The role of economic fundamentals in the emergence of currency crises in emerging markets

Following the currency crises in some Asian emerging market economies, the question as to what causes such crises has once again become the focus of interest. Occasionally the responsibility for such crises is placed on speculative capital movements detached from macroeconomic fundamentals which attack currencies at random, so to speak; i. e., completely independently of whatever the economic surroundings happen to be at that particular time. This report refutes that at times quite stereotypical view by systematically and comprehensively studying the development of macroeconomic fundamentals in the run-up to currency turbulence in 12 countries over a period of more than 25 years. It also shows that macroeconomic misalignments from the past bear at least a significant share of the responsibility for most currency crises.

Preliminary remarks

Currency crises in Asia ...

The eruption of the currency crises in Asia in the summer of 1997 caught many observers by surprise. The immediate cause of the outbreak of the crises was the sudden emergence of doubts concerning the sustainability of Thailand's current account deficits, the export sector having been confronted with major sales problems owing to the plunge in world market prices for semiconductors. The massive pressure on the Thai baht triggered a confidence shock among international invest-

ors which at the same time also called the sustainability of some other countries' exchange rate peg to the dollar into question. Thus, within a few weeks, the Philippine peso, the Malaysian ringgit, and the Indonesian rupee were drawn into the devaluation spiral created by the Thai baht. Following repeated speculative attacks, the South Korean won also fell sharply towards the end of 1997. In the period thereafter, the situation deteriorated considerably, which meant that the currencies involved fell to all-time lows against the US dollar in the first half of 1998. Compared with exchange rates of June 1997, the value of the Indonesian rupee had sunk by a maximum of over 80 % by the spring of 1998; the losses sustained by the currencies of Thailand, Malaysia, the Philippines and South Korea were between 35 % and 50 %.

... led to burdens on the real economy

Due to the relatively sizeable short-term external indebtedness, denominated in foreign currency, as well as the sudden disruptions to the exchange rate relations, the turbulence in the foreign-exchange markets spilled over quickly to the banking systems (which in some countries were already fragile to begin with) and to the real economy. The devaluations and slump in share prices intensified by the withdrawal of international lenders and residents' capital exports led to considerable losses in assets. Furthermore, the slumping growth in those countries generated considerable political and social tension. From 1986 to 1996 Thailand, Indonesia, Malaysia and South Korea had annual growth rates averaging over 7 %; in 1998, however, real GDP shrank considerably in those countries. Over the past year, the decline in GDP in Thailand, Malaysia and South Korea ranged from 6½ % to 8 %; in Indonesia, this figure was even as high as 15 %. The sharp rise in import prices caused by devaluation, but also the fact that implementation of the necessary stabilisation measures was insufficient at first, caused inflationary risks to increase as well. In most of those countries, though, inflation picked up much less strongly than was originally feared. However, Indonesia formed the exception, its inflation rate jumping from single digits to approximately 60 %.

... and rising inflation

Cause: speculative movements or ...

Opinions diverge greatly on the determinants of the Asian currency crises. On the one hand, many argue that the fundamental economic data of those economies prior to the outbreak of the crisis were no cause for worry and that the crises were more likely attributable to speculative movements completely detached from macroeconomic factors. At all events, none of those countries pursued an excessively expansionary fiscal policy financed by printing money, which, according to standard theories, would have been an important factor explaining currency crises. On the contrary, the government budgets of Thailand, Malaysia and Indonesia were even running surpluses before the crises. Moreover, those countries had been showing strong growth rates for several years, and inflation was fairly restrained compared with other developing countries; therefore, for some time those countries were even regarded as a model for successful development processes.

... fundamental imbalances

On the other hand, rising current account deficits were pointing to increasing competi-

tive problems. As long as the excessively booming securities and real-estate markets of those countries and the – in some cases – foreign-exchange-rate-oriented domestic monetary policy were ensuring ample inflows of foreign capital, though, "bankrolling" those deficits did not appear to be a problem. The short-term nature of the incoming capital from abroad, though, also magnified the danger of setbacks and sudden capital withdrawals. The risk potential was increased also by the fact that a large portion of this capital was denominated in foreign exchange and flowed into those countries upon confidence in an alleged exchange rate guarantee for those domestic currencies vis-à-vis the US dollar. To make matters worse, the problem was not completely understood by lenders for a long time because there was insufficient transparency in the banking systems of many emerging market economies, which were insufficiently supervised. Only when the persistent strength of the dollar threatened to severely weaken the competitiveness of many South-East Asian countries (owing to the pegging of their currencies to the dollar), which are strongly dependent on exports, and enterprises and banks were increasingly encountering difficulties, did the market participants become more and more aware of the risks.

Selected economic data

Country	1986–96	1995	1996	1997	1998
	Growth (% per year)				
Thailand	9.1	8.8	5.5	– 0.4	– 8.0
Malaysia	7.8	9.5	8.6	7.8	– 6.4
Philippines	3.7	4.8	5.7	5.1	– 0.6
Indonesia	7.4	8.2	8.0	4.6	– 15.0
South Korea	8.6	8.9	7.1	5.5	– 7.0
	Inflation (% per year)				
Thailand	4.5	5.8	5.9	5.6	9.0
Malaysia	2.6	3.4	3.5	2.7	6.0
Philippines	8.9	8.1	8.4	6.0	10.0
Indonesia	8.2	9.4	7.9	6.6	60.0
South Korea	5.7	4.5	4.9	4.4	8.5
	Balance on current account (as a % of GDP)				
Thailand	– 4.9	– 7.9	– 7.9	– 2.0	10.7
Malaysia	– 2.6	– 10.0	– 4.9	– 4.8	6.5
Philippines	– 2.5	– 4.4	– 4.7	– 5.2	– 1.5
Indonesia	– 2.8	– 3.3	– 3.3	– 1.8	2.5
South Korea	0.9	– 1.9	– 4.7	– 1.8	12.9

Source: IMF.

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The term "currency turbulence" and its definition

Systematic analysis

The following empirical analysis of the economic fundamentals prior to currency turbulence spans a period between January 1970 and June 1997. It includes 12 emerging market economies which for the most part have been classified by the World Bank as middle-income countries and which have a sufficiently well-developed domestic financial system and a somewhat liberal capital account. These countries are Argentina, Brazil, Chile, Indonesia, South Korea, Malaysia, Mexico, the Philippines, South Africa, Thailand, Uruguay and Venezuela. For this relatively homogeneous group of countries, the development of selected fundamentals in the year prior to the onset of currency turbulence ("run-up period") was compared to that in periods of tranquillity.

Operationalisation of the term "currency turbulence"

To make such a comparison, it is necessary at first to operationalise the term "currency turbulence". That means a catalogue containing

a sufficient number of such crisis phases in the selected countries must be compiled. There are basically two possible approaches. One is to compile a catalogue of currency turbulence according to how it is judged by economic history in that particular country. The other is to identify currency turbulence using a pressure indicator constructed for precisely that purpose.

Collecting episodes by studying the literature

The compilation of a catalogue of crises using the first of the two methods would have the disadvantage that this relatively historically based selection method would not be neutral in its judgement of the outcome of the crisis. Speculative attacks that have been warded off relatively quickly and successfully are generally given considerably less attention, historically speaking, than more protracted crises which in the end led to a sharp devaluation of the currencies involved. Hence, there would be the danger that the study would ultimately be limited to a certain category of currency turbulence and would therefore unnecessarily narrow the scope.

Developing a pressure indicator using crisis symptoms

Some recent scholarly papers have therefore proposed identifying turbulence in the foreign exchange markets using an indicator relying on the known symptoms of such episodes of currency turbulence:[1]

- an extremely sharp devaluation of the affected country's currency;
- plummeting foreign exchange reserves; and
- an abrupt rise in interest rates.

This study basically follows the aforementioned approach. However, since for many emerging economies there was often a lack of interest rate data having a sufficient quality, this variable was dropped. This procedure seems to be justified methodologically, since there is a close correlation between interest rate increases and foreign exchange market interventions to sustain exchange rates in times of speculative attacks.[2] The devaluation criterion here is based on the movement of the real (US dollar) exchange rate of the currencies under observation, since the economic environment in some of the emerging economies being studied here was characterised at times by high inflation. The pressure indicator used here is thus calculated as a weighted average of the percentage change of the real exchange rate and of the foreign exchange reserves (each vis-à-vis the previous month), with the weights corresponding to the ratio of the different variances of those two variables.[3]

Identification of currency crises

Speculative strains on a given currency cause the pressure indicator calculated in this manner to fluctuate sharply, since the exchange rate generally nose-dives and/or the foreign exchange reserves of the country in question are considerably depleted. A country's foreign

1 See, for example, Eichengreen, B. et al. (1995), Exchange Rate Mayhem, The Antecedents and Aftermath of Speculative Attacks, Economic Policy, Vol. 21, pages 249 to 312; Sachs, J.D. et al. (1996), Financial Crises in "Emerging Markets": The Lessons from 1995, Brookings Papers on Economic Activity, No. 1, pages 147 to 198; Kaminsky, G. et al. (1998), Leading Indicators of Currency Crises, IMF Staff Papers, Vol. 45, No. 1, pages 1 to 49.
2 See Corsetti, G. et al. (1998), Paper Tigers? A Model of the Asian Crisis, NBER Working Paper No. 6783, Cambridge, MA, page 22.
3 See Schnatz, B. (1998), Macroeconomic determinants of currency turbulences in emerging markets, Discussion paper 3/98, Economic Research Group of the Deutsche Bundesbank, for a more thorough description and critique of this calculation method.

exchange trends can thus be termed "currency turbulence" once the indicator has exceeded a given threshold. Here, this threshold has been set at 1.5 times the standard deviation of the indicator calculated for all countries. The extreme values of the indicator determined in this manner often show up at rather short intervals. This is a reflection of the fact that in many cases speculative attacks precede currency crises or that currency crises become exacerbated over time, as could be observed in several Asian countries. In order to be able to define the length of a currency crisis more precisely, the beginning of the crisis was set at the time where the pressure indicator crosses the critical threshold for the first time following a period of tranquillity. The end of a crisis is that time when the indicator remains below the threshold value for the following three quarters. Using this definition, a total of 49 cases of foreign exchange market turbulence were identified in the 12 countries concerned.

On selecting possible explanatory factors

Fundamental determinants of currency turbulence

In order to more precisely specify the explanatory approach, there are basically a number of fundamental determinants to choose from. For this study, seven factors were selected which in earlier studies proved to be relevant and quite robust against alternative specifications.[4] These factors are:

- the deviation of the real exchange rate from the trend;
- export growth,
- balance on current account as a percentage of GDP,
- foreign exchange reserves in terms of a broadly defined monetary aggregate,
- domestic credit growth (as a percentage of GDP),
- the inflation differential between the country in question and the US, and
- the international interest rate level, represented by the US money market rate.

Data frequency versus data availability

Restricting the study to those variables is the result of a compromise between capturing a broad range of determinants, the corresponding data availability and the desirable high frequency of data. In order to take account of the fast reactions in the financial markets, it seemed necessary to take recourse to data published at least monthly; even quarterly data may obscure much of the information used by foreign exchange market agents in their actions. Unfortunately, this means that some explanatory factors which do share some part of the responsibility for the currency crises of the past few years will have to be dropped owing to their low data frequency. They include, in particular, data on the composition, denomination and maturity structure of foreign debt. Moreover, in such an analysis there are also a number of other influencing factors of a more qualitative nature which are difficult to capture. Some of these are the institutional terms of the exchange rate regime and the underlying political, legal and cultural conditions. These limitations must be taken into account when interpreting the results presented here. In the final analysis, the results do not claim to comprehensively explain the evolution of currency turbulence, but are instead

4 Schnatz (1998), page 45 ff.

meant to classify important macroeconomic data within this context.

Comparison of mean values

A simple comparison of the mean values of the seven aforementioned macroeconomic variables in the period prior to the outbreak of currency crises with their mean values in periods of tranquillity may provide some clues. Specifically, the mean values of the variables during periods of tranquillity were compared with their corresponding mean values in the twelve months prior to the onset of a crisis.

Real exchange rate and export growth

Such a comparison of real exchange rates shows initially that those currencies tended to be overvalued prior to speculative attacks. In the case of Asia, too, the test calculations for most currencies usually point to such overvaluation prior to the outbreak of the crises.[5] Consequently, export growth generally declines visibly in the run-up to currency turbulence – including the period prior to the outbreak of the currency crises in Asia, when export growth of Thailand, Malaysia and South Korea declined noticeably over past levels. Taken as an average of all cases of currency turbulence, export growth in the run-up period was down by more than ten percentage points over its level in tranquil phases. Current-account deficits, too, were around 1% of GDP higher in the periods prior to currency turbulence than in periods of tranquillity; in most of the Asian countries, in 1996 they were even over 3% higher than their average in tranquil periods.

Large credit growth and inflation differential

The other variables being examined also show striking differences in both phases. Thus, domestic credit growth (as a percentage of GDP) is an average of around five percentage points higher than in periods of tranquillity. For one thing, this could indicate that those countries are conducting an excessively expansionary economic policy in the run-up to currency crises. One argument in favour of this interpretation is the fact that the inflation differential vis-à-vis the industrial countries (represented here by the United States) is higher on average. Prior to the currency crises in Asia, though, the impact exerted by this differential is likely to have played a relatively minor role in this general form. More important in this context, though, was asset price inflation, especially real estate and equities. For another thing, a relatively large level of domestic credit growth could also indicate excessive lending which, in many cases, is financed by the exchange-rate-oriented monetary policy in those particular countries. The impetus was often provided by large inflows of short-term funds from abroad received by the banks of some Asian emerging economies which were then used to refinance their own lending to their domestic economies.

Foreign exchange reserves and inflation differentials

Besides, prior to currency turbulence the countries under observation tend to show, on average, lower levels of foreign exchange reserves (in terms of broad monetary aggregates) than during tranquil periods. This observation also fits in with the theoretically expected pattern of development. What is less clear in this simple comparison, however, is the influence the level of international inter-

5 See also Chinn, M. D. (1998), Before the Fall: Were East Asian Currencies Overvalued?, NBER Working Paper No. 6491, Cambridge, MA.

est rates has on the vulnerability of the emerging economies under observation to crises. This applies in any event if the interest rate variable is approximated using US money market rates, as has been done here. For example, at the beginning of the eighties, those rates – prior to the outbreak of the international debt crisis – had reached quite a high level. By contrast, in the run-up to the Asian crisis, they were even below their average during periods of tranquillity. On average, prior to currency crises international interest rates were only marginally higher than in periods of tranquillity. However, the simple method of comparing mean values is too imprecise for drawing reliable conclusions concerning the relevance of the variables observed here.

Selected fundamentals prior to currency turbulence and in periods of tranquillity

Item	Average in the 12 months prior to currency turbulence	Average in periods of tranquillity
Real exchange rate 1	– 11.53	0.54
Export growth 2	3.31	14.69
Credit growth 2, 3	7.36	2.16
Inflation differential	47.22	20.14
Foreign exchange reserves 4	19.31	25.66
Balance on current account 3	– 2.77	– 1.54
US money market rate 5	7.30	6.71

1 Deviation of the real exchange rate from the trend; real exchange rates based on consumer price movements compared with the US. — **2** Change from the previous year in %. — **3** As a % of GDP. — **4** In terms of the (broadly defined) money stock. — **5** Per year, in %.

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Results of a systematic analysis of data

Results

Hence, the analysis was run using a more sophisticated method. This was based on regressions, with the help of which the interaction of the variables under observation was captured. The method used and the results obtained are explained in more detail in the overviews on pages 22 and 23. On the whole, the interrelationships presented in the preceding text can be confirmed in this manner; all variables are in a reliable and plausible relationship (in terms of the sign) to the situation in the foreign exchange markets under observation. The interest rate variable also proves to be relevant.

Crisis indicator

In order to gain an impression of the accuracy of the results, these estimations were then used to calculate forecast values for the resulting "crisis indicator", and on the basis of those values the forecast accuracy of the indicator was tested. The estimated indicator is interpreted as a crisis warning signal if it exceeds a given threshold value.

Defining the threshold value means striking a balance between two opposing goals. If the value is set at a relatively low level so as not to miss a crisis warning if at all possible, the danger exists that warning signals would be received not just prior to currency turbulence but frequently also (erroneously) in tranquil periods. Yet if the threshold value is set at a relatively high level to avoid this problem, there is the risk of the appropriate early warning signal not being received. Therefore, the decision on the threshold value for each of

Methodological explanations

To perform the econometric calculations, a method was used which incorporated "pooled" data. In simple terms, this means combining the traditional time-series analysis with the cross-country analysis. This made it possible to include the time series of all countries in the estimations simultaneously. The idea is basically to explain the state of each individual country's foreign exchange market by the developments of a series of macroeconomic variables. One thing that makes this more difficult than standard quantitative analysis methods is that there is no simple method of measuring this state – or, more precisely, the vulnerability of a country to currency turbulence. Therefore, for the purpose of this estimation, the latent variable Y^*_{it} (called latent because it is actually impossible to observe) is represented by the binary variable Y_{it}, which is equal to 1 twelve months prior to the onset of currency turbulence and 0 in the remaining periods of tranquillity. [1]

The variable Y_{it} thus specified for country i at time t is defined by the vector of the fundamentals X_{it} for country i and period t.

Specifically, X_{it} is made up of the following variables:

- the deviation of the real exchange rate from its trend;
- year-on-year growth of exports ;
- year-on-year growth of domestic credit (as a percentage of GDP);
- the inflation differential compared with the United States;
- holdings of foreign exchange reserves in terms of broad money;
- the current account deficit as a percentage of GDP; and
- US money market rates.

For the estimation, a (multivariate) logit model was estimated using the maximum likelihood method. [2] The expected value of the binary variable is represented by:

$$E(Y_{it} \mid X_{it}, \beta) = F(\beta' X_{it}),$$

where E denotes the expectation operator and F the underlying logistical distribution function, which serves here as a probability transformation.

In the first step, the estimations were conducted using monthly data from 12 developing countries and emerging market economies between the beginning of 1970 and mid-1997 (Estimation I). However, the values observed during the period of currency turbulence itself were excluded, and only the data that occurred during the run-up to such crises and during periods of tranquillity were entered into the calculations. To be able to test the goodness of fit of the forecasts outside the observation period, as a second step the calculation was limited to data up to December 1993 (Estimation II). The remaining observations were then used to calculate the forecast values on the basis of the estimation results.

All in all, the results support the central hypothesis that the macroeconomic situation in the run-up to currency turbulence differs from that during periods of tranquillity. In the first estimation, all coefficients show the expected sign and are statistically significant given an error probability of less than 5 %. The second estimation, run using the abbreviated estimation period, largely supports these results. Apart from the growth of domestic credit, which is no longer significant at the usual levels of confidence, the correlation between all other variables remains well protected.

1 A similar method is also used by Berg, A. and C. Pattillo (1998). — **2** For a discussion of this method see, e. g., Maddala, G. S. (1992), Introduction into Econometrics, 2nd ed., New York et al., page 322 ff.

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Logit estimations

	Estimation I		Estimation II [1]	
Variable	Coefficient	z value	Coefficient	z value
Real exchange rate [2]	– 0.035	– 9.697 **	– 0.033	– 8.224 **
Export growth [3]	– 0.028	– 8.858 **	– 0.034	– 9.612 **
Credit growth [3, 4]	0.010	2.710 **	0.005	1.151
Inflation differential	0.009	8.678 **	0.014	10.554 **
Foreign exchange reserves [5]	– 0.018	– 4.181 **	– 0.014	– 2.718 **
Balance on current account [4]	– 0.045	– 2.845 **	– 0.044	– 2.427 *
US money market rate [6]	0.037	1.996 *	0.110	4.843 **
Constant	– 1.993	– 10.340 **	– 2.950	– 11.833 **
Number of observations	2.595		2.113	
Mc Fadden's R^2	0.153		0.228	
Chi^2 (7) [7]	341.0	(0.000)	383.6	(0.000)

/* Significant at a level of 1%/5 %. — **1 Estimated up to December 1993. — **2** Deviation of the real exchange rate from the trend. Real exchange rates based on consumer price movements compared with the US. — **3** Change from the previous year in %. — **4** As a % of GDP. — **5** In terms of the (broadly defined) money stock. — **6** Per year, in %. — **7** In parentheses: error probability.

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the countries under observation was taken using a uniform formula, with allowances being made for the past experience of each individual country, though. Specifically, the value was set as the percentile of the distribution of the appropriate crisis indicator forecast values. The rank of the percentile was set as a ratio of the overall number of values available in the year prior to currency turbulence to the total number of the observations available for that country. Using this method, in nearly 70 % of all cases of currency turbulence, at least one value exceeded the critical limit in the preceding year, thus signalling that particular country's vulnerability to currency turbulence.

Interpretation of false signals

However, false signals were also given; this meant that prior warnings were not followed by turbulence. There are two possible reasons: one is that they might be random forecasting errors. The other is that this may be a sign that the countries affected recognised the looming misalignments in a timely manner and used the remaining room for manoeuvre to undertake a lasting economic policy reversal which then heightened their currencies' resistance to crises. In that case, the susceptibility of those currencies to speculative attacks would have been accurately flagged but would have ended up not being accurate to the extent that it was possible to prevent the outbreak of the crisis in time.

Categorisation of signals

The range of possible cases can be split up into four categories (see chart on page 24):[6]

6 See: Kaminsky, G. et al. (1998).

Framework for classifying signals

State of the signalling variable	Within twelve months, currency turbulence ...occurs	...does not occur
Warning signal is issued	A	B
No warning signal is issued	C	D

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The signals are correct if

- the crisis indicator exceeds a given threshold value and currency turbulence ensues within the predefined run-up period (here: twelve months) (A);
- the crisis indicator remains below the threshold value and no currency turbulence ensues within the run-up period (D).

The signal is false if:

- the threshold value is exceeded yet currency turbulence does not occur (B);
- the threshold value is not exceeded although currency turbulence occurred (C).

This can be used as a basis for calculating a measure of the goodness-of-fit of the results, known as the "adjusted noise-to-signal" ratio. This ratio is the quotient of

- the number of false warning signals divided by the number of observations in tranquil periods (B/(B+D))
- and the number of correct warning signals divided by the number of observations in the run-up period (A/(A+C)):

$$Q = \frac{(B / (B + D))}{(A / (A + C))}$$

This quotient has the following features:

- In the case of a purely random process, it is expected to be 1;
- it approaches 0 the more correct warning signals are sent prior to currency turbulence or the fewer false signals are sent during periods of tranquillity.

This sample yields a value of 0.25, which is clearly less than 1 and therefore shows that the explanatory ability of this approach is rather reliable.

Applied to Asian crises

This observation is tempered somewhat, though, when the Asian currency crises are analysed. In the cases of Indonesia, Malaysia and the Philippines, none of the forecast values exceeds the calculated threshold value. The framework presented here would have yielded no clues, based on the data used, for an increased vulnerability of these countries to speculative attacks. For Thailand and South Korea, too, this framework only provides very isolated indications of the then-looming crisis. If the regression is limited to the period prior to 1994 and the resulting relationships are taken as a basis for analysing the behaviour of the indicator during the Asian crisis, the estimated indicators did not

provide any clues whatsoever that would point to increased vulnerability to crises.

Modification of the analysis

Yet this cannot be construed to mean that speculative movements and not fundamental weaknesses are responsible for the Asian currency crises. It is just as possible that the market participants may have learned from past experience and now react more sensitively to macroeconomic disequilibria than, for instance, prior to the outbreak of the international debt crisis at the beginning of the eighties. Technically speaking, that would mean that the threshold value is not to be regarded as a constant – as specified up to now – but would have to be set considerably lower than in the seventies and early eighties.

Limiting the period to the nineties

In order to test this hypothesis, the threshold values used were not calculated based on the distribution of the series over the entire observation period starting in 1970 but were calculated solely from their distribution over the nineties. Following this adjustment, the results improved considerably. The number of correct warning signals prior to the outbreak of currency turbulence rose considerably without impairing the quality of the results in terms of the noise-to-signal ratio. In both test calculations, warning signals are sent out prior to almost all episodes of currency turbulence in the countries under observation during the nineties. Only in the year before the unsuccessful speculative attack against the Argentine peso following the Mexican crisis did the indicator not show an unambiguous crisis warning.

According to those calculations, crisis warnings were given for both Thailand and Malaysia in the last 18 months prior to the outbreak of the Thai currency crisis of July 1997, whereas the indicator showed no conspicuous movement between January 1990 and December 1995. In the case of Thailand, the signal values were, on average, more than twice as high as during the period of tranquillity in the nineties, and for Malaysia the corresponding figures were nearly twice as high.

Clear signals in Thailand and Malaysia

Prior to the outbreak of the Thai currency crisis, the crisis indicator considerably exceeded its average value during periods of tranquillity in the other three countries (the Philippines, Indonesia, South Korea) as well, by around 50 %. The indicator, having sent at least five concrete warning signals between January 1996 and July 1997, does flag a certain vulnerability of those countries to speculative

... and signs of suspicion in other countries

Signalling behaviour prior to currency turbulence

Item	In-sample [1]	Out-of-sample [2]
Period between 1990 and 1997		
Number of turbulences	14	14
Percentage signalled	100	92.8
Noise-to-signal ratio	0.216	0.275
Percentage signalled in Asia in 1997	100	100
Entire estimation period		
Number of turbulences	35	35
Percentage signalled	68.6	62.8
Noise-to-signal ratio	0.245	0.276
Percentage signalled in Asia in 1997	40.0	0.0

1 Forecast values based on the estimation over the entire estimation period. — **2** Forecast values based on the estimation up to December 1993.

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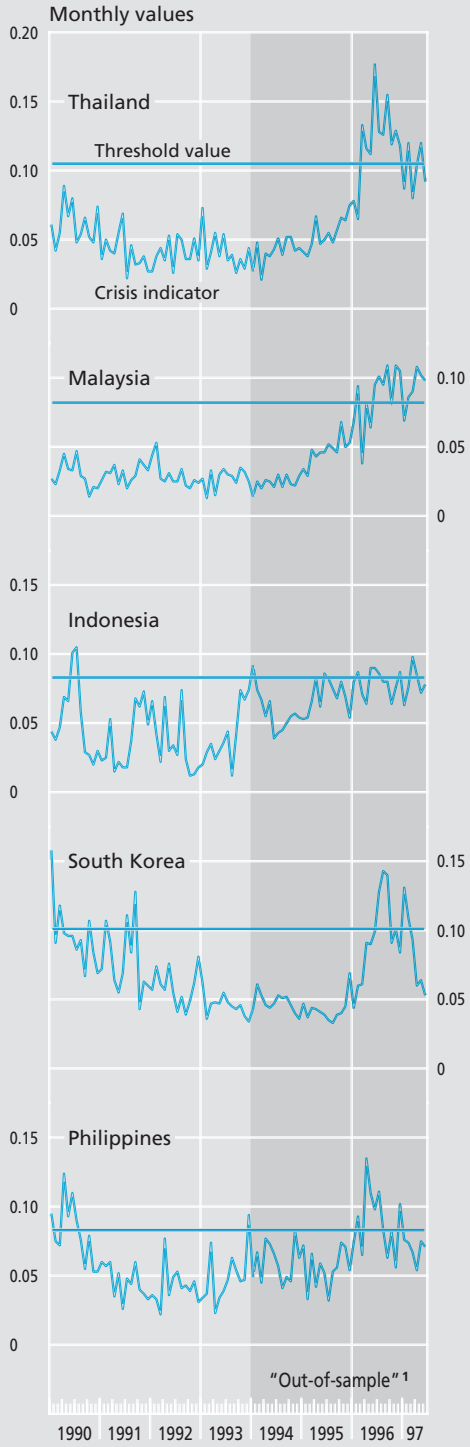
Estimated indicator for Asian crisis countries



1 Forecast going beyond the estimation period.

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attacks at that time. However, the indicator sent occasional false signals for those countries at the beginning of the nineties, too.

Summary and conclusions

Result: turbulence is not an accident

On balance, it can be concluded that currency crises in the emerging markets studied here are, on the whole, not the accidental results of speculative movements detached from macroeconomic fundamentals; rather, in the run-up to the crises, there were very often macroeconomic misalignments. At any rate, in the past the movements of the macroeconomic variables examined here during the year prior to currency turbulence were markedly different from conditions during periods of tension-free foreign exchange markets. On the whole, this means macroeconomic misalignments are likely to bear at least a significant share of the responsibility for much of the turbulence in the foreign exchange markets of the emerging markets.

No reliable early warning system

However, one must not expect too much of such a crisis indicator. This is especially the case regarding the indicator's suitability as an early warning system for looming currency crises, which some recent studies have set out to demonstrate.[7]

Thus, it is hardly possible to predict with sufficient accuracy the point in time when turbulence will break out. The most that can be

7 See Kaminsky, G. et al. (1998), for a critique and comprehensive analysis of different strategies: Berg, A. and C. Pattillo (1998), Are Currency Crises Predictable? A Test, IMF Working Papers 98/154, Washington, D. C.

achieved is to ascertain a greater degree of vulnerability to speculative attacks. Besides, one must not forget the risk that, in addition to many correct warning signals in the run-up to currency turbulence, false alarms are sounded now and then in periods of tranquillity, too. This harbours the danger, which must not be underestimated, that the announcement of such (erroneous) forecasts can trigger otherwise preventable currency crises if it influences market sentiment and encourages market participants to withdraw their funds accordingly.

Furthermore, there is another fundamental problem. If the market participants are given a basically functioning instrument to predict currency crises, they would use that new information when making their decisions and then change their behaviour. The structural relationships recognised while analysing the past would no longer carry over to the future, thus calling the value of the early warning indicator into question. At any rate, the studies presented here provide some indications that the market participants do not always react at the same constant speed. These reactions have become faster as the financial systems have become more integrated and the markets have become more globalised.