EUROPEAN UNIVERSITY INSTITUTE

DEPARTMENT OF ECONOMICS

EUI Working Paper ECO No. 99/39

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Printed in Italy in December 1999
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November 15, 1999

Abstract

This paper is an attempt to explain currency crises and exchange rate movements in open emerging markets during the 1990s. A model is developed that allows a systematic comparison and evaluation of three competing explanations for crises: weak economic fundamentals, contagion and sunspots, i.e. exogenous shifts in agents' beliefs. Markov-switching regimes models and panel methodologies confirm that exogenous shifts in beliefs and in particular contagion, i.e. a high degree of real integration and financial interdependence among affected countries, are core explanations for the financial crisis of the 1990s. The model has a remarkably good out-of-sample predictive power. The findings suggest that the degree of financial interdependence and real integration among emerging markets is the single best indicator to explain and to predict which economies were hit and how severely they were affected by the 1994-95 Latin American crisis and the 1997-98 Asian crisis.

JEL no. F30, E60, E65, E44.
Keywords: currency crises, contagion, prediction, Asia, Latin America.

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1 Introduction

> *”[T]he power of contagion in the last two years settles a long-running dispute about currency crises in general: the dispute between ’fundamentalists’ and ’self-fulfillers’. ... I hereby capitulate. I cannot see any way to make sense of the contagion of 1997-98 without supposing the existence of multiple equilibria, with countries vulnerable to self-validating collapses in confidence, collapses that could be set off by events in faraway economies that* ***somehow*** *served as a trigger for self-fulfilling pessimism.”*
>
> Paul Krugman (1999, p.8/9, bold added)

This quotation from Paul Krugman underlines two important points about economists’ current thinking about currency crises: first, that analyzing economic fundamentals *alone* does not allow us to understand the causes and dynamics of financial crises, and second, that crises tend to be contagious though we still lack the knowledge as to *why* they may spread across countries. The aim of this paper is to help fill this gap and provide an answer with regard to why many crises of the 1990s clustered within regions and affected almost simultaneously a broad variety of countries, and why they have turned out to be far more severe than fundamentals would have warranted.

It is not an exaggeration to say that our understanding of the causes and the dynamics of the emerging market crises of the 1990s is still far from complete. Empirical tests of standard models of currency crises show that these models are not only poor in explaining those crises but that they have outright failed in predicting them (Berg and Pattillo 1998). This failure may partly reflect the heterogeneity of crises in different countries and during various episodes but, more importantly, it questions the usefulness of first-generation and second-generation models that concentrate on economic fundamentals and non-linearities in government decisions in explaining the causes of currency crises.

But the tide has started to turn, and current work is focusing increasingly on the role of private sector expectations and how changes in beliefs can shift markets across multiple equilibria (Chang and Velasco 1998, Radelet and Sachs 1999). Building upon the Diamond and Dybvig (1983) model of bank runs, much of the recent work shows how a loss of investor confidence can lead to a capital flow reversal, a liquidity squeeze and ultimately to the collapse of the domestic currency (Valdes 1996, Goldfajn and Valdes 1997). A consensus is emerging that a key reason for the severity of the recent crises is that an initially modest devaluation may initiate a vicious cycle in which a subsequent attempt of investors and companies to cover their foreign exchange exposure may drive foreign currency values further down, which in turn may render debtors unable to service their debt. The postponement or default on debt servicing might then set off another round of devaluation which would further worsen the liquidity situation in the country, in particular in the banking sector. Due to this self-sustaining dynamic, exchange rates tend to overshoot any level that might be considered sensible from a macroeconomic perspective.

Kaminsky and Reinhart (1999) find compelling empirical evidence for this link between financial sector crises and balance-of-payments crises, or ”twin crises”. However, while such ”third-generation” models may account for why crises can become so severe, they fail to explain what triggers the shift in expectations among market participants and why this has occurred almost simultaneously in various countries as witnessed during the Latin American crisis of 1994-95 and the recent Asian crisis.

Despite this emphasis on the role of private sector beliefs, no systematic attempt has yet emerged that compares competing causes for currency crises. The aim of this paper is to provide such a framework in which one can compare and evaluate three explanations for crises: weak economic fundamentals, contagion and sunspots, i.e. exogenous shifts in agents' beliefs. What motivates the paper in particular is the current literature's omission of how crises are linked across countries. An *infection function* is presented in section 2 in which the crisis severity of a country is not only determined by the strength of its fundamentals and exogenous changes in agents' beliefs, but also by the degree to which crises in other countries are transmitted across economies.

How does one define contagion? The debate on this seemingly trivial question is still controversial.[1] I define contagion here as the transmission of a crisis that is not *caused* by the affected country's fundamentals (although, of course, the transmission has an impact on the country's fundamentals ex post) but by its "proximity" to the country where the crisis originated. Two types of "proximity", i.e. two channels of contagion, are identified. I refer to the first channel as "real integration contagion": a crisis and sharp devaluation in one economy worsens the competitiveness of others and lowers the trade balance, in particular of close competitors, thus putting more pressure on those currencies

[1] Jeanne and Masson (1998) adopt a broad definition in which contagion is identified as factors other than fundamentals that connect countries. Rigobon (1999) adopts a far narrower definition in which links across countries need to intensify in order to constitute contagion.

to devalue. The second channel is what I call ”financial integration contagion”: the event of a crisis in one market induces investors to withdraw assets from others either (a) to raise cash for redemptions (”institutional contagion”) or (b) to follow other investors to avoid losses in closely integrated financial markets (”herding contagion”), hence raising the likelihood that these markets will also become victims of currency attacks and devaluations.

Only few empirical studies of these contagion channels exist so far. Glick and Rose (1999) present findings which suggests that trade linkages might have played some role in the transmission of recent financial crises, although their empirical measure is controversial because it looks only at bilateral trade while third market competition seems to be a more important channel for most emerging markets. There is more convincing evidence for the role of financial linkages in transmitting crises: Calvo and Mendoza (1999) argue that herding behavior in financial markets can be fully rational as the globalization of financial markets reduces the incentive for investors to collect first-hand information and encourages them to follow common investment strategies. Frankel and Schmukler (1996) indeed find evidence that such herding behavior and institutional factors were partly responsible for the spread of the Mexican crisis in 1994 to other emerging markets, while Fratzscher (1998b) shows that a higher correlation of stock market returns with countries where the crisis originated meant that countries were more likely to be affected by the Latin American and Asian crises. Using daily data, Baig and Goldfajn (1998) reveal how important contagion channels can be by showing that news about economic or political events in one Asian country strongly affected exchange rates and stock markets of other regional countries during the course of the Asian crisis.

The goal of the empirical analysis in section 4 is to compare the power of contagion channels with the role of fundamentals in causing and transmitting currency crises, as suggested by the infection function of section 2. A Markov-switching regimes methodology is used to proxy jumps in market beliefs which are not warranted by changes in economic fundamentals. The Markov-switching model performs well for most of the 24 emerging markets in the sample, indicating that beliefs and asset values in foreign exchange markets may exhibit jumps that cannot be related to fundamentals but are caused by contagion. A panel analysis then produces compelling evidence that the Latin American crisis in 1994/95 and the Asian crisis of 1997 spread across emerging markets not primarily due to the weakness of those countries' fundamentals but due to a high degree of financial interdependence among affected economies, thus confirming the importance and predominance of this contagion channel. Section 5 tests the model's ability to predict the Asian and the Latin American crises out-of-sample and shows that taking contagion factors into account would have permitted a quite accurate prediction of which countries were affected by these two crises. The paper concludes by outlining some general policy implications.

2 A Framework of Contagious Currency Crises

The aim of this section is to present a simple model that can be tested empirically and that allows the distinction between three separate causes of crises: weak economic fundamentals, contagion and sunspots.[2] Thus the model not only synthesizes arguments of first-generation and second-generation type of models but also allows for contagion linkages across countries as the cause of currency crises.

2.1 Modeling the transmission of currency crises

This simple, two-sector balance-of-payments model is basically a liquidity model in which the occurrence of a devaluation is solely determined by supply and demand factors for foreign exchange (*FX*): the peg $\bar{e}$ is sustainable only if the supply of foreign exchange is greater than or equal to its demand and e is floated otherwise. The government is assumed to be passive in that it has available a fixed amount of foreign exchange $\bar{R}$, which may include not only current reserves but also funds that could be borrowed to defend the currency.[3]

As the first sector, the domestic production sector's net demand for foreign exchange is FX^F to meet expenses from trading and for debt servicing:

(1) $$FX_t^F = D_t(X,\pi,r)_t - TB_t(RER_t)$$

where X measures the strength of the country's economic fundamentals, with $X_t \in [0,1]$, TB_t the trade balance and D_t the net debt service this period. Changes in debt servicing obligations can have three causes: first, an increase in world interest rates i at which the debt stock $\overline{D_t}$ needs to be serviced (external effects); second, a jump in devaluation expectations π_t or weakening fundamentals X (internal effects); third, the danger of a currency crisis in another economy (π_t^j):

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[2] The model builds on, although it is distinct in important aspects from earlier work by Cole and Kehoe (1996), Jeanne (1997), Jeanne and Masson (1998) and Masson (1999).

[3] The model ignores the possibility that multiple equilibria may be caused by non-linearities in government behavior, as in escape clause models introduced by Obstfeld (1986), since we want to focus on private sector non-linearities as a source of multiple equilibria.

(2) $$D_t = r\overline{D_t} + \pi_t(1 - X_t)\overline{D_t} + \gamma\pi_t^j\overline{D_t}$$

An increase in the probability of a crisis in country j (π_t^j) may induce foreign lenders to withdraw funds from the home economy and refuse a roll-over of loans in order to reduce their overall exposure (institutional contagion). The home economy is hit harder by such a shock the more financially connected it is with the crisis economy, which is measured in the model by the weight γ.

The second source for a jump in the demand for foreign exchange by the real sector is via the trade balance TB_t. An appreciation of the real exchange rate, i.e. a drop in *RER*, either vis-a-vis the rest of the world (RER^{ROW}) or vis-a-vis the country *j* where a currency crisis occurred (RER^j) worsens the trade balance:

(3) $$TB_t = \overline{TB} + \psi RER_t^j + \theta RER_t^{ROW}$$

with ψ, θ as weights which determine how important the impact of a bilateral real exchange rate change is for the home country's trade balance. A currency crisis in country *j* can be contagious in raising the crisis probability in the home country, in this case by worsening the trade balance (real integration contagion).

The second sector in the model is the financial sector, in which investors hold a stock of domestic currency $\overline{FX_t^S}$. In each period, investors decide whether or not to convert the domestic currency into US dollars. The total foreign exchange demand by investors FX_t^S is determined by the probability of devaluation in the home country π_t, domestic fundamentals *X*, the degree of capital controls δ (or transaction costs) which constrains how much capital they can withdraw; and by currency crises occurring elsewhere in the world (π_t^j):

(4) $$FX_t^S = \delta\left[\pi_t(1 - X_t)\overline{FX_t^S} + \lambda\pi_t^j\overline{FX_t^S}\right]$$

The degree to which a currency crisis in country *j* affects the forex demand in the home country is determined by the degree of herd behavior in the markets (herding contagion) and by institutional contagion: a crisis in country *j* (π_t^j) may induce foreign lenders to withdraw funds from the domestic economy in order to reduce their overall exposure or raise cash for redemptions. The home economy is hit harder by such a shock the more financially connected it is with the crisis economy, which is measured in the model by the weight λ.

Based on these arguments, the devaluation probability in our model is

(5) $$\pi_t = prob_t\left[\overline{R_t} < FX_t^F + FX_t^S\right]$$

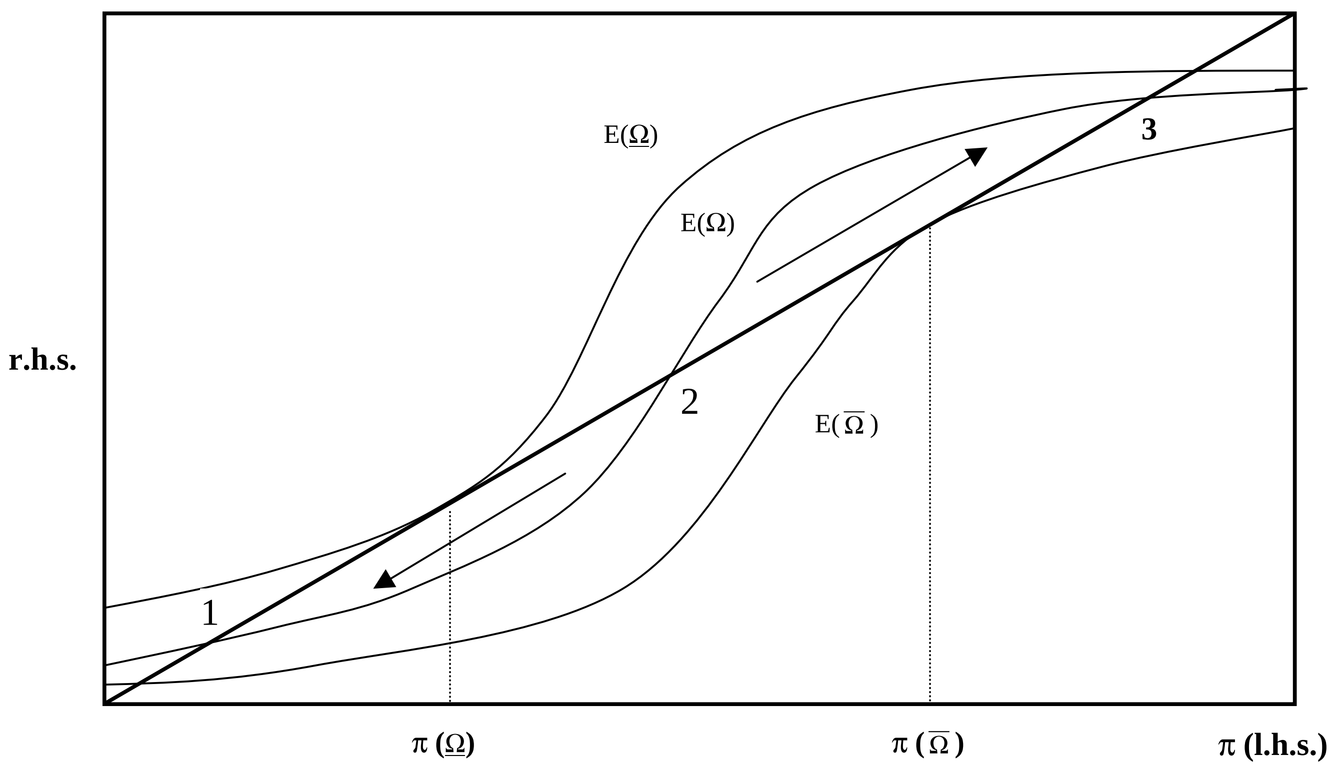
which, by substituting with the relations above, becomes

(6) $$\pi_t = F\left[\pi_t\left((1 - X_t + \gamma\frac{\pi_t^Z}{\pi_t})\overline{D_t} + \psi\frac{\pi_t^j}{\pi_t}(\Delta RER_t^j) + \delta(1 - X_t + \lambda\frac{\pi_t^j}{\pi_t})\overline{FX_t^S}\right) - \Omega\right]$$

with F as the cumulative distribution function, $\Omega = \overline{R}_t - i\overline{D}_t - \overline{TB} - \theta RER_t^{ROW}$ as the net excess supply of foreign exchange reserves that is certain and independent of devaluation expectations in either the home country or the foreign country *j*.

When do multiple equilibria arise in this model? The fact that π_t is found on both sides of this last equation implies that multiple equilibria may be possible, though two further conditions have to hold : first, the right hand side of equation (6) must intersect the left hand side, which is represented by the 45° line, at more than one value of π_t (Figure 1). This is possible only if the slope of the r.h.s. is steeper than the l.h.s. for some values of π_t and less steep at others.

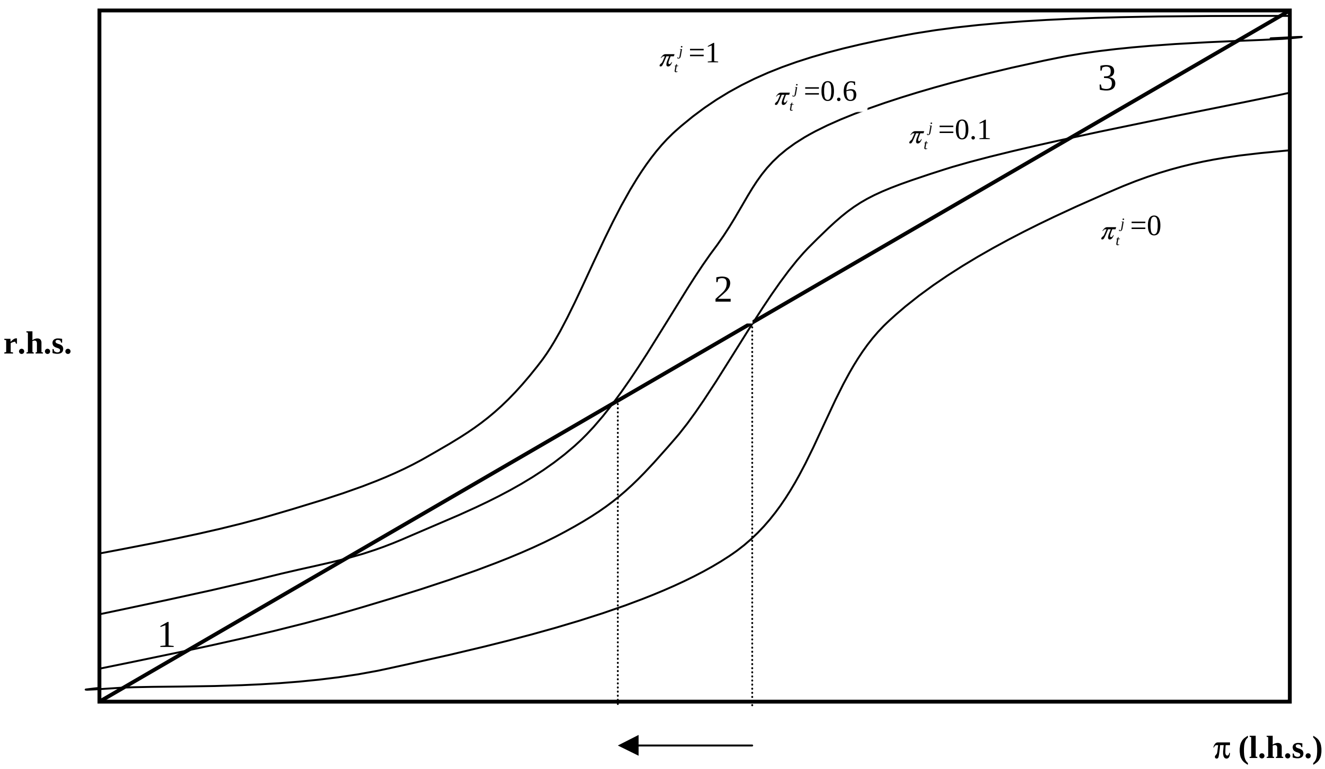
Figure 1: Multiple Equilibria and the "Zone of Vulnerability"



The second necessary condition is that Ω must lie in a zone of vulnerability. If the net foreign exchange supply is high, so that $R_t > FX_t^F + FX_t^S$ with certainty, then the probability of devaluation is determined uniquely and is close to π_t=0. If Ω is below a certain threshold so that $R_t < FX_t^F + FX_t^S$, then there is a unique equilibrium close to π_t =1. Hence only for $\Omega \in [\underline{\Omega}, \overline{\Omega}]$ do multiple equilibria exist.

In Figure 1, the area of multiple equilibria is between π_t ($\underline{\Omega}$) and π_t ($\overline{\Omega}$). Any curve E(Ω), for which these two conditions hold, has at least three equilibria. The important point is that only the first and the third equilibrium are stable whereas the second one is unstable, i.e. a small deviation from it will lead to either the first or the third equilibrium.

Figure 2: Multiple Equilibria Arising from Contagion



What is the role of contagion or, in other words, what is the impact of π_t^j on the domestic equilibrium of π_t? Figure 2 illustrates that an increase in π_t^j entails an upward shift of the curves, thus raising both the low-level and the high-level equilibrium of π_t. The interesting case is that an actual currency crisis in a related country j (π_t^j =1) might abolish the existence of multiple equilibria and cause an attack on the domestic currency. In other words, real and financial interdependence between the two economies might be so strong that a devaluation in a closely related economy will necessarily mean that the domestic economy will lack foreign exchange supplies to maintain the peg.

2.2 Infection function and Markov-switching regimes methodology

To derive a model that is testable empirically, one can linearize the non-linear model of equation (6) under the assumption that the volatility of the fundamentals is sufficiently small (Jeanne 1997). This linearization yields a reduced form model, or *infection function*, that can be expressed as

$$(7)\; y_{i,t} = \alpha_i + \beta_R{}' \sum_{j \neq i} \left(y_{j,t} \times REAL_{ij,t} \right) + \beta_F{}' \sum_{j \neq i} \left(y_{j,t} \times FIN_{ij,t} \right) + \beta_X{}' x_{t-1} + u_{i,t}$$

with $y_{j,t}$ as the exchange market pressure or credibility in country *i*, and β_R, β_F, β_X as the vectors of coefficients. Thus, this *infection function* allows for two sources for changes in the domestic currency regime: weak economic fundamentals x_{t-1} and contagion. The extent to which the home economy *i* is affected by crises in country *j* crucially depends on the degree of real integration ($REAL_{ij}$) or financial interdependence (FIN_{ij}) with other countries *j*.

The key shortcoming of the linear infection function of equation (7) is that it ignores the possibility that changes in expectations and private sector beliefs, which are caused by neither fundamentals nor contagion, may also be a cause of a crisis. To also analyze the role of exogenous shifts in expectations in causing crises, a more promising approach is to employ a non-linear Markov-switching regimes model that was developed for time series analysis by Hamilton (1989, 1990). Hamilton (1989) initially developed the Markov-switching methodology for the analysis of US business cycles, but this methodology can be extended so that regime shifts represent jumps between multiple equilibria, thus allowing for jumps rather than only smooth realignments in exchange rates.[4]

[4] The use of Markov-switching regimes models to analyze foreign exchange markets is still rather new. Gomez-Puig and Montalvo (1997) and Engel and Hakkio (1994) estimate a Markov-switching regimes model for ERM currencies although their weakness is that they base their credibility estimates on macroeconomic fundamentals (domestic interest rate differentials and deviations of the spot rate from the central parity, respectively) which are rather inaccurate measures of true market expectations. Jeanne (1997) and Jeanne and Masson (1998) analyze the French Franc and indeed find evidence that a Markov-switching regimes model with two regimes performs better than a linear OLS estimation for 1987-93, though their model is rather ad hoc and ignores many potentially important fundamentals.

Exogenous jumps in beliefs can be modeled in different ways within the Markov-switching framework. Given the characteristics of the data, I model exogenous shifts in beliefs as switching intercepts α and changes in the error variance Σ (heteroskedasticity).[5] Thus the infection function with the Markov-switching regimes methodology becomes:

$$y_{i,t} = \alpha_i(s_t) + \beta_R{}' \sum_{j \neq i} \left(y_{j,t} \times REAL_{ij,t} \right) + \beta_F{}' \sum_{j \neq i} \left(y_{j,t} \times FIN_{ij,t} \right) + \beta_X{}' x_{t-1} + \Sigma^{1/2}(s_t) u_{i,t} \quad (8)$$

where s_t indicates the state in period t, and u_t is $NID\ (0,I_K)$. The reformulation of the infection function as a Markov-switching model thus enables us to now distinguish between three causes of currency crises: weak fundamentals, contagion, and exogenous jumps in beliefs.

The key assumption in this model is that regime switches reflect changes in expectations that are unrelated to fundamentals or contagion. A potential problem with this assumption is that the shifts in the intercept and the variance may not just represent sunspots but possibly also changes in unobservable fundamentals or in expectations about future fundamentals. The empirical investigation of these and other issues is the subject of the following sections.

3 Empirical Methodology

Since the central objective of this paper is to analyze the question whether contagion or sunspots have played a role in the recent emerging market crises, the focus of the empirical analysis is exclusively on 25 *open* emerging markets, as defined by the IFC plus some transition economies, for the period 1986 to 1998 (see appendix). The reason for choosing this sample and time period is that contagion as defined above can affect currencies only where capital flows are relatively free. This section discusses the definition of the exogenous variables and contagion measures, while the fundamentals have standard definitions and are explained in the appendix.

[5] Note that a regime shift may also be constituted by a change in the mean or a switch in the autoregressive parameters. Due to the short length of the time series and the limited degrees of freedom these sources could not be analyzed in this context. See Krolzig (1997) for a thorough discussion of different sources of regime shifts.

3.1 Measuring private sector expectations and currency crises

The obvious difficulty is how to measure the exogenous variable, i.e. the probability of a devaluation and in particular how to proxy the beliefs of agents. It is this motivation of understanding the subjective perception of markets that has given rise to extensive work on exchange rate expectations over the years. Early work mostly focuses on interest rate differentials and on measuring expectations within target zone bands via the drift-adjustment method which distinguishes between expectations of currency changes within the bands and the realignment probability of the central parity. The drift-adjustment method can sensibly be applied only to target zones, but it also has severe shortcomings, partly through its reliance on the assumption of uncovered interest parity and on past fundamentals, and therefore is not a useful method to proxy expectations for emerging markets.[6] A more promising approach is one that looks at option prices since these are highly accurate in reflecting market perceptions of exchange rate risks (Campa and Chang 1996, and Malz 1996). The problem is that such markets either do not exist or are very thin for emerging markets.

I therefore employ two alternative credibility measures of an exchange rate regime. First, I construct a credibility measure of a particular currency by using the *Financial Times Currency Forecaster* data, which is a geometric average of exchange rate predictions by traders, multinationals and forecasting agencies. This data is used to measure the credibility ($CRED_t$) of a particular exchange rate regime at time t as the percentage deviation of the three-month ahead prediction ($PRED_t^{t+3}$) from the commitment level for that time ($COMMIT_t^{t+3}$):

(9) $$CRED_t \equiv \frac{PRED_t^{t+3}}{COMMIT_t^{t+3}}$$

The obvious difficulty is to determine what the actual commitment is. This problem is easily solved for pegged exchange rates, but it is trickier for those currencies under a managed float, independent float or crawling peg regime. For regimes with exchange rate bands, I use the deviation from the central parity as a credibility measure, implying that a currency has less credibility the more that agents expect the rate to be depreciated relative to the parity. For those few currencies that did not have bands, I employ credibility measures that are based on exchange rate trends over the past three months, one year or two years. For instance, if a currency without bands had depreciated at a steady three-month

[6] Branson (1994) provides a short but compelling critique of this methodology.

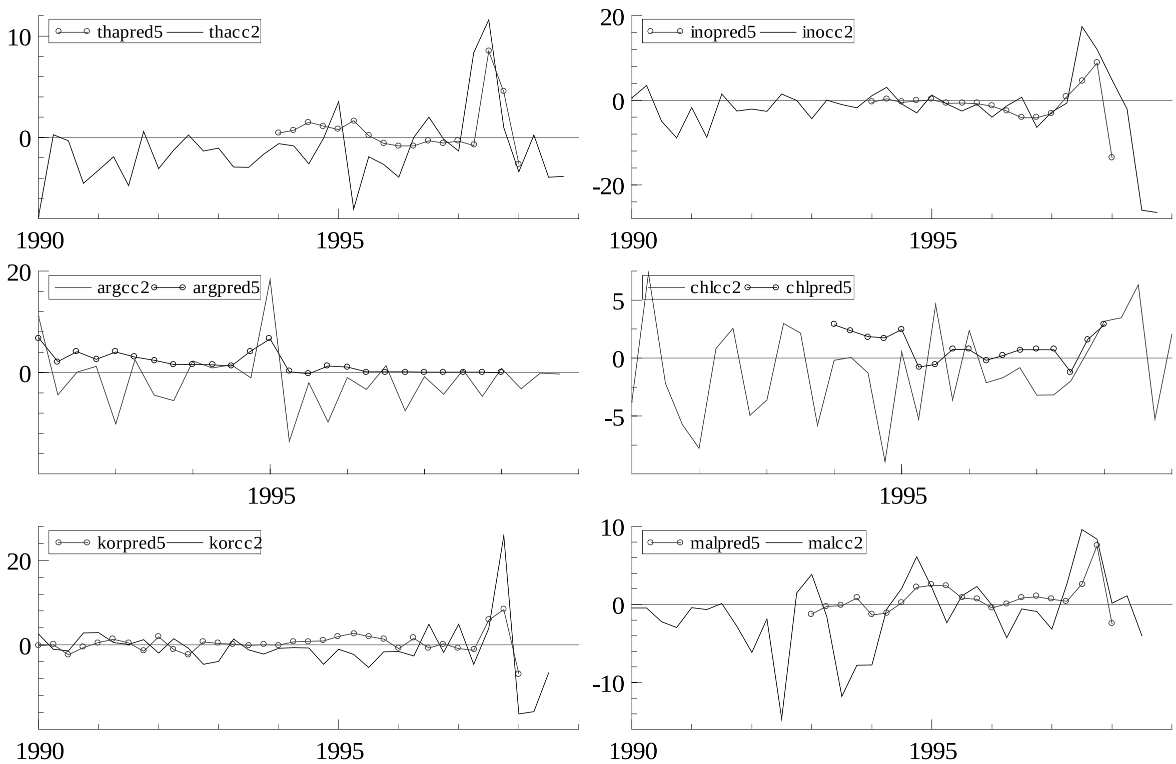
rate of 1% over previous years, I use for the committed rate in three months the spot rate on the day of the prediction plus a 1% depreciation.

The second measure is the actual exchange market pressure (*EMP*) on a particular currency. This measure is a weighted average of the changes in the exchange rate *e*, the interest rate *i* and the foreign exchange reserves *R*:

$$EMP_t \equiv \eta(\Delta e_{i,t}) + \varphi(\Delta(i_{i,t} - i_{US,t})) - \psi(\Delta R_{i,t}) \qquad (10)$$

with *i* and i_{US} as the domestic and US interest rates, respectively, δ as the change of a variable, and η, φ, ψ as weights.[7] The intuition for using this measure is that when facing pressure on its currency, a government has basically the option of either devaluing the currency, raising interest rates and/or running down reserves. Hence such exchange market pressure (*EMP*) is a fairly good proxy for the strength of the pressure against the existing currency regime and also captures speculative attack episodes which fail to bring about a devaluation.

Fig. 3: Comparisons of CRED (pred5) and EMP (cc2)



[7] Each of the three measures is weighted by their relative precisions, calculated as the inverse of the series' variance in the past. It has been employed in various studies of currency crises, including Eichengreen, Rose and Wyplosz (1996) and Sachs, Tornell and Velasco (1996).

Figure 3 shows the exchange market pressure (*EMP*) and credibility (*CRED*) measures for a few select countries that were hit hardest by some of the crises in the 1990s. As for other countries, the data show that both measures are fairly similar and, in particular, reveal highly credible exchange rate regimes in Southeast Asia prior to July 1997 and for Latin America, i.e. *CRED* often took on a negative value indicating that investors expected the currencies to strengthen rather than weaken. The similarity in the two data series also demonstrates that the crises in the listed countries were widely unanticipated.

3.2 Contagion: measuring real and financial interdependence

The balance-of-payments model in section 2 distinguishes between two channels of contagion, one based on real integration and one on financial interdependence among economies. To measure these two contagion channels, I build on the methodology that I developed in Fratzscher (1998b).

3.2.1 Real Integration Contagion

Concerning the first channel, a country is affected more adversely by a devaluation in another country the more the two countries trade with each other and the more strongly they compete in third markets *d*. The degree of trade integration ($REAL_{ij}$) of country *j* with the country *i* where a crisis originates is measured as

(11) $$REAL_{ij} = \sum_{c} \sum_{d} \left(\frac{X_{id}^{c}}{X_{\cdot d}^{c}} \times \frac{X_{jd}^{c}}{X_{j\cdot}} \right) + \sum_{c} \left(\frac{X_{ij}^{c} + X_{ji}^{c}}{X_{\cdot j}^{c} + X_{j\cdot}^{c}} \right)$$

The first term indicates the degree of competition between countries *i* and *j* in the export market of commodity *c* (X^c) in the third market *d*. The larger the export market share of country *i* is in region *d* $\left(X_{id}^{c} / X_{\cdot d}^{c}\right)$ and the higher the share for country *j* of total exports of that commodity to region *d* ($X_{jd}^{c} / X_{j\cdot}$), the more strongly will country *j* be affected by a devaluation in country *i*. The second term measures the degree of bilateral trade between the two countries, implying that country *j* will be affected more by a devaluation in country *i* the greater the amount of bilateral trade between them.

Table 1 shows that the degree of real integration is particularly high for economies of the same region. Due to the large economic size and trade volume, Southeast and East Asian countries are the strongest competitors outside the own region, although the degree of competition with these economies is generally much smaller than with those within the same region (except for South Asia). The degree of trade competition proved robust to the choice of weights between bilateral and third market trade. Thus, these findings provide a first indication that if a currency crisis occurs in one country, the crisis is likely to spread through real integration mostly to other regional economies and much less to those located elsewhere in the world.

Table 1: Real Integration of Regions

country i: / country j:	Avgerage Real Integration: L. America	Asia	SE&E Asia	S Asia	Others
Latin America	35.7	3.8	4.2	2.6	3.7
Asia:	7.8	40.0	41.3	36.0	13.2
Southeast & East Asia	9.9	49.9	53.7	38.2	16.5
South Asia	1.3	10.3	3.9	29.4	3.4
Others	4.4	4.9	4.1	7.3	22.5

Note: Real Integration for 1996, scaled to lie between 0 and 100.
Others: Eastern Europe, Middle East, Africa.
See Appendix for countries included.

3.2.2 Financial Integration Contagion

How to measure financial integration contagion (FIN_{ij}), the second transmission channel, is a more difficult and controversial matter. While much recent work focuses on the openness of the capital account and the degree and timing of financial integration of emerging markets with developed markets (Bekaert et al. 1998, Phylaktis 1999) the issue I am interested in here for the purpose of measuring contagion is how an investment decision in a financial asset in one emerging market affects investment decisions in other emerging markets, i.e. to what extent underlying asset prices are interdependent.

It is crucial to emphasize that a higher degree of openness of the capital account does not necessarily imply a larger extent of comovements of asset prices. There are three reasons for this: financial interdependence can also result from investors, correctly or incorrectly, considering economies of the same region as having similar prospects, thus having to adjust their portfolio or to raise cash for redemptions when one economy is hit by a crisis (“external institutional contagion”) or simply following other investors in withdrawing funds in fear of contagion ("herding contagion"). Moreover, financial interdependence can result from direct cross-border links among financial and non-financial institutions which transmits movements of asset prices across countries ("internal institutional contagion"). As mentioned above, there is some evidence for the existence of these contagion channels (Frankel and Schmukler 1998).

To measure financial interdependence, I use the monthly averages of the correlation of weekly stock market returns.[8] Since a high correlation of returns may be partly explained by similarities in fundamentals or by the exposure to common external shocks in developed markets, I control for these factors by regressing the country return index (*RI*) on country-specific fundamentals as well as on weighted returns of the S&P 500, FTSE 100 and NIKKEI (*GRET*):

$$(12) \quad RI_{i,t} = \beta_0 + \beta_1 CAP_{i,t} + \beta_2 TB_{i,t} + \beta_3 r_{i,t} + \beta_4 P_{i,t} + \beta_5 S_{i,t} + \beta_6 GRET_t + \mu_{i,t}$$

with the independent variables of portfolio capital inflows (*CAP*), the trade balance (*TB*), the change in a country's interest rate (*r*), the rate of inflation (*P*) and the spot exchange rate (*S*) for each country *i*. The correlations of the residual μ should give a reasonably good idea about the true interdependence of various emerging stock markets.[9]

Table 2 confirms that financial interdependence is significantly higher among markets of the same region. Two results stand out: first, controlling for global shocks and country-specific factors mostly raises the degree of financial interdependence; and second, the residual correlations are particularly high among Southeast and East Asian markets. This suggests that financial integration contagion is stronger both within regions and in particular within Southeast and East Asia. For instance, South Asian markets have a low degree of financial interdependence with Southeast and East Asia, possibly offering an

[8] Baig and Goldfajn (1998) also look at cross-country correlations of exchange rates, interest rates and sovereign risk spreads during the course of the Asian crisis. None of these three measures is appropriate in the context of this paper because the first two were a policy tool under managed exchange rate regimes prior to the crisis and the sovereign risk spreads reflect the market perception of the default risk rather than the interdependence of financial markets.

[9] Wolf (1998) shows that another potential bias, apart from similarities in fundamentals, may result from the similarity of the sectoral composition of countries' stock market return indices. I.e., if the sectoral composition of stock market indices in two countries are similar, then it is possible that comovements of these two indices are caused by changes in one particular sector which in turn may be caused by global developments. However, Wolf finds that the correlation of returns is in many cases higher after controlling for such similarities, thus confirming the importance of contagion.

explanation as to why contagion did not hit South Asia during the 1997-98 Asian financial crisis. The empirical analysis of the role of contagion is the subject of the following sections.

Table 2: Financial Interdependence of Regions

	Avg. Return Residual Correlations					Avg. Return Correlations				
	L. America	Asia	SE&E Asia	S Asia	Others	L. America	Asia	SE&E Asia	S Asia	Others
Latin America	30.1					34.9				
Asia:	14.7	29.4				15.9	16.5			
Southeast & East Asia	13.1	36.1	57.2			17.9	19.9	31.2		
South Asia	17.3	18.3	11.9	47.2		12.4	10.7	12.2	26.4	
Others	18.7	10.0	13.9	3.5	23.3	6.6	9.5	10.0	8.6	19.8

Note: Correlations are for the period of 1992/Q1-1996/Q4.
Others: Eastern Europe, Middle East, Africa. See Appendix for countries included.

4 Empirical Results: Explaining Currency Crises

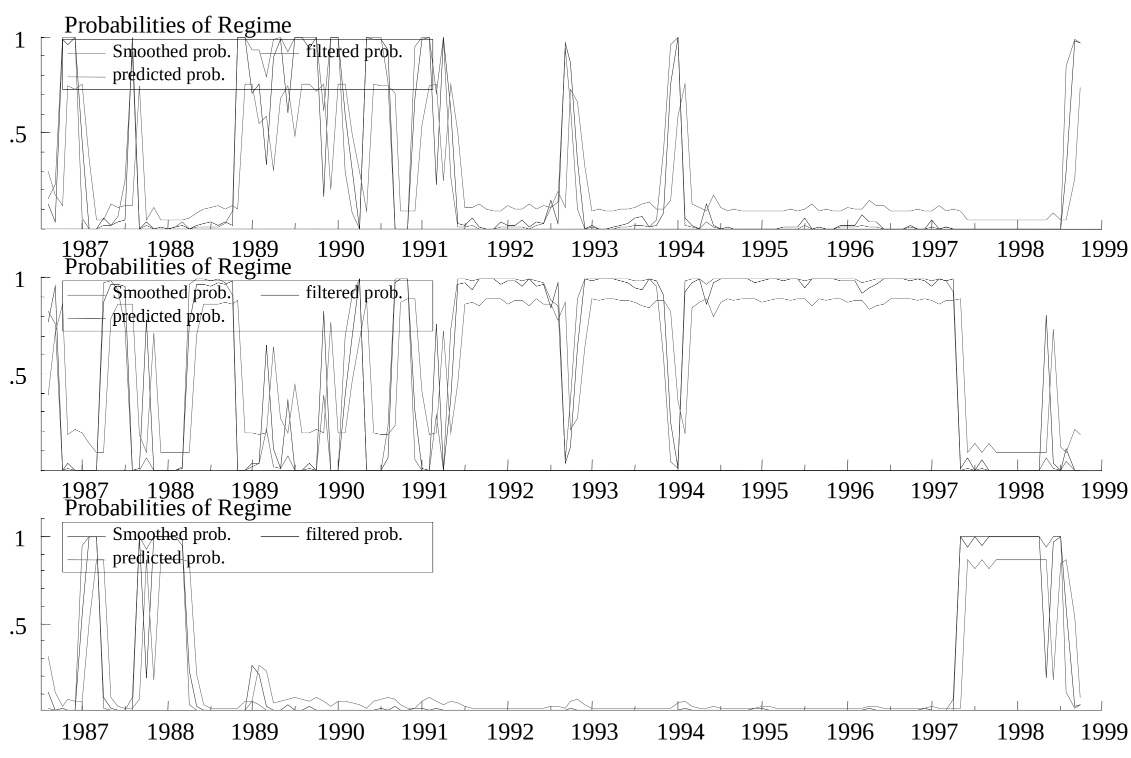
I follow a three-pronged testing strategy. In order to check whether contagion exists, I first test for the presence of comovements in foreign exchange markets across countries, and then look at individual countries to analyze whether jumps in foreign exchange markets exist and which variables play a dominant role. As a final step, a panel analysis compares the role of fundamentals with the power of contagion in explaining movements in foreign exchange markets and crises.

4.1 Comovements and common shocks

To test for contagion, this subsection looks at comovements, or cross correlations, in foreign exchange markets in order to understand whether transmission channels for shocks really exist. From an intuitive point of view, comovements in foreign exchange markets and private sector expectations seem to be present for regional economies during crisis periods. But does this hold also across countries of different regions? And does it exist during periods other than crisis episodes? To answer these questions, I employ an atheoretical MSVAR model with intercept and variance switching (MSIH-VAR), as presented in equation (8), in which current values of the exchange market pressure variable (*EMP*) or credibility (*CRED*) of a vector of emerging markets only depend on their past values.

First, I look only at regional country groupings and I indeed find evidence that exchange rates as well as expectations show strong comovements across regional economies in both Asia and in Latin America. As an example, Table 3a and Figures 4(a)-4(c) (also see appendix) show the results for the exchange market pressure variable (*EMP*) of the five Asian economies which were hit hardest by the 1997-98 Asian crisis (Indonesia, Malaysia, Korea, Philippines, Korea). The interesting finding is that MSVAR models with different numbers of regimes are permissible and provide complementary explanations. The model with two regimes distinguishes between tranquil periods with low volatility and relatively low correlation across currencies (Regime 1) and crisis periods of the late 1980s and the Asian crisis of 1997-98 with a high degree of volatility and high correlations in exchange rates, in particular with the Thai baht (Regime 2).

Fig. 4(b): Regime Switching Probabilities, MSIH(3)-VAR, EMP of 5 Asian economies



In contrast, the model with three regimes (see Figure 4(b) above) identifies the same crises regime (Regime 3), but now distinguishes between a period of high exchange rate volatility which was mostly in the late 1980s and early 1990s (Regime 1), and a period of tranquility with low exchange rate volatility in the 1990s till the collapse in mid-1997 (Regime 2). The model with four regimes makes a further distinction within the volatile period between times when exchange rates were stable and volatile (Regime 2) and a few episodes when the exchange rate appreciated significantly, which was mainly following currency crises or devaluations (Regime 1).

The MSVAR analysis, however, does not detect any meaningful comovements for countries across regions. Even when looking at only a narrow grouping of 13 open emerging markets in Latin America and Asia, the model fails to detect meaningful common trends or patterns because there are few similarities across currencies to be found within regimes. For instance, a particular regime may indicate a large appreciation and high volatility for some countries while at the same time it shows depreciating currencies and low volatility for others (Table 3c). These results are robust to changes in the cross-regional country groupings.

A note of caution is necessary at this point because one potentially important reason for comovements in foreign exchange markets is that almost all of the analyzed currencies primarily target the US dollar. However, while US dollar movements were likely to have affected emerging market exchange rates which were tied to it (an argument also investigated more formally in the next subsection) these movements alone could not have been the driving force for emerging market currencies. In particular, if the US dollar had been the driving force one would expect to see a much stronger correlation of currency movements across regions since most Asian and Latin American currencies are closely tied to the dollar. The fact that this is not observed indicates that there must be other, regional factors that are responsible. Second, dollar movements are often contrary to developments observed in emerging markets. The Latin American crisis of 1994-95, for instance, came during a period where the US dollar was weakest, in particular against the yen and the mark.

Overall, the presented results and similar findings for the credibility variable (*CRED*, see Figures 5(a)-5(c) and Table 3c in appendix) in both Asia and in Latin America reveal that there are indeed strong comovements in exchange rates across countries of the same region. The striking feature is that movements in regional currencies and their credibility are particularly highly correlated during crises, though they also remain significant during tranquil periods (Tables 3a and 3b). This suggests that there is not only a permanently strong link across regional currencies but that contagion is particularly important during crisis periods.

4.2 Contagion versus fundamentals in an individual-country framework

Is it fundamentals or rather contagion which is responsible for the exchange market movements and crises in emerging markets in the 1990s? And how important are exogenous shifts in investors' beliefs? When looking at individual countries, the key finding of this subsection is that contagion is important for most countries in understanding exchange rate dynamics and its inclusion often eliminates the existence of regime shifts. This suggests that contagion is the main explanation for jumps in exchange rates in the analyzed emerging markets.

First, the Markov-switching regimes model with three regimes performs well for most countries, but only if the contagion variables are not included (regressions 1 and 2, Table 4).[10] This finding is intuitively convincing because when looking at the data on exchange market pressure, one can easily detect three regimes: a tranquil one where the exchange market pressure is around zero; a second one where there is a high degree of exchange market pressure and low credibility as during times of speculative attacks and crises; and a third one where there is a significant negative exchange market pressure, i.e. a currency appreciates, interest rate differentials fall and reserves are built up, which often occurs immediately after devaluations.

Second, when including contagion (regressions 3 and 4), the coefficient for financial contagion, and sometimes for real contagion, is mostly large and significant. The explanatory power and the fit of the model are mostly improved (i.e. lower variance and log-likelihood) by introducing the contagion variables and the need for regime switches is eliminated or reduced in many cases. What this implies is that the existence of contagion explains many of the regime shifts that can not be explained by fundamentals alone.

The case of the Philippines provides a good example: a Markov-switching model with three regimes and no contagion (Fig. 6(b) and Table 4) performs much better than the same model with only one regime (Fig. 6(a)). The linear model with no regime changes but with contagion (Fig. 6(c)), however, performs about as good and thus eliminates the need for regime shifts that are not due to changes in fundamentals. Note that contagion not only helps to explain the Philippines' increased exchange market pressure during the Asian

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[10] Using the methodology developed by Krolzig (1998), the MSVAR model is implemented empirically by applying the expectation maximization (EM) algorithm, programmed in Ox. With this, maximum likelihood estimates for the regime-switching models are obtained.

crisis but also during the Latin American crisis. Similar conclusions apply to a number of other countries which were victims of either of these two crises (Indonesia, Korea, Thailand, Mexico: see Table 4) while contagion does not explain regime shifts for other countries which were affected less (Chile, India).

Fig. 6(a): Philippines, M=1; No Contagion

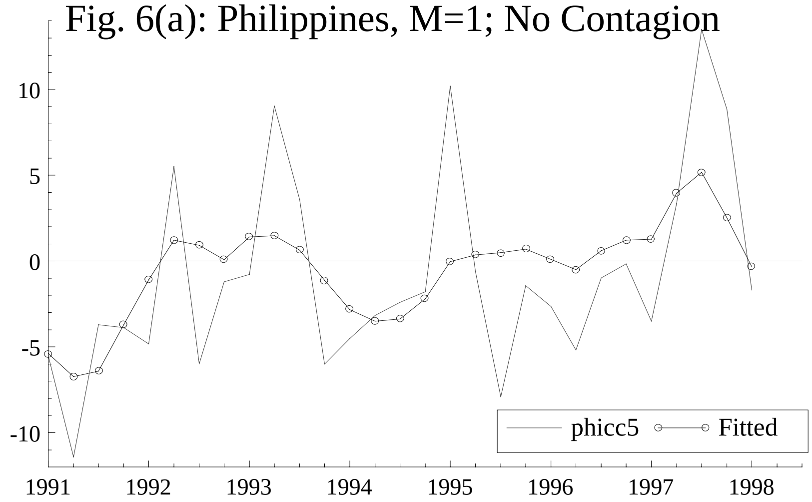


Fig. 6(b): Philippines, M=2; No Contagion

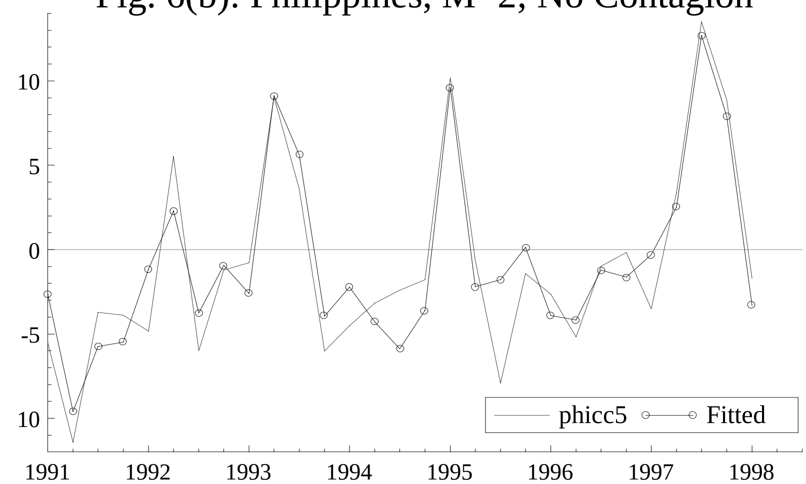
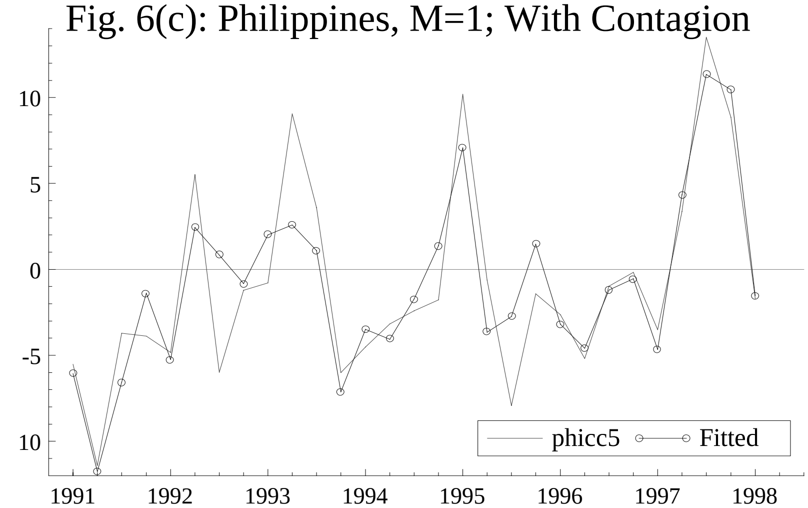


Fig. 6(c): Philippines, M=1; With Contagion



Third, there is no single economic fundamental that seems to have played a role in explaining the movements of the dependent variables in *all* countries over time. This indicates that what drives exchange rate movements and causes currency crises to spread across countries can differ significantly from country to country and across episodes. This renders it much harder to find common explanations for different crises and makes it obviously very difficult to predict crises reliably with fundamentals alone. Nevertheless, either the large size of foreign debt, fast domestic credit expansion ("Lending Boom") or an overvalued exchange rate (or often a combination of these three) is important in understanding movements in foreign exchange markets and expectations. Thus, looking at these three variables *together* should indeed provide a more promising idea of what is likely to happen in foreign exchange markets.[11]

Two other striking results are (1) that the size of capital flows (both total and short-term) has no explanatory power for almost any of the countries that were affected by the Asian or Latin American crises, and (2) that it is the change over the past years, and not the level, of domestic credit expansion which is significant. What these findings suggest is that large capital inflows and a permanently high level of domestic credit expansion may not necessarily constitute a problem for an economy as long as those resources are used in a sound way. For instance, Asian economies experienced large capital inflows since financial liberalization, but were unaffected by the Latin American crisis which hit countries that did not receive such large inflows of foreign capital.

A number of robustness checks were conducted. Most importantly, other fundamentals than those listed in Table 4 did not prove significant, such as external variables (growth, interest rates in industrialized countries) and other domestic variables (government deficit, short term debt and capital flows, etc.). It is also important to emphasize the shortcoming of the MSVAR methodology of tending to "over-fit" the data by using maximum likelihood estimation. I.e. the model with multiple regimes has a good fit but also in some cases produces coefficient estimates that do not make sense (showing either a large change in the coefficient or a wrong sign). Otherwise the MSVAR methodology appears sound from various test statistics, such as the switching probabilities (P_{ij}) shown in Table 4. The Markov transition matrices confirm that the probability of remaining in a particular state is usually about 50% or higher. Only very few

[11] Note also that there are in some cases significant differences between the estimates for *CRED* and those for *EMP*. This may partly reflect the differences between these two variables and also the shortened time period for the estimations using *CRED* for some countries.

regimes are characterized by one or two events, and most regimes are reached at least three times over the time span of ten or eleven years for *EMP*.

In conclusion, the Markov-switching regimes model is a superior alternative to the linear models used in most of the empirical literature on currency crises, but only when contagion variables are not included. The inclusion of contagion often eliminates the need for regime switches and shows that shifts in exchange rates are mostly explained by contagion rather than other external shifts in investors' beliefs or changes in fundamentals.

4.3 Contagion versus fundamentals in a panel framework

The key purpose of the panel analysis is to test whether the results for individual countries outlined in the previous subsection are robust across countries and whether we can detect factors that were common to the majority of countries. In particular, the weakness of the analysis for individual countries is that it fails to explain why some countries with more healthy fundamentals were affected so severely while others with worse economic conditions manage to escape unscathed. The answers to these issues can be found only in a panel framework, which uses equation (7) as discussed in section 2.2.

Table 5: Panel Estimation: Random Effects Model (MLE) for 24 Emerging Markets Worldwide, 1989/Q1-1998/Q2

	EMP					CRED				
	FUND. MODEL	FULL MODEL Contin.	CONT. MODEL Contagion	FULL MODEL Crises	CONT. MODEL Contagion	FUND. MODEL	FULL MODEL Contin.	CONT. MODEL Contagion	FULL MODEL Crises	CONT. MODEL Contagion
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Capital Flows	0.045	0.045		0.041		0.011	0.003		0.006	
Short-Term Cap. Flows	0.001	0.001		0.001		0.001	0.001		0.001	
Lending Boom	* 7.021	* 7.754		* 5.059		1.748	1.992		* 2.486	
Foreign Debt	* 10.71	* 9.295		* 8.327		* 3.139	* 2.748		* 1.135	
Short-Term Debt	* 4.719	* 4.322		* 4.479		* 1.007	* 0.824		0.210	
Overvaluation	* 6.225	* 5.303		* 5.558		* 5.289	* 4.437		* 4.274	
Reserves	-0.559	-0.587		-0.460		-0.227	-0.184		0.071	
Trade Balance	2.141	1.980		1.382		*-8.454	*-7.726		*-7.930	
Real Contagion		* 1.473	* 1.497	* 2.665	* 3.002		* 1.292	* 1.407	* 2.992	* 3.098
Financial Contagion		* 13.63	* 15.65	* 14.36	* 16.55		* 3.884	* 3.831	* 7.213	* 6.467
Constant	*-4.639	*-3.810	*-0.459	*-4.370	*-0.777	* 1.522	* 1.841	* 1.197	* 1.457	* 0.912
Log Likelihood	-1778	-1647	-1830	-1765	-2214	-596	-590	-600	-586	-597

Note: Estimations for CRED are only for 15 countries and 1994/Q1-98/Q2 due to the data availability (see appendix). Regressions for "Crisis contagion" include the contagion variables only for the crisis episodes of 1994/Q4-1995/Q2 and 1997/Q3-1998/Q1. * denotes statistical significance of coefficients at the 90% level.

The panel estimation yields some powerful and convincing results (Table 5). First, the most interesting result for our hypothesis is that there is indeed strong evidence that both the Asian crisis and the Latin American crisis were contagious. The primary channel of contagion seems to have been the channel of financial sector interdependence, whereas the coefficient of trade integration is much smaller though still significant. The importance of contagion is underlined when comparing the Full Model (including both fundamentals and contagion variables) with the Fundamentals Model (with only fundamentals) and the Contagion Model (with only contagion variables) and their log-likelihoods: the Full Model has a much better fit than the Fundamentals Model. Moreover, contagion seems to be of particular importance during crisis periods (the 1994-95 Latin American crisis and the 1997-98 Asian crisis) as indicated by the increase in the size of the coefficients (regressions 4, 5, 9, 10), though contagion is still relevant during tranquil periods.

Second, the fundamentals that turned out to be significant are the level of total foreign debt/GDP and short debt/GDP, a prior change in the ratio of domestic credit expansion to GDP (*"Lending Boom"*), and the overvaluation of the exchange rate. Many other variables were tested but did not show any significance (such as changes in the US dollar value vis-a-vis the mark and the yen, a country's government deficit, the current account, the trade balance, etc.).

Finally, the results are robust to changes in variable definitions and the time span but are sensitive to country groupings. To test for differences across regions, I employ an analysis of variance (ANOVA) methodology that takes for each country i, analogously to equation (7), the following form:

(13) $$y_{i,t} = \alpha_i + \gamma_i z_{i,t-1} + u_{i,t}$$

with *z* as the vector of fundamentals and contagion variables. The null hypothesis of interest is that the coefficient for an individual country (γ_i) is equal to the coefficient for the country grouping as a whole (β):

$$H_0 : \quad \gamma_i = \beta$$

The results reveal significant differences in the size and significance for most coefficients across regional groups whereas the size of the coefficient is reasonably robust within those regional groups (Table 6). Another important finding is that financial contagion seems to have been particularly strong across Asian countries and less significant, though still positive, in Latin America. On the contrary, the overvaluation of the exchange rate was more of a driving force in Latin America than in Asia.

Table 6: Analysis of Variance (ANOVA) of Panel Estimation for Full Model (EMP)

	Global		Asia		Latin America		Others	
	Global Coefficient	ANOVA accept H_0	Regional oefficient	ANOVA accept H_0	Regional oefficient	ANOVA accept H_0	Regional oefficient	ANOVA accept H_0
Capital Flows	0.045	12 / 24	0.111	4 / 9	0.058	6 / 8	-0.075	3 / 7
Short-Term Cap. Flows	0.001	11 / 24	0.008	5 / 9	-0.008	2 / 8	0.007	2 / 7
Lending Boom	* 7.754	13 / 24	3.473	4 / 9	* 15.99	5 / 8	* 7.164	3 / 7
Foreign Debt	* 9.295	10 / 24	* 18.99	4 / 9	* 5.887	3 / 8	* 7.061	4 / 7
Short-Term Debt	* 4.322	11 / 24	* 4.431	5 / 9	* 2.968	5 / 8	2.086	3 / 7
Overvaluation	* 5.303	10 / 24	0.717	4 / 9	* 13.06	5 / 8	* 4.517	4 / 7
Reserves	-0.587	10 / 24	-0.831	4 / 9	-0.731	5 / 8	-0.201	3 / 7
Trade Balance	1.980	9 / 24	2.525	4 / 9	-13.72	2 / 8	1.523	2 / 7
Real Contagion	* 1.473	14 / 24	* 1.843	6 / 9	1.235	6 / 8	-0.257	2 / 7
Financial Contagion	* 13.63	14 / 24	* 14.99	7 / 9	* 6.189	6 / 8	* 19.38	3 / 7

Note: ANOVA shows how many of the countries' coefficients are statistically equal to their group's coefficient at the 90% significance level. The contagion variables are continuous variables as defined in the infection function of equation (7
* denotes statistical significance of coefficients at the 90% level.

Overall, the results of the panel estimation and its analysis of variance largely support and strengthen the results of the MSVAR analysis for individual countries in section 4.2. In particular, while crises have diverse causes and no single fundamental variable is significant for every country and every time period, looking at the size of foreign debt, the rate of domestic credit expansion and the competitiveness of a country *together* helps in understanding a good amount of the movements in foreign exchange markets and expectations for most countries. But even after controlling for fundamentals, real sector contagion and in particular financial sector contagion still seem to have played an important role in the foreign exchange markets of many emerging markets.

5 The Full Model's Predictive Power

The ultimate proof of the quality of an empirical model is its out-of-sample forecasting ability. How would the Full Model have predicted the two major crises of the 1990s in Latin America and in Asia? And how does this predictive power compare to alternative models of currency crises?

Berg and Pattillo (1998) show that the fact that a model is good in explaining particular crises is no guarantee that it is capable of forecasting future crises. They evaluate and compare the predictive power of three of the most cited models, each representing a different type of model: Kaminsky, Lizondo and Reinhart's (1997) signaling approach which identifies when fundamentals provide signals for potential future crises, Frankel and Rose's (1996) panel data analysis with probit techniques reaching back to the 1970s, and Sachs, Tornell and Velasco's (1996) cross-sectional approach which focuses on a set of 20 open emerging markets during the Latin American crisis in 1994-95.

Even after improving on these methodologies, Berg and Pattillo find that none of the models would have predicted the 1997 Asian crisis in a satisfactory way. Table 7, reproduced from Berg and Pattillo (1998), provides a comparison of the models. Frankel and Rose's panel model and Sachs, Tornell and Velasco's cross-sectional approach are both very poor in forecasting the 1997 Asian crisis. They tend to predict crises in countries that were relatively unscathed and often fail to anticipate crises where they did occur. The revised signaling approach by Berg and Pattillo (BP) is by far the most promising model with a reasonably high Spearman rank correlation indicating that the model correctly forecasts which countries will be most severely affected by a crisis *if* the crisis occurs. The key weakness of this methodology, however, is that it is not able to predict the timing of a crisis and that false alarms, i.e. a signal that a crisis will occur but then in fact does not take place, are far more numerous than correct signals.

In comparison, Table 8 shows that the predictive power of our Full Model for the Asian crisis is superior in terms of ranking to all of the models tested by Berg and Pattillo. This superiority is particularly strong when the Full Model is compared with the models by Frankel and Rose and by Sachs, Tornell and Velasco, i.e. the models that have the most similar methodology. The superiority mostly stems from the inclusion of the contagion variables in the Full Model because the Fundamentals Model alone does not have a much better predictive power than the models by Frankel and Rose and by Sachs, Tornell and Velasco which are both built entirely on fundamentals.

Table 7: The 1997 Asian Crisis: Comparing the Predictive Power of Models by Kaminsky, Lizondo, Reinhart (KLR), Berg and Pattillo (BP), Frankel and Rose (FR) and Sachs, Tornell, Velasco (STV)

	KLR			BP		FR			STV		
	Actual Crises Index 1997	Predicted Probabilities of Crisis in 1997 Noise-to-signal Weighted Sum of Indic.1/		Predicted Probabilities of Crisis in 1997		Actual Crises Index 1997	Predicted Probabilities of Crisis in 1997 4/		Actual Crises Index 1997	Predicted Severity of Crisis in 1997	
		Original 2/	Augm. 3/	Indicators Model 1	Lincar Model 2		Model 2	Model 4		Model 3	Model 4
Thailand	1	16	7	4	2	3	7	11	2	7	5
Korea	2	4	5	3	9				3	12	11
Indonesia	3	18	11	8	8	2		7	1	14	9
Malaysia	4	8	13	5	1				4	6	6
Zimbabwe	5	3	3						5	23	12
Taiwan (POC)	6	5	4	6	5				9	11	22
Colombia	7	9	12	7	4	8	8	6	8	18	4
Philippines	8	1	1	2	12	7		8	6	1	1
Brazil	9	2	2	1	10	10	6	5	14	4	21
Turkey	10	7	10	13	18	1	3	2	7	9	13
Venezuela	11	14	16	13	20	5	10	12	21	22	13
Pakistan	12	10	9	11	6	6	11	9	10	17	20
South Africa	13	6	8	12	11				12	15	16
Jordan	14	15	18	13	13				17	20	15
India	15	20	21	13	19	14	13		13	5	19
Sri Lanka	16	17	19	13	14	11	14	13	15	16	17
Chile	17	18	20	13	15	15	9	10	16	19	14
Bolivia	18	20	21	13	21	13	12		22	13	10
Argentina	19	12	17	13	17	16	5	3	23	2	7
Mexico	20	13	14	13	22	12	4		18	21	18
Peru	21	11	6	10	7	9	1	4	20	8	23
Uruguay	22	20	21	13	16	4	2	1	11	3	3
Israel	23	20	15	9	3				19	10	8
Correlation 5/		0.54	0.60	0.67	0.48		0.33	0.12		0.11	0.23
P-value		0.007	0.003	0.001	0.026		0.253	0.694		0.612	0.295
R^2		0.29	0.36	0.47	0.23		0.11	0.02		0.01	0.05

1/ Based on average of weighted-sum probabilities during 1996:1-12, using out-of-sample estimates.

2/ Original KLR variables.

3/ Addition of current account and M2/reserves in levels to original variables.

4/ Average predicted probabilities for 1996:1-12 where model was estimated up to 1995:4.

5/ Spearman Rank Correlation of the fitted values and the actual crisis index and its p-value. The R2 is from a regression of fitted values on actual values.

Source: Berg and Pattillo (1998), Table 14, p. 54.

Table 8: The 1997-98 Asian Crisis: Comparing the Predictive Power of the Full Model, the Fundamentals Model and the Contagion Model

prediction: 1997/Q3-1997/Q4			Out-of-Sample Prediction						In-Sample Prediction					
	Actual Crisis EMP		Full Model		Fundamentals Model		Contagion Model		Full Model		Fundamentals Model		Contagion Model	
country:	rank	severity	rank	severity	rank	severity	rank	severity	rank	severity	rank	severity	rank	severity
Indonesia	1	42.0	5	12.0	19	-2.7	4	12.8	4	15.4	4	6.8	3	13.9
Korea	2	32.6	6	8.5	16	-0.4	9	3.4	6	7.8	5	6.2	7	4.3
Thailand	3	27.4	3	19.2	10	1.4	2	15.3	2	21.0	1	16.4	2	14.7
Malaysia	4	27.0	1	24.1	6	3.5	1	17.5	1	26.3	2	14.9	1	17.9
Philippines	5	22.4	2	20.4	2	4.8	3	13.1	3	17.3	3	7.4	4	12.0
Colombia	6	9.1	8	7.2	5	3.7	21	-2.5	9	4.6	9	1.5	21	-2.1
Russia	7	4.5	11	6.8	9	1.9	16	0.3	13	2.6	12	0.1	17	1.1
Sri Lanka	8	4.3	7	8.5	3	4.7	10	3.4	11	3.6	17	-3.7	11	3.3
India	9	2.6	16	3.7	17	-0.8	11	3.3	12	2.7	22	-5.1	8	4.2
Poland	10	1.6	14	4.6	11	1.3	12	1.9	14	1.7	19	-4.0	13	2.2
Jordan	11	1.4	12	5.9	1	5.8	19	-0.9	16	1.4	10	0.7	19	-0.6
South Africa	12	1.1	9	6.9	18	-2.1	6	6.7	8	7.5	8	2.5	6	6.3
Brazil	13	0.6	19	0.0	14	0.0	17	0.0	20	0.2	15	-2.1	15	1.6
Pakistan	14	0.1	22	-7.7	21	-2.7	22	-6.9	22	-6.5	18	-3.9	22	-5.7
Chile	15	-0.6	4	12.9	8	2.7	5	8.9	5	10.9	6	4.8	5	8.2
Hungary	16	-1.3	20	0.0	15	0.0	18	0.0	21	-0.9	20	-4.7	12	2.3
Peru	17	-2.4	17	3.0	7	2.9	20	-1.2	19	0.6	13	-1.1	20	-1.0
Argentina	18	-3.4	13	5.7	13	0.4	8	3.7	10	4.6	11	0.7	10	3.4
China	19	-4.5	10	6.9	4	3.7	15	0.5	7	7.6	7	2.9	16	1.6
Mexico	20	-5.9	18	1.6	22	-4.0	7	6.0	17	1.3	21	-5.0	9	3.8
Venezuela	21	-6.9	21	-0.4	20	-2.7	14	0.5	18	0.7	14	-1.7	18	0.6
Turkey	22	-9.0	15	4.0	12	1.1	13	1.6	15	1.4	16	-2.5	14	1.9
Spearman correlation			0.694		0.228		0.380		0.636		0.535		0.467	
P-value			0.000		0.309		0.081		0.001		0.010		0.028	
R^2			0.457		0.047		0.431		0.521		0.558		0.496	

Note: R^2 is obtained from a regression of predicted on actual values of EMP.

The Full Model does not only forecast accurately the *ranking* of how strongly countries were affected by the Asian crisis, but it also performs relatively well in forecasting the *degree* of severity. Indonesia and Korea are the only countries for which the Full Model underestimates the degree of the crises substantially, indicating that fundamentals and the extent of real and financial interdependence did not seem to warrant the severity with which these countries were hit.[12] The overall results prove robust to various sensitivity analyses, such as altering the forecasting horizon and using in-sample prediction (see Tables 8 and 9) to test for parameter constancy, and altering the size of the country sample to check for the impact of individual countries.

What makes us believe that the model presented in this paper is superior to the signaling approach and other models developed to-date, as it is for instance presented in the paper by Berg and Pattillo? First, despite the good performance in terms of Spearman rank correlation, the signaling approach has the mentioned shortcoming that it fails to predict the timing of crises. The fact that it provides many false signals makes it questionable as a forecasting tool. Second, the signaling approach only estimates crisis probabilities and is not designed to forecast their severity.

On the contrary, the Full Model presented in this paper has the advantage of being able to estimate both the rankings of countries and the absolute severity of a crisis, i.e. it allows us to understand not only why some countries are affected more than others, but also why a particular country is hit so severely. It seems that currency crises in emerging markets in the 1990s have some essential differences from those in the past: most importantly, they occurred in relatively open and financially integrated economies. It therefore seems imperative to look only at emerging markets which are relatively open (both financially and in trade), and thus the model estimation in this paper was conducted only for 25 open economies during the 1990s. Using a panel approach has the added advantage of allowing a better understanding of the dynamics of exchange rates changes and their credibility. The results confirm that factors that help explain exchange rate movements during tranquil periods may become even more important during crises. This was shown to be the case in particular for contagion through real and financial interdependence among economies.

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[12] Political factors were probably another important reason for why Indonesia was the main victim of the Asian crisis. Such factors are not analyzed in this paper and are difficult to include on a cross-sectional basis; a discussion of the role of political factors can be found in Drazen and Masson (1994).

In summary, the findings of this section confirm the importance of contagion during the Asian crisis and also the Latin American crisis (Table 9, appendix). The results suggest that one of the most important if not the single most important indicator for predicting which countries will be affected most severely by a crisis are the degree of real integration and financial interdependence with those countries where the crisis originated. Moreover, the panel model developed in this paper seems to be a more appropriate methodology in understanding the dynamics and contagious character of the emerging market crises of the 1990s than other approaches developed to-date.

6 Conclusions

The goal of this paper has been to show that the main reason for the limited explanatory power and poor predictive ability of standard models of currency crises is their neglect of the role of contagion, i.e. the fact that crises may be transmitted across countries. A model was developed which allows a systematic comparison of weak fundamentals, contagion and sunspots as the causes for crises. The empirical analysis has found compelling evidence that the Latin American crisis of 1994-95 and the Asian crisis of 1997-98 were indeed contagious in spreading to countries which were not only vulnerable economically but which were closely linked financially to those countries where crises had occurred. The model performs remarkably well out-of-sample in predicting both the Asian crisis and the Latin American crisis, implying that the single most valuable factor in predicting which countries would be affected most severely by a crisis is the degree of financial interdependence and real integration across economies.

It is nevertheless imperative to emphasize that the empirical findings of this paper do not imply that the financial crises of the 1990s were merely the result of fickle capital flows and nervous investors. It would be wrong to deny that countries that were hit by recent crises were vulnerable and showed weaknesses in their economic foundations. It would be equally wrong, however, to deny that rapid capital account liberalization and the opening to international markets in affected countries played a crucial role in explaining both the timing as well as the severity of those crises. In essence, therefore, the results of this paper support those economists who question the benefits of unfettered capital flows and unregulated international financial markets (for instance, Bhagwati 1998, Eichengreen et al. 1995, and Rodrik 1998). At the present time, however, it seems that no major international initiative, such as proposals calling for a global lender of last resort or taxes on certain types of capital flows, will be politically feasible in the near future.

Lawrence Summers (The Economist 14/3/98) compared the liberalization and globalization of capital markets with the invention of the jet aeroplane: it enables one to reach one's destination much faster, but if crashes occur they are all the more dramatic. Considering that very few emerging markets have yet reached their destination without one or even numerous serious crashes, it would indeed be wise if an international consensus emerged that shifted more attention to the safety of that mission and less to the speed.

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Appendix: Data Definitions and Sources

Country Sample

The 24 countries included in the panel analysis are: Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, Peru, Venezuela; China, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand; Czech Republic, Hungary, Jordan, Poland, Russia, South Africa, Turkey.

Fundamentals

The set of fundamentals covers a fairly wide range of variables, many of which have been mentioned in the academic literature as potential culprits for some currency crisis or another. Kaminsky, Lizondo, and Reinhart (1997) provide a comprehensive review of empirical work on currency crises and emphasize the lack of empirical consensus on what may cause crises. The empirical analysis above started from a broad approach to avoid ignoring potentially powerful factors in the analysis:

- foreign debt: total foreign debt/GDP, total short-term debt/GDP, and short-term debt/total foreign debt. Source: *IMF/WB/OECD/BIS* joint publication.
- capital inflows: total capital inflows/GDP, short-capital inflows/GDP and short-term to total capital inflows. Source: *IMF*.
- trade balance: (exports+imports)/GDP and current account. Source: *IMF*.
- overvaluation of exchange rate: real effective exchange rate (REER) relative to 1990, and the change in REER during the prior one or two years. Source: *JP Morgan*.
- foreign exchange reserves: ratio of total foreign exchange reserves to either M2 or to imports. Source: *IMF*.
- lending boom: rate of credit expansion to the private sector relative to GDP. Source: *IMF*.
- government deficit/GDP and government debt/GDP. Source: *IMF*.
- changes in interest rates and growth rates in industrial countries. Source: *IMF*.
- US$ exchange rate changes to Japanese yen and German mark. Source: *IMF*.

Exogenous Variables

- Exchange Rate Credibility (CRED): definition in text. Source: *Financial Times Currency Forecaster* data of exchange rate predictions by traders and forecasting agencies; various issues of *IMF Annual Report on Exchange*

Arrangements and Exchange Restrictions for exchange rate commitments. The FT prediction data is available for a sufficiently long time span only for the following 15 countries: Argentina, Brazil, Chile, Colombia, Mexico, Venezuela; India, Indonesia, Korea, Malaysia, Philippines, Thailand; Hungary, Poland, South Africa.

- Exchange Market Pressure (EMP): definition in text. Source: *IMF* and national central banks.

Contagion Variables

- Real Integration Contagion: definition in text. Source: *World Trade Analyzer* (1989-97); commodities measured at the 3-digit SITC level, excluding agriculture and natural resources.
- Financial Integration Contagion: definition in text. Source: *Datastream/Reuters* and *IMF*.

Table 3a: Markov-Switching Regimes Model (MSIH-VAR) for Exchange Market Pressure (EMP) of 5 Asian economies 1986-98

REGIMES: M=1 **ln L = -1819.14**

a_1 = (a_{INO}, a_{KOR}, a_{MAL}, a_{PHI}, a_{THA}) =

0.185
-0.292
-0.293
-0.771
-0.487

A=

0.121	-0.038	-0.005	0.036	* -0.144
0.125	* 0.262	0.014	0.197	* 0.100
* 0.206	-0.119	0.158	0.110	0.089
0.073	0.015	-0.015	-0.079	0.002
* 0.395	* 0.359	-0.011	0.014	0.043

V_1=

11.195	-1.405	0.362	-1.489	0.466
-1.405	7.537	0.265	-1.913	0.631
0.362	0.265	5.444	2.853	0.908
-1.489	-1.913	2.853	31.841	1.055
0.466	0.631	0.908	1.055	3.186

C_1=

1	-0.153	0.046	-0.079	0.078
-0.153	1	0.041	-0.123	0.129
0.046	0.041	1	0.217	0.218
-0.079	-0.123	0.217	1	0.105
0.078	0.129	0.218	0.105	1

REGIMES: M=2 **ln L = -1693.85**

a_1=

-0.092
-0.137
-0.631
-1.358
-0.750

a_2=

0.588
1.380
0.417
1.292
0.017

P=

0.973	0.079
0.027	0.921

A=

0.158	-0.034	0.026	0.035	* -0.032
-0.092	* 0.172	-0.060	0.183	-0.026
* 0.120	-0.031	0.103	-0.011	-0.018
0.073	-0.021	-0.034	-0.078	-0.023
* 0.126	* 0.305	-0.091	0.011	0.070

V_1=

3.750	0.029	-0.670	-2.044	-0.218
0.029	2.579	-0.214	-1.685	0.079
-0.670	-0.214	4.682	1.787	-0.080
-2.044	-1.685	1.787	35.160	0.036
-0.218	0.079	-0.080	0.036	1.096

V_2=

44.990	-6.184	6.264	1.850	5.259
-6.184	26.535	3.606	-0.312	4.078
6.264	3.606	8.268	5.154	5.122
1.850	-0.312	5.154	13.606	3.891
5.259	4.078	5.122	3.891	12.914

C_1=

1	0.009	-0.160	-0.178	-0.108
0.009	1	-0.062	-0.177	0.047
-0.160	-0.062	1	0.139	-0.035
-0.178	-0.177	0.139	1	0.006
-0.108	0.047	-0.035	0.006	1

C_2=

1	-0.179	0.325	0.075	0.218
-0.179	1	0.243	-0.016	0.220
0.325	0.243	1	0.486	0.496
0.075	-0.016	0.486	1	0.294
0.218	0.220	0.496	0.294	1

REGIMES: M=3 **ln L = -1631.82**

a_1=

-0.510
-1.456
-1.732
-3.883
-0.994

a_2=

-0.073
-0.222
-0.225
-0.085
-0.625

a_3=

1.248
0.200
0.870
1.397
0.060

P=

0.753	0.095	0.043
0.188	0.891	0.089
0.060	0.014	0.868

A=

* 0.162	-0.035	0.071	0.035	* 0.027
0.087	* 0.244	-0.080	0.069	-0.041
0.087	* -0.049	0.035	-0.176	0.001
* 0.114	-0.008	-0.016	0.088	-0.022
* 0.189	* 0.304	-0.040	0.114	* 0.052

V_1=

19.377	1.312	0.648	-6.802	-0.200
1.312	4.968	-0.712	-3.113	0.177
0.648	-0.712	5.992	1.225	-1.398
-6.802	-3.113	1.225	90.744	-1.416
-0.200	0.177	-1.398	-1.416	0.709

C_1=

1	0.134	0.060	-0.162	-0.054
0.134	1	-0.131	-0.147	0.094
0.060	-0.131	1	0.053	-0.678
-0.162	-0.147	0.053	1	-0.177
-0.054	0.094	-0.678	-0.177	1

Table 3a (cont.): Markov-Switching Regimes Model (MSIH-VAR) for Exchange Market Pressure (EMP) of 5 Asian economies 1986-98

REGIMES: M=3 (continued):

	1.561	-0.236	-0.200	-0.248	-0.310		1	-0.151	-0.083	-0.068	-0.226
	-0.236	1.561	0.202	-0.358	0.120		-0.151	1	0.084	-0.099	0.088
V_2=	-0.200	0.202	3.692	0.392	0.233	**C_2=**	-0.083	0.084	1	0.070	0.110
	-0.248	-0.358	0.392	8.392	0.156		-0.068	-0.099	0.070	1	0.049
	-0.310	0.120	0.233	0.156	1.204		-0.226	0.088	0.110	0.049	1
	32.527	-7.471	0.535	-1.065	4.022		1	-0.239	0.033	-0.046	0.174
	-7.471	30.099	4.181	-2.012	4.217		-0.239	1	0.271	-0.090	0.189
V_3=	0.535	4.181	7.922	5.878	7.001	**C_3=**	0.033	0.271	1	0.511	0.613
	-1.065	-2.012	5.878	16.706	5.314		-0.046	-0.090	0.511	1	0.320
	4.022	4.217	7.001	5.314	16.457		0.174	0.189	0.613	0.320	1

REGIMES: M=4 **ln L = -1513.86**

	-4.393		0.208		-0.160		1.480
	-3.332		-0.307		-0.264		0.368
a_1=	-3.789	**a_2=**	-0.312	**a_3=**	-0.324	**a_4=**	1.301
	-2.848		-2.305		-0.328		1.868
	-2.365		-1.150		-0.639		1.527

	* 0.121	0.000	-0.023	0.072	-0.079		0.485	0.000	0.024	0.125
	0.024	* 0.185	-0.056	0.052	-0.015	**P=**	0.179	0.888	0.035	0.001
A=	0.076	* -0.101	0.179	-0.130	0.054		0.179	0.086	0.930	0.064
	* 0.080	0.024	-0.027	0.094	-0.030		0.156	0.025	0.012	0.809
	* 0.105	* 0.308	0.060	0.098	-0.010					

	65.860	-21.515	-10.896	-12.468	-8.386		1	-0.798	-0.383	-0.679	-0.439
	-21.515	11.044	-1.986	6.690	6.453		-0.798	1	-0.170	0.890	0.825
V_1=	-10.896	-1.986	12.287	-1.057	-5.449	**C_1=**	-0.383	-0.170	1	-0.133	-0.660
	-12.468	6.690	-1.057	5.114	3.605		-0.679	0.890	-0.133	1	0.677
	-8.386	6.453	-5.449	3.605	5.546		-0.439	0.825	-0.660	0.677	1
	8.719	-0.218	-0.886	-3.026	-0.077		1	-0.021	-0.209	-0.104	-0.025
	-0.218	12.027	-1.433	-8.736	-0.055		-0.021	1	-0.288	-0.254	-0.015
V_2=	-0.886	-1.433	2.055	4.058	-0.258	**C_2=**	-0.209	-0.288	1	0.286	-0.171
	-3.026	-8.736	4.058	98.003	-0.513		-0.104	-0.254	0.286	1	-0.049
	-0.077	-0.055	-0.258	-0.513	1.104		-0.025	-0.015	-0.171	-0.049	1
	1.590	-0.260	-0.315	-0.354	-0.265		1	-0.157	-0.116	-0.100	-0.197
	-0.260	1.722	-0.062	-0.718	0.152		-0.157	1	-0.022	-0.194	0.108
V_3=	-0.315	-0.062	4.651	1.054	0.222	**C_3=**	-0.116	-0.022	1	0.174	0.096
	-0.354	-0.718	1.054	7.925	-0.136		-0.100	-0.194	0.174	1	-0.045
	-0.265	0.152	0.222	-0.136	1.139		-0.197	0.108	0.096	-0.045	1
	39.251	-7.143	2.751	-3.361	5.601		1	-0.242	0.159	-0.301	0.240
	-7.143	22.178	1.764	1.678	-0.333		-0.242	1	0.135	0.200	-0.019
V_4=	2.751	1.764	7.673	4.087	4.539	**C_4=**	0.159	0.135	1	0.827	0.440
	-3.361	1.678	4.087	3.183	1.419		-0.301	0.200	0.827	1	0.214
	5.601	-0.333	4.539	1.419	13.860		0.240	-0.019	0.440	0.214	1

Note: a denotes the intercepts, A the matrix of coefficients, C the cross-country correlations, V the variances, P the transition probabilities and the subscript the regime. For A, the lagged (independent) variables are on the vertical and the contemporaneous (dependent) ones on the horizontal axis. * indicates significance at the 95% level.

Table 3b: Markov-Switching Regimes Model (MSIH-VAR) for Exchange Rate Credibility (CRED) of 5 Asian economies 1994-98

REGIMES: M=1 **ln L = -406.87**

a_1=

a_{INO}	=	-1.245
a_{KOR}		-0.185
a_{MAL}		-0.281
a_{PHI}		0.810
a_{THA}		0.720

A=

* 0.372	-0.098	* -0.407	0.009	0.199
-0.226	0.316	0.201	-0.346	-0.534
0.593	0.408	* 0.475	0.200	* 0.363
-0.040	0.026	0.017	* 0.676	-0.102
* 0.534	0.238	* 0.461	-0.045	* 0.640

V_1=

8.153	4.779	3.243	3.759	3.520
4.779	4.243	2.432	2.440	2.404
3.243	2.432	2.453	2.132	1.944
3.759	2.440	2.132	3.360	2.386
3.520	2.404	1.944	2.386	2.726

C_1=

1	0.813	0.725	0.718	0.747
0.813	1	0.754	0.646	0.707
0.725	0.754	1	0.743	0.752
0.718	0.646	0.743	1	0.788
0.747	0.707	0.752	0.788	1

REGIMES: M=2 **ln L = -328.36**

a_1=

-1.211
-0.334
-0.728
0.467
-0.021

a_2=

1.151
2.472
2.603
4.416
2.688

P=

0.931	0.105
0.069	0.895

A=

* 0.772	0.086	* -0.424	0.103	0.117
* 0.280	* 0.725	* 0.465	-0.095	-0.140
0.160	0.106	0.297	-0.087	0.098
-0.233	-0.243	* -0.232	* 0.312	-0.213
-0.040	-0.258	-0.018	* 0.493	* 0.366

V_1=

12.836	6.553	1.746	2.772	2.863
6.553	3.847	0.902	1.433	1.582
1.746	0.902	0.320	0.302	0.370
2.772	1.433	0.302	0.960	0.742
2.863	1.582	0.370	0.742	0.894

V_2=

2.420	1.414	2.412	1.966	2.154
1.414	3.456	2.382	1.009	1.314
2.412	2.382	3.763	1.850	1.775
1.966	1.009	1.850	2.813	1.364
2.154	1.314	1.775	1.364	2.990

C_1=

1	0.933	0.862	0.790	0.845
0.933	1	0.813	0.746	0.853
0.862	0.813	1	0.545	0.692
0.790	0.746	0.545	1	0.801
0.845	0.853	0.692	0.801	1

C_2=

1	0.489	0.799	0.753	0.801
0.489	1	0.661	0.324	0.409
0.799	0.661	1	0.569	0.529
0.753	0.324	0.569	1	0.470
0.801	0.409	0.529	0.470	1

REGIMES: M=3 **ln L = -231.31**

a_1=

-6.235
-2.574
-1.416
-1.172
-1.437

a_2=

-0.234
0.110
-0.455
1.078
0.541

a_3=

0.009
1.564
2.466
4.095
2.108

P=

0.692	0.035	0.061
0.308	0.895	0.066
0.000	0.070	0.873

A=

* 0.806	-0.012	-0.461	0.130	0.166
0.061	0.739	0.441	-0.231	-0.305
0.031	-0.066	0.166	-0.390	-0.079
-0.042	-0.234	-0.263	0.454	-0.144
0.441	0.354	0.414	-0.094	* 0.811

V_1=

54.173	34.661	11.294	10.681	15.353
34.661	22.793	7.223	6.4179	9.5444
11.294	7.223	2.3701	2.2344	3.2308
10.681	6.4179	2.2344	2.4087	3.2414
15.353	9.5444	3.2308	3.2414	4.5437

C_1=

1	0.986	0.997	0.935	0.979
0.986	1	0.983	0.866	0.938
0.997	0.983	1	0.935	0.985
0.935	0.866	0.935	1	0.980
0.979	0.938	0.985	0.980	1

Table 3b (cont.): Markov-Switching Regimes Model (MSIH-VAR) for Exchange Rate Credibility (CRED) of 5 Asian economies 1994-98

REGIMES: M=3 (continued)

V_2=

0.396	-0.090	-0.049	-0.172	-0.253
-0.090	0.190	0.025	0.185	0.094
-0.049	0.025	0.199	0.101	0.058
-0.172	0.185	0.101	0.439	0.163
-0.253	0.094	0.058	0.163	0.245

C_2=

1	-0.328	-0.174	-0.413	-0.811
-0.328	1	0.131	0.641	0.434
-0.174	0.131	1	0.343	0.264
-0.413	0.641	0.343	1	0.496
-0.811	0.434	0.264	0.496	1

V_3=

3.211	1.497	1.950	2.668	3.065
1.497	4.144	1.856	1.055	1.771
1.950	1.856	2.574	1.108	1.345
2.668	1.055	1.108	3.757	1.989
3.065	1.771	1.345	1.989	4.038

C_3=

1	0.410	0.678	0.768	0.851
0.410	1	0.568	0.267	0.433
0.678	0.568	1	0.356	0.417
0.768	0.267	0.356	1	0.511
0.851	0.433	0.417	0.511	1

REGIMES: M=4 **ln L = -95.49**

a_1=	a_2=	a_3=	a_4=
-14.147	0.167	0.276	1.576
-7.673	-0.106	0.627	2.296
-2.795	-0.696	0.088	3.938
-2.883	0.517	2.499	4.102
-3.137	-0.171	0.893	4.053

A=

* 1.033	0.072	* 0.331	0.161	0.016
* -0.229	* 0.681	* 0.339	-0.253	-0.051
0.169	0.185	* 0.515	0.097	-0.009
-0.079	-0.046	* 0.041	* 0.446	-0.088
0.138	-0.102	-0.206	* 0.350	* 0.481

P=

0.904	0.000	0.000	0.143
0.000	0.952	0.052	0.000
0.096	0.001	0.948	0.001
0.000	0.046	0.000	0.857

V_1=

8.929	8.559	6.741	7.961	2.083
8.559	8.205	6.462	7.632	1.997
6.741	6.462	5.089	6.010	1.573
7.961	7.632	6.010	7.099	1.858
2.083	1.997	1.573	1.858	0.486

C_1=

1	0.986	0.997	0.935	0.979
0.986	1	0.983	0.866	0.938
0.997	0.983	1	0.935	0.985
0.935	0.866	0.935	1	0.980
0.979	0.938	0.985	0.980	1

V_2=

0.433	-0.023	0.077	0.012	-0.119
-0.023	0.537	0.076	-0.098	-0.050
0.077	0.076	0.147	-0.096	-0.015
0.012	-0.098	-0.096	0.261	-0.023
-0.119	-0.050	-0.015	-0.023	0.125

C_2=

1	-0.048	0.304	0.035	-0.512
-0.048	1	0.272	-0.262	-0.192
0.304	0.272	1	-0.493	-0.112
0.035	-0.262	-0.493	1	-0.128
-0.512	-0.192	-0.112	-0.128	1

V_3=

0.041	-0.022	-0.009	0.013	-0.047
-0.022	0.062	0.085	0.064	0.059
-0.009	0.085	0.508	0.713	0.176
0.013	0.064	0.713	1.635	0.279
-0.047	0.059	0.176	0.279	0.130

C_3=

1	-0.435	-0.064	0.050	-0.652
-0.435	1	0.478	0.200	0.658
-0.064	0.478	1	0.783	0.685
0.050	0.200	0.783	1	0.607
-0.652	0.658	0.685	0.607	1

V_4=

5.809	0.581	1.504	3.402	2.631
0.581	6.746	1.667	0.029	1.540
1.504	1.667	3.030	-0.142	-0.979
3.402	0.029	-0.142	2.753	1.593
2.631	1.540	-0.979	1.593	4.978

C_4=

1	0.093	0.358	0.851	0.489
0.093	1	0.369	0.007	0.266
0.358	0.369	1	-0.049	-0.252
0.851	0.007	-0.049	1	0.430
0.489	0.266	-0.252	0.430	1

Note: a denotes the intercepts, A the matrix of coefficients, C the cross-country correlations, V the variances, P the transition probabilities and the subscript the regime. For A, the lagged (independent) variables are on the vertical and the contemporaneous (dependent) ones on the horizontal axis. * indicates significance at the 95% level.

Table 3c: Markov-Switching Regimes Model (MSIH-VAR) for Exchange Market Pressure (EMP) of 13 Emerging Markets, 1990-98

REGIMES: M=3 **ln L = -2082.25**

	a_1	a_2	a_3
a_{ino}	0.151	-0.027	1.645
a_{kor}	-0.627	-0.109	-0.457
a_{mal}	-2.253	-0.251	2.328
a_{phi}	-5.305	-0.652	2.121
a_{tha}	-1.439	-0.632	1.369
a_{ini}	3.138	-0.518	0.900
a_{pak}	-10.606	-0.470	2.488
a_{arg}	-1.766	-1.074	1.994
a_{col}	-1.420	-0.318	0.766
a_{mex}	-3.027	0.040	-2.446
a_{bol}	-5.108	-0.915	4.274
a_{chl}	-0.346	-0.345	-0.507
a_{per}	0.357	-0.064	0.774

Table 4: Markov-Switching Regimes Models (MSI-VAR): Exchange Market Pressure (EMP) and Exchange Rate Credibility (CRED)

	MEXICO								THAILAND							
	EMP				CRED				EMP				CRED			
	(1)	**(2)**	(3)	**(4)**	(1)	**(2)**	(3)	**(4)**	(1)	**(2)**	**(3)**	(4)	(1)	**(2)**	**(3)**	(4)
Const.(Regime 1)	*-66.05	* **-52.00**	-66.91	* **-64.38**	-5.604	**3.382**	-5.790	**3.632**	4.346	* **3.695**	**14.30**	* 14.70	13.83	**13.83**	**14.62**	14.61
Const.(Regime 2)		* **-51.98**		* **-33.15**		* **5.571**		* **5.757**		**-0.26**		* 14.76		**13.82**		14.60
Const.(Regime 3)		* **-26.87**				* **10.72**		* **10.94**		* **17.37**		* 14.98		**13.86**		14.64
Capital Flows	0.136	**0.095**	0.058	**0.049**	0.048	**0.044**	0.048	**0.044**	-0.214	**0.708**	**-0.641**	-0.686	-1.584	**-1.534**	**-1.135**	-1.135
Lending Boom	-12.49	**-8.959**	-37.17	**5.221**	-3.961	* **-7.353**	-8.908	* **10.83**	0.108	* **-17.32**	**-3.578**	-3.579	-0.428	**-0.483**	**1.519**	1.519
Foreign Debt	* 24.98	* **19.21**	* 26.86	* **22.39**	* 4.676	* **5.727**	4.372	**-1.416**	* 6.725	* **6.081**	* **9.962**	* 9.964	* 20.28	* **21.78**	* **18.53**	* 18.53
Overvaluation	* 0.716	**0.482**	* 0.819	* **0.549**	* 0.100	**-0.013**	* 0.983	* **0.912**	* 48.66	* **40.95**	* **54.99**	* 54.99	* 34.74	* **14.74**	* **39.02**	* 39.02
Reserves	-3.248	**2.544**	-18.33	**15.94**	-3.071	**-3.159**	-3.463	**-4.417**	0.208	* **5.871**	**-2.663**	-2.663	-7.993	**-7.993**	**-8.737**	-8.737
Trade Balance	131.6	**57.95**	116.9	**122.1**	43.21	**25.22**	22.04	**16.93**	75.36	**22.20**	**92.16**	92.16	0.354	**0.354**	**5.701**	5.701
Real Contagion			* 4.514	* **6.558**			1.431	* **1.244**			**1.178**	1.178			**0.567**	0.567
Financial Cont.			0.465	**0.450**			2.757	* **2.511**			* **12.79**	* 12.83			* **4.003**	* 4.013
Log-likelihood	-132.4	**-114.2**	-101.2	**-82.44**	-66.71	**-51.09**	-57.45	**-43.05**	-104.7	**-77.40**	**-72.95**	-72.95	-27.75	**-22.31**	**-26.46**	-26.46
Variance	43.95	**10.84**	49.73	**9.597**	3.339	**0.741**	3.078	**0.654**	11.00	**1.141**	**7.582**	7.581	1.880	**0.531**	**1.599**	1.599
P_{11}		**0.673**		**0.964**		**0.424**		**0.592**		**0.686**		0.686		**0.490**		0.480
P_{22}		**0.716**		**0.382**		**0.959**		**0.955**		**0.912**		0.912		**0.540**		0.529
P_{33}		**0.299**				**0.644**		**0.697**		**0.499**		0.499		**0.531**		0.518

	ARGENTINA								INDONESIA							
	EMP				CRED				EMP				CRED			
	(1)	**(2)**	(3)	**(4)**	(1)	**(2)**	(3)	**(4)**	(1)	**(2)**	**(3)**	(4)	(1)	**(2)**	**(3)**	(4)
Const.(Regime 1)	*-9.497	* **-18.28**	-2.298	* **-7.041**	3.221	**1.066**	-3.711	* **-9.815**	* -47.62	* **-71.57**	* **-43.39**	* -43.53	* -41.76	* **-52.77**	**-21.99**	-22.06
Const.(Regime 2)		* **-16.72**		**-5.739**		**1.052**		* **-9.545**		* **-66.38**		* -43.44		* **-47.13**		-21.98
Const.(Regime 3)		* **-13.61**		**-2.654**		* **5.060**		* **-6.399**		**-60.32**		* -43.26		* **-42.13**		-21.93
Capital Flows	-0.015	**-0.091**	-0.110	**-0.080**	-0.062	**-0.002**	-0.285	**-0.146**	0.276	**-0.612**	**0.030**	0.030	-0.503	**-0.808**	**-0.239**	-0.239
Lending Boom	* 10.11	* **14.04**	63.41	* **9.358**	20.45	**8.654**	* 96.21	* **90.96**	* 49.97	* **89.69**	* **61.99**	* 61.99	* 23.06	* **26.74**	* **84.98**	* 84.96
Foreign Debt	-12.38	**-13.70**	-7.167	**-8.323**	-4.177	* **-5.227**	2.974	* **1.946**	* 25.02	* **19.31**	* **15.37**	* 15.37	-11.825	**-9.268**	**4.234**	4.237
Overvaluation	* 12.61	* **12.46**	* 13.99	* **17.25**	* 1.897	* **4.039**	* 0.585	* **6.741**	* -19.45	* **-8.342**	* **-22.78**	* -22.77	* 53.76	* **64.52**	* **84.13**	* 84.13
Reserves	-11.24	**-9.721**	-12.58	**-14.87**	-2.710	**0.378**	4.482	**11.51**	59.89	* **90.00**	**54.86**	54.85	36.39	**40.38**	**14.15**	14.15
Trade Balance	*-25.51	* **-21.10**	* -25.61	* **-29.31**	-47.72	**26.21**	68.90	**152.9**	52.14	* **-88.64**	**52.99**	53.08	178.1	**281.4**	**243.4**	243.4
Real Contagion			1.228	* **1.689**			0.984	**0.393**			* **1.336**	* 1.333			**1.101**	1.100
Financial Cont.			* 10.11	* **9.109**			* 21.32	* **11.39**			* **12.32**	* 12.31			* **2.799**	* 2.801
Log-likelihood	-50.84	**-40.57**	-46.89	**-36.62**	-40.93	**-32.93**	-34.15	**-19.81**	-77.72	**-66.81**	**-65.91**	-65.90	-41.80	**-34.26**	**-34.49**	-34.49
Variance	2.926	**0.317**	2.719	**0.261**	1.547	**0.441**	0.899	**0.141**	12.46	**1.383**	**5.518**	5.518	8.003	**0.887**	**4.367**	4.364
P_{11}		**0.531**		**0.571**		**0.769**		**0.941**		**0.198**		0.537		**0.653**		0.454
P_{22}		**0.442**		**0.584**		**0.742**		**0.059**		**0.784**		0.629		**0.595**		0.529
P_{33}		**0.150**		**0.333**		**0.413**		**0.303**		**0.690**		0.590		**0.653**		0.487

Note: Columns in bold indicate the best number of regimes for the specific model. P_{ij} denotes the regime switching probabilities.
* indicates statistical significance at the 10% level.

Table 4 (cont.): Markov-Switching Regimes Models (MSI-VAR): Exchange Market Pressure (EMP) and Exchange Rate Credibility (CRED)

	PHILIPPINES								KOREA							
	EMP				CRED				EMP				CRED			
	(1)	**(2)**	**(3)**	(4)	(1)	**(2)**	**(3)**	(4)	(1)	**(2)**	**(3)**	(4)	(1)	**(2)**	**(3)**	(4)
Const.(Regime 1)	3.512	2.079	0.656	0.603	-10.822	* -18.73	-7.644	-7.673	2.573	4.992	15.237	15.16	* -13.82	* -12.10	* -17.12	* -17.24
Const.(Regime 2)		* 13.30		0.695		* -16.62		-7.651		5.087		15.20		* -9.522		* -17.11
Const.(Regime 3)						* -13.36		-7.601		5.235		15.36		* -3.916		* -17.02
Capital Flows	0.043	0.077	-0.084	-0.084	0.085	* 0.062	0.051	0.051	-0.035	-0.052	-0.092	-0.092	-0.003	-0.023	0.003	0.003
Lending Boom	12.06	16.68	-52.60	-52.61	-8.488	* 7.173	* 8.796	* 8.795	* 69.64	* 59.39	* 90.63	* 90.62	* 43.63	* 13.38	* 58.93	* 58.93
Foreign Debt	* 4.412	* 8.796	* 14.67	* 14.67	-5.084	* -4.424	-2.940	-2.940	* 30.55	* 19.17	* 48.69	* 48.69	* 20.89	* 19.84	* 17.79	* 17.79
Overvaluation	* 14.42	2.800	* 13.79	* 13.79	* 0.120	* 0.178	* 0.091	* 0.091	* 18.81	* 23.91	* 25.92	* 25.32	* 0.271	* 0.193	* 0.316	* 0.316
Reserves	7.023	* 14.67	* 14.46	* 14.46	1.126	* 1.629	1.579	1.579	-8.618	-11.33	-23.24	-23.24	* -17.68	-11.23	-17.28	-17.27
Trade Balance	88.99	155.5	81.71	81.71	-5.916	3.911	-11.13	-11.13	-255.7	-184.8	-245.2	-245.2	84.45	114.7	107.8	107.8
Real Contagion			* 8.889	* 8.889			4.802	4.802			* 10.04	* 10.04			2.032	2.032
Financial Cont.			* 14.29	* 14.29			* 6.359	* 6.358			* 10.21	* 10.52			* 4.974	* 4.976
Log-likelihood	-111.9	-105.7	-69.49	-69.49	-67.35	-57.91	-54.67	-54.67	-121.2	-101.7	-90.44	-90.44	-66.91	-51.83	-55.98	-55.98
Variance	24.83	6.869	7.063	7.063	3.479	0.359	2.542	2.541	25.16	22.19	24.32	24.32	3.379	0.531	2.781	2.774
P_{11}		0.849		0.623		0.393		0.505		0.686		0.688		0.668		0.447
P_{22}		0.588		0.744		0.635		0.573		0.786		0.669		0.686		0.573
P_{33}						0.345		0.475		0.001		0.615		0.642		0.462

	CHILE				INDIA			
	EMP				EMP			
	(1)	**(2)**	(3)	**(4)**	(1)	**(2)**	(3)	**(4)**
Const.(Regime 1)	3.513	-1.722	* -23.26	* -32.27	-14.12	-55.14	-13.19	* 74.84
Const.(Regime 2)		* 4.469		* -25.80		-49.65		* 80.29
Const.(Regime 3)		2.449		* -22.62		-42.78		* 85.48
Capital Flows	-0.509	-0.776	-0.417	-1.126	* 0.316	* 0.496	* 0.324	* 0.309
Lending Boom	-13.04	-17.52	-62.12	-52.87	-98.71	-21.62	-38.48	* -4.854
Foreign Debt	* 9.549	* 10.06	* 6.502	* 4.358	* 24.63	* 3.591	* 19.94	* 17.00
Overvaluation	-2.160	0.743	* 37.02	* 31.78	0.382	0.678	0.200	* 0.351
Reserves	-1.632	-1.212	7.158	8.187	1.247	0.770	1.156	-0.275
Trade Balance	-16.38	-16.98	-112.6	-93.23	* 30.68	* 27.48	220.3	186.2
Real Contagion			5.367	2.774			0.939	* 0.764
Financial Cont.			2.679	* 4.705			* 7.942	* 16.79
Log-likelihood	-108.6	-101.4	-72.32	-52.71	-64.35	-50.37	-62.86	-52.95
Variance	7.321	1.832	7.264	0.388	10.08	0.906	8.947	0.954
P_{11}		0.623		0.568		0.701		0.701
P_{22}		0.407		0.703		0.916		0.916
P_{33}		0.075		0.109		0.573		0.573

Note: Columns in bold indicate the best number of regimes for the specific model. P_{ij} denotes the regime switching probabilities.
* indicates statistical significance at the 10% level.

Table 9: The Latin American Crisis: Comparing the Predictive Power of the Full Model, the Fundamentals Model and the Contagion Model

prediction: 1995/Q1-1995/Q2	Actual Crisis EMP		Out-of-Sample Prediction: Full Model		Out-of-Sample Prediction: Fundamentals Model		Out-of-Sample Prediction: Contagion Model		In-Sample Prediction: Full Model		In-Sample Prediction: Fundamentals Model		In-Sample Prediction: Contagion Model	
country:	rank	severity	rank	severity	rank	severity	rank	severity	rank	severity	rank	severity	rank	severity
Mexico	1	26.1	2	8.7	18	-4.2	2	5.2	2	9.5	7	-0.4	1	7.0
Brazil	2	17.5	1	9.3	1	9.4	3	4.4	1	9.9	1	5.4	2	6.9
Philippines	3	10.2	4	4.2	16	-2.0	7	0.4	4	3.7	11	-1.0	5	3.0
Argentina	4	6.9	3	4.7	10	-0.5	1	6.4	3	4.9	12	-1.2	3	6.4
Jordan	5	6.7	16	-0.4	21	-11.4	20	-1.3	20	-2.4	10	-0.8	21	-1.4
Peru	6	4.7	5	3.6	2	6.4	10	0.1	8	1.8	15	-2.2	9	1.8
Sri Lanka	7	4.7	12	0.6	11	-0.5	14	-0.6	16	-0.7	21	-4.4	8	1.9
Pakistan	8	4.0	17	-0.5	14	-1.7	18	-0.9	18	-1.3	16	-2.4	19	-0.6
Chile	9	3.5	9	2.6	3	4.4	11	-0.3	5	3.4	4	1.1	4	3.2
Hungary	10	3.4	20	-2.1	20	-7.2	21	-1.4	19	-2.4	14	-1.3	18	-0.2
Malaysia	11	3.4	8	3.1	7	0.3	4	1.9	9	1.7	8	-0.8	12	1.3
South Africa	12	2.7	15	0.0	17	-2.7	15	-0.7	12	1.3	13	-1.3	7	2.1
Indonesia	13	2.7	6	3.3	6	0.5	6	1.0	7	2.0	3	2.0	13	1.2
Thailand	14	2.6	7	3.2	9	-0.5	5	1.4	6	2.9	2	4.9	10	1.6
Colombia	15	1.5	10	1.9	5	0.7	13	-0.5	11	1.5	6	0.5	16	0.5
Korea	16	0.9	11	1.2	15	-1.7	9	0.2	10	1.6	9	-0.8	11	1.5
India	17	0.7	14	0.4	8	-0.3	8	0.3	14	0.2	19	-3.9	6	2.3
China	18	0.6	19	-1.6	19	-4.8	12	-0.4	17	-1.1	18	-2.7	17	0.3
Poland	19	-4.1	13	0.4	12	-1.4	16	-0.7	15	-0.4	17	-2.4	15	0.5
Venezuela	20	-6.8	18	-0.6	4	3.0	17	-0.8	13	0.5	5	0.9	14	0.6
Turkey	21	-7.1	21	-3.1	13	-1.6	19	-1.3	21	-3.6	20	-4.0	20	-0.7
Spearman correlation			0.644		0.053		0.401		0.518		0.227		0.530	
P-value			0.002		0.819		0.071		0.016		0.322		0.014	
R2			0.663		0.052		0.464		0.611		0.102		0.544	

Note: R^2 is obtained from a regression of predicted on actual values of EMP.

Fig. 4(a): Regime Switching Probabilities, MSIH(2)-VAR, EMP Asia 5

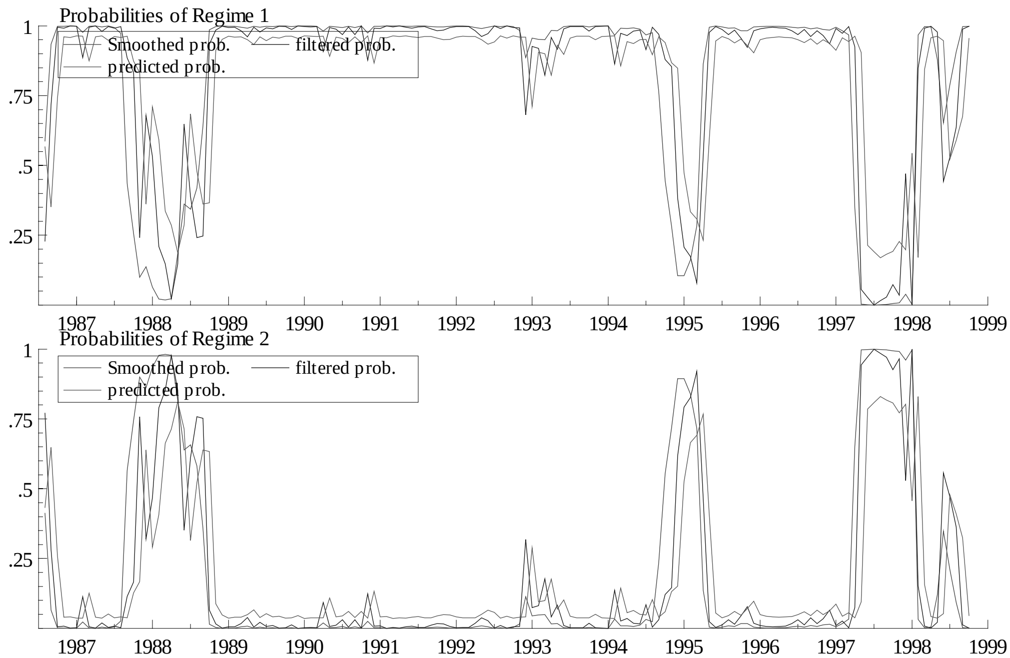

Fig. 4(c): Regime Switching Probabilities, MSIH(4)-VAR, EMP Asia 5

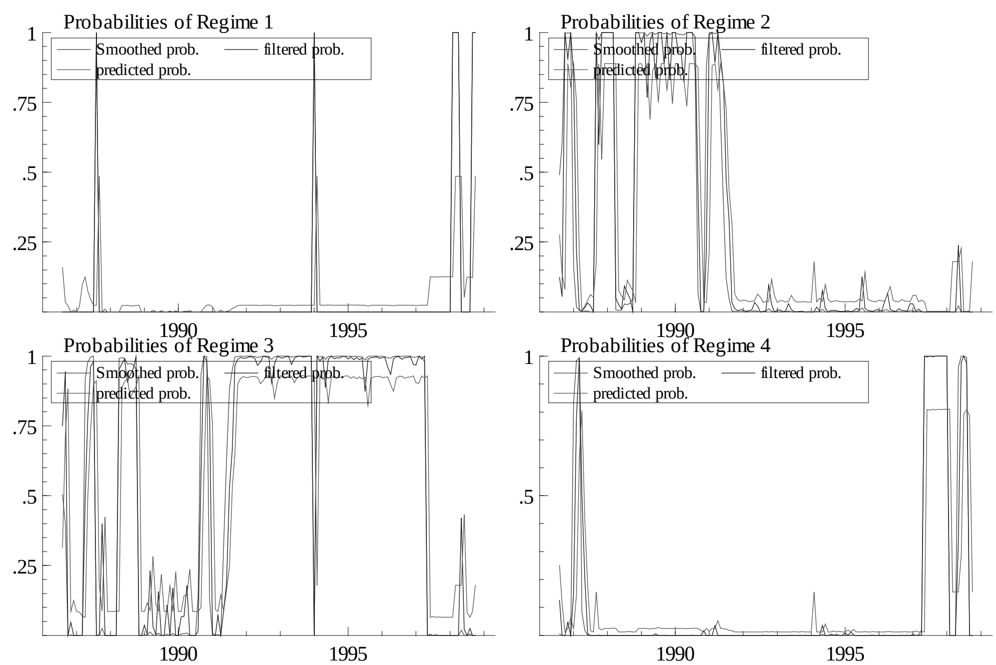

Fig. 5(a): Regime Switching Probabilities, MSIH(2)-VAR, CRED Asia 5

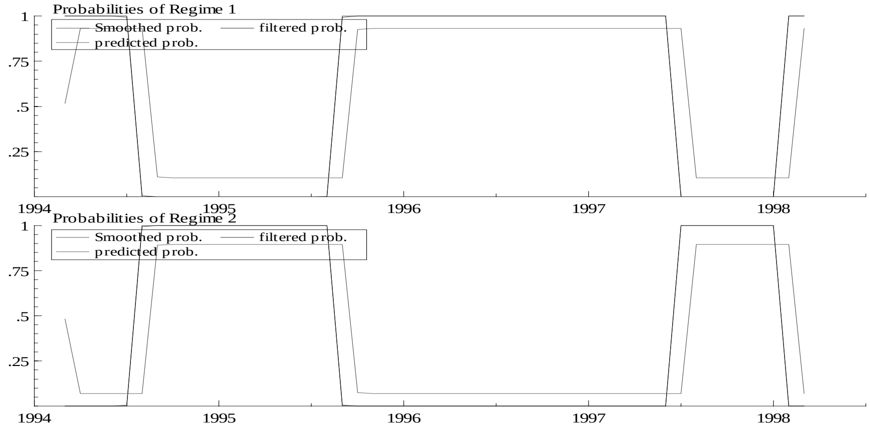

Fig. 5(b): Regime Switching Probabilities, MSIH(3)-VAR, CRED Asia 5

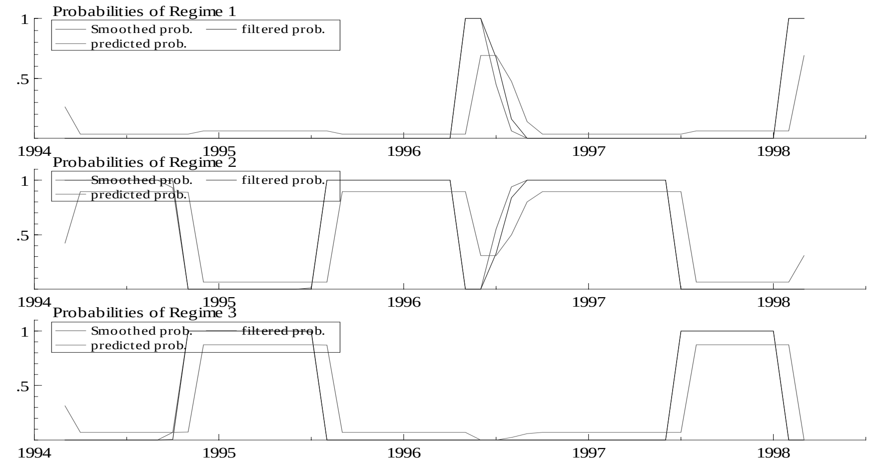

Fig. 5(c): Regime Switching Probabilities, MSIH(4)-VAR, CRED Asia 5