

Index	East Asia						Latin America			
	Indonesia	**Korea**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**	**Argentina**	**Brazil**	**Chile**	**Mexico**
ERW	July 1997 July 1998	Feb. 1989 June 1991 Nov. 1997	Feb.1985 April 1986 Jan. 1989 May, Dec. 1997	March 1985 Feb. 1986 March 1987 January, Sept. 1990 March 1995 July 1997 Nov. 2000	Sept. 1985 July 1988 Jan. 1991 Oct. 1997 May 1998	Feb. 1985 Sept. 1990 Jan. 1995 Feb., Sept. 1997	Jan. 1989 Feb. 1990	Jan., Dec. 1989 July 1994	March 1985 April 1989 March 1992 Jan. 1998	Aug. 1985 Dec. 1987 April, Dec. 1994 Nov. 1995 Sept. 1998
KLR	Dec. 1986 Aug. 1997 July 1998 Feb. 2001	March 1985 Jan. 1986 June 1991 Aug. 1996 March, Nov. 1997	Feb.1985 April 1986 May, Dec. 1997	March 1985 Feb. 1986 March 1987 Jan., Sept. 1990 March 1995 July 1997 Nov. 2000	Sept. 1985 Oct. 1997 May 1998 Oct. 1999	Feb.1985 Jan. 1995 Feb., Sept. 1997 June 1998	Jan. 1989 Feb. 1990	Jan. 1989 Feb. 1990 July 1994 Sept. 1998	March 1985 April 1989 April 1991 March 1993 Jan. 1998	Aug. 1985 Jan. 1988 March 1990 April, Dec. 1994 Nov. 1995 Sept. 1998
STV	Sept. 1986 Aug. 1997 May 1998	July 1986 Jan. 1988 Dec. 1997	March 1986 Oct. 1988 Dec. 1990 Dec. 1993 May, Dec. 1997	April 1985 Feb., Dec. 1986 Aug. 1990 March 1995 Aug. 1997 Nov. 2000	May 1987 Jan. 1990 June 1995 March, Oct. 1997 May 2000 Oct. 2001	Dec. 1985 July 1997 June 1998 Sept. 1999	April, Dec. 1989 Feb. 2002	Jan. 1989 Jan. 1990 May 1994	Feb., Dec. 1985 Dec. 1988 Nov. 1989 Oct. 1990 Nov. 1991 July 2001 Jan. 2003	Aug. 1985 Jan. 1988 March 1990 April, Dec. 1994 Nov. 1995 Sept. 1998

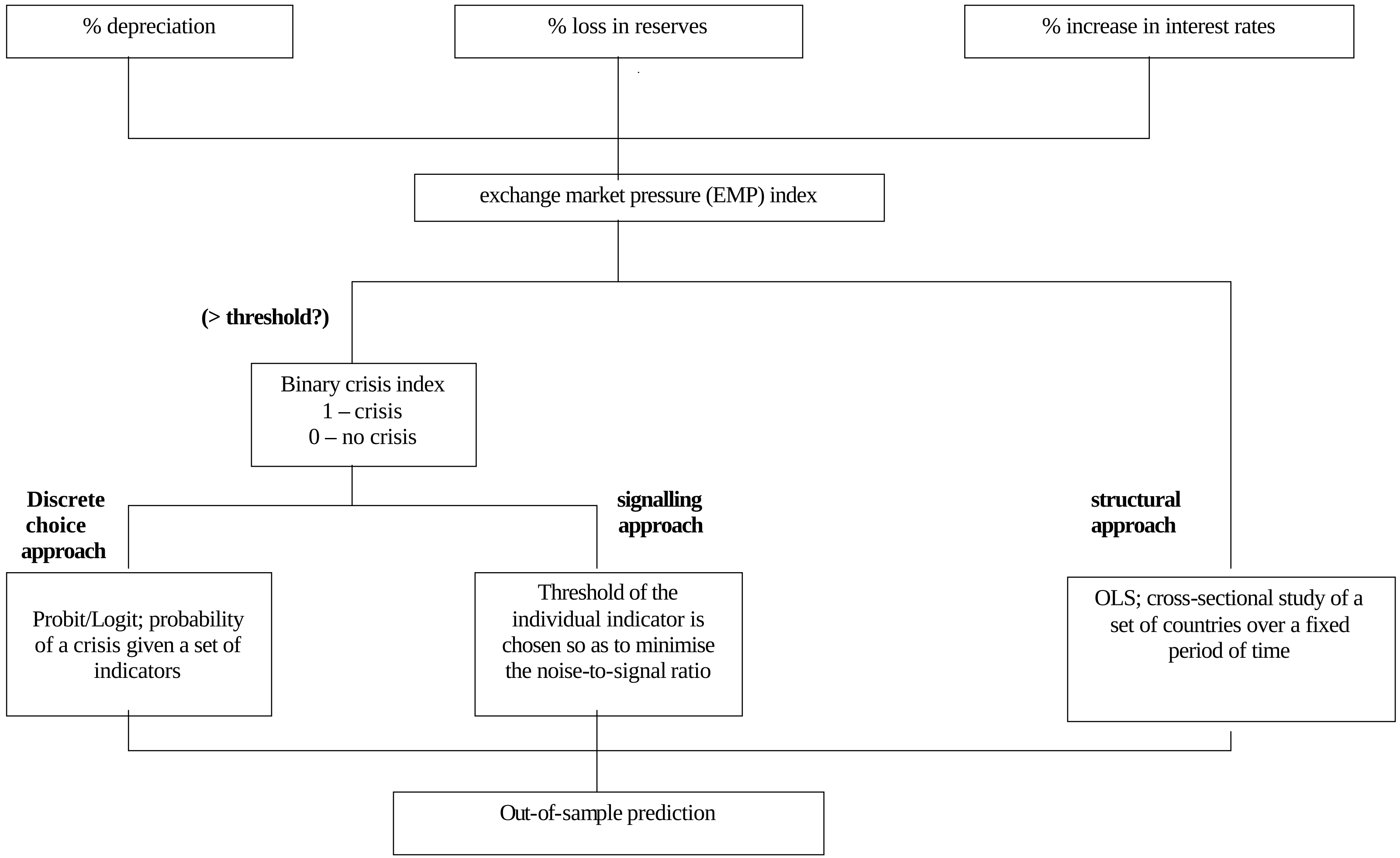
Notes: The actual dates of the crisis episodes were based on a 6-month exclusion window using 1.5 standard deviations above the mean.
See Pontines-Siregar (2004, forthcoming) for the corresponding chronologies of economic and political events.

Table 12
Crisis Episodes According to Extreme Value Theory (EVT)

	East Asia						Latin America			
Index	**Indonesia**	**Korea**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**	**Argentina**	**Brazil**	**Chile**	**Mexico**
ERW	March, Dec. 1986 July 1988 June 1989 Dec. 1992 Feb. 1995 Aug. 1997 April 1998 Dec. 1999 Dec. 2000 Dec. 2001	March 1985 January 1986 December 1987 December 1988 Sept. 1989 Sept. 1990 June 1991 Dec. 1992 Aug. 1994 Aug. 1996 March, Nov. 1997 Sept. 1998 January 2001 Sept. 2001 March 2003	Feb., Nov. 1985 Aug. 1986 Feb. 1988 Jan. 1989 Jan. 1990 Aug. 1991 Dec. 1992 Jan. 1994 Jan., Sept. 1995 May, Dec. 1997	March, Oct. 1985 March 1987 Jan. 1990 Sept. 1990 May 1992 Oct. 1993 March 1995 July 1997 July 1998 Nov. 2000	Feb. 1985 Sept. 1985 May 1987 July 1988 April 1989 Jan. 1990 Jan. 1991 Jan. 1992 June 1995 Aug. 1997 May 1998 Jan. 1999 Dec. 1999 March 2001 Nov. 2001	Feb. 1985 Oct. 1985 Jan. 1987 April 1990 Dec. 1990 Dec. 1991 Dec. 1992 Dec. 1993 Jan. 1995 Feb., Dec. 1996 July 1997 June 1998 Oct. 1999 March 2003	June 1985 Nov. 1986 Jan. 1989 Sept. 1989 Feb. 1991 Jan. 1993 Jan. 1994 Oct. 1994 July 1995 Oct. 1998 July 1999 March 2001 Nov. 2001 June 2002 March 2003	April 1986 Dec. 1987 Jan., Nov. 1989 July 1994 Oct. 1997 Sept. 1998 Dec. 1999 Dec. 2001 Aug. 2002	March 1985 Aug. 1987 April 1989 April 1990 Nov. 1991 Aug. 1992 March 1993 Feb. 1995 Sept. 1995 Dec. 1997 July 2001 June 2002 June 2003	July 1985 June 1986 Dec. 1987 Nov. 1988 Oct. 1989 Aug. 1991 Nov. 1993 Nov. 1994 Oct. 1995 Nov. 1996 Nov. 1997 Sept. 1998 June 2002
KLR	Feb., Sept. 1985 Nov. 1986 June 1987 July 1988 June 1989 April 1990 April 1994 Sept. 1995 Aug. 1997 April 1998 Feb., Nov. 2001	March 1985 Jan. 1986 March, Dec. 1987 Feb. 1989 April 1990 June 1991 Aug. 1994 Aug. 1996 March, Nov. 1997	Feb., Nov. 1985 Aug. 1986 Feb., Sept. 1988 Dec. 1992 Dec. 1994 Sept. 1995 April, Nov. 1997 June 1998 March 2001	March, Oct. 1985 Sept. 1987 Oct. 1988 July 1989 March, Nov. 1990 May 1992 May 1993 Feb. 1995 July 1997 July 1998 July 2000 April 2001 March 2003	Feb., Sept. 1985 May, 1986 June 1988 March 1990 March 1991 March 1992 March 1994 March 1996 Oct. 1997 May 1998 Feb., Oct. 1999 July 2000 March 2001 Jan. 2002	Feb., Oct. 1985 April 1990 Jan. 1995 Feb., Sept. 1997 June 1998	Jan. 1989 Feb. 1990 Feb. 1991 Sept. 1992 Jan., Oct. 1995 March 1999 Aug. 2000 March, Oct. 2001 May 2002	Jan., Aug. 1986 Jan. 1989 Feb. 1990 March 1991 July 1994 March 1995 April, Nov. 1997 June 1998 March, Oct. 1999 Oct. 2001 Aug. 2002 April 2003	March 1985 July 1986 Nov. 1988 April 1989 April 1991 March 1993 Sept. 1995 Dec. 1997 July 1998 June 1999 Sept. 2000 April 2001 June 2003	July 1985 June 1986 Dec. 1987 Sept. 1988 May 1989 March 1990 Nov. 1993 Nov. 1994 Oct. 1995 Nov. 1997 Sept. 1998
STV	Sept. 1986 June 1987 March 1988 June 1990 March 1991 Dec. 1996 Aug. 1997 May 1998 Jan., Aug. 1999 May 2000 Feb., Sept. 2001	Sept. 1985 April 1986 Nov. 1987 Aug. 1988 March 1989 Oct. 1989 June 1991 Nov. 1992 June 1993 June 1994 May 1996 March, Dec. 1997 Dec. 2000	March 1986 Oct. 1988 Dec. 1990 Dec. 1993 July 1997 June 1998	April 1985 Feb., Dec. 1986 Sept. 1989 Aug. 1990 Sept. 1992 Oct. 1993 March 1995 July 1997 Oct. 2000	Feb., Sept. 1985 May 1986 May 1987 Jan. 1990 March 1991 Jan. 1992 April, Nov. 1993 June 1995 Jan. 1996 Feb., Oct. 1997 May 1998 Dec. 1999 Sept. 2000 Oct. 2001 Sept. 2002 June 2003	Feb., Sept 1985 Dec. 1986 Dec. 1989 Jan. 1991 April 1992 March 1993 May 1994 Jan., Aug. 1995 July 1997 June 1998 Sept. 1999 July 2000	April 1985 Oct. 1987 May 1988 Feb., Dec. 1989 Dec. 1990 June 1995 Dec. 1996 June 2000 Sept. 2001 May 2002	May 1987 Jan., Dec. 1989 Dec. 1991 Oct. 1992 July 1993 Feb. 1994 June 2002	Feb., Dec. 1985 Oct. 1986 May 1987 April, Dec. 1988 Oct. 1989 July 1990 Nov. 1991 June 1992 May 1993 Aug. 1995 Oct. 1999 May 2000 March, Oct. 2001 June 2002 Jan. 2003	July 1985 July 1986 Dec. 1987 Sept. 1988 May 1989 March 1990 Nov. 1993 Nov. 1994 Oct. 1995 Nov. 1997 Sept. 1998

Notes: The actual dates of the crisis episodes were based on a 6-month exclusion window. See Pontines-Siregar (2004, forthcoming) for the corresponding chronologies of economic and political events.

Figure 1 : Approaches in building leading indicator models of currency crises



Source: Chui (2002).

Figure 2 Histogram of Country EMP (ERW) Measures and Corresponding Normal Probability Density Function (East Asia)

(a) with *ei,t* measured as the real exchange rate

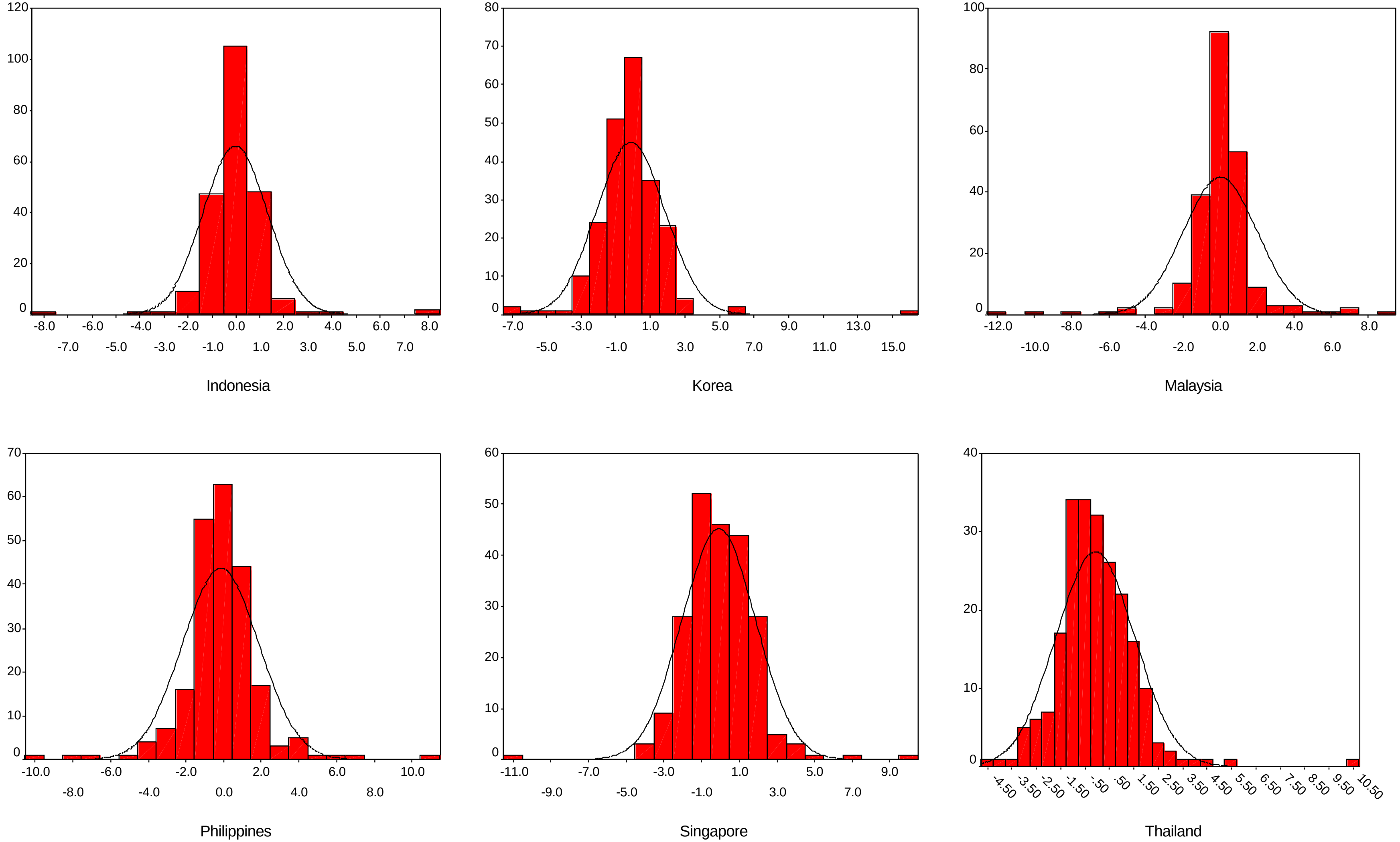


Figure 3 Histogram of Country EMP (ERW) Measures and Corresponding Normal Probability Density Function (Latin America)

(a) with *ei,t* measured as the real exchange rate

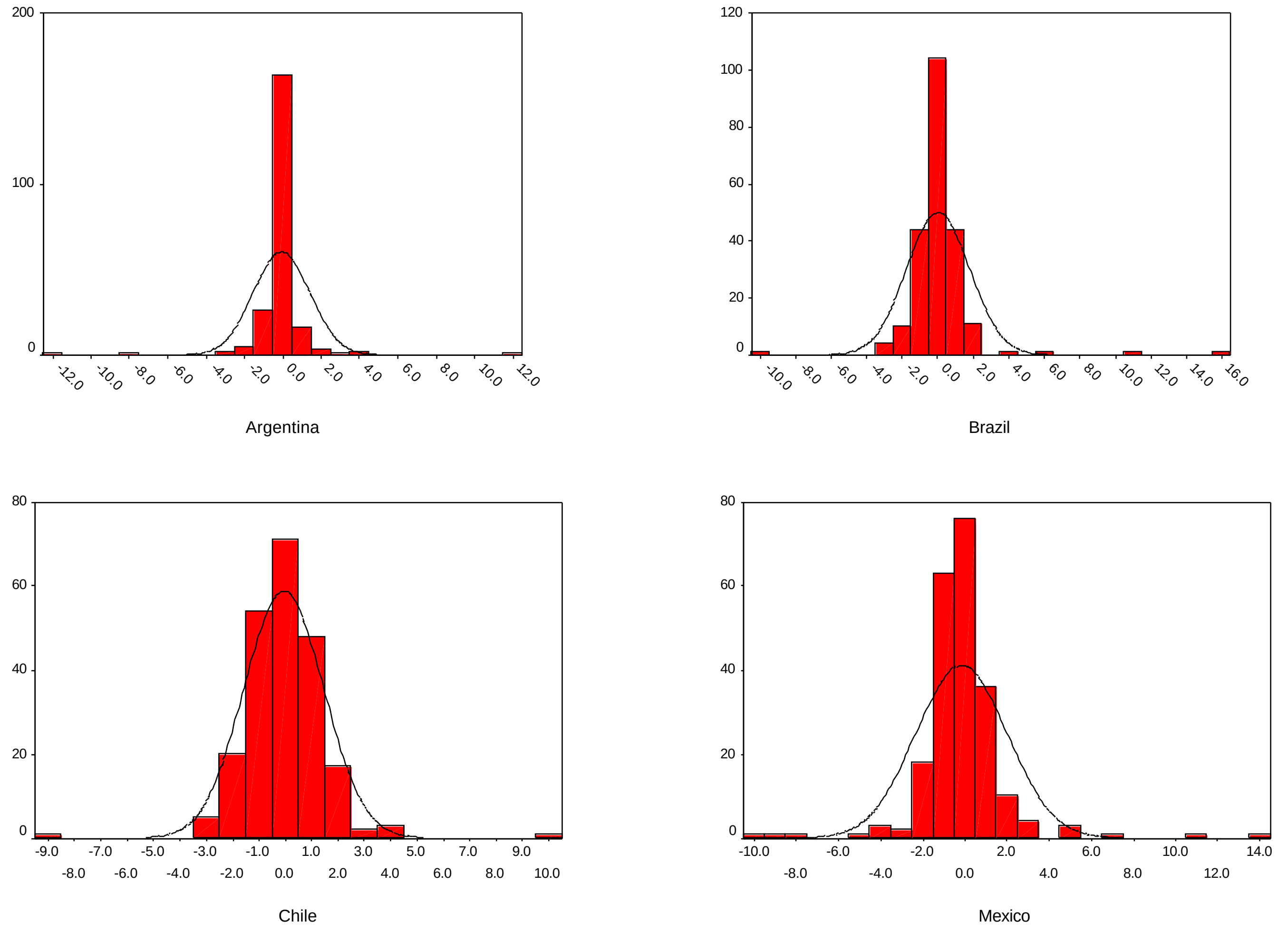


Figure 4 Histogram of Country EMP (KLR) Measures and Corresponding Normal Probability Density Function (East Asia)

(a) with *ei,t* measured as the real exchange rate

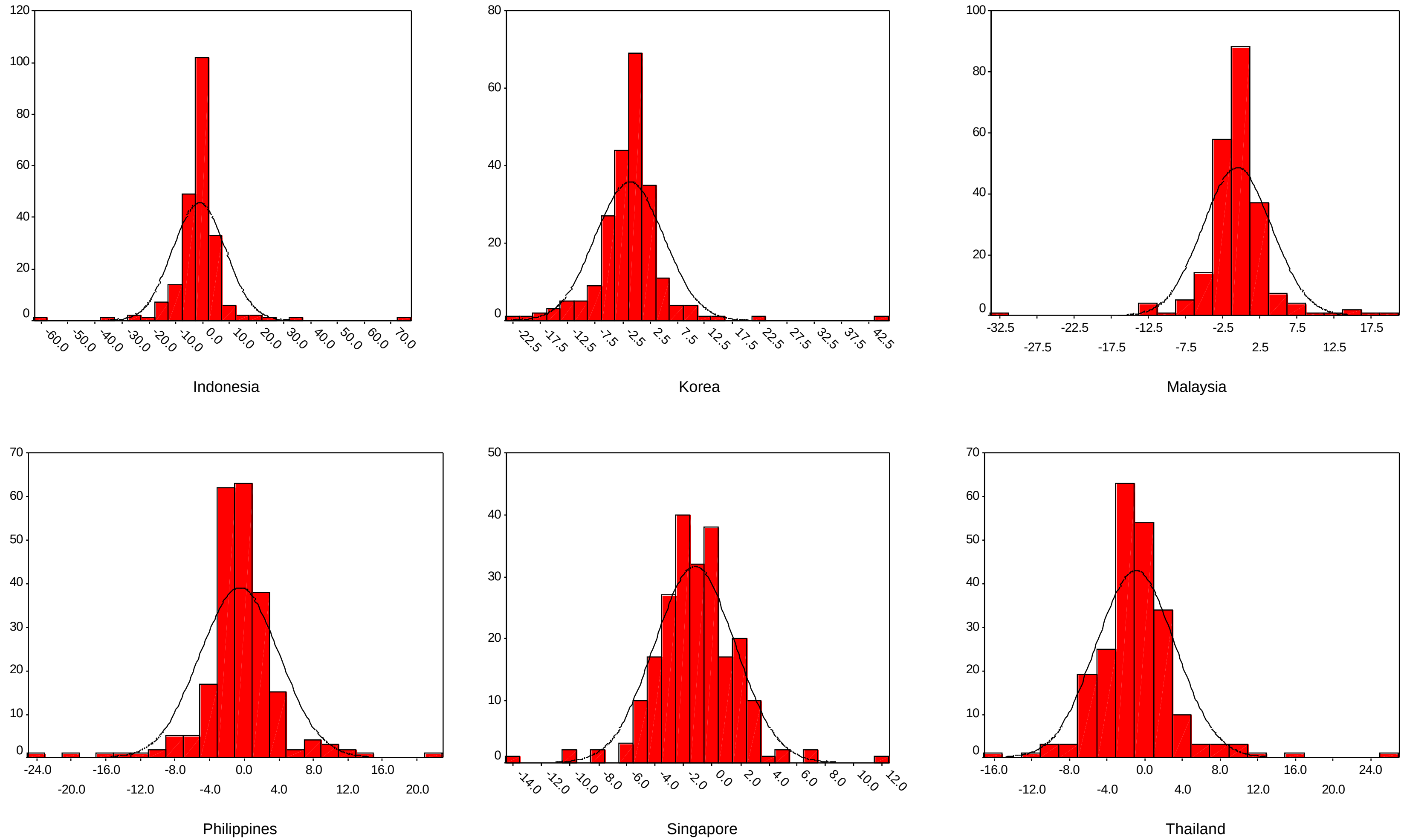


Figure 5 Histogram of Country EMP (KLR) Measures and Corresponding Normal Probability Density Function (Latin America)

(a) with *ei,t* measured as the real exchange rate

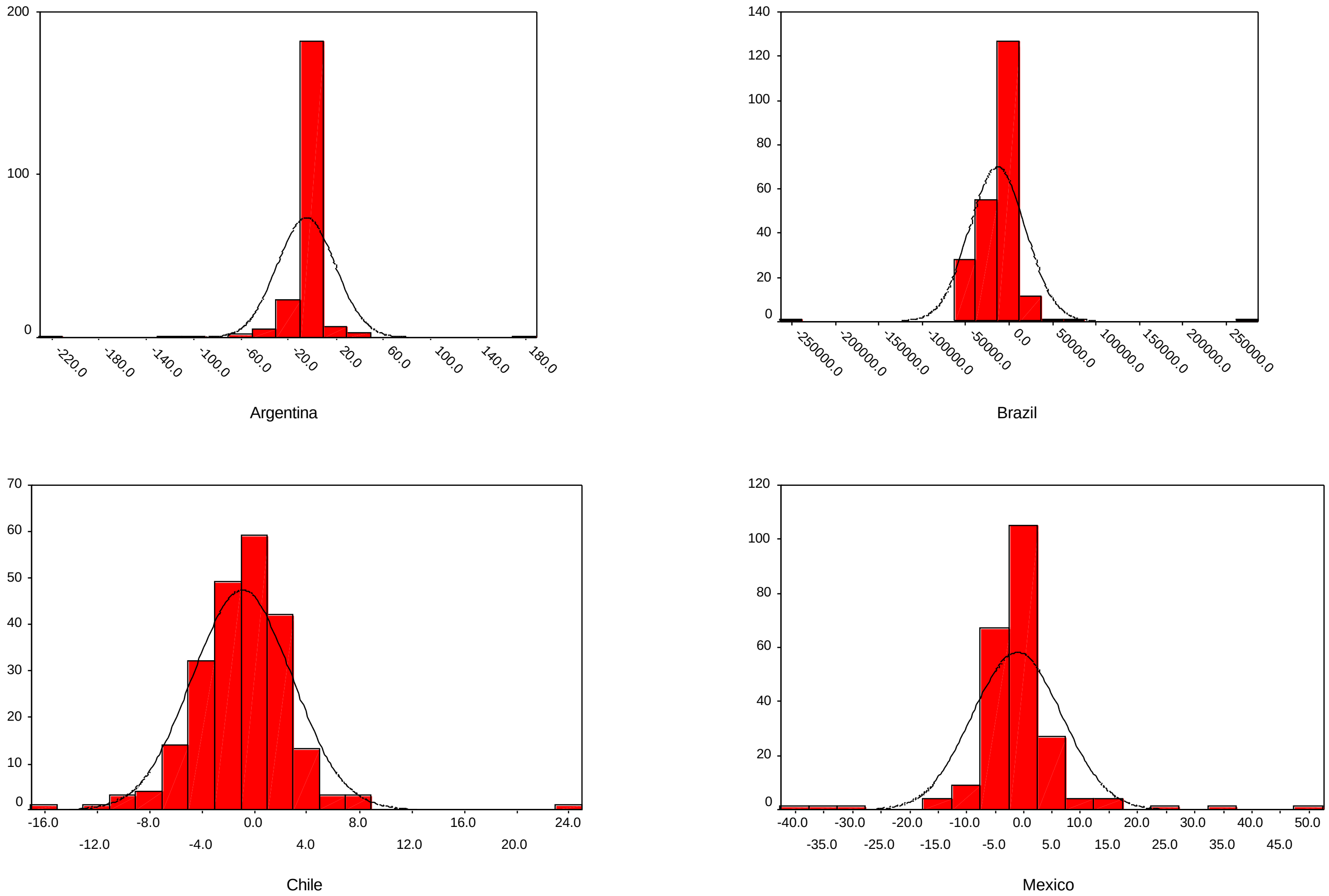
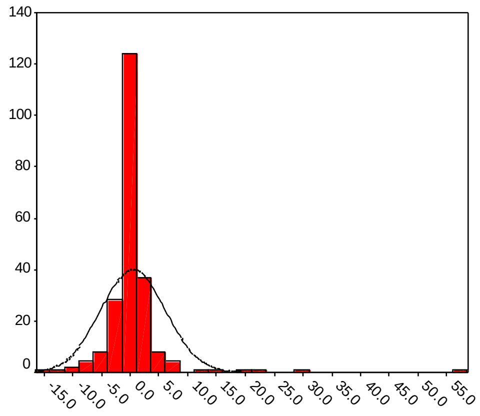
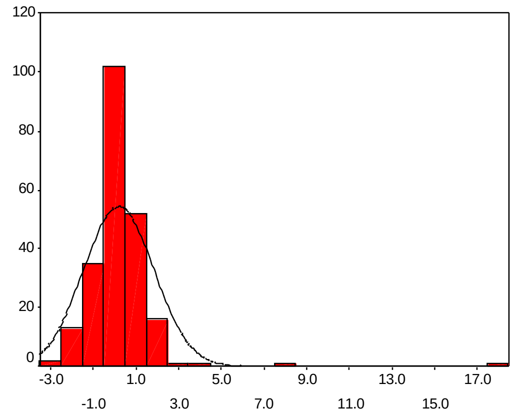


Figure 6 Histogram of Country EMP (STV) Measures and Corresponding Normal Probability Density Function (East Asia)

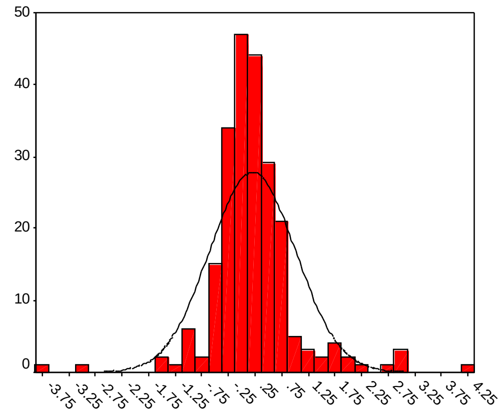
(a) with *ei,t* measured as the real exchange rate



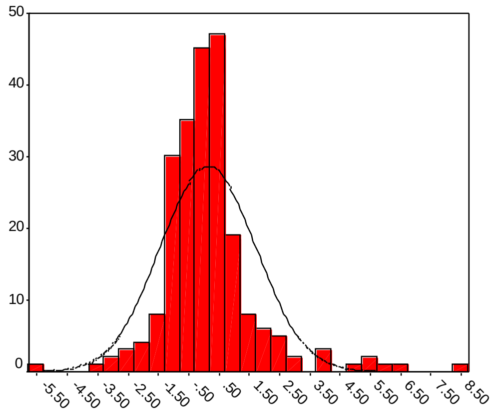
Indonesia



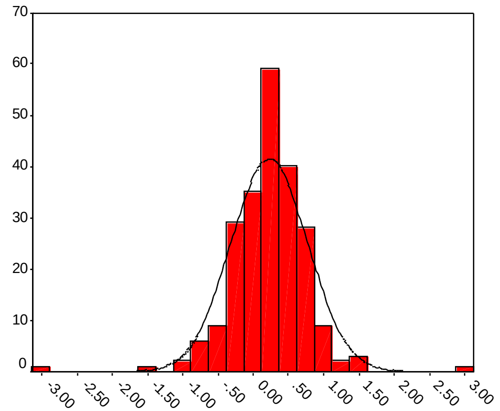
Korea



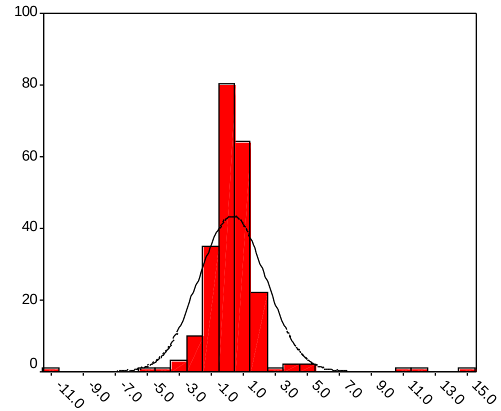
Malaysia



Philippines



Singapore



Thailand

Figure 7 Histogram of Country EMP (STV) Measures and Corresponding Normal Probability Density Function (Latin America)

(a) with *ei,t* measured as the real exchange rate

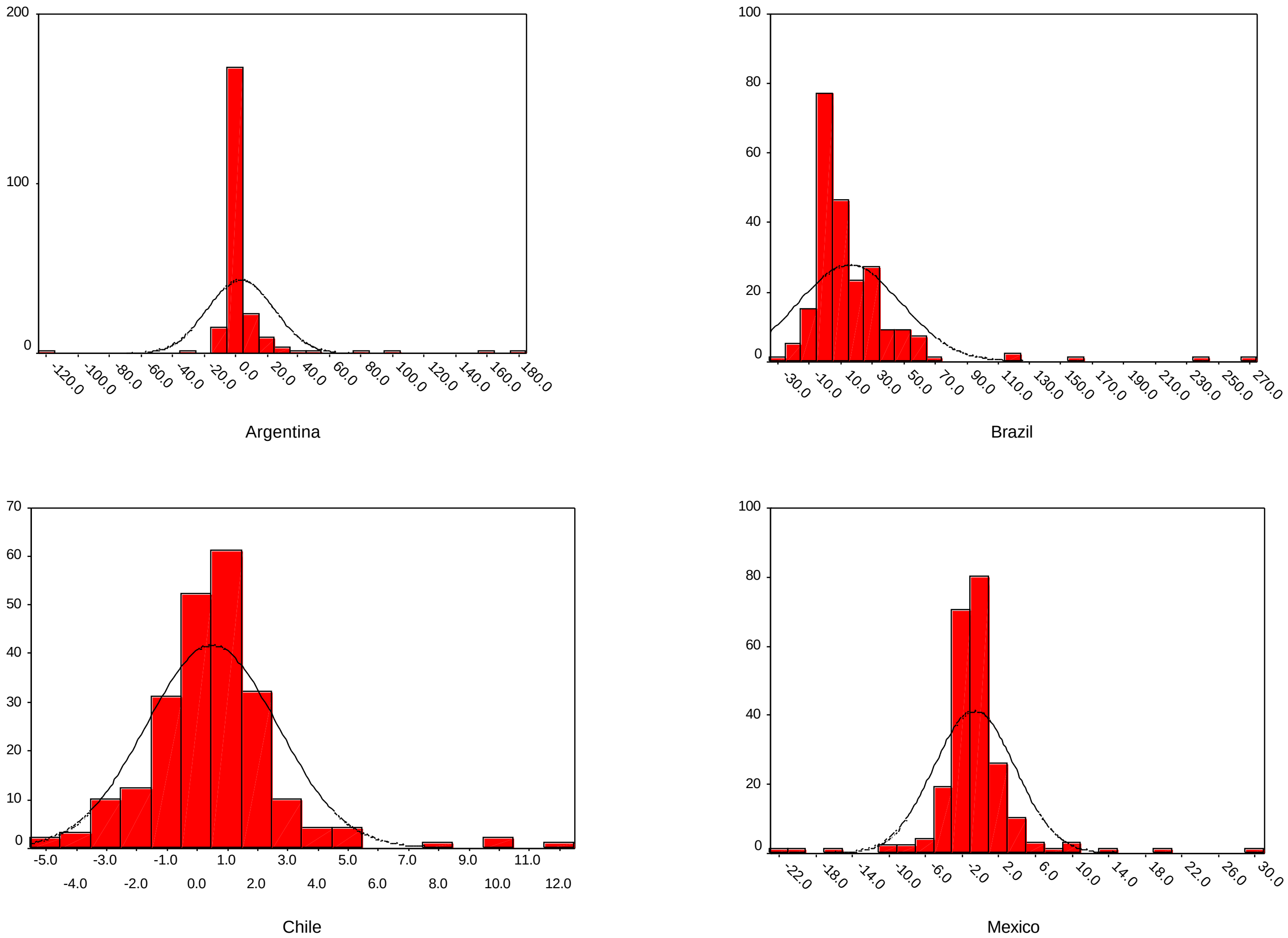


Figure 8 Recursive Residuals for East Asia using ERW as the EMP Measure

(a) with *ei,t* measured as the real exchange rate

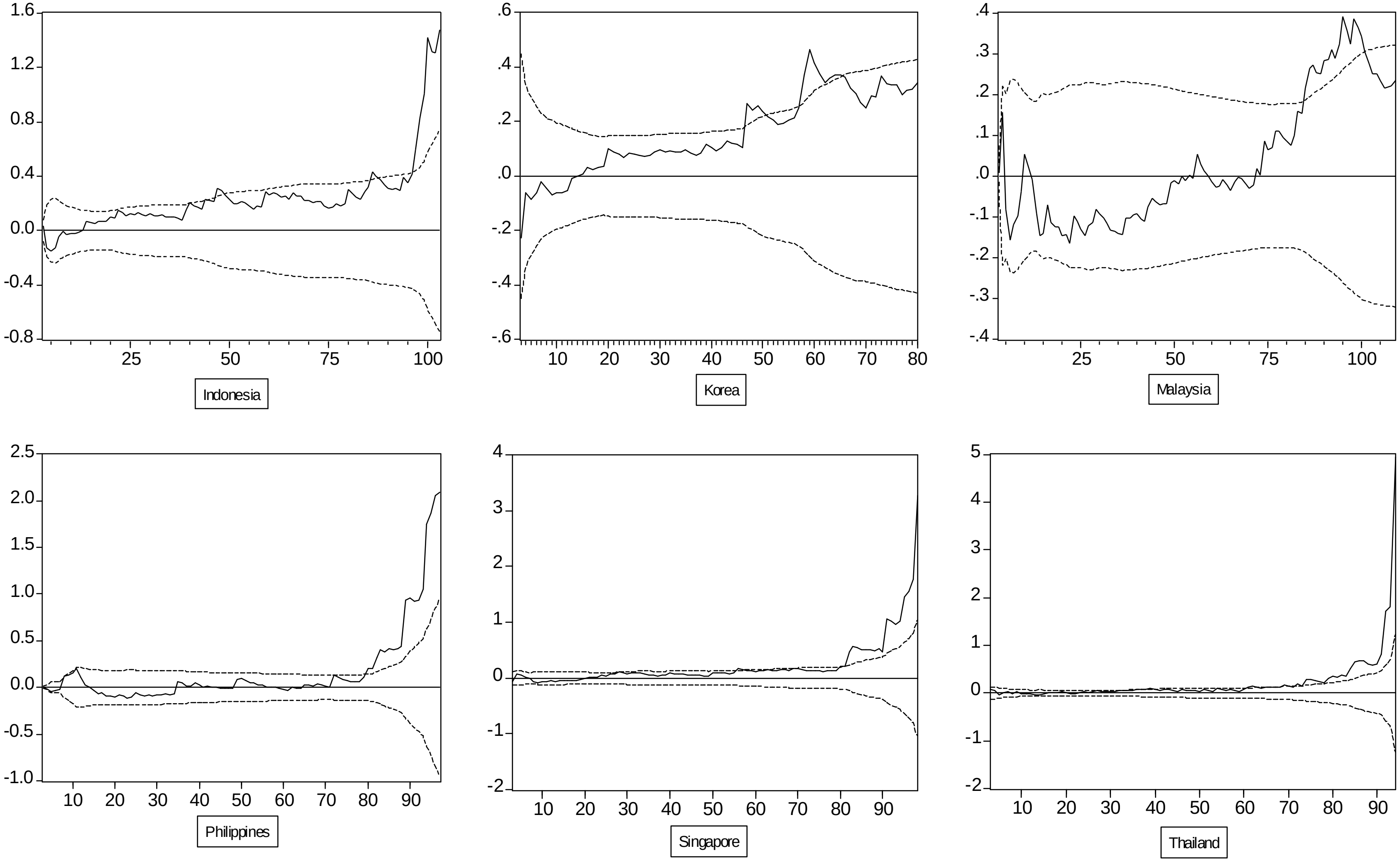


Figure 9 Recursive Residuals for Latin America using ERW as the EMP Measure

(a) with *ei,t* measured as the real exchange rate

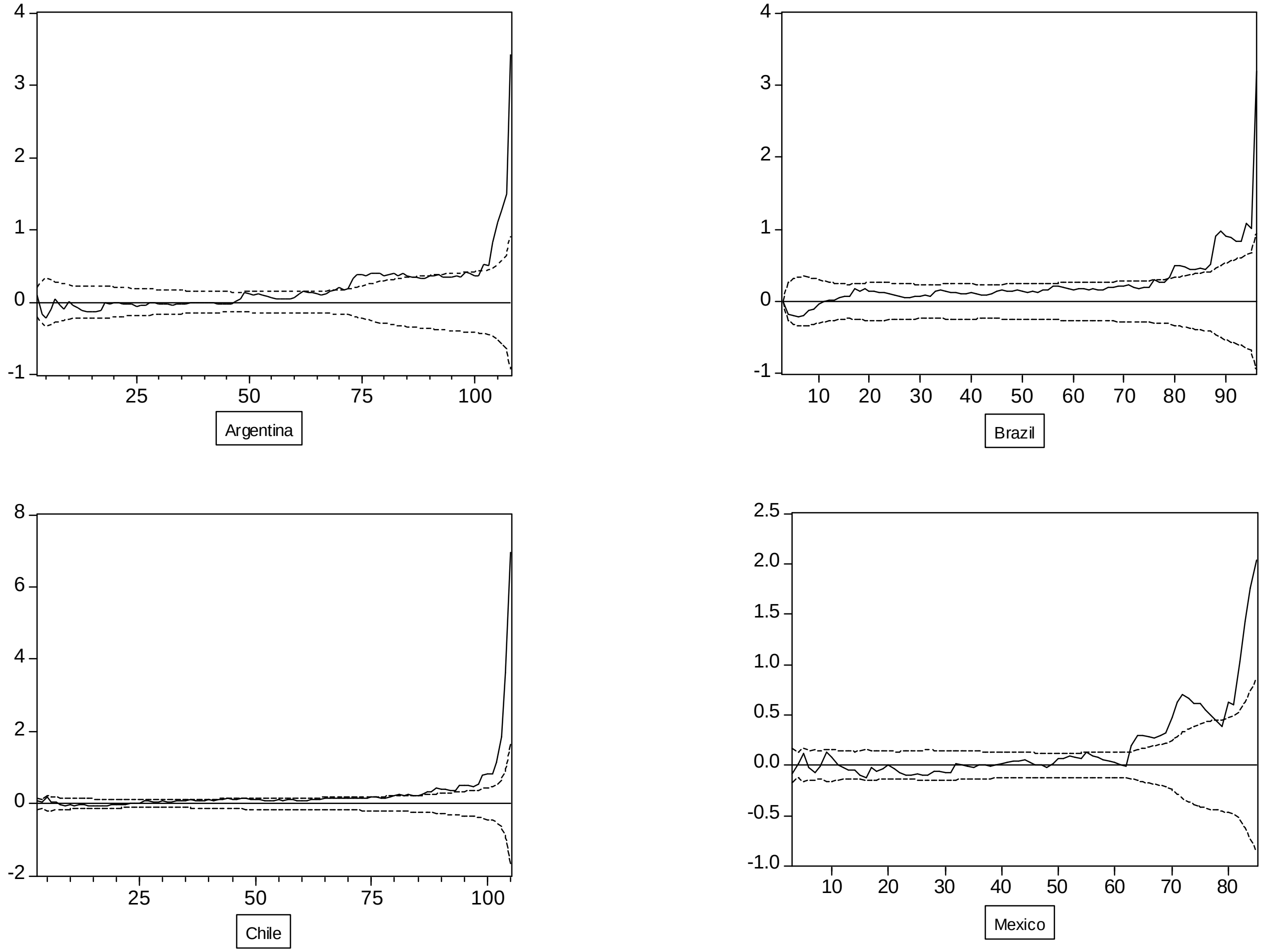


Figure 10 Recursive Residuals for East Asia using KLR as the EMP Measure

(a) with *ei,t* measured as the real exchange rate

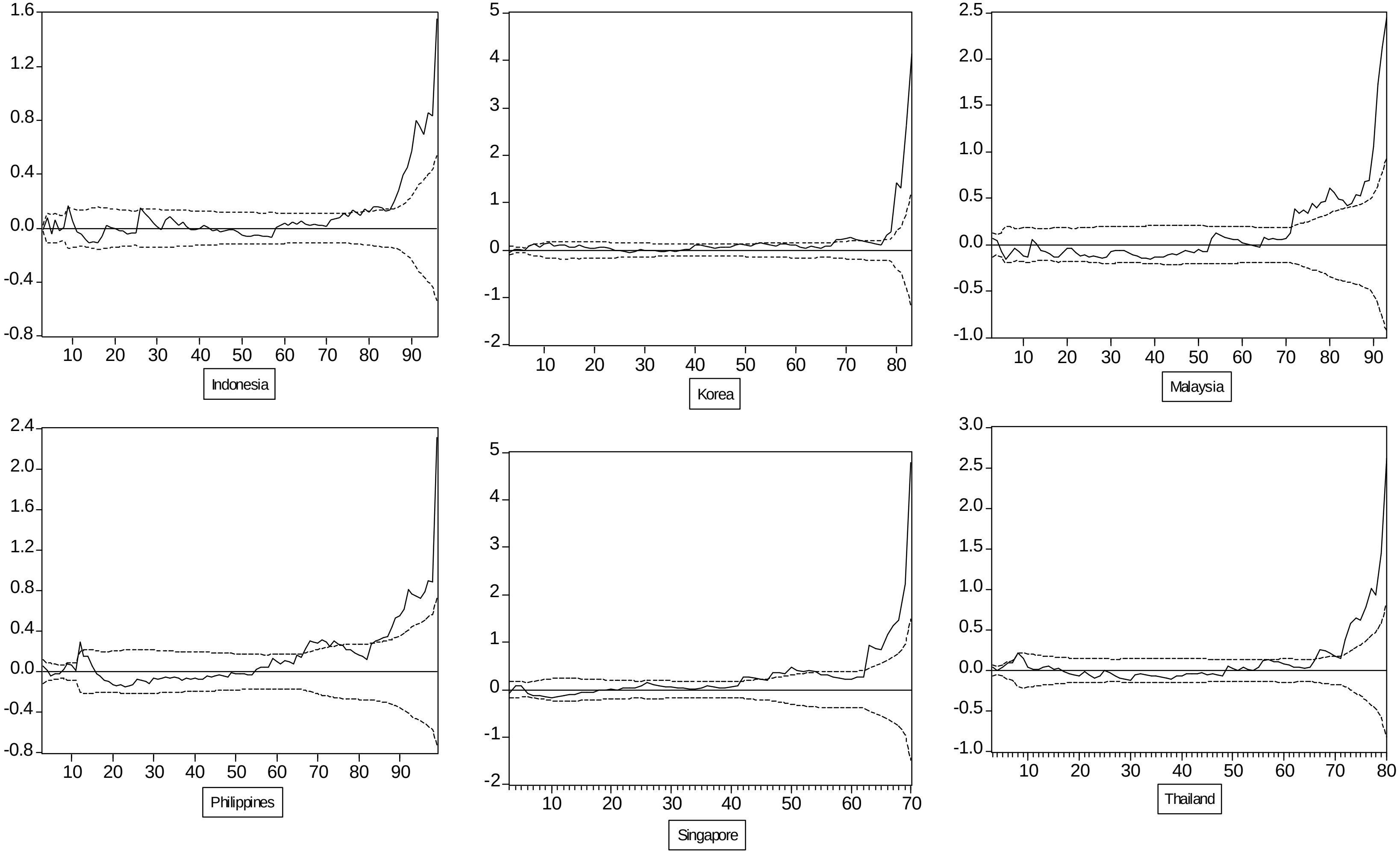


Figure 11   Recursive Residuals for Latin America using KLR as the EMP Measure

(a) with *ei,t* measured as the real exchange rate

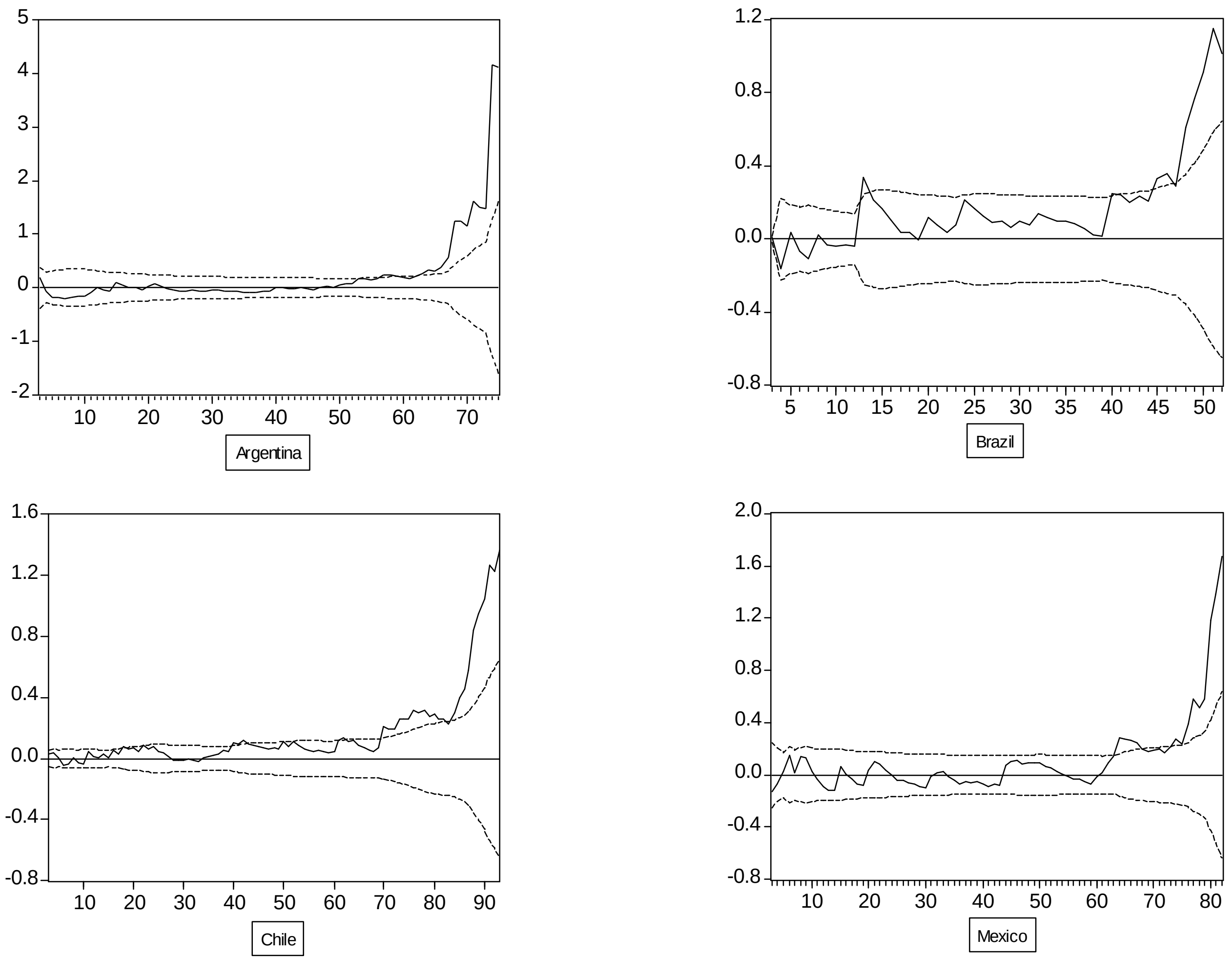


Figure 12 Recursive Residuals for East Asia using STV as the EMP Measure

(a) with *ei,t* measured as the real exchange rate

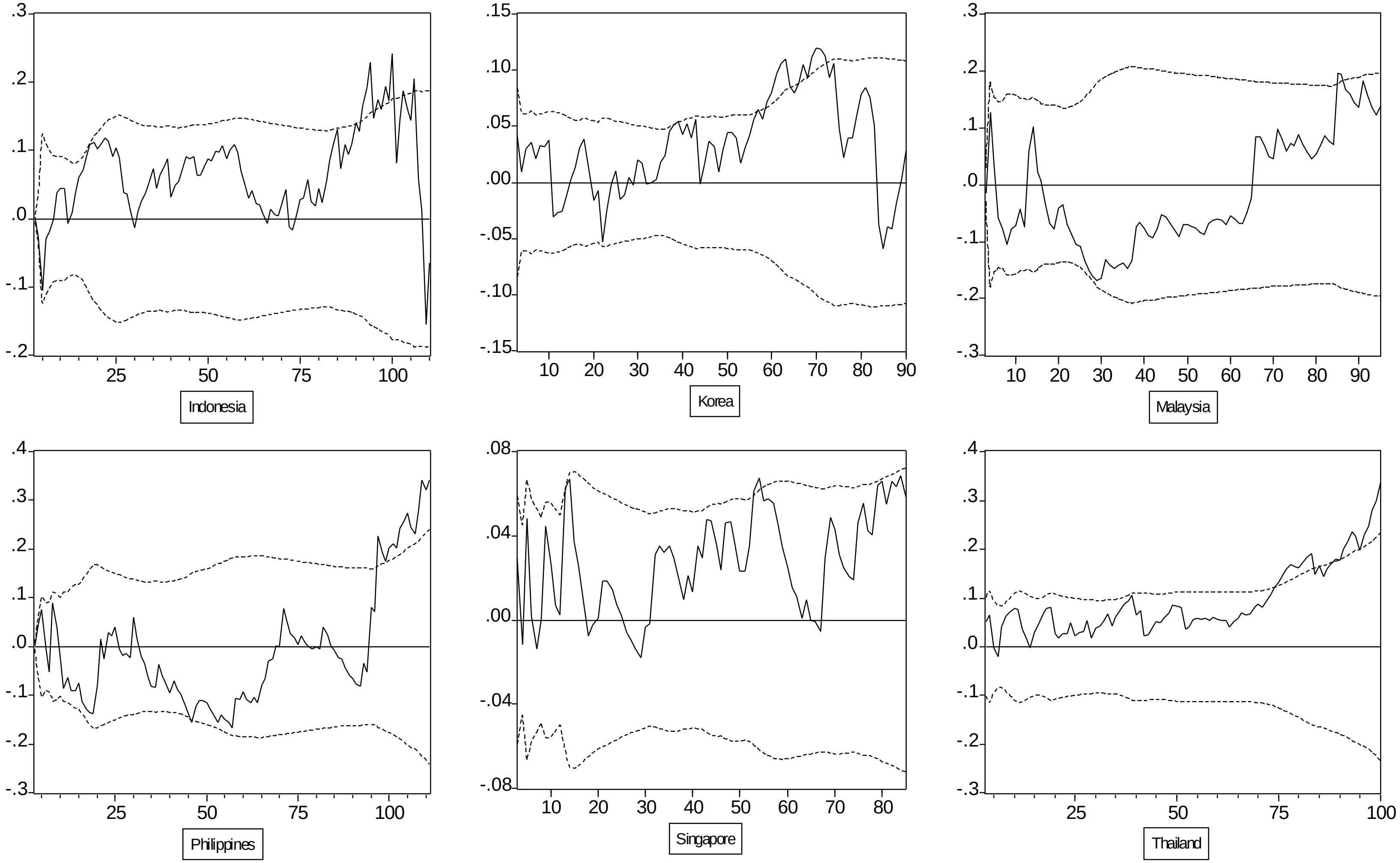


Figure 13 Recursive Residuals for Latin America using STV as the EMP Measure

(a) with *ei,t* measured as the real exchange rate