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Speculative Attacks in Emerging Markets: The Role of Macroeconomic Fundamentals

The recent currency crises in several emerging markets have touched off a debate about their causes. Whereas some blame fickle speculators for triggering speculative attacks virtually at random, others argue that the typical currency crisis is attributable to myopic economic policies. This paper examines common patterns of a large number of balance-of-payments crises focusing on a comprehensive sample of 26 emerging markets. Following a consistent categorising of events in the foreign exchange markets, it analyses the behaviour of a set of relatively easily accessible variables prior to speculative attacks. Applying univariate as well as multivariate statistical methods, it gives support to the view that in the past countries were not hit randomly by attacks on their currencies.

While no major currency disruptions were evident in the industrial world after the crisis in the EMS, the second half of the 1990s witnessed some violent speculative attacks against emerging markets' currencies. The associated tremendous social costs, contagion risks for similarly structured economies, and, ultimately, potential hazards to the stability of the international monetary system, spurred a renaissance of academic studies on the driving forces of speculative attacks. Furthermore, in order to develop a suitable operational framework for avoiding and – in a crisis scenario – mitigating the impact of currency turbulence, it is important to understand the responsibilities: are fickle speculators who attack currencies almost at random to blame, or are the players on the international financial markets only living up to their assigned monitoring role by mercilessly penalising policy deficiencies?

This study analyses a largely homogeneous sample of 26 emerging markets.¹ In order to get an impression of whether crises appear out of the blue or are attributable to myopic economic policies in the countries affected, a non-structural approach is applied. The term currency turbulence is used in this study to include both currency crashes and speculative attacks which were successfully repelled to avoid a source of sample selection bias. An index for

the foreign exchange market is used to identify more than 100 speculative episodes in those countries over a span of more than 25 years and to classify them by type and intensity. Since rapid reaction to fundamental disequilibria is a characteristic of financial markets, monthly data has been chosen. The analysis is restricted to a relatively broad spectrum of 24 easily available macroeconomic variables. It will initially be assessed using univariate tests whether there is any difference in the variables' behaviour prior to currency turbulence from that in tranquil periods. The robustness of these results will then be the subject of a multivariate examination.

Defining Episodes of Turbulence

There is likely to be a consensus that what we observed in Mexico in December 1994 and in Thailand in mid-1997 may safely be labelled currency crises. Other cases, e.g. assessing which countries were affected by the aftershocks of the Mexican crisis, are not as clear-cut. Therefore, currency turbulence must first be defined uniformly.

Following the lines of other empirical studies, the definition of currency turbulence draws on the symptoms: diminishing foreign exchange reserves and/or a sharp currency depreciation.² From the monthly rates of change of these variables, a weighted index for foreign exchange market pressure

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¹ The following countries were included: Argentina, Brazil, Chile, Colombia, the Czech Republic, Hungary, India, Indonesia, Israel, Jordan, Korea, Malaysia, Mexico, Pakistan, Peru, the Philippines, the Slovak Republic, Slovenia, South Africa, Sri Lanka, Thailand, Turkey, Uruguay, Venezuela, and Zimbabwe. Since this list also includes countries where no turbulence was identified during the period under review, this study mitigates the sample selection bias which may affect the results in some other papers.

is calculated. However, instead of the nominal exchange rate, the real exchange rate is used to construct this index.³ That eliminates the need for arbitrary corrections for periods of high inflation rates, in which nominal depreciations only reflect inflation differentials and are not necessarily a sign of speculative pressure.⁴ In view of the different variabilities of the foreign exchange reserves and the real exchange rate, they were weighted, as usual, to equalise their conditional volatilities.⁵

This method permits the use of uniform criteria to assess for each country from month to month whether there were tensions in the foreign exchange markets showing up in the form of extreme fluctuations of the index (called "events"). Additionally, the turbulences will be categorised by type and intensity. As far as the type is concerned, a distinction will be made between (unsuccessful) "speculative attacks" and (successful) "currency crises"; with regard to intensity, they will be classified as severe, strong, and ordinary (Table 1).

Turbulences are termed "severe" if the indicator calculated exceeds three times the standard deviation (σ) of the indicator.⁶ In the case of strong turbulences, the threshold value is reduced to twice the standard

deviation, and for ordinary turbulences, 1.5 times the standard deviation. Above and beyond that, turbulences are classified as currency crises if the share of the explanatory contribution of the real exchange rate in the foreign exchange market index accounts for at least 60%. Otherwise, they are classified as speculative attacks.

However, extreme values in the index often appear at short intervals. Deep-seated currency crises are often preceded by (unsuccessful) speculative attacks or become exacerbated if, for instance, they further destabilise an already fragile banking system, which in turn has repercussions on the value of the currency. Therefore, such turbulences can drag on for several months or even quarters. In order not to count the same incidence twice, the length of an episode is defined as follows: it begins when the indicator first exceeds the critical threshold of 1.5 times the standard deviation following a tranquil period. A window of three quarters is drawn from this point on. If a new event occurs during that time, then the period in between is defined as an "episode". Otherwise, the last point in time of an event is defined as the end of the episode. The incident is classified in terms of the highest ranking of the episode; if necessary, the classification as a crisis always takes precedence over classification as an attack.

According to this method, a total of 103 episodes of turbulence were identified for the 26 emerging markets under review between early 1970 and mid-1997. They can be broken down into 76 currency crises and 27 speculative attacks, as shown in Table 2.

According to the identification procedure used here, speculative attacks are in the minority vis-à-vis

² See e.g. B. Eichengreen, A. K. Rose, C. Wyplosz: Is There a Safe Passage to EMU? Evidence on Capital Controls and Proposal, in: J. Frankel, A. Giovannini (eds.): *The Micro-Structure of Foreign Exchange Markets*, Chicago 1994, pp. 303-328; G. Kaminsky, S. Lizondo, C. M. Reinhart: *Leading Indicators of Currency Crisis*, IMF Staff Papers 45 (1), 1998, pp. 1-49. Sharply rising short-term interest rates are not considered, since for the period under review the data available for this variable is of insufficient quality. Moreover, it is argued that in periods of speculative pressure, increasing interest rates are highly correlated with non-sterilised foreign exchange intervention, leading to a fall in reserves; see G. Corsetti, P. Pesenti, N. Roubini: *Paper Tigers? A Model of the Asian Crisis*, NBER Working Paper 6783, Cambridge, MA 1998.

³ The real exchange rate is defined as the nominal exchange rate of a currency to the US dollar, adjusted for the trends in consumer prices in the United States and in a given emerging market. A rise in the real exchange rate corresponds to a real depreciation of the currency.

⁴ Most other studies used the nominal exchange rate and then adjusted it for periods of high inflation rates; see e.g. J. A. Frankel, A. K. Rose: *Currency Crashes in Emerging Markets. An Empirical Treatment*, in: *Journal of International Economics* 41, 1996, pp. 351-366. I. Goldfajn, R. O. Valdés: *Are Currency Crises Predictable?*, IMF Working Paper 97/159, Washington D. C. 1997, however, also drew on the change in the real exchange rate, among other indicators, to determine periods of turbulence.

⁵ For an extensive description see B. Schnatz: *Macroeconomic Determinants of Currency Turbulences in Emerging Markets*, Discussion Paper 3/98, Economic Research Group of the Deutsche Bundesbank, Frankfurt am Main 1998.

⁶ At this point the analysis differs, say, from the study performed by G. Kaminsky et al., op. cit., which calculated the overshooting of the standard deviation in a country-specific manner. Whereas turbulences are defined uniformly throughout the entire sample in this analysis, their study defines turbulences as behaviour deviating from the norm valid for that country.

Table 1
Classification of Turbulences

Deviation	Real exchange rate contributes	
	more than 60 %	less than 60 %
more than 3 σ	severe crisis (1)	severe attack (4)
between 2 σ and 3 σ	strong crisis (2)	strong attack (5)
between 1.5 σ and 2 σ	ordinary crisis (3)	ordinary attack (6)
less than 1.5 σ	uneventful times	

Table 2
Turbulences in the Sample

	Crises	Attacks	Total
Severe	36	5	41
Strong	16	11	27
Ordinary	24	11	35
Total	76	27	103

currency crises in every category. This finding indicates that speculative attacks are largely successful. In particular, in the first category of severe turbulences, the ratio of currency crises to speculative attacks is particularly high.

However, it is necessary to see this catalogue of episodes against the background of some fundamental data restrictions. Firstly, countries often tend to clamp down tightly on international capital movements in order to thwart speculative attacks. To the extent that such measures (in isolation) can ease pressure on the foreign exchange markets, the attack remains undetected by the indicator chosen here. Secondly, the change in the foreign exchange reserves, especially in the emerging markets, only provides limited information on the extent of intervention in the foreign exchange markets, since neither credit lines in foreign currency (to which recourse can be taken in the event of a speculative attack) nor forward market intervention are booked – in fact, they are usually not even mentioned – in the published balance sheets.

Despite these inadequacies, there are good reasons for taking foreign exchange reserves into account. Leaving them out of the definition of currency turbulence entirely, and thus restricting the study to successful speculative attacks, creates a serious sample selection bias.⁷ Abandoning a certain parity primarily hinges on whether the policy-makers are willing to depart from their exchange rate target in favour of another economic policy goal. However, regardless thereof, if macroeconomic variables play a significant role as determinants of currency turbulence, they should behave differently prior to speculative attacks, no matter whether the government finally decides to defend or to relinquish a given parity.

Macroeconomic Variables with a Potential of Distinct Behaviour

When selecting macroeconomic variables which may perform differently prior to currency distress, the analysis relies on variables which can be derived from the theoretical literature on speculative attacks and which, in previous empirical studies, were already suggested as being able to contribute to the explanation of foreign exchange market turbulence.⁸ The study is limited to variables, though, which are available at rather short notice and have a relatively high frequency of data. However, some explanatory variables which may have played a role in the recent crises in Mexico and Asia are not taken into consideration. For example, no reliable data are available on the maturities and the structure of foreign

debt in sufficient frequency. Moreover, the interplay between banking and balance of payments crises, contagion effects, and political conditions is difficult to capture without allowing further arbitrariness.⁹ This does not mean that such factors are irrelevant to explaining speculative attacks; rather, the determinants which prove to be relevant in the following analysis must always be supplemented *ad hoc* by such qualitative moments so that an overall picture can be drawn of a country's vulnerability to speculative attacks. Thus, it may be that only part of the story will be told in the following, but it seems to capture the main ingredients, which are important in order to understand the full story.

The macroeconomic variables to be studied are divided into three categories: external, financial and real.¹⁰ For the indicators of the external sector, the analysis takes into account both the real exchange rate and individual components of the balance of payments. The real exchange rate enters as a percentage change.¹¹ The higher the previous appreciation of the real exchange rate, *ceteris paribus*, the greater the probability that the external sector has suffered an exceeding loss of competitiveness demanding an adjustment of parities. Furthermore, an indicator of the adequacy of the real exchange rate is taken into consideration. Following Kaminsky and Reinhart,¹² however, not a complex equilibrium concept is estimated but instead the deviation of the real exchange rate from its (linear) trend. This means that for an insignificant trend variable, on the one hand, the theory of purchasing power parity is implied

⁷ See J. A. Frankel, A. K. Rose, *op. cit.*

⁸ For a detailed survey of the existing empirical literature, see G. Kaminsky et al., *op. cit.*

⁹ For some empirical support for contagion see J. D. Sachs, A. Tornell, A. Velasco: Financial Crises in Emerging Markets: The Lessons from 1995, Brookings Papers on Economic Activity (1), 1996, pp. 147-198. B. Eichengreen, A. K. Rose, C. Wyplosz: Is There a Safe Passage to EMU? Evidence on Capital Controls and Proposal, *op. cit.*, claim that contagion effects are very important factors of currency crises. Support for political factors as determinants of currency crises in OECD countries is given in B. Eichengreen, A. K. Rose, C. Wyplosz: Exchange Rate Mayhem, The Antecedents and Aftermath of Speculative Attack, in: Economic Policy 21, 1995, pp. 249-312. In fact, the approach also provides some satisfactory results for the Asian crises, see B. Schnatz: The Sudden Freeze of the Asian Miracle: The Role of Macroeconomic Fundamentals, in: Asia Pacific Journal of Finance, 2, 1999, pp. 1-19.

¹⁰ This classification follows G. Kaminsky, C. M. Reinhart: The Twin Crises: The Causes of Banking and Balance-of-Payments Problems, in: American Economic Review, 89 (3), 1999, pp. 473-500.

¹¹ Percentage changes are calculated as against the previous year. Data on GDP and the balance of payments have been interpolated as appropriate. The data used are from the CD-ROM version (November 1997) of International Financial Statistics. The IFC Global Price Index in US \$ of each country was used as a basis for stock market data.

¹² G. Kaminsky, C. M. Reinhart, *op. cit.*

as an "equilibrium concept". On the other hand, the trend variable, especially for emerging markets, leaves enough room for economic catching-up processes, which could be reflected in a balanced appreciation according to the well-known theorem of Balassa and Samuelson.

Real appreciations generally have repercussions on trade flows. Under the usual elasticity assumption, they decrease the growth of exports and increase the growth of imports. These relationships should in turn be reflected in a deterioration of the balance of trade and current account positions, the ratio of both of which to GDP are included in the analysis.¹³ Since current account deficits usually go hand in hand with an increase in external debt, the ability to repay the debt, and thus the creditworthiness, decline, which means that on the whole the probability of a speculative attack is likely to increase along with a higher current account deficit.¹⁴

Furthermore, the ratio of foreign exchange reserves to imports is used as an indicator of sufficient holdings of foreign exchange reserves to cover import expenditures. In addition, global economic developments should also enter into this category, since analyses by Calvo et al. show that external factors may have been an important factor in explaining the recent surge in capital flows to emerging markets.¹⁵ Conversely, according to these studies, rising interest rates in the industrial countries might result in a drying out or even a reversal of capital flows between industrial countries and emerging markets. Therefore, the US money market rate is additionally incorporated into the catalogue of variables.¹⁶

The standard speculative attack models feature an excessively expansionary monetary and fiscal policy, the environment of which is analysed in the context of *financial indicators*. These include the growth of a narrowly defined and a broadly defined monetary aggregate as a share of nominal GDP. However, their signs are not unambiguous. On the one hand, an excessively expansionary monetary policy is likely to cause an above-average growth of those variables prior to turbulences. From a demand point of view, on the other hand, the incentives for holding domestic currency will decline as the risk of a currency crisis becomes visible. From that vantage point, one would tend to expect a declining trend prior to a speculative attack. In order to gain a better understanding of the monetary policy stance of a country, simple money demand functions are estimated for each country. If the actual real balances are higher than their forecast values, this could indicate an excessively expansion-

ary monetary policy.¹⁷ Finally, as an indicator of a non-stability-oriented policy, the inflation differential between each emerging market and the United States is included.

Furthermore, the growth of domestic borrowing as a share of GDP continues to be taken into account as an indicator of an excessively expansionary economic policy. Admittedly, this may also reflect banks' added leeway for lending due to far-reaching deregulation measures in the domestic financial system. In order to take account of the recent surge of (short-term) capital inflows which is being routed to a marked degree through the banking sector in many emerging markets, the change of loans to the private sector as a share of GDP is also included. Moreover, the ratio of foreign exchange reserves to a broadly defined and a narrowly defined monetary aggregate is taken into consideration. The analysis assumes that the higher this ratio is, and the stronger it rises, the less vulnerable a country is to speculative attacks. By including the ratio of foreign exchange reserves to a broadly defined monetary aggregate, an argument by Calvo and Mendoza is taken account of:¹⁸ they assert that, especially in emerging markets, savers convert their financial assets into a "safe haven" currency as the credibility of monetary and exchange rate policy diminishes. Accordingly, this measure is designed to capture the central bank's ability to meet these (exchange) requirements, if necessary. As fiscal policy cannot be illuminated using key variables for the budget deficit owing to data limitations, the behaviour of the public sector is approximated through the growth in central bank lending to the public sector.

Real output growth and the change in the stock market index enter into the analysis as *real economic*

¹³ The balance of trade position was also analysed in relative terms, e.g. as a ratio of exports to imports.

¹⁴ Statements on the sustainability of current account deficits, however, require a more comprehensive analysis which includes both the long-term growth outlook of the country and investors' portfolio decisions (see H. Reisen: Sustainable and Excessive Current Account Deficits, OECD Technical Paper No. 132, Paris 1997), which means that the indicator applied here is rather crude.

¹⁵ G. A. Calvo, L. Leiderman, C. M. Reinhart: Capital Inflows and Real Exchange Rate Appreciation in Latin America, IMF Staff Papers 40 (1), 1993, pp. 108-151.

¹⁶ J. A. Frankel, A. K. Rose, op. cit., take a weighted foreign money market rate into account (p. 357).

¹⁷ Following G. Kaminsky, C. M. Reinhart, op. cit., the demand for real balances, deflated by consumer prices, was estimated as a function of real growth, the rate of inflation and a (linear) time trend. The deviation of the estimated value from the actual value, in per cent, was included as an indicator.

¹⁸ See G. A. Calvo, E. Mendoza: Mexico's Balance-of-Payments Crisis: A Chronicle of a Death Foretold, in: Journal of International Economics 41, 1996, pp. 235-264.

indicators. If the market players' expectations are reflected correctly in the stock markets, a below-average trend might also indicate a fragile situation of the economy as a whole or even an anticipation of future turbulences. A relatively low rate of output growth also increases vulnerability to speculative attacks. The lower the rate of real growth is, the less vigour is generally expected of the government to permit a further real economic downturn through a tight-money policy in the event of foreign exchange market tensions.¹⁹

Univariate Analysis

In the following, univariate tests will be performed to derive some stylised facts regarding the statistical distribution of these macroeconomic variables in the year prior to the currency turbulences and in comparison to their behaviour in tranquil periods. This analysis may give some initial hints on whether speculators attack currencies in the foreign exchange markets randomly, i.e. regardless of the underlying macroeconomic fundamentals, or whether the macroeconomic environment in fact does play a role regarding the consistency of a certain parity. If the behaviour of macroeconomic variables prior to turbulences differs significantly from that in tranquil periods, this may indicate that the adopted policy stance is not in line with the existing parity in the run-up to currency turbulences.

Analogously to other analyses two univariate tests are performed.²⁰ In deviation from these studies, however, a distinction is made between three periods: (1) the actual "episode" according to the definition presented above; (2) a period of twelve months as a "pre-episode period", and (3) the remaining observations, defined as a "tranquil period". In contrast to the earlier studies, the observations during the actual episode are disregarded. Since many variables show very volatile movement during this period, this could exert undesirable effects on their distribution and thus on the content of the results. Rather, the behaviour of macroeconomic variables in pre-crisis periods is

compared with their behaviour in periods of tranquillity. After excluding the values for turbulent periods, nearly 6,000 observations are left on average for each variable, around 20% of which are located in pre-episode periods. In order to rule out sensitivity regarding the pre-crisis period of 12 months chosen *ad hoc*, the tests were repeated with a pre-crisis window of 18 months.

Owing to the rather high number of observations, a t-test for the equality of means should be able to produce sufficiently precise results. In order to underline the robustness of the results, moreover, a nonparametric test (Mann-Whitney test) was run.²¹ The results of this test are presented in Table 3.

The variables and their expected signs are given in the first two columns. A positive sign indicates that the value of a variable should be lower in periods of tranquillity than prior to currency turbulence. Both tests are subject to the null hypothesis that the mean and the median of the variables, respectively, are not different prior to currency turbulences and in periods of tranquillity. A rejection of this hypothesis accordingly suggests that the behaviour of the mean of the variable prior to turbulences differs from that in periods of tranquillity.

The statistical results support the view that macroeconomic variables move conspicuously differently prior to currency turbulences compared to periods of tranquillity. The majority of the variables have the expected sign and are highly significant. The statistics for alternative specification of pre-crisis periods of 18 months underscore the robustness of the findings. In the external sector variables, the significant result for the real exchange rate indicates that the exchange rates clearly diverged from their fundamentals prior to turbulences and were considered overvalued. The sharp appreciation of the real exchange rate was also reflected in a below-average export growth. However, import growth does not seem to be extraordinarily high prior to speculative attacks. This may reflect the fact that in the run-up to currency turbulences, a cyclical downturn was usually noticeable; hence it is possible that price effects were eclipsed by income

¹⁹ In addition, an analysis of the indicators of the labour market situation is conceivable; given high unemployment, the authorities would probably be more willing to make a surprise devaluation in order to make use of short-term Phillips curve trade-offs. However, reliable labour market data are available only for a very few emerging markets and are generally scarcely comparable owing to the existence of a prominent informal sector. The overall effect is not unambiguous: depending on the underlying elasticities, sluggish growth can lower the demand for imports, leading to a simultaneous improvement in the balance of trade and the mitigation of tensions (I. Ötker, C. Pazarbasioğlu: Speculative Attacks and Currency Crises: The Mexican Experience, IMF Working Paper 95/112, Washington D. C. 1995, p. 13).

²⁰ See B. Eichengreen, A. K. Rose, C. Wyplosz: Is There a Safe Passage to EMU? Evidence on Capital Controls and Proposal, op. cit.; R. Moreno: Macroeconomic Behavior During Periods of Speculative Pressure or Realignments: Evidence from Pacific Basin Economies, in: Economic Review, Federal Reserve Bank of San Francisco (3), 1995, pp. 3-16. The Kruskal-Wallis test used in those studies is a more general form of the Mann-Whitney test and leads to the same results.

²¹ An exception is the change in the stock exchange index, for which there are only around 1,000 observations available.

effects. The results for the real sector variables lent support to this supposition.

The influence of imports seems strong enough so that the balance of trade does not show any conspicuous behaviour, either. By contrast, the current account deficits (as a share of GDP) were, on average, significantly higher prior to speculative attacks than in periods of tranquillity. Therefore, it was probably not only the deterioration in international competitiveness which was important for assessing a country's vulnerability to speculative attacks, but also, for example, the amount of debt service reflected in the current account position. This argument is supported to some degree by the fact that the US money market rate was higher, too, prior to turbulences in emerging markets. Higher interest rates in the industrial countries not only contain incentives to invest fewer funds in emerging markets and even to withdraw them, but at the same time also increase the external debt burden.

Furthermore, highly significant results for foreign exchange reserves are noticeable. Regardless of

whether the foreign exchange reserves were measured in relation to monetary aggregates or to imports, both their levels and their percentage change indicate a subproportional development during the pre-episode period. By contrast, for the growth rates of the monetary aggregates, a significant result prior to currency turbulences can be ascertained only with the t-test, whereas the nonparametric test cannot reject the null hypothesis. The change in domestic lending (as a share of GDP) and the inflation differential, both of which reveal above-average values in the run-up to speculative attacks, likewise speak in favour of an overly expansionary economic policy. The changes in the claims of a monetary authority on the central government to GDP as an approximation of the fiscal policy stance, too, indicate significant differences in the two samples, at least according to the Mann-Whitney test statistics. In contrast, neither the change in domestic lending to the private sector nor the estimated indicators of money demand prior to currency turbulences provide clues for special behaviour.

Table 3
Tests for Differences in the Behaviour of Macroeconomic Variables in Tranquil Periods and Prior to Turbulences

Pre-episode Period Variables	Expected Sign	12 months		18 months	
		t-test	MW	t-test	MW
External Sector Variables					
Real exchange rate (deviation from trend)	-	-13.809**	-14.338**	-15.218**	-15.926**
Δ real exchange rate	-	-5.688**	-4.013**	-5.509**	-4.932**
Current account/GDP	-	-5.835**	-6.820**	-4.926**	-6.274**
Trade balance/GDP	-	2.601	1.423	4.465	2.859
Exports/imports	-	1.128	1.188	3.060	0.035
Δ exports	-	-6.654**	-8.024**	-4.764**	-6.384**
Δ imports	+	-1.028	-0.993	-1.167	-1.042
Foreign exchange reserves/imports	-	-8.854**	-10.822**	-9.443**	-11.937**
Δ foreign exchange reserves/imports	-	-3.585**	-4.285**	-2.422**	-3.355**
US money market rate	+	8.845**	8.094**	11.049**	11.280**
Financial Sector Variables					
Δ domestic credit/GDP	+	2.999**	5.007**	1.834*	4.251**
Δ domestic credit (private sector)/GDP	+	-2.686	-1.015	-2.156	-1.211
Δ claims of mon. auth. on central gov./GDP	+	1.329	7.066**	1.511	7.095**
Δ narrow money/GDP	-/+	-2.749**	-1.427	-2.644**	-1.456
Δ broad money/GDP	-/+	-1.937*	-1.225	-2.610**	-1.842
Money Demand Indicator (narrow money)	+	1.034	2.588*	1.074	3.220**
Money Demand Indicator (broad money)	+	-1.504	-0.591	-2.285	-0.483
Foreign exchange reserves/narrow money	-	-7.902**	-13.170**	-9.000**	-14.499**
Δ foreign exchange reserves/narrow money	-	-4.505**	-3.044**	-2.265**	-3.554**
Foreign exchange reserves/broad money	-	-11.820**	-11.229**	-11.668**	-11.787**
Δ foreign reserves/broad money	-	-3.334**	-5.250**	-2.415**	-4.424**
Inflation differential	+	7.867**	11.970**	9.204**	13.486**
Real Sector Variables					
Δ production index	-	-2.004*	-3.343**	-1.860*	-3.512**
Δ stock market index	-	-3.452**	-3.627**	-4.099**	-3.781**

Δ = Percentage change from the previous year, MW = Mann-Whitney rank sum test,

*/** Significant at a level of 5%/1%.

Table 4
Logit Estimations

	All countries		Sensitivity of results	
	(1)	(2)	Asia	post-1985
External Sector Variables				
Real exchange rate (deviation from trend)	-0.039**	-0.038**	-0.104**	-0.062**
Δ real exchange rate	0.000		0.012	-0.006
Current account/GDP	-0.071**	-0.073**	-0.162**	-0.063**
Δ exports	-0.014**	-0.013**	-0.024**	-0.003
US money market rate	0.070**	0.064**	-0.126**	0.210**
Financial Sector Variables				
Δ domestic credit/GDP	0.011**	0.009**	0.011	0.011*
Δ claims of mon. auth. on central gov./GDP	0.002*	0.002	0.006*	0.003*
Δ narrow money/GDP	-0.011**	-0.011**	0.070**	-0.015**
Δ foreign exchange reserves/broad money	0.003*		0.013**	0.008**
Foreign exchange reserves/broad money	-0.036**	-0.033**	-0.182**	-0.059**
Inflation differential	0.010**	0.010**	0.053*	0.021**
Real Sector Variable				
Δ production index	0.005		0.023**	0.016*
Number of observations	3844	3855	1840	1768
Pseudo R ² (Mc Fadden)	0.219	0.219	0.321	0.274

*/** Significant to a level of 10%/1%.

Model estimated with a constant.

Multivariate Analysis

The univariate analysis offers a suitable starting point for a multivariate approach applying logit techniques.²² The binary endogenous variable of the estimation equation is given the value 1 in the 12 months prior to turbulences, 0 in tranquil periods, whereas once again the episode is not taken into consideration at all.²³ The selection of the independent variables is determined by three factors. Firstly, the variables should have shown conspicuous behaviour in the univariate analysis; secondly, to avoid multicollinearity in the estimates some variables are excluded; and thirdly, the change in the stock exchange index is not taken into account, since the relatively low number of available observations would have considerably reduced the number of degrees of freedom in the overall estimation.²⁴

In the first column of results in Table 4, the estimates encompassing all countries are shown; from this equation, those variables which were statistically insignificant or did not have the sign expected were dropped in the second regression. The third and fourth columns, in turn, test the sensitivity of the results in view of alternative specifications: for one, the sample was restricted to the Asian countries; for another, the sample was restricted to the period following 1985, since it is occasionally stated that owing to the far-reaching liberalisation of international capital movements in the eighties, the validity of the structural relations over the entire period is no longer ensured.

Most variables, however, have the expected sign and are statistically highly significant, regardless of the underlying specification. Thus, they confirm important results of the univariate tests. Prior to speculative attacks, in fact, the real exchange rate shows a sharp deviation from its trend, the level of foreign exchange reserves to M2 is conspicuously low, and both the inflation differential and the current account deficit are significantly higher than in periods of tranquillity. The claims of the monetary authority on the central government, too, increase disproportionately prior to currency turbulences, though this result is statistically not as well established as for the

²² Since this is a logit analysis with panel data, an estimation with conditional maximum likelihood is actually called for here (see G. Chamberlain: *Analysis of Covariance with Qualitative Data*, in: *Review of Economic Studies* 47, 1980, pp. 225-238). For long time series, the results are almost identical, however. As a consequence of the specification with fixed effects, the conclusions relate only to this sample.

²³ B. Eichengreen, A. K. Rose, C. Wyplosz: *Exchange Rate Mayhem, The Antecedents and Aftermath of Speculative Attack*, op. cit., and J. A. Frankel, A. K. Rose, op. cit., give the currency turbulences the value 1, all other observations the value 0, and then estimate the model using lagged variables. This approach is not chosen here for two reasons: firstly, the data frequency is rather high, which means that it is not enough to adhere to just one lagged variable, and secondly, the turbulent episodes in this study extend over different periods of time, making it difficult to perform an estimation with several lagged variables.

²⁴ In the multivariate analysis, only those countries are included in which turbulences were identified during the period under review. Therefore, the variables should already have shown conspicuous behaviour in a less biased country sample. The multicorrelation problem especially affects variables analysed univariately with various definitions and/or on a different basis (e.g. foreign reserves to narrow money and foreign reserves to broad money).

other variables. Apart from the Asian sub-sample, the results also suggest that domestic lending in the pre-crisis period was excessively high, and rising US interest rates fundamentally increased the vulnerability of emerging markets to speculative attacks.²⁵ In addition, the over-valuation of the currency generally seems to be reflected in a disproportionately sluggish export growth, though no statistical evidence of this relationship is found for the sample period after 1985. In contrast, for the changes in the reserve position, the real exchange rate and output, either it is not possible to identify any peculiar statistical behaviour prior to currency turbulence, or the sign is not pointing in the direction expected.

In order to receive an idea of the accuracy of the results, on the basis of the second equation forecast values were computed. Afterward, a country-specific threshold value was calculated in order to delineate benign patterns against those of vulnerability to speculative attacks. The predicted values should have a systematically higher value prior to currency turbulences than in tranquil periods. Since the univariate tests have shown to be robust towards different pre-episode periods, a peculiar behaviour in the twelve months prior to currency turbulences is in turn assumed. The threshold value was calculated as a percentile of the distribution of the predicted values of each country, with the rank of the percentile defined according to the following rule: the number of observations (for which data were available) in the pre-warning periods was taken as a share of the total number of observations available for a country. This value was then subtracted from 1 to place the threshold value in the area of the distribution with the high values. A good indicator should send signals in the twelve months prior to turbulences, i.e. it should be higher than the threshold value, and in tranquil periods it should not send signals, i.e. it should be below the threshold value. With this method, it was

possible to diagnose at least one signal in nearly three-quarters of all turbulences in the twelve months prior to turbulences (Table 5). Overall, this accuracy rate was higher for currency crises (77%) than for speculative attacks (63%) and was at its highest for severe crises (nearly 90%).

Admittedly, in none of the countries were signals sent only in the period prior to turbulences; signals were also sent in periods which later turned out to be tranquil. To rule out the possibility of the localised signals following a random process which generates high values at regular intervals, a yardstick is necessary for the quality of the indicator. The analysis follows Kaminsky et al.²⁶ who compute an (adjusted) "noise-to-signal" ratio to assess the quality of single variables as indicators in their univariate analysis. This approach can fundamentally be applied to this multivariate approach. If a predicted value exceeds the threshold value, then during the pre-episode period it is evaluated as a correct signal, whereas the same behaviour in tranquil periods is interpreted as a false alarm. The "noise-to-signal" ratio is a ratio of false alarms (as a percentage of the maximum possible number of false alarms) in tranquil periods to the number of correct signals (as a percentage of the maximum possible number of correct signals) prior to turbulences. This figure has the useful feature that, in the event of a random process, its expected value is 1 and it converges towards 0 the more correct signals are sent prior to turbulences and the fewer false alarms are sent in tranquil periods, respectively. Calculated across the entire sample, this leads to a value of 0.218, which is distinctly lower than 1 giving evidence that the signalling behaviour, and thus also the explanatory ability of the multivariate approach, are both solidly supported.

Final Remarks

This paper examined the behaviour of easily available macroeconomic variables in a comprehensive sample of emerging markets with sufficiently well-developed domestic financial markets. A statistical analysis was used to show that speculative attacks and currency crises generally did not come out of the blue in this sample. Rather, the persistent defence of parities not in line with fundamentals may

Table 5
Signalling Behaviour Prior to Foreign Exchange Market Turbulences

	Signalled	Not signalled	Total	Per cent
Currency Crises	30	9	39	77
- severe	17	2	19	89
- strong	2	4	6	33
- ordinary	11	3	14	79
Speculative Attacks	10	6	16	63
- severe	1	2	3	33
- strong	3	2	5	60
- ordinary	6	2	8	75
Total	40	15	55	73

²⁵ However, substituting the US interest rate by the Japanese call money rate, and excluding India, Pakistan and Sri Lanka as these countries still restrict international capital movement, the interest rate variable shows the expected positive sign at a statistically highly significant level.

²⁶ G. Kaminsky, C. M. Reinhart, op. cit.

probably have paved the way for the turbulences. In the past there has been a series of macroeconomic variables whose behaviour in the year prior to currency turbulence differed markedly from their behaviour in tranquil periods. An over-valuation of the currency, low levels of foreign exchange reserves and a below-average export growth were symptomatic of periods prior to typical turbulences. Moreover, Frankel and Rose,²⁷ who were themselves rather surprised by their (non-) findings, conclude that "... neither current account nor government budget deficits appear to play an important role in a typical crash ...", statistical evidence is provided that both variables in fact do increase economies' vulnerability to speculative attacks. In many cases, too, a sharp expansion of domestic lending, and almost as a consequence thereof, high inflation differentials, may also have shared responsibility. Above and beyond that, susceptibility to speculative attacks also seems to increase whenever interest rates in the United States rise, impelling internationally oriented investors to re-think their global portfolios, for one thing, and impairing the creditworthiness of the emerging markets due to a rising debt burden, for another.

It might be quite ambitious, though, to see such studies on the behaviour of macroeconomic variables prior to currency turbulences as an appropriate starting-point for establishing an early warning system to avoid future turbulences in the foreign exchange markets. A basic problem in setting up an early warning system may lie in the fact that international financial market players, if given such an instrument to forecast currency turbulences, will change their behaviour, meaning that the relationships of the past would not be able to be carried over into the future. To the extent that this theoretical critique does not fully apply in practice, the empirical model may support the examination of the vulnerability of an emerging market to currency turbulences. After all, the study was able to show that the financial market players generally did not act out of tune with the fundamentals in the past. It has identified a number of macroeconomic variables to which political decision-makers would have to pay attention when striving to minimise the vulnerability of their currencies to speculative attacks.

²⁷ J. A. Frankel, A. K. Rose, *op. cit.*, p. 365.

Karen McCuskert

Are Trade Restrictions to Protect the Balance of Payments Becoming Obsolete?

With the removal of exchange controls and other restrictions to capital mobility, the need for, and the use of, import restrictions for balance-of-payment reasons, as provided for under GATT Articles XII and XVIII:B, has diminished. Since a recent WTO ruling also seems to have put a stop to developing countries' using the ambiguity of treaty language to justify measures designed to protect their domestic industries, there is reason to expect that trade restrictions justified with a foreign exchange crisis will finally fall into disuse.

The WTO, formerly the GATT, is the source, keeper and final arbiter of basic rules governing international trade. As a legal treaty, based on economic principles, it is subject to juridical interpretation. The ultimate form of such interpretation is through trade disputes, based on alleged infringements, which are settled either by a panel or the WTO Appellate Body.

Before cases are brought to the WTO, there are various forms of "surveillance" implemented to ensure that member governments are in conformity with their obligations. One form of such surveillance is the work performed by the Committee on Balance-of-Payments Restrictions.

For the last several decades, this Committee has overseen the use of the exception to the GATT obligations which allows for the use of import restrictions applied "to safeguard the level of foreign

* WTO Secretariat, Geneva, Switzerland. The views reflected here are solely those of the author and should not be attributed to the WTO.