

**THE ACCUMULATION OF FOREIGN EXCHANGE BY CENTRAL BANKS:
FEAR OF CAPITAL MOBILITY?**

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Abstract

Foreign exchange holdings by central banks have increased significantly in the recent past. This article explains this development as a result of the liberalization of international capital markets. First, central banks accumulate reserves in order to protect the economy from potentially detrimental effects of sudden stops of capital flows and flow reversals. Second, central banks use the accumulation of reserves as a substitute for capital controls. Changes in the level of reserves are a form to manage net capital inflows. They permit the central bank to preserve some leeway for an independent monetary and financial policy despite the classic policy trilemma. The empirical analysis of a large panel data set supports the hypothesis that the accumulation of reserves is the consequence of a “fear of capital mobility” suffered by central banks.

Keywords: International Reserves, Capital Mobility, Macroeconomic Trilemma

JEL Classification: E58, F31

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1 Introduction

Recent years witnessed an enormous increase in central banks' foreign exchange holdings. Whereas average foreign exchange holdings amounted to 5.1% of GDP in 1975, they reached 18% of GDP in 2006. This increase is a puzzle for the standard literature on the demand for international reserves. Since at the same time exchange rates have become more flexible and countries more integrated in the international capital market, standard theory predicts a decline in foreign exchange holdings.

The existing literature usually explains the demand for foreign exchange as a buffer stock to defend the exchange rate. Whereas traditional approaches argue that reserves are needed to finance imbalances in the balance of payments under a fixed exchange rate system, the more recent literature, which emerged after the series of financial crises during the 1990s, focuses on the stock of reserves, which is seen as a lifejacket against financial crisis. Both approaches coincide in the view that there exists an adequate level of reserve holdings, which is the outcome of an optimising behaviour of the central bank.

This article takes a different approach: It explains the accumulation of reserves as a side effect of the liberalization of national capital markets and, more particularly, of the integration of emerging and developing economies in the world capital market. According to this hypothesis, central banks do not optimise their reserve levels, but suffer from a "fear of capital mobility". The accumulation of foreign exchange is a response to capital inflows. It aims at reducing the interdependence of an open economy from developments in the rest of the world.

Two different lines of argumentation will be presented: First, it is hypothesised that a central bank's reserves increase in the degree of capital mobility. The motive for this behaviour might be the central bank's desire to protect the economy from potentially detrimental effects of sudden stops of capital flows and flow reversals. Second, a central bank might accumulate reserves in order to manage net capital flows in the absence of capital controls. The management of capital inflows allows the central bank to preserve some leeway for the conduct of an independent monetary policy despite the classic policy trilemma. Furthermore, the central bank can limit the real effects of capital inflows, which might interfere with domestic policy objectives.

In the first case, the central bank supports the open capital account but takes precautionary measures. According to the second motive, it intends to insulate the domestic economic policy from the world capital market under a fixed exchange rate. In either case the accumulation of reserves can be regarded as a management of capital flows by the central bank.

The article is organized as follows. Section 2 describes the hypothesis that central banks suffer from a fear of capital mobility. Section 3 discusses different measures of capital mobility and shows statistical evidence in support of the hypotheses. Section 4 presents and discusses the empirical results. The final section concludes.

2 The hypothesis: Fear of capital mobility

The following section describes the hypothesis that central banks suffer from a fear of capital mobility. This fear of capital mobility arises in two different forms: First, central banks fear the openness of the capital account and, second, manage private capital inflows.

2.1 Capital mobility and the level of reserves

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. Therefore, a central bank might take precautionary measures in the form of foreign exchange hoardings.

On theoretical grounds the effect of the liberalization of the capital account on the level of reserves is ambiguous. On the one hand, the eased access to external credit sources reduces the importance of reserves in financing international transactions. Any balance of the current account can, at least theoretically, be counterbalanced by proportionate capital flows. On the other hand, open capital markets increase the exposure to external financial disturbances and speculative flows. Especially emerging and developing countries may be subject to sudden stops of capital flows and capital flight.

The risk of capital flight originates from two sources: First, foreign investors might suddenly withdraw their capital invested in the domestic economy. Second, domestic agents might prefer to invest their wealth in foreign currency. This form of currency substitution may be

restricted to currency in circulation or can comprise bank deposits. These savings, in turn, can be deposited at domestic or foreign commercial banks. These possibilities of capital flight also increase the risk of speculative attacks and ensuing currency crises.

Capital mobility has two dimensions: de jure and de facto capital mobility. De jure capital mobility corresponds to the extent and nature of regulations governing capital account transactions. It can be measured by the existence of legal restrictions of cross-border capital flows. It is a pre-condition for financial integration. De facto capital mobility refers to the actual mobility of capital measured by stocks and flows of cross-border assets and liabilities.

Central banks might fear both forms of capital mobility: Countries which have liberalised their capital account but whose cross-border capital flows and stocks are limited, might fear that domestic investors prefer to invest abroad, leading to large capital outflows. Countries with substantial financial linkages to the rest of the world might fear a double outflow of capital, namely of domestic and foreign investors.

This reasoning leads to the following hypotheses, which shall be tested empirically in section 4:

Hypothesis 1: The higher the degree of capital mobility, the more foreign exchange a central bank hoards.

This hypothesis can be split into two different lines of argumentation:

Hypothesis 1a: Central banks fear a de jure open capital account independently of the country's actual degree of integration in the international capital market.

Hypothesis 1b: Central banks fear the potentially negative effects of a country's financial integration. They accumulate foreign exchange in order to protect the economy from potential sudden stops of capital flows and capital flight.

2.2 Capital flows and changes in reserves: Management of capital inflows

This section is devoted to the hypothesis that central banks actively manage capital flows.¹ Both capital controls and changes in reserves allow a central bank to manage capital inflows. Changes in reserves are evidence for a “fear of capital mobility” if they are a counter movement to the removal of capital controls.

2.2.1 Foreign exchange accumulation as a substitute for capital controls

Changes in foreign exchange reserves can be regarded as an imperfect substitute for capital controls because both have to a certain extent the same macroeconomic effects.² In the following paragraphs different theoretical approaches are used to show these common effects.

Balance of payments implications

Both foreign exchange accumulation and capital controls lead to smaller net capital inflows. Through decreased net capital inflows they reduce the pressure towards an appreciation of the domestic currency. This might be in the interest of the central bank if a fixed nominal exchange rate regime is in place, if the economy pursues a development strategy of export-led growth or if a reallocation of resources towards the nontradable sector is not desired.

The balance of payments restriction implies that both capital controls and the accumulation of reserves (*ceteris paribus*) may lead to an increase in the current account balance.

¹ With respect to capital flows, the following definitions apply throughout this article Net capital flows are the difference between capital inflows and capital outflows. If this difference is positive, it is also called net capital inflows. Capital flows are always measured as private flows excluding changes in official reserves.

The empirical literature distinguishes two concepts of capital flows: In the terminology of the IMF (see World Economic Outlook) total net capital flows comprise direct investment, portfolio investment and other long- and short-term investment flows. In the standard balance of payments presentation total net capital flows are equal to the balance on the financial account minus the change in reserve assets. Other publications (see UNCTAD 1999, p. 100) define net capital flows as the sum of the balance on capital and financial accounts, that is to say they additionally include capital account transactions like debt forgiveness, official grants and migrants’ transfers as well as the acquisition or disposal of nonproduced, nonfinancial assets (patents, trademarks etc.). For the purpose of this article I prefer the first concept because it focuses on the financial account, which is the origin of the volatility of capital flows. Capital account transactions, in contrast, are fairly stable or even counter cyclical.

² Their degree of substitutability is imperfect because the accumulation of reserves cannot accomplish all effects, which are obtained (or at least intended) by capital controls. For instance, whereas capital controls, in the form of a fixed-term unremunerated reserve requirement, aim at changing the composition (from portfolio to direct investment flows) and maturity structure of capital inflows, the accumulation of foreign exchange cannot bias the nature of capital inflows. Moreover, whereas capital controls can be designed to target specific capital flows (prohibitions, requirement of special permission for pre-defined types of flows), the accumulation of reserves cannot prohibit certain kinds of capital movements. In this sense, the accumulation of reserves is a simple instrument that cannot be designed to achieve specific objectives concerning the nature of capital flows. Finally, capital controls and the accumulation of foreign exchange are costly distortions of the efficient allocation of capital. However, they differ in the distribution of these costs: whereas the costs of capital controls have to be carried by lender and borrower, the costs of foreign exchange reserves fall on the society as a whole.

If private capital is perfectly mobile, the accumulation of reserves, which is a form of official capital export, will be offset by an additional import of private capital. Hence, the capital account balance including official reserve changes is unaffected while the gross sum of capital flows increases.

In the case of imperfect capital mobility, the balance of payments restriction implies that the accumulation of foreign exchange has to increase the current account balance. To increase the current account balance, the exchange rate has to depreciate or – in the case of a fixed nominal exchange rate – domestic prices have to fall. In any case, the current account is distorted towards less domestic investment and consumption. Exports are driven up and imports are depressed.

If controls are used to reduce capital inflows, they distort the current account towards a surplus. So capital controls and the accumulation of foreign exchange are substitutes in the sense that both allow the government to increase the current account balance.

Implications for the domestic money market

The comparable effects of capital controls and reserve accumulation in the face of capital inflows also become evident on the domestic money market. Both cushion it from the effects of foreigners demanding domestic currency. Net capital inflows imply an increase in the supply of foreign currency and an increase in the demand for domestic currency. According to the monetary approach to the exchange rate, this relative increase in the demand for domestic currency leads to an appreciation of the exchange rate.

Capital controls, which decrease capital inflows, reduce the demand for domestic currency by foreigners. The accumulation of reserves satisfies the foreign demand for domestic currency such that the domestic money market remains in equilibrium for a given price level. Both policies result in a more depreciated exchange rate than would be the equilibrium outcome without policy distortion.

We now turn to common effects of capital controls and reserve accumulation for economic policy.

Effect 1: Preservation of monetary policy independence

In the context of a fixed exchange rate, capital controls and the accumulation of reserves preserve some room for the conduct of an independent monetary policy despite the classic policy trilemma.

Capital controls loosen the interest rate parity. If capital flows are prohibited or restricted by quantitative controls, the domestic interest rate can be set independently of the world interest rate. If capital controls are imposed in the form of a tax – an explicit tax or an implicit one like an unremunerated reserve requirement –, the domestic interest rate can lie between the international interest rate and the international interest rate plus the tax without inducing any capital movements. Within this band monetary policy is independent.

Similarly, foreign exchange interventions give a government some leeway for domestic monetary policy in spite of exchange rate fixity. If the central bank sells foreign exchange, there is a tendency towards appreciation in the exchange rate. The central bank can at least restore the monetary base while holding the exchange rate fixed. A nonsterilized intervention is compatible with a larger increase in money supply than a sterilized one. Moreover, if bonds in different currencies are imperfect substitutes, the central bank can pursue an expansionary policy even if the interventions are sterilized at home and abroad (Branson 1977, Dreher and Vaubel 2009). Conversely, an accumulation of reserves allows the central bank to pursue a contractionary monetary policy while holding the exchange rate fixed. More precisely, for a given money demand at home and abroad the growth rate of the monetary base at home may be lower than that abroad. In the case that domestic and foreign-currency bonds are imperfect substitutes this is still true for a sterilized intervention.

Effect 2: Reconciliation of the policy trilemma

The relationship between capital mobility and reserve accumulation can be analysed in the framework of the macroeconomic policy trilemma. The trilemma imposes a constraint on the choice of macroeconomic policies. It states that the objectives of exchange rate stability, monetary independence and capital mobility are mutually inconsistent. Only two out of these three possible objectives can be attained jointly.

Figure 1 illustrates the trilemma. The corners of the triangle show three possible goals of economic policy and the sides indicate the policy regimes which meet (pairs of) these goals. Since at most two goals can be reached at the same time, the side connecting the two chosen corners excludes the attainment of the third goal. If, for example, a country opts for an independent monetary policy under an open capital account, it cannot pursue an active

exchange rate policy. The demand for and supply of domestic and foreign currency, which result from the interest rate set by monetary policy and the open capital account, determine the level of the exchange rate.

The policy trilemma, however, constrains economic policy only in the long run. Standard theories overlook that all three objectives are jointly attainable in the short run if they are supported by accompanying policies. Changes in reserves are such a policy to reconcile the trilemma.

The accumulation of reserves allows a country to reach the three goals of the trilemma simultaneously. To illustrate the mechanisms, consider the example from above in which a country opts for an independent monetary policy and capital mobility. According to the trilemma, policy cannot stabilize the exchange rate. This, however, is not true in the short run. Assume that the given interest rate leads to an outflow of capital such that the exchange rate tends to depreciate. The central bank can stabilize the exchange rate if it counteracts the outflow of capital by the sale of foreign exchange reserves. This is the policy of exchange rate defence through an exchange market intervention.³ It allows to achieve all three objectives of the trilemma until reserves reach their lower bound if domestic and foreign bonds are imperfect substitutes.

Whereas this policy configuration is extensively analysed by economists, the opposite case of a foreign exchange intervention aimed at preventing an exchange rate appreciation is usually disregarded. According to the trilemma, in the presence of net capital inflows an independent monetary policy and a fixed exchange rate system are incompatible. However, if the central bank absorbs the capital inflow with the accumulation of reserves, it can reconcile an open capital account with an independent monetary policy and a fixed exchange rate.

In general, if the central bank absorbs capital inflows and satisfies capital outflows through proportional changes of reserves, it can neutralise the effects of an open capital account. This is possible as long as capital is not perfectly mobile.

Net capital inflows increase the relative demand for domestic currency. The demand for foreign money decreases and the demand for domestic money increases. According to the

³ It is assumed that the interest rate remains at its level consistent with domestic goals of monetary policy. Alternatively, the central bank might rise the interest rate to defend the exchange rate peg. Then, however, it would subordinate monetary policy to the objective of a stable exchange rate.

monetary approach, the exchange rate appreciates. The exchange rate is stable in the presence of net capital inflows if for a given output and interest rates at home and abroad domestic money supply increases and foreign money supply decreases. A non-sterilized accumulation of foreign reserves satisfies the increased demand for domestic currency and reduces the supply of foreign currency. Technically, a central bank can influence the supply of domestic and foreign currency such that the exchange rate remains unchanged.

In comparison with the opposite policy of exchange rate defence in the face of capital outflows, this policy has the merit that there exists no upper reserves bound above which this policy is no longer feasible. The recent experience of reserve accumulation shows that this policy is sustainable over a long time period.

Since this article focuses on the explanation of the recent period of reserve accumulation, one has to question whether the choices countries have made with respect to the trilemma in the recent past might have favoured systematic central bank interventions to prevent the exchange rate from appreciating. Since the demise of the Bretton Woods system, countries have moved towards greater exchange rate flexibility and financial openness (see Figure 2). Nevertheless, according to the IMF classification of exchange rates the majority of exchange rates are still managed or fixed. This implies that monetary policy autonomy has become more limited in many countries. However, the accumulation of reserves by central banks reverses this trend. As described in the preceding paragraphs, in this configuration the accumulation of reserves may be seen as an instrument to restore monetary independence. Although capital is mobile, the central bank intervention can manage capital flows such that both a fixed exchange rate and an independent monetary policy can be attained jointly.

Empirical evidence in support of the trilemma is provided by Obstfeld et al. (2005) and Aizenman et al. (2008). The latter show empirically that a move towards one goal of the trilemma induces a shift away from at least one of the other two policy objectives. They note that the accumulation of reserves may be related to the changing configuration of the trilemma over time, but do not analyse its role in detail. Levy-Yeyati and Sturzenegger (2007) argue that in the 2000s foreign exchange interventions increasingly aimed at depressing the domestic currency rather than defending it. They ascribe this behaviour to a “fear of appreciation”.

The foregoing analysis leads to the following hypothesis:

Hypothesis 2: The accumulation of foreign exchange is a response of central banks to the removal of capital controls. Central banks aim at managing capital inflows.

2.2.2 Explanations for the substitution of capital controls by the accumulation of foreign exchange

This hypothesis, however, raises the question why governments abolish controls on capital movements albeit they still have an interest in managing capital flows.

It could be that they had to liberalize their capital account due to conditions associated with IMF lending or external consultants advised them to do so. Joyce and Noy (2008) find empirical evidence that the participation in an IMF programme during the 1990s is correlated with capital account liberalization. Perhaps countries could not resist the general market development (bandwagon effects) and liberalized their capital account after neighbouring countries or members of their peer group had done so.⁴ When neighbours relax capital controls it becomes harder to justify them politically and economically. At the same time, relative to its neighbours, the country becomes a less attractive destination for foreign capital. Countries that resist the tendency to relax capital controls fall behind countries that do remove controls. Finally, the relaxation of capital controls could be the result of some kind of bargaining between industrialized and emerging economies where the first loosened their trade barriers and, in return, the second had to open up their capital markets.

The removal of capital controls can be in the proper interest of the central bank. The abandonment of capital controls means that the central bank loses one of its instruments of financial policy. However, there are several reasons why a central bank could be willing to give up capital controls anyway. First, capital controls are not an instrument that can be set independently by the central bank; on the contrary, the imposition of capital controls either has to be explicitly permitted by the central bank's statute or be specified by other laws, which, in turn, have to be approved by government. In most cases, the central bank constitution defines a maximum percentage that can be required as mandatory reserves from

⁴ Recent studies (e.g. Simmons and Elkins 2004) show empirically that countries are more likely to open their capital account when members of their peer group have done so. This behaviour is called "policy contagion".

capital importers. So, in principle, the central bank only enforces and administers the pre-defined capital controls. The accumulation of reserves, in contrast, is a policy that is independently set by the central bank. Capital controls are an inflexible instrument whereas the accumulation of reserves can be adjusted easily and without time lag to changing economic conditions and objectives of financial policy.

Both capital controls and reserve accumulation are costly distortions but differ in the distribution of these costs: Whereas the cost of capital controls have to be born by borrower and lender, the costs of foreign exchange reserves fall on the society as a whole. Capital controls can lead to revenues for the central bank (for example if unremunerated reserves have to be held at the central bank), whereas reserves generally entail quasi-fiscal costs because of the interest differential between domestic bonds and bonds denominated in the reserve currency.⁵ In sum, central banks are financially worse off if capital controls are replaced by foreign exchange reserves. However, this might not bother the central bankers. The economic theory of bureaucracy assumes that public officials are primarily interested in their power, prestige and independence (see Vaubel 1997), but not in the profits of their institution. In fact, large reserve holdings may be preferred by the central bank because they increase its power and independence from government.

3 Data and descriptive statistics

3.1 Description of the data

The empirical analysis is carried out 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 70 to 174 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, variables and their data sources can be found in appendices A and B.

⁵ This argumentation assumes that the effect of the accumulation of reserves on the domestic monetary base is sterilized by the issue of domestic bonds.

3.2 Measures of capital mobility

For our analysis of the links between capital mobility and the accumulation of reserves both concepts of de jure and de facto capital mobility are relevant. The empirical analysis uses different measures of capital mobility, which allow to distinguish between the effects of de jure and de facto capital mobility.

Most indices of de jure capital account openness are based on the information provided in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). It offers a binary variable that informs about the existence of controls in different categories of restrictions.

An index of capital account openness that is based on this information was developed by Chinn and Ito (2002, 2006). It embodies four binary dummy variables on restrictions on international financial transactions. In the empirical analysis I refer to this index as de jure capital mobility (Chinn-Ito)

An alternative index of de jure capital mobility is provided by Edwards (2007). He combines the information of the indices of Quinn (2003) and Mody and Murshid (2005), which are based on data from the IMF. Country-specific information is used to revise and refine the index. Since the index provides data only until the year 2000, regressions including the index cover a reduced period ending in 2000. This variable is called de jure capital mobility (Edwards) in the empirical analysis.

A measure of de facto capital mobility is constructed from data on external capital stocks. As proposed by Lane and Milesi-Ferretti (2007) an index is given by the sum of total external assets and total external liabilities as a proportion of GDP.

Additionally, 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. Hence, this index combines information of de jure and de facto capital mobility with information of trade openness.

For all indices higher values indicate that countries are more open to cross-border financial transactions.

Figure 2 illustrates the evolution of capital mobility over time. All four measures indicate a trend of increasing capital mobility. This trend was temporarily halted by the Latin American debt crisis, the Mexican Tequila crisis in 1994 and the East Asian financial crisis. This overall trend is independent of a country's capital mobility at the beginning of our period of consideration: The trend is observable in industrial, emerging and developing countries. Whereas on average industrial countries are in every single year more open than the other two country groups, capital mobility in emerging markets does not differ much from that in developing countries. Emerging markets are characterised by a higher volatility of capital mobility over time.

3.3 Statistical evidence

In the case that a central bank does not intervene in the foreign exchange market or intervenes only temporarily, the current account and the capital account excluding reserve changes are the main components of the balance of payments. Changes in official reserves are only a residual entry that brings about the overall balance. Every international transaction leads to two offsetting entries in the balance of payments. Since the balance of the current account equals the change in a country's net foreign liabilities, a current account deficit is offset by a surplus of the capital account, namely net capital inflows.

This picture has changed dramatically since the Asian financial crisis (see Figure 3). The current account deficits of the developing countries as a group have been replaced by surpluses in 1999. At the same time, these countries still registered net capital inflows (excluding changes in reserves) despite an initial fall in capital inflows. This joint incidence of net private capital inflows and a current account surplus is somewhat unusual. Capital inflows cannot be explained as the counterpart of a current account deficit, that is to say, they do not finance the current account deficit.

The puzzle can be solved when we include the change in official reserves in the analysis. In fact, since 1999 the developing countries registered net financial outflows including official reserves. Hence, they have increasingly become net exporters of capital. The increase of reserves equals the sum of current account surplus and net capital inflows (plus errors and omissions).

Table 1 shows the absolute values of net capital inflows and changes in reserves as well as changes in reserves expressed as a percentage of inflows over different time periods and for

different country groups. The variable of primary interest is the change in reserves expressed as a percentage of capital inflows. In the second half of the 1970s, changes in reserves accounted for a relatively large part of capital inflows. This is primarily due to the low level of cross-border capital flows during this period. Since the second wave of capital account liberalization, which took place in the late 1980s and early 1990s, this has changed fundamentally: In the 1980s, capital flows increased such that the accumulation of reserves only offset a minor part of capital inflows (between 7.7% in the world and 13.1% in developing countries). Since then, these figures have increased steadily. Between 2000 and 2003, the majority of capital inflows to emerging and developing countries was reversed via the accumulation of reserves, namely 86.5% and 76.3%, respectively. This means that in developing countries only 23.7% of capital inflows (emerging markets 13.5%) could be used for domestic investment. Central banks in emerging and developing countries increasingly offset net capital flows. Both country groups show the same pattern, which, however, is more pronounced in emerging markets.

A large part of net private capital inflows is absorbed – or, to say it more precisely, reversed – by national central banks, which accumulate official foreign exchange. Consequently, only a minor part of the net private capital inflow is invested domestically.

This is also first evidence that central banks replaced capital controls by a policy of reserve accumulation, thereby still pursuing the objective of regulating capital flows. In comparison with developing countries, emerging markets as a group are characterised by both less capital account restrictions (see Figure 2) and a larger extent of capital inflow management.

Figure 4 shows the Chinn-Ito index of capital mobility. It compares the average value of the index over all countries with its value for the ten countries that accumulated the largest absolute value of reserves over the period 1996-2006. It is striking that until the East Asian financial crisis these ten countries were characterised by a significantly higher degree of de jure capital mobility than the average country. This is first evidence that countries which have had few capital controls tend to hoard reserves. In 1998, capital mobility of the reserve accumulators fell to the level of an average country and has not differed significantly from the average country since then.

Finally, Figure 5 presents some country examples that illustrate the effects of a removal of capital controls. The graphs show the time-series of capital inflows, reserve changes and de jure capital mobility for India, Korea, Russia and the Slovak Republic. Despite some

downward outliers in crisis years, capital inflows increased after the liberalization of the capital account. More importantly, changes in reserves increased simultaneously. The reserve changes were larger than the capital inflows. These country cases may be regarded as first evidence that the accumulation of foreign exchange and capital controls are substitutes.

This preliminary empirical evidence supports the hypothesis that despite the removal of capital controls governments still want to control capital flows. They now do it in a disguised way by accumulating foreign exchange reserves. Non-market barriers to capital movements – capital controls in the form of taxes, administrative controls, prohibitions and quantity controls – have been replaced by a policy of reserve accumulation of a non-market actor – the domestic central bank. To put it differently: Methods have changed, but the objective of regulating net capital flows remained the same.

4 Regression analysis

The remaining task consists in testing empirically whether the degree of capital mobility has an effect on the level of reserves (hypothesis 1) and whether capital inflows are managed through changes in reserves (hypothesis 2).

4.1 Traditional control variables

The set of control variables consists of those variables that were identified as significant determinants of the level of reserves in studies of the demand for reserves (Aizenman and Lee 2007, Lane and Burke 2001).

Trade openness is included to control for the effects of real linkages with other economies. The more open the economy, the more vulnerable it is to external shocks and is expected to hold more reserves for precautionary motives. External debt is another source of vulnerability. Empirical studies show that both a high level of external debt and a low level of reserves increase the probability of a financial crisis. Reserves might offset this vulnerability. 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.

According to the monetary approach to the balance of payments, any disequilibrium in the money market leads to an equal change in the level of reserves. Therefore, a proxy for monetary disequilibrium is included. in our set of determinants of the level of reserves.

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.

4.2 Estimation results

We first test the hypothesis that foreign exchange holdings are larger, the higher the degree of capital mobility is (hypothesis 1). Table 2 presents the results for a static specification where the dependent variable is reserves over GDP. Country fixed effects are included in all regressions. Column 1 contains the benchmark regression, which includes the control variables that were found to be significant determinants of reserve holdings in other studies. The results confirm previous findings: The more open countries are with respect to trade of goods and services, the more reserves they hold. Reserve holdings increase with the amount of total external debt, but decrease in short-term external debt. The latter effect supports the hypothesis that for a given external indebtedness an increase in short-term borrowing is an indication of an emerging financial crisis. Hence, under these circumstances short-term debt increases and reserves fall. The measure for a disequilibrium in the domestic money market is not significant. The overall explanatory power of the included covariates is low ($R^2=0.04$)⁶.

Columns 2 to 6 add different measures for capital mobility to test the hypothesis that countries increase their reserve holdings in the face of increasing capital mobility. Columns 2 and 3 examine the hypothesis 1a and columns 4 to 6 hypothesis 1b.

Column 2 analyses the effect of de jure capital mobility proxied by the index of Chinn and Ito (2002, 2006). The coefficient is significant and positive implying that countries with fewer restrictions on capital flows hold a larger amount of reserves. Sign and significance of the control variables are unchanged with respect to column 1, which does not control for capital mobility. The effect of a monetary disequilibrium is now significant with the expected sign. The adjusted R^2 doubles due to the inclusion of de jure capital mobility

Column 3 examines the robustness of these results. It uses an alternative measure for de jure capital mobility, namely the index of Edwards (2007). The effect of capital mobility is again positive and significant. In comparison with the Chinn-Ito index, Edwards uses a wider set of

⁶ This R^2 , however, is due to the covariates. A simple regression with fixed effects but without covariates leads to a R^2 of zero.

information to construct this index. It shows that the results of column 2 are insensitive with respect to the definition of de jure capital mobility. The smaller magnitude of the effect comes from the fact that both indices use different scales with the Edwards index usually being larger than the Chinn-Ito index.

We now turn to the question whether de facto capital mobility has an effect on reserve holdings (hypothesis 1b). To this end, column 4 adds a measure of de facto capital mobility defined as the sum of external assets and liabilities divided by GDP. This measure is named financial openness. The effect is positive and significant. Countries with a large stock of cross-border assets relative to their economic size hold more international reserves. However, the inclusion of this measure for de facto capital mobility affects the results with respect to the standard control variables. Trade openness and short-term external debt are no longer significant and total external debt is significant, but with a negative sign. This might be due to the fact that total external debt and the measure for de facto capital mobility are correlated since the construction of the latter contains total external debt. Hence, the assumption of exogenous regressors is violated and the results might be biased. Therefore, we re-estimate the effect of de facto capital mobility after dropping total external debt and the proxy for a monetary disequilibrium (see column 5). Trade openness and short-term external debt have the expected effects. A country's reserves increase with the degree of its de facto openness to the world capital market.

Economic globalisation, which is added in column 6, is a combined measure of de facto and de jure capital mobility and trade openness. It confirms the previous results that capital mobility – both de jure and de facto – increases a country's reserve holdings. This specification has the highest explanatory power if the misspecified results of column 4 are disregarded.

Table 3 replicates the regressions of Table 2 with the difference that it uses a dynamic specification that includes the lagged level of reserves as one of the explanatory variables. The dynamics imply that central banks adjust their reserve holdings gradually to the desired level. As a consequence, the fixed effects estimator is asymptotically biased. Therefore, the difference GMM estimator, also known as the Arellano-Bond estimator, is used. The tests of the validity of instruments support these specifications.

Two of the four measures of capital mobility are significant and positive, namely the de jure index of Edwards and the measure of financial openness. The effects of the control variables have the expected sign. Hence, although with reduced significance, the dynamic specification

supports the hypothesis of a positive relationship between capital mobility and the level of foreign exchange holdings to some extent.

The previously used measures of de facto capital mobility implicitly assumed that the fear of capital mobility stems from the fact that a central bank has less instruments to steer foreign liabilities and capital flows when the capital account is liberalized. Table 4 turns to the domestic component of capital flight, which starts when domestic agents attempt to convert their bank deposits in foreign exchange. Since this domestic component of capital flight is proportional to the liabilities of the domestic banking system, broad money supply (M2) is used as an indicator of potential capital flight. The static estimation results (columns 1 to 3) show that central banks' reserves are higher, the larger the potential for domestic capital flight is. As columns 2 and 3 show, this effect comes in addition to the effect of de jure capital mobility and economic globalisation. When a dynamic specification is considered (columns 4 and 5), the effect of M2 is only significant in the specification with economic globalisation.

So far it was shown that there exists a fear of capital mobility in the sense that central banks increase their holdings of foreign exchange when capital controls are dismantled and when the integration in the international financial market deepens (hypothesis 2). We now analyse the related but different question whether central banks' accumulation of foreign exchange is a direct response to capital flows. The accumulation of reserves is a form of managing capital inflows and allows a central bank to influence the amount of foreign capital channelled to domestic uses even in the absence of capital controls. Hence, the accumulation of foreign exchange might be a substitute for capital controls.

Table 5 tests whether capital flows cause changes in reserves. According to the hypothesis, higher net capital inflows imply that central banks absorb a part of these inflows via the accumulation of reserves. The dependent variable is nominal changes in reserves net of gold, measured in US\$. Net capital flows are measured by the balance of the financial account of the balance of payments, i.e., excluding the central bank. It equals the difference between capital inflows and capital outflows. It encompasses the categories direct investment, portfolio investment, financial derivatives and other investment. As possible other determinants of reserve changes, changes in money supply, a disequilibrium in the domestic money market and a dummy for a currency crisis are included. Given a central bank's balance sheet, an increase in money supply implies a decrease in domestic bonds in private hands or an increase in international reserves. According to the monetary approach to the balance of payments, any disequilibrium in the domestic money market implies a reduction of reserves

of equal size. Finally, we control for the effect that reserves generally fall during a currency crisis. The dummy for currency crises takes the value one in years where a speculative attack – unsuccessful or successfully leading to a crisis – is identified by an exchange market pressure index. Additional control variables, derived from the regressions in Table 2, are changes of trade openness, of total external debt and of short-term external debt. However, they all turn out to be insignificant in regressions explaining changes in reserves.

In all specifications of Table 5, net capital flows have no significant impact on reserve changes. Their explanatory power is zero ($R^2=0$). The other three possible determinants, however, are significant and have the expected signs: An increase in money supply is associated with a positive change in reserves whereas an excess money supply reduces reserves. Reserves are significantly lower in years with a currency crisis.

The missing influence of net capital flows on reserve changes might be due to the fact that central banks react with a very long lag to net capital flows (see Table 1) or that they respond asymmetrically to capital flows. The action of a central bank in the face of capital inflows (= positive net capital flows) might differ from its response to capital outflows (= negative net capital flows). We hypothesise that central banks manage capital inflows via the accumulation of reserves since capital inflows cause an appreciation of the exchange rate and imply an increasing external indebtedness of the country. If there are capital outflows, the central bank does not intervene in the foreign exchange market as long as these outflows do not lead to a systemic crisis.

Table 6 shows the results. The variable capital inflows equals the amount of capital inflows and is set to zero if capital inflows are zero or negative. The variable capital outflows, respectively, equals capital outflows and zero otherwise.

The results fully support the hypothesis. In all specifications (columns 1 to 4) capital inflows lead to a significant increase in reserves.⁷ Central banks offset a fraction of capital inflows via the accumulation of foreign exchange and thereby export capital. In the face of capital outflows, central banks do not adjust their reserves. An increase in money supply affects reserve changes positively (column 2) whereas a disequilibrium in the domestic money market leads to a fall of reserves (column 3). Currency crises are associated with losses of reserves (column 4).

⁷ Although capital flows cannot explain reserve changes ($R^2 = 0$), reserves increase significantly when capital flows are positive. The latter result suffices to support the hypothesis that central banks manage capital inflows.

Finally, Table 7 investigates whether central banks dislike large swings in the financial account. It analyses whether changes in capital flows – i.e. from a moderate level of capital inflows to a much larger amount – are offset by changes in reserves. Changes in net capital inflows are defined as changes of the financial account on a year-to-year basis. Independently of the specification, this variable has a positive and significant effect on reserve changes. A positive change in capital flows with respect to the previous year is counteracted by an increase in reserves. The effects of the control variables are in line with previous findings.

5 Conclusion

The empirical analysis supports our hypothesis: The accumulation of foreign exchange may be regarded as an indication of a “fear of capital mobility“ suffered by central banks. First, central banks fear that capital inflows are volatile and subject to sudden reversals. Therefore, they demand reserves as a buffer stock against potential capital flight. Second, central banks accumulate reserves in order to manage net capital flows in the absence of capital controls because they fear the real effects which these capital flows might have on the real exchange rate and thus on the domestic economy.

The second argument differs in an important way from the standard analysis concerning the accumulation of reserves. If the accumulation of foreign exchange is explained as a buffer stock, which will be used to defend the exchange rate in a period of crisis, what matters is the level of reserves. The accumulation of reserves itself has no function and, more precisely, the timing of the accumulation is irrelevant. However, if the objective of the foreign exchange accumulation consists in managing capital flows, the accumulation itself – and its effects – is the target of the central bank policy. The level of reserves does not matter. Only changes in reserves have macroeconomic effects.

These results also affect the literature on the costs and benefits of capital account liberalization. These studies have to take the costs of increased foreign exchange holdings into account when capital account liberalizations are evaluated.

For further research there remains to find out whether this foreign exchange buffer is rational in the sense that countries that accompanied the liberalization of the capital account by an increased level of reserves outperformed less prudent countries in terms of growth and

volatility. Moreover, one could analyse whether the potentially positive effects of a reserve lifejacket are temporary, namely restricted to the process of liberalization, or long-lasting, thus arising also for countries that are known for their open capital account.

In sum, the accumulation of foreign exchange has to be analysed in a broader context. Central banks might deliberately distort the balance of payments. Foreign reserves are not only used to defend the exchange rate in periods of crisis but also to manage capital flows even in periods without major economic disturbances. The liberalization of capital markets is to a certain extent compensated by the accumulation of official reserves. A microeconomic policy distortion – capital controls – is replaced by a macroeconomic one – the accumulation of foreign exchange.

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Figure 1: Reconciliation of the classic policy trilemma in the short run

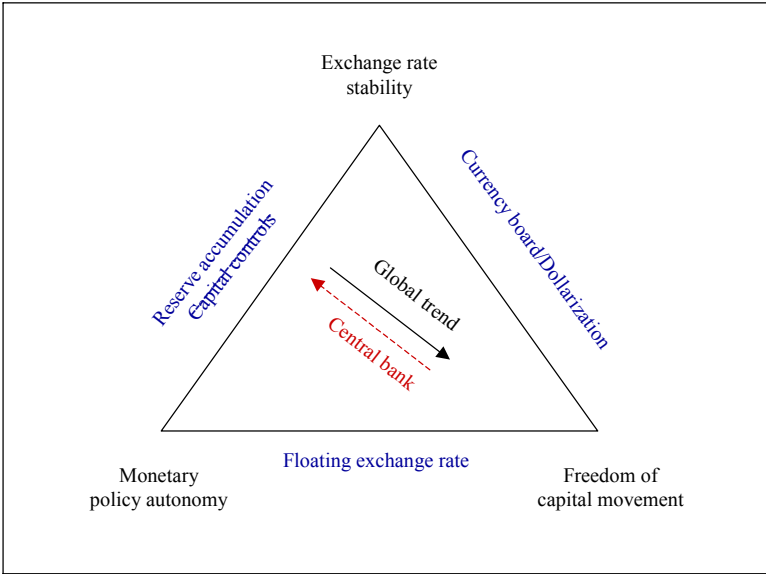
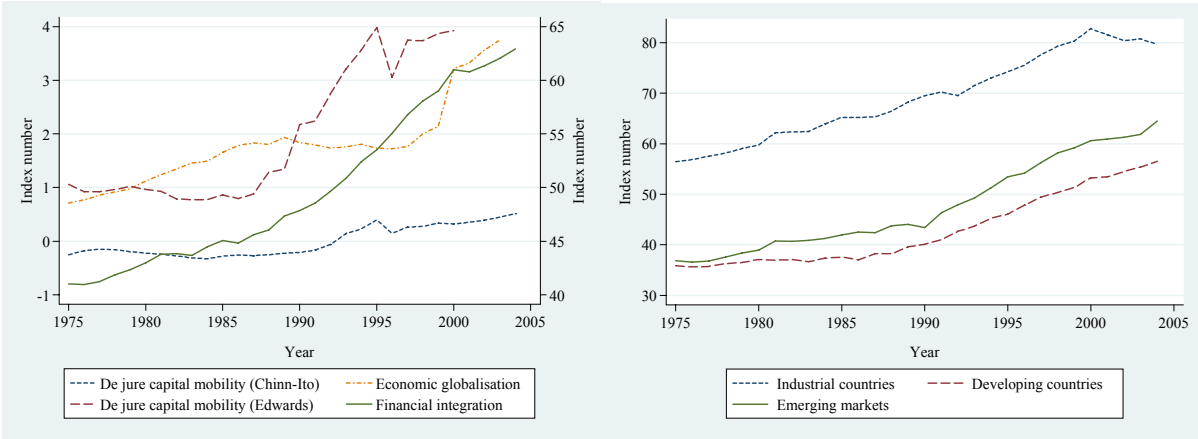
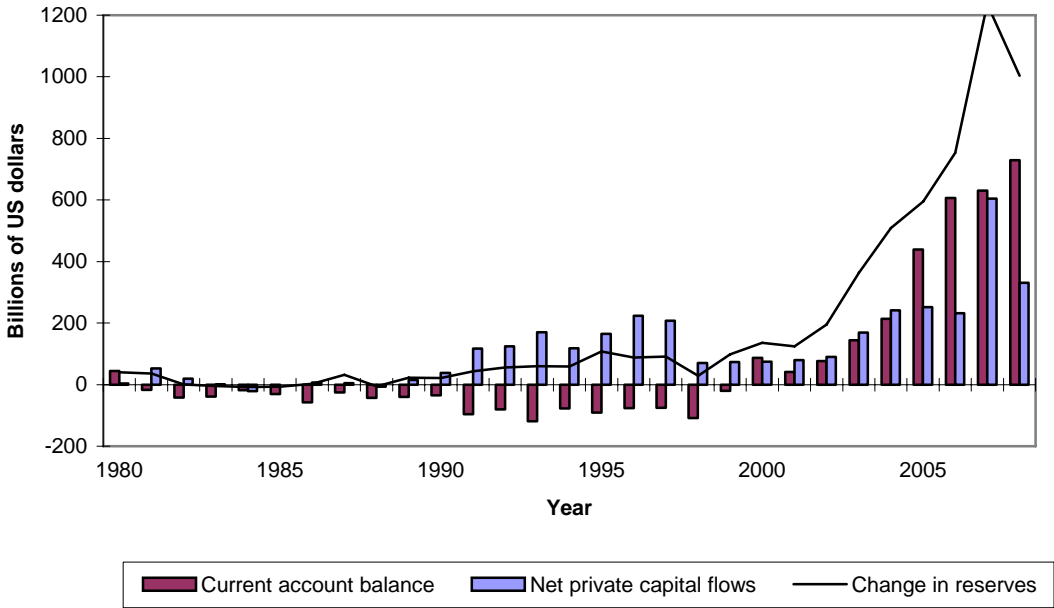


Figure 2: Measures of capital mobility



Note: The scale on the left-hand side axis corresponds to the Chinn-Ito index and the measure for financial integration. For the index of Edwards and economic globalisation the right-hand axis applies.

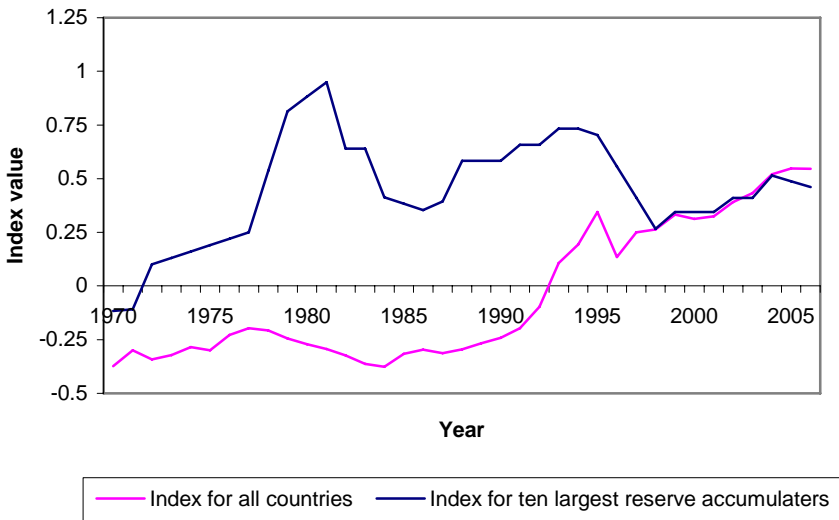
Figure 3: Balance of payments of emerging and developing countries



Data source: World Economic Outlook database, April 2008

Notes: A positive sign in the change of reserves indicates an increase in foreign exchange holdings.
 Net capital flow is equal to the balance of the financial account.
 The data cover 146 emerging and developing countries as well as selected advanced economies (Hong Kong, Israel, Korea, Singapore, and Taiwan Province of China).

Figure 4: Index of de jure capital mobility (Chinn-Ito) and reserve accumulation



**Figure 5: Capital account openness, capital flows and reserve accumulation:
Country examples**

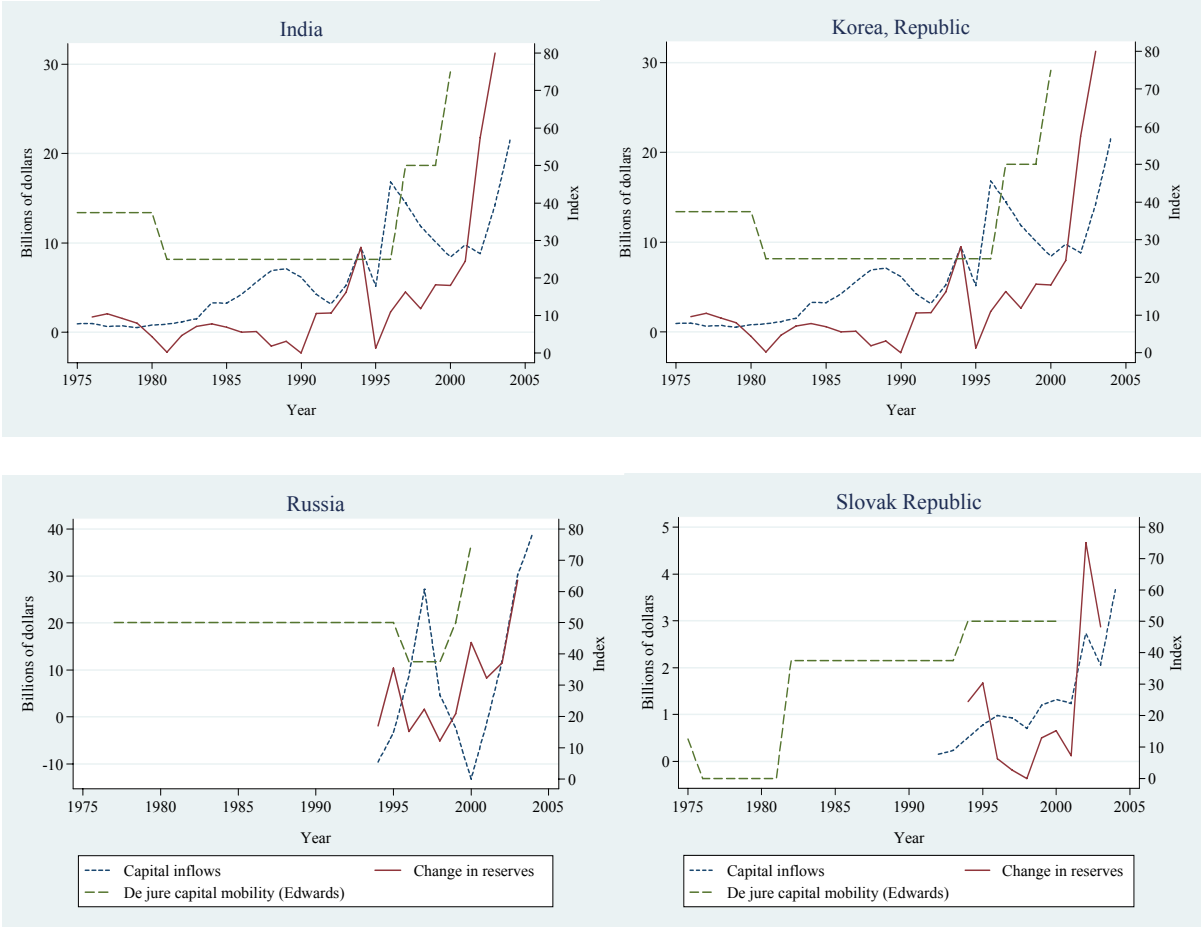


Table 1: Net capital inflow and change in reserves

	World	Emerging-market countries	Developing countries
1975-79		Billions of dollars	
Net capital inflow	608.0	44.0	103.9
Change in reserves	120.4	21.4	34.9
		Percentage of net capital inflow	
Change in reserves	19.8	48.6	33.6
1980-89		Billions of dollars	
Net capital inflow	4093.9	178.7	257.5
Change in reserves	316.6	22.9	33.9
		Percentage of net capital inflow	
Change in reserves	7.7	12.8	13.1
1990-99		Billions of dollars	
Net capital inflow	13033.8	1389.9	1573.9
Change in reserves	838.4	368.0	551.3
		Percentage of net capital inflow	
Change in reserves	6.4	26.5	35.0
2000-2003		Billions of dollars	
Net capital inflow	12467.0	623.2	911.4
Change in reserves	1121.6	539.2	695.6
		Percentage of net capital inflow	
Change in reserves	9.0	86.5	76.3

Note: Net capital inflows are defined as changes of the investment position of foreigners in the domestic economy in the categories direct investment, portfolio investment and other investment. Due to data limitations, investment in financial derivatives is not included although it is a component of the financial account. Since this definition only considers transactions of foreigners, it differs from the financial account (= net capital flows), which additionally takes the transactions of domestic residents into account.

The group of emerging-market countries contains the following countries: Argentina, Brazil, Chile, China, Egypt, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Russia, South Africa, Thailand, Turkey

Table 2: Reserves and capital mobility: Static models

Dependent variable: Reserves/GDP

Estimation method: Fixed effects estimator

	(1)	(2)	(3)	(4)	(5)	(6)
Trade openness	0.0969 (7.54***)	0.1111 (8.45***)	0.0743 (5.16***)	-0.3343 (-1.49)	0.0751 (6.15***)	0.1079 (6.27***)
Total external debt (per cent of GDP)	0.0389 (6.19***)	0.0378 (5.99***)	0.0468 (6.67***)	-0.1721 (-5.67***)		0.0147 (1.97**)
Short-term external debt, lagged (per cent of GDP)	-0.1880 (-8.16***)	-0.1722 (-7.31***)	-0.1926 (-7.63***)	-0.0497 (-1.31)	-0.1341 (-5.19***)	-0.1336 (-6.17***)
Monetary disequilibrium (excess money supply)	-0.0020 (-1.53)	-0.0020 (-1.88*)	-0.0030 (-1.18)	-0.0007 (-0.32)		-0.0014 (-0.85)
De jure capital mobility (Chinn-Ito)		0.0134 (5.46***)				
De jure capital mobility (Edwards)			0.0006 (3.71***)			
Financial openness				0.1606 (6.74***)	0.0240 (4.38***)	
Economic globalisation						0.0021 (7.11***)
Number of countries	119	119	112	95	103	72
Number of observations	2007	1911	1475	1570	2253	1313
R ² (overall)	0.04	0.08	0.08	0.31	0.13	0.17

Notes:

t-statistics (in brackets) computed with heteroskedasticity-consistent standard errors.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 3: Reserves and capital mobility: Dynamic models

Dependent variable: Reserves/GDP

Estimation method: Difference GMM estimator (Arellano-Bond)

	(1)	(2)	(3)	(4)
Lagged endogenous variable	0.7156 (10.89***)	0.7307 (10.69***)	0.7697 (18.45***)	0.7750 (15.10***)
Trade openness	0.0620 (4.42***)	0.0521 (2.92***)	0.0107 (0.77)	0.0515 (3.33***)
Total external debt (per cent of GDP)	0.0211 (4.17***)	0.0232 (3.87***)		0.0229 (5.10***)
Short-term external debt, lagged (per cent of GDP)	-0.0601 (-3.41***)	-0.0525 (-2.32**)	-0.1074 (-2.90***)	-0.0552 (-4.24***)
Monetary disequilibrium (excess money supply)	-0.0002 (-0.76)	-0.0013 (-0.82)	-0.0002 (-0.85)	-0.0002 (-1.45)
De jure capital mobility (Chinn-Ito)	-0.0020 (-0.54)			
De jure capital mobility (Edwards)		0.0003 (1.93*)		
Financial openness			0.0346 (3.58***)	
Economic globalisation				0.0007 (0.91)
Number of countries	118	109	94	70
Number of observations	1740	1318	1428	1194
Sargan Test (p-level)	1.0	1.0	1.0	1.0
Arellano-Bond-Test (p-level)	0.97	0.96	0.79	0.66

Notes:

t-statistics (in brackets) computed with heteroskedasticity-consistent standard errors.

As recommended by Arellano and Bond in the case of finite samples, the coefficients are obtained from a two-step estimation, whereas the t-statistics are based on the one-step standard errors.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4: Reserves and capital mobility: the domestic component

Dependent variable: Reserves/GDP

	(1)	(2)	(3)	(4)	(5)
Lagged endogenous variable				0.7585 (14.80***)	0.7909 (17.25***)
Trade openness	0.0999 (10.03***)	0.1028 (10.15***)	0.0751 (5.26***)	0.0502 (4.09***)	0.0554 (3.33***)
Total external debt (per cent of GDP)	0.0269 (5.60***)	0.0301 (6.13***)	0.0188 (3.07***)	0.0170 (4.21***)	0.0161 (5.01***)
Short-term external debt, lagged (per cent of GDP)	-0.1688 (-8.30***)	-0.1544 (-7.48***)	-0.1397 (-6.32***)	-0.0819 (-2.85***)	-0.0577 (-2.43**)
M2 (per cent of GDP)	0.0003 (3.84***)	0.0003 (3.83***)	0.0385 (3.44***)	0.0000 (0.29)	0.0328 (2.01**)
De jure capital mobility (Chinn-Ito)		0.0154 (8.72***)		0.0032 (1.05)	
Economic globalisation			0.0021 (9.37***)		0.0009 (1.51)
Number of countries	129	129	77	129	75
Number of observations	2685	2519	1801	2311	1641
Method of estimation	Fixed effects	Fixed effects	Fixed effects	Difference GMM (two step)	Difference GMM (two step)
R ²	0.08	0.11	0.22		
Sargan Test (p-level)				1.0	1.0
Arellano-Bond-Test (p-level)				0.60	0.68

Notes:

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

Table 5: Management of capital flows

Dependent variable: Changes in reserves

Estimation method: Fixed effects

	(1)	(2)	(3)	(4)
Net capital flows (excluding central bank)	0.0054 (1.06)	0.0059 (1.17)	0.0058 (1.12)	0.0059 (1.18)
Δ M1		0.0452 (1.98**)		0.0351 (2.02**)
Monetary disequilibrium (excess money supply)			-0.0027 (-3.01***)	-0.0024 (-3.13***)
Currency crisis, dummy				-700.17 (-1.67*)
Number of countries	174	168	159	158
Number of observations	3479	3220	2660	2618
R ² (overall)	0.00	0.14	0.26	0.30

Notes:

t-statistics (in brackets) computed with heteroskedasticity-consistent standard errors.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 6: Management of capital inflows: Asymmetric effects

Dependent variable: Changes in reserves

Estimation method: Fixed effects

	(1)	(2)	(3)	(4)
Capital inflows (excluding central bank)	0.0095 (1.96**)	0.0081 (1.67*)	0.0094 (1.91*)	0.0097 (2.04**)
Capital outflows (excluding central bank)	-0.0251 (-0.92)	-0.0106 (-0.38)	-0.0227 (-0.77)	-0.0216 (-0.73)
$\Delta M1$		0.0451 (1.97**)		
Monetary disequilibrium (excess money supply)			-0.0027 (-3.01***)	-0.0027 (-3.00***)
Currency crisis, dummy				-730.05 (-1.69*)
Number of countries	174	168	159	159
Number of observations	3479	3220	2660	2660
Adjusted R ² (overall)	0.00	0.14	0.26	0.26

Notes:

t-statistics (in brackets) computed with heteroskedasticity-consistent standard errors.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 7: Management of capital flows: Changes in net capital flows

Dependent variable: Changes in reserves

Estimation method: Fixed effects

	(1)	(2)	(3)	(4)
Δ net capital flows	0.0209 (1.88*)	0.0182 (1.70*)	0.0197 (1.76*)	0.0186 (1.77*)
Δ M1		0.0445 (1.95*)		0.0343 (1.98**)
Monetary disequilibrium (excess money supply)			-0.0027 (-3.00***)	-0.0024 (-3.13***)
Currency crisis, dummy				-768.81 (-1.96**)
Number of countries	174	168	159	158
Number of observations	3383	3133	2611	2573
Adjusted R ² (overall)	0.00	0.14	0.26	0.30

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

Note: Countries marked with an asterisk belong to the group of emerging-market countries.

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.
Trade openness	World Bank (2005a)	Openness is defined as the sum of exports and imports divided by GDP. Data are expressed in per cent.
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 external 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.
M1	IMF (2008)	Money (line 34 IFS) is the sum of currency outside banks and demand deposits (excluding those of the central government). Data are in millions of current national currency.
M2	IMF (2008)	M2 is the sum of M1 and quasi money. Quasi money (line 35 IFS) is defined as the sum of time, savings and foreign currency deposits of residents (excluding the central government). Data are in millions of current national currency.
Interest rate (money market)	IMF (2008)	Money market rate (line 60b IFS): interest rate on short-term lending between financial institutions, measured in per cent.

Appendix B (continued)

Variable	Source	Description
De jure capital mobility (Chinn-Ito)	Chinn and Ito (2002, 2006)	Measure of the de jure openness of the capital account. Calculation is based on the binary dummy variables of the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAR).
De jure capital mobility (Edwards)	Edwards (2007)	Index that combines the measures from Quinn (2003) and Mody and Murshid (2002) [both are based on the information provided by the AREAR] and information from country-specific sources
Financial openness	Lane and Milesi-Ferretti (2007)	Sum of total external assets and liabilities divided by GDP.
Economic globalization	Dreher (2006)	Index based on actual flows of goods and capital and restrictions concerning these flows.
Net capital inflows	IMF (2008)	Financial account (IFS line 78bjd) is defined as the difference of net capital inflows (investment from domestic residents abroad) and net capital outflows (investment from foreigners in the domestic economy). It comprises direct investment, portfolio investment, financial derivatives and other investment.
Currency crisis, dummy	Own calculations	The identification of a currency crisis is based on an exchange market pressure index. The calculation follows the procedure as described in Eichengreen et al. (1996).