How Central Banks Prepare for Financial Crises
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An Empirical Analysis of the Effects of Crises and Globalisation on International Reserve Holdings

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Abstract

Central banks' international reserve holdings have increased significantly in the recent past. While traditional models fail to explain this accumulation of reserves, the more recent literature argues that reserves are used as a lifejacket against currency crises. However, research so far has neglected the question whether and how central banks change their precautionary reserve holdings after the country was affected by a currency crisis.

This paper tests the hypothesis that central banks revise their reserve policy in the aftermath of currency crises. A dynamic panel data model is estimated for developing and industrial countries covering the period from 1975 to 2003. The evidence suggests that currency crises induce a permanent increase of reserves. This effect is particularly strong for recent currency crises since the Asian financial crisis.

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1 Introduction

One puzzle of the international financial system is the enormous increase in international reserve holdings by central banks since the demise of the Bretton Woods system. In contrast to general wisdom, the transformation to de-jure more flexible exchange rate regimes was not accompanied by a permanent reduction in the level of reserves. Between 1975 and 2006, the absolute value of worldwide official reserve holdings increased by a factor of 17.[1] This build-up of reserves is mainly due to developing and transition economies. Their share in total worldwide reserves has risen from 40% in 1975 to more than 70% in 2006. Although the increase of the absolute level of reserves is driven by a small number of countries, e.g. China, Japan, Russia, Korea (Figure 1), the phenomenon of reserve accumulation is not restricted to a small number of outliers, but rather observable in the majority of countries (see Figure 2). The number of systematic accumulaters has even increased in the recent past. Whereas from 1973 to 1996 on average 57% of all countries increased their real reserves in a given year, this share amounted to 65% over the period from 1997 to 2006 (Figure 3).
The increase is also observable in commonly used indicators of reserve adequacy, which consider the level of reserves in relation to a scaling variable like imports, GDP or external debt. This shows that the increase cannot be explained by simple rules of thumb: Whereas traditionally a level of reserves that covers three to four months of imports was considered to be adequate, in 2006 reserves covered on average more than six months of imports. Even recent models of the optimal amount of reserves fail to explain the actual accumulation. According to Jeanne and Rancière (2006) the optimal level of reserves for a benchmark economy amounts to 10% of GDP. However, in 2006 central banks' reserves averaged 18% of GDP.

This unexpected increase in reserves gave rise to a series of papers that investigate two main research questions. The first group of papers analyses the optimality of reserve holdings given that reserves exceed traditional indicators of reserve adequacy. The second group aims at finding rationales for this unprecedented reserve accumulation.

This paper contributes to the latter strand of the literature. It proposes a new explanation for reserve accumulation, namely that central banks revise their reserve policy after they have

[1] All data in the introduction are obtained from calculations based on the International Financial Statistics (IMF 2008).

experienced a currency crisis and significantly increase their reserves after a crisis. Questions of the optimality and adequacy of this reserve policy are not touched.

Existing papers explaining the reserve accumulation can be grouped into two lines of argumentation: The first strain argues that the accumulation of reserves is driven by mercantilist motives and the result of an export-led growth strategy (Dooley et al. 2003). The second group highlights the precautionary motive of reserve hoardings. Reserves are seen as a form of self-insurance against financial crises. Examples of the latter are Jeanne and Rancière (2006) and Mendoza (2004). Aizenman and Lee (2007) contrast both motives and test their empirical relevance. Their results confirm the relevance of a precautionary reserve demand, whereas the mercantilist motive turns out to be economically insignificant.

This article contributes to both lines of argumentation: If the experience of a currency crisis alters a central bank's reserve policy, the additional hoardings might be precautionary. The central bank changes its assessment of the country-specific crisis probability and fears future currency crises. It wants to be better prepared to defend the currency and manage a crisis after a future attack. The reserve accumulation after a crisis might also be driven by mercantilist motives. An undervalued exchange rate – or, more precisely, the maintenance of an undervalued exchange rate given that a crisis often includes a large nominal depreciation – might be regarded as an instrument to ease the negative growth effects of the crisis.

Empirical tests of the proposed relationship between economic crises and reserves are rare. Typically, studies confirm that reserves decrease during a currency crisis whereas the long-run effects of a crisis are disregarded. To my knowledge there is only one exception, namely Aizenman and Lee (2007) who test for the long-run effect of crises on reserve holdings. However, their approach is rather simple and some refinement is warranted. They include two dummies in their specification, one for the Mexican Tequila crisis in 1994 and another for the Asian financial crisis of 1997-98. These are applied for all countries independently whether they were directly affected by these crises or not.

This article extends the existing literature in several ways. First, it identifies crises for each country individually and hence allows to test whether countries change their reserve holdings after they have suffered from a crisis. Second, it uses a large data set that includes the period of reserve accumulation beginning in the 1990s. To confirm the robustness of the findings, the

results of three different estimators are compared. Finally, and most importantly, it tests the hypothesis that reserve holdings are significantly higher in countries that have experienced a currency crisis. To this end, a panel data set of a maximum of 114 countries over the period 1975 – 2003 is used.

This paper is organized as follows. Section 2 describes how reserves and currency crises are related and postulates the hypothesis of the article. Section 3 presents the data which are used in the empirical analysis. After a description of the panel data estimators, section 4 presents and discusses the empirical results. The final section concludes.

2 How are reserves and currency crises related?

This section analyses the link between currency crises and reserves, both theoretically and empirically and motivates the hypothesis that central banks change their reserve policy after the experience of a currency crisis.

2.1 The role of reserves in models of currency crises

First, the role of reserves in different models of currency crises is reviewed.[2] Second, empirical evidence of the relationship between reserves and the probability of a currency crisis is presented.

In the first generation of currency crises models an inconsistency between fiscal and monetary policy on the one hand and the commitment to a fixed exchange rate on the other leads to a continuous loss of reserves and, consequently, to a change of the fixed parity or even free float when reserves have fallen below some critical value (e.g. Krugman 1979 and Flood and Garber 1984). Thus, a high level of reserves cannot avoid this type of currency crisis. It can only postpone its occurrence and provide a time buffer within which domestic policy can be reconciled with the exchange rate commitment.

[2] The models which are presented here are known as models of balance of payments crises. Balance of payments crises are a broader concept than currency crises. However, in these models a currency crisis often precedes a balance of payments crisis as a precondition since once reserves are exhausted – as a consequence of the currency crisis – they can no longer support the balance of payments.

Models of the second-generation type emphasise that a currency crisis might be the result of an optimising behaviour of the government. A government trades-off the costs of fiscal austerity – additional unemployment and a depressed economy – against the costs of losing its reputation for a credible exchange rate policy. The abandonment of an exchange rate peg is seen as a deliberate and active policy choice. In this class of models crises can be self-fulfilling since the government's cost of maintaining the peg depends on the mass of individuals who attack. The more speculators attack, the more probable a crisis.

One of the pioneering works of the second-generation type is Obstfeld (1994). He affirms "that reserve losses certainly accompany a crisis, but they are not the factor that triggers it and not the factor that ultimately leads the authorities to devalue." (p. 211)

This view, however, neglects the relationship between individuals' expectations and the level of reserves. In models of the second-generation the costs of a defence of the exchange rate depend on the expectations of the individuals. If individuals expect a devaluation because reserves are low, a defence of the exchange rate is more costly which, in turn, makes a devaluation more probable. Hence, a low level of reserves – which is considered as inadequate – may be one of the ultimate causes of a currency crisis.

The third generation approach to balance of payments crises was developed as a response to the Asian financial crisis of 1997-98 and highlights a variety of factors that might serve as explanations for a currency crisis. These factors include the following: weakly supervised financial systems and implicit government guarantees that lead to moral-hazard-driven overlending; an increase of the real debt service burden due to a large currency depreciation in the presence of a currency mismatch (foreign currency liabilities are backed by domestic currency assets); interactions with other kinds of financial crises, namely banking crises (twin crises); and contagion due to linked fundamentals or herding behaviour of investors. In these third-generation models the role of reserves is ambiguous: On the one hand, a high level of reserves might be interpreted by investors that the government is ready to intervene in a crisis situation. Reserves are part of the government guarantee and consequently foster moral-hazard driven overlending. On the other hand, reserves reduce the currency mismatch of the government and reduce the vulnerability of the country's consolidated balance sheet in the face of large depreciations.

It can be concluded that the level of international reserves plays a prominent role in models of currency crises. High levels can reduce the probability of a currency crisis from a theoretical perspective (second and third generation models) or postpone its occurrence (first generation).

This is especially relevant for countries that are financially integrated in the world capital market. Whereas financial integration facilitates private financing of balance of payments deficits in good times, open capital markets increase the exposure to external financial disturbances and speculative flows in crisis periods. Crises may stem from the capital account with no change in the current account. Therefore the more recent literature views reserves as a precautionary cushion against the risks of capital account liberalization, namely sudden stops, reversals of capital flows and financial volatility. The empirical analysis will account for these effects by the inclusion of measures of financial integration.

The empirical relationship between reserves and currency crises has been studied extensively.[3] Kaminsky, Lizondo and Reinhart (1998) present a review of studies on indicators of currency crises and report that international reserves belong to the leading indicators. They reduce the probability of a currency crises significantly in 12 out of a sample of 13 studies. The estimation results of Bussière and Mulder (1999) even suggest that high liquidity (defined as international reserves over short-term debt) can offset weak fundamentals and reduce contagion. In an extensive probit analysis of crisis probability, Frankel and Wei (2005) find that the ratio of short-term external debt to international reserves together with expansionary monetary policy are the most likely contributors to a crisis. In a historical comparison of the causes of currency crises in two periods (1880-1913 vs. 1972-1997) Bordo and Meissner (2005) show that a strong reserve position relative to money decreased the probability of a crisis in both periods.

2.2 The hypothesis

We hypothesise that central banks accumulate international reserves after they have experienced a currency crisis.[4] There might be several reasons why a central bank changes its reserve policy after a currency crisis has occurred.

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[3] Reserves are usually one of the leading indicators to forecast a currency crisis in the literature of early warning systems of financial crises.

[4] In this article we use a broad concept of currency crisis. The term currency crisis encompasses successful speculative attacks on a currency as well as unsuccessful ones.

First, the experience of a currency crisis might lead to a re-examination of the optimal amount of reserves. A central bank might want to signal international investors and speculators that it is disposed to defend the currency. They might be concerned to disseminate positive signals in the form of increasing reserve levels, which, in turn, might reduce the probability of speculative attacks. If a currency crisis cannot be avoided, the central bank might at least wish to be endowed with the resources for a better crisis management.

Second, a central banks might change its evaluation of risks linked to the integration into the international financial market. The occurrence of a crisis highlights the risks and costs of sudden stops of capital flows and contagion. These risks might have been undervalued in good times of financial tranquillity.

Third, central bankers might not only be more vigilant concerning possible risks. Even more important, they might become more risk averse after they have been blamed for the severe effects of a crisis by politicians and the public. Central bank governors might be concerned about the loss of reputation – of their person and of the institution as a whole – and fear to be fired.

Fourth, currency crises usually depress economic growth. Governments might intend to fasten the recovery from low growth and return to the pre-crisis growth path on the basis of an export-led growth strategy. Central banks may contribute to this strategy by maintaining the exchange rate undervalued. This can be facilitated if reserves are accumulated.

Finally, the accumulation of reserves after a crisis can be explained by political economy considerations. According to the theory of bureaucracy, bureaucrats try to maximize their power through increases in their budget, staff and discretion. International reserve interventions are both powerful and often discrete instruments. Central bankers might use a crisis episode to justify a further increase of reserves. In the moment when the costs of a crisis are evident, the costs of reserve holdings might be underestimated by the public.

To test this hypothesis a dynamic panel data model is estimated. It expands traditional models of the demand for reserves by the inclusion of a dummy variable that accounts for currency crises.

3 Empirical strategy

The following section sets the foundations for the empirical analysis: It describes the data set, presents the standard control variables and explains how currency crises are identified.

3.1 Data

The empirical analysis is carried on the basis of a pooled data set of cross-country and time-series observations. It contains annual data from 1975 to 2003 for a maximum of 181 countries. Since data for several explanatory variables are missing for some countries, the number of countries used in the econometric analysis depends on the particular specification and is indicated in the respective tables. It ranges from 40 to 114 countries. With a few exceptions data are taken from the International Financial Statistics of the IMF and the World Development Indicators of the World Bank. A detailed description of the sample and data sources can be found in the appendices A and B.

For the identification of currency crises, annual observations miss the necessary fineness. Therefore, an additional data set is constructed that contains monthly observations of the relevant variables (international reserves, nominal exchange rate and interest rate) for the same sample of countries. It covers the period 1970-2003 such that also currency crises in the five years before the period of the main empirical analysis (1975-2003) can be identified.

3.2 Traditional control variables

In the following section the control variables are presented. The set of control variables consists of those variables that were identified as important determinants of the level of reserves in an accompanying paper.

Output per capita is included to control for the level of development. Less developed countries are expected to hold more reserves since they are more affected by sudden changes in the flows of goods and capital. Another explanatory variable is trade openness. The more open the economy, the more vulnerable it is to external shocks and is expected to hold more reserves for precautionary motives. Higher volatility measured as the standard deviation of the previous years of the growth rate of exports is also expected to be associated with a higher level of reserves (precautionary motive).

Empirical studies show that both a high level of external debt and a low level of reserves increase the probability of a financial crisis. Hence, reserves might offset the vulnerability induced by external debt. Therefore, it is expected that countries with a high level of external debt hold more reserves for precautionary reasons. Additionally, short-term external debt is included. Reserves that cover short-term external debt enable a central bank to mitigate the real exchange rate effects of capital flight. Finally, dummies for different types of exchange rate regimes are considered. The more flexible the exchange rate, the less reserves are needed for its management.

According to the monetary approach to the balance of payments, an excess supply of money leads to an equal loss of reserves and vice versa. Therefore, a proxy for monetary disequilibrium is included in the set of control variables. This effect is expected to be the stronger, the more rigid the exchange rate is. An interaction term between fixed exchange rate regimes and monetary disequilibrium is intended to capture this relationship.

Since the time-series of reserves are characterized by a high degree of persistence, the determination of the level of reserves is a natural candidate for a dynamic specification that includes the lagged level of reserves as one of its determinants. This specification can be motivated by a partial adjustment or habit-persistence model.

The dependent variable international reserves is measured net of gold holdings and scaled by GDP.

3.3 Definition of a currency crisis

The existing empirical literature uses two alternative ways to identify a crisis episode: event-based methods and index methods.

The event-based method dates crisis episodes on the basis of events like a sharp depreciation, an interest rate hike or news referring to a crisis situation. In this analysis, the event-based method will not be applied due to its conceptual shortcomings. Both the definition of an event – what is a sharp depreciation? – and its timing are likely to be arbitrary. Moreover, a given rate of depreciation might qualify as a crisis in one country whereas it is regarded as normal in another country.

According to the index method, a currency crisis is defined to occur if an index of exchange market pressure (EMPI) exceeds a threshold. Whereas the event-based method only identifies

actual currency crises, the index method reveals both successful and unsuccessful speculative attacks.

Whereas actual currency crises are characterized by sharp depreciations, an unsuccessful speculative attack can be identified indirectly by counteractive measures taken by a central bank: The currency may be defended by the sale of reserves or an increase of the interest rate may intend to stop massive capital outflows and thereby reduce the pressure on the currency. Eichengreen et al. (1996) propose an index that summarizes the changes of the nominal exchange rate, reserves and the interest rate, each weighted by the inverse of their standard deviation. All changes are computed relative to a reference country, namely Germany or the US.

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

where e is the nominal exchange rate, R are reserves, and i is the nominal interest rate. t indicates the time period and the index i denotes a certain country. The standard deviation σ is calculated individually for each country over the whole period. In our application changes in e and i are calculated relative to the U.S. Changes in reserves are not compared with a reference country since a simultaneous fall of reserves in many countries might signal a global crisis.

A currency crisis is defined to occur if the index exceeds its mean plus two standard deviations.[5] In order to avoid double-counting, the three years that follow a currency crisis are discarded. In comparison with the event methods where the threshold is fix over all countries and periods – e.g. a depreciation of 25% in the case of Frankel and Rose (1996) – the index method calculates country-specific thresholds. This has the merit that it takes into account different institutional settings. A devaluation in a fixed exchange rate regime is much more costly than the same devaluation under a floating exchange rate since in the latter economic agents are used to be exposed to a higher volatility and might be better prepared for such situations.

Figure 4 shows the distribution of currency crises for the pressure index. It succeeds in identifying the two periods of numerous crises at the beginning of the 1980s and at the end of the 1990s.

[5] I also used smaller and larger threshold values. The choice of a threshold, however, does not change the number of identified currency crises significantly.

The following time path of reserves is assumed: Reserves decrease during a currency crisis and reach a lower point. After the disorder of the crisis passed and the economy is stabilized, the central bank restocks reserves. It is natural to assume that the central bank aims at accumulating reserves in the post-crisis period. Therefore, we expect that reserves grow in the first months or years after a currency crisis. If our currency crisis dummy variable took the value one beginning in the first crisis month, a positive relationship between crisis and reserves would be natural. However, it would not indicate a revised reserve policy but, in contrast, affirm that the central bank replenishes its reserves. Conclusions would be misleading.

Therefore, we focus on the end of a currency crisis. The end of a currency crisis is defined as the moment where – at least from the point of view of the central bank – the economy is stabilized again. After a currency crisis was identified we determine in which month reserve restocking is completed. The dummy for currency crises takes the value one in that year and all following years. Hence the crisis dummy only evaluates if reserves exceed their pre-crisis level.

Figure 5 illustrates the construction of the crisis dummies and the expected time path of reserves before and after currency crises. According to the hypothesis, reserves are expected to increase in the aftermath of currency crises and to rise above their pre-crisis level. This increase is permanent.

There are two different views how to determine when pure restocking is completed. First, the central bank might end its policy of reserve accumulation once reserves reach their pre-crisis level. However, for a given reserve strategy of the central bank, the desired post-crisis level usually differs from the desired pre-crisis level. During a crisis typical determinants of reserves like the amount of external debt, the economy's trade openness and even the exchange rate system may be affected by important changes. Therefore, as a second approach, I calculate the fitted values of reserves over GDP in a bias-corrected dynamic fixed effects estimation, which includes the same control variables as the majority of our later regressions except the crisis dummies. In the year when actual reserves exceed their fitted value, the currency crisis dummy then takes for the first time the value one. To test for the robustness of the findings, the empirical analysis will make use of both approaches. They are referred to as methods based on the pre-crisis level and fitted values, respectively.

Given this currency crisis dummy I use two different approaches to employ it in the estimation.
First, I use all dummies individually in their chronological order. That is to say, the effect from the first until the last identified crisis is examined. The dummy "first crisis" then analyses the impact of the first crisis during 1973-2003 independently of the year of its occurrence. The first crisis might hit one country in 1973 whereas another country suffers its first crisis in 2003.

As a second approach, I distinguish three periods: Crises between 1973 and 1981, between 1982 and 1996 and between 1997 and 2003. The partition in episodes is justified by the occurrence of important crises: the breakdown of the Bretton Woods system in 1973, the debt crisis of 1982 and the East Asian financial crisis of 1997. These crises might have changed the general perception of a crisis since these crises can be regarded as prototypes of crises. Moreover, these three crises periods also coincide with the theoretical distinction of three generations of currency crises (see section 2.1). The crisis dummy takes the value one after a country experienced its first currency crisis within this period. Relevant is the year in which reserve restocking is completed. The dummy makes no difference whether this was the only currency crisis for a certain country in this period or whether a country suffered several crises in the same period.

In a nutshell, crises dates are identified according to an exchange market pressure index. On the basis of these dates, two different methods are applied to determine the year when reserve restocking is completed. The dates of completed restocking are used in two versions of crisis dummies in the empirical analysis: absolute number of crises and categorized in periods of crises.

3.4 Financial liberalization and economic globalisation

Financial liberalization and economic globalisation both allow a country to profit from international capital flows. However, they also make countries more vulnerable to sudden stops and capital flow reversals. It is interesting to investigate whether capital account liberalization and economic globalisation go along with increasing self-insurance in the form of reserve hoardings. More importantly, the question arises whether this planned self-insurance was adequate or if a central bank revises its reserve policy after the occurrence of a

currency crisis although they already took precautionary measures before the crisis. If we did not control for these effects, the currency crisis variable might simply proxy increased economic integration.

We rely upon the index of capital account openness developed by Chinn and Ito (2002). This index embodies four binary dummy variables on restrictions on international financial transactions, which are reported in the IMF´s Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The index measures de jure financial openness and makes no attempt to include de facto openness. Higher values indicate that countries are more open to cross-border financial transactions.

As a proxy for the integration of an economy in the international markets we use an index of economic globalisation. It is a sub-index of the KOF index of globalisation proposed by Dreher (2006). The index of economic globalisation has two main components which are weighted equally: actual flows of goods and capital and restrictions to these flows. The index takes values between one and hundred where higher values denote greater globalisation.

4 Empirical evidence

4.1 Statistical evidence

As a nonparmetric test of our hypothesis, figure 6 plots in a scatter diagram the relationship between the largest annual reserve loss during 1975-2003 and the subsequent change in the level of reserves. The diagram includes those countries of our sample that experienced an annual reserve loss of at least 25%. Analogously to Frankel and Rose's (1996) definition of a currency crisis (nominal devaluation larger than 25%), this is our indicator of a successful or unsuccessful speculative attack. The ordinate depicts the level of reserves relative to its pre-crisis level five (right hand) and eight (left) years after the reserve loss, respectively. The horizontal line at the value zero divides the diagram in two parts: in countries below the line, reserves did not reach its pre-crisis level whereas in countries above the line reserves are larger than before the crisis. It is evident, that the majority of countries increases its reserves well above the pre-crisis level. Whereas five years after a crisis there is still a minority of countries with lower reserves than before the crisis, eight years after the crisis in only six countries reserves are below their pre-crisis level. At least three of these countries suffered

from (civil) wars during those years.[6] The diagram illustrates that already after five years the reserves of the majority of countries are twice their pre-crisis level (values larger than one on the vertical axis). The downward sloping line of fitted values indicates that there is a positive link between the absolute loss of reserves and the subsequent accumulation of reserves. In sum, the figures show first evidence that central banks accumulate reserves in the years after a currency crisis until reserves are significantly higher than before the crisis.

4.2 Method of estimation

Since the level of reserves is partly determined by its level of the previous period, I use a dynamic specification where the lagged dependent variable enters as an explanatory variable. Since the lagged level of reserves is correlated with the error term the assumption of strict exogeneity is violated. Fixed effects estimators - which are the standard estimation technique in static models - are biased and inconsistent for the number of units of observation going to infinity and a fixed number of time periods.

The literature proposes two different solutions to the problem: a correction for the bias or, alternatively, estimation by the Generalized Method of Moments (GMM). In order to check for the robustness of the results, the empirical analysis will make use of both methods.

For dynamic panel data models with serially uncorrelated errors and strongly exogenous regressors, Kiviet (1995) derives an approximation for the bias of the fixed effects estimator. He proposes a corrected fixed effects estimator that subtracts a consistent estimator of this bias from the standard fixed effects estimator.

Instrumental variables estimators are proposed as an alternative solution. This class of estimators eliminates the country-specific effects by first differencing and then applies instrumental variables to the transformed equation. The difference GMM estimator, also known as Arellano-Bond estimator (Arellano and Bond 1991) uses all feasible lagged values of the dependent variable as instruments. Estimation is executed by a two-step procedure. Since the two-step standard errors tend to be biased downward in small samples, the one-step

[6] These six countries with a lower reserve level than before the crisis are Afghanistan (crisis in 1981 during the civil war between 1979 and 1989), Bahamas (1987), Burkina Faso (1994), Nicaragua (1984, in the year of the first free elections after the Sandinista revolution), Paraguay (1992) and Sri Lanka (1980, beginning civil war in 1983).

standard errors are used for inference. The consistency of the GMM estimator is checked by two specification tests The Sargan test of overidentifying restrictions, which evaluates the overall validity of the instruments, and the Arellano-Bond test for autocorrelation in the residuals. The results of both tests are reported at the bottom of the output tables.

These estimators assume that the slope parameters are constant over time and over all countries. The previous chapter highlighted the theoretical result that the estimation coefficients may be biased if this assumption does not hold. Tests of the poolability of the dataset rejected the hypothesis of common slope parameters. Therefore, one has to check whether the results are robust to neglected country heterogeneity. On this account, the mean group estimator, proposed by Pesaran and Smith (1995) is employed. It estimates an individual regression for each country by OLS and averages the coefficients over countries.

4.3 Estimation results

Table 1 presents the estimation results for the individual currency crises dummies in their chronological order. As described above, the crises dummies switch from zero to one when the central banks finishes to restock reserves after a currency crisis. Columns (1) and (2) assume that this is the case when reserves have reached their pre-crisis level. The determination of crises dummies in columns (3) to (5), however, is based on an auxiliary regression: The dummies take the value one beginning in the period when actual reserves exceed their fitted values from the auxiliary regression. We employ three different estimation techniques: the difference GMM estimator, the bias-corrected fixed effects estimator and the mean group estimator.

With respect to the traditional determinants of reserves, the results confirm previous results. Independently of the chosen estimator the effects of openness and external debt are positive and significant. More open and more indebted countries hold higher levels of reserves. Short-term external debt has a significant negative effect on reserves. This supports the hypothesis that an increase in short-term external debt is an indication of an emerging financial crisis – investors prefer to lend short-term – , which is reflected in a fall of central banks' reserves. The lagged level of reserves is highly significant. The effects of the remaining variables are not significant. In particular, the level of development, external volatility and the exchange rate system do not significantly influence the level of reserves.

With respect to the impact of currency crises, we can record the following: Whereas the currency crisis dummies are insignificant when restocking of reserves is defined by a comparison with their pre-crisis level (columns 1 and 2), a minimum of one and a maximum of four currency crises have a significant positive effect on the level of reserves when fitted values are used (columns 3 to 5). This implies that countries revise their reserve policy after the experience of a currency crisis. The level of reserves is a positive function of the number of crises they suffered from during the period of consideration.

Table 2 shows the results when crises are categorized by their incidence in three different periods. All crises dummies are constructed on the basis of a comparison of reserves with their pre-crisis level. In the case of crisis periods, the alternative use of fitted values is disregarded since in this specification the errors are serially correlated (Arellano-Bond test has a very low p-value), which might lead to misleading inferences. In this specification, all currency crisis dummies turn out to be insignificant.

Table 3 replicates column 3 of table 1 (number of currency crises) where capital account openness and economic globalisation are added to control for the effects of international financial integration. The results concerning currency crises are robust to this change: Crises imply an increase in the level of reserves. The effects are slightly smaller in magnitude than without the additional control variables but still highly significant. The first three crises increase the level of reserves significantly, whereas the fifth crisis leads to a significant reduction in the level of reserves. Central banks do not increase the level of reserves after each crisis. However, the cumulative effect of the first five crises is still positive. The effects of capital account openness and economic globalisation are not significant.

The robustness checks for currency crises periods are presented in table 4. It replicates column 1 of table 2 after adding the control variables for international financial integration. The 1973-81 crisis dummy is still insignificant, the significance of the 1982-1996 dummy ambiguous and the 1997-2003 dummy is positive and significant. Hence, the inclusion of measures for financial openness even reinforce the results with respect to currency crises.

Table 5 additionally includes interaction terms between the crisis dummies and a fixed exchange rate system. It tests whether central banks' reserve policies in the aftermath of currency crises depend on the exchange rate system. One might expect that the increase in

reserves after a crisis is especially strong in countries with a commitment to a fixed exchange rate. The effects of the interaction terms are not significant. However, independently of the exchange rate regime, both crises between 1982 and 1996 and crises between 1997 and 2003 now significantly increase central banks' international reserves.

Additionally, we check the robustness of the results by the use of a different definition of a currency crisis. Based on an extended approach proposed by Zhang (2001) the time-series of the exchange rate, reserves and the interest rate are considered. A currency crisis is identified if the rate of change of at least one of the variables exceeds a certain threshold. So constructed currency dummies given even stronger support to the hypothesis than the presented results.

5 Conclusions

The widespread accumulation of international reserves by central banks in recent years is often explained as a precautionary buffer against the risks of international financial integration. Although theoretically plausible, empirical tests of this argument are still scarce.

This chapter analyses empirically whether currency crises have an effect on countries' level of reserves. It is especially interesting to investigate central bank behaviour when the risks of international financial integration are not only represented by a probability measure, but after they have become real in the form of a speculative attack with or without ensuing devaluation of the national currency.

It tests the hypothesis that central banks increase their holdings of international reserves after they have experienced a currency crisis. A dynamic model is estimated for a large panel data set of developing and industrial countries covering the period from 1975 to 2003. The evidence suggests that currency crises induce a permanent increase of reserves. This effect is particularly strong for recent currency crises since the Asian financial crisis. The more currency crises a country suffered from, the higher the level of reserves is. These findings are robust for different definitions of a currency crisis and across different estimation methods.

Central banks revise their reserve policy after the experience of a currency crisis and accumulate reserves in its aftermath.

References

Aizenman, Joshua and Jaewoo Lee (2007), "International reserves: Precautionary versus mercantilist views, theory and evidence", Open Economies Review forthcoming.

Arellano, Manuel and Stephen Bond (1991), "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations", Review of Economic Studies 58: 277-297.

Bordo, Michael D. and Christopher M. Meissner (2005), "The role of foreign currency debt in financial crises: 1880-1913 vs. 1972-1997", NBER Working Paper No. 11897.

Bussière, Matthieu and Christian Mulder (1999), "External vulnerability in emerging market economies: how high liquidity can offset weak fundamentals and the effect of contagion", IMF Working Paper No. 99/88.

Chinn, Menzie and Hiro Ito (2002), "Capital account liberalization, institutions and financial developments: cross country evidence", NBER Working Paper 8967.

Dooley, Michael P., David Folkerts-Landau and Peter Garber (2003), "An essay on the revived Bretton Woods system", NBER Working Paper No. 9971.

Dreher, Axel (2006), "Does globalization affect growth? Evidence from a new index of globalization", Applied Economics 38, No.10: 1091-1110.

Eichengreen, Barry, Andrew K. Rose and Charles Wyplosz (1996), "Contagious currency crises", Scandinavian Journal of Economics 98, No.4: 463-484.

Flood, Robert P. and Peter M. Garber (1984), "Collapsing exchange rate regimes: Some linear examples", Journal of International Economics 17: 1-13.

Frankel, Jeffrey A. and Andrew K. Rose (1996), "Currency crashes in emerging markets: an empirical treatment", Journal of International Economics 41: 351-366.

Frankel, Jeffrey A. and Shang-Jin Wei (2005), "Managing macroeconomic crises: policy lessons", in: Joshua Aizenman and Brian Pinto (eds.), Managing economic volatility and crises: a practitioner's guide, Cambridge University Press.

Ghosh, Atish R., Anne-Marie Gulde and Holger C. Wolf (2002), Exchange rate regimes: Choices and consequences, Cambridge, Mass: The MIT Press.

International Monetary Fund (2005), International Financial Statistics, CD-Rom (March), Washington, DC.

International Monetary Fund (2007), International Financial Statistics, online database (various months), Washington, DC.

International Monetary Fund (2008), International Financial Statistics, online database (various months), Washington, DC.

Jeanne, Olivier and Romain Rancière (2006), "The optimal level of international reserves for emerging market countries: Formulas and applications", IMF Working Paper 06/229.

Kaminsky, Graciela and Carmen Reinhart (1999), "The twin crises: The causes of banking and balance-of-payments problems", American Economic Review 89: 473-500.

Kaminsky, Graciela, Saul Lizondo and Carmen Reinhart (1998), "Leading indicators of currency crises", IMF Staff Papers 45, No.1: 1-14.

Kiviet, Jan F. (1995), "On bias, inconsistency, and efficiency of various estimators in dynamic panel data models", Journal of Econometrics 68: 53-78.

Krugman, Paul R. (1979), "A model of balance-of-payments crises", Journal of Money, Credit and Banking 11, No.3: 311-325.

Mendoza, Ronald U. (2004), "International reserve-holding in the developing world: self-insurance in a crisis-prone era?", Emerging Markets Review, Vol.5, No.1: 61-82.

Obstfeld, Maurice (1994), "The logic of currency crises", Cahiers économiques et monétaires No.43 : 189-213

Obstfeld, Maurice (1996), "Models of currency crises with self-fulfilling features", European Economic Review 40: 1037-1047.

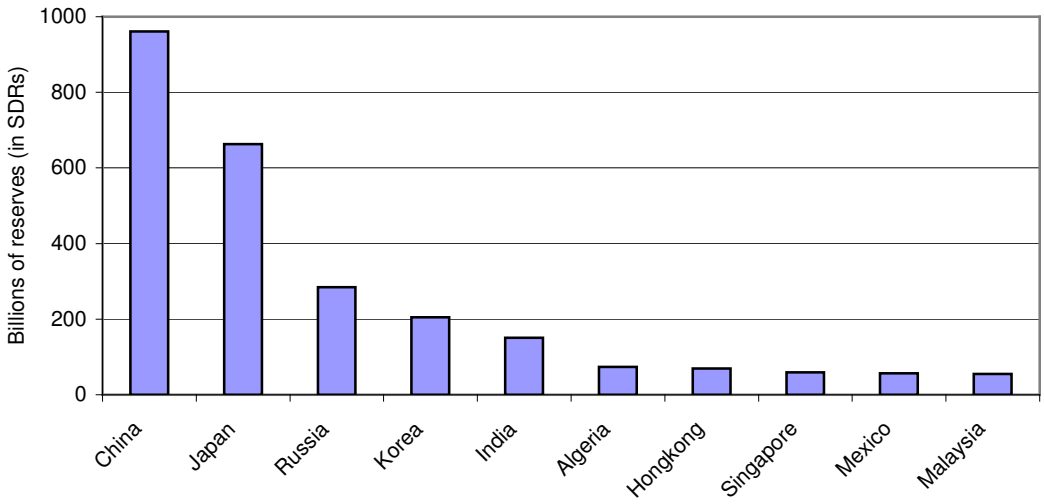
Soto, Claudio and Rodrigo Valdés (1999), "Exchange volatility and risk premium", Central Bank of Chile, Working Paper No. 46.

World Bank (2005a), World Development Indicators, Washington, DC.

World Bank (2005b), Global Development Finance, Washington, DC.

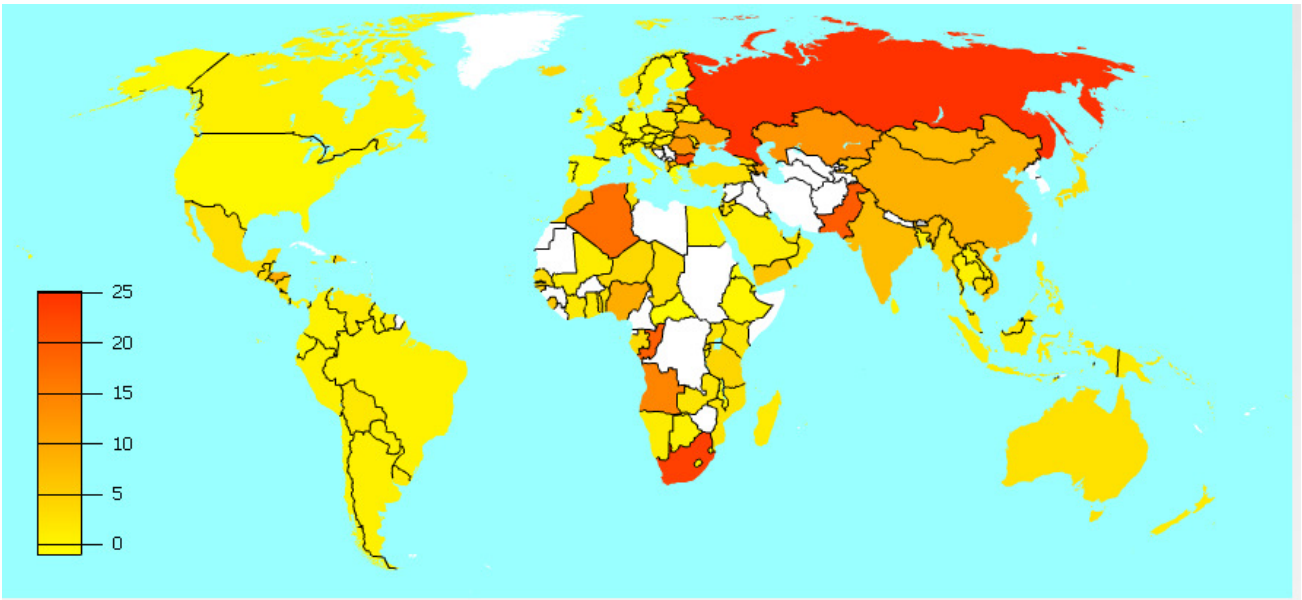
Zhang, Zhiwei (2001), "Speculative attacks in the Asian crisis", IMF Working Paper 01/189.

Figure 1: Countries with largest absolute increase of reserves (1996-2006)



Data source: International Monetary Fund (2007)

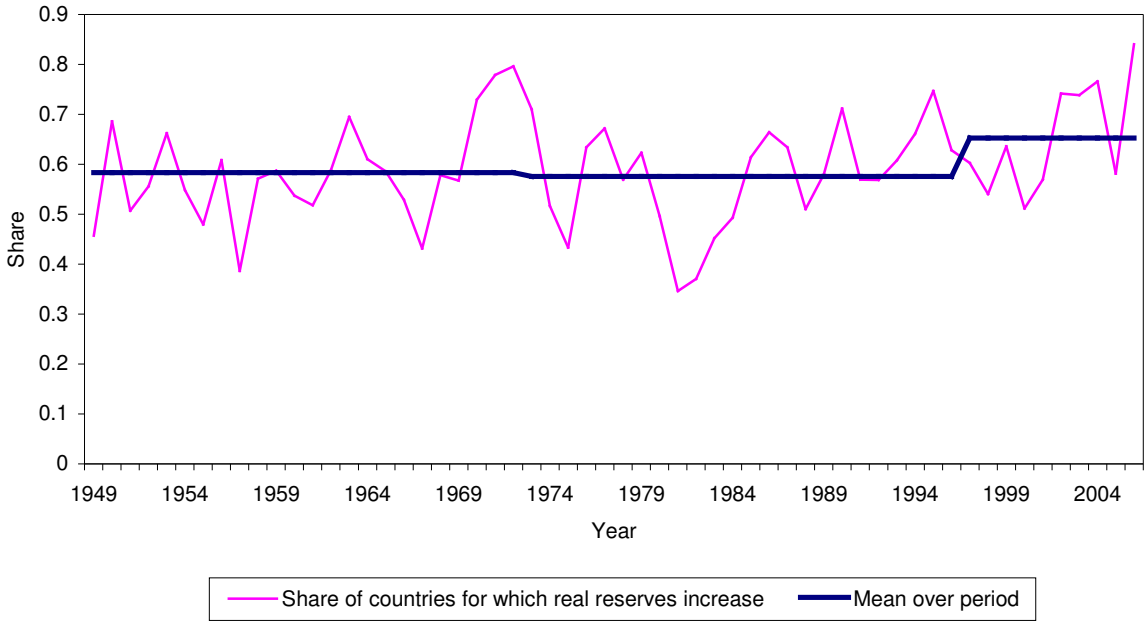
Figure 2: Relative increase of international reserves (1996-2006)



Data source: International Monetary Fund (2007)

Notes: The relative increase of reserves is calculated as the ratio of the level in the year 2006 and the level in 1996.
Countries with missing data are marked white. Moreover, the following outliers (very large increase) are disregarded: Cameroon, Equatorial Guinea, Liberia and Sudan.

Figure 3: Share of countries with positive reserve accumulation



Source: Author's computations based on International Monetary Fund (2007).
Note: Real reserves are defined as total international reserves (in dollars) divided by the GDP deflator for the US. The chosen periods and calculated mean values for the share of countries are the following: 1949-1972: 58.3%; 1973-1996: 57.6%; 1997-2006: 65.3%.

Figure 4: Identified currency crises by the exchange market pressure index

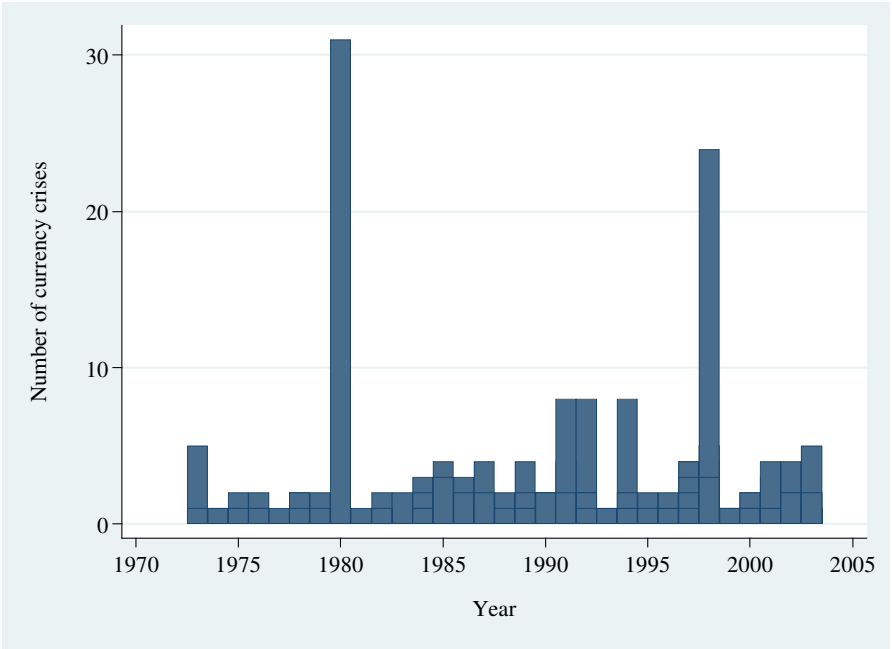


Figure 5: Stylized time path of reserves according to the hypothesis

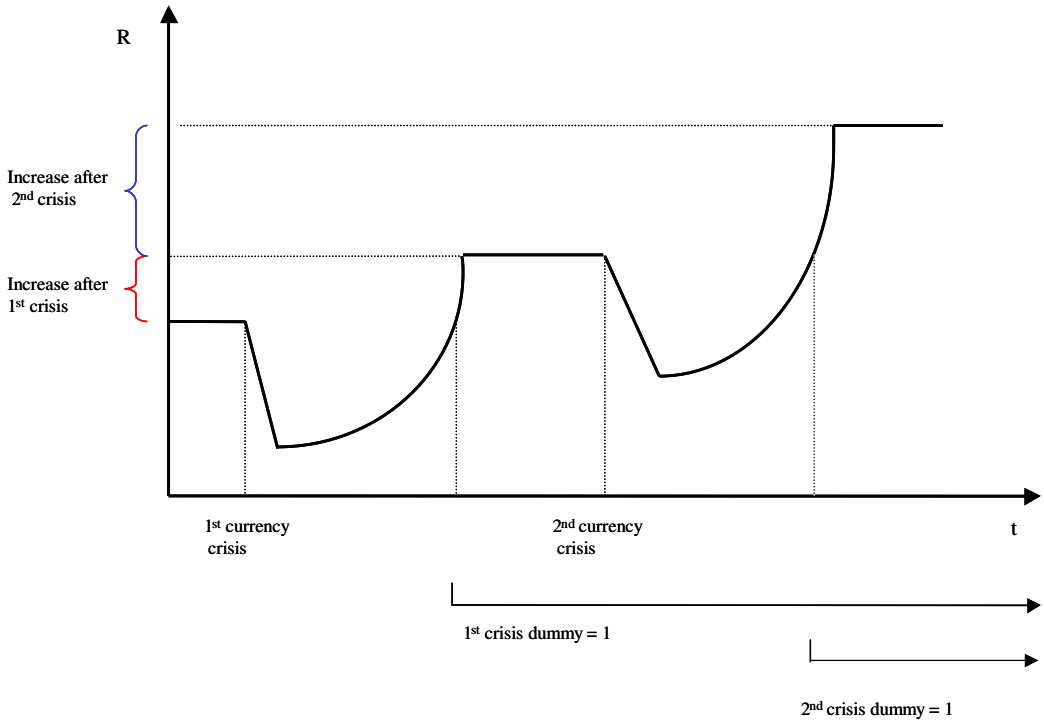


Figure 6: Reserve losses and subsequent reserve accumulation

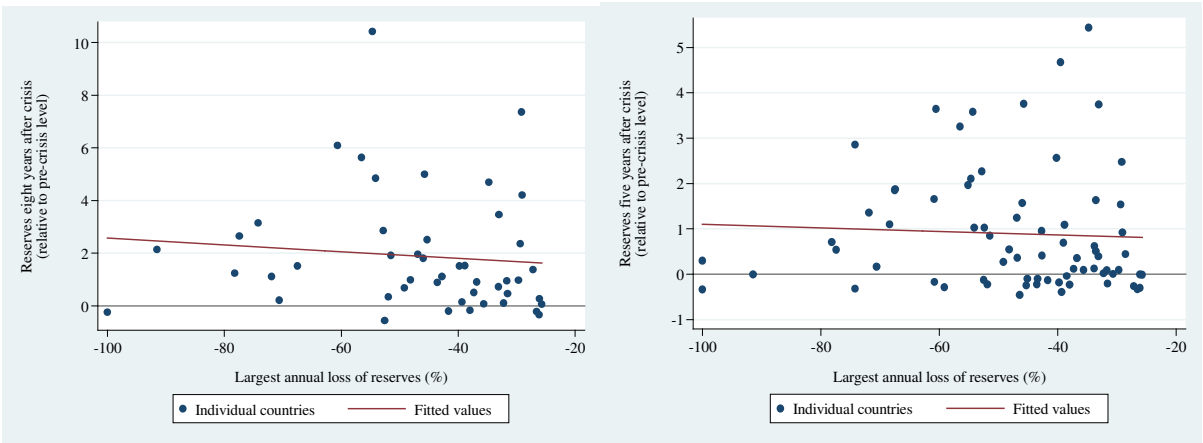


Table 1: International reserves and currency crises: fine classification

Dependent variable: Reserves/GDP	(1)	(2)	(3)	(4)	(5)
Lagged endogenous variable	0.7339 (12.52***)	0.9335 (57.68***)	0.6973 (11.92***)	0.9122 (55.47***)	0.3911 (7.18***)
Real GDP per capita	-0.0046 (-1.10)	-0.0015 (-0.82)	-0.0040 (-1.08)	-0.0019 (-1.04)	0.0197 (0.97)
Trade openness	0.0563 (3.62***)	0.0356 (5.11***)	0.0577 (3.72***)	0.0324 (4.55***)	0.0460 (2.04*)
Volatility (nominal)	-0.0028 (-0.94)	-0.0048 (-1.72*)	-0.0016 (-0.89)	-0.0034 (-1.23)	-0.0246 (-0.69)
Total external debt (per cent of GDP)	0.0193 (3.89***)	0.0196 (5.28***)	0.0164 (4.02***)	0.0172 (4.66***)	0.0365 (1.61)
Short-term external debt, lagged (per cent of GDP)	-0.0570 (-3.55***)	-0.0353 (-2.91***)	-0.0602 (-3.67***)	-0.0318 (-2.60***)	-0.1702 (-2.25**)
Fixed exchange rates, dummy	-0.0002 (0.14)	0.0035 (0.79)	0.0030 (0.55)	0.0064 (1.47)	-0.0071 (-2.06*)
Intermediate exchange rates, dummy	0.0044 (1.01)	-0.0002 (-0.05)	0.0067 (1.59)	0.0004 (0.09)	0.0077 (1.57)
Monetary disequilibrium (excess money supply)	-0.0003 (-1.66*)	-0.0004 (-0.51)	-0.0002 (-1.29)	-0.0002 (-0.22)	0.1033 (0.61)
First crisis	0.0084 (1.37)	0.0062 (2.19**)	0.0397 (4.92***)	0.0122 (4.32***)	0.0230 (3.13***)
Second crisis	0.0153 (1.36)	0.0025 (0.71)	0.0348 (2.88***)	0.0041 (1.11)	0.0304 (3.62***)
Third crisis	0.0180 (1.47)	-0.0038 (-0.98)	0.0374 (3.46***)	0.0053 (0.97)	0.0140 (1.92*)
Fourth crisis	0.0098 (0.63)	0.0023 (0.28)	0.0078 (0.31***)	0.0130 (0.76)	-0.0015 (-1.35)
Fifth crisis	-0.0194 (-1.40)	-0.0036 (-0.24)	-0.0233 (-2.27**)	-0.0349 (-1.76*)	0.0012 (0.37)
Sixth crisis			0.0110 (0.27)	0.0192 (n.a.)	

Number of countries	114	114	114	114	40
Number of observations	1651	1651	1651	1651	
Method of estimation	Difference GMM (two step)	LSDV	Difference GMM (two step)	LSDV	MG
Sargan Test (p-level)	1.0		1.0		
Arellano-Bond-Test (p-level)	0.91		0.85		

Notes:

t-statistics (in brackets) computed with heteroskedasticity-consistent standard errors.
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.
LSDV: least-squares dummy variable estimator (= fixed effects estimator)
MG: mean group estimator
Since the mean group estimator is based on individual regressions for each country, the sample is restricted to countries for which at least 20 observations for each variable are available. This explains the reduced number of observations.
As described in the text, the crisis dummies of columns (1) and (2) take the value one after reserves have reached their pre-crisis level. The crisis dummies in columns (3) to (5) are based on an auxiliary regression: The dummies take the value one beginning in the period when actual reserves exceed their fitted values from the auxiliary regression.

Table 2: International reserves and currency crises: classification in periods of crises

Dependent variable: Reserves/GDP	(1)	(2)
Lagged endogenous variable	0.7407 (12.19***)	0.9350 (59.04***)
Real GDP per capita	-0.0046 (-1.23)	-0.0012 (-0.70)
Trade openness	0.0516 (3.26***)	0.0355 (5.21***)
Volatility (nominal)	-0.0036 (-1.39)	-0.0047 (-1.70*)
Total external debt (per cent of GDP)	0.0193 (3.63***)	0.0209 (5.53***)
Short-term external debt, lagged (per cent of GDP)	-0.0580 (-4.02***)	-0.036 (-2.94***)
Fixed exchange rates, Dummy	-0.0011 (-0.08)	0.0043 (0.97)
Intermediate exchange rates, Dummy	0.0045 (0.95)	0.0002 (0.04)
Monetary disequilibrium (excess money supply)	-0.0003 (-1.76*)	-0.0003 (-0.49)
Crisis 1973-81	-0.0045 (-0.26)	-0.0064 (-1.24)
Crisis 1982-96	0.0147 (1.04)	0.0040 (1.21)
Crisis 1997-03	0.0124 (1.56)	0.0038 (1.13)
Method of estimation	Difference GMM (two step)	LSDV
Sargan Test (p-level)	1.0	
Arellano-Bond-Test (p-level)	0.86	

Notes:

Estimation is based on a sample of 114 countries comprising a total of 1651 observations.
t-statistics (in brackets) computed with heteroskedasticity-consistent standard errors.
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.
LSDV: least-squares dummy variable estimator (= fixed effects estimator)

Table 3: Robustness checks including measures of financial integration

Dependent variable: Reserves/GDP	(1)	(2)
Lagged endogenous variable	0.6942 (10.34***)	0.7196 (11.49***)
Real GDP per capita	-0.0057 (-0.92)	-0.0010 (-0.37)
Trade openness	0.0612 (5.14***)	0.0395 (2.43**)
Volatility (nominal)	-0.0015 (-0.85)	-0.0150 (-0.86)
Total external debt (per cent of GDP)	0.0168 (3.50***)	0.0197 (4.95***)
Short-term external debt, lagged (per cent of GDP)	-0.0521 (-3.58***)	-0.0636 (-4.10***)
Fixed exchange rates, dummy	0.0013 (0.58)	0.0072 (0.90)
Intermediate exchange rates, dummy	0.0063 (1.80*)	0.0064 (1.02)
Monetary disequilibrium (excess money supply)	-0.0002 (-1.29)	-0.0001 (-0.83)
First crisis	0.0352 (6.56***)	0.0368 (4.23***)
Second crisis	0.0307 (4.39***)	0.0347 (2.48**)
Third crisis	0.0322 (3.19***)	0.0453 (4.42***)
Fourth crisis	0.0106 (0.46)	0.0238 (1.21)
Fifth crisis	-0.0261 (1.89*)	-0.0457 (-3.21***)
Sixth crisis	0.0807 (0.55)	0.0201 (0.83)
Capital account openness	0.0019 (0.42)	
Economic globalization		0.0009 (1.20)
Number of countries	114	70
Number of observations	1606	1150
Method of estimation	Difference GMM (two step)	Difference GMM (two step)
Sargan Test (p-level)	1.0	1.0
Arellano-Bond-Test (p-level)	0.79	0.66

Table 4: Robustness checks including measures of financial integration

Dependent variable: Reserves/GDP	(1)	(2)
Lagged endogenous variable	0.7321 (11.70***)	0.7542 (12.31***)
Real GDP per capita	-0.0070 (-1.49)	-0.0014 (-0.51)
Trade openness	0.0633 (5.12***)	0.0555 (4.16***)
Volatility (nominal)	-0.0019 (-1.34)	-0.0157 (-1.34)
Total external debt (per cent of GDP)	0.0203 (3.30***)	0.0247 (3.51***)
Short-term external debt, lagged (per cent of GDP)	-0.0505 (-3.62***)	-0.0494 (-5.08***)
Fixed exchange rates, dummy	-0.0017 (-0.25)	0.0049 (0.57)
Intermediate exchange rates, dummy	0.0039 (1.03)	0.0069 (0.95)
Monetary disequilibrium (excess money supply)	-0.0003 (-1.78*)	-0.0003 (-1.57)
Crisis 1973-81	-0.0149 (-1.11)	-0.0010 (-0.12)
Crisis 1982-96	0.0065 (0.91)	0.0163 (1.72*)
Crisis 1997-03	0.0119 (1.74*)	0.0187 (2.55**)
Capital account openness	-0.0014 (-0.33)	
Economic globalization		0.0009 (0.91)
Number of countries	114	70
Number of observations	1606	1150
Method of estimation	Difference GMM (two step)	Difference GMM (two step)
Sargan Test (p-level)	1.0	1.0
Arellano-Bond-Test (p-level)	0.78	0.63

Table 5: Robustness checks: Interactions between crises and fixed exchange rate system

Dependent variable: Reserves/GDP	(1)	(2)
Lagged endogenous variable	0.5228 (7.63***)	0.7426 (11.72***)
Real GDP per capita	-0.0042 (-0.39)	-0.0038 (-1.04)
Trade openness	0.0624 (2.11**)	0.0503 (3.41***)
Volatility (nominal)	-0.0105 (-0.44)	-0.0031 (-1.23)
Total external debt (per cent of GDP)	0.0189 (2.05**)	0.0186 (3.65***)
Short-term external debt lagged (per cent of GDP)	-0.0464 (-1.90*)	-0.0611 (-4.26***)
Fixed exchange rates, dummy	0.0054 (0.37)	0.0097 (1.07)
Intermediate exchange rates, dummy	0.0045 (0.65)	0.0037 (0.96)
Monetary disequilibrium (excess money supply)	-0.0021 (0.007)	-0.0002 (-1.71*)
Crisis 1973-81	0.0509 (1.68*)	0.0079 (0.36)
Crisis 1973-81 under a fixed exchange rate system	0.0019 (0.49)	-0.0118 (-1.13)
Crisis 1982-96	0.0427 (4.83***)	0.0219 (2.12**)
Crisis 1982-96 under a fixed exchange rate system	-0.0110 (-1.89*)	-0.0112 (-0.72)
Crisis 1997-2003	0.0274 (4.10***)	0.0184 (1.74*)
Crisis 1997-2003 under a fixed exchange rate system	0.0195 (1.91*)	-0.0117 (-1.11)
Number of countries	108	114
Number of observations	772	1651
Method of estimation	Difference GMM (two step)	Difference GMM (two step)
Sargan Test (p-level)	1.0	1.0
Arellano-Bond-Test (p-level)	0.49	0.88

Notes:
t-statistics (in brackets) computed with heteroskedasticity-consistent standard errors.
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix A: Country list

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Argentina
Armenia
Aruba
Australia
Austria
Azerbaijan
Bahamas, The
Bahrain
Bangladesh
Barbados
Belarus
Belgium
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brazil
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Canada
Cape Verde
Central African Republic
Chad
Chile
China
Colombia
Comoros
Congo, Dem. Rep.
Congo, Rep.
Costa Rica
Cote d'Ivoire
Croatia
Cyprus
Czech Republic
Denmark
Djibouti
Dominica
Dominican Republic
Ecuador
Egypt, Arab Rep.
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Fiji
Finland
France
Gabon
Gambia, The
Georgia
Germany
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hong Kong, China
Hungary
Iceland
India
Indonesia
Iran, Islamic Rep.
Iraq
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Korea, Rep.
Kuwait
Kyrgyz Republic
Lao PDR
Latvia
Lebanon
Lesotho
Liberia
Libya
Lithuania
Luxembourg
Macao, China
Macedonia, FYR
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Mauritania
Mauritius
Mexico
Micronesia, Fed. Sts.
Moldova
Mongolia
Morocco
Mozambique
Myanmar
Namibia
Nepal
Netherlands
Netherlands Antilles
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Romania
Russian Federation
Rwanda
Samoa
San Marino
Sao Tome and Principe
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Singapore
Slovak Republic
Slovenia
Solomon Islands
Somalia
South Africa
Spain
Sri Lanka
St. Kitts and Nevis
St. Lucia
St. Vincent and the Grenadines
Sudan
Suriname
Swaziland
Sweden
Switzerland
Syrian Arab Republic
Tajikistan
Tanzania
Thailand
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Vanuatu
Venezuela, RB
Vietnam
Yemen, Rep.
Zambia
Zimbabwe

Appendix B
List of variables and data sources

Variable	Source	Description
Reserves	World Bank (2005a)	Net international reserves comprise special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities. Gold holdings are excluded. Data are in current U.S. dollars.
Real GDP per capita	World Bank (2005a)	GDP is measured as gross domestic product in constant international dollars with the year 2000 as base. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. This measure of GDP is divided by the population which counts all residents regardless of legal status or citizenship.
Openness	World Bank (2005a)	Openness is defined as the sum of exports and imports divided by GDP. Data are expressed in per cent.
Volatility (real)	World Bank (2005a)	The proxy for volatility uses exports measured as a capacity to import as its base variable. Exports as a capacity to import equal the current price value of exports of goods and services deflated by the import price index. Data are in constant local currency. Volatility is then calculated as the standard deviation of the previous five years of the growth rate of this measure of exports .
Total external debt (divided by GDP)	World Bank (2005a)	Total external debt is the sum of public, publicly guaranteed, and private nonguaranteed long-term debt, use of IMF credit, and short-term debt. Data are in current U.S. dollars divided by GDP.
Short-term debt (divided by GDP)	World Bank (2005b)	Short-term external debt includes all debt that has an original maturity of one year or less. Data are in current U.S. dollars divided by GDP.

Appendix B (continued)

Variable	Source	Description
Capital account openness, dummy	Chinn and Ito (2002)	Measure of the de jure openness of the capital account. Calculation is based on the binary dummy variables of the IMF publication Annual Report on Exchange Arrangements and Exchange Restrictions (AREAR)
Economic globalization	Dreher (2006)	Index based on actual flows of goods and capital and restrictions concerning these flows.
Fixed exchange rates, dummy	Ghosh, Gulde and Wolf (2002) and own update based on AREAER	Equals one if one of the following finer categories applies: dollarized, currency board, monetary union, single currency peg, published basket peg and secret basket peg.
Intermediate exchange rates, dummy	Ghosh, Gulde and Wolf (2002) and own update based on AREAER	Equals one if one of the following finer categories applies: cooperative system, crawling peg, target zone, unclassified rule-based intervention, managed float with heavy intervention, unclassified managed float and other floats.